MOUNTAIN PINE BEETLE RESPONSE TO LODGEPOLE PINE STANDS OF DIFFERENT CHARACTERISTICS

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Abstract

Flying mountain pine beetles, Dendroctonus ponderosae Hopkins, were trapped using passive nondirectional barrier traps. Traps were hung at three levels above ground--1.8 m, midbole and midcrown--in thinned and unthinned lodgepole pine stands, Pinus contorta var. latifolia Engelmann. Overall, 48% of the 488 beetles trapped were caught in the midbole traps followed by the bottom (35%) and the midcrown traps (17%). Proportionately more females than males were usually caught at all levels, the highest proportion of females to males being in middle traps. Beetles were caught with about equal frequency in thinned and unthinned stands but more trees were infested in unthinned stands.

INTRODUCTION

The mountain pine beetle, Dendroctonus ponderosae Hopkins, kills the largest diameter lodgepole pine in infested stands during each successive year of an outbreak (Cole and Amman 1969), so that by the time the outbreak collapses, only the smallest diameter trees remain (Evenden and Gibson 1940, Hopping and Beall 1948). The beetle prefers the large diameter trees

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even when small trees in the vicinity are baited with the beetles' aggregative pheromone (Rasmussen 1972). Earlier measures of the height of beetle flight within 20 feet of the ground and their landing and attack pattern on the lower bole revealed that within this stratum most beetles fly within 8 to 16 feet above ground, and attack densities decrease with increasing height on the bole (Avis 1971). Visual stimuli and silhouette size are believed to play dominant roles in the final phases of tree selection (Schönherr 1976, Shepherd 1966). This knowledge has led to the development of cutting strategies directed at harvesting the large diameter trees and those having thick phloem to determine if their removal would reduce the amount of tree killing caused by the beetle (Hamel 1978, Cahill 1978).

During 1978 and 1979 the response of flying beetles to thinned stands having different average diameter at breast height (d.b.h.) and numbers of trees per hectare was measured at four study sites. Specific objectives of this preliminary study were to determine: (1) the vertical distribution of flying mountain pine beetles between midcrown and the ground; and (2) the incidence of flying beetles in stands that had been thinned to remove prescribed numbers of large diameter or thick phloemed trees.

METHODS AND MATERIALS

Study areas were selected on the Gallatin National Forest in southwestern Montana, the Lolo and Kootenai National Forests in western Montana, and the Shoshone National Forest in northwestern Wyoming. These areas were selected because they were to serve as demonstration areas to evaluate the effects of different diameter and basal area thinnings on subsequent tree killing by the mountain pine beetle. Stands selected for in-flight measures of the density of mountain pine beetle populations were chosen from treated stands where cutting and log removal had been completed prior to beetle emergence (Table I). Stands in the Gallatin area were thinned from 1974-76 (Hamel 1978), those on the Lolo some time after 1969 and those on the Kootenai and Shoshone Forests in the fall of 1978 and spring of 1979. Precut stand surveys were conducted by forest personnel prior to timber sales. Similar post-cut surveys were conducted by Forest Insect and Disease Management personnel to determine residual basal area and number of trees killed by the mountain pine beetle.

Table I. Location and treatment of stands selected for in-flight measures of mountain pine beetle abundance.

Cutting treatment[1]	Study area			
	Gallatin	Lolo	Kootenai	Shoshone
7-inch (18 cm)	X	X		X
10-inch (25 cm)	X		X	X
12-inch (30 cm)				X
0.09-inch phloem thickness (2.3 mm)	X			
80 ft^2 BA (7.4 m^2)			X	
100 ft^2 BA (9.3 m^2)			X	
Unthinned	X	X	X	X

[1]All lodgepole pine larger than the diameter listed or in excess of the desired basal area (BA) specified were removed.

