

SEQUENTIAL SAMPLING PLAN FOR DETERMINING INFESTATION AND DAMAGE LEVELS OF
MONOCHAMUS (COLEOPTERA : CERAMBYCIDAE) WOODBORERS IN DECKED LODGEPOLE PINE LOGS
IN ALBERTA

by

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FOREST RESEARCH LABORATORY

CALGARY, ALBERTA

INTERNAL REPORT A-26

CANADIAN FORESTRY SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY
JANUARY, 1970

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INTRODUCTION

Rising logging costs and closer utilization of timber stands have, in recent years, caused logging companies to be more concerned about the degrade of lumber as a result of woodborer holes in decked logs. Even though logging and milling practices in Alberta usually prevent most woodborer damage, often economic losses are incurred when logs are not processed before the end of the first season.

Because the degrade of lumber has a direct bearing on the feasibility of logging and milling operations, a fast and reliable sampling procedure is needed to estimate the expected monetary loss as a result of woodborer damage.

The correlation of woodborer densities with monetary loss was mainly established with small-diameter logs, where the highest possible grade was "construction" for 2-inch dimension lumber and "No. 2 common" for 1-inch lumber. The value-loss curve (Fig. 1) may need adjusting for large-

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diameter logs, and if a portion of the lumber is clear lumber, this curve would not be applicable.

The sampling plan will tend to slightly overestimate the damage from woodborer holes because it does not take into account the current mill practice of including some "standard" grade with "construction" grade dimension lumber, but we feel it is better to overestimate than to underestimate the monetary loss. This report presents a sequential sampling plan for assessing damage caused by Monochamus larvae in lodgepole pine logs. These larvae are the most economically important insects of recently felled logs in Alberta. The sampling plan is based on the relation between woodborer damage and economic loss. It classifies borer-hole density into low, medium, and severe in terms of expected per cent monetary loss. Further refinements to this sampling plan are being investigated.

HOW THE SAMPLING PLAN WAS DEVELOPED

Data for the sampling plan were collected from 143 sixteen-foot infested lodgepole pine logs cut in 1962-1964 near Rocky Mountain House, Alberta. The diameters of the logs ranged from 6 to 19 inches, with an average of 9.32 inches. Forty of these logs were individually scattered on the forest floor and the remaining 103 logs were drawn from the surface of log-deck piles. The number of woodborer entrance holes in a randomly selected 4-foot strip comprised the sample. The width of this strip equalled one-twelfth of the log's circumference. The strip corresponded to the 9-10 and the 2-3 o'clock positions (12 o'clock being the top of the log). Previous studies showed that these positions coincided with the average density for both individually scattered logs and for cold-deck logs.

Forty logs sawn into normal lumber products by a circular saw having a $\frac{1}{4}$ inch kerf were used for calculating value-loss caused by woodborer holes. The 40 sample-logs were grouped into the following four borer-hole-density classes: 0-1.0, 1.1-2.0, 2.1-3.0, and 3.1+ woodborer holes per square foot. All log products were graded twice; the first time it was assumed that woodborer holes were not present, and the second time woodborer holes were taken into consideration. In this study, degrade caused by fungi was not investigated. Sometimes stain fungi were present which could have caused additional degrade. The monetary loss was calculated with prices supplied by the Department of Lands and Forests (See Appendix).

HOW TO RECOGNIZE MONOCHAMUS LARVAE²

With this sampling plan, it is important to count larvae (called worms or grubs) of Monochamus (pine sawyer beetle) and their entrance holes into the log only (Fig. 2a), and not the larvae nor entrance holes of other insects under the bark. The other woodboring insects do not bore as deeply into the wood as do Monochamus larvae, and are usually eliminated with the slabs and edgings. Damage to pine logs in Alberta by other woodboring insects is negligible.

