THE ROLE
OF SUBSIDIARY FOREST CROPS
IN DOUGLAS-FIR FORESTS

by

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THE ROLE OF SUBSIDIARY FOREST CROPS IN DOUGLAS-FIR FORESTS

INTRODUCTION

Purpose

A person who reads one of the United States Department of Agriculture pamphlets on forest statistics for counties in the states of the Pacific Northwest will notice references to certain minor forest industries. Further study shows that there are several minor forest products which are common to practically all the counties in the Douglas-fir region.

It is the purpose of this thesis to give pertinent information concerning those products or crops which are most common, and to show how they contribute to sustained production in the Douglas-fir forests of the region. It is important in a long range program of forestry to know something of the possibilities which these products offer in furnishing revenue while timber-lands are regrowing a new forest crop.

Limits of the Study

This study is not concerned with the returns from timber, piling, or other major products produced from
Douglas-fir trees or the major species most commonly associated with them.

It was found that accurate information was lacking as to volumes and prices for some of the minor products, and in these cases the most accurate estimates available were presented. Often these estimates varied considerably, and in such instances several sets were presented, with an attempt made at evaluating them.

The study was of a nature which required more library research than field investigation, and it has certain limitations because of this fact.

**Methods Used**

Much of the information presented in this work was the result of library research. Considerable information was supplied by letters from men engaged in the various industries concerned or by other interested persons.

Some information was gathered as the result of personal interviews with men who are concerned with some of these subsidiary crops.

Five subsidiary products were considered to be more important than the rest, and a chapter was therefore written concerning each. A sixth chapter was written on
several less important subsidiary crops and on secondary products obtained from the timber producing species.

Definitions

The term "subsidiary crop" is used in this thesis to mean a crop produced on forest land, which does not come from the timber producing species growing in the Douglas-fir forests or which is not usually considered as a product of these species when grown for timber purposes.

"Secondary products" are considered as those products which come from the timber producing species in the Douglas-fir forests, and are either the by-products of timber production, or are removed to improve the timber producing qualities of the remaining trees.
Chapter One

CASCARA

Introduction

The harvesting of the bark of cascara buckthorn (Rhamnus purshiana De Candolle) is frequently mentioned as a minor industry in forests of western Oregon and Washington (19)(34)(55)(59). Much of this bark comes from trees growing in stands of Douglas-fir, or from cut-over lands previously in Douglas-fir. This industry is therefore properly treated as one in which the product is a subsidiary crop in Douglas-fir forests.

This chapter will give pertinent information concerning the cascara tree, the industry based upon the tree, and will show something of the contribution of the cascara industry to Douglas-fir forestry.

Part I

THE CASCARA TREE

History of the Tree

Cascara, as this tree is commonly called, was first noted near the banks of a tributary of the Columbia River about 1805 by members of the Lewis and Clark expedition.

1. Numbers in parentheses refer to bibliography.
Eschscholtz, a Russian naturalist, noted it in California in 1816, and early priests of Mexican and Spanish settlements in old California were supposed to have known this species as early as 1800 (49).

The tree was first called *Rhamnus cathartica* in about 1820, but in 1890 the name of *Rhamnus purshiana* was officially adopted, commemorating the botanical labors of Frederick Pursh, who first described the tree. This name is accepted by the botanical and scientific world, while cascara sagrada is the name adopted by the materia medica.

The tree belongs to the genus *Rhamnus*, of the *Rhamnaceae* or Buckthorn family, of which several species exist, widely distributed on four continents (21). It has many common names, among which the following are noted by Sudworth: shittim wood, cascara sagrada, bearberry, bearwood, wahco, chittim, cascara buckthorn, yellow wood, coffee berry, Oregon bearwood, and others. Cascara buckthorn is the name adopted by the United States Forest Service in 1940 (63).²

### Distribution

Cascara is found distributed from southwestern

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² Sudworth's check list, revised January 24, 1940, is followed for accepted common names.
British Columbia southward to Central California, extending along mountain ranges of northern Washington, to the Bitterroot Mountains of Idaho, and occurring occasionally on eastern slopes of the Sierra Nevada mountains. It reappears on the mountains of Colorado and western Texas. The commercial range of the tree is confined to northwest California, western Oregon and Washington, and southern British Columbia. The most important part of the range is western Oregon and Washington, but British Columbia also produces considerable quantities of bark (5) (22).

