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TEN-YEAR HISTORY OF AN OREGON COASTAL PLANTATION

by Robert H. Ruth

PACIFIC NORTHWEST FOREST & RANGE EXPERIMENT STATION
R.W. COWLIN DIRECTOR
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(Maintained in cooperation with the
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INTRODUCTION

Very productive forest land, capable of producing 1,000 to 1,500 board-feet of softwood per acre per year, is common in the "fog belt" along the Oregon Coast. Good forest management requires that this valuable land be kept in constant production with minimum time lost during the regeneration period. Also, if the land is to be managed for conifer production, prompt regeneration is essential to keep seedlings ahead of fast-growing native hardwoods and brush. One way to meet these objectives is to plant seedlings for the next rotation as soon as possible after harvesting mature timber.[2/] There are, however, many unanswered questions regarding plantation establishment and factors affecting growth and survival.

The 12,000-acre Blodgett tract, located between Waldport and Yachats in about the center of the Oregon Coast, is typical of this highly productive timberland. The entire area was clear cut between 1919 and 1936, and a stand of huge old-growth Douglas-fir (Pseudotsuga menziesii), Sitka spruce (Picea sitchensis) and western hemlock (Tsuga heterophylla) was removed. Almost the entire cutover area was burned and mostly reburned by wildfire in September and October 1936, and most of the seed trees were killed. The tract was acquired by the Federal Government in 1941. Tree planting

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1/ Maintained by the Pacific Northwest Forest and Range Expt. Station at Corvallis, Oregon, in cooperation with the School of Forestry, Oregon State College.

2/ Ruth, Robert H. Plantation survival and growth in two brush-threat areas in coastal Oregon. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 17, 14 pp., illus. 1956.

was started immediately (fig. 1) and continued until late 1944, when it was decided that brush and alder had developed over the remainder of the area to a point where planting was impractical.

In 1943, a study area was established on the ridge between Vingie Creek and the south fork of Big Creek near the center of the tract. The nearest seed source was 40 acres of old-growth Douglas-fir, and other species about 2,000 feet southeast. There was also a small seed source of mature hemlock with some spruce on a ridge one mile east, and 100 acres of spruce and hemlock near the Pacific Ocean about 2.5 miles southwest by west. This report describes what happened to 3,585 staked seedlings during a 10-year period.

THE STUDY

Plot layout was designed to test: (1) species, (2) survival rates of fresh and stored planting stock, (3) effects of variations in planting techniques, and (4) influence of aspect (fig. 2). Approximately 1,200 trees each of Douglas-fir, Sitka spruce, and Port-Orford-cedar (Chamaecyparis lawsoniana) were planted and staked in long rows beginning in a creek bottom and extending up and over a high ridge. Elevation ranged from 700 to 1,000 feet.

Trees were spaced on an average of six feet with eight feet between rows. The planting covered about 4 acres, with 908 trees to the acre. Three experienced planters alternated species and rows to eliminate bias due to variations in planting techniques. One-half of the Douglas-fir and Port-Orford-cedar had been freshly dug and the other half kept in a cool, dark storage room at the nursery for approximately two months before planting. Douglas-fir, Port-Orford-cedar, and half the spruce stock came from the Oregon Forest Nursery at Corvallis, Oregon. The remainder of the spruce, from a nursery at Neah Bay, Washington, dried out during shipment and was not in as good condition for planting as the Oregon-grown trees. All planting stock was 2 years old (2-0). Seed origin was unknown.

Trees were examined in October 1943 after the first growing season; October 1944, after the second season; November 1945, after the third; March 1948, after the fifth; and June 1952, during the tenth growing season. Tree heights were measured, mortality recorded, and animal damage noted. The amount of shade