The larvae (Fig. 2b, c) are the grub stage of a large black beetle (often with white spots) with unusually long antennae (Fig. 2a). It can be recognized in several ways:

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Woodborer larvae that you cannot identify may be sent to:

Department of Fisheries & Forestry
132A Ninth Avenue S.W.
Calgary 2, Alberta

for identification or confirmation of your identification. Larvae should be placed in a container with liquid containing some alcohol and sent in well-protected with excelsior-like material.

- 1) Larvae - a) completely legless. Even tiny legs on first three segments behind the head are absent, b) sides of brown head capsule are only slightly arched (Fig. 2c). A 10X hand lens should be used to check these characteristics.
- 2) Entrance holes into log - elliptical and approximately the size of a pencil (Fig. 3a).
- 3) Frass (droppings plus wood shavings) - excelsior-like, never granular. Packed fairly loose, often extruded through the bark or from interior of the log (Fig. 3b).
- 4) Damage - scar the wood up to $\frac{1}{2}$ inch deep and irregularly (Fig. 3c).

DATA NEEDED FOR THE SEQUENTIAL SAMPLING PLAN

The relationship between value-loss, on a per-log-basis, and woodborer hole density is illustrated in Fig. 1. The graph shows that the maximum monetary loss (net prices at the planer mill) is about 30%. The value-loss increases linearly with an increase in borer-hole density from 0 to about 25% value-loss. The curve then rapidly levels at 30% value-loss. This is because even the severest woodborer damage results in utility grade lumber and not cull, and there is about 30% difference in value between construction and utility grade lumber. Figure 1 was used to establish three infestation classes: Light, Moderate, and Severe (Table I).

The sequential sampling plan is given in Table II³. A sequential sampling system is a method by which populations are classified into

³ For detailed discussion of the mathematical basis of the sequential plan, see Safranyik, L. and A.G. Raske "Sequential Sampling Plan for Monochamus larvae in Decked Lodgepole Pine Logs", Jour. Econ. Ent. (In Press).

Figure 1. Relation between per cent value-loss and woodborer hole density. Zones I, II and III, respectively, designate light, moderate, and severe infestation classes.

