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Containment of Small Group Infestations of the Mountain Pine Beetle in Ponderosa Pine

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Mountain pine beetle tree baits were placed on two sides of each of 11 small infestations. Baited trees were attacked and 82% of the new infestations developed within a 55-foot radius of the baited trees. Infestations outside of the baited area but within 5 acres surrounding the baited trees were found on 2 of the 11 sites. This tree baiting strategy effectively contained MPB populations.

Keywords: Mountain pine beetle, pheromones, ponderosa pine

Introduction

Semiochemicals have shown promise as a means of managing populations of the mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins. Funnel traps baited with semiochemicals can be used to determine the presence or absence of MPB populations and the beginning and duration of their emergence period (Phero Tech 1987, USDA Forest Service 1988). Semiochemical baits on green trees, hereafter referred to as tree baits, have been used experimentally both to concentrate MPB in small spots which can later be logged (Borden et al. 1983b) and contain MPB within active timber sales (Borden et al. 1983a, 1983c).

The efficacy of the tree baits has generally been tested under outbreak conditions in stands of lodgepole pine, *Pinus contorta* Dougl. ex Loud. Treatment strategies under these conditions have been to install the baits in a grid pattern encompassing the infested trees (see Borden et al. 1983a, 1983c; Gray and Borden 1989). The outbreaks had generally reached a status where the number of infested trees per acre was high and individual spot infestations had coalesced. Outbreaks of this magnitude have progressed beyond the point where tree mortality can be minimized and the outbreak suppressed.

The more appropriate time for initiation of a containment strategy is when an outbreak is just starting and small group infestations appear. This study investigated the ability of semiochemical tree baits to contain small group infestations of the MPB in ponderosa pine, *Pinus ponderosa* Lawson.

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Methods

Eleven infestations, each consisting of 1 to 13 currently infested trees, were selected for study on the Black Hills National Forest during May 17-19, 1988. The infestations were located about 4 and 8 miles (6.4 and 10.8 km) southeast of Lead, S. Dak. Seven of the infestations were at least 0.25 miles (0.4 km) from other infestations, while four infestations had infested groups within 500 feet (152 m). These infestations were either in dense stands with basal areas of more than 200 square feet per acre (45 square meters per hectare) or in partially cut stands where basal area was 60 to 100 square feet per acre (13.5 to 22.5 square meters per hectare). Three infestations had paper birch, *Betula papyrifera* Marsh., and white spruce, *Picea glauca* (Moench) Voss, intermixed with the pine, while the other eight sites were essentially pure ponderosa pine.

On July 12 and 13, 1988, one Phero Tech MPB tree bait[3] was placed on each of two uninfested green trees immediately adjacent to each infestation. The installation of the tree baits coincided with the emergence of the first beetles. MPB emergence usually begins the last 10 days of July with peak emergence around August 15 (Schmid 1972), but the unseasonably warm temperatures in June and July prompted earlier emergence.

The baits were generally placed on a tree on the west and east side of each infestation—predominantly the windward and leeward directions, respectively. Each bait was placed on the north side of the tree about 6 feet (1.8 m) aboveground. Distance between baits and the nearest 1987 infested tree were as follows:

[3]The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.

Infestation	Distance between baits	Distance from closest bait to closest 1987 infested tree
	----------feet----------	
1	--	5
2	175	10
3	52	12
4	81	24
5	64	22
6	100	34
7	107	4
8	103	15
9	90	45
10	88	8
11	164	17

By September 15, 1988, each infestation was resurveyed. All trees within a 260-foot (ca 80-m) radius of the baited trees were examined and classified as green or MPB-infested. The direction and distance of each infested tree from a baited tree were recorded. During the survey of each infestation, 6- by 12-inch (15- by 30-cm) bark samples were removed from one 1987 infested tree, one 1988 baited tree, and one 1988 unbaited infested tree of similar size. MPB attack density was determined for each sample. *T*-tests were performed on the mean attack densities to determine significant differences between 1987 infested, 1988 baited, and 1988 infested but unbaited trees, α = 0.05.

