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U.S. Forest Service
Region 6

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# 1975 PRESUPPRESSION RESULTS WESTERN SPRUCE BUDWORM WARM SPRINGS INDIAN RESERVATION OREGON

## INTRODUCTION

The western spruce budworm, *Choristoneura occidentalis*, Freeman, is always present to some degree in the Douglas-fir - true fir - Engelmann spruce type of western forests. Normally, this insect exists in an endemic status, presumably held in check by natural enemies and lack of suitable climatic and forest conditions. Periodically, the budworm escapes its natural control, reaches epidemic numbers, and causes widespread damage. These epidemics are believed to be a part of a series of natural events associated with climatic variations and the maturing of large areas of Douglas-fir, true fir, and Englemann spruce. Prior to 1943, western spruce budworm was not considered a serious forest pest in either Oregon or Washington. The first major outbreak recorded in Region 6 was in 1943 in the Methow Valley in north central Washington, the same general area infested today. A total of 200,000 acres of Douglas-fir and true fir were defoliated before the outbreak collapsed in 1948. Between 1947 and 1975, western spruce budworm epidemics have occurred on about 16 million acres in Region 6. The majority of this damage (70 percent) occurred between 1948 and 1954. Nearly 91 percent of this damage took place in eastern Oregon. From 1965 to 1970 budworm populations declined and no damage was reported. Since 1970 there has been a general increase in budworm activity. The infested acreage has increased from 18,000 acres in 1970 to nearly 700,000 acres in 1975. Most of this damage has occurred in north central Washington on the Okanogan and Wenatchee National Forests.

Prior to 1947, because of the lack of dependable control methods, forest entomologists and land managers had to rely on natural control factors to keep the western spruce budworm populations in balance with its environment. However, when nearly a million acres of Douglas-fir and true fir were being severely damaged during 1946 after 3 to 4 years of continuous defoliation it became apparent that natural control was lacking and that direct control would be necessary.

The first operational western spruce budworm control project in Region 6 took place in 1949 when a total of 267,000 acres were treated. Two areas were treated - one on the westside of the Cascades near Eugene, Oregon, and the other on the eastside of the Cascades on the Mt. Hood National

Forest and Warm Springs Indian Reservation. Since 1949, there have been nine spruce budworm spray projects. The last one involving approximately 46,000 acres was in 1962 near Goldendale, Washington. Between 1949 and 1962, a total of 4.7 million acres were treated (29 percent of the 16 million acres infested) with DDT. These included three separate spruce budworm projects on the Warm Springs Indian Reservation involving approximately 130,000 acres.

During the 1974 aerial insect detection survey, spruce budworm defoliation was detected on about 7,200 acres on the Warm Springs Indian Reservation. Most of this damage occurred in the same general area that had been treated with DDT in 1949.

The results of a biological evaluation made in the fall of 1974 indicated the infestation would continue at epidemic levels in 1975. The results of the 1975 aerial survey revealed that the perimeter of the outbreak had expanded encompassing a total of 10,560 acres and that some apparent top-killing was in progress.

In early September 1975 a presuppression survey was made to determine the amount of top-kill and/or tree mortality expected and the extent and location of areas needing direct control in 1976. The results and recommendations are presented in this report.

## TECHNICAL INFORMATION

Causal Agent: Western spruce budworm, *Choristoneura occidentalis*, Freeman.

Host Trees Attacked: Western spruce budworm feeding occurs primarily on Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco and grand fir, *Abies grandis* (Dougl.) Lindl., Pacific silver fir, *Abies amabilis* (Dougl.) Forbes and to a lesser extent, Noble fir, *Abies procera* Rehd. have both been defoliated when present in Douglas-fir or grand fir stands. Engelmann spruce *Picea engelmanni*, Parry, western larch, *Larix occidentalis* Nutt., western hemlock, *Tsuga heterophylla* (Raf.) Sarg., ponderosa pine, *Pinus ponderosa* Laws, and lodgepole pine, *Pinus contorta* Dougl., have all been lightly defoliated when associated with heavily defoliated Douglas-fir or true fir.

Location of Outbreak: The current damage, occurs in mixed conifer type in the Bunchgrass, Beaver Butte Creek, and Warm Springs River drainages in the vicinity of Mount Wilson (T. 6 and 7 S., R. 9 and 10 E.). This area includes essentially all of the host type defoliated last year, as shown on Map 1, Appendix.

