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WESTERN SPRUCE BUDWORM

A 5-YEAR SUMMARY FOR YEARS 1979 THROUGH 1983

By

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I. Introduction

The western spruce budworm (*Choristoneura occidentalis* Freeman) is the most widely distributed and destructive defoliator of coniferous forests in the western United States. The larvae feed on the expanding buds and new foliage of its host trees, leading to reduced growth and top-kill. Rarely will this feeding cause significant mortality.

The budworm has one generation per year and progresses from adults to eggs to larvae to pupae.

Adult moths are about 1/2 inch (12.7 mm) long and have a wingspread of 7/8 to 1-1/8 inches (22 to 28 mm). The gray- or orange-brown forewings are banded or streaked, and each usually has a conspicuous white dot on the wing margin. Eggs are oval, light green, and about 3/64 inch (1.2 mm) long and overlap like shingles.

Larvae develop through six stages. Newly-hatched larvae are yellow-green with brown heads. In the next three stages, larvae have black heads and collars and orange- or cinnamon-brown bodies. In the fifth stage, larvae have reddish-brown heads, marked with black triangles, black collars, and pale olive-brown bodies marked with small whitish spots. Mature larvae are 1 to 1-1/4 inches (25 to 32 mm) long, with tan or light chestnut-brown heads and collars and olive- or reddish-brown bodies with large ivory-colored areas (Picture 1).

The adults emerge a few weeks after pupation, usually in July, mate, and the female lays its eggs on the host tree's needles. The eggs hatch in about 10 days, and the larvae seek shelter under bark scales and among lichens. The next spring they feed in old needles and mine the expanding buds.

The most common host-tree species of the western spruce budworm are Douglas-fir and grand fir. Often budworm larvae feed on and seriously damage coniferous trees that are planted as ornamentals such as Norway spruce and Scotch pine. See appendix for a complete list of hosts.

Both the budworm and its hosts occur in the Rocky Mountains from Arizona and New Mexico northward into Colorado, Utah, Wyoming, Montana, and Idaho, and on the West Coast in California, Oregon, and Washington.

II. Historical Perspective

Although a native insect, the western spruce budworm was not reported in the United States until 1914 in Oregon; however, it was not recognized as a serious threat to western coniferous forests until 1922, when two outbreaks were reported near Priest Lake in northern Idaho. From 1922 to present, many outbreaks have occurred in the western United States and, since 1949, large aerial suppression projects have been used to control them.

No typical pattern or trend in western spruce budworm epidemics has been apparent; most of the early epidemics lasted for a few years and then subsided naturally; others persisted longer, at times without spreading over large areas. An epidemic in the northern Rocky Mountains, which began in 1949, has now persisted for more than 30 years. Insecticidal treatment between 1952 and 1966 covered more than 6,000,000 acres (2,430,000 ha.) of forests. Some smaller epidemics in the southern and central Rockies were apparently terminated by aerial spraying; others subsided naturally. In the Pacific Northwest, over 4.7 million acres were treated with insecticides between 1949 and 1962. In 1976 and 1977, 722,000 acres were treated.

Many of the areas of heavy damage are former ponderosa pine stands that have changed to fire-intolerant white or grand fir as a result of an 85-year-old fire exclusion policy and past cutting practices of leaving true firs and harvesting the more valuable pines.

III. Resources Affected

Damage

Cones and seeds. In addition to foliage, budworm larvae feed heavily on staminate flowers and developing cones of host trees. The resultant decline in seed production has a serious impact in seed orchards, seed production areas, and forest sites that are difficult to regenerate naturally. Moreover, artificial regeneration practices are affected because seed is not available for nurseries or direct seeding.

Unlike some cone and seed insects, budworm larvae do not restrict their feeding to a single cone. Often, second- or third-stage larvae feed on newly developing conelets that soon shrivel up, dry out, and fall from the tree. As these cones dry out and become unsuitable for food, larvae continue feeding on other cones or on foliage.

In some Douglas-fir stands, nearly all cones may be damaged or destroyed by feeding larvae, especially when larval population densities are high and cone crops are light. Top-killing of some host trees, as a result of persistent heavy defoliation, often precludes cone production for many years, even when budworm populations subside.

