Report on

# SANITATION-SALVAGE BEETLE CONTROL IN THE PONDEROSA PINE FORESTS OF THE PACIFIC NORTHWEST

Submitted to

Mr. James W. Groshong
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by

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May 23, 1955

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May 20, 1955

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Dear Mr. Groshong:

I have completed the report that you requested for Wr. 227. I am submitting this report to you early with the hope ~~in mind~~ that you will return it to me on or before May 26 so that I may submit it to the School of Forestry for credit in Senior Seminar. Thank you very much.

Sincerely yours,

[redacted]

Norman E. Johnson

This summary is perhaps longer than the length of the discussion warrants

# SUMMARY


Each year bark beetles kill 600-800 million board feet of ponderosa pine in Washington and Oregon. In addition to the direct losses, there may be indirect losses to the community through a reduced annual timber cut, loss of asthetic value, and damage to the watershed.

The most destructive insect enemy of ponderosa pine is the western pine beetle, Dendroctonus brevicomis. The larvae of this small, dark brown to black, stout and cylindrical beetle kill the host trees by their irregular tunneling in the cambium layer. They girdle the tree. Unlike most bark beetles, the western pine beetle shows a definite preference for over-mature and weakened trees. It is from this fact that sanitation-salvage cutting is successful.

In the early days of bark-beetle control, the infested trees were felled and burned or peeled and left in the woods, but because of the high timber prices prevailing today, these practices are no longer considered necessary. ref? With this [This what?] and the habits of the western beetle in mind, Dunning, Keen, Salman, Bongberg and others developed the concept of sanitation-salvage cutting or "beating the beetles to the trees."

Is this the right word? Do you mean "the industry can no longer afford such practices?"

The objectives of sanitation-salvage cutting are usually the following:

1. To Remove live trees highly susceptible to insect attack and thereby reduce current and future insect losses.

2. " Remove merchantable trees that are dead or dying from all causes and thereby salvage timber that would otherwise be lost.

3. " Establish a permanent road system to facilitate future salvage or other cutting operations.

4. " Reduce fire hazard and aid fire control.

The susceptible trees are marked in accordance with the particular tree classification or risk-rating system chosen to be used on a particular area. Most of these are based on tree ages, crown class, needle complement and vigor. Each marked tree is usually plotted on a map to facilitate its future location by the loggers.

~~Due to~~ Because of the comparatively small volumes removed by sanitation-salvage--usually less than 18% of the stand volume--small, portable equipment has proved to be the most successful. But, even (after using the most appropriate equipment,) logging costs can be expected to be from 15-50% greater than those that of ordinary logging. dangler Agr.

If a permanent road system is to be established, special care should be taken to construct roads that will meet specifications designed for long use.

Bongberg found that the cumulative reduction in insect-caused losses was more than 70% for a 10-year period following sanitation-salvage cutting. After the first year the reduction was 90.6%. This shows that the effectiveness is reduced about 2% per year following cutting. In comparison, control by treating only the currently infected trees reduced the losses 90-95% the first year, but this figure dropped to 25% after five years and there was no appreciable reduction ten years after cutting.

On the Pringle Falls experiment it was predicted that the sanitation-salvage treatment would produce a net gain of $1.07 per acre per year.

An area that has been logged by the principles of sanitation-salvage will develop high-risk trees in the future. (Seventeen years after logging on the Blacks Mountain Experimental Forest in California,) dangler the volume of high-risk trees was only 37% as great as the volume of high-risk trees in the original stand.

Sanitation-salvage cutting does not hold all of the answers to bark-beetle control. It is successful only with beetles that show a definite host preference. It may not be economical in stands that are not readily accessible and which are of poor quality. Yet It has proved to be the most successful and economical control method of reducing losses from *D. brevicomis* in the ponderosa pine forests of the Pacific Northwest.

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SANITATION-SALVAGE BEETLE CONTROL IN THE PONDEROSA

PINE FORESTS OF THE PACIFIC NORTHWEST

## INTRODUCTION

### Subject

Each year bark beetles kill over 600 million board feet of timber in the ponderosa pine forests of Washington and Oregon alone. In other pine regions the losses are also great. Orr says that pine beetles destroy 16 times as much timber value as does fire. (12:1) Other authorities place this figure at 3 to 10 times as much. But, even using the most conservative figures, one can readily see that the losses caused by these tiny insects are significant in the management of ponderosa pine forests.