**Medicinal Value--Importance of the Tree**

The commercial importance of cascara buckthorn is based upon the medicinal properties of its bark, the extract of which is widely used as a laxative or cathartic. The medicinal property of the bark, which has never been isolated, increases the secretion of the intestinal canal and at the same time acts as a tonic. This tonic quality tends to prevent constipation which usually follows the use of similar drugs, and thus allows a gradual decrease in dose until none is needed. Since the medicinal property has never been isolated, there is no way in which it can be extracted. It is not used for any purpose other than as a cathartic because of the inability of chemists
to isolate the medicinal principle (49).

In use, therefore, a certain quantity of powdered dried bark is made into a solution with various other medicines and drugs.

Official preparations of cascara are:

Extract of cascara sagrada
Fluid extract of cascara sagrada
Aromatic fluid extract of cascara sagrada
Fluid glycerate of cascara
Aromatic fluid extract of cascara

Cascara was no doubt first used by American Indians, who taught its use to early priests in California. The medical profession first introduced the use of this laxative in 1877 (49).

The bark of several other species of this genus has been used as a laxative since an early date, so it is not surprising that the bark of Rhamnus purshiana has been found to be valuable for this purpose.

Description of the Tree

Cascara is a small tree and is moderately gregarious, often forming small groves on moist bottom lands and burns. It usually occurs as an understory species in Douglas-fir forests, and is commonly mixed with fir, hemlock, bigleaf maple, vine maple, and red alder in
many sections of the Pacific Northwest.

A condensed detailed description of the tree follows:

**Size**

Cascara has been recorded as reaching a height of 60 feet, and a diameter of 2½ to three feet, but is usually 20 to 40 feet in height and six to 15 inches in diameter in its commercial range.

**Age**

The longevity of this tree has not been completely determined, but four trees growing on the Smith River in southwestern Oregon, ranging in diameter from 10 to 16 inches, were from 57 to 65 years old.

A tree 79 years of age has been reported on the Siuslaw National Forest. Peeling of the bark has killed most mature trees, so figures on the size to which the tree might grow are lacking.

**Leaves**

The tree is deciduous save for seedlings. The leaves are arranged alternately on the stems, and are broadly elliptical, obtuse or blunt-pointed at the apex, rounded at the base, and finely serrate on the edges. They have prominent veins, and are 1⅛ to seven inches long and 1⅛ to two inches wide.
Flowers

The flowers, appearing in May or June, are small, five-petalled, greenish, and are borne in clusters near the ends of the branches.

Fruit

The fruit, which matures in one season, is round, one-fourth to one-third inch in diameter, smooth and black when ripe, red when immature. It has two to three hard, smooth, olive green seeds enclosed in a juicy, rather thin pulp, and is relished by birds and mammals. It is thought that cascara begins to produce seed at five to seven years of age.

Buds

The buds of cascara offer a very sure means of identification in winter, since it is the only known deciduous tree on the Pacific Coast whose buds are not covered by bud scales.

Bark

The bark of the cascara tree varies from one-tenth to two-tenths inch in thickness and rarely reaches one-fourth inch. Its color ranges from dark to light brown or gray, tinged with red. The inner surface is bright yellow when freshly exposed, but darkens on exposure. It has a bitter taste and colors the saliva yellow.

Wood

The wood of this tree is moderately heavy, having a
specific gravity of 0.5836, weighing 36.37 pounds per cubic foot, according to Sargent. It is ring porous with diffuse porous tendencies, firm but brittle, brown tinged with red, with lighter sapwood. It is of little economic value, being used only for posts, cheap furniture, and spokes. Tests indicate a short life for this species when used as a post.

The wood also contains the medicinal property found in the bark, but in smaller quantities. Twigs less than one-fourth inch in diameter have 50 per cent of the medicinal value of the bark, while twigs one inch and less have about 30 per cent of the medicinal value of the bark.

Roots

Cascara has a rather shallow root system, with no tap root except in a very porous, well-drained soil. Seedlings have a fibrous root system which makes transplanting easy.