Regeneration. The budworm also seriously affects regeneration-host trees usually less than 5 feet (1.5 m) tall and 1 to 2 inches (2.5 to 5.0 cm) in diameter. These young trees are especially vulnerable when growing beneath mature trees, since larvae disperse from the overstory and feed on the small trees below. Coniferous seedlings have relatively few needles and shoots and can be seriously deformed or killed by only a few larvae.

Seedling damage or mortality, coupled with the impact of larvae feeding on seeds and cones, can significantly delay the establishment of natural regeneration of host-tree species. Newly established seedlings are particularly vulnerable to being seriously damaged or killed by larvae, particularly when partial cutting methods leave host-tree species in the residual overstory stand. At times, however, very small seedlings are not seriously damaged or killed, probably because many larvae dispersing to the forest floor are eaten by insect and small mammal predators.

Young stands. As with regeneration, young stands are particularly vulnerable when growing beneath a canopy of overstory trees. In stands of Douglas-fir, true firs, and spruce, after 3 or more years of sustained larval feeding, many trees are almost entirely defoliated, and diameter and height growths are sharply reduced. Some trees are top-killed, which often results in stem deformity, multiple leaders, or the death of the entire tree (picture 2).. In young western larch stands, sustained larval feeding and severance of new shoots cause top deformity and can reduce height growth by as much as 25 to 30 percent. Severe defoliation and top-killing predispose young trees to secondary insects and wood-decaying fungi.

Mature stands. The greatest impact from budworm defoliation in mature stands is reduced growth, although repeated defoliation sometimes results in top-killing and tree mortality. Recent studies in Idaho and Washington showed that radial growth of defoliated trees declined about 25 percent over a 5-year period, while radial growth of undefoliated, nonhost trees in the same stand declined only 2 percent. At times, larger, dominant trees are severely defoliated and top-killed, but do not die because the trees produce adventitious foliage throughout the length of the crown, allowing the trees to survive.

In some mature stands, trees severely defoliated by the western spruce budworm may be predisposed to one or more species of tree-killing bark beetles, mainly the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins) and the fir engraver beetle (*Scolytus ventralis* LeConte).

Other. Since the budworm usually does not kill trees, as many of the other insects and diseases do, losses to other resources are speculative. It has been suggested that budworm may affect other resources such as a temporary reduction in aesthetic quality or a temporary increase in food supply for certain birds, but nothing has been quantatively demonstrated.

IV. 5-Year Western Spruce Budworm Status/Trend 1979-1983

Acreage of western spruce budworm defoliation to Douglas-fir and true fir stands has been on an upward trend during the last five years. The acreage of defoliation was 5 million acres in 1979 and 11 million in 1983 (See Table 1). The locations of the defoliation are shown on the maps.

Growth loss appears to be the major loss, but some top-killing and scattered mortality is expected.

V. Prevention/Suppression

Traditionally, chemical insecticides have been used to reduce budworm populations to nondamaging levels. During the last five years, carbaryl, acephate, and mexacarbate have been used in Oregon, Idaho, and New Mexico. In addition, *Bacillus thuringiensis*, a biological insecticide, has been used in Oregon and New Mexico to demonstrate its effectiveness (See Table 2). Figure 1 shows a comparison between acreage defoliated and acreage treated over the last five years. Another promising area is silvicultural prevention. Presently, except on small areas, silviculture is viewed as a long-term project having little impact on existing populations. It is hoped that by managing stocking control and species composition, future outbreaks can be prevented or minimized.

VI. OUTLOOK

While survey methods have not been developed to allow precise prediction of long-term trends, it is expected that western spruce budworm defoliation will continue at or near current levels in the near future.

Outbreaks probably can be expected to periodically occur until causes of outbreaks are identified and intensive management is utilized to reduce the hazard.