Extent of Outbreak: The results of the 1975 aerial detection survey show about 10,560 acres of light to heavy defoliation. This is an increase of approximately 3,360 acres over the 7,200 acres recorded during the 1974 survey. The results of ground sampling at accessible points along the perimeter of this infestation indicate that no significant understory feeding occurs beyond the defoliation boundary. Larvae were recovered in late June during a defoliator monitoring survey in areas near the southern perimeter, but no visible feeding was observed.

Type of Damage: Light to heavy defoliation has occurred on trees. Aerial and ground surveys indicate trees are beginning to lose their vigor as evidenced by failure to produce new buds and foliage. Some trees in the heavier defoliation centers are beginning to exhibit dead tops, twigs, and branches.

Biological Data: Biological control agents such as birds, insects, and spiders often cause high percentage mortalities in epidemic budworm populations. However, they have never been known to control an epidemic population. These biological control agents are most effective at low population densities or in the late stages of an outbreak.

The budworm is affected by a variety of diseases including viruses, bacteria, microsporidion, protoza, and fungal diseases. These diseases seldom cause a high rate of mortality except when abnormal weather reduces budworm resistance.

During prolonged outbreaks starvation can be an important factor in controlling budworm populations. This normally does not take place until after prolonged feeding has caused extensive top-kill and some tree mortality.

No biological control agents are currently known to be causing significant population reductions in the outbreak.

Environmental Factors: The precise reasons for the occurrence of a spruce budworm outbreak are not well known. However, the essential ingredients of an outbreak appear to be a suitable food supply and consecutive years of warm, dry spring weather that favor high budworm survival (Wellington et al, 1950). Between 1970 and 1974, the spring and summer climate has been generally warm and dry. This condition has undoubtedly contributed to the recent build up of spruce budworm populations on the Warm Springs Indian Reservation.

During the spring of 1975 the weather was considerably cooler and wetter than normal. It is anticipated this condition probably had some adverse affect on larval survival. However, the results of the 1975 fall egg mass survey indicate the populations will be high enough to cause moderate defoliation in 1976.

## METHODS

Western spruce budworm egg mass evaluations were made on 38 plots in the outbreak area. Each plot consisted of a cluster of three host trees.

Tree selection within the plots was limited to trees 25 to 50 feet tall. This size limitation was necessary in order to permit convenient sampling with pole pruners. Only dominant or co-dominant host trees were selected. On rare occasions, plot trees were overtopped by non-host species, but no plot trees were overtopped by host species.

Two 30-inch branches were collected from opposite sides of the sample tree at mid-crown with pole pruners. Each branch was measured for length and width to determine square inches of foliage. The branches were stored in individual paper bags for transport to the laboratory in Portland, Oregon where egg masses were counted.

Crown Classifications - The same sample trees were used for both population densities and crown classification. Each sample tree was rated as to degree of defoliation present. This was done by first dividing the live crown of the tree into three equal levels. Each crown level was then observed and evaluated individually. Old and new growth foliage were rated separately and recorded on the field tally sheet. Intensity codes are as follows:

New Foliage Intensity Code

| Defoliation | Intensity Code |
|---|---|
| No visible damage | 0 |
| Less than 10% defoliated | 1 |
| 11 - 50% defoliated | 2 |
| 51 - 90% defoliated | 3 |
| 91 - 100% defoliated | 4 |

Old Foliage Intensity Code

| Defoliation | Intensity Code |
|---|---|
| Non-visible | 0 |
| Defoliation barely visible on previous years foliage | 3 |
| Defoliation easily visible on twigs of at least two earlier years; general thinness of crown evident | 6 |
| Defoliation severe on two or more years of older twig growth; crowns noticeably thin and grey in appearance with top bare of foliage | 9 |

## LABORATORY PROCEDURES

Foliage was examined one branch at a time. Each side of the needles was examined for egg masses. When an egg mass was found, it was removed and placed in a pill box, needle and all. A separate box was used for each plot. When this was completed, an entomologist using a microscope examined these egg masses and classified them as old or new eggs.

