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PROGRESS REPORT No. 6

on

COOPERATIVE RESEARCH ON CONTROL OF THE MOUNTAIN PINE BEETLE

December 18, 1969

by

ROYCE G. COX, CHAIRMAN

WHITE PINE COMMITTEE

MONTANA-NORTHERN IDAHO FOREST PEST ACTION COUNCIL

(P.O. Box 600, Lewiston, Idaho 83501)

of

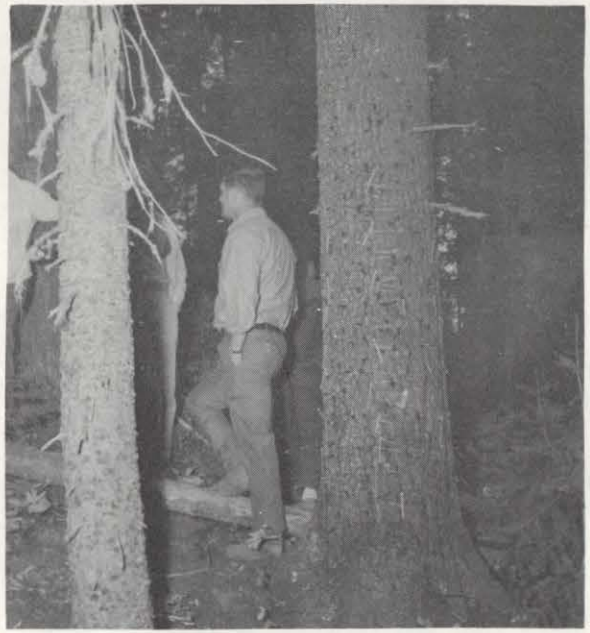
WESTERN FOREST PEST COMMITTEE

of

WESTERN FORESTRY AND CONSERVATION ASSOCIATION

(Founded 1909)

1. Method of baiting trap trees in Lightning Point area.



2. White pine baited with 200′ of attractant-charged polyethylene tubing near Jaype.

3. Closeup of # 2

4 & 5. Vertical and horizontal simulated trees baited with polyethylene tubing and treated with sticky material. Jaype area.

WHITE PINE COMMITTEE

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P. O. Box 600, Lewiston, Idaho

December 18, 1969

Cooperative Mountain Pine Beetle Control Research Project

PROGRESS REPORT #6

Synthetic Attractants Proven Effective

This report summarizes and briefly discusses the more significant results of our 1969 effort and outlines plans for 1970. For those interested in the details which support our conclusions, more comprehensive reports will be supplied on request, i.e.:

1. Progress Report on Study of Dendroctonus ponderosae Attractants by G. B. Pitman, Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York, September 15, 1969.*

2. Progress Report on Isolation, Identification, and Synthesis of Pine Bark Beetle Attractants, to Boyce Thompson Institute, August 5, 1969, by G. W. Kinzer and A. F. Fentiman, Battelle Memorial Institute, Columbus, Ohio. *

3. List of 25 questions and answers about details of the research since its inception in 1965.

Dr. Pitman, who has headed this cooperative work since 1965, is leader of the Grass Valley, California, Forest Research Laboratory of the Boyce Thompson Institute. Messrs. Kinzer and Fentiman, who have performed most of the chemical analytical and synthesis work, are Project Leader and Research Chemist, respectively, of the Columbus Laboratories of Battelle Memorial Institute.

Conclusions

The primary objective of our 1969 research was to determine whether or not the mountain pine beetle in white pine can be manipulated to a significant degree through the use of synthetic trans-verbenol plus alpha pinene. Completion of most of the planned tests produced results which are highly encouraging. We are not claiming actual control of the insect over large areas, but the tests, conducted in a typical forest environment, have

* The writer is indebted to these reports for much of the information condensed in this Progress Report #6.

conclusively demonstrated that large numbers of naturally-emerged, flying beetles can be attracted to baited white pines with few attacks occurring on unbaited pines in the treatment area. Therefore, the possibility of some degree of control through pest density regulation has been greatly enhanced. The major hurdle remaining is the development of a more simplified and sure method of exterminating attracted beetles.

These conclusions are based on the following facts:

1. Synthetic trans-verbenol at microgram levels plus alpha pinene is highly competitive with natural attractant sources.

2. The attractant is not difficult to synthesize and high purity is not required for optimum activity.

3. The physical properties of trans-verbenol and alpha pinene make possible simple and practical delivery systems such as in small-bore polyethylene tubing.