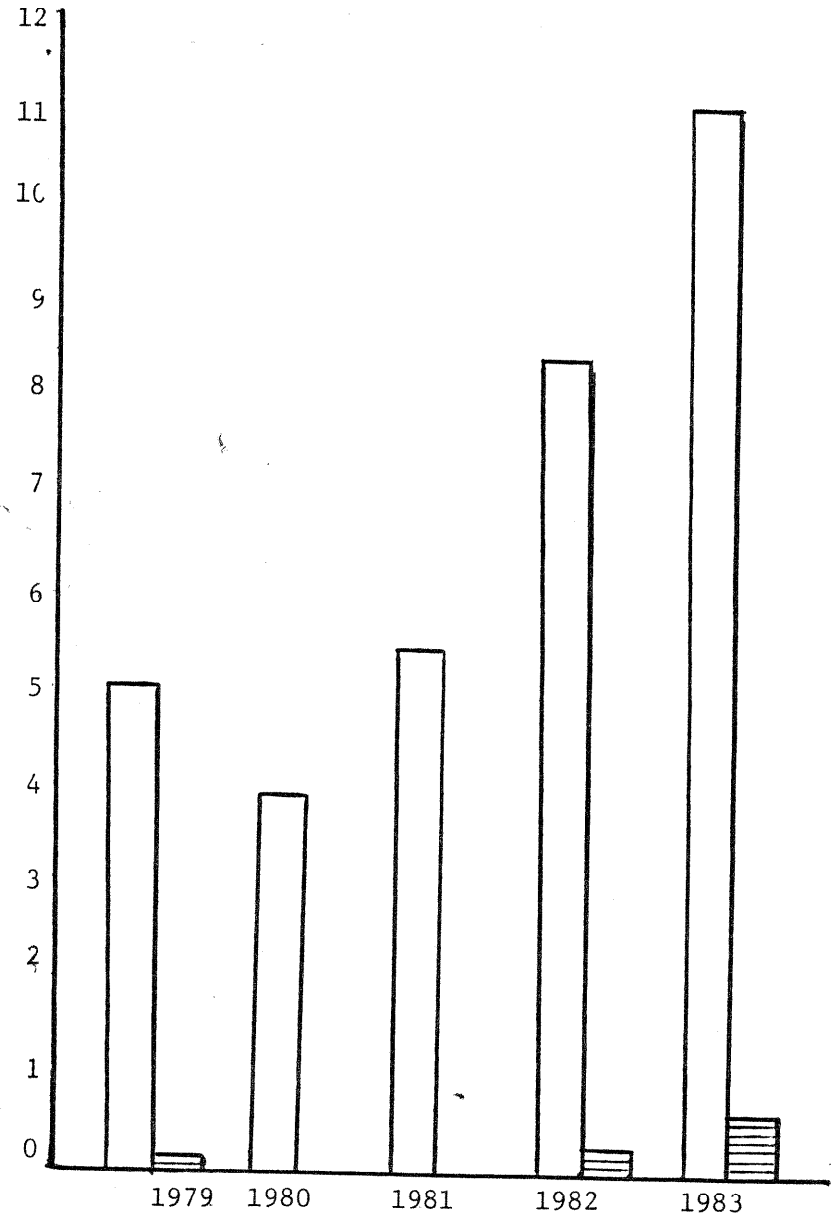
Table 1.--Western Spruce Budworm Defoliation
by State From 1979 Through 1983

State	1979	1980	1981	1982	1983
Washington	378,070	126,790	30,050	9,270	37,850
Oregon	28,590	2,340	312,640	1,530,730	2,439,168
Idaho	1,124,045	1,244,170	1,402,175	2,262,635	2,399,378
New Mexico	44,496	232,702	358,325	337,035	330,900
Montana	2,185,052	848,342	894,713	2,210,200	2,545,326
Wyoming	235,025	399,560	971,240	445,276	586,221
Colorado	930,000	1,052,000	1,400,000	1,800,000	2,600,000
Arizona	87,143	66,458	120,200	31,450	19,925
Utah	0	6,000	5,100	51,400	78,500
Total	5,007,421	3,978,362	5,494,443	8,677,996	11,037,268

Table 2.--Operational Controls Against Western Spruce Budworm 1979 Through 1983

Year	State	Acres Treated	Control Agent
1979	Oregon	34,440	Carbaryl
	Idaho	139,000	Acephate/Carbaryl
1982	Oregon	178,549	Acephate/Carbaryl
	New Mexico	68,300	Carbaryl/*B.t.*
1983	Oregon	524,561	Carbaryl/*B.t.*/mexacarbate
	New Mexico	37,600	Carbaryl/*B.t.*