## EVALUATION PROCEDURES

Hazard Index - A hazard index was calculated for each sample plot. The technique has been used effectively in eastern Canada. Simmons (1973) modified and adapted this method to fit budworm conditions in Maine. This technique has value since only a single number is needed to express the likelihood that tree mortality and/or top-kill from spruce budworm feeding will occur during the following season on the sample plot.

The index was determined by assigning numerical values to each of the following categories collected at each sample point: Egg mass density, current defoliation, and previous defoliation. The values assigned to each category are outlined below.

1. Egg Mass Density

The number of new eggs per thousand square inches of foliage were calculated for each plot. Based on the egg mass density a direct prediction of defoliation for 1976 was made using the following values established by Carolin and Coulter (1970), and assigning an egg mass density code to be used in hazard rating the plot. The egg mass density code follows:

| Egg Masses Per 1,000 sq. inches | Defoliation Category | Egg Mass Density Code |
|---|---|---|
| 0 - 1.3 | very light | 0 |
| 1.4 - 3.5 | light | 1 |
| 3.6 - 8.9 | moderate | 3 |
| 9.0 - 17.7 | heavy | 5 |
| 17.7 and larger | very heavy | 7 |

2. Defoliation Hazard Code

The defoliation hazard code was determined by summing separately the new and old defoliation intensity codes from each of the crown thirds. The total was then converted to a single number for both the new and old defoliation using the following scale:

| Intensity Code | | | Defoliation Hazard Code | |
|---|---|---|---|---|
| New | Old | Category | New Foliage | Old Foliage |
| 0 - 1 | 0 - 1 | very light | 0 | 1 |
| 2 - 4 | 2 - 8 | light | 1 | 3 |
| 5 - 7 | 9 - 15 | moderate | 3 | 5 |
| 8 - 10 | 16 - 21 | heavy | 4 | 7 |
| 11 - 12 | 22 - 27 | severe | 6 | 9 |

The hazard index was caculated by summing the egg mass density code and the two defoliation hazard codes. The result is a single number or hazard index at that point for 1976. The higher the hazard index, the greater the danger to the affected trees. An index higher than 16 indicates top-killing and tree killing is likely to occur.

Data Analysis - Measurements of budworm egg mass density was made from egg mass counts expressed as a number of egg masses per 1,000 square inches of foliage. Egg mass densities were calculated for each branch sample as follows:

$$\text{Egg masses/1,000 sq. in.} = \frac{\text{(no. of egg masses) x 1,000}}{\text{sq. in. foliage}}$$

$$\text{Where sq. in. foliage} = \frac{\text{length x width}}{2}$$

Mean egg mass densities for each plot within each entomological unit were calculated in a multi-stage context (Hazard and Stewart, 1974); i.e., egg mass densities over branches and trees (y) and egg mass densities over branches, trees, and plots (y) as follows:

$$\text{Egg Mass Density per plot } y = \sum_{i=1}^{m} \sum_{j=1}^{k} y_{ij/mk}$$

$$\text{Egg Mass Density per unit } y = \sum_{y/n}^{n}$$

n = number of plots (first-stage unit)
m = number of trees (second-stage unit)
k = number of branches (third-stage unit)

Egg mass densities (y) were calculated for each plot and combined with foliage assessment data to establish a hazard index.

Treatment recommendations are based on both the computed average hazard index and the average egg mass density for the sample area. Units containing an overall average of four or more egg masses per 1,000 square inches of foliage and an average hazard index of 10 or higher will be recommended for treatment.

The use of this system insures that high hazard stands with egg mass levels sufficient to cause at least moderate defoliation next year will be treated.

## RESULTS

Western spruce budworm populations are expected to increase on the Warm Springs Indian Reservation in 1976. Egg mass densities for the 38 plots averaged 6.9 per 1,000 square inches of foliage (See Table 1. in Appendix). This density is sufficient to cause moderate defoliation in 1976. The averaged hazard index of 10.1 indicates that significant growth loss and some top-killing is expected to occur if no direct control is taken.

## DISCUSSION

The development of a strategy to cope with the problem, involving ecological, economic and social components, is difficult to formulate because the future extent, severity, persistance, and impact of any particular outbreak cannot be precisely predicted. However, previous experience in Oregon indicates that budworm outbreaks, if left untreated, may continue for as long as 14 years before subsiding (Carolin, 1972). Direct effect on trees included top-killing and a reduction in height and diameter increment; with true firs being the most severely affected (Williams, 1966).