A passive nondirectional barrier trap was used to monitor the number of beetles in flight. Traps were constructed of two plexiglas panels (30 cm wide x 57 cm high) cut lengthwise along the center to allow them to slip together at right angles to one another (Fig. 1). The top halves of four 4 ℓ plastic milk containers were inverted and fastened to the base of the panels. Flying beetles struck the panels, dropped into the funnels and were directed into 0.25 ℓ plastic bottles screwed into inverted lids affixed to the mouth of the funnels. The bottles were partially filled with water to prevent beetles from escaping. Small holes, punched midway up the sides, allowed excess rainwater to drain from the bottle. At each sampling site within a stand three traps were tied to a vertical 5 mm diameter nylon line that was suspended from a pulley fastened to a horizontal support line of the same size (Fig. 2). The horizontal line was positioned in the crown of two adjacent trees using a bow and arrow or line gun. The line gun employed a plastic projectile, to shoot a line through the crown of the supporting trees. The two loose ends of the horizontal line were tied to the bole of the support trees to maintain tension. The vertical line was positioned so that the traps did not touch adjacent foliage. The pulley allowed the vertical line with traps to be adjusted so that the top trap was at midcrown, midway between the extremities of the live crown; the middle bole, midway between the ground and the bottom of the live crown; and the bottom trap about 1.8 m above ground level. In 1978, two sets of three traps were located at each of two locations (12 traps total) in each test stand. In 1979, one set of three traps was located at each of three locations within the test stands to improve trap distribution in each stand selected on the Gallatin and Shoshone National Forests; one set of three traps was used in each of two locations within stands on the Kootenai National Forest. Beetles were collected from traps daily or twice weekly and identified, sexed and counted in the laboratory.

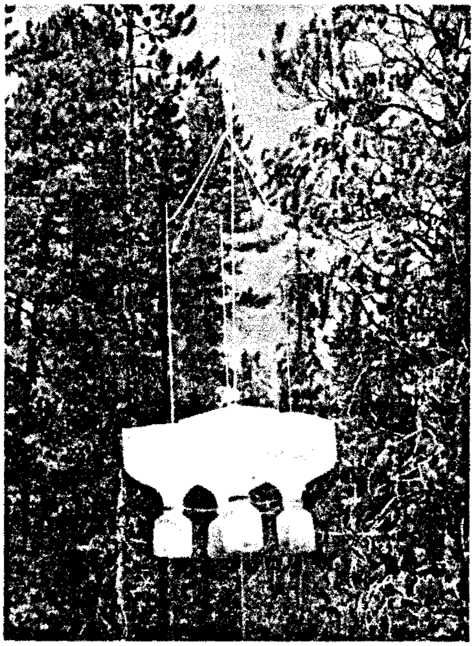

Fig. 1. Passive nondirectional barrier trap constructed of Plexiglas and plastic milk containers.

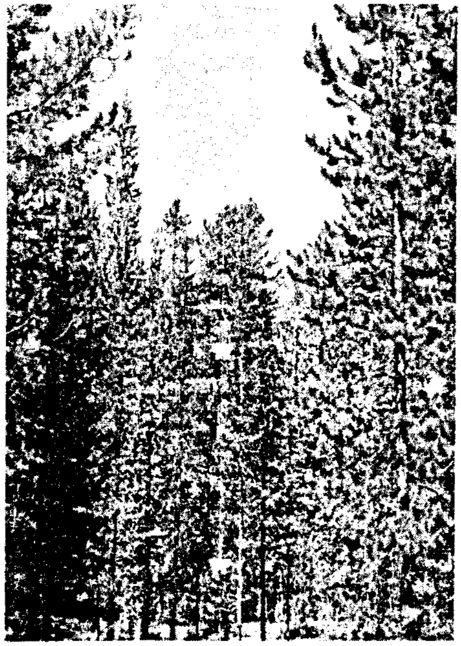

Fig. 2. Three traps were suspended from an overhead line shot over two adjacent trees.

