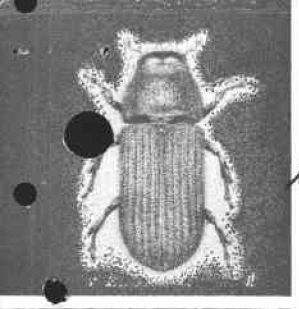
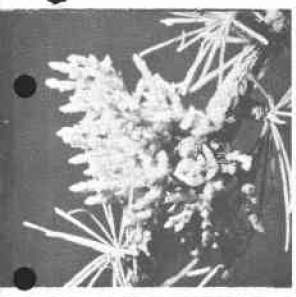


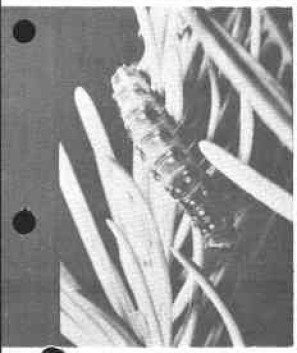
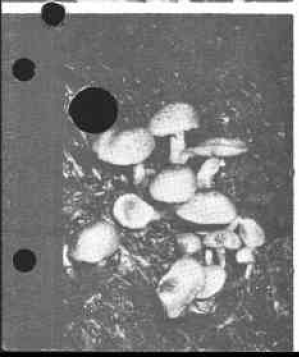

FOREST INSECT & DISEASE MANAGEMENT

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STATUS OF MOUNTAIN PINE BEETLE INFESTATIONS KOOTENAI NATIONAL FOREST, MONTANA 1977

By

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ABSTRACT

Mountain pine beetle populations increased to epidemic levels on the Kootenai National Forest in 1972. Nearly 397,000 trees containing almost 32 million board feet have been killed. More than 84,000 trees will probably be killed in 1978. Infestation has the potential to intensify in high hazard stands, and some increase may occur in stands of low and moderate hazard. Potential losses can be reduced through an accelerated program of (1) sanitation salvage cutting and (2) silvicultural management. High-hazard stands should receive first priority.

INTRODUCTION

Mountain pine beetle, Dendroctonus ponderosae Hopk., populations increased to epidemic levels in lodgepole pine, Pinus contorta var. latifolia Engelm., stands in the Yaak River drainage, Kootenai National Forest, in 1972. Infestation increased from 1,000 acres in 1973 to 21,413 acres in 1976, and decreased to 11,700 acres in 1977.

Beetle populations developed to epidemic status in Snell and Gold Creek drainages. Groups of infested trees ranging in size from 5 to 100 trees/group are scattered throughout lodgepole pine type on the southern end of the Forest.

Plots were established in 11 areas in the Yaak River drainage, and additional ground checking was done on the south end of the Forest to maintain a record on infestation status and predict trend and losses in 1978.

METHODS

Tree and volume loss estimates/acre and buildup ratios were based on 110 1/10-acre plots on lines at 5-chain intervals in 11 drainages. A hypsometer was used to determine trees to be tallied within plots. All green and infested trees 5 inches d.b.h. (diameter at breast height) and larger were recorded to the nearest inch and placed into one of the following classes:

0 = healthy trees
1 = unknown or natural mortality
2 = current beetle attack
3 = 1-year-old attack
4 = 2-year-old attack
5 = unsuccessful attack

Heights were recorded on each of two tree species/plot for estimating volume loss. Data were analyzed by the computer program INDIDS (Bousfield 1977), and used for predicting 1978 tree mortality.

RESULTS

Infestation intensity: Infestation intensity by year is shown in tables 1 and 2. Number of infested trees/acre fluctuated yearly in areas surveyed. Acres infested increased steadily from 1973 through 1976, then declined in 1977. Number of infested trees increased yearly through 1975, decreased in 1976, then increased in 1977. Based on number of infested trees/acre (previous year:current year), buildup ratios were 1:0.5 from 1973 to 1974; 1:3.5 from 1974 to 1975; 1:0.6 from 1975 to 1976; and 1:1.3 from 1976 to 1977.