Many control measures have been applied, with varying degrees of success, to combat the bark beetles. Sanitation-salvage cutting has proved to be one of the best control measures yet devised. Sanitation-salvage may be defined as "beating the beetles to the trees." (8:187) For many years authorities have noted that the western pine beetle showed preference for over-mature and weakened trees. It is from this fact that sanitation-salvage has proven successful. [Cut the susceptible trees and utilize them before the beetles destroy them.] Don't give directions

### Purpose

The purpose of this report is to emphasize the importance of losses

See last sentence of your beginning summary.
Proven common nowadays only in legal context

from bark beetles; to give a brief description and explain the habits of the most destructive pine bark beetle; to explain the concepts of bark beetle control; and to show why sanitation-salvage has proved to be the most economical and useful method of control yet devised.

Scope

In this report will be included a brief history of sanitation-salvage; a description of the primary insect involved; and the objectives, means of accomplishing these objectives and the results of sanitation-salvage. Emphasis will be placed on the economic feasibility of sanitation-salvage, although, as yet, limited data are available on this phase. ?
Dunning's Risk-Rating System will not receive the same emphasis as other systems because it has been considered, by most authorities, to be too broad and inclusive for practical use. Neither will individual logging methods and equipment descriptions be discussed, except in a general way.

As the title suggests, this report will be mainly confined to the ponderosa pine forests of the Pacific Northwest with the other regions mentioned only to show similarities or contrasts.

## ECONOMIC IMPORTANCE OF BARK-BEETLE LOSSES

As mentioned previously, bark beetles kill from 600-800 million board feet of ponderosa pine in Washington and Oregon each year. This results in a monetary loss of several million dollars when one considers that ponderosa pine stumpage is worth between $20 and $60 a thousand b.f. In addition to this direct loss, the community als~~o~~ looses several mil- sp. lion dollars more from a reduced annual timber cut and the resulting awkward phrase.



non-full use of labor. (13:42) ~~The amount of money paid as~~ Wages for the conversion of trees into lumber ~~is~~ are often three or four times ~~as great as the amount paid for~~ the value of the trees ~~to begin with~~. Also, if endemic beetle populations build up to epidemic numbers and kill the majority of the timber on a given area, the losses may ~~tend to~~ create a serious fire hazard and also the asthetic value of the forest is reduced. In some cases, when several different insects combine forces and kill all the trees, the watershed value of the forest is reduced because of the abnormal soil erosion resulting from the decreased water-holding capacity of the disabled plant community. It is difficult, if not impossible, to place a definite dollar value on such losses, but if they could be expressed in dollars and added to the tangible losses, the sum would be impressive enough to convince most people that the control of bark beetles is warranted.

don't shift voice

## DENDROCTONUS BREVICOMIS

Ponderosa pine has more insect enemies than any other native American tree. The most destructive of these insects are the bark beetles belonging to the genus Dendroctonus; the most important Dendroctonus in the Pacific Northwest is D. brevicomis, the western pine beetle. In other localities other species or genera may be more important.

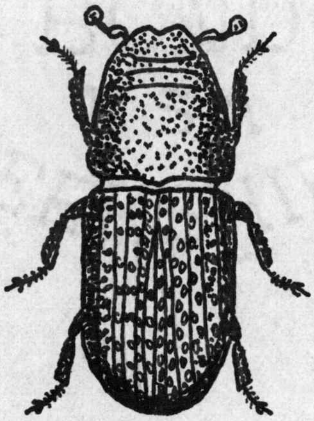
### Description

The adult beetles are about the smallest western species of Dendroctonus and measure from 1/8 to 1/5 inch long. They are dark brown to black, stout and cylindrical. The larvae, found in the outer bark, are white, curved and about the size of a grain of rice. The easiest way to distinguish this beetle from others occurring within the same range is by the winding egg galleries that cross and recross each other. (3:154) Each species of bark beetle makes its own characteristic design on the bark and wood. If this were not so, or if the beetle only were present to be identified, one would have to resort to minute anatomical details for positive identification.