4. On the average, the synthetic pheromone attracts nearly equal numbers of male and female beetles.

5. Large-scale testing of insect and host components of the attractant complex in a practical release system has been successfully completed.

6. Although lindane killed an undetermined number of beetles, it was not completely effective in protecting baited trees.

In this light, trans-verbenol becomes an adjunct to the concepts of biological control.

SUMMARY REPORT

The 1969 project again consisted of two phases. As previously, Phase I was basic and developmental research, while Phase II was application of the best available techniques in a fairly large-scale, but limited, forest test.

The objectives of Phase I are listed below. Following each is a resume of the methodology and results, with brief discussion where appropriate.

Objective 1: Develop and test a simple and reliable technique of disseminating the attractant compounds in the forest.

Method: Based on numerous tests of several techniques in 1968, the decision was made to use small-bore, thin-walled polyethylene tubing charged with the two attractant compounds, synthetic trans-verbenol and alpha pinene. Laboratory tests of diffusion rates of the two compounds through tubing walls were successfully completed early in 1969, thus making possible the use of

this delivery system in Phase II. The tubing used had an inside diameter of .034" and an outside diameter of .050"; it was loaded with a 60-40 mixture of trans-verbenol (> 92% pure) and alpha pinene (95% pure).

Results: The system worked as planned under forest conditions for disseminating trans-verbenol, with adequate diffusion occurring over a period of at least two months. However, the diffusion rate for the more volatile alpha pinene proved too high under forest conditions; this necessitated the placement of supplemental supplies of alpha pinene in separate containers on all baited trees to maintain the essential simultaneous transmission of the two compounds.

Objective 2: Determine the relative attractiveness of the formulated materials used in Phase II, as compared to the natural pheromone.

Method: The attractant-charged polyethylene tubing developed under objective one, above, was used. One and six foot lengths of the tubing were tested against fresh white pine billets infested with 125 females in field olfactometers.

Results: Both the 1' and 6' lengths of attractant tubing consistently attracted more beetles than the female-infested billets, averaging 12:1. The ratio of attracted males to females varied among tests but averaged close to 1:1.

Objective 3: Evaluate the attractiveness of synthesized trans-verbenol with varying amounts of impurities.

Method: Field olfactometers were used to test three levels of impurities, i.e., crude trans-verbenol, trans-verbenol purified by one distillation only, and trans-verbenol purified by distillation and thin layer chromatography (TLC).

Results: No significant difference in numbers of responding beetles was detected among the three levels of purity. This means that the crude material could be used effectively at considerable cost savings.

Objective 4: Assess the role of selected host volatiles in the attraction complex.

Method: Several white pine terpines were tested with trans-verbenol in field olfactometers to measure their relative flight-arrestment activity.

Results: Alpha pinene is the most effective. Myrcene showed some flight arrestment activity, but even raw white pine resin was not as effective as alpha pinene.

Objective 5: Determine the range of attractiveness of the polyethylene tubing used in Phase II.

Method: Two field olfactometers were triangulated upwind from a known brood source (a load of infested logs stacked in a meadow). Pheromone concentration in one olfactometer was changed as both were moved farther apart and farther from the infested log deck.

Results: Inconclusive. The test will be repeated in 1970 in a completely different experimental design.

Objective 6: Ascertain whether or not mountain pine beetles can be attracted to nonhost tree species and exterminated.

Method: The plan was to spray five each grand fir and western red cedar with quick-knockdown insecticide (lannate + buticide) and then to bait each tree with the standard attractant tubing. A plastic apron was to be placed around the base of each tree to catch dead beetles.

Results: None. The plan could not be carried out because of a shortage of attractant tubing, i.e., the Phase II project took more than estimated. The test will be made in 1970.

Objective 7: To determine if the mountain pine beetle (D.p.) could be induced by heavy baiting of the synthetic attractant to over-attack white pines to the extent that the resulting brood would be too crowded to develop to maturity.

Method: A single 22" white pine located approximately 1000' west of the Jaype log decks was baited with 200' of the standard attractant tubing. The experiment was established on July 16, four weeks after the peak flight of D.p. on June 12-15. All known brood trees had been salvage-logged from the surrounding area; therefore, the only local source of beetles was from the log decks in the Jaype mill yard.

