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# Harvesting Strategies for Management of Mountain Pine Beetle Infestations in Lodgepole Pine:

Preliminary Evaluation, East Long Creek  
Demonstration Area, Shoshone National  
Forest, Wyoming

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## ABSTRACT

*Diameter-limit and leave-tree cuts were tested as ways to reduce or minimize lodgepole pine losses to the mountain pine beetle. In the first year after treatment, loss reductions were proportional to the intensity of cut. According to the Rate of Loss Model, the 100-leave-tree cut was the best deterrent of recurring infestation, measured as amount of losses and length of time. The 100-leave-tree cut also should provide the best regeneration and has the added benefit of reducing dwarf mistletoe infection.*

**KEYWORDS:** mountain pine beetle, *Dendroctonus ponderosae*, lodgepole pine, *Pinus contorta* var. *latifolia*, harvest strategies

East Long Creek in the Shoshone National Forest is one of a series of demonstration area projects that used management alternatives derived from research (Cole and Cahill 1976) and small-scale tests (Cahill 1978; McGregor and Cole, in press) in an attempt to reduce or minimize lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) losses to the mountain pine beetle (*Dendroctonus ponderosae* Hopkins).

The objective of this initial large-scale application of management alternatives was to prevent undue losses of lodgepole pine by changing or reducing the food supply of the mountain pine beetle, and also to manipulate the stand to grow at or near optimum site capacity with continued prevention of large losses to the beetle.

Some constraints on the project were to protect or enhance key resource values, remove merchantable material through a commercial timber sale, develop permanent access roads for general land use and management, improve forest cover growing conditions through disease control and stocking to attain timber production potentials on regulated lands, and develop a cost-benefit analysis for each strategy. This report is limited to the reaction of the mountain pine beetle and tree growth response the first year after cutting.

Future efforts to manage stands to prevent losses to the beetle must be made before the beetle epidemic cycle. East Long Creek Demonstration Area provided this opportunity.

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## STUDY AREA

The East Long Creek Demonstration Area lies between 7,600 and 8,800 ft (2 317 and 2 683 m) elevation, which is the lower half of the forested zone in the Wind River Drainage. The climate is cool and dry; moisture availability is the most limiting growth factor during the season.

Soils are derived from sedimentary formations and glacial moraines derived from the Wiggins formation. The clay content of the soils and seasonal distribution of precipitation make natural regeneration difficult on southerly and westerly aspects and flats, especially below 8,500 ft (2 591 m).

Cover types change with aspect and elevation; coniferous trees grow only on favorable aspects below 7,600 ft (2 317 m), and seldom occur on more adverse aspects at higher elevations.

Reestablishment of conifers following fire is extremely slow on adverse aspects. Recovery from any drastic disturbance on this area can be expected to be slow unless seedlings are planted as the regeneration method. On some of the adverse aspects, the scattered limber pine (*P. flexilis* James) and lodgepole pine trees appear to be pioneers of a first generation forest.

The lower part of the coniferous cover could be classed as *Abies lasiocarpa*-*Arnica cordifolia* habitat type, milk vetch phase. This habitat type on the Wind River District has almost no potential to be dominated by *Abies lasiocarpa* because the development of the climax community requires more time than is permitted by the natural fire cycle.

Inland Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) predominates in an alternative seral community on this habitat type where soils are basic. At this elevation, the inland Douglas-fir/mountain snowberry habitat is present on soils derived from limestone formations.

Aspen (*Populus tremuloides* Michx.) is a short-lived seral community replaced by limber pine or lodgepole pine in the first generation. Retention of aspen as a cover type requires a reduction in competition for moisture and cutting the live aspen to break the auxin flow so sprouting can occur.

In most of the stands in this zone, the lodgepole pine component of the stand is 150 to 200 years old and dying out rapidly. Younger stands are still dominated by lodgepole pine and have a manageable pole and small-size sawtimber component. This zone of the coniferous forest is an *Abies lasiocarpa*-*Vaccinium scoparium* habitat type.