Observations on the Nez Perce National Forest in Idaho (Ciesla et al, 1972) indicate that repeated defoliation causes tree mortality, extensive top-killing, and reduced height and diameter increment.

A no action alternative means the likely acceptance of sizeable losses to the timber resources of this area as well as the risk of incurring changes in the ecosystem which may be detrimental to management. Increased defoliation will increase the risk of forest fires which could effect a considerable larger area than the present outbreak.

Additional possible affects include changes in wildlife habitat, water quality, seed and cone production, and vulnerability to bark beetle problems.

With the knowledge obtained from previous outbreaks and the one now in progress in north central Washington, it is reasonable to assume that the outbreak on the Warm Springs Indian Reservation is likely to intensify and expand unless control action is taken. The immediate cost of a no-control decision might be low; however, the future costs could be quite high from both a monetary and ecological stand point.

A decision to control will involve the financial costs of an aerial spray project as well as minimal but temporary disturbances to the biological environment of the area considered for treatment.

The results of studies in Minnesota indicate that decisions concerning suppression should be made during the first 3 years of an infestation before serious cummulative damage has occurred (Balzer, 1973). Previous western spruce budworm suppression experience in Oregon in the late 40's and early 50's indicates that outbreaks can be successfully terminated by prompt spraying. Therefore the most effective control strategy from a total benefit/cost standpoint is to treat during the third year of an outbreak.

## RECOMMENDATIONS

Direct control should be undertaken in 1976. A continuation of western spruce budworm activity on the Warm Springs Indian Reservation will cause significant growth loss and result in an acceleration of top-kill in areas which were heavily defoliated in 1975.

All of the host type on a total of 12,400 acres are recommended needing control in 1976 as shown on Map2, Appendix.

Depending on the availability of insecticides in 1976, the objectives of the proposed action will be to significantly reduce budworm populations to prevent an acceleration of growth loss and top-kill, restore tree vigor, reduce the threat of extensive loss of the future timber crop, prevent the increase of fire hazard within and adjacent to the infested area, reduce the threat of extensive loss of cone and seed production, and to prevent serious inpairment of the aesthetic and recreational values of the area.

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Table 1.--Summary of the 1975 western spruce budworm egg mass and predicted conditions for 1976 on the Warm Springs Indian Reservation.