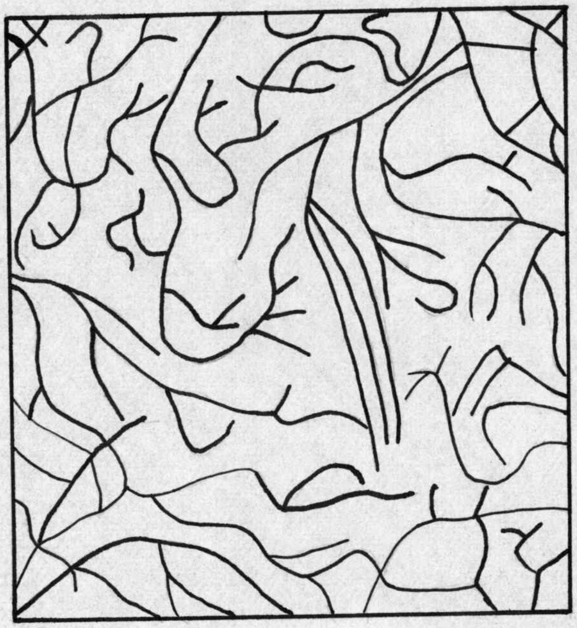
Habits

After alighting on the trunk of a host tree, the adult beetles bore an entrance tunnel through the bark. Upon reaching the cambium, the beetles mate and the female lays eggs. The eggs hatch and the larvae mine outwards in all directions feeding on the ~~cambium layer~~ inner bark as they go. Their galleries show no definite pattern, but are winding and irregular. Adults do the girdling in D. brevicomis J.J. Thus, the tree is girdled and its natural functioning stops, resulting in its death. After wandering around--usually all winter--the larvae tunnel into the outer bark where they pupate and later emerge as adults ready to attack other trees. In most localities there is only one generation per year, but in the warmer areas, two or more generations may occur.

Normally this beetle breeds in over-mature trees, in windfalls, unhealthy trees or trees weakened by drought, stand stagnation or fire; semicolon better here but under epidemic conditions, it will attack and kill trees of all ages and vigor that has bark thick enough for its development. Agr. Trees under 6 inches in diameter are rarely attacked. (9:132) Just why the beetles are attracted to certain trees is not clearly understood. Some authorities say that they are attracted by the odor of the fermenting cambium Agr. layer in the older and dying trees. Others suggest that the beetles will



Dendroctonus brevicomis



Gallery Pattern of D. brevicomis

bore into any tree they happen to alight on, but That the more vigorous trees put up enough resistance to overcome the attack by "pitching the beetles out" with quantities of sap. It is only when tremendous numbers of insects attack the vigorous trees that they are killed. This argument sounds logical, but *D. ponderosae*, a close Rocky Mountain relative of *D. brevicomis*, actually shows a preference for vigorous trees. The mountain pine beetle, *D. monticolae*, attacks spruce, Douglas-fir and true firs during an epidemic. It is with the beetles that have the latter habits that sanitation-salvage is ineffective because of the difficulty in predicting which trees will be attacked.

## CONCEPTS OF BARK-BEETLE CONTROL

Bark-beetle control may be divided into natural and applied control. Natural control refers to the conditions of nature that keep insects from reproducing to a theoretically unlimited degree. The degree to which an insect could reproduce is often termed the biotic potential of the insect. The conditions of nature that prevent an insect from reaching its biotic potential are referred to as environmental resistance. It is when the balance between biotic potential and environmental control is upset that epidemic populations, or, on the other hand, extinction of a species, occur~~s~~. Applied control refers to the actions taken by man to reduce insect populations. P. Agr

### Natural Control

Nature controls insects through food supply, climatic conditions, predators and parasites.

As an example of natural control, the western pine beetle suffers heavy brood mortality when prolonged winter temperatures of minus 20 degrees Fahrenheit exist. This species also has many natural enemies. During the flight period birds and lizards destroy a certain number. Is it certain? Woodpeckers dig into the trees to prey on the various stages. on stages or on insects? ~~Fungus~~ and bacterial diseases play a minor ~~roll~~ in control. (awkward rhyme) R.P. Several other scolytids (beetles) and an ant prey on the western pine beetle, but these natural enemies alone are usually not sufficient to maintain the desired level of control necessary to meet the standards of management set by man. To meet these standards man applies other means to reduce the beetle populations to the desired level. (3:39)

## Applied Control

There are two general types of applied control. One type is control with the utilization of the wood and the other is control without utilization. The latter type is the one that has been principally used in the past.

Control Without Utilization: Control without utilization can take almost any form depending upon the species of tree attacked and the species of bark beetle. Very little detail will be given on each of the various methods as many of them are little used today.

One of the first-used methods of controlling bark beetles was to fell the infected trees, pile the limbs on the trunk and burn all that would burn. Another method consists of peeling the bark off the felled trees and exposing the larvae to the killing rays of the sun. Oil has been used to burn both the standing and felled trees. The solar-heat method consists of felling the infested trees and allowing the hot sun to kill the broods on the upturned surface and then turning the log over ~~so as~~ to expose the other side. This method is limited to thin-barked trees and is only successful during the hotter days of the summer. Air temperatures of 80 to 90 degrees Fahrenheit are necessary to raise the temperature under the bark to 120 to 130 degrees, the temperature necessary for adequate control. Other methods such as piling and burning and trap trees have also been used. Doane gives a complete description of each of these methods. (4:43-56) The main disadvantage of most of these systems of control is the waste of wood. not clear

Control With Utilization: Wherever possible, logging of the infested trees is recommended because there is the possibility of the operation being self-supporting or even yielding a profit. (4:44) But, even logging the dead and currently infested trees does not guarantee that this process of control will not have to be carried on year after year. True, all the above-listed methods of control will reduce the current beetle populations, but there are no marked lasting effects. Why marked?

