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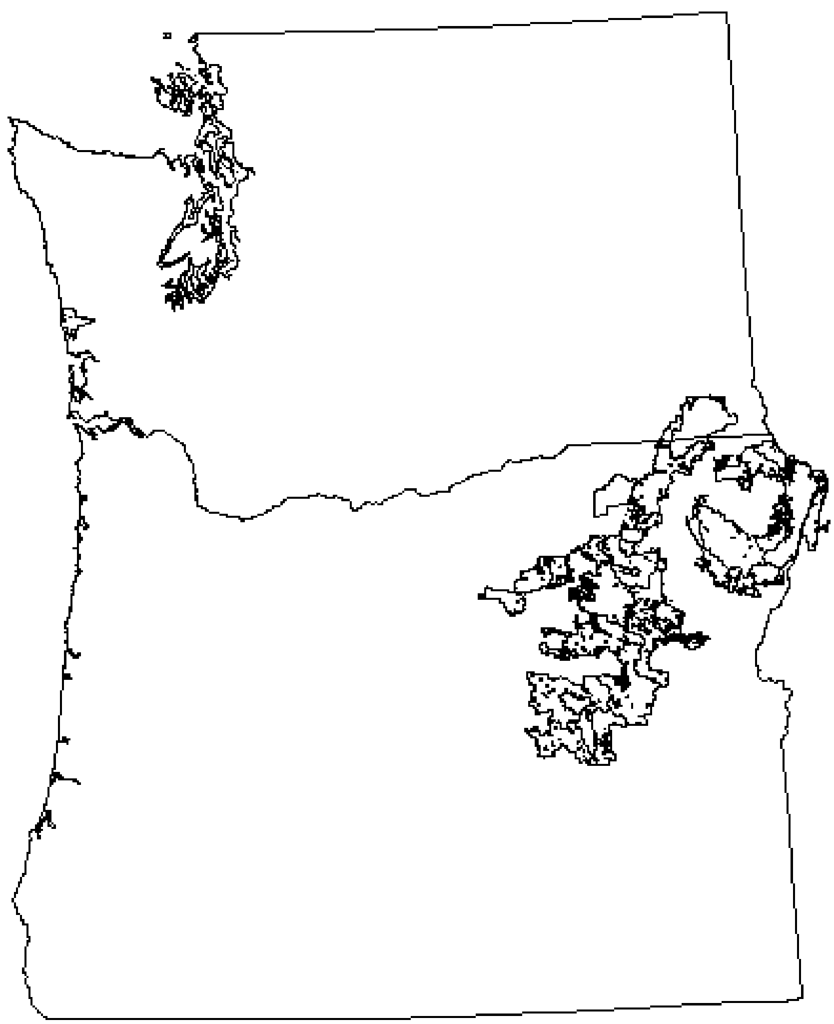
A Rationale and Procedure For Determining Imminent Susceptibility of Stands to Insects in the Blue and Wallowa Mountains of Southeastern Washington and Northeastern Oregon



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Caring for the Land and Serving People

A Rationale And Procedure For Determining Imminent Susceptibility Of Stands To Insects In The Blue And Wallowa Mountains Of Southeastern Washington and Northeastern Oregon

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Introduction

Forest management operations often necessitates the removal of green trees along with the salvage of dead and dying trees to improve stand health and reduce susceptibility to insects, diseases, and fire. This action is preventative in nature when there is imminent risk of tree mortality from these agents. It removes trees already dead, or in the process of dying because of current infections with diseases or infestations of insects (bark beetles, defoliators, etc.), or because stocking levels, stand composition, and conditions of the stand create the likelihood that trees within the stand will be killed by insects or other agents within a modest period of time (i.e., imminently susceptible). Smith (1962) describes the purpose of salvage cuttings as

> **". . . made for the primary purpose of removing trees that have been or are in imminent danger of being killed or damaged by injurious agencies other than competition between trees. The kind of salvage cutting easiest to visualize is that aimed at capturing the highly perishable values in trees that are seriously damaged, dying, or already dead. A more sophisticated variant, sometimes called presalvage cutting, is that designed to anticipate damage by removing highly vulnerable trees. Sanitation cuttings involve the elimination of trees**

> **that have been attacked or appear in imminent danger of attack by dangerous insects and fungi in order to prevent these pests from spreading to other trees."**

Recent legislation (Public Law 104-19) known as the "Rescission Bill" contained a "salvage rider" for an emergency salvage timber sale program that accelerated the removal of dead, damaged, down, disease- or insect-infested trees, or those killed by wildfire, from federal lands.