Form

The form of the tree varies with the condition under which it is grown. Open grown trees have a short trunk with a brushy crown, while forest grown trees have a long, slender bole, clear for 15 to 20 feet, and have a much less dense crown.

When cultivated in plantations and pruned, the tree
produces a bole clear for about one-third its total height and develops a main stem which maintains its size well. Trees of this type may be seen in the plantation of Mr. Thomas Miller, Route 1, Brownsville, Oregon.

**Silvics of Cascara**

**Soil and Moisture**

Cascara is rather exacting in its soil and moisture requirements, growing best in deep, rich, clayey, sandy, rocky, or humus soils in low river bottoms, flats, valleys, and borders of streams. It seems to grow best on clay loam and must have moist but well drained soils. The soil and moisture requirements of cascara are similar to those of Oregon ash, red alder, aspen, and Douglas-fir.

**Light Requirement**

This tree is exceedingly tolerant of shade in humid air and moist soils, factors of assistance in commercial plantings where it is grown in close stands. It grows best in close stands with side shade but plenty of overhead light (22)(49).

**Enemies of Cascara**

*Rhamnus purshiana* is quite hardy, being relatively free from insect pests and fungous disease. A few saprophytes grow on dead parts of trunks and branches but no parasitic fungi have been noted.
Flat headed borers, aphids, a small leaf miner, a type of scale, and certain moths have been noted attacking cascara, but not seriously.

Cascara is shallow rooted and thin barked, which makes it quite susceptible to fire damage. Its foliage is relished by livestock, particularly cattle, so that few seedlings reach maturity in pastured areas.

In commercial plantations, residual trees are severely damaged by sunscald when the stand is opened. This damage results when trees not accustomed to direct sunlight are suddenly exposed to the sun (31).

Growth

When cut in early summer, cascara produces numerous sprouts during the growing season. If thinned and cared for properly, such sprouts will do well, for growth is faster than in seedlings. Figures on coppice sprouts show an average yearly height growth of about 2½ feet up to 10 years of age. The rate of such growth depends upon (a) season when peeled; (b) condition and age of stumps; (c) light conditions; and (d) number of sprouts per stump (49).

Seedling growth averages about six to 18 inches in height at the end of the first year. Seedlings have a shallow root system and can be transplanted easily. When not too crowded or shaded out, they will reach a
height of 10 to 12 feet in six years. The oldest trees in the Brownsville plantation are now about 14 years of age and are about six to seven inches in diameter. Trees planted two feet apart in rows spaced five feet wide seem to have stagnated in the past few years because of too great density. The more recent plantings are not as dense and show improved growth.

Seed production

Cascara is a prolific seeder, producing much seed each year, although the seeds quite frequently do not germinate until the second season after they are mature. The germination per cent is moderate to low, but the vitality is fairly persistent, retaining its germinating qualities for at least two years.

The trees may produce berries when only five to seven years old on good sites.

Part II

THE CASCARA INDUSTRY

Size of the Industry

Estimates as to the quantity of cascara bark harvested each year from the Pacific Northwest vary considerably. Hall and Rosely estimate that the total production has probably reached 7,000,000 pounds annually in recent years (19). According to information furnished in
February, 1942, by I. P. Callison and Sons, dealers in
cascara, Port Orchard, Washington, the prices and volu-
mes of cascara over the past 10 years have been esti-

mated as follows (6):

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Price Per Pound</th>
<th>Approximate Volume Peeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1931</td>
<td>5¢</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1932</td>
<td>4</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1933</td>
<td>3½</td>
<td>6,500,000 lbs.</td>
</tr>
<tr>
<td>1934</td>
<td>4½</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1935</td>
<td>3½</td>
<td>3,000,000 lbs.</td>
</tr>
<tr>
<td>1936</td>
<td>6½</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1937</td>
<td>7</td>
<td>6,000,000 lbs.</td>
</tr>
<tr>
<td>1938</td>
<td>5</td>
<td>3,750,000 lbs.</td>
</tr>
<tr>
<td>1939</td>
<td>4</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1940</td>
<td>6½</td>
<td>4,500,000 lbs.</td>
</tr>
<tr>
<td>1941</td>
<td>10</td>
<td>4,500,000 lbs.</td>
</tr>
</tbody>
</table>

The 11 year average is 5.4¢, but preliminary figures
indicate a price of 12 to 13¢ in 1942 due to the war boom.