It is here that the habits of the beetle causing the infestation are important. (11:854)

The western pine beetle shows a definite preference for overmature and weakened trees. If these trees were removed before the beetles attacked them, it is conceivable that the beetle populations would be reduced until more susceptible or high-risk trees are developed. The vigorous and healthy trees that are left would be somewhat resistant to attack, and it would take several years for some of them to become high-risk trees.

One might object to the fact that half the paper is elapsed before you get to your stated topic



SANITATION-SALVAGE BEETLE CONTROL

In 1928, Duncan Dunning noted that the very destructive western pine beetle, which had been more or less epidemic in the pine for years, showed a definite preference for certain of his tree classes. (5:755) In that same year Person found that the western pine beetle also showed preference for slow-growing trees. (14:564) Later Keen, Salman, Bongberg and others confirmed these observations and added valuable contributions of their own. From the findings of these men came the concept of sanitation-salvage. One of the first projects was started in 1937, in California. Since then, successful projects have been carried on throughout the Pacific Northwest by both private and public agencies.

## Objectives of Sanitation-Salvage

Sowder lists the following as the usual objectives of sanitation-salvage: (16:4)

1. Remove live trees highly susceptible to insect attack and thereby reduce current and future insect losses.
2. Remove merchantable trees that are dead or dying from all causes and thereby salvage timber that would otherwise be lost.
3. Establish a permanent road system to facilitate future salvage or other cutting operations.
4. Reduce fire hazard and aid fire control.

as stated, these are not objectives, but directions, or imperatives

At this point one might ask why not just cut the high-risk trees along with the regular logging. The reason is that the regular cutting progresses too slowly and many high quality trees may be lost in the meantime. The object is to get over the entire areas as soon as possible and in this way reduce the chances of an epidemic, as well as to salvage ~~salvaging~~ what is already dead or dying. It is not a substitution for

ref?

regular cutting, but rather a method to reduce losses until the area can be logged.

## Recognition and Marking of High-Risk Trees

Dunning, Keen, Salman, Bongberg and others have developed tree classification and penalty systems designed to rate individual ponderosa and Jeffrey pine trees according to beetle susceptibility. While a complete discussion of each system would take needless time and in many cases would be repetitious, a detailed copy of several of them will be found in the appendix. (Appendix pp. 20-27)

The particular penalty or tree classification system used will depend a lot on the preference of the individual in charge, past precedence or particular features included in the system that render it particularly suitable for a given stand or area. No single classification system may fit the needs of all areas perfectly, and adjustments or combinations of two or more may be necessary. Dunning's system is too broad to be considered applicable to sanitation-salvage cutting in the Pacific Northwest. It has, however, been used in California. Bongberg's "Penalty System for Rating High-Risk Trees" has been used with success on the Pringle Fall's Experimental Forest near Bend, Oregon. (16:5)

Bongberg has assigned a numerical rating to each of several conditions that might make a tree a high risk. (Appendix p.22) Among the more important features included in the system are needle condition, twig and branch condition, top crown condition, and a category called "other factors" which includes lightning strikes, broken tops, mistletoe, etc. After a tree has accumulated a numerical rating of "9," it is considered a high-risk tree and should be marked. (2:4-6)

Should there not be another 2nd order heading in here to account for felling, roads, loading, etc?



Keen's classification system, which includes mainly age and crown vigor, has been widely used with good success. Modifications of this system have been used in almost all the ponderosa pine regions. (Appendix p.24)

Two markers and a tally man made up the marking crew at Pringle Falls. The tally man ran the compass, recorded the marked trees and prepared a map on which he plotted the approximate location of each marked high-risk tree. The two markers worked a $2\frac{1}{2}$-chain strip on each side of the tally man and marked the trees that they estimated had a "penalty" of "9" or more. Each marked tree was numbered and a corresponding number was placed on the map.

Copies of the map were given to the logging contractor, the fallers, the choker setters and the scalers. Knowing exactly where the marked trees are located has been an important factor in minimizing logging costs on many sanitation-salvage shows. (16:8)

Before any logging can be started, the roads must be constructed. If the objective of establishing a permanent road system is to be met, special emphasis should be given to the road specifications. The roads should be built to conform to standards of grade, drainage, side slopes, etc. to minimize erosion, thus minimizing maintenance and prolonging their usable life. The cost will depend on the character of the topography, the standard of road to be built, amount of rock to be moved and the type of equipment used, etc. On the Pringle Falls experiment this cost was $2.68 per 1000 board feet net scale. (16:7) If the road system can be completely financed on the first cut, so much the better, but it may be necessary to amortize the system over a period of years.