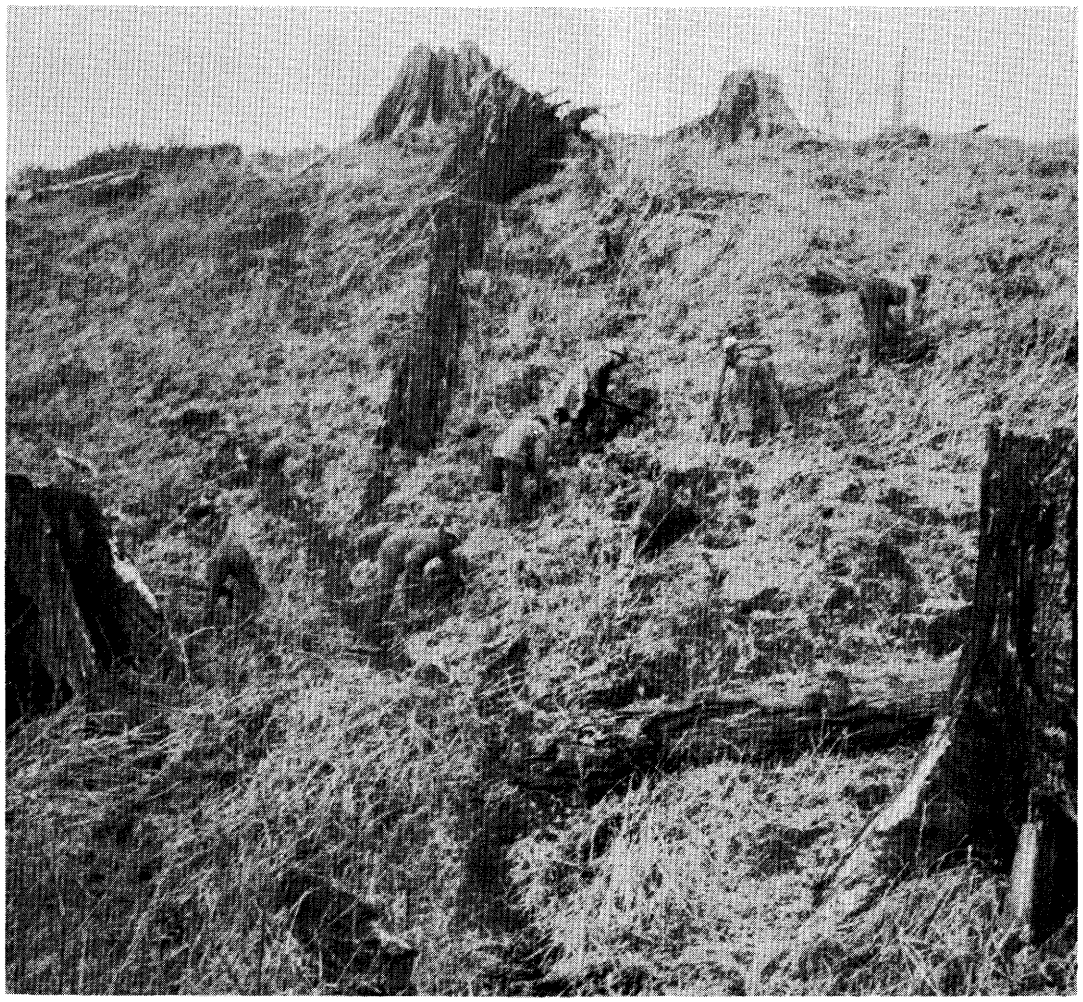

Figure 1.--A 6-man crew planting seedlings on the Blodgett tract, 1943.