The legislation specifically defined the conditions under which a salvage timber sale might fall under Section 2001(b), the Emergency Salvage Timber Sale Program section of the Law as:

> **". . . a timber sale for which an important reason for entry includes the removal of disease- or insect-infested trees, dead, damaged, or down trees, or trees affected by fire or imminently susceptible to fire or insect attack. Such term also includes the removal of associated trees or trees lacking the characteristics of a healthy and viable ecosystem for the purpose of ecosystem improvement or rehabilitation, except that any such sale must include an identifiable salvage component of trees described in the first sentence."**

The intent and policy direction provided in the Interagency Memorandum of Agreement on Timber Salvage Related Activities Under Public Law 104-19 and associated interagency guidelines (MOA), was further clarified in a July 2, 1996 Memorandum from The Secretary of Agriculture. Point 6(a) of that memorandum stated:

> **"Trees "imminently susceptible to insect attack" are trees in areas that have a high risk of incurring insect attack (as determined by a risk rating system as appropriate) and an anticipating change in stand structure or character in 3 years or less."**

The difficulty in accurately determining which stands may be imminently susceptible to insects--bark beetles in particular--has been compounded by this last point of clarification. Hence, this document has been prepared in order to help foresters risk-rate stands and determine with reasonable prudence those stands that are imminently susceptible to insect attacks, and would result in altering stand structure or character in 3 years or less.

Rationale and Discussion

One could argue that it is impossible to determine that any particular stand will be attacked by insects, let alone **when** it will be attacked; and in part, they might be right, given the complexity of factors involved. However, research studies, coupled with years of field observations and experience of professional entomologists all across the West, have provided a good degree of confidence in using procedures for risk-rating the susceptibility of stands to insects when given sets of variables or conditions are met, specific for the particular insect under consideration.

This document is not an attempt to describe the various risk-rating methods available for all the potential insects that could affect stand composition and structure, nor is it summarization of reports describing the conditions under which stands develop susceptibility to insects. Rather, the purpose is to provide some basic principles regarding insect susceptibility gleaned from literature and professional experience, develop the rationale behind a general risk-rating procedure, and finally, describe the risk-rating procedure to help identify imminently susceptible stands.

Some Principles of Insect Susceptibility

In consideration of a forest stand encompassing a variable range of acres from tens of acres to thousands of acres, the degree, or imminent susceptibility of the stand to insects, regardless of size, is related to both factors of the stand and factors of the insect population. Keen (1958) recognized the combined importance of biological factors that favor development of a large population of beetles, and need for a quantity of susceptible host for development of bark beetle outbreaks, in that lacking either of these two ingredients outbreaks fail to develop. Each of these factors are briefly examined in the following discussion, and will be developed further later for the purpose of determining imminent susceptibility of stands to insects.

1. Stand Factors.

The tree species comprising a stand varies with regard to susceptibility to insects. Inherited factors of any given species of tree, and environmental influences determine the susceptibility of the tree to attack by insects (Graham 1963). Inherited factors generally have to do with the chemical and physical properties of trees that either induce insect attacks or prevent or repel attacks by insects. For example, the chemical composition of trees, especially with regard to the terpenes--the volatile fraction of oleoresin, has a great influence on bark beetles in particular. Certain monoterpene hydrocarbons are attractive to insects while others may repel. Concentrations and the volatile hydrocarbon composition of trees may elicit attack by a bark beetle species or influence some other behavioral response. Certain of these volatile compounds are primary attractants for bark beetles that respond to host tree odors during initial host-finding attacks on injured and weakened trees. In addition, the resin itself may help protect trees from insect attack by physically pitching beetles out or disrupting attack by infiltrating egg galleries in those tree species containing these protective mechanisms. The oleoresin exudation pressure and various properties of the resins produced in trees as defensive mechanisms vary considerably among species, within the geographic distribution of a single tree species, and over diurnal or seasonal periods (Barbosa and Wagner 1989).