Regeneration following disturbance is more rapid in this habitat and will tend to be mixed aged, with some tolerant species seedlings and saplings present in the first 50 years of stand development. The number of spruce and fir trees present during early stand development probably depends on seed source, once the lodgepole pine component accomplishes the necessary site modification. In some cases, competition by density stocked lodgepole pine may reduce spruce and fir regeneration.

Site index values for lodgepole pine are 30 to 35 ft (9.1 to 10.7 m) in 50 years in the *Abies lasiocarpa*-*Arnica cordifolia*-milk vetch phase habitat, increasing to 45 to 50

ft (13.7 to 15.2 m) in 50 years in the *Abies lasiocarpa*-*Vaccinium scoparium* habitats.

Throughout this area of the forest, basal area in natural stands follows the site index values, with basal areas as low as 65 ft<sup>2</sup>/acre (14.4 m<sup>2</sup>/ha) on the lower site index areas and increasing to 140 ft<sup>2</sup>/acre (31.1 m<sup>2</sup>/ha) on the most productive sites. Total live conifer trees over 2 inches (5.08 cm diameter at breast height) (d.b.h.) on the 1,789 acres (724 ha) cruised rarely exceeded 400 per acre (988 per ha).

The demonstration area contained approximately 1,898 acres (768 ha). Before harvesting, the area contained 3,777 board feet (bd.ft.) of gross green volume per acre and 1,664 bd.ft. of dead standing volume per acre. Net volumes were 3,397 bd.ft. of green volume per acre and 1,332 bd.ft. of dead volume per acre, or 4,729 bd.ft. total net volume per acre.

## STAND PRESCRIPTIONS

Three general prescriptions were applied: (1) cutting levels based on diameters, (2) leave-tree cuts, and (3) clearcuts. In each case, the primary purpose was to remove the food supply from the beetle; the larger diameter trees generally contain the thicker phloem. However, other criteria were considered in each case. Each prescription required retention of adequate forest cover to promote natural regeneration, wildlife needs, and visual qualities, and was designed to fit the condition of the stand and its ecology to promote future development under natural conditions.

The prescriptions and their applications were:

1. Diameter cuts.
  - a. Cut all lodgepole pine 7 inches (17.78 cm) d.b.h. and larger and salvage dead trees 8 inches (20.32 cm) d.b.h. and larger. This prescription was applied to three different stand conditions:
    - (1) Late transitional stands that had converted to the spruce-fir type. The lodgepole pine component was decadent or dying rapidly. In this case, adequate lodgepole pine growing stock was to be retained. Lodgepole pine regeneration could be expected to fill in openings created by logging.
    - (2) Two-aged lodgepole pine stands that contained very few tolerant trees. The understory was primarily lodgepole pine, and the residual stand of seedlings and saplings would be understocked. Trees less than 7 inches (17.78 cm) d.b.h. down to the seedling-sapling understory were not suitable growing stock because of disease—dwarf mistletoe (*Arceuthobium americanum*) and comandra blister rust (*Cronartium comandrae*). It was necessary on these sites to retain the undesirable pole timber to protect the site until natural regeneration occurs to bring the seedling-sapling stand up to 300 per acre (121 per ha). Timely removal of mistletoe-infected trees will be required.

In some cases where stocking was inadequate and residual trees were sparse—less than 100 per acre (40 per ha)—planting would be necessary. Lodgepole pine or inland Douglas-fir containerized stock should be planted at 200 to 400 trees per acre (81 to 162 per ha) depending on the number and size of residual growing stock trees.

- (3) Heavily stocked lodgepole pine pole timber stands where the age and disease conditions made regeneration of the stand desirable, and enough trees less than 7 inches (17.78 cm) d.b.h. were present to furnish adequate cover to meet forest cover objectives, including site protection. Adequate natural regeneration was expected in these stands.

- b. Cut all lodgepole pine trees 10 inches (25.40 cm) d.b.h. and larger and salvage all dead or attacked trees 8 inches (20.32 cm) d.b.h. and larger. This prescription was applied to isolated stands in the unthinned component where forest cover was not maintained for production of wood products, but primarily where lodgepole pine was the principal component and cover objectives required retaining forest cover to protect other values.