RESULTS AND DISCUSSION

Vertical Distribution of Flying Beetles

Overall 48% of the 488 beetles trapped were caught in the midbole traps followed in order by the bottom (35%) and midcrown traps (17%) (Table II). Comparison of the vertical distribution by year, treatment and geographic location revealed considerable variation in catch totals. The most notable difference between years occurred on the unthinned Gallatin plots. During 1978, 60 beetles were trapped and 42% were caught in the bottom trap while in 1979 only 5 beetles were caught, all in midbole or midcrown traps. The drastic reduction in the 1979 catch may have been the result of unusually light snowfall and subzero winter temperatures that combined to kill most of the overwintering brood in exposed portions of infested boles above the snowpack. A similar but less drastic reduction in catch between years was also recorded on the thinned plots supporting the contention that cold temperatures were likely responsible for the reductions.

Beetles were caught with about equal frequency in thinned (211) and unthinned (277) stands. Again most were caught in the midbole traps. Percentages trapped by height, from the bottom trap toward midcrown, were: 33, 49, 18 for all thinned plots combined and 37, 46, 17 for the unthinned plots. There was no consistent difference in the number of beetles trapped by height between thinning treatments. One possible reason for differences in height of flight between test localities may be that the beetle continually adjusts its flight height to select the stratum with the fewest physical barriers within a stand environment that allows visual cues to be used in tree selection (Schönherr 1976, Shepherd 1966). Accordingly the height at which a beetle is trapped would likely vary between stands because of variations in stand structure and understory vegetation.

Not surprisingly the greatest number of beetles trapped were caught within the Gallatin plots where mountain pine beetle populations were in an outbreak status. In contrast populations on the Kootenai and Shoshone Forests, where fewer beetles were caught, had yet to reach the population densities common in the Gallatin area.

Response of Females and Males

Both females and males were caught in all strata and proportionately more were females. However, the proportion of the females caught was generally greater in the midbole traps than at the other two trapping heights in thinned and unthinned stands during both years (Table III). The proportion of males caught in any vertical stratum was not consistent. A larger proportion of males was caught in the bottom traps in 1978 and in

Table II. Number and percent of mountain beetles caught at three heights in selected lodgepole pine stands during 1978 and 1979.

Stand treatment	Trap position							
	Bottom		Midbole		Midcrown		Total	
	No.	%	No.	%	No.	%	No.	%
			Gallatin National Forest, Montana					
			1978					
Unthinned	25	42	24	40	11	18	60	31
7-inch (18 cm)	4	8	29	57	18	35	51	26
10-inch (25 cm)	10	31	17	53	5	16	32	16
Phloem	18	35	27	52	7	13	52	27
Total	57	29	97	50	41	21	195	100
			1979					
Unthinned	0	0	4	80	1	20	5	13
7-inch (18 cm)	0	0	7	64	4	36	11	29
10-inch (25 cm)	4	33	8	67	0	0	12	32
Phloem	0	0	6	60	4	40	10	26
Total	4	11	25	65	9	24	38	100
			Lolo and Kootenai National Forests, Montana					
			1978 (Lolo)					
Unthinned	0	0	0	0	0	0	0	0
7-inch (18 cm)	4	22	11	61	3	17	18	100
Total	4	22	11	61	3	17	18	100
			1979 (Kootenai)					
Unthinned	7	17	26	63	8	20	41	77
10-inch (25 cm)	1	12	3	38	4	50	8	15
100ft² BA (9.3 m²)	0	0	3	100	0	0	3	6
80 ft² BA (7.4 m²)	0	0	1	100	0	0	1	2
Total	8	15	33	62	12	23	53	100
			Shoshone National Forest, Wyoming					
			1978					
Unthinned	35	47	31	42	8	11	74	100
			1979					
Unthinned	12	39	12	39	7	22	31	28
7-inch (18 cm)	14	61	7	30	2	9	23	21
10-inch (25 cm)	6	46	6	46	1	8	13	12
12-inch (30 cm)	31	72	11	26	1	2	43	39
Total	63	57	36	33	11	10	110	100
All areas & years	171	35	233	48	84	17	488	100

Table III. Number and sex of mountain pine beetles caught by thinning treatment and trap height in selected lodgepole pine stands during 1978 and 1979.