Trees may be predispositioned to attack by insects by various factors resulting in abnormal susceptibility to insects (Graham 1963). Often trees that are injured or forced into a state of stress from factors such as drought (Craighead 1925; St. George 1930), disease (Barbosa and Wagner 1989), wind (Jacobs 1936), fire (Barbosa and Wagner 1989), temperature (Barbosa and Wagner 1989), defoliating insects (Gast et al. 1991; Graham 1963), and overstocking or competition (Barbosa and Wagner 1989; Gast et al. 1991) become high risk to attack by bark beetles. Overstocking in pine stands, is especially important to the susceptibility of trees to bark beetles such as mountain pine beetle, *Dendroctonus ponderosae*, western pine beetle, *D. brevicomis*, and pine engraver, *Ips pini*.

Tree age and diameter are also factors related to the susceptibility of trees to insects. As trees age, changes in physical and biochemical condition occur that affect tree vigor (Barbosa and Wagner 1989). Bark beetles apply host selection criteria based on cues that reflect the host tree's age and size. For example, bark (or phloem) thickness significantly influences colonization and survival of mountain pine beetle in lodgepole pine (Amman, 1972); hence, tree diameter is an important host selection factor for this beetle because larger diameter trees contain thicker bark. Many bark beetles favor trees of older ages, while others may favor young trees. Overmature trees that manifest slow growth and poor vigor generally are more susceptible to bark beetle attack than their more vigorous neighbors. In light of this, bark beetles sometimes play an important ecological role in determining forest plant succession. For many forest stands there seems to be an "entomological" rotation age beyond which heavy timber losses may be expected as a result of bark beetle attack. The lodgepole pine and western white pine/mountain pine beetle models illustrates this well. Lodgepole and western white pine stands are relatively immune to mountain pine beetle attack for the first 50 years. Then they become increasingly susceptible up to 100 years of age. From 100 to 150 years of age they are extremely vulnerable to being swept by a mountain pine beetle epidemic, which will leave only a few highly resistant individuals to act as seed for the new stand (Keen 1956).

Site quality can affect tree health, which is closely allied with vigor. Low site quality resulting from insufficient plant nutrients and minerals or moisture limits potential tree growth, and leads to overall poor stand vigor and poor tree health. As with other living organisms, a sick or weakened individual is much less resistant to parasitic or pathogenic organisms and adverse environmental influences than a normal one. Trees that are unhealthy have increased susceptibility to insects. Where site resources are limited, competition between trees for limited resources often leads to bark beetle attack. High quality sites can support higher stocking levels without trees becoming susceptible to insects, because the threshold of limiting site resources is higher on these sites than on poor quality sites; hence, tree vigor as indicated by relatively rapid production of bolewood remains high for a longer period of time over the life of the stand. Trees producing small quantities of stemwood per square meter of foliage are more susceptible to bark beetles like mountain pine beetle than trees producing larger quantities of stemwood (Waring and Pitman 1980). As beetle epidemics increase in intensity, tree vigor becomes decreasingly important. During the height of bark beetle epidemics very few trees are immune to attack.

Stand density is one of the most important factors influencing certain insect populations. Conditions within the stand that favored habitat for some insects like the bark beetles of the genus *Dendroctonus* are regulated to a great extent by stand density. These beetles prefer attacking stands in a more or less closed-canopy condition. Bartos and Amman (1989) found that microclimatic changes resulting from thinning lodgepole pine stands resulted in higher light and temperature levels, and more wind movement beneath the canopy, and under these conditions mountain pine beetles would not arrest flight and attack trees. When stands become too dense, tree competition increases leading to stand stagnation and development of a suppressed class of trees (Cochran et al. 1994; Keen 1958). Bark beetles typically build up populations under these stand conditions as nature's way of relieving this pressure (Keen 1958).