Figure 1,--Millions of Acres Infested and Treated by Year for Last 5 Years

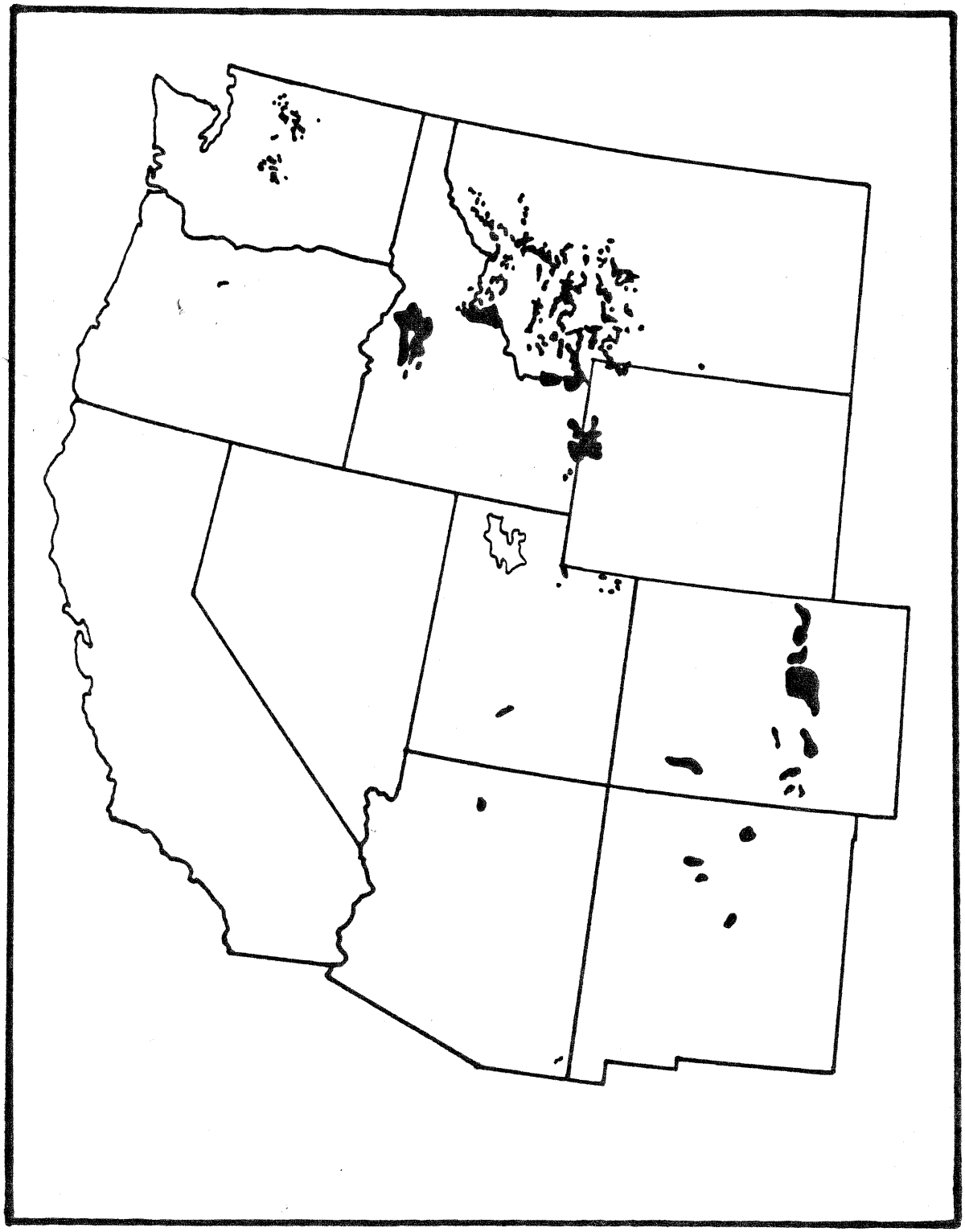


Appendix

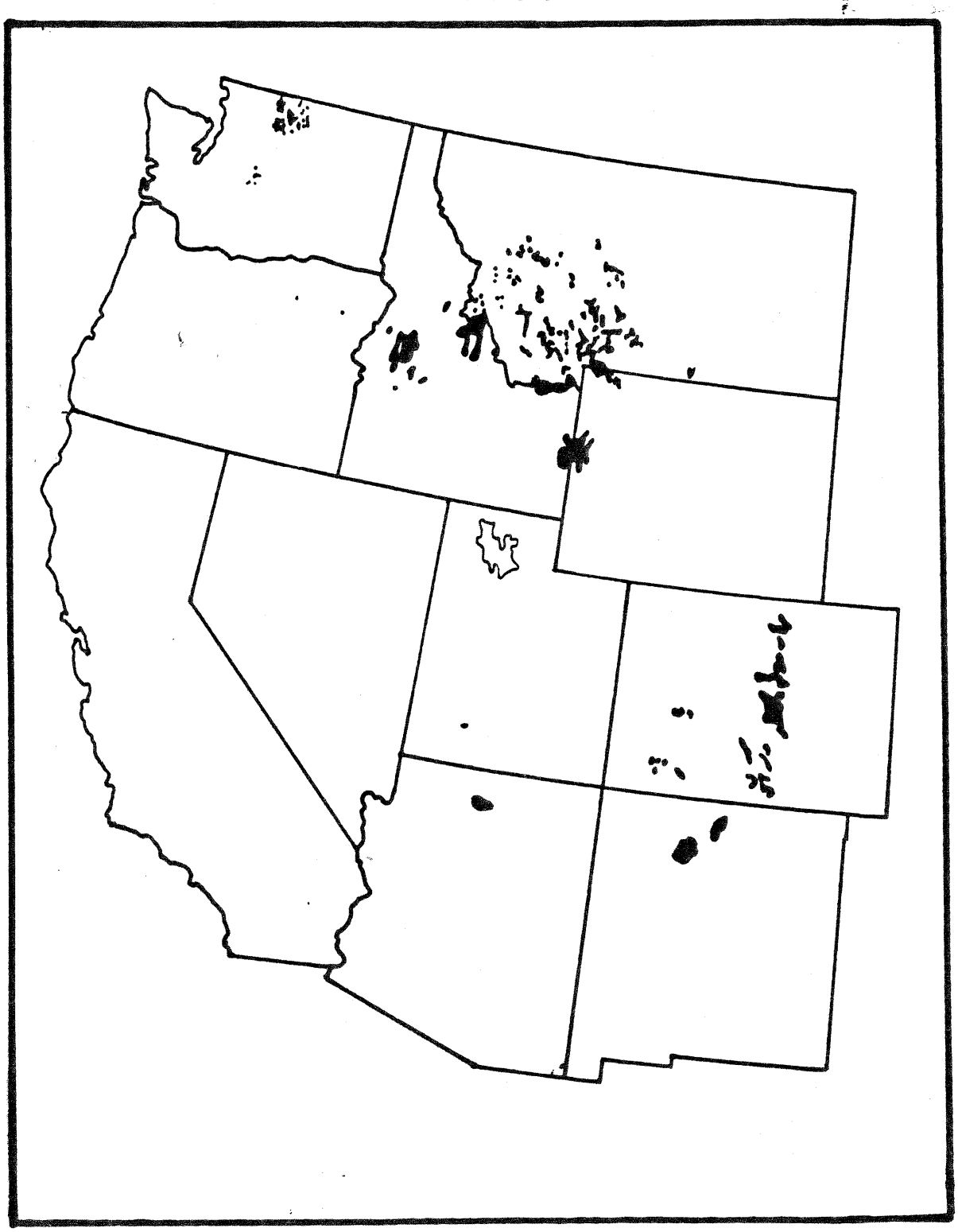
Hosts of Western Spruce Budworm

1.	Douglas-fir	*Pseudotsuga menziesi* (Mirb.) Franco
2.	Grand fir	*Abies grandis* (Gord. and Glend.) Lindl. ex Hildebr.
3.	Subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.
4.	Corkbark fir	*Abies lasiocarpa* var. *arizonica* (Merriam) Lemm.
5.	Blue spruce	*Picea pungens* Engelm.
6.	Engelmann spruce	*Picea engelmannii* Parry ex Engelm.
7.	White spruce	*Picea glauca* (Moench) Voss
8.	Western larch	*Larix occidentalis* Nutt.
9.	Pacific silver fir	*Abies amabilis* Dougl. ex Forbes
10.	Mountain hemlock	*Tsuga mertensiana* (Bong.) Carr.
11.	Western hemlock	*Tsuga heterophylla* (Raf.) Sarg.
12.	Lodgepole pine	*Pinus contorta* var. *latifolia* Englem.
13.	Ponderosa pine	*Pinus ponderosa* Dougl. ex Laws.
14.	Western white pine	*Pinus monticola* Dougl. ex D. Don.
15.	Limber pine	*Pinus flexilis* James
16.	Whitebark pine	*Pinus albicaulis* Engelm.
17.	Norway spruce	*Picea abies* L. Karst.
18.	Scotch pine	*Pinus sylvertris* L.