The success of the baited tree strategy to contain small group infestations was evaluated by the examination of the 5-acre area (260-foot radius) surrounding the baited trees. Containment of MPB infestations was considered successful if (1) the baited tree(s) were infested; (2) additional infested trees, when present, were adjacent to the baited trees; and (3) no infested trees were found disjunct from those infested trees adjacent to the baited tree. Unsuccessful containment was indicated by infested trees within the 5-acre area but disjunct from the baited trees which were or were not attacked.

Results and Discussion

At 9 of the 11 infestations, all 1988 infested trees were within 55 feet (16.7 m) of a baited tree; no infested trees were found 55 to 260 feet distant from a bait. In the nine infestations, the 1988 attacked trees were adjacent to each baited tree and uninfested green trees were not intermingled with the infested trees. The closest 1988 infested tree to the baited tree was 16 feet (4.9 m) or less:

Infestation	Distance from baited trees to closest 1988 infested tree	Maximum distance across the 1988 infested groups
	--------------feet--------------	
1	12	13[4]
2	10	58
3	16	21
4	9	18[4]
5	8	21
6	11	80
7	12	94
8	11	15
9	6	21
10	3	40
11	2	50

Average distance to closest 1988 infested tree was 9 feet (2.7 m).

The other two infestations had one or more 1988 infested trees beyond the 55-foot radius in addition to the infested trees adjacent to the baited tree. Infestation 1 had a single 1988 attacked tree 93 feet (28.3 m) from the baited tree. This tree was a 1987 pitchout that was reattacked in 1988. Infestation 4, the remaining site, had another 1987 infestation within 100 yards (91 m). Beetles from this adjacent infestation were thought to have created the 1988 infestation 172 feet (52 m) from the baited tree. Other infested trees surrounding the baited tree were within 70 feet (21 m).

In infestations not subjected to artificial baits, Knight and Yasinski (1956) found 52% of the new infestations within 66 feet (20 m) of the previous year's infestations and 84% within 330 feet (100 m). In our study, 82% of the new infestations were within 55 feet. In terms of Knight and Yaskinski's distances, 82% of the 1988 infestations were within 66 feet. Based on these results, the MPB baits were generally successful in holding populations in place. The two exceptions appear to have been influenced by an additional unknown attractant or by the presence of another infestation.

The exceptions suggest effective trapping distance of the bait is of prime importance if this strategy is to function effectively. When the role of pheromones was first elucidated, forest managers visualized a capability of drawing beetles for miles—for example, from inaccessible steep slopes to the canyon floors where suppressive treatment could be applied more efficiently. Indeed, recent Forest Pest Management memos suggest an effective trapping distance of 1 to 2 miles. As pheromone knowledge expanded, however, it became apparent that the effective trapping distance of the currently available

[4]*Does not include the disjunct infested spot.*

bait for the MPB was considerably less than desired and probably less than 0.25 mile. Evidence from this study suggests that the consistently effective distance is less than 100 yards and probably 100 to 150 feet. At infestation 4, the creation of an infestation 172 feet from the closest baited tree and disjunct from the 1988 infested trees around the baited trees indicates the baits did not draw the beetles from distances over 150 feet (46 m). The beetles creating the separate spot probably originated from an undetected spot less than 500 feet (152 m) from the baited trees.

The effective trapping distance is influenced by wind direction. Both baited trees were attacked at the 10 infestations with two baited trees, but at some, the largest number of infested trees developed around the baited tree farthest from the 1987 infested trees. Presumably, the pheromone plume of the closest baited trees was directed away from the 1987 infestation by the wind. Simultaneously, the pheromone plume of the more distant baited tree was probably directed toward the 1987 infested trees and thus provided a source of attraction for beetles emerging from them. If wind direction does not account for this relationship, then it must be assumed that some beetles do not respond to the tree bait and disperse to other locations no matter how close the bait is to the dispersing population. These beetles do not contribute to the newly created infested trees adjacent to the baited trees but create additional disjunct infestations. If that has happened in this study, the new additional infestations were created outside the 5-acre area surrounding the baited trees.