Site potential was low in these stands, ecosystems were exceptionally fragile, and values other than timber were paramount. The prescription was applied to stands that were sparsely stocked and on adverse aspects. These stands were suspected to be first-generation coniferous forests, hence were fragile ecotones, and disruption could reverse ecologic trends. Subsequent treatments on regulated lands will be overstory removal in one or two steps, depending on disease conditions, regeneration success, and visual quality needs.

- c. Cut all lodgepole pine trees 12 inches (30.48 cm) d.b.h. and larger and salvage all dead or attacked trees 8 inches (20.32 cm) and larger. This prescription was applied to stands where lodgepole pine was the principal component, site potential was extremely low, stands were sparsely stocked, aspects were adverse, and stands contained trees exceeding this diameter limit.

## 2. Leave-tree cuts.

The leave-tree prescription was applied to two stands and required leaving 100 trees per acre (40 trees per ha), while removing the balance of the lodgepole pine component of the stand. All selected leave trees were the largest, most desirable lodgepole pine, growing stock, and sufficient desirable growing stock trees of other

species were retained to result in an average stocking of 100 trees per acre (40 per ha) over 7 inches (17.78 cm) d.b.h.

Because of small islands of old lodgepole pine that escaped the fire that regenerated these two stands, and because these stands contained mistletoe infection centers, small clearcuts also were required. Natural regeneration could be expected in 5 years if these clearcuts did not exceed 5 acres (2 ha).

## 3. Clearcuts.

Six areas, averaging 14 acres (5.7 ha) each, were clearcut. These were in fire-regenerated pole timber stands. There were small islands of old-aged, larger diameter lodgepole pine trees that were diseased and decadent. Some of these islands had lodgepole pine and/or spruce-fir understories. Because of the heavy fuel accumulations in the pockets of old growth, bulldozer piling and slash burning were desirable to meet fuel management objectives.

## METHODS

A total of 37 cutting units and one check block unit were laid out in the demonstration area:

- 10 units in the 7-inch (17.78-cm) cutting block
- 17 units in the 10-inch (25.40-cm) cutting block
- 2 units in the 12-inch (30.48-cm) cutting block
- 2 units in the 100-leave-tree cutting block
- 6 units in the clearcut block
- 1 check block unit

Harvesting began in January 1979 and was completed in February 1981, well before the 1981 beetle flight. A summary of the pretreatment stand structure and proposed cuts is shown in table 1.

A survey of the demonstration area was made in the spring of 1982 to determine tree loss to the mountain pine beetle. A 20-percent survey was conducted in 22 of the 38 units:

- 6 of 10 units in the 7-inch (17.78-cm) cutting block
- 11 of 27 units in the 10-inch (25.40-cm) cutting block
- 2 of 2 units in the 12-inch (30.48-cm) cutting block
- 2 of 2 units in the 100-leave-tree block
- 1 check block unit

The 20-percent survey used a 1-chain-wide strip (20 m) every 5 chains (100 m) and recorded beetle-killed trees in 1979, 1980, and 1981, other causes of death, and diameter.

Tree growth data were collected during the loss surveys. Basal area and radial growth measurements were taken at 5-chain (100 m) intervals along the cruise strip, using a 10 BAF gage. Unfortunately, similar data were not taken before the harvest for comparison.

Table 1.—Summary of stand data and proposed cuts for East Long Creek Demonstration Area