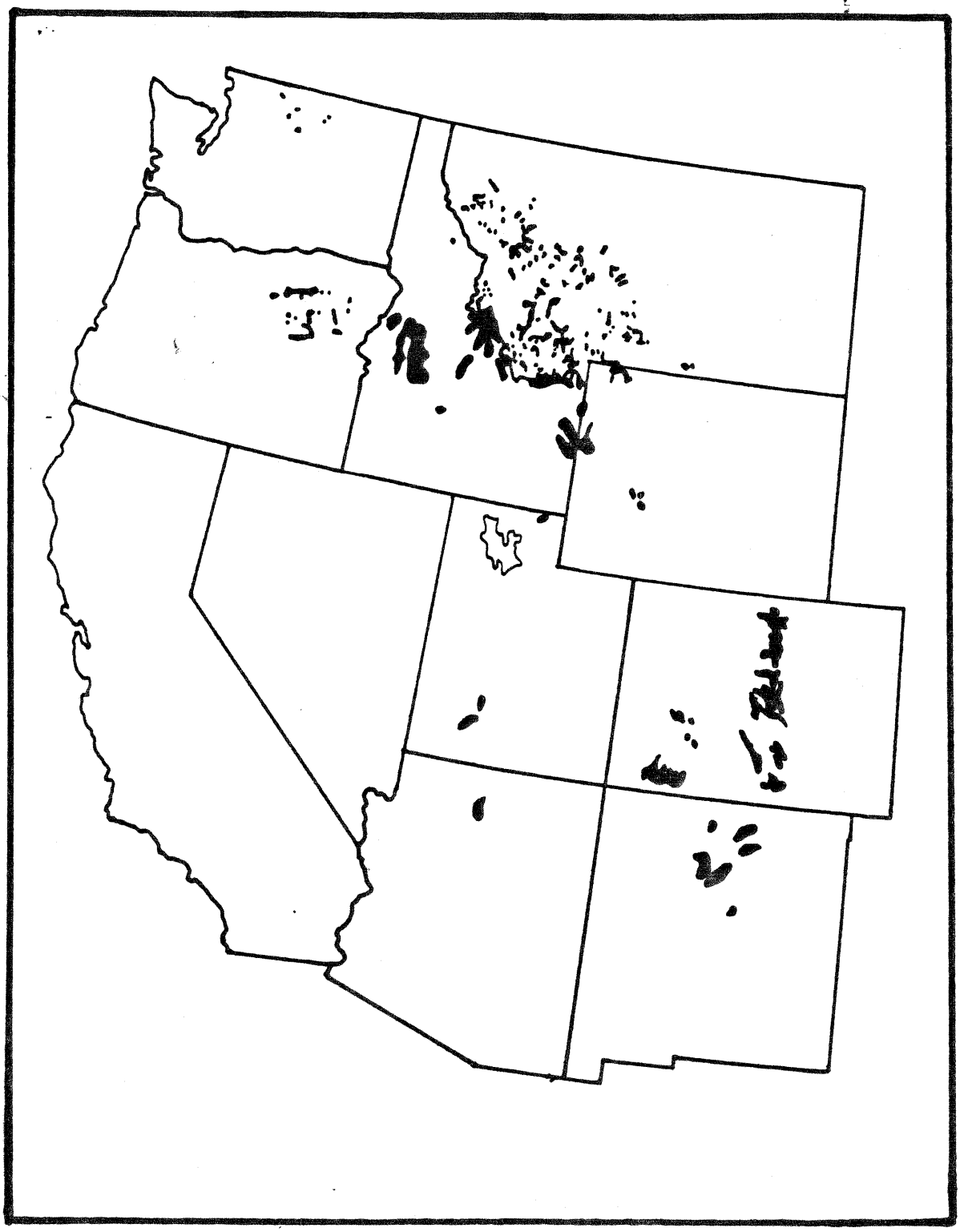
WESTWIDE
WESTERN SPRUCE BUDWORM
DEFOLIATION
1979