Because of the small volume per acre and the comparatively great distances between trees, small, portable equipment is often necessary for a profitable operation. Very seldom does the volume cut on a sanitation-salvage operation exceed 15-18% of the present stand and often this figure is around 10% or about 1000 board feet or one medium-sized tree per acre.

Is there any spreading of beetles upon felling?

of?

The margin for profit is generally small and it is often the size of the equipment and the coordination of the operation to eliminate unnecessary steps that determine whether there will be a profit or not. Planning is essential. (17:20-22) what is the subject of this verb?

After the trees have been located, felled and bucked, they are skidded to the nearest road where they are decked (grouped) to await loading. Tractors of the D-6 type will generally do the job economically and with less damage to the remaining stand than will larger tractors. The logs are then loaded on small- to medium-sized trucks with a portable loader. Self-loading trucks have been used to advantage in some cases. The method of logging will generally be dictated by the topography, volume cut, size of the trees and equipment already available.

On the Pringle Falls experiment, the total logging cost, exclusive of road building, was \$20.39 per 1000 board feet. (16:9) On the Blacks Mountain experiment in California, in 1940, the cost was from \$1.50 to \$2.25 more per 1000 board feet than ordinary logging. (1:3) Orr, of the Weyerhaeuser Timber Company, gives the following figures on logging costs: Log-making costs were up about 16%--skidding costs up about 18% on one area. On another area with less favorable topography, the log-making costs were expected to be up about 25% and the skidding costs up

50% above regular selection cutting. (12:2)

Results and Values of Cutting

Bongberg found that the cumulative reduction in insect-caused losses was more than 70% for a 10-year period following sanitation-salvage cutting. The average reduction in loss due to light cutting on the Blacks Mountain Experimental Forest was 90.6% after the first year. This percentage was expected to decrease about 4% a year, but the actual figures show the decrease to be about 2% per acre per year. (2:2) Results from the old methods of treating only the infested trees showed a 90-95% reduction the first year but dropped to only 25% at the end of three years. At the end of a 10-year period there was no appreciable reduction.

what is the subject of this verb?

Assuming that present values for ponderosa pine remain unchanged for the next ten years and disregarding interest, the sanitation-salvage treatment at Pringle Falls is expected to produce a gain of $1.07 per acre per year. This gain is due to an estimated 100% increase in net growth. (16:9) In addition to the actual dollar gain, the chances of an epidemic of the western pine beetle occurring have been practically eliminated. Sanitation-salvage does not assure that damage from other bark beetles or other insects will be reduced to the extent of that caused by D. brevicomis. If the slash from the operation is not properly cared for, it could provide breeding grounds for the pine engraver beetles of the genus Ips. These secondary beetles can cause serious loss, especially to reproduction, if the conditions are right. One must not overlook this possibility. (Table 1, p. 18)

But does cutting actually destroy all D. brevicomis in the felled tree?

## Development of High-Risk Trees Following Sanitation-Salvage

In 1954, 17 years after sanitation-salvage cutting on Blacks Mountain, high-risk trees averaged 1,110 board feet, or one high-risk tree per acre. At the time of the original cutting, high-risk trees averaged 3000 board feet or 2.7 trees per acre. In 1954, high-risk trees made up 7.7% of the estimated stand volume, in comparison to 17.2% in the virgin stand in 1937. The volume of high-risk trees in 1954 was, therefore, only 37% of that in 1937. (6:2) (Table 2, p. 19)

Sanitation-salvage cutting does not hold all of the answers to bark-beetle control. In stands ~~that~~ which are not readily accessible, and which are of poor quality, sanitation-salvage may not be profitable. It may be cheaper in these situations to resort to one of the other methods of applied control. Johnson, in working with control in California, devised five classifications for stands and the control that should be applied to each. (7:278)

| Classification | Infestation | Control |
|---|---|---|
| I | Very light | No control |
| II | Light | Direct control (felling, burning, etc.) |
| III | Moderate | Sanitation-salvage (13-15% of stand) |
| IV | Heavy | Sanitation-salvage (20-25% of stand) |
| V | Very heavy | Utilization cut of stand (60-80%) |

Sanitation-salvage is successful only with beetles that show a definite host preference. In the Black Hills ponderosa pine region and in the Southwest, the major pine beetles do not show this tendency. In certain parts of the California pine forests *D. brevicomis* does not react with the same definite patterns as it does in Oregon.

Sanitation-salvage is not a panacea for controlling all losses due to bark beetles, but it has prove~~n~~d to be the most effective and economically sound method yet used to reduce losses ~~by~~ from the western pine beetle in the Pacific Northwest.