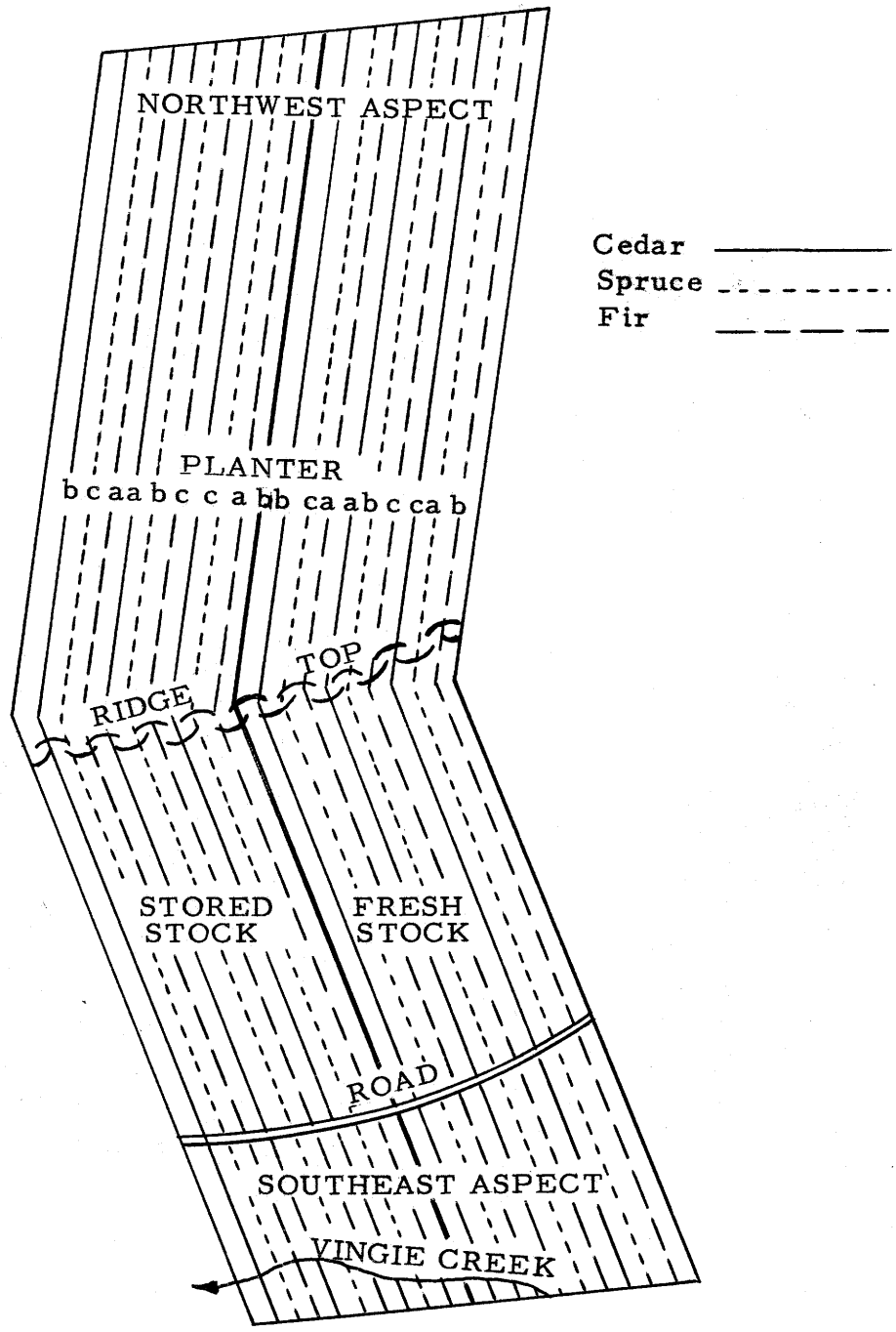

Figure 2.--Diagram of plot layout. Letters a, b, and c refer to planters.

received by each tree was estimated at every examination except in 1944 in order to study the effects of competing vegetation. Shade classes were as follows:

0 -- Tree not shaded.
1 -- Shaded from the sides and only a small amount of overtopping.
2 -- Partly overtopped with considerable top light cut off.
3 -- Fully overtopped by a canopy of alder, brush, or weeds.

Regardless of season of examination, shade classes were estimated assuming early summer conditions with the brush in full leaf and the herbage fully grown. Shade type was recorded for each tree as follows:

Evergreen brush
Salal (Gaultheria shallon)
Oregon grape (Mahonia spp.)

Deciduous brush
Thimbleberry (Rubus parviflorus)
Salmonberry (Rubus spectabilis)
Elderberry (Sambucus callicarpa)

Hardwoods
Red alder (Alnus rubra)
Willow (Salix spp.)

Bracken fern (Pteridium aquilinum pubescens)

Herbaceous plants other than bracken fern.

THE PLANTATION AFTER TEN YEARS

General Results

By the tenth growing season, the study area had a good stocking of planted conifers with 581 trees per acre or 64 percent survival. Height averaged 6.2 feet, with Douglas-fir surviving better and growing faster than either spruce or Port-Orford-cedar (table 1).

