MOUNTAIN PINE BEETLE AGGREGATION SEMIOCHEMICAL USE IN ALBERTA AND SASKATCHEWAN, 1983-1987

H. F. Cerezke

ABSTRACT: A recent outbreak (1976-1986) of the mountain pine beetle, Dendroctonus ponderosae Hopk. in southwestern Alberta and Saskatchewan prompted control programs to be initiated in 1980-82 within three forested areas and involving three provincial agencies. The programs incorporated newly developed mountain pine beetle semiochemical tree baits during 1983 to 1987 to assist in the control strategies. A variety of information collected mostly in 1983 was used to help evaluate functional aspects of the tree baits for efficient detection, population monitoring and direct control. Data are presented on tree bait distribution, numbers of baits and their placement pattern, and incidence of attacks and attack densities on baited and adjacent unbaited trees.

INTRODUCTION

The recent mountain pine beetle (MPB), Dendroctonus ponderosae Hopkins, outbreak in southwestern Alberta was first detected in 1977 (Hiratsuka et al. 1980). It subsequently expanded rapidly northward along the eastern slopes of the Rocky Mountains, and attained maximum spread some 130 km north of the Canada-United States border by 1980-81 (Hiratsuka et al. 1982). During 1979 and 1980 numerous small but scattered infestations were discovered in the Porcupine Hills in southwestern Alberta, and in the Cypress Hills, an area straddling the southern Alberta-Saskatchewan boundary. The latter area is a distinct forested island isolated from the foothills region by over 200 km of intervening prairie agricultural zone (Newsome and Dix 1968). In addition, small infestation patches were observerd in 1982 in the Alberta foothills (Kananaskis area) directly east of Banff National Park. By 1986, after 10 years of outbreak period, MPB populations had declined to endemic levels at all locations in Alberta and Saskatchewan. Previous historical records of the MPB having occurred in either of these three areas was entirely unknown.

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Prior to 1977, only two observational records had indicated that endemic populations of the MPB existed in southwestern Alberta during the late 1960's and in the early 1970's. The only previous recorded outbreak in Alberta occurred in Banff National Park between 1939 and 1944 (Hopping and Mathers 1945).

During the recent outbreak period in Alberta and Saskatchewan intensive salvage and control programs were initiated by the provinces in 1980-82 (Alberta Forestry, Lands and Wildlife 1986). The control programs consisted of detecting patches of infested trees, followed by destruction of live beetle broods by cutting, burning, bark-peeling and log processing at the mill. Semiochemicals of the MPB had previously been tested successfully in British Columbia and in the Cypress Hills (Borden et al. 1983a, 1983b, 1983c; Cerezke et al. 1984; Conn et al. 1983) and were incorporated initially into the control strategies by three different provincial agencies in 1983. This paper reviews the semiochemical tree baiting strategy from 1983 to 1987, describes the baiting results observed and offers some interpretations of the results.

METHODS AND MATERIALS

Control programs utilizing MPB semiochemicals were deployed in three general areas: Porcupine Hills and adjacent forested lands (PH); Cypress Hills (CH) in Alberta and Saskatchewan and in the Kananaskis (K) area directly east of Banff National Park (fig. 1).

All agencies deployed the same commercially prepared tree bait (Phero Tech Inc., Vancouver, B.C.), consisting of two MPB pheromone components and a host tree monoterpene. The objectives of the baiting program were: to test the tree bait as a reliable detection tool, and thus help reduce costs of subsequent aerial and ground surveys and tree treatments, and to test the baits for survey monitoring to indicate yearly trends of relative MPB abundance and as part of the direct control strategy of beetle population manipulation and/or reduction.

During the first year of semiochemical deployment (1983) an attempt was made to standardize the baiting procedure with the three provincial agencies (Alberta Forest Service, Alberta Parks and Recreation and Saskatchewan Parks, Recreation and Culture) to provide a basis for data analyses and interpretation. In subsequent years the pattern of bait