| Stand structure and volumes       | Treatment |         |         |                |          |
|-----------------------------------|-----------|---------|---------|----------------|----------|
|                                   | 7-inch    | 10-inch | 12-inch | 100-leave-tree | Clearcut |
| Acres                             |           |         |         |                |          |
| Total                             | 1,132.0   | 581.0   | 60.0    | 39.0           | 86.0     |
| Mean                              | 113.2     | 34.2    | 30.0    | 19.5           | 14.3     |
| Live lodgepole/acre               |           |         |         |                |          |
| Total                             | 1,633.0   | 3,668.0 | 686.0   | 428.0          | 1,475.0  |
| Mean                              | 163.3     | 215.7   | 343.0   | 214.0          | 245.8    |
| < 7-inch                          | 864.0     | 1,925.0 | 458.0   | 242.0          | 769.0    |
| Mean                              | 86.4      | 113.2   | 229.0   | 121.0          | 128.2    |
| > 7-inch                          | 769.0     | 1,743.0 | 228.0   | 186.0          | 706.0    |
| Mean                              | 76.9      | 102.5   | 114.0   | 93.0           | 117.7    |
| > 10-inch                         | 352.0     | 656.0   | 88.0    | 62.0           | 271.0    |
| Mean                              | 35.2      | 38.6    | 44.0    | 31.0           | 45.2     |
| > 12-inch                         | 166.0     | 282.0   | 14.0    | 24.0           | 156.0    |
| Mean                              | 16.6      | 16.6    | 7.0     | 12.0           | 26.0     |
| Live species/acre                 |           |         |         |                |          |
| Subalpine fir and other           | 768.0     | 699.0   | 66.0    | 30.0           | 1,006.0  |
| Mean                              | 76.8      | 41.1    | 33.0    | 15.0           | 167.7    |
| Engelmann spruce                  | 194.0     | 47.2    | 0       | 2.4            | 248.0    |
| Mean                              | 19.4      | 2.8     | 0       | 1.2            | 41.3     |
| Aspen                             | 1,683.0   | 232.0   | 0       | 64.0           | 34.0     |
| Mean                              | 168.3     | 13.6    | 0       | 32.0           | 5.7      |
| Proposed cut                      |           |         |         |                |          |
| T/A                               | 769.0     | 656.0   | 14.0    | 228.0          | 1,475.0  |
| Mean                              | 76.9      | 38.6    | 7.0     | 114.0          | 245.8    |
| Gross volume/acre                 |           |         |         |                |          |
| Live cut                          | 4,468.0   | 3,518.0 | 3,683.0 | 3,205.0        | 4,093.0  |
| Mean                              | 4,468.0   | 3,518.0 | 3,683.0 | 3,205.0        | 4,093.0  |
| Salvage cut                       | 2,290.0   | 1,480.0 | 1,583.0 | 1,231.0        | 2,337.0  |
| Mean                              | 2,290.0   | 1,480.0 | 1,583.0 | 1,231.0        | 2,337.0  |
| Gross volume (M)                  |           |         |         |                |          |
| Green                             | 5,058.0   | 2,044.0 | 221.0   | 125.0          | 352.0    |
| Mean                              | 505.8     | 120.2   | 110.5   | 62.5           | 58.7     |
| Dead ( $\geq 8"$ )                | 2,592.0   | 860.0   | 95.0    | 48.0           | 201.0    |
| Mean                              | 259.2     | 50.6    | 47.5    | 24.0           | 33.5     |
| Uncut per acre                    |           |         |         |                |          |
| Lodgepole pine ( $\geq 2"$ )      | 891.0     | 2,916.0 | 558.0   | 39.0           | 877.0    |
| Mean                              | 89.1      | 171.5   | 279.0   | 19.5           | 146.2    |
| Total trees ( $\geq 2"$ )         | 1,602.0   | 3,661.0 | 624.0   | 43.0           | 2,132.0  |
| Mean                              | 160.2     | 215.4   | 312.0   | 21.5           | 355.3    |
| Average gross volume per acre (M) |           |         |         |                |          |
| Green                             | 4.468     | 3.518   | 3.683   | 3.205          | 4.093    |
| Dead                              | 2.290     | 1.480   | 1.583   | 1.231          | 2.337    |
| Average net volume per acre (M)   |           |         |         |                |          |
| Green                             | 4.023     | 3.166   | 3.315   | 2.885          | 3.684    |
| Dead                              | 1.832     | 1.184   | 1.267   | .985           | 1.870    |
| Total adjusted net volume         |           |         |         |                |          |
| Volume per acre                   | 5.855     | 4.350   | 4.582   | 3.870          | 5.554    |
| Net volume                        | 6.628     | 2.528   | .275    | .151           | .478     |