Table 1.--Tree survival and average height, Blodgett tract study, tenth growing season, June 1952

Species	Trees planted	Trees alive	Average height
	Number	Percent	Feet
Douglas-fir	1,189	73	9.8
Sitka spruce	1,198	60	5.5
Port-Orford-cedar	1,198	60	2.5
Average		64	6.2

Overall distribution of established trees was poor. The ridgetop was the most successful part of the plantation, the upper two-thirds of the southeast slope partly successful, and the remainder mostly a failure. On the ridgetop, conifers from both planting and natural regeneration clearly dominated the site (fig. 3). The tallest trees were natural Douglas-fir, averaging 14 years old. Next in order of height were willow, 10-year-old planted Douglas-fir, natural hemlocks averaging 11 years, planted spruce, natural alder, and planted Port-Orford-cedar. Scattered seedlings of western redcedar (Thuja plicata) were also noted. Port-Orford-cedar was not as vigorous as other species, even where there was no competing vegetation. Many had a shrub-like appearance, probably the result of frequent browsing by deer and damage by storm winds common in this exposed location.

On the southeast slope, conifers formed the dominant canopy for about two-thirds of the way from ridge to creek. Except for widely scattered large willow and alder, the area was dominated by vigorous Douglas-fir and hemlock natural reproduction and planted Douglas-fir. Planted Douglas-fir was not as tall as natural reproduction. Trees from both sources were generally shorter and less dense than those on the ridgetop. Ground cover was salal 2-feet tall with some Oregon grape and bracken fern. The lower third of the slope was dominated by 16-year-old alder and willows (fig. 4). Planted conifers were growing very slowly under the hardwood canopy and many had dropped out. Very scattered natural conifer reproduction had become established. Ground cover was salal and thimbleberry 2 to 3 feet tall.

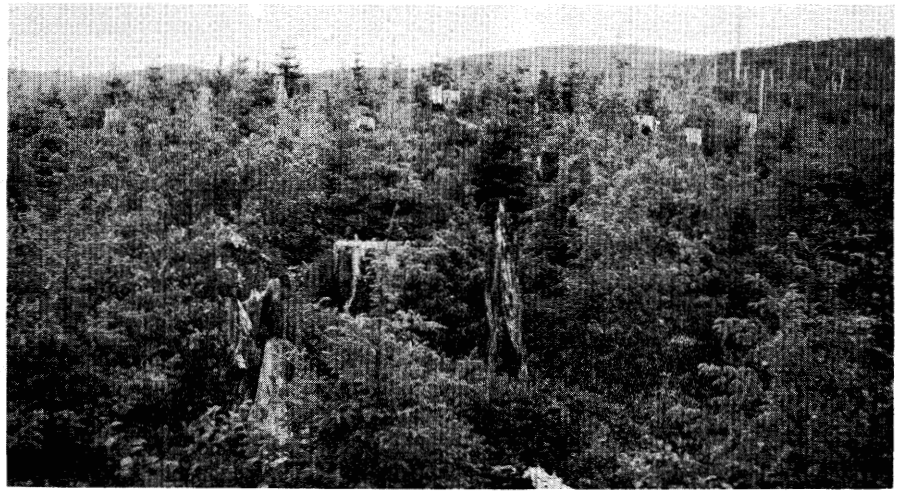

Figure 3.--By the tenth growing season conifers dominated the ridgetop site.