| Plot No. | Location | Egg Masses Per 1,000 sq. in. Foliage[1/] | Hazard Index[2/] | Predicted Defoliation for 1976[3/] |
|---|---|---|---|---|
| 1 | T. 6 S., R. 9 E., sec. 23 | 32.7 | 16 | Very Heavy |
| 2 | T. 6 S., R. 9 E., sec. 22 | 10.8 | 16 | Heavy |
| 3 | T. 6 S., R. 9 E., sec. 15 | 5.7 | 11 | Moderate |
| 4 | T. 6 S., R. 9 E., sec. 28 | 9.7 | 14 | Heavy |
| 5 | T. 6 S., R. 9 E., sec. 34 | 2.2 | 7 | Light |
| 6 | T. 6 S., R. 9 E., sec. 28 | 0.0 | 9 | Very Light |
| 7 | T. 6 S., R. 9 E., sec. 33 | 5.4 | 16 | Moderate |
| 8 | T. 6 S., R. 9 E., sec. 28 | 6.1 | 13 | Moderate |
| 9 | T. 6 S., R. 9 E., sec. 29 | 3.5 | 9 | Light |
| 10 | T. 6 S., R. 9 E., sec. 29 | 5.9 | 12 | Moderate |
| 11 | T. 6 S., R. 9 E., sec. 20 | 0.7 | 3 | Very Light |
| 12 | T. 6 S., R. 9 E., sec. 28 | 4.7 | 13 | Moderate |
| 13 | T. 6 S., R. 9 E., sec. 28 | 24.1 | 14 | Very Heavy |
| 14 | T. 6 S., R. 9 E., sec. 28 | 13.5 | 13 | Heavy |
| 15 | T. 6 S., R. 9 E., sec. 27 | 5.6 | 8 | Moderate |
| 16 | T. 6 S., R. 9 E., sec. 28 | 2.4 | 7 | Light |
| 17 | T. 6 S., R. 9 E., sec. 33 | 2.6 | 2 | Light |
| 18 | T. 6 S., R. 9 E., sec. 33 | 6.4 | 12 | Moderate |
| 19 | T. 6 S., R. 9 E., sec. 33 | 0.0 | 11 | Very Light |
| 20 | T. 6 S., R. 9 E., sec. 33 | 0.9 | 10 | Very Light |
| 21 | T. 6 S., R. 9 E., sec. 34 | 1.0 | 4 | Very Light |
| 22 | T. 6 S., R. 9 E., sec. 16 | 0.9 | 3 | Very Light |
| 23 | T. 6 S., R. 9 E., sec. 22 | 8.8 | 16 | Moderate |
| 24 | T. 6 S., R. 9 E., sec. 21 | 7.5 | 17 | Moderate |
| 25 | T. 6 S., R. 9 E., sec. 21 | 21.3 | 22 | Very Heavy |
| 26 | T. 6 S., R. 9 E., sec. 8 | 0.5 | 1 | Very Light |
| 27 | T. 6 S., R. 9 E., sec. 28 | 13.0 | 18 | Heavy |
| 28 | T. 6 S., R. 9 E., sec. 21 | 7.1 | 17 | Moderate |
| 29 | T. 6 S., R. 9 E., sec. 22 | 22.5 | 20 | Very Heavy |
| 30 | T. 6 S., R. 9 E., sec. 23 | 1.1 | 3 | Very Light |
| 31 | T. 6 S., R. 9 E., sec. 19 | 8.2 | 14 | Moderate |
| 32 | T. 6 S., R. 9 E., sec. 24 | 16.1 | 16 | Heavy |
| 33 | T. 6 S., R. 9 E., sec. 12 | 0.5 | 5 | Very Light |
| 34 | T. 6 S., R. 9 E., sec. 12 | 6.3 | 10 | Moderate |
| 35 | T. 6 S., R. 10 E., sec. 6 | 2.8 | 4 | Light |
| 36 | T. 6 S., R. 10 E., sec. 6 | 0.5 | 1 | Very Light |
| 37 | T. 6 S., R. 10 E., sec. 8 | 0.0 | 1 | Very Light |
| 38 | T. 6 S., R. 10 E., sec. 8 | 0.0 | 1 | Very Light |
| All Plots | | 6.87 $\pm$ 1.25<br>SE = 30.1 | 10.1 | Moderate |

1/Egg mass density of 4 or more per thousand square inches of foliage will cause visible defoliation.

2/Control is recommended for prevention of top-kill and additional growth loss when hazard index is 10 or greater.

3/Direct prediction of defoliation from egg mass density (Carolin, 1972).