In mixed conifer stands containing high stand densities and multi-storied canopies composed of predominantly true firs and Douglas-fir, western spruce budworm, *Choristoneura occidentalis* and Douglas-fir tussock moth, *Orgyia pseudotsugata*, populations may develop to outbreaks when favorable conditions exist for their increase, especially in the drier pine communities. These conditions provide favorable habitat for defoliators and provide ideal conditions to ensure their survival, particularly during dispersal stages (Carlson 1987; Carlson and Wulf 1989). The juxtaposition of host trees to one another in an overstocked stand increases the probability that larvae dispersing from higher canopy layers will alight on a target of host foliage, and will waste little energy finding a suitable source of food. Moreover, less time is spent exposed to natural enemies, increasing survival chances when larvae avoid wandering around in search of food and shelter within foliage.

2. Biological Factors Influencing Insect Populations.

Insect populations are ever-present in forests at endemic levels, usually causing mostly inconspicuous damage to trees, or killing an occasional widely-scattered tree on the landscape. These normally low levels of insect depredation of trees contribute to process and function of healthy forest ecosystems. Stands--though they may be susceptible to insects--are normally not "imminently" susceptible because insect populations are extremely low and not presently a threat to these stands. Over the long-term, though, because they may soon be "set-up" for outbreak, or develop into a more susceptible and unstable condition, stands may become imminently susceptible with time, and under the right conditions in which the overall environment is optimal for a given species. Hence, populations of insects can, and do, fluctuate over time; being inconspicuous most of the time, but increasing to conspicuous, precipitous levels at certain other times. Wallner (1987) pointed this out when he noted that "populations of organisms are never truly stable, but rise from some low density and then fall to approximately their original size." It was noted earlier, that certain factors favor the development of insect populations. Some of these factors are physical (climate, temperature, light, moisture, wind, etc.); others are biological (availability of insects and their capacity to reproduce, relative aggressiveness of the insect, natural control factors, quality and abundance of food supply, etc.); others still may contain both physical and biological properties that affect insect populations (e.g., conditions of host trees and stands). The previous section discussed several of the primary host and habitat conditions affecting the insect--the physical environment within or upon which the insect lives. This section examines some of the biological-related factors that affect insect numbers.

Whether considering bark beetle populations or defoliating insects, both groups cannot increase to significant numbers without an abundant supply of food. It should go without saying that population increase, growth, and survival are dependent upon a supply of both a susceptible and suitable source of food. While suitable host tree species for a particular insect or group of insects may exist in a stand, these trees may not contribute to an increase in populations of insects because they are not susceptible due to any number of reasons. A simple example serves to illustrate this. Earlier, the example was given of age and diameter of lodgepole being important in relation to mountain pine beetle habitat. Bark thickness of older, larger diameter trees is the critical factor to successful brood production by mountain pine beetles in this host. A stand composed of mature (80+ year-old) lodgepole pine, with an average diameter of 10 inches d.b.h. (diameter breast height) and stocked at 120 sq. ft. of basal area per acre is a stand that contains suitable host trees, and also may be susceptible to beetle attack because of the low vigor and slow-growth of overcrowded trees, and microclimatic conditions of the stand. By contrast, a different lodgepole pine stand composed of 4 inch d.b.h. poles stocked at 80 sq. ft. of basal area per acre is neither suitable (trees are too small in diameter to support beetle brood) nor susceptible to mountain pine beetles (does not show low vigor/poor growth because stand is not overstocked with mature trees competing for limited resources). However, if the latter stand contained 8-inch d.b.h. trees, other things being equal, it would now contain a suitable class of trees, but would still not be susceptible to beetles because the site is still capable of supporting the level of stocking.