Results: By August 21 this tree had a D.p. attack density averaging approximately 12 beetles per square foot at d.b.h., or about the normal mass-attack density. Although this particular result was disappointing, two other results provided a most convincing demonstration of the drawing power of the synthetic attractant: (a) the mass attack extended to a height of about 100 feet, and (b) careful inspection of all surrounding unbaited white pines revealed not even a single beetle attack. This tree has now been felled and sections placed in forced-rearing chambers to determine final brood development.

Objective 8: To determine the effectiveness of simulated or bogus trees as trapping devices.

Reason for test: Observations over many years have indicated that the mountain pine beetle (D.p.) shows a preference for freshly windthrown white pines. The first tests made by B.T.I. in Idaho in 1965 indicated that, with sleeve-type olfactometers, D.p. preferred a horizontal alignment of the traps 10 to 1 over a vertical alignment. Tests in 1968 showed that D.p. had a strong preference for baited white pines recently pushed over by a bulldozer

to baited live, standing white pines. If this apparent preference of D.p. for horizontal configurations could be utilized in some practical way, perhaps an economical method of control could be developed.

Method: Because of higher-priority project commitments, this experiment could not be established until late in the season on September 8, a time when virtually no beetles were flying. Three "bogus trees" consisting of 10" x 8' paper roll cores from PFI's Lewiston paperboard mill were placed in the forest edge east of the Jaype mill. The exterior surface of each tube was coated with "Stickum Special" and baited with 25 to 30 feet of the attractant tubing. One trap was erected vertically, and the other two were placed horizontally within one foot of the ground.

Results: On September 12 and 13, a minor emergence of mountain pine beetle occurred, just prior to the first fall rain. The source of the beetles apparently was the log decks in the Jaype mill yard because, as in the preceding experiment, all brood trees had been previously removed from the surrounding forest. This emergence, as usual, was much smaller than the major peak which occurred in June. Even so, in one day the vertical trap attracted 77 beetles, one of the horizontal traps attracted 239 beetles, and the other horizontal trap attracted 329 beetles. Total trapped during the two-week period before cold weather halted beetle activity were 137, 391 and 392 for a total of 920. No white pine trees were attacked adjacent to or in the vicinity of the traps--again a convincing demonstration of the attractant's drawing power. Also, these results tend to confirm the earlier studies which showed D.p. has a preference for attractant sources having a horizontal configuration.

Discussion: Three major faults of the traps were noted--

1. Failure of the sticky compound to securely hold the beetles. They walked through the "Stickum" much as they do pitch, eventually crawling to the inside, uncoated surface of the tube. The beetles were immobilized by cold weather before observations could be completed, but presumably under spring weather conditions the beetles could have eventually cleaned themselves and resumed flight. This could be easily overcome by adding a small amount of insecticide to the "Stickum"; however, we would prefer to develop a purely biological control. One potential technique is to coat the inside as well as the outside of the tube with the tacky compound.

2. The "Stickum Special" lost its tackiness after only three weeks' exposure, which would complicate its use in large-scale deployment. We will present this problem to the chemists.

3. The upper tacky surface of the horizontal traps was rather quickly fouled with needles and twigs falling from the forest canopy. This could be overcome by use of a paper roof over the trap. Or, the tube could be coated only on the inside, with the walls perforated to permit beetle entry as in one olfactometer design. Or vertical traps only could be used, although these

were not as effective in this test.

While no definite conclusions on the value of these traps can be drawn from this small-scale test, it did produce sufficient results to warrant a much larger test next year. Large numbers of these traps can be made inexpensively from reject grade polyethylene-coated paperboard. Coating and placing them in the forest will be costly and cumbersome, but no more so than spraying bait trees with insecticide. If successful, the advantages of the traps over live trees are obvious.

Phase II:

Phase II had one major objective--to demonstrate whether or not trans-verbenol plus alpha pinene can be used effectively to manipulate populations of the mountain pine beetle in its natural environment. A secondary objective was to protect baited trees from lethal attack by attracted beetles.

Method: The study area lies near Lightning Point approximately 20 miles northwest of Potlatch Forests, Inc.'s Headquarters operation in Idaho. A stand of mature 140-180 year old white pine was selected and eight 40-acre plots were delineated in a semi-checkerboard pattern so that they were not side by side but their corners could touch. Within each plot white pine on two-chain centers were selected, marked and sprayed to a height of 18 to 20 feet with lindane and water (approx. 2.3% solution).