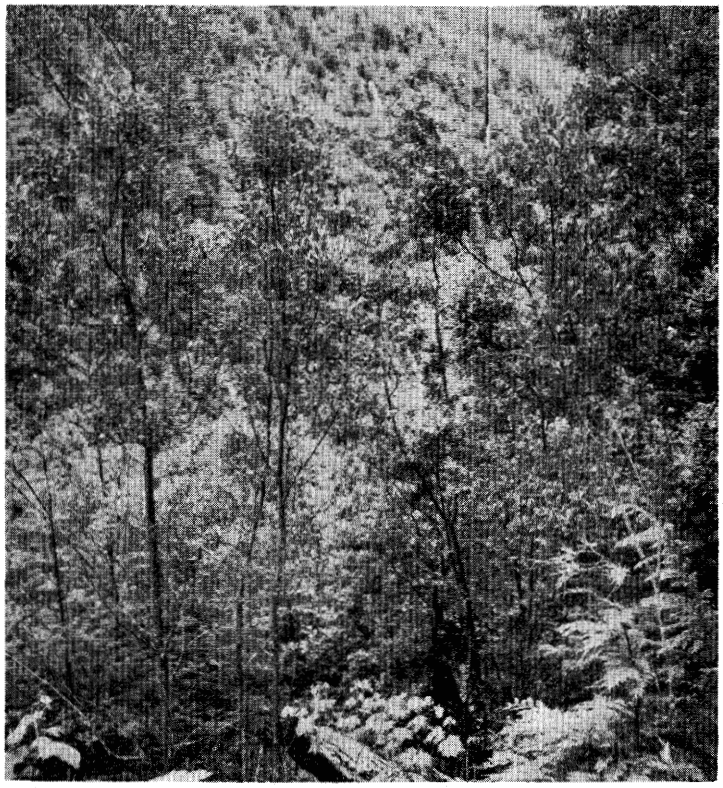

Figure 4.--Willow and alder dominated the lower southeast slope. Planted trees under this canopy were doing poorly and natural conifer reproduction was scarce.

On the northwest slope, 15-year-old red alder became the dominant species beginning about 100 feet below the brow of the ridge. Average diameter breast high was 6 inches and height 45 feet. The plantation was doing poorly under the alder canopy (fig. 5), and no natural conifer reproduction had become established. Ground cover was composed of salmonberry, elderberry, grass, and herbs. There was practically no salal on this slope.

At the creek bottom very few planted trees had survived, and there was no natural reproduction of any tree species. The site was dominated by a dense thicket of thimbleberry, salmonberry, and salal.

Figure 5.--Planted trees under the alder canopy were doing poorly.

Fresh or Stored Planting Stock

Douglas-fir and Port-Orford-cedar trees stored in a cold room at the nursery for two months prior to planting survived and grew as well as the freshly dug trees (table 2).[3/] Early survival and height measurements indicated slightly better results with stored stock. By the tenth growing season, none of the differences were significant, and no significant variations in survival or height were found.

Table 2.-Survival and height of freshly dug and stored planting stock.

Item	Douglas-fir		Port-Orford-cedar	
	Freshly dug	Stored	Freshly dug	Stored
Number of trees planted, spring, 1943	600	589	599	599
Survival, percent,				
fall, 1943	92	94	86	92
summer, 1952	73	72	60	59
Average height, feet, summer, 1952	9.8	9.8	2.3	2.7

Comparison of Planters

In terms of survival, there was no significant difference among the three planters (table 3).

Table 3.-Survival of trees planted by different planters.

Planter	Survival	
	To October 1943	To October 1944
	Percent	
A	87.4	82.0
B	88.2	81.2
C	89.8	83.1
Average	88.5	82.1

3/ Ruth, Robert H. Survival and growth of fresh and stored planting stock. Pacific Northwest Forest and Range Expt. Station, Res. Note 93, 2 pp. 1953.

A row-by-row study of survival showed that almost all the advantage gained by planter "C" came from one row of fresh Port-Orford-cedar stock planted on the northwest slope. By October 1943 the row planted by "C" lost only one tree, while similar rows planted by "A" and "B" lost 19 and 12 trees, respectively. Considering the entire plantation, however, differences between planters were probably no more than expected. Any effect of this variation on other factors under study was no doubt minimized by alternating rows and species.

Aspect

The plantation was more successful on the southeast than northwest slope. Survival of the three species averaged 19 percent better on this slope by the tenth growing season, and Douglas-fir trees averaged 1.6 feet taller (table 4). Sitka spruce, however, averaged 0.7 feet taller on the northwest slope. Growth of Port-Orford-cedar was poor on both slopes.

Table 4.--Tree survival and height on northwest and southeast aspects by tenth growing season, June 1952.