The availability of insects within, or in relative close proximity to a stand, is an important factor governing the fluctuation of insect numbers, and ultimately determining the degree of risk of a stand being attacked by insects. However, the changes in population size on a given area is a bit more complicated than that. Size of populations are determined by factors that either result in an increase or a decrease in the numbers of individuals making up a given population. Coulson and Witter (1984) identify three population processes important in regulating population size: (1) *natality* (birth rate), (2) *mortality* (death rate), and (3) *dispersal*. By applying these three processes it is possible to describe net changes in population size, since populations increase in size through reproduction (births), and dispersal into an area (immigration) and decrease in size through mortality (deaths) and dispersal out of an area (emigration) (Coulson and Witter 1984). Given this model, under favorable environmental conditions and provided a large enough supply of food, bark beetles will disperse (immigrate) into an area through pioneering flights of unmated adults, or through attraction to pheromones produced by pioneering adults, and breed in the susceptible host trees producing a new generation (births). Numbers of beetles may increase rapidly, and though losses of individuals occur through mortality (deaths) and dispersal (emigration) of the new generation that is produced, the net change in population size often is one of increase, perhaps to epidemic levels. Populations decline when mortality and dispersal from an area exceeds natality and dispersal into the area.

Keen (1938) lists the vigor of bark beetle species and strains as one of the factors influencing the production of bark beetle populations. This topic has not been fully explored, but we know that certain bark beetles exhibit more aggressiveness than others. When populations build up some beetles aggregate mass attacks on trees enabling them to kill healthy, green trees. These beetles possess higher tolerance to host terpenes that comprise the defensive chemicals of trees, or their fungal symbionts are moderately to highly pathogenic to their host trees, or their aggregation pheromones exhibit a high degree of attractiveness for the species (Berryman 1986). These factors sometimes operate in combination, enabling beetles to easily kill healthy trees during aggressive stages of their host selection and attack behavior. Given differences in bark beetle vigor and aggressiveness, species of concern in the Blue and Wallowa Mountains may be ordered by aggressiveness from most aggressive to least aggressive in roughly the following manner: mountain pine beetle, spruce beetle, Douglas-fir beetle, pine engraver, western pine beetle, and fir engraver. It should be noted, however, that any one of these species may become relatively more aggressive when host and environmental conditions are optimal for their rapid increase.

Insects usually have a relatively large complex of natural control agents and factors that help modify population size or regulate insect numbers. Some factors are abiotic in nature, but most others are biotic. These agencies are responsible for preventing natural populations from ever reaching their full biotic potential or carrying capacity in their environment. Coulson and Witter (1984) listed a number of mortality factors limiting population size: (1) climate and weather, (2) food quality and quantity, (3) host susceptibility and habitat suitability, (4) predation, (5) parasitization, (6) disease, (7) competition among individuals of the same species (intra-specific competition), (8) competition between members of different species (intraspecific competition), and (9) genetic defects. Absence of these control factors favors population build-up (Keen 1958). Natural control factors such as predators, parasites, and diseases are usually at low levels when insect populations begin to build. In time, these mortality factors respond to increased density of the host insect and help to bring about a decline in their numbers.

Weather and environmental conditions, though not biotic factors, can have great influence on insect populations. Each species of insect possess a range of conditions which could be considered optimum for their breeding, development, and survival. For example, the optimum temperatures for most species range between 50^{o} F and 80^{o} F (Keen 1958). Generally, warm, dry years favor the production of most species of insects--they develop through different life stages more quickly and are exposed to natural enemies for shorter periods of time than under other conditions. This factor, in concert with the stress of severe drought can have on the host tree tends to favor insect populations over the host. By contrast, cold, wet years tend to discourage insect populations. Extremely cold temperatures for prolonged periods of time often have deleterious effects on overwintering insect populations, though many insects have quite a capacity for recovery after a few seasons.

Development of a General Risk-Rating Procedure to Determine Imminent Susceptibility

Having described some factors involved in the susceptibility of trees to insects, this information can now be applied in developing a general risk-rating procedure for stands. There are clearly factors about the host tree, the site it grows on, the interactions of host-plant or stand of host-plants and insect, and the insect itself that need to be considered in developing such a procedure.

The risk-rating system is a "penalty" type system in which penalty values are assigned for each factor and summed to obtain a "composite score" for the stand. This composite score is looked up in a "stand classification table" for the insect species in question, and the "degree of imminence" of the stand to insects is obtained. Stands that rate out as "borderline" are stands that could, and will eventually be attacked by insects in the future, but the probability of an infestation within a 3-year timeframe is somewhat lower than stands that rate out as "imminently susceptible." Rating of individual factors of any given stand can change in a short period of time. It should not be assumed that borderline stands automatically are excluded from consideration in a salvage sale because other factors such as disease levels, fire risk, and overall stand health should also be considered in accordance with Secretary of Agriculture direction (Memorandum dated July 2, 1996). This rating is strictly for insects and does not rate stand conditions in terms of these other components.