Volume killed was 778 bd. ft./acre in 1975; 758 bd. ft./acre in 1976; and 579 bd. ft./acre in 1977. Of the lodgepole pine killed, 35 percent was killed in 1975, 31 percent in 1976, and 34 percent in 1977. In areas surveyed, about 35 percent of the stands were killed in 1975, 27 percent in 1976, and 38 percent in 1977.

Percent loss by diameter class is shown in table 3.

Table 1--Summary of mountain pine beetle-caused tree and volume loss estimate, Kootenai National Forest, 1975-1977.

Area	d.b.h.	Trees/Acre infested			Volume/Acre infested (bd. ft.)			Percent lodgepole pine killed			Percent stand killed			Total % LPP killed	Total % Stand killed
		1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977		
Basin Creek	5-11.9	3	7	15	167	338	454	2	4	8	1	3	6	13	9
	> 12	-	3	1	-	444	139	-	11	4	-	8	3	15	11
	Total	3	10	16	167	782	593	2	5	8	1	3	5	13	9
Caribou Creek	5-11.9	2	-	1	160	540	77	1	-	1	1	-	< 1	2	1
	> 12	-	3	1	-	-	127	-	5	2	-	4	1	6	5
	Total	2	3	2	160	540	204	1	1	1	1	1	1	3	2
E. Fk. Yaak	5-11.9	1	2	3	4	78	96	2	4	6	1	1	2	11	4
	> 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	1	2	3	4	78	96	2	3	5	< 1	1	1	10	3
Solo Joe Creek	5-11.9	1	-	-	47	-	-	1	-	-	1	-	-	1	1
	> 12	2	-	1	267	-	136	2	-	1	2	-	1	4	3
	Total	3	-	1	314	-	136	2	-	1	1	-	< 1	2	2
Yaak River	5-11.9	13	8	6	299	342	41	8	5	4	5	3	3	16	10
	> 12	2	1	1	301	111	127	14	8	9	10	5	6	29	19
	Total	15	9	7	600	453	168	8	5	4	5	3	3	17	11
French Creek	5-11.9	2	-	-	128	-	-	5	-	-	1	-	-	5	1
	> 12	3	3	1	629	439	161	16	19	8	5	5	2	37	11
	Total	5	3	1	757	439	161	9	6	2	1	1	< 1	16	12
Lap Creek	5-11.9	10	3	24	390	171	1046	4	1	11	3	1	8	16	11
	> 12	6	1	5	718	86	768	29	7	36	13	3	13	57	26
	Total	16	4	29	1108	257	1814	6	2	12	4	1	8	19	13
Hensley Creek	5-11.9	18	4	11	809	185	641	24	7	20	12	3	8	43	21
	> 12	12	10	7	1852	2079	1055	32	38	44	13	13	10	76	32
	Total	30	14	18	2661	2264	1696	26	12	26	12	7	9	54	25
W. Fk. Yaak	5-11.9	6	8	25	53	47	414	6	8	29	2	3	10	39	15
	> 12	1	1	4	119	165	706	9	10	44	3	3	13	55	18
	Total	7	9	29	172	212	1119	6	9	30	2	3	11	40	15
Pete Creek	5-11.9	8	5	2	256	168	42	12	8	4	5	3	1	22	9
	> 12	5	2	1	810	270	180	17	8	5	7	3	1	28	11
	Total	13	7	3	1066	438	222	13	8	4	5	3	1	24	10
Lang Creek	5-11.9	13	9	1	824	600	68	31	31	5	5	3	< 1	5	8
	> 12	6	10	1	727	1524	101	29	67	20	8	16	2	81	25
	Total	19	19	2	1551	2124	169	30	43	8	5	5	1	63	11

Table 2.--Infested trees/acre, acreage infested, and total number of lodgepole pine infested, Kootenai National Forest, 1973-1977