Species	Survival		Average height	
	Northwest	Southeast	Northwest	Southeast
	----- Percent----		-------- Feet --------	
Douglas-fir	65	81	8.9	10.5
Sitka spruce	53	64	6.0	5.3
Port-Orford-cedar	44	75	2.4	2.5
Average	54	73	6.2	6.3

Looking at mortality from year to year, there was a gradual reduction in seedling loss with the increasing age of the plantation and greater mortality on the northwest than southeast slope (table 5). First season mortality averaged about 11.5 percent, and considering all species, it was 1.3 percentage points greater on the northwest slope. Port-Orford-cedar was the exception, with 1.0 percentage point greater loss on the southeast slope. During the second season mortality averaged about 7.2 percent with a difference of 3.2 percentage points in favor of the southeast slope. This second season probably marked the end of mortality from failure to survive the planting operation and subsequent seedling losses were probably traceable directly to plant competition or injuries. During the

third year, mortality was 4.1 percentage points higher on the northwest slope. Sitka spruce was the exception, however, with greater mortality on the southeast slope. During the fourth and fifth years, overall mortality was 4.7 percentage points greater on the northwest slope. During the next four years, mortality on the whole was lower on both slopes but still 2.5 percentage points higher on the northwest.

Table 5.--Annual mortality by aspect and species

Year and species	Annual mortality	
	Northwest aspect	Southeast aspect
	Percent	
1943		
Douglas-fir	7.0	6.9
Sitka spruce	19.4	14.5
Port-Orford-cedar	10.2	11.2
Average	12.2	10.9
1944		
Douglas-fir	7.4	3.5
Sitka spruce	10.0	9.2
Port-Orford-cedar	9.3	4.3
Average	8.8	5.6
1945		
Douglas-fir	5.8	4.1
Sitka spruce	6.9	7.7
Port-Orford-cedar	13.7	2.6
Average	8.8	4.7
1946-1947		
Douglas-fir	6.3	1.3
Sitka spruce	5.3	1.8
Port-Orford-cedar	7.4	2.0
Average	6.4	1.7
1948-1952		
Douglas-fir	2.2	1.0
Sitka spruce	3.0	1.5
Port-Orford-cedar	6.6	1.4
Average	3.8	1.3

Effects of Shade

There was a general increase in shading of planted trees the first three years followed by a decrease for those trees that overtopped competing vegetation. During the first two growing seasons, most of the planted trees were in shade class 1 or 2. By the end of the third season, many trees of all species were overtopped by brush or alder, resulting in a pronounced increase of trees in class 3. Shading was heavier on the northwest slope, with 725 trees classified as fully overtopped, compared to 483 trees on the southeast. This heavy shading was a result of rapid height growth of alder and deciduous brush predominant on this slope, compared to slower growth of evergreen brush predominant on the southeast. During the fourth and fifth seasons many trees, mostly Douglas-fir on the southeast slope, overtopped their competition and were placed in class 0, not shaded. By the tenth season, 42 percent of all Douglas-fir were in shade class 0 or 1.

Throughout the ten years of the study, annual mortality was consistently greater in heavy shade (table 6). It averaged under 3 percent for shade classes 0 and 1 and almost 4 percent for shade class 2. For shade class 3, it was over 8 percent. This indicates that most planted trees could tolerate side shade and some top shade but did not survive long when overtopped. An earlier study[4/] of two other brush-threat areas on the Oregon Coast provided similar results. On those areas most planted conifers were found to tolerate three-fourths shading and still survive; but there was an abrupt increase in mortality when they were overtopped.

Table 6.--Annual mortality by shade class

Growing seasons	Shade class			
	0	1	2	3
	---- Percent ----			
1st--March to October 1943	10	11	9	17
2nd --October 1943 to October 1944	7	4	6	17
3rd--October 1944 to November 1945	5	4	8	10
4th & 5th--Nov. 1945 to March 1948	0	2	3	7
6th to 10th--March 1948 to June 1952	1	1	2	5
Weighted average	2.7	2.8	3.9	8.3

4/ Ruth, Robert H. Planting survival and growth in two brush-threat areas in coastal Oregon. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 17, 14 pp., illus. 1956

Higher mortality occurred in the deciduous brush than any other type. This was true for all three species on both aspects, with the exception of Port-Orford-cedar on the northwest slope, which had slightly greater mortality under alder.

Animal Damage

During the first year the only animal damage noted was some nipping by rodents, mostly mountain beaver (Aplodontia rufa pacifica). A few trees were buried or uprooted by mountain beaver digging their burrows. These animals were clearly more active on the northwest slope in deciduous brush and alder cover types.