The establishment of the new infestations may be influenced by stand conditions. At 8 of the 11 infestations, stand conditions were variable surrounding each infestation. In one direction would be a stand of over 150 square feet of basal area, while stands in other directions had basal areas ranging from 50 to 150 square feet. In these infestations, the baited tree in the denser stand created the larger number of surrounding 1988 infested trees. This suggests stand density plays a role in containing small infestations. To enhance containment, the bait should be placed on a tree in the densest stand proximal to the existing infestation.

Density of Attacks

The mean density of attacks per square foot (900 square cm) of bark at breast height on the 1987 infested, 1988 baited, and 1988 infested-but-unbaited trees was 8.2, 10.2, and 7.6, respectively. Attack densities on the baited tree were significantly higher than on the unbaited 1988 infested tree but not significantly different from the 1987 infested tree. Tree baits increased the density of attacks.

Although bark samples were not taken above breast height, observations of pitch tubes indicated attacks became less dense where the lower crown began and then terminated within a few feet above this point.

Observations of attacks on other nonsampled trees in each spot indicated some 1988 infested trees were pitchouts, especially at infestations 2, 7, and 10. Pitchouts were generally evident on trees of 6 to 7 inches d.b.h.

Numbers of Infested Trees

The ratio of the number of 1988 infested trees to the 1987 infested trees, a.k.a. the green-red ratio, was ≤1.5 in 6 of the 11 infestations. For the other five infestations, the number of 1988 trees was considerably greater in 1988 than in 1987, green-red ratio >2.0:

Infestation	MPB-infested trees		1988/1987 ratio[5]
	1987	1988	
1	2	3	1.5
2	4	16	4.0
3	6	4	0.7
4	12	10	0.8
5	6	8	1.3
6	4	14	3.5
7	11	28	2.5
8	8	6	0.8
9	1	5	5.0
10	10	23	2.3
11	13	20	1.5

At first glance, this result suggests the baited trees at five infestations may be attracting beetles from other distant infestations, thereby discrediting previous statements regarding effective trapping distance. Whether the 1988/1987 infested tree ratio properly evaluates the annual changes in numbers of infested trees depends on how well the underlying assumptions are met. Gray and Borden (1989) indicate that containment and concentration within baited areas will result in a higher green-red ratio only if baiting does not cause a proportionately lighter attack on more trees (i.e., either less infested surface area or a lesser density per unit area). Attack densities at breast height on unbaited infested trees in this study were 8.2 on 1987 trees vs. 7.6 on 1988 trees, thus indicating similar attack densities. However, attack densities were not determined on all trees and several infestations had numerous pitchout trees. In most cases, pitchouts indicate a lower density of attacks; thus, the criterion of similar densities was not uniformly met. In addition, two other conditions must also be met before the green-red ratio is considered valid. First, the size of

[5] *Green-red ratio of Borden et al. (1983a).*

infested trees should be comparable. In three of five infestations with a >2.0 green-red ratio, the average diameter of the 1988 infested trees was smaller than the diameter of the 1987 infested trees. Smaller trees will absorb fewer beetles, so the 1988/1987 ratio should increase. Second, and probably most important, the trend of the population for each infestation should be determined. A decreasing population trend will lead to a <1 green-red ratio, other conditions being equal. Similarly, an increasing population trend will create a >1 green-red ratio if other conditions are met. Although population trend via bark sampling prior to emergence was not determined in this study, our observations during other simultaneous studies indicated generally static to decreasing populations. In several of the infestations with >2 1988/1987 ratios, we believe the greater number of 1988 infested trees is accounted for by the combination of lower attack densities on smaller trees. Thus, more trees would be required to absorb the attacking population from the 1987 infestations. By this reasoning, an increase in the number of infested trees from 1987 to 1988 does not necessarily mean the baits were attracting beetles from other infestations.

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