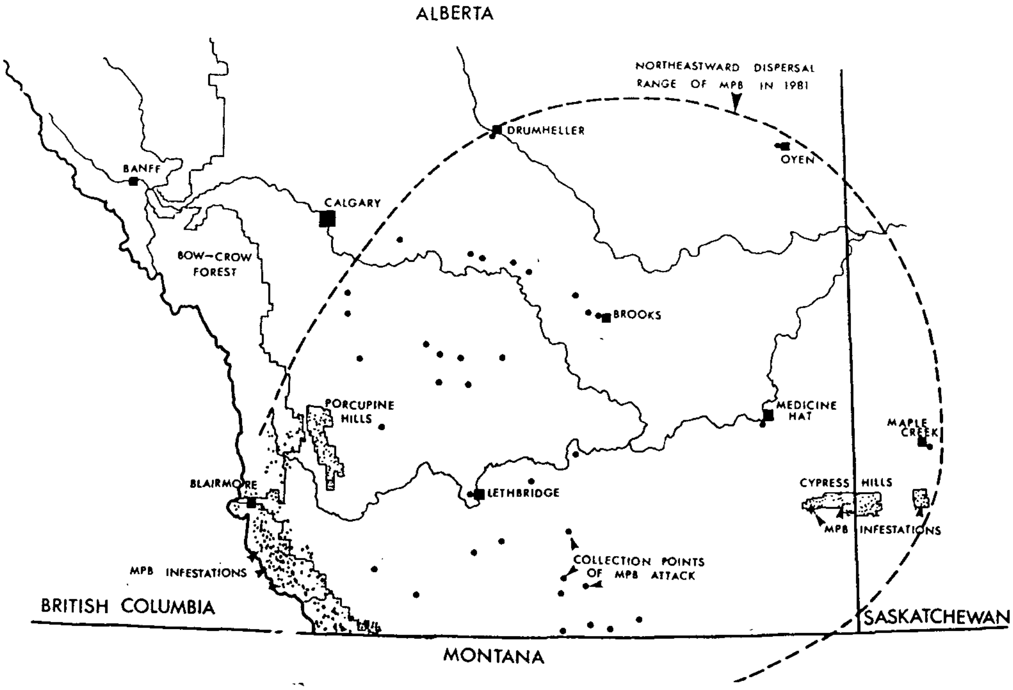

Figure 1--Map of southern Alberta and Saskatchewan showing the maximum extent of D. ponderosae (MPB) infestations in 1981, including the Porcupine Hills and Cypress Hills. Dots indicate collection points of MPB attacks observed on ornamental and shelterbelt planted pines.

distribution remained similar but with some variation in the number and location of baiting sites and in the number of baits deployed per site.

The guidelines adopted by each agency were as follows: baits were placed in mature lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) stands over 60 years of age and with an average DBH of 20 cm or greater in PH, CH and K control areas, and in a few limber pine (*P. flexilis* James) sites, also in the PH area. Various topographical sites were selected for baiting, including ridge tops, along creeks, on east-facing slopes and adjacent to clearcuts. The baits were placed one per tree on average stand diameter or greater size trees, 2 m above ground level and on the north aspect. Baits were distributed within a number of designated baiting locations (fig. 2) at which 5 to 21 baits were placed 50 m apart in mostly a single line transect or grid pattern. All baits were distributed prior to beetle flight and retrieved in late August or September.

At the end of the flight season all baited and adjacent unbaited trees within a 5-m radius of the baited tree were tallied. In addition, a measure of attack density was obtained on each baited tree and on adjacent unbaited trees by a count of the number of adult gallery initials within two 20x40 cm bark samples removed from each tree, both centered at bait placement level, one each on the north and south aspects. The samples were oriented with the long side vertically positioned on the stem and attack density was expressed as an average of the number of attacks per m^2 of bark surface.

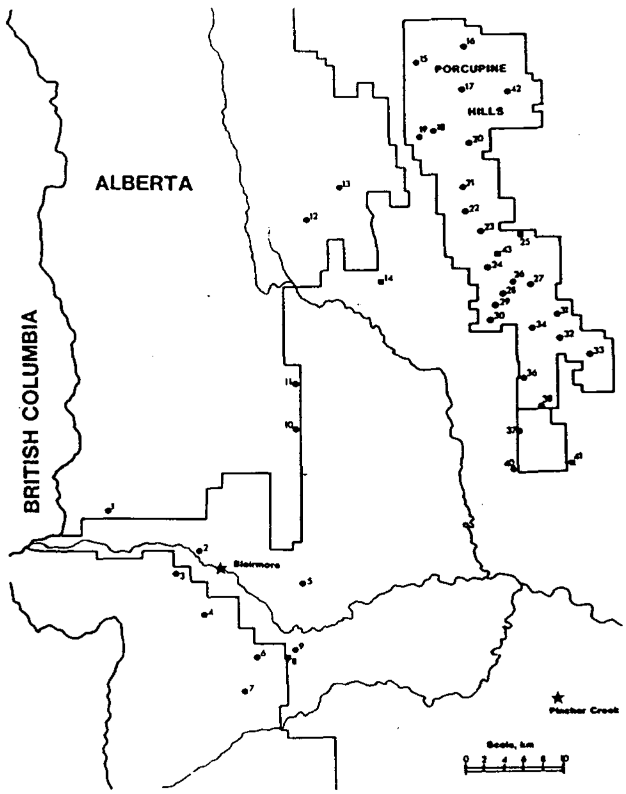

Figure 2--Distribution of D. ponderosae tree baiting sites in southwestern Alberta in lodgepole pine (dots) and limber pine (squares) stands in 1983.