	1973	1974	1975	1976	1977
Infested trees/acre	6.3	3.4	12.1	8	10.9
Acres infested	< 1,000	1,873	8,505	21,413	11,700
Total No. infested trees	1,125	6,368	97,405	171,304	120,510

Table 3.--Percent loss by diameter class, Yaak Ranger District, Kootenai National Forest, 1975-1977

	D.b.h.	1975	1976	1977
Lodgepole pine killed	5-11.9	39	28	34
	> 12	61	72	66
Stand killed	5-11.9	38	25	43
	> 12	62	75	57
Trees/acre killed	5-11.9	68	57	79
	> 12	32	43	21

A greater percentage of the lodgepole pine ≥ 12 inches d.b.h., trees killed/acre, and total stand killed increased from 1975 to 1976, then decreased. However, percentage of lodgepole pine and stand killed, and trees killed/acre decreased from 1975 to 1976, then increased in trees 5-11.9 inches d.b.h.

Based on ground plots and aerial survey acreage estimates, 396,700 trees have been killed since 1972.

SUMMARY AND DISCUSSION

More than 31 million bd. ft. of merchantable lodgepole pine volume has been killed since 1973 on the Yaak Ranger District.

In 1976, the Kootenai Forest hazard rated their lodgepole pine stands and prepared a hazard map based on habitat type, age, and tree diameter (Hamel and McGregor 1976a). Management priorities were subsequently assigned to forest areas supporting significant lodgepole pine components ≥ 60 years old[1/]. Infestation by year, in areas rated high, medium, and low hazard are shown in table 4.

Table 4.--Acres and percent infestation/hazard class/year, Kootenai National Forest, 1975-1977

Hazard class	1975		1976		1977	
	Acres	Percent infested	Acres	Percent infested	Acres	Percent infested
High	5,110	4	17,638	13	10,863	9
Medium	0	0	0	0	827	3
Low	0	0	0	0	10	< 1

In 1975, 5,110 of the 118,345 acres rated high hazard were infested; 17,638 acres (13 percent) were infested in 1976. Then in 1977, area of infested high hazard declined to 10,863 acres (9 percent); 827 acres (3 percent) were infested in areas rated moderate hazard; and 10 acres (< 1 percent) of the area rated low hazard were infested.

The marked decline in infested acres in high hazard rated stands may be due to salvage logging of green and infested trees by the Yaak Ranger District. In 1976, 3,585 acres of high-risk stands were logged. More than 798 acres (22 percent) were infested. In 1977, 1,600 acres of lodgepole pine, including 21 MMBF, were logged from high-risk stands. About 400 acres (25 percent) were beetle infested. The forest plans to do green stand sanitation salvage on 1,495 acres containing 17 MMBF in FY 1978.[2/]

1/ Pers. comm. with John R. Naumann, silviculturist, Kootenai National Forest, 1975

2/ Pers. comm. with L. G. Michalsky, silviculturist, Yaak Ranger District, 1978.

Based on buildup ratios from 1975 to 1977, and on the formula $Y' = y + bx$ (Baker 1968) where:

Y' = The potential cumulative number of trees killed predicted through 1978
y = Cumulative number of trees killed through 1977
x = Number of trees killed in 1977
x_1 = Number of trees killed in 1976

$$b = \frac{x}{x_1},$$

at least 84,357 trees will probably be killed in 1978, bringing the cumulative kill to 481,069 through 1978 based on 5 years mortality data (1973-1977). If the buildup ratio (1977:1978 killed trees) is only 1:1, more than 120 M trees will be killed. Buildup ratio is expected to be 1:1 or slightly higher in 1978.

Based on the hazard rating system developed by Amman et al. (1977), stands were rated using age, elevation, and average d.b.h. By multiplying the factors 1 = low, 2 = moderate, and 3 = high, a susceptibility classification for the stands was obtained (table 5).