MAP - 1
WESTERN SPRUCE BUDWORM DEFOLIATION
WARM SPRINGS INDIAN RESERVATION
1974 Defoliation
1975 Defoliation
Mt Wilson
Lookout
Wests Butte
Red Wolf Pass
Summit Butte
Willow Springs
Cold Spring
Deadman Spr
Beaver Butte
Rocky Point
Long Ridge
Warm Springs Meadows
Schoolie Pasture
Big Spring
Warm Springs River
Clackamas River
Big Meadows
Wilson Creek
Beaver Creek
Bunchgrass Creek
Bunchgrass Cr
Spring Butte
FOREST RESERVATION BOUNDARY
NATIONAL INDIAN
CAMPBELL LINE
MT WILSON ROAD
SCHOOLIE ROAD
BEAVER LOOKOUT ROAD
DRIVEWAY
TRAIL
SKYLINE
BM 3633
BM 3878
BM 4094
BM 4007
BM 3982
BM 3885
BM 3766
BM 3479
BM 3290
BM 2884
BM 2820
BM 2759
BM 2731
BM 2816
BM 3188
BM 2874
3558
3951
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5200
3600
3200
2760
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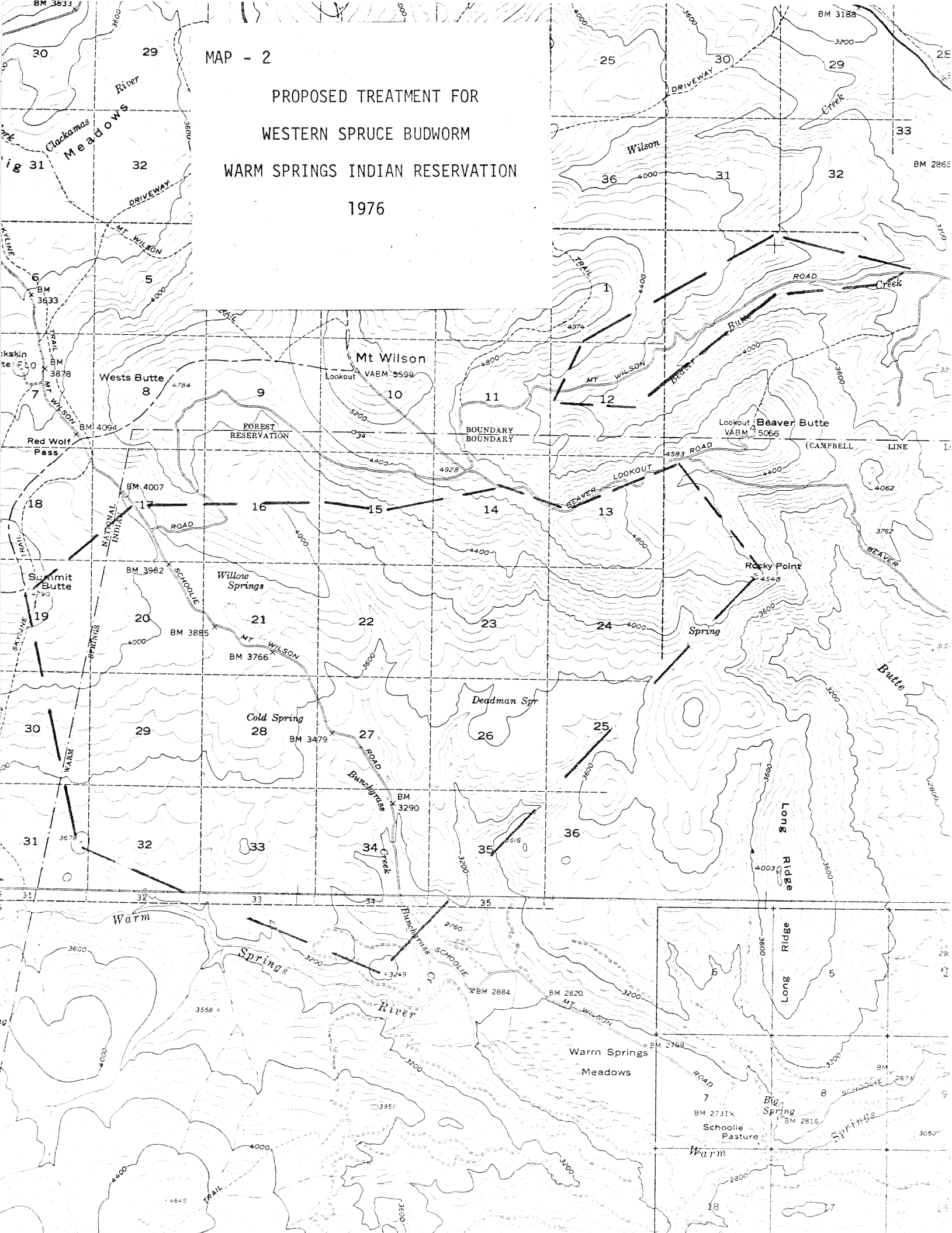
MAP - 2
PROPOSED TREATMENT FOR
WESTERN SPRUCE BUDWORM
WARM SPRINGS INDIAN RESERVATION
1976
Clackamas River
Meadows
Wilson Creek
Mt Wilson
Lookout
VABM 5599
Wests Butte
Red Wolf Pass
FOREST RESERVATION BOUNDARY
BOUNDARY
Beaver Butte
Lookout
VABM 5066
(CAMPBELL LINE
BEAVER LOOKOUT ROAD
Summit Butte
Willow Springs
Rocky Point
Spring
Deadman Spr
Cold Spring
Bunchgrass Creek
Long Ridge
Warm Springs River
Warm Springs Meadows
Schoolie Pasture
Big Spring
MT WILSON
SCHOOLIE
DRIVEWAY
TRAIL
NATIONAL INDIAN
WARM SPRINGS