## RESULTS

The stand structure changed proportionally to the intensity of harvest cut used in each block (table 2). Stand average diameter (d.b.h.) changes were:

| Treatment              | Original diameter |       | Diameter after harvest |       |
|------------------------|-------------------|-------|------------------------|-------|
|                        | Inches            | cm    | Inches                 | cm    |
| 7-inch (17.78-cm) cut  | 7.8               | 19.81 | 7.0                    | 17.78 |
| 10-inch (25.40-cm) cut | 7.7               | 19.56 | 7.0                    | 17.78 |
| 12-inch (30.48-cm) cut | 7.4               | 18.80 | 7.3                    | 18.54 |
| 100-leave-tree cut     | 7.5               | 19.05 | 8.0                    | 20.32 |

Considering only the kill by the mountain pine beetle, the trend for the 3 years (2 years before the cut was completed and 1 year after completed cuts) is rather dramatic (table 3 and fig. 1). In all cutting blocks, the number of trees infested dropped considerably after harvesting; the check block continued to lose trees to the beetle at about the same rate.

It is evident that tree loss to secondary insects, such as *Ips*, *Pityophthorus*, *Pityogenes*, and *Pityokteines*, and comandra rust lessened after treatment (table 4). However, this apparent reduction of loss may be an artificial effect of sampling, because the check areas also showed no loss due to these factors in 1981 (the year after cutting was completed).

Table 2.—Stand structure before and after cutting

| Treatment          | Live lodgepole pine per acre by diameter class |                   |        |        |        |                          |                    |                   |        |        |        |
|--------------------|------------------------------------------------|-------------------|--------|--------|--------|--------------------------|--------------------|-------------------|--------|--------|--------|
|                    | Before cut                                     |                   |        |        |        | Trees<br>cut per<br>acre | After cut          |                   |        |        |        |
|                    | Total                                          | <7                | 7-9    | 10-11  | >12    |                          | Total              | <7                | 7-9    | 10-11  | >12    |
|                    |                                                | inches            | inches | inches | inches |                          |                    | inches            | inches | inches | inches |
| 7-inch cut         | 163.3                                          | 86.4              | 41.7   | 18.6   | 16.6   | 76.9                     | 86.4               | 86.4              | 0      | 0      | 0      |
| 10-inch cut        | 215.7                                          | 113.2             | 63.9   | 22.0   | 16.6   | 38.6                     | 177.1              | 113.2             | 63.9   | 0      | 0      |
| 12-inch cut        | 343.0                                          | 229.0             | 70.0   | 37.0   | 7.0    | 7.0                      | 336.0              | 229.0             | 70.0   | 37.0   | 0      |
| 100-leave-tree cut | 214.0                                          | 121.0             | 62.0   | 19.0   | 12.0   | 114.0                    | <sup>1</sup> 100.0 | —                 | —      | —      | —      |
| Clearcut           | 245.8                                          | 128.2             | 72.5   | 19.2   | 26.0   | 245.0                    | 0                  | 0                 | 9      | 0      | 0      |
| Check area         | 251.0                                          | <sup>2</sup> 55.0 | 196.0  | 91.0   | 42.0   | 0                        | 251.0              | <sup>2</sup> 55.0 | 196.0  | 91.0   | 42     |

<sup>1</sup>Data not available on distribution.

<sup>2</sup>Include only 4- to 6-inch trees.