RESULTS AND DISCUSSION

Figure 1 shows the distribution pattern of infestations of the MPB in southwestern Alberta, concentrated in stands of lodgepole pine and limber pine, and in lodgepole pine stands in the Cypress Hills. Collection points of MPB attacks within the agricultural zone were mainly on planted Scots pine (P. sylvestris L.), used extensively as an ornamental and shelterbelt species. The suggested northeastward dispersal range of MPB attacks extended some 200-300 km from the nearest population source and is assumed to have been aided by southwesterly flow wind patterns common during the time of beetle flight (Finklin 1986).

The semiochemical baits deployed and the numbers of selected baiting sites during 1983 are summarized in table 1. Numbers of tree baits used in subsequent years in the three control areas are given in table 2.

Populations were relatively high for the MPB in all control areas in 1983 as indicated by the high incidence of attacked baited trees (table 2). Many of the tree baits also influenced the aggregation of beetles onto large numbers of adjacent unbaited trees in over half of the baiting sites. Population declined sharply in most areas after 1984 (Moody and Cerezke 1986). While much of the control efforts of sanitation cuttings and tree bait aggregations to baited sites contributed to the population decline, severe winter temperatures during 1984-85 enhanced the success of the control programs by causing significant beetle mortality. The higher percentage attack incidence in 1987, compared to 1986, probably reflects higher overwinter survival of MPB, reduced numbers of baits in two of the control areas, and possibly the placement of baits into more selected baiting sites known to have populations.

The incidence of attacked baited trees in the Cypress Hills suggests there was a faster rate of decline after 1983 on the Saskatchewan side compared to the Alberta side. This may indicate a more direct population reduction due to concentrations of adult beetles onto baited and unbaited trees.

Table 1--Numbers of D. ponderosae tree baits and baiting sites deployed in 1983

Control areas	No. baiting sites	Baits per site (range)	Total no. baits
Kananaskis	7	10 (9-12)	71
Porcupine Hills and adjacent areas	41	10.3 (5-21)	423
Cypress Hills:			
Alberta	12	8.3 (5-20)	100
Saskatchewan	29	11.5 (5-20)	335

Attack densities of baited and adjacent unbaited trees are compared in table 3 and confirm higher attraction rates to the baited trees than to adjacent unbaited trees in all lodgepole pine and limber pine sites where data were available. Also, the percentages of attack incidence on north and south aspects of baited and adjacent unbaited trees were generally similar between the two groups in the different control areas and agree with similar published observations (Amman and Cole 1983).

An attempt was made to evaluate the efficiency of attracting MPB adults onto baited trees placed in a single line transect versus baited trees arranged in a grid (4 x 4 or 4 x 5) pattern. While average attack density was slightly higher on trees baited in a grid pattern the means of the two bait placement patterns were not statistically different. The results of this test, however, may vary with MPB population source and its nearness to the baiting site and with population abundance.

Table 2--Percentage of trees baited with semiochemicals that were attacked by D. ponderosae in three control areas during 1983 to 1987

Control areas	1983	1984	1985	1986	1987
Kananaskis and Porcupine Hills areas:	94 [1](494)	48 (2000)	- (1000)	15 (600)	55 (150)
Cypress Hills:					
Alberta:	100 (100)	48 (200)	19 (200)	3 (200)	10 (200)
Saskatchewan:	97 (335)	23 (1000)	10 (800)	0 (500)	1 (300)

[1]Values in brackets indicate the number of tree baits deployed each year.

Table 3--Summary of D. ponderosae attack densities and percentage of attacks on north (N) and south (S) aspects of baited and unbaited adjacent lodgepole pine (LPP) and limber pine (LMP) trees in three control areas in 1983

Control areas	Baited trees			Unbaited adjacent trees		
	Density/m^2	% attacks		Density/m^2	% attacks	
		N	S		N	S
Kananaskis (LPP):	62.4	62.7	37.3	44.2	45.4	54.6
Porcupine Hills and adjacent areas; (LPP):	64.1	53.4	46.6	46.8	56.5	43.5
(LMP):	117.1	47.9	52.1	72.4	50.2	49.8
Cypress Hills;						
Alberta (LPP):	100.2	53.8	46.2	[1]-	-	-
Saskatchewan (LPP):	76.6	54.3	45.7	61.7	51.0	49.0

[1]No data recorded.