The following paragraphs discuss the factors that contribute to risk-rating stands for imminent susceptibility to insects.

1. Stand Susceptibility.

Site quality varies considerably across the Blue and Wallowa Mountains. Each site and its environment has a capability of providing a defined plant community (Johnson and Clausnitzer 1992). In any given plant community, tree growth is governed by the tree's inherited genetic traits expressed in response to the environmental conditions of the site upon which it grows.

Insects sometimes associate more closely with certain plant communities than others because their favored host plant occurs there in relative abundance. Moreover, if site resources are limited by competition of vegetation, and suitable and susceptible hosts occupy the stands in fully stocked or overstocked condition, insect populations may build to become epidemics and cause high levels of tree mortality on these sites.

The availability of growing space to individual trees in stands is an important factor governing tree and stand vigor (Cochran et al. 1994). These conditions are important in determining stand susceptibility to insects--bark beetles in particular. Growing space for individual trees occupying a particular site, then, is partly a function of the carrying-capacity of the site, and is closely linked to the insect populations that might utilize tree species occurring on the site when growing space is limited.

Since trees may occupy the growing space of a site at different levels, it has been easy for entomologists and foresters to assess the relative susceptibility of a stand to bark beetles by measuring the basal area of trees occupying a stand on a per acre basis, and compare that basal area with a uniform "beetle-risk" threshold stocking level to gauge relative departures from the threshold. While this works well in general, it does not take into account site quality and productivity differences inherent to different plant associations. Sites differ greatly in their capability to support tree stocking, and therefore have differing thresholds of insect risk. Moist sites generally are capable of supporting higher stand densities than dry sites, and their plant assemblages differ as well. Habitat for insects often will vary by these plant associations. For example, a host tree component favored by an insect species in a warm, dry forested setting, may not occur in a cold, dry type; thus, risk levels for that particular insect are quite different in either case, based on species composition alone.

But species composition is only one of the factors important in stand susceptibility to insects. Other factors were discussed in the previous section. Going back to further consider the issue of growing space, however, helps identify another important susceptibility factor--namely, stand density. Cochran et al. (1994) have developed a method for estimating the upper stocking limits for managed stands of various species and species mixes in different plant associations. Their method facilitates the evaluation of inherent differences in site occupancy of different plant associations to take into account growing stock levels that could be sustained while avoiding significant losses from competition mortality and insect-caused mortality. By defining upper density limits or management zones (UMZs) for each species within each different plant association, the desirable tree species could be managed so that a suppressed class of trees never develops and potential production of the site would then shift to fewer, larger trees, thereby reducing mortality and allowing capture of more of the potential growth by trees to meet specific resource objectives (Cochran et al. 1994).

I have chosen to include the suggested stocking levels by plant association (see Cochran et al. 1994) in the risk-rating procedure for imminent susceptibility to insects because it more accurately reflects the thresholds for beetle susceptibility of given hosts by specific plant associations in the Blue and Wallowa Mountains, than any other procedure currently available. The UMZ is expressed as Stand Density Index (SDI), which is the number of trees per acre when average stand diameter is 10 inches (Quadratic Mean Diameter Breast Height). Upper management zones are set at 75 percent of "normal" or "full" stocking. Cochran et al. (1994) also defines the lower density limits or management zones (LMZ) for the same plant associations. Lower management zones are also expressed as SDI and are set at 50 percent of normal density. Standard practice is to manage stands between the UMZ and LMZ for the stand, and given plant association. When density exceeds the UMZ, tree mortality from insects can become serious. Accordingly, for this factor in the risk-rating system, I have assigned increasing levels of penalty values for increasingly higher levels of SDI relative to UMZ.