# APPENDIX

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Table 1.--Financial gain of sanitation-salvage cutting over no cutting at the Pringle Falls Experimental Forest--calculated for an average acre for ponderosa pine only[1]

| Item | If no cutting had been done | After sanitation-salvage cutting |
|---|---|---|
| Average gross volume, 1951 | 17,722 bd.ft. | 16,116 bd.ft. |
| Average gross volume, 1961 | 18,122 bd.ft. | 16,916 bd.ft. |
| Estimated net growth for 10 years[2] | 400 bd.ft. | 800 bd.ft. |
| Estimated increase in net growth (gross scale)[3] | | 400 bd.ft. |
| Value of increased net growth ($24.26 per M gross scale less $1.56 per acre sale administration cost) | | $8.14 |
| Capital investment in timber stand improvement | | 1.55 |
| Capital investment in roads, including logging spur roads | | 1.04 |
| Estimated gain due to cutting | | $10.73 |
| Average gain per acre per year | | $1.07 |

1/ Assuming that present values for ponderosa pine remain unchanged for 10 years and disregarding interest. Also, assuming that maintenance of logging spur roads will be taken care of by periodic light salvage cutting of dying trees, estimated to average 10 board feet per acre per year. Maintenance of main roads should be carried as an annual charge against the production of the national forest working circle.

2/ Growth estimates are based upon unpublished plot data from both virgin and partially cut stands covering the period since 1937.

3/ Volume in "net growth" excludes tree mortality but includes defects in the tree as represented by "gross scale." (16:19)

BLACKS MOUNTAIN EXPERIMENT

Table 2.--Volume and number of high-risk trees 1/ at the time of sanitation-salvage cutting and 16 and 17 years later

| Compartment | Area | Original stand 2/ volume per acre | High-risk trees at the time of cutting: Volume per acre | High-risk trees at the time of cutting: Number per acre | High-risk trees 16 & 17 yrs. after cutting: Volume per acre | High-risk trees 16 & 17 yrs. after cutting: Number per acre |
|---|---|---|---|---|---|---|
| | acres | bd. ft. | bd. ft. | | bd. ft. | |
| G 2-14 | 81.3 | 17,480 | 2,740 | 2.4 | 770 | 1.1 |
| G 8-10 | 63.4 | 19,210 | 2,680 | 1.9 | 1,180 | 1.0 |
| B 25-1 | 112.7 | 16,310 | 2,590 | 2.5 | 1,500 | 1.3 |
| B 27-4 | 95.7 | 17,460 | 3,890 | 3.8 | 880 | .6 |
| All | 353.1 | 17,460 | 3,000 | 2.7 | 1,110 | 1.0 |

1/ Risk 3 and 4 ponderosa and Jeffrey pine.

2/ Pine only. (6:2)

# DESCRIPTIONS OF RISK RATINGS FOR PONDEROSA AND JEFFREY PINE IN EASTSIDE FOREST AREAS OF CALIFORNIA

The characters used in defining risk are concerned only with the apparent vigor of the crown as evidenced by the foliage, twigs and branches. Factors of age, crown form and crown position do not enter into the appraisal of risk from insect attack.

In the following descriptions, risk has been tentatively segregated into four groups. These four groups have been established primarily to provide sufficiently small gradations to allow for variation in application in selective logging practice. Where the prevention of insect loss in the near future is the primary objective, either the highest risk group alone (Risk 4) or the two highest risk groups (Risks 3 and 4) may be removed. Where utilization cuts are desired, material from the moderate and high risk groups might be supplemented with trees that are cut for silvicultural or economic reasons.

## DESCRIPTIONS OF RISK RATINGS

### RISK I. LOW RISK

Full foliaged, healthy appearing crowns. Foliage of healthy appearance, needles unusually long and coarse, color good dark green. Practically all twigs with normal foliage complement. No weakened portions of crown.

### RISK II. MODERATE RISK

Fair to moderately healthy crowns, imperfect in spots. Foliage mostly healthy, needle length average or better, color fair to good. Some twigs or branches may lack foliage, but such injury should not be localized to form definite "weak" spots in crown.

### RISK III. HIGH RISK

Crowns of fair to poor health, somewhat ragged or thin in portions of crown. Foliage in parts of crown thin, bunchy, or unhealthy, needles average to shorter than average in length, color fair to poor. Some to many twigs or branches lacking foliage, some to many twigs or branches fading or dead. Small localized weakened portions of crown usually present.

### RISK IV. VERY HIGH RISK

Crowns in poor condition, ragged or thin, often showing evidence of active insect infestations in upper portions. Foliage thin or bunchy, needles short or sparse, color poor. Twigs and branches dead or dying, portions of crown definitely weakened. Active top-killing or partial infestations often present.

Some types of tree injuries are not associated with a normal rating of risk. They may be the result of accident, such as lightning or mechanical injury, and when such injuries affect the immediate risk of infestation and early death they should be appraised independently of the characters given above for rating risk. In addition, the following tree characters are not considered to be primarily concerned with current risk.