Another set of figures shows that the shipments of
cascara bark from this region in 1938 totaled 791.6 tons,
384 of which went to the Atlantic coast (22).

Shipments of cascara from Oregon and Washington
reached a total of 609.9 tons in 1938 according to H. M.
Johnson of the Pacific Northwest Forest and Range
Experiment Station. Of this total, Oregon shipped 220 tons and Washington about 390 tons. Approximately 100 tons of this total were exported to the United Kingdom, 59.5 tons to Australia, and 25 tons to Germany. The chief cities of export were (7):

<table>
<thead>
<tr>
<th>City</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland, Oregon</td>
<td>180 tons</td>
</tr>
<tr>
<td>Tacoma, Washington</td>
<td>161 tons</td>
</tr>
<tr>
<td>Olympia, Washington</td>
<td>108 tons</td>
</tr>
<tr>
<td>Grays Harbor, Washington</td>
<td>32 tons</td>
</tr>
<tr>
<td>Seattle, Washington</td>
<td>77 tons</td>
</tr>
</tbody>
</table>

Other cities shipped smaller amounts, and the total may have been somewhat larger. During the period from 1932 to 1936, Astoria, Oregon, shipped by water an average annual volume of 75 tons of cascara bark (55). Grays Harbor County in Washington produces 500 to 600 tons of cascara bark per year (59).

It can be seen that these statistics do not exactly agree, but they do serve to give some indication of the amount of bark produced each year. Probably an average figure of 5,000,000 pounds per year would be as accurate as any chosen.

**Prices Paid for Bark**

Prices paid by different dealers varied considerably
over the period of years covered. The list of prices paid by I. P. Callison and Sons has already been presented above. One set of figures shows that during the period from 1912 to 1939 the prices ranged from a low of 2½ cents per pound to a high of 15 cents per pound. In 1937 the price was 11 cents per pound, while in 1939 the price was four or five cents per pound. The average price for this period was estimated as 8½ cents per pound (22).

The 11 year average of Callison's figures was 5.4 cents per pound, considerably lower than the 8½ cents average given above.

Value of the Industry

Using a conservative average of six cents per pound, and the average of 5,000,000 pounds produced per year, the industry produces a yearly figure of $300,000. This is the amount of money paid the collectors, and gives no indication of the amount received by the wholesalers who ship their products east to large drug companies. Probably their return is considerably larger than this.

Source of Supply

Most of the cascara bark is harvested from scattered trees growing in stands of Douglas-fir mixed with other
species such as hemlock, maples, and red alder. Year by year it has become necessary to go further back into the mountains or into more isolated areas to harvest bark. Scattered trees are harvested where found, and often occur along streams or in fence rows. Birds scatter the seed along the fence rows, and trees are common in such places. Most of them are not allowed to reach a very large size before being peeled.

In burned, timbered, or cut-over areas, restocking and development depend upon a relatively open cover, source of seed, and suitable drainage. Growth in the open is faster than in more shaded areas. Logging opens more areas and makes them suitable for natural cascara growth. Restocking on such areas is dependent upon seed supply, and is largely a matter of chance (49).

A forest survey in Grays Harbor County, Washington, showed that one-sixth of the total area of non-stocked cut-over land cut before 1920 and between 1920 and 1930 in that county were restocked with cascara. About four mature trees per acre were found on such areas (59).

Areas such as these will be future sources of cascara, especially if trespass can be controlled.

The Elliott State Forest, an area of 71,105 acres lying along the coast in northern Coos and western Douglas counties in Oregon, contains the largest block of
cascara trees remaining in the range of the species.
The State Board of Forestry opened the area to sale of
cascara in 1937, and the successful contractor was com-
pelled to follow certain rules to safeguard the supply
for the future. These rules are outlined later in this
paper. The total cut from this area in 1937 was about
20 tons taken from about one section of land. During
1941, 20,209 pounds were taken from the area, and from
this sale the sum of $653.49 was added to the irreduc-
ible school fund of the state of Oregon. The area is
now operated on a continuous production basis, and the
sale of bark will provide annual sums to the school
fund. The present contract provides for harvesting
25,000 pounds per year for the next two years (13).