A few weeks prior to the anticipated spring flight of D.p., 725 white pines were baited at breast height with the polyethylene tubing charged with a mixture of synthetic trans-verbenol (1 distillation + TLC) and alpha-pinene. (If a nonhost species was located on the center, it was not baited.) Approximately 5,500 feet of the tubing was required for the 725 trees. At the concentration used, trans-verbenol was evaporating at a rate of approximately 25 µg/hr/ft of tubing during the period of peak flight. Alpha-pinene evaporated at a much faster rate and the tubing was depleted of terpene within a few days. Since alpha-pinene is the key host constituent for trans-verbenol activity, each tree was rebaited with alpha pinene contained in small polyethylene bottles or 2 to 4 inch lengths of large-core polyethylene tubing. The rate of loss was within the range of 1000 - 5000 µg/hr/container.

Some four weeks after the trees were baited, which preceded the period of peak emergence, surveillance of the plots was initiated by examining each treated tree. This was continued until the end of August.

A total cruise was made also within each 40-acre plot to ascertain the 1969 beetle activity in unbaited trees as well as the number and position of 1968 brood sources.

Results: The influence of deploying the attractant is illustrated by the following table.

Effect of baiting mature white pine with polyethylene tubing containing trans-verbenol and alpha pinene on 320 acres.

Plot No.	No. pines Baited	Number of trees attacked* Mass	Moderate	Few	Percent of baited Mass	Mod.	Few	No. of pines mass attacked but not baited
1	95	25	1	17	26.3	1.0	17.9	1
2	88	11	1	5	12.5	1.1	5.7	2
3	88	12	5	4	13.6	5.7	4.5	2
4	95	10	4	14	10.5	4.2	14.7	3
5	60	7	3	4	11.6	5.0	6.6	0
6	100	23	5	14	23.0	5.0	14.0	4
7	100	23	1	10	23.0	1.0	10.0	3
8	99	22	4	16	22.2	4.0	16.2	6
Tot.	725	133	24	84	18.3	3.3	11.6	21

* Mass = 100 visible attacks or more (approximation)
Moderate = 10 - 99 visible attacks
Few = 1 - 10 visible attacks

Of the 725 pines baited, D. ponderosae activity was noted on 241 or 33%; 133 or 18% were mass attacked. Only 21 unbaited pines were mass attacked in all of the eight 40-acre plots.

Conclusions: The sum of these observations clearly indicates naturally emerged, flying beetles can be attracted for some distance and induced to attack trees baited with trans-verbenol + alpha pinene, with relatively few attacks occurring on unbaited trees. Measurement or even estimation of the distance of attraction is a function of many variables which presently are only partially understood. Lindane was not 100% effective in preventing mass attack and subsequent tree mortality.

Discussion: From the available data little can be concluded concerning the distance or over what dimensions the attractant was effective. No statistical analysis of data has yet been made; however, there are several features of the attack pattern within and outside of the treated 40-acre blocks which are of interest. There was a definite tendency for the beetles to attack baited trees in the outer perimeter of the block. This tendency was nearly 2 to 1. An explanation for this tendency can be offered in that mountain pine beetles will not fly by an attractive source in search of one more distant. While the majority of attacks within the baited 40's undoubtedly resulted from internal brood trees, it is also apparent that the attractant drew a significant number of beetles from adjacent untreated areas into the boundaries of the treated 40's.

Failure of the lindane to protect baited trees was disappointing. Lindane is recorded elsewhere as being highly effective on Dendroctonus, and the reason for its failure in this test is not apparent. Final brood development in

the lindane treated trees will not be known until next spring, but based on present observations, most of the 133 mass-attacked trees will die. Also, a number of the baited trees were hit well above the 20' of bole sprayed with lindane (one tree up to 75'). While this provided a graphic demonstration of the attractant's power, we had hoped the lindane would protect trees from lethal attack so as to avoid later removal or treatment. Effective beetle control requires the elimination of a high percentage of the brood. We have no way of directly measuring the number of attracted beetles killed by the lindane; an indication is derived from the fact that 484 of the 725 baited trees show no attacks, and, even more significantly, only 21 of the intermingled unbaited pines (at least 7,800 trees) were mass attacked, and half of these were within 10 to 15 feet of a baited tree.

Additional information will, no doubt, come to light as we continue to study the treatment area which will be baited again next year. All 1969 brood trees will be left in the study area to assure an uninterrupted sequence of beetle population and behavior as affected by the research procedures.