2. External Beetle Pressure (Last Year).

This is the first of several components in the risk-rating system that take into account the available population of beetles described by Keen (1958). Shore and Safranyik (1992) point out that if there is no source of beetles to move into a susceptible stand, it has a low likelihood of damage even though it may be very susceptible, whereas a marginally susceptible stand in the path of a raging epidemic may experience heavy damage. For this reason I have included a component that takes into account external sources of beetles to the stand being rated. Bark beetles are capable of sustained periods of flight. It is not uncommon for beetles to appear in stands where previously not present, many miles from the source (Schmid and Frye 1977), so external populations pose a real threat to a susceptible stand. Most bark beetles usually fly no more than 3-5 miles or so, if even that, before finding a breeding habitat, so I have included risk components ranging from less than 0.25 miles to greater than 2.0 miles in the risk-rating system. Closer populations are greater threat to stands than those further away; thus, populations close by are given higher penalty values.

3. Internal Beetle Pressure (Last Year).

This component penalizes the stand based on the number of infested trees from the previous year. Greater numbers of trees killed equate to larger populations of beetles, and greater tree killing during the current year of stand examination for risk rating. Higher ratings are given for stands with greater numbers of trees killed by beetles. The risk levels range from less than 3 trees to greater than 10 trees killed.

4. Current Beetle Pressure.

This is a component to take into account current beetle populations in trees on the stand. Presence of beetles in the stand will be larger than numbers the year before in increasing populations as indicated by greater numbers of infested green trees. The penalty values increase with increasing numbers of current-infested trees. The standards range from less than 10 trees to greater than 50 trees for this risk component.

5. Stand Size.

The size of the stand being rated is important because smaller populations of beetles can have a greater overall impact on small stands than on large stands. A small stand that is currently infested with beetles could be wiped out in a matter of a few years if it contains a highly susceptible component of host trees. Larger stands would incur less mortality under the same conditions. Accordingly, large stands would be rated with lower penalty than small stands. Standards for risk-rating this component range from greater than 100 acres to less than 40 acres.

6. Bark Beetle Species Aggressiveness.

As indicated in discussions above, different insect species differ in their relative aggressiveness during an outbreak. Bark beetles like mountain pine beetle and spruce beetle are extremely aggressive and are weighted more heavily with penalty values than less aggressive beetles like fir engraver, western pine beetle, and pine engraver. It's almost a toss-up whether pine engravers are more aggressive than western pine beetle--in some situations they are. However, western pine beetle can sustain outbreaks for longer periods of time than pine engravers. Since both often occur together in the same tree during outbreaks, it matters very little which is more aggressive.

7. Blowdown Habitat.

Blowdown is a very important factor in the development of outbreaks of bark beetles like spruce beetle and Douglas-fir beetle. Most outbreaks of spruce beetle can be attributed to blowdown. Pine engravers usually develop in blowdown and move into tops of larger trees or pole-size thickets nearby, so this is an important habitat for these insects, especially in ponderosa pine. Risk-rating standards for this component range from no blowdown to greater than 5 trees blown down. These values reflect numbers of beetles that could easily initiate a large-scale outbreak during a 2 or 3 year period. Schmid and Frye (1977) report that large spruce blowdown can produce ten times the numbers of beetles that a standing infested tree produces, so this component is critical in terms of its contribution to epidemic beetle populations.

8. Bark Beetle Predisposition--Root Disease and Mistletoe.

Root diseases, and to a lesser extent dwarf mistletoes, predispose trees to insect attack. In some cases, high correlations exist between root disease infection and bark beetle attack: studies in the Pacific Northwest found that greater than 85 percent of all true fir trees attacked by fir engraver also contained one of several different root diseases that infect the true fir species (see Lane and Goheen 1979). Given the significance of root disease over dwarf mistletoes to predisposing trees to insect attack, root disease infections in the stand are given a higher penalty value than dwarf mistletoes.

The composite score rating thresholds used to classify the stand's degree of imminent susceptibility to insects vary for each insect owing largely to the contribution of the beetle aggressiveness component of the score. However, it should be noted that the ratings are done independent of one another so competition does not exist for ratings between different insect species. Also, the scores rated for one species do not affect score ratings of other species. They are completely independent. The absence of rating for defoliators is due to the fact that these insects are quite cyclical in nature of their outbreaks, and neither Douglas-fir tussock moth nor western spruce budworm are due to increase to outbreak levels, based on historical patterns and published models, for several more years, to several decades.