Stag Tops: An old bare spike, which is the result of an old top-killing injury from which the tree has recovered, is termed a stag top. Although a deterioration of the remaining crown often follows below stag tops and such trees may be rated as high risks, the stag top alone is not considered a character of high risk. When the remaining parts of the crown are vigorous and healthy, such trees can be considered low risks.

Mule Tail Foliage: In some trees the foliage has a distinctly bunchy appearance though the needles are long. This condition seems to be due to a peculiar development of the branches and apparently is a normal characteristic of a certain strain or type of pine tree. Other things being equal, it should be ignored in rating risk.

Off Color Due to Cold: In certain years and locations needles may be browned due to the effects of low temperatures. Light, local or generalized light browning of needles is not usually considered in rating risk. However, in some areas cold injury has been so severe as to cause a cambium injury in addition to a foliage injury. Severe injuries may have a considerable effect on the current risk from insect attack.

Cone Fade: Often, in seed years, needles behind the cones die and fade. Apparently this fading has no relation to risk.

Natural Needle Fall: During the fall months of the year, the normal fading of old needle complements may create an appearance of high risk. However, this needle fall is natural and the seasonal condition should not be counted as a factor in determining the risk of individual trees.

Natural Shading Out of Branches: On most trees in a fairly closed canopy the lower branches lose their foliage and die. Such natural shading out of branches does not indicate high risk. This must be differentiated from the dying of twigs and branches in the upper, unshaded parts of the crown, a condition which is considered a definite indication of high risk from insect attack.

In stands and in individual trees there apparently are no clearly marked steps in the change, over time, from a resistant to a susceptible condition or from a vigorous to a weakened condition. Those changes are marked by the appearance of no definite single character that can be used for all trees. Usually several or different evidences of deterioration develop in different trees. Some appear to be more particularly concerned with the early stages of deterioration while others may be more closely connected with the later stages. (15)

# A DEFINITION OF A HIGH RISK TREE[1/]

## PENALTY SYSTEM FOR RATING HIGH RISK TREES

(A high risk tree will have a penalty score of 9 or more)

A. Needle condition

(1) Needle complement (number of needle fascicles per twig)

Less than normal complement throughout crown. No contrast evident in complement between upper and lower crown. 2

Thin complement in upper crown; normal complement in lower crown. Contrast in complement evident between upper crown and lower crown. 4

(2) Needle length (length of individual needle)

Needles shorter than normal throughout crown. No contrast evident in needle length between upper crown and lower crown. 2

Needles short in top; normal length below. Contrast in needle length evident between upper crown and lower crown. 4

(3) Needle texture (apparent weight of needle - coarse or fine)

Light needles throughout crown. No contrast in texture evident between needles in top crown and lower crown. 1

Feathery needles in top crown; normal or light texture in lower crown. Contrast in texture evident between top and lower crown. 2

(4) Needle color (green color of needles)

Needle color light green - lighter than normal green. 1

Needles definitely off color. 2

B. Twig and branch conditions

(1) A few scattered dead or dying twigs or branches in crown. 0

(2) Many scattered dead or dying twigs or branches in crown. 1

(3) Severe scattered dead or dying twigs or branches in crown. 2

(4) Severe dead or dying twigs or branches in crown which form a definite weak spot or hole in crown, particularly in top 1/3 of crown (localized weakness). 3

1/ Prepared by Jack W. Bongberg, Bureau of Entomology and Plant Quarantine, Forest Insect Laboratory, Berkeley, California, 1949, and used here by permission of the Bureau of Entomology and Plant Quarantine.

(5) Severe dead or dying twigs or branches in crown which form more than one weak spot in crown, particularly in top 1/3 of crown (<u>localized weakness</u>). 5

C. <u>Top crown condition</u>

(1) Old top kill where there is no progressive weakness or killing in green crown below. 2

(2) Old top kill and a progressive weakness or killing in green crown below. 4

(3) Old spike where there is no progressive weakness or killing in green crown below. 1

(4) Old spike and a progressive weakness and current killing of limbs and branches below. 5

(5) Long bare spike (1/3 or more of total stem length) which leaves only a few widely spaced breen branches in crown. 6

D. <u>Other factors</u>

(1) Keen tree classes. All C and D crowns. 2

(2) Lightning strikes - currently struck. 9
old strike (healed). 1

(3) <u>Dendroctonus</u> <u>valens</u> attacks in basal bole - current. 6
old, pitched out. 2

(4) Broken tops - current break leaving only a few branches on bole. 9
old break and new terminal starting. 0

(5) Mistletoe - heavy witches broom. 1
canker on stem. 5

(6) Fire scar 50 percent or more of circumference or basal area which indicates progressive deterioration of wood (mechanical risk). 3

(7) High risk trees in group of other trees which might serve as a focal point for infestation of entire group. 3

(8) Hot spot - where tree is located in the midst of large group of snags indicating that group has been killed gradually over the years. 1

(9) Mistletoe in smaller diameter trees.2/ Very heavy mistletoe witches brooms and where the crown excluding the witches brooms would be D crown. 9

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2/ Not necessarily a high risk tree from the entomological point of view. (16:22-23)

## KEEN'S REVISED DESCRIPTION OF TREE CLASSES

Age Class 1.--Young trees. Commonly referred to as "bull pines" or "black jacks"; thrifty trees making rapid height and diameter growth; age usually less than 80 years.