A comparison was made between attack densities on baited trees in sites where few or none of the baited trees had associated adjacent unbaited attacked trees and with attack densities on baited trees in sites where 50% or more of the baited trees had adjacent unbaited attacked trees (table 4). This was to examine the likely relationship between MPB population source and abundance and the efficiency of the semiochemical attractants for concentrating beetles on to trap trees. Average attack densities in sites where 50% or more of the baited trees had adjacent unbaited attacked trees were all higher. The data support the idea that the numbers of beetles attracted to semiochemical tree baits are at least partly proportional to the surrounding population, and therefore indicate that the baits can serve as a reliable monitoring tool.

Sites in which different numbers of tree baits were deployed were arranged in classes of numbers of baits per site and plotted against average attack density (fig. 3). The data suggest that highest attack density on baited trees occurred where the numbers of baits was 4 to 6 and decreased to a constant density level when 10 or more tree baits per site were used.

Data on average attack densities in all lodgepole pine baiting sites in the Porcupine Hills were arranged according to topographical features in the landscape to help identify locations that may favor more efficient attraction and/or interception of dispersing MPB. While the data were highly variable some trends are apparent but would require additional field evaluation. Four topographical sites were selected to illustrate possible trends(table 5).

Table 4--Comparison of attack densities on baited trees having few or no adjacent attacked unbaited trees with baited trees having more than 50% of the baited trees with adjacent attacked unbaited trees

Control areas	Few or no adjacents			More than 50% adjacents		
	No. of sites	No. baited trees	Ave. attack density/m^2	No. of sites	No. baited trees	Ave. attack density/m^2
Kananaskis	4	40	33.9	3	30	[2] 97.5
Porcupine Hills and adjacent area	24	257	58.9	9	96	[1] 85.5
Cypress Hills:						
Alberta	9	75	95.7	2	15	[2] 120.3
Saskatchewan	15	175	58.6	12	135	[1] 98.5

[1]Means with more than 50% adjacents were significantly higher ($p<0.001$; t-test).
[2]Means not tested because of low numbers of baiting sites.

Table 5--Average attack densities of D. ponderosae on baited lodgepole pine trees at selected topographical sites in the Porcupine Hills in 1983

Topographical sites	No. of sites	No. baited trees	Ave. attack density/m^2
East-facing slopes:	2	13	98.7
Adjacent to creeks:	4	43	95.8
On ridge tops:	5	38	69.9
Adjacent to clearcuts:	3	18	60.0

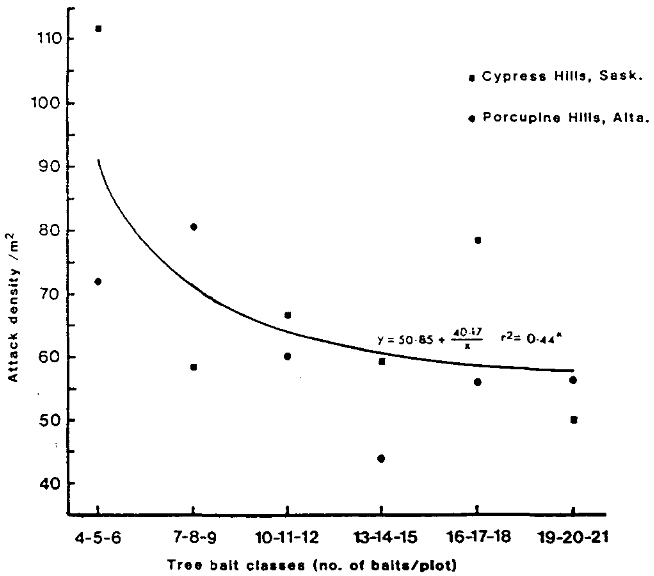

Figure 3--Numbers of tree baits deployed per baiting site (plot) in relation to D. ponderosae attack density on baited lodgepole pine trees.

SUMMARY

The integration of semiochemical tree baits into recent provincial programs to control MPB infestations in Alberta and Saskatchewan provided several important benefits in the overall control strategies. The baits induced aggregation of beetles into specific baiting sites which were often selected for easy access. Hence, infested trap trees could be easily monitored for control by sanitation cuttings during the same year. This allowed more time to be spent on locating isolated pockets of infested trees. The baits may have intercepted dispersing beetles both to and from the control areas. Attack densities on baited and adjacent unbaited trees appeared to vary directly with nearby sources of MPB populations, thus supporting the baits as a monitoring tool.