Table 5.--Hazard rating for infested lodgepole pine stands evaluated, Yaak Ranger District, Kootenai National Forest, 1977

Area	Avg. age of lodgepole pine ≥ 5 in. d.b.h. (years)	Rating	Elevation	Rating	Avg. d.b.h. of lodgepole pine ≥ 5 in. d.b.h. (inches)	Rating	Overall index	Hazard
Basin Ck.	115	3	3,700-4,400	3	11.5	3	27	High
Caribou Ck.	105	3	3,700-7,000	3	10.0	3	27	High
E. Fk. Yaak	110	3	3,100-5,840	3	11.0	3	27	High
Solo Joe Ck.	105	3	3,600-5,600	3	10.0	3	27	High
Yaak River	110	3	4,000-5,800	3	9.0	3	27	High
French Ck.	105	3	3,580-5,240	3	11.0	3	27	High
Lap Ck.	100	3	3,400-4,400	3	10.0	3	27	High
Hensley Ck.	120	3	3,200-4,320	3	10.0	3	27	High
W. Fk. Yaak	110	3	3,000-3,600	3	10.0	3	27	High
Pete Ck.	100	3	3,000-4,300	3	10.0	3	27	High
Lang Ck.	120	3	2,900-4,800	3	11.0	3	27	High

Based on this hazard rating, stands are approaching maturity (120 years old) (Tackle 1955). Elevations and latitude will not be a limiting factor in beetles completing one generation/year (Amman and Baker 1972; Amman et al. 1973; Safranyik et al. 1974). Average d.b.h. indicates that sufficient preferred large diameter trees (Cole and Amman 1969; Evenden and Gibson 1940; Hopping and Beall 1948) are available to sustain epidemic infestation for several more years. Mortality and stand depletion will continue until preferred trees are killed.

SUGGESTED MANAGEMENT ALTERNATIVES

Current and potential losses from the mountain pine beetle can be reduced through an accelerated program of (1) sanitation salvage cutting (Safranyik et al. 1974; Cole 1977) and (2) silviculture management. This, of course, depends upon land management objectives (Amman et al. 1977).

Infested stands and stands rated high hazard that could sustain extensive mortality for several years can be managed in several ways depending upon land use objectives and whether stands are pure even-aged, or pure uneven-aged, and mixed species (Amman et al. 1977; Cole 1977).

Where stand composition of lodgepole pine is pure and form is even-aged, management may be limited to: (1) salvage cutting; (2) organized clear-cutting in blocks to create age, size, and species mosaics from mature stands; and (3) stocking control in young stands (Cole 1977). Sanitation salvage is aimed at reducing beetle populations by removing and processing infested trees prior to beetle flight. It should be directed to infested stands where beetle populations have preempted preventive management. An accelerated salvage effort in these stands should partially protect adjacent high-value stands.

Organized block cutting to create age and size mosaics from extensive, pure, even-aged stands is recommended (Roe and Amman 1970; Amman 1976). Since large acreages of high-hazard stands are infested, there is a need to examine the lodgepole pine inventory to identify commercial forest land for: (1) currently vulnerable--but not yet infested stands, as well as (2) those stands rated low and moderate hazard that will attain the tree size and phloem thickness preferred by the beetle within about 15 years (Cole 1977). In identifying these stands, difference in stand susceptibility according to habitat type, age, soil, elevation, slope, aspect, stand density, and species composition will aid in selecting stand to receive priority management.

In considering a schedule of block cutting on sites where probability of loss is high, future losses can be prevented by regeneration of sites to patterns of alternating species among blocks or mixed species within blocks, suited to specific habitat types (Cole 1977).

Stocking control is an important preventive practice in pure, even-aged lodgepole pine because it allows the reduction of stand growth toward moderate tree size and rotation objectives that are not greatly threatened by the mountain pine beetle. Stocking control by age 25 to a spacing of about 10 x 10 ft. results in culmination of mean annual cubic volume increment on medium to good sites at about 80 years, with average stand diameters of about 10 inches d.b.h. (Cole 1973). Projected diameter distributions for this kind of stand indicate largest diameter classes (14 inches d.b.h.) represent less than 1 percent of the stand; while trees $\geq$ 2 inches d.b.h. comprise 8-10 percent of the stand. These rotation limits do not appear to be very susceptible to the mountain pine beetle, and with only a few preferred trees, mortality would be low (Safranyik et al. 1974; Cole and Cahill 1976) except at low elevations or extremely good sites (Amman et al. 1977).