D.b.h.--Rarely over 20 inches.

Height.--In lower crown canopy usually less than 60% of total mature height.

Bark.--Dark, grayish brown to black; rough, and deeply furrowed without plates, but with narrow ridges between the fissures (sometimes coloring at extreme base).

Branches.--Upturned and in whorls for upper three-fourths of crown; small for diameter of bole.

Top.--Usually pointed, with distinct whorls.

Age Class 2.--Immature trees; still making rapid height and diameter growth in thrifty trees; age approximately 80 to 180 years.

D.b.h.--Rarely over 30 inches.

Height.--Usually less than 90% of total height at maturity. Trees still under the general crown canopy.

Bark.--Dark reddish brown, with narrow, smooth plates between fissures on lower half of bole; dark, rough bark on upper half.

Branches.--Mostly upturned and in whorls for upper half of crown; horizontal near middle, horizontal or drooping below; small to medium size for diameter of bole.

Top.--Usually pointed, sometimes rounded, but with whorls indistinct.

Age Class 3.--Mature trees. Height growth practically complete; diameter growth slow; age approximately 180 to 300 years.

D.b.h.--Rarely over 40 inches.

Height.--Practically that of the general crown canopy; except intermediate, suppressed or top-killed trees.

Bark.--Light reddish brown with moderately large plates between the fissures on lower three-fourths of bole;dark bark showing in upper quarter.

Branches.--Upturned near top, middle crown horizontal, lower ones drooping; moderately large for size of bole.

Top.--Usually pyramidal or rounded, occasionally pointed; whorls indistinct except at extreme top.

Age Class 4.--Over-mature trees. Making no further height growth; diameter growth very slow; age more than 300 years.

D.b.h.--Wide latitude in diameters, but usually large in dominant trees.

Height.--Full height of general crown canopy, except suppressed, spike-topped or broken trees.

Bark.--Light yellow and uniform for entire bole, except in extreme top; plates usually very wide, long, and smooth; fissures often rather shallow.

Branches.--Large, heavy limbs, often gnarled or crooked; mostly drooping except in extreme top.

Top.--Usually flat; occasionally rounded or irregular.

Vigor Class A--Full vigor

Crown.--Full vigorous crowns with a length of 55% or more of the total height, and of average width or wider; with density average or better for its age class.

Foliage.--Needles of average length or longer, usually dense and thrifty.

Position.--Usually isolated or dominant; rarely codominant.

D.b.h.--Large for age.

Vigor Class B--Good to fair vigor

Crown.--Good to moderately vigorous crowns, with length from 30 to 55% of total height, if of average width and density; or a longer crown if narrow or somewhat thin; but neither sparse nor ragged.

Foliage.--Needles of average length, usually dense and thrifty.

Position.--Usually codominant, but sometimes isolated or dominant; rarely intermediate.

D.b.h.--Average or above for age.

Vigor Class C--Fair to poor vigor

Crown.--Fair to poor crowns, with length from 10 to 30% of total height if of average width and density, or long, sparse, and narrow; often flat on one or more sides.

Foliage.--Needles often short and thinly distributed, but of normal length and density when confined to top one-third of crown.

Position.--Usually intermediate, sometimes codominant or suppressed, but rarely isolated.

D.b.h.--Usually below average for age; sometimes large in decadent trees.

Vigor Class D--Very poor vigor

Crown.--Very short, less than 10% of the total heitht; sometimes merely a tuft at top of tree, or somewhat longer when sparse and ragged; usually very narrow or limbs all on one side.

Foliage.--Needles often short, and foliage sparse or scattered, or only tufts at end of twigs; but of normal length and density if reduced in quantity.

Position.--Usually suppressed or intermediate, but may occupy other positions if greatly reduced in vigor.

D.b.h.--Decidedly subnormal for age, but very old decadent trees may be of large diameter.

Keen states that 72% of the volume lost to bark beetles is composed of tree classes 3B, 3C, 3D, 4B, 4C, and 4D. These specifications are copied directly from Keen's works. (10:249-250)

KEEN'S PONDEROSA PINE TREE CLASSIFICATION