The baiting of selected sites provided substantial savings in "probe cruising", in search of random infestations, and also in reducing some aerial survey requirements. Depending upon the intensity and distribution of the baits throughout each control area, the aggregation of beetles onto baited and adjacent trees provided an indication of time of beetle flight, of relative population abundance, their geographical distribution and may also have indicated likely sources of populations such as in wind thrown trees and broken tree tops.

Data presented in table 2 suggest the baits may be sufficiently sensitive to detect small changes in population fluctuations when at endemic levels. This is an important aspect where eradication of the MPB from a forested area is the objective. Where only a few MPB induced attacks are successful, the individual galleries can be destroyed without killing the tree. For efficient detection and monitoring use in endemic populations only one, two or three baits per site are likely necessary.

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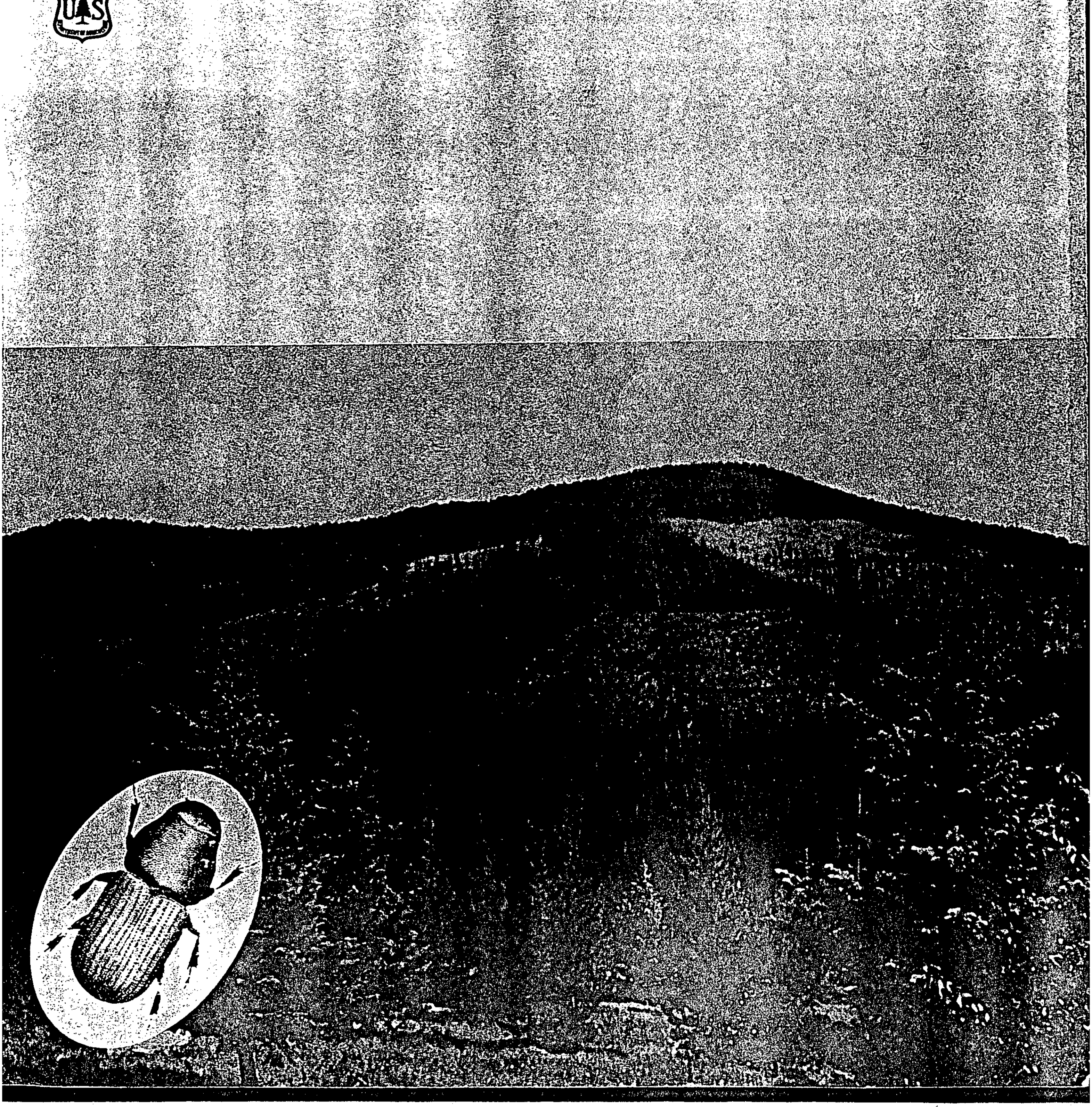

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