In mature, even-aged, or mixed species stands with large lodgepole pine in the overstory, cutting units could be treated by block clearcutting as a preventive, and if the stand or block is infested, losses could be reduced by salvage-cutting practices. If immature, species discrimination and stocking control is possible in the process of reducing stand density in mixed species stands (Cole 1977).

Cole (1977) recommends selecting against lodgepole pine in older mixed stands through partial cuts in which only the preferred lodgepole pine portion is removed.

Partial cutting of large diameter lodgepole pine will reduce infestation potential in susceptible stands (Cole and Cahill 1976; Hamel and McGregor 1976b;Hamel 1977). However, susceptible lodgepole pine stands will not maintain good productivity when either partially cut or attacked by the mountain pine beetle unless the residual stand is less than 50 years old. Beyond this age, periodic annual increment steadily declines for most lodgepole pine. In such stands, overstory removal may be better than such partial cutting for growth of understory (Cole 1977).

Partial cutting, or "green sanitation salvage," is encouraged in stands that are being attacked or soon will be. Larger lodgepole pine should be removed prior to attack (along with those already infested), thus reducing productivity of the residual stand and accept it as the condition in which the beetle would leave it. Utilization of sound trees and direct control of

mountain pine beetle populations is made possible by denying the beetle preferred host trees for a population buildup. This can buy time for accomplishing preferred block cutting otherwise precluded by lack of time (Cole 1977).

Two factors must be carefully considered when planning and implementing green sanitation salvage to avoid doing more damage than the mountain pine beetle would:

1. Only those trees preferred by the beetles should be removed. Guidelines have been developed by Cole and Cahill (1976); and Amman et al. (1977).

2. Seed should be salvaged from the more vigorous, larger trees, and regenerated on site (Cole 1977). This is because the beetles appear to select the faster growing genotypes in the lodgepole pine stand over slower growing ones, consequently, also by green stand sanitation salvage. In a natural stand, fast growing genotypes will be maintained despite mountain pine beetle. Because they are represented in stored seed of serotinous cones, they will be naturally regenerated by fire.

REDUCING LOSSES IN NONCOMMERCIAL UNITS

One viable management alternative is to do nothing. However, losses are usually determined in terms of impairment of visual resource and increased costs to maintain convenience and safety for users of the areas.

Trees in high-use areas, picnic areas, campgrounds, and around visitor centers and summer and permanent homesites, can have a much higher value than trees in commercial forests.

Preventing snags in high-use areas and administrative sites will reduce the shedding of needles, dead branches, or portions of the tip or trunk of snags weakened by decay (Wagner 1963).

Preventative sprays (Sevimol-®4) are available for protecting high value trees, and must be applied before beetle flight (Gibson 1978). Hazard trees should be removed. Protecting high value trees until the infestation subsides will prevent the need to rehabilitate campgrounds by planting and will protect esthetic values.

A conscious silvicultural program of fire management and prescribed burning should be instituted in some areas. Stands should be accurately mapped for stand age, size structures, and fuels. With these data, fires could be let burn under "supervision" to create a mosaic of young stands within extensive areas of large timber that have developed from past wildfires. Prescribed fire can be used to more quickly return these ecosystems to their natural

balance with fire. Prescribed burning is advantageous over trying to manage naturally occurring fires in high-hazard situations such as in mountain pine beetle infested areas, particularly in areas where dead fuels accumulate to the point that large, hot fires could occur. These fires are more destructive than those that would have naturally occurred, and they also intensify and perpetuate extremes in mountain pine beetle-fire relations (Cole 1977).

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