Again in 1944, after the second growing season, it was noted that most beaver damage was on the edges of alder and deciduous brush thickets, which were more numerous on the northwest slope. Of 2,943 living trees, 413 were within four feet of rodent activity. Ninety-two of these were on the southeast slope and 321 on the northwest. Rodent damage seemed greater in the heavy shade class; but at the same time there was a tendency for the animals to abandon burrows in very dense shade and start new ones nearer the edges of alder and deciduous brush thickets. A few trees of all species showed signs of nipping and some trees were buried as the rodent dug their burrows.

The same types of animal damage were found in later examinations. Following the third growing season, 49 trees were nipped by rodents or deer on the northwest slope compared to 29 on the southeast. Third-year mortality was somewhat greater on the northwest slope due to rodent and deer activity. Again in 1948, following the fifth season, damage was greater on the northwest slope, where 29 percent of the Douglas-fir was damaged, against 13 percent on the southeast. Port-Orford-cedar was 76 percent damaged on the northwest slope compared to 66 percent on the southeast.

Rodents preferred Port-Orford-cedar and Douglas-fir to Sitka spruce. This was first noted following the third season, when it was found that beaver had done considerable nipping of Port-Orford-cedar and Douglas-fir, but about the only effects on spruce were root damage from beaver burrowing or the covering of small trees with soil from the burrows. Some damage to trees growing in the openings was also noted, probably caused by deer. By 1948, it became apparent that rodents and deer much preferred Port-Orford-cedar and Douglas-fir to Sitka spruce. At the 1948 examination

70 percent of the Port-Orford-cedar and 20 percent of the Douglas-fir were damaged, but only 0.6 percent of the spruce.

SUMMARY AND DISCUSSION

Results of the 10-year study of a conifer plantation on the Oregon Coast are:

1. After 10 years the stocking of planted conifers was good with 581 trees per acre. Survival was 64 percent.
2. Douglas-fir survived better and grew faster than either Sitka spruce or Port-Orford-cedar.
3. Douglas-fir and Port-Orford-cedar seedlings stored in a cold room at the nursery for two months prior to planting survived and grew as well as the freshly dug trees.
4. There was no significant difference in tree survival among seedlings planted by different planters.
5. The plantation was more successful on the southeast than northwest slope.
6. There was a general increase in shading of planted trees the first three years followed by a decrease for those trees that overtopped competing vegetation.
7. Annual mortality was consistently greater for overtopped trees.
8. Animal damage was greatest on the northwest slope.
9. Rodents preferred Port-Orford-cedar and Douglas-fir to Sitka spruce.

Most significant is the disclosure that stand establishment could have been obtained more economically if different regeneration treatments had been applied to different parts of the 4-acre study area.

On the ridgetop, reliance could have been placed entirely on natural regeneration or perhaps spot planting could have been used to fill gaps between natural seedlings and speed up full stocking. The upper two-thirds of the southeast slope, now dominated by natural and planted conifers, received adequate planting treatment. This area needed full planting to supplement natural regeneration. On the northwest slope and lower third of the southeast slope planting was also needed but was not enough. Most of the small trees were overtopped by competing vegetation and mortality has been high and can be expected to continue at a high level until most overtopped trees drop out of the stand.

Survival would have been greatly improved if release treatments had been applied about the time the planted trees were first overtopped. The need for release treatments was recognized early by Siuslaw National Forest personnel, and several methods for controlling alder and brush on the Blodgett tract were tested starting in 1948. Chemical control using two pounds, acid equivalent, of 2,4-D per acre proved to be the most economical treatment with costs of spraying 1,000 acres in 1951 averaging $5.15 per acre.[5/] Subsequent examinations of treated areas have indicated that a somewhat heavier application of 2,4-D would have provided better release although damage to exposed leaders of conifers would also have been greater.

It is apparent that planting the study area immediately after the 1936 fire would have met with even greater success. Planted trees would then have had a head start on competing vegetation and been less subject to overtopping. Even so, some release treatments would probably have been needed to maintain full stocking of conifers.

5/ Hawkes, Carl. Planes release tree plantation. Jour. Forestry 51:345-348.