Costs of Project to Date

Source of Funds	Amount by Years			
	1966	1967	1968	1969
	Approx.			
Boyce Thompson Institute(1)	$50,000	$77,000	$63,000	$32,000
Potlatch Forests, Inc.	5,000	15,000	12,000	22,000
Idaho Forest Management Fund(2)	none	20,000	25,000	25,000
Total	$55,000	$112,000	$100,000	$79,000

(1) Includes funds from the Boyce Thompson Institute and grants to the Institute from the U. S. Public Health Service, and the Margaret T. Biddle Foundation.

(2) A special account established by state law (Idaho Code 38-407 & 408) for cooperative forest pest abatement and control, which accumulates to a ceiling of $100,000 from 5% of monies collected by the state from timber harvest on private lands and state timber sales for logging slash disposal and fire hazard reduction. Disbursements from this fund must be approved by the Idaho State Land Board.

FUTURE PLANS

Plans for 1970 again include two phases--Phase I on continued basic research and Phase II on application of knowledge gained to date.

Phase I will include:

1. Development of a process for producing trans-verbenol in large quantities for use by all interested landowners and forest protection agencies. Comment: This will be contracted to a commercial chemical firm. Battelle

Memorial Institute, which has produced all the synthetic used to date, can continue to produce compounds for research purposes but not in the quantities necessary for larger scale application.

2. Improvement in attractant formulations and technology of dissemination. Comment: This summer's tests developed excellent information but further refinements will be tested in 1970. For example, the necessity to place supplemental supplies of alpha pinene on all baited trees resulted in higher labor costs than anticipated. One approach to overcoming this problem is the use of two tubes or "double-barrelled" tubing of different inside diameters for different volume capacities and different wall thicknesses for different diffusion rates. Another possibility is the formulation of the attractant with latex compounds.

Also, a system which would maintain the attractant stations over two or three growing seasons without interim servicing would simplify the operation. The attractant compounds are relatively stable during cold weather, becoming liquid and consequently more volatile when temperatures reach about 60° F.

Battelle's chemists will explore these and other ideas during the winter so as to have an improved system ready for next spring.

3. Development and testing of various trapping techniques, e.g., large vs. small trees, white pine vs. other species, road right-of-way logs, pushed-over trees, simulated trees, etc. An intensive installation of simulated tree traps will be placed around the Jaype mill yard to determine their effect on the 1970 attack pattern. Douglas fir beetle attractant will also be utilized.

4. Further testing of maximum effective spacing of beetle attraction stations as related to topographic and surface-weather factors.

5. Development and testing of more effective methods of exterminating trapped beetles, both pesticidal and nonpesticidal.

The use of tacky compounds will be further tested for effectiveness in eliminating beetles. We would prefer, of course, to develop a purely biological system employing no poisonous compounds, but this may not be practicable. In any event, the highly selective manner of deployment of the insecticides in these projects should not pose a threat to humans or wildlife.

Another approach will be to attempt to induce "autocidal" beetle behavior by: a-Activating ultra-high attack densities in baited trees so that resultant broods would prematurely exhaust their phloem space, and b-Concentrating attacks on small, suppressed, thin-barked white pines wherein there would be insufficient phloem and bark thickness to support egg and larvae galleries.

6. Study of the effect of beetle trapping and exterminating techniques

on wildlife, principally birds. This was planned for 1968, but the hoped-for specialists were not available. Based on observations to date, we foresee no hazards to wildlife, but a scientific investigation will be made to satisfy critics.

Note: Some of the tests of Phase I will be conducted in conjunction with and on the same areas as Phase II.

Phase II

Phase II will be primarily a greatly expanded test of the synthetic attractant on a large area of white pine type in the same and surrounding area of this year's project. Techniques successfully used this year will be applied in a modified form. A "practical grade" (crude with one distillation) of trans-verbenol plus alpha pinene will be used as "bait". Approximately 8,000 trees will be baited on 4,000 acres of private land at a level averaging two trees per acre. Each tree will be baited with three times the volume of attractant used this year to increase its range of attraction. Bait trees will be selected from intermediate crown classes instead of dominant as this year.