Study area	Bottom			Midbole			Midcrown			Total		
	♀	♂	%♀	♀	♂	%♀	♀	♂	%♀	♀	♂	%♀
1978												
Unthinned stands												
Shoshone	20	15	57	26	5	84	5	3	63	51	23	69
Gallatin	14	11	56	11	13	46	8	3	70	33	27	57
Lolo	0	0	0	0	0	0	0	0	0	0	0	0
Total	34	26	57	37	18	67	13	6	68	84	50	63
Thinned stands												
Gallatin	20	12	63	52	21	71	18	12	60	90	45	67
Lolo	2	2	50	6	5	55	1	2	33	9	9	50
Total	22	14	61	58	26	69	19	14	58	99	54	65
1979												
Unthinned stands												
Shoshone	9	3	75	10	2	83	5	2	71	24	7	77
Gallatin	0	0	0	4	0	100	0	1	0	4	1	80
Kootenai	6	1	83	13	13	50	6	2	100	25	16	61
Total	15	4	78	27	15	80	11	5	67	53	24	69
Thinned stands												
Shoshone	28	23	55	15	9	63	3	1	75	46	33	58
Gallatin	3	1	75	13	8	62	5	3	63	21	12	64
Kootenai	0	1	0	6	1	86	2	2	50	8	4	67
Total	31	25	55	34	18	65	10	6	60	75	49	60

the midbole traps in 1979 in unthinned stands. However, in thinned stands just the reverse occurred.

The overall response to thinned and unthinned stands for the 2 years shows that females comprise about the same proportion of the population in thinned stands (65 and 60%) as in unthinned stands (63 and 69%). The greater number of females caught in the traps compares favorably with the sex ratios determined by sexing newly emerged beetles caught in cages on infested trees.

Beetle Catch in Relation to Lodgepole Pines Killed

Data are available for both beetle catch and trees killed only for the Gallatin study area. In this study area the incidence of flying beetles appears about equal for most thinned and the unthinned stands. In 1978, beetle catch was similar for the unthinned stand (31% of total catch), the 18 cm thinning (26%) and the phloem thinning (27% of the catch). However, the numbers of trees infested in these stands were markedly different. In the unthinned stand 54 trees/ha were infested, compared to only 2 trees/ha in the 18 cm cut and 21 trees/ha in the phloem cut (Table IV). The slightly higher proportion of females caught in the unthinned stands is not likely to account for the much larger number of infested trees in that stand. One might expect, then, that the population in 1979 would come primarily from the unthinned stands where more trees/hectare were infested than in all other stands combined. However, catch in 1979 in the unthinned stand was only 13% of the total, compared to 29% in the 18 cm thinning and 26% in the phloem thinning.

The data from the Gallatin plot suggest that the beetle did not discriminate between the four stand densities in which flight intensity was measured. Rather they apparently flew through all stands with about equal frequency but killed more trees in the unthinned stands where the large diameter, thick phloem trees had not been cut. Trapping will be continued in all plots for an additional 2 years to verify these preliminary findings.

CONCLUSIONS

The conclusions of this preliminary study of mountain pine beetle flight in lodgepole pine stands are:

Table IV. Number of mountain pine beetles caught and lodgepole pines killed by thinning treatment, Gallatin National Forest, Montana - 1978 and 1979.

Stand treatment	Trees killed 1978	Mountain pine beetles caught 1978		Mountain pine beetles caught 1979	
	Number/acre	Number	Percent	Number	Percent
Unthinned	21.7 (54/ha)	60	31	5	13
7-inch (18 cm)	0.8 (2/ha)	51	26	11	29
10-inch (25 cm)	6.1 (15/ha)	32	16	12	32
Phloem	8.5 (21/ha)	52	27	10	26
Total		211	100	38	100

1. Most beetles fly at midbole level or lower.
2. Both males and females fly at all levels in the stand.
3. Beetles fly in thinned and unthinned stands with about equal frequency but infest more trees in unthinned stands.

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