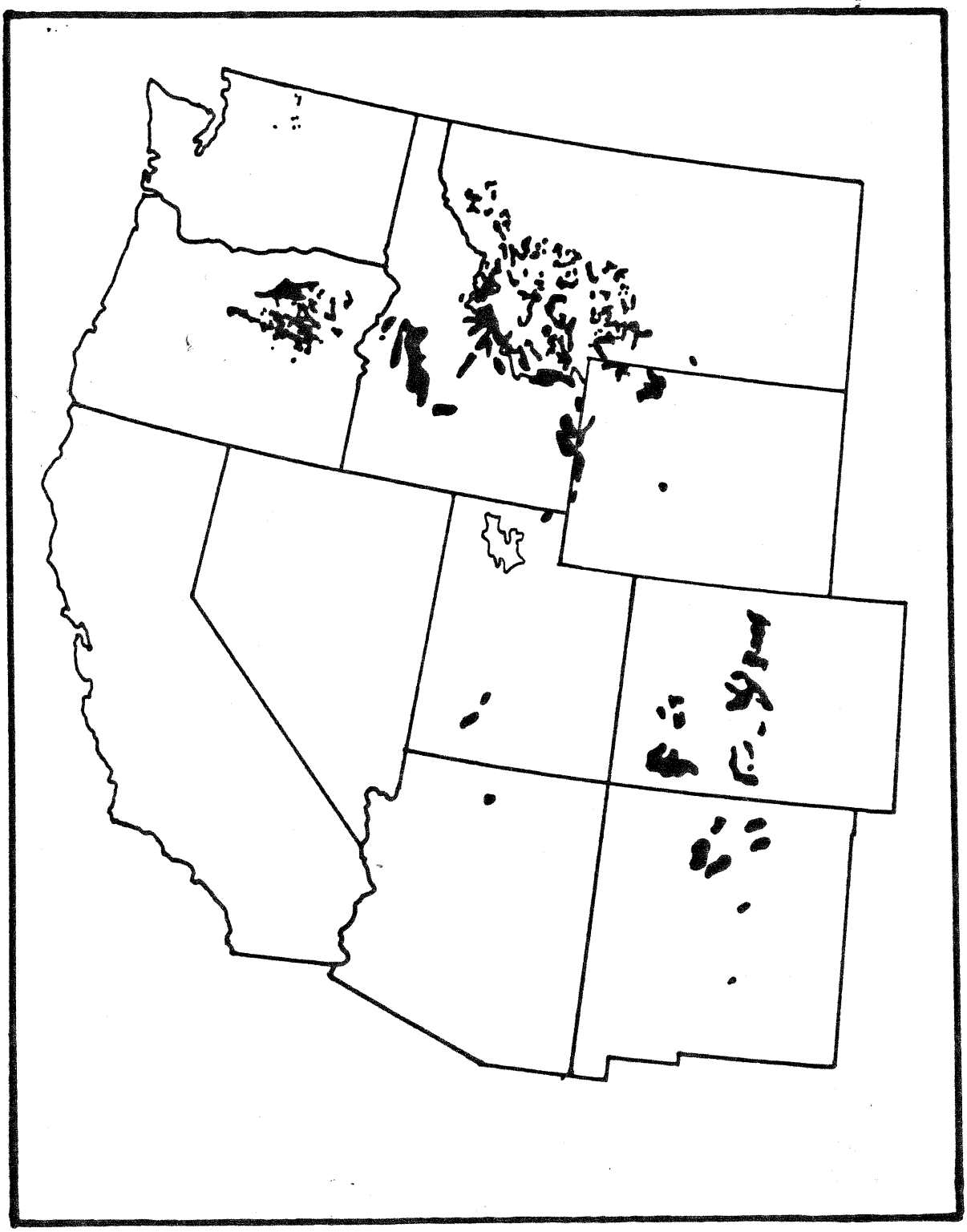
WESTWIDE
WESTERN SPRUCE BUDWORM
DEFOLIATION
1980



WESTWIDE
WESTERN SPRUCE BUDWORM
DEFOLIATION
1981



WESTWIDE
WESTERN SPRUCE BUDWORM
DEFOLIATION
1982



WESTWIDE
WESTERN SPRUCE BUDWORM
DEFOLIATION
1983