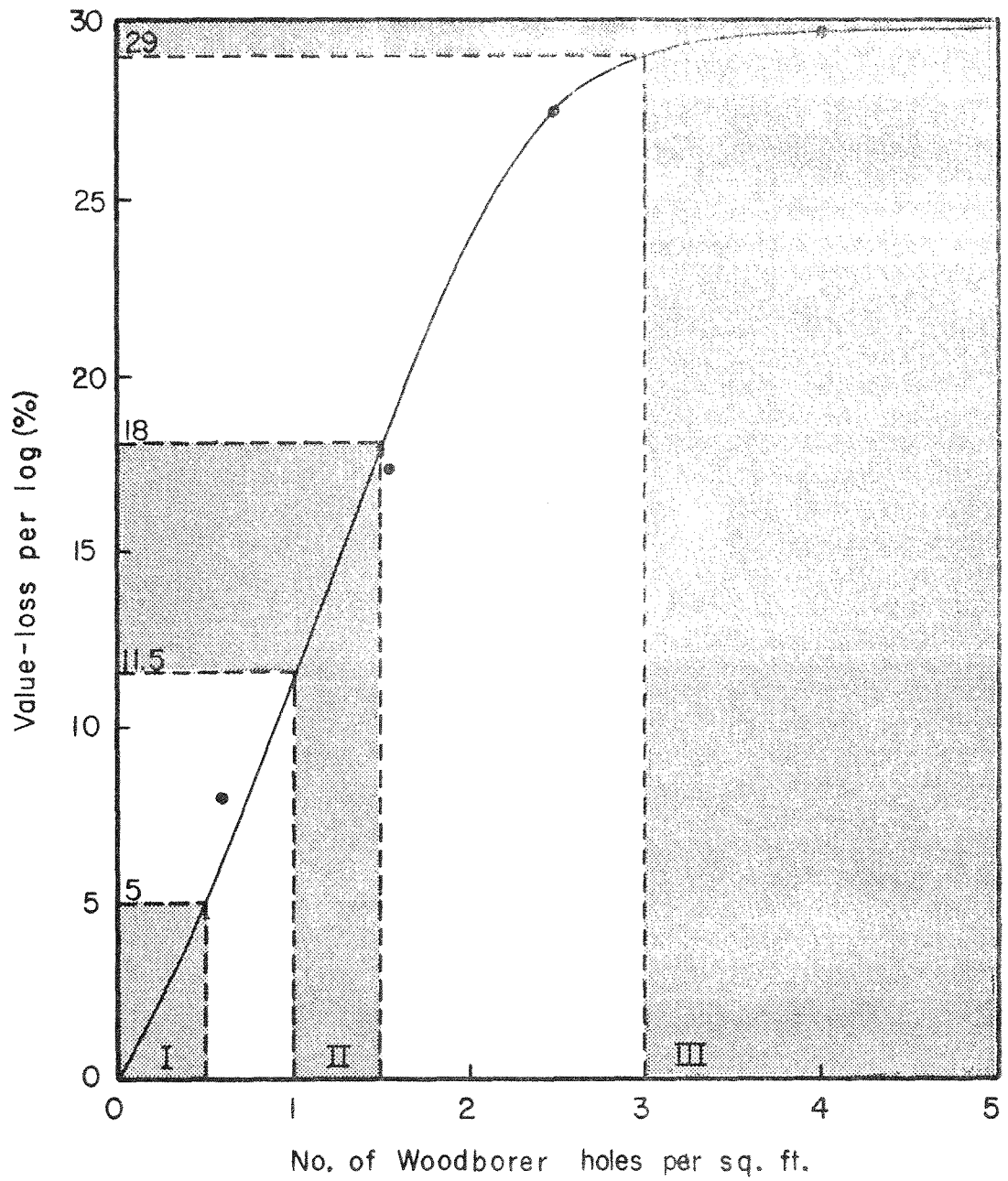


TABLE I

Class	Infestation	Number of woodborer holes and larvae per sq. ft.	Per cent value-loss corresponding to infestation classes in column 2
I	Light	0.5 or less	5% or less
II	Moderate	1.0 to 1.5	11.5% to 18.0%
III	Severe	3.0 or more	29% or more

categories (usually 2 or 3) on the basis of a flexible sample size. In a sequential sampling system, the sampler counts that which is required (in this case Monochamus larvae and their entrance holes on 1 sq. ft. of log surface, i.e., the sampling unit) and adds to this the count of the second sampling unit and, if necessary, the count of the third, fourth, fifth, etc. sampling unit until the cumulative total falls within a category of infestation (light, moderate, or severe). The cumulative total is important, and not the count of any one sampling unit.

INSTRUCTIONS

Sampling can be carried out at any time of the year, but it is much easier in spring, summer, and fall, when the bark is not frozen to the stem. The age of the log is also not an important factor. Reliable samples can be obtained in any year beginning late September after the first summer that logs have been exposed to attack. Maximum damage will have occurred by late September of the first year of exposure. If the log has been cut earlier than about two years, the samplers must not count the

TABLE II

Sequential sampling table for₃classifying the severity of woodborer-hole damage to lodgepole pine logs. (Sampling continues until the cumulative number of woodborer holes are less than or equal to, or greater than or equal to, the tabulated values).