On most of the area, baited trees will be left unprotected (not sprayed with insecticide) to obtain a more accurate assessment of mass attack pattern and density as influenced by the attractant. Trees mass-attacked in 1970 will be either salvage-logged or sprayed with penetrating insecticide to exterminate the broods. Bait trees will be located in clumps of two or more spaced at 200 to 400 foot intervals on main and lateral ridges, rather than single trees on a 132' systematic grid on separated 40-acre blocks as in 1969; this revised technique will reduce time required for baiting the trees and will make access much easier, both for placing the attractant and for follow-up treatment of new brood trees.

In addition to the 4,000 acres of private land, some adjacent state land may be treated by state financing.

Estimated Cost of Phase II for 1970

The following cost estimates are reported as guidelines for those who have expressed interest in applying the system on their own lands. While these estimates are based on the best present information, please bear in mind that Items 2 and 3 in particular are subject to much variation, depending on topography, access, weather, and other variables.

1. Attractant:

This year Battelle Memorial Institute produced 140 grams (about 1/3 pound or 1/2 pint) of high purity trans-verbenol for PFI for use in Phase II at a cost of $3,000 plus about $1,000 for tubing and charging, or a total of $4,000. (This computes to a price of about $800 per oz. or 32 times the price of Channel No. 5!) The 140 grams was used to bait 725 trees, which computes

to 0.1931 grams and $5.52 per tree. The cost of synthetic trans-verbenol will, of course, be greatly reduced under mass production. Also, this summer's tests proved that semi-refined trans-verbenol is just as attractive as the highly purified; use of this "practical grade" will greatly reduce costs. On the other hand, we plan to use about three times the volume per bait tree in next year's Phase II. We now have a semi-firm quote of $150 per pound, which will bait about 760 trees at three times the 1969 level, or 20¢ per tree.

In addition, some money may be needed to underwrite the development of the process for producing synthetic attractant in large quantities. Dr. McNew*, in his negotiations with chemical firms, has guaranteed up to $10,000 of Boyce Thompson funds to cover the cost so as to assure the availability of sufficient trans-verbenol in time for use in the spring of 1970. However, BTI is under no obligation to stand this cost, so we will try to solicit reimbursement funds, if necessary.

The second required compound in the attractant, alpha pinene, presents no problem because it is readily available from chemical supply houses at $1.30 per gallon. One gallon is sufficient for 500 bait trees at anticipated levels, which computes to 0.3¢ per tree--a negligible amount.

We have a firm price on the polyethylene tubing--$2,500 for 50,000 feet, which we anticipate will be enough for the 8,000 bait trees planned for Phase II. This computes to 31¢ per tree.

We have no firm quote on the cost of charging the tubing with the attractant, but we think this should not run more than 6¢ per tree.

Summary of estimated material costs:

Trans-verbenol	$0.20 per tree
Alpha pinene	--
Tubing	0.31 " "
Charging	0.06 " "
Total	$0.57 per tree

This is only about one-tenth of the 1969 cost.

Cost per acre at the planned levels of baiting of two trees per acre is, therefore, $1.14.

2. Baiting the trees:

The cost of locating the bait trees and placing the attractant is a

* Dr. George L. McNew, Managing Director, Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.

significant item which will vary markedly depending on topography, ease of access, and weather. Our actual costs in 1969 were 97¢ per tree for the 320 acres, but access was extremely difficult and the trees were located on a systematic 132-foot grid in 8 separated 40-acre blocks. Our 1970 plan to locate the bait trees on main and lateral ridges will reduce the time required. However, most of the attractant will have to be placed while several feet of snow remain on the ground, which will again require over-snow vehicles, and snow conditions may be difficult. Consequently, we are budgeting 50¢ per tree or $1.00 per acre for the planned level of baiting.

3. Brood extermination:

The most crucial and difficult to estimate cost item is the treatment of mass-attacked trees to eliminate beetle broods. This year our per tree costs averaged $3.64 for labor and 17¢ for lindane, for a total of $3.81. However, our 1970 plan to leave the baited trees untreated prior to beetle flight with follow-up treatment prior to 1971 emergence may increase costs over 1969 experience. This year we treated all of the 725 baited trees prior to beetle flight, of which only 133 or 18% were mass attacked. Our present knowledge is insufficient to provide a good estimate of what percentage of the unprotected bait trees will be attacked. We are guessing not more than 40%. However, the unprotected trees which are mass attacked may have to be felled for spraying, which would nearly double the cost over 1969. Consequently, we are budgeting $7.00 per tree which, at the 40% mass attack level, computes to $5.60 per acre. This is assuming lindane can be used; if ethylene dibromide is required, cost will be increased somewhat. Of course, this cost will be eliminated for trees which are salvageable at a break-even or better cost.