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Blue Mountains Pest Management Zone
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La Grande, Oregon 97850

Report No. BMZ-96-15

July 22, 1996

SCORE

(1) Stand Susceptibility

What is the current SDI[1] for plant association of this stand?

< 50% of UMZ	**(value = 1)**
50-100% of UMZ	**(value = 2)**
> 100% of UMZ	**(value = 3)**

(2) External Beetle Pressure (Last Year)

What is the distance from this stand to the nearest known similar bark beetle infestation occurring outside this stand?

> 2.0 Miles	**(value = 1)**
0.25-2.0 Miles	**(value = 2)**
< 0.25 Miles	**(value = 3)**

(3) Internal Beetle Pressure (Last Year)

How many beetle-killed trees (red-top trees killed last year) occur inside the stand?

< 3	**(value = 1)**
3-10	**(value = 2)**
> 10	**(value = 3)**

[1]Cochran, P. H.; J. M. Geist; D. L. Clemens; R. R. Clausnitzer; D. C. Powell. 1994. Suggested stocking levels for forest stands in northeastern Oregon and southeastern Washington. Research Note PNW-RN-513. Portland, OR: U. S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

(4) **Current Beetle Pressure**

How many current-year (green-infested trees) beetle-infested trees occur in the stand?

< 10	**(value = 1)**
10-50	**(value = 2)**
> 50	**(value = 3)**

(5) **Stand Size**

How many acres in size is the stand?

> 100 acres	**(value = 1)**
40-100 acres	**(value = 2)**
< 40 acres	**(value = 3)**

(6) **Bark Beetle Species Relative Aggressiveness**

What single species of bark beetle currently within the stand (i.e. green-infested trees), or that killed trees in the stand last year (i.e. red-top trees), is causing most of the mortality in the stand?

No Beetles	**(value = 0)**
Fir Engraver	**(value = 1)**
Western Pine Beetle	**(value = 2)**
Pine Engraver	**(value = 3)**
Douglas-fir Beetle	**(value = 4)**
Spruce Beetle	**(value = 5)**
Mountain Pine Beetle	**(value = 6)**

(7) **Blowdown Habitat**

How many ponderosa pines, Douglas-firs or Engelmann spruces have blown down in the stand within the last 18 months?

None	**(value = 0)**
< 5 trees	**(value = 1)**
> 5 trees	**(value = 2)**

(8) **Bark Beetle Predisposition--Root Disease and Mistletoe**

Are root diseases or dwarf mistletoe present in species in the stand that are also affected by bark beetles?

None Present	**(value = 0)**
Dwarf Mistletoe Present	**(value = 1)**
Root Disease Present	**(value = 2)**

STAND COMPOSITE SCORE ________

Stand Classification Table:

Bark Beetle Species	Composite Score Range	Degree of Imminence	Comments
Fir Engraver	< 13 13-14 15-18	None Borderline Imminently Susceptible	Low likelihood of a fir engraver epidemic except in cases of defoliation, drought, root disease, and overstocking.
Western Pine Beetle	< 12 12-14 15-22	None Borderline Imminently Susceptible	Drought stress, root disease, and overstocking predisposes stands.
Pine Engraver	< 16 16-18 19-23	None Borderline Imminently Susceptible	Drought, blowdown, slash, and overstocking predisposes stands.
Douglas-fir Beetle	< 15 15-17 18-24	None Borderline Imminently Susceptible	Drought, defoliation, disease, dwarf mistletoe, overstocking, overmaturity, and logging slash predisposes stands.
Spruce Beetle	< 13 13-15 15-24	None Borderline Imminently Susceptible	Windthrow, logging slash and overmaturity predisposes stands.
Mountain Pine Beetle (ponderosa pine)	< 14 14-15 16-26	None Borderline Imminently Susceptible	Overstocking, root disease, and drought predisposes stands.
Mountain Pine Beetle (lodgepole pine)	< 13 13-14 15-26	None Borderline Imminently Susceptible	Overstocking, drought, and overmaturity predisposes stands.