Table 3.—Tree mortality due to the mountain pine beetle

| Treatment          | Number of trees killed per acre |      |      |
|--------------------|---------------------------------|------|------|
|                    | 1979                            | 1980 | 1981 |
| 7-inch cut         | 0.72                            | 0.51 | 0.09 |
| 10-inch cut        | .35                             | .66  | .07  |
| 12-inch cut        | .19                             | 5.00 | 1.15 |
| 100-leave-tree cut | .20                             | .10  | 0    |
| Check area         | 2.53                            | 5.77 | 4.23 |

cut completed

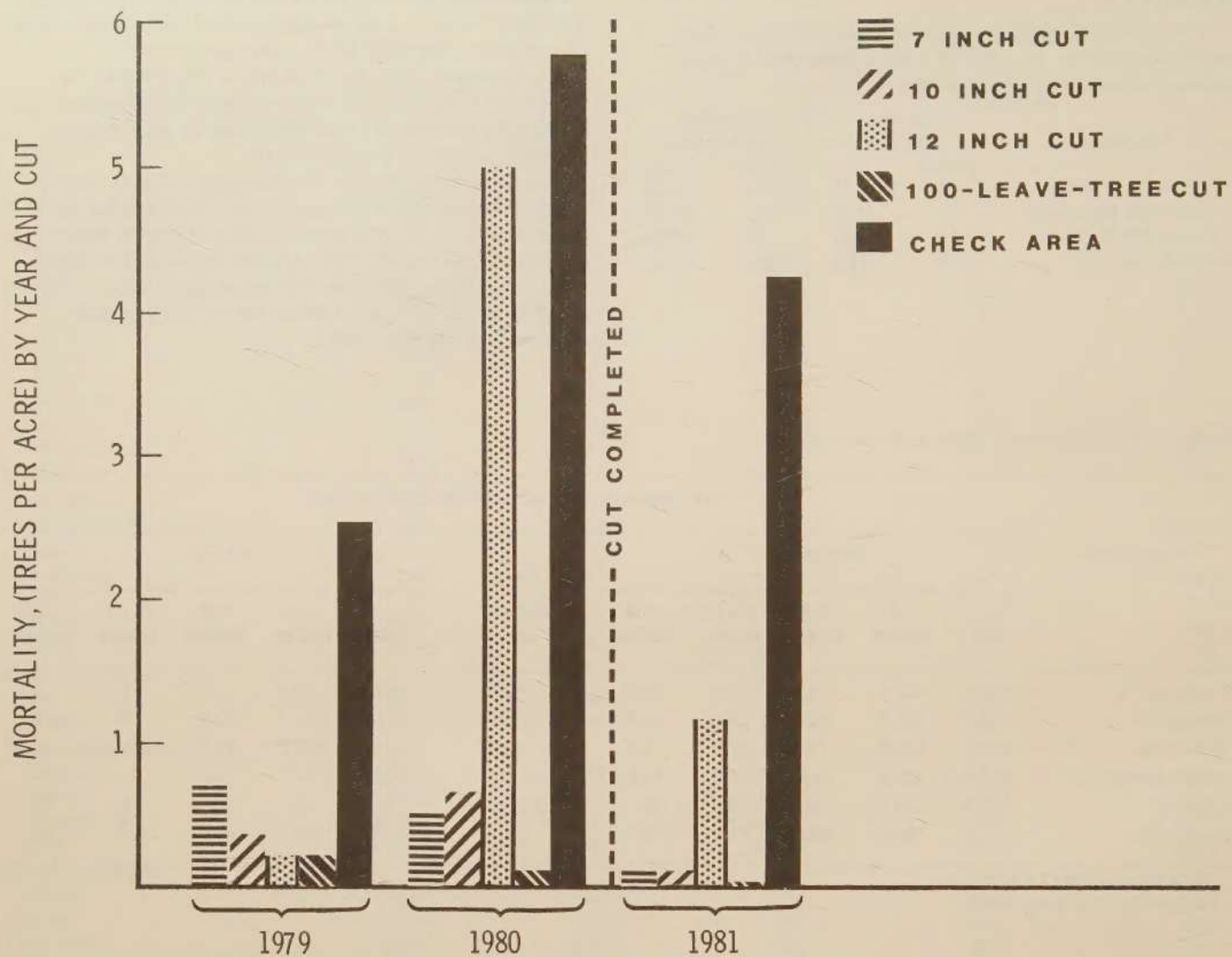


Figure 1.—Tree loss due to the mountain beetle within the demonstration areas.