Summary of estimated 1970 total costs for Phase II:

	Per Tree					Per Acre
1. Attractant	$0.57	x	2			$1.14
2. Baiting trees	0.50	x	2			1.00
3. Brood treatment	7.00	x	2	x	.40	5.60
						$7.74

Justification for Phase II

While the estimated cost of $7.74 per acre for Phase II may seem a heavy burden, it is considerably lower than any control effort we have made in the past. Use of the attractant to draw beetles to pre-located bait trees greatly lessens the time required to locate new brood trees as compared to searching for them in large unbaited areas. Also, in general, bait trees can be established in much more accessible locations as compared to naturally-attacked brood trees.

Our 1968 survey of four sections in the Lightning Point project area indicated a D.p. mass attack density averaging about 4% annually of total white pine stand volume over the last five years, or per acre mortality of about 800 bd. ft. annually and 4,000 bd. ft. for the five-year period. This is equivalent to a stumpage value loss of $28 per acre annually, or $140 for the five years at $35 per MBF.

Furthermore, unless checked soon, this present full-scale epidemic can be expected to "blow" into super-epidemic proportions as has already occurred in other similar stands where infestations have been recorded as high as 12% annually, with over 50% of the white pine volume killed within five years.

We do not anticipate that one year's intensive control effort will stop the epidemic. Perhaps two to three years will be required to reduce the infestation to an endemic or level of low economic impact. This estimate is based on two basic assumptions: 1-The attractant will continue to work as effectively as it did this year; and, 2-The beetle broods concentrated by the attractant can be economically eliminated.

If these assumptions prove correct, and if three years are required to achieve control, the total estimated cost would be 3 x $7.74 = $23.22. This is less than the stumpage value of one year's past losses. Also, if the bogus or simulated bait trees prove effective, costs should be further reduced. In addition, reducing the number of snags will reduce the fire hazard and lower fire protection costs. Hence, the control effort is more than justified on an economic basis alone.

Financing

As in the past, continuation of financial support for this project, especially Phase I, is based on "faith, hope and charity." Budgeting the 1970 project is almost completed. Boyce Thompson Institute will continue to provide, gratis, the necessary direction, field supervision and technical assistance for both Phases I and II. Potlatch Forests, Inc., has budgeted coverage of all other costs of Phase II on PFI lands, as was done this year, and will again provide field laboratory space and some other facilities for both phases. PFI may also make a direct cash contribution to Phase I (if necessary) to assure continuation of the project.

To help underwrite Phase I, we are hopeful of drawing, for the third time, from the special forest pest abatement account under the Idaho Forest Management Fund. We will submit a request to the Idaho State Land Board in the near future. Justification for this request lies in the fact that the results of the research will benefit all forest owners, public and private. The 1970 project has been endorsed by the North Idaho Forestry Association, the Southern Idaho Forestry Association, the Clearwater-Potlatch Timber Protective Association, and the Intermountain Forest Pest Action Council.

Participation by Others

There are many thousands of acres of white pine stands on federal, state and private lands where mountain pine beetle infestations are as high or higher than in the Lightning Point area. Logging all of these stands rapidly enough to achieve effective salvage is a physical impracticability.

We feel this research has advanced to the point where testing of applications by other forest managing agencies, at least on a small scale, is justified. Also, tests of the attractant in lodgepole and ponderosa pine stands invaded by D. p. now seem justified. We encourage such tests, which would add to the fund of knowledge.

Anyone who decides to conduct their own forest trials should notify us immediately so we can forward this interest on to Dr. McNew for use in his negotiations with the chemical companies for production of trans-verbenol. Potlatch Forests, Inc. plans to order about 13 pounds for use in Phases I and II of our 1970 project, plus some additional treatment of hot-spot infestations in other white pine stands. The conversion factor we are using for trans-verbenol is 1.32 lbs. per 1,000 trees. This will vary depending on tree size; we are estimating an average d.b.h. of 20" for the intermediate trees in the stands planned for treatment.

Any significant changes in cost estimates will be communicated to those who request it. Also, we can supply labor cost estimates on a man-day basis on request.

If requested, we will conduct an orientation and discussion session early in 1970.

So, again, if you are interested let us know.

Any questions, ideas and criticisms will be welcomed.

Hopefully submitted,

Royce G. Cox

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Chairman