Number of 1 sq. ft. sampling units examined	Cumulative number of woodborer holes and larvae			
	Light: equal to or less than	Moderate: equal to or greater than	Moderate: equal to or less than	Severe: equal to or greater than
1	-	-	-	12
2	-	-	-	14
3	-	-	-	16
4	-	-	-	18
5	-	-	-	20
6	-	-	-	23
7	-	-	-	25
8	0	-	-	27
9	1	-	-	29
10	1	-	-	31
11	2	13	13	33
12	3	14	15	35
13	3	15	17	37
14	4	15	19	40
15	5	16	22	42
16	5	17	24	44
17	6	18	26	46
18	7	18	28	48
19	8	19	30	50
20	8	20	32	52
21	9	20	34	54
22	10	21	36	56
23	10	22	38	59
24	11	23	41	61
25	12	23	43	63
26	13	24	45	65
27	13	25	47	67
28	14	25	49	69
29	14	26	51	71
30	15	27	53	73
31	16	27	55	75
32	17	28	57	77
33	17	29	59	80
34	18	30	62	82
35	19	30	64	84
36	19	31	66	86
37	20	32	68	88
38	21	33	70	90
39	22	33	72	92
40	22	34	74	94

Continue sampling

Continue sampling

circular adult exit holes (Fig. 3d), but only the elliptical larval entrance holes (Fig. 3a). It is also important that only Monochamus entrance holes and live Monochamus larvae be counted.

Procedure:

1. Determine if infestation is limited to the surface of the deck and what percentage of the deck is composed of surface logs. Do this by randomly peeling pieces of bark throughout the deck and noting presence or absence of woodborers. After the extent of infestation has been determined, proceed with the sequential plan.
2. Randomly choose any one of the first 10 surface logs to sample.
3. Take only one sample per log, at least 6 inches away from the end or from any large bark-free area.
4. Sampling unit size must be equal to 1 sq. ft., and on logs less than 20 inches in diameter it should be rectangular in shape. We found that a 6 x 2¹/₄ inch rectangle was satisfactory. The long axis of the rectangular unit should be oriented parallel to the grain.
5. It is important that the sampling unit be centered on either the 2 o'clock or 10 o'clock position of the log (12 o'clock being the top of the log).
6. Peel bark from the sampling unit area and tally Monochamus entrance holes, plus any live Monochamus larvae (which are potential entrance holes).⁴

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If larva is in entrance hole count one but not both.

7. Continue examining a 1 sq. ft. surface on every tenth log (taking the first sampled log as No. 1) while walking over the deck, until the cumulative total of woodborer holes falls into one of the damage classes. If a decision has not been reached after arriving at the end of the deck, turn around and repeat the same procedure until you arrive at a decision.
8. Read corresponding per cent value-loss from Table I, and apply to percentage of deck infested.
9. Infestation levels of logs scattered on the forest floor can be determined by sampling every 10th log while you are walking in a straight line.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Mr. B. M. Dahl for his assistance in the field and in analyzing the data. We thank Mr. D. Jackson, of Revelstoke, Rocky Mountain House, Alberta for grading the logs, and Mr. F. McDougall, Department of Lands and Forests, Edmonton, Alberta for supplying price lists of lumber.