This forest is a part of the state school lands,
but is administered by the state forestry department.
It was set up in 1930 by legislative action which in-
volved the exchange of scattered school lands with the
national forests to form a block of state land.

There has been considerable interest in the rais-
ing of cascara trees in plantations and numerous plant-
ations have been established. There is no record of
the acreage in such plantations or of the volume of
bark produced by them. The expansion of the industry
may lie in this direction, however.
Collecting and Curing the Bark

The collecting season for cascara bark begins about the middle of April and closes about the end of August. Peeling should be done when the trees are in full leaf at which season the bark slips better. The bark should be peeled in large pieces, and moss and lichens should be scraped off the bark before peeling. Peeling is usually accomplished by using an axe and a peeling "spud" made from an old file or a leaf from an old car spring. The blade of the spud is slightly curved, and the end has a projection at each side which aids in cutting the bark. The axe is used merely for felling the trees. It is advisable to cut the stump about six inches high, leaving it unpeeled and with a smooth sloping surface which will delay the rotting of the stump and thus aid in coppice production (49).

Curing is usually done in the open air on a platform or canvas, and in good weather four days will suffice for drying. The practice now is to chip the bark into smaller pieces before drying. Care should be taken not to expose the inside of the bark to the sun, for discoloration results. The bark must be aged for from one to two or more years before being used for medicinal purposes. Usually the collector sells the dried bark
and does not concern himself with the aging process (22).

Yield

Open grown trees do not yield as much bark as trees of the same diameter grown in a closer stand. Tables showing the estimated yield of dry bark for trees of a given diameter have been made, and show a range of from five pounds for a three inch diameter tree, to 175 pounds for a 17 inch tree. One tree three feet in diameter and 60 feet tall yielded nearly 1000 pounds of green bark (49).

The present standard of utilization shows yields which could probably be increased by 25 per cent with more careful peeling. Green bark on the average loses about 50 per cent of its weight in drying, and bark cut earlier in the season loses a greater percentage than does bark collected later.

Suggested Harvesting Methods

In the past, most peelers have given little consideration of the supply of cascara. Recently, the British Columbia government set forth the following steps in harvesting cascara bark in an attempt to prevent waste (5):

1. Take bark only from trees five inches in diameter and over.
2. Cut each tree down clean, leaving an unpeeled stump not over one foot in height.

3. Do not expose the inner surface of the bark to the sun when curing it.

4. When dry, the bark may be broken into smaller pieces to facilitate packing.

It has been suggested that trees be peeled so that vertical strips of bark may be left on the stem to heal over and produce new bark. This practice seems to weaken the tree, and is not practicable (22)(49).

The United States Forest Service has suggested that when seedlings are planted, all lateral buds save four at the top be removed. These will develop into four main branches and the largest of these may be cut when of sufficient size for harvesting. The others will continue to grow and a new branch will develop in the place of the old one so that each year or so a harvest of bark may be collected.

Cutters removing cascara bark from state lands of Oregon must follow certain rules, which specify that (38):

1. The minimum stump diameter shall be four inches, one foot above the ground.

2. Stumps must be at least six inches high, but not over one foot in height.

3. Stumps must not be peeled.

4. Bark should be collected from limbs down to 1 1/2 inches in diameter.
5. Where sprouts arise from a stump, the smallest sprout among the group should be left.

One grower has harvested a crop of prunings yearly since the fourth year after planting and has saved all the prunings. These contain a relatively high percentage of the valuable medicinal principle.

**Growing Cascara in Plantations**

**Planting stock**

Planting stock for cascara plantations may be secured from several sources. Commercial nurseries grow this species at reasonable prices and government nurseries may have stock available for sale.

Seeds may be gathered and planted in seed beds, then moved to transplant beds. Some nurserymen separate the seed from the pulp and stratify it in moist sand over winter. Planting is then done in early spring, February as a rule. One grower plants the whole berry in the fall, generally in November, and seems to get good results.

Wild seedlings may be gathered and put in a transplant bed. They develop a well formed fibrous root system and are well adapted for planting in areas where cultivation is not possible (22)(49).
Preparation of Planting Site

All competing vegetation should be removed from areas to be planted, and cultivation is advisable if possible. Plowing and harrowing are the usual cultivation procedures practiced before planting.