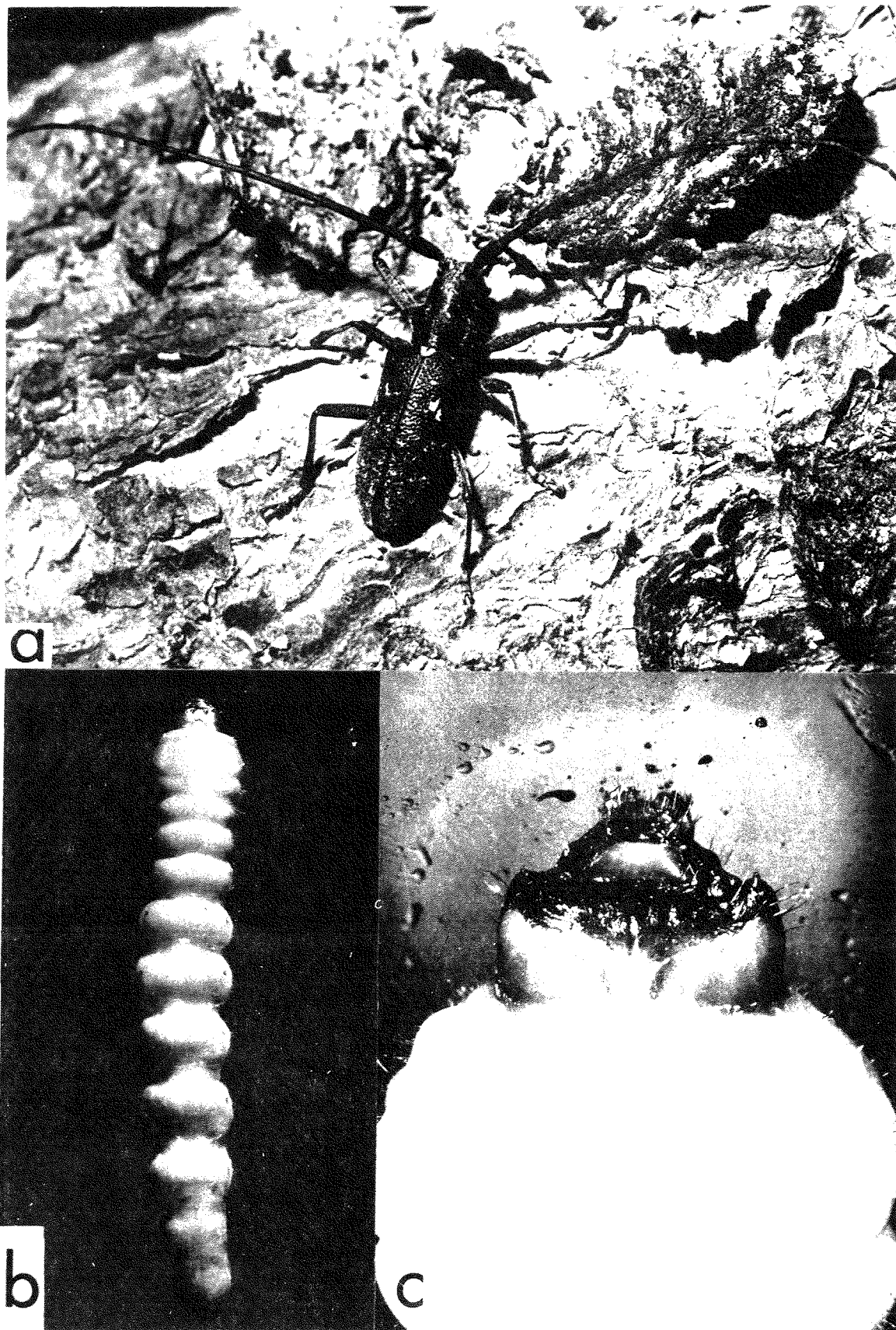


Fig. 2. Monochamus sp. a) Adult (♂) (2X), b) mature larva (2X), c) head capsule of larva.



Fig. 3. *Monochamus* sp. damage (IX). a) larval entrance holes, b) excelsior-like frass, c) scarring of wood, d) adult exit holes.

APPENDIX

The following prices were used in the calculation of the monetary loss. The prices represent weighted averages from July 1, 1968 to Dec. 31, 1968, and were supplied by the Department of Lands and Forests, Edmonton, Alberta. They were net prices at the planer mill:

2" Dimension

2 x 4 Construction and better	\$ 87.00 per M FBM
2 x 4 Utility and better	68.50 per M FBM
2 x 6 Construction	120.00 per M FBM
2 x 6 Utility and better	85.00 per M FBM
2 x 8 Construction	125.00 per M FBM
2 x 8 Utility and better	85.00 per M FBM

1" Common Boards

No. 2; 6", 8" and 10" widths	105.00 per M FBM
No. 3; 6", 8", and 10" widths	87.50 per M FBM
Mixed grades and widths	58.00 per M FBM