Planting

One year old planting stock will give good results on moist sites, but transplants should be used on more adverse sites. Transplants are the best stock to use in planting areas where cultivation is impracticable.

Spades, grub hoes, or mattocks may be used to plant the young trees. Furrows may be plowed and the plants set in these. The same care should be taken as in planting fruit trees. The roots should not be allowed to dry out, and the earth should be packed firmly around them. They should be arranged so that they are not twisted or cut out of shape in the hole. They should be planted the same depth as they grew in the nursery.

Spacing should be such as to give about 2,000 trees per acre, and four by five feet spacing will give 1815 trees per acre. If rows are spaced so as to facilitate cultivation, trees can be placed closer together in the rows.

Survival is usually high if care is taken in planting, 85 to 90 per cent being common (22).
Care after Planting

The trees should be cultivated two or three times a year for the first three or four years after planting. If the trees are in an area where cultivation is not possible, weeds and other vegetation should be kept cut down for two or three years to allow the cascara to become established. Cover crops such as clover may be grown between the rows to supply nitrogen for the trees.

Expected Returns

The financial returns to be expected from cascara plantations are affected by many factors. One of the most serious hazards to cascara plantations, especially in times of unemployment and high price for the bark, is trespass. In such times people often peel bark from cascara trees wherever they find them.

Another factor which may affect the industry is the development of substitutes, or other laxative materials such as mineral oils. Cascara has certain properties which are claimed by many authorities to give it superiority over substitutes, so the demand should be maintained.

Returns will vary with the quality of the site, the care given the trees, the price received for the bark, the expenses involved in establishing and
maintaining the plantation, etc. Under one set of assumed figures, with interest computed at five per cent, the results are:

Costs: Per Acre

Seedlings, at $2.50 per M. $ 5.50
Planting costs. 10.00
Preparation of ground for planting. 10.00
Annual cultivation and other costs. 7.50
Harvesting costs. 100.00
Land value. 100.00

The total cost at five per cent interest compounded annually for the 15 years is as follows:

Investment in land, seedlings, planting costs, preparation for planting. $260.91
Less value of land. 100.00
160.91
Annual cost. 161.85
Harvesting cost (not capitalized). 100.00
Total $422.76

Gross Return:

2,000 trees, 12 pounds bark per tree, at 6% per pound $1440.00
Less costs. 422.76
Net Return $1017.24

This equals a return of $67.81 per acre for each of the 15 years.

Part III

RELATIONSHIP OF CASCARA TO DOUGLAS-FIR FORESTS

As can be seen from the figures presented in the earlier part of this chapter, the cascara industry returns perhaps $500,000 annually to the citizens of the
Pacific Northwest. Most of the cascara bark produced comes from private lands, since these lands are situated for the most part in the lower elevations, on which cascara does best. Considerable bark is cut from lands previously logged over, and may return a considerable sum to the owners of such lands.

Few attempts have been made to plant cascara trees on cutover lands or lands otherwise denuded of forest cover. When such lands are replanted, a timber tree such as Douglas-fir is the type generally used. It would seem, however, that there might exist a possibility of interplanting cascara with the Douglas-fir on the better sites. The cascara would develop rapidly and yield a crop of bark within a few years. The return from this bark would help a great deal in paying for the cost of establishing the Douglas-fir stand.

Probably the chief drawback to such an idea would be the great possibility of trespass. It would be almost impossible to keep people from peeling bark from trees in isolated areas. The idea seems to offer possibilities, however, and experiments in this direction might be advisable. It may prove true that cascara alone is the best species to plant on these better sites, leaving the timber species to be planted on the drier portions.
The cascara industry does not return a very large sum in comparison with returns from timber crops, but this income should not be overlooked. Any crop which can help to utilize lands now lying idle is of value and should be encouraged.
Chapter Two

CHRISTMAS TREES

Introduction

The production of Christmas trees in the Pacific Northwest is a thriving minor industry. Most of the trees sold as Christmas trees from this area are Douglas-firs. This crop is definitely a subsidiary crop of Douglas-fir forests and is therefore treated in this thesis.

The industry in the Northwest ranks below that of the Adirondack region in production but is of considerable size. This chapter will point out the major features of this industry, and will show how the Pacific Northwest compares with other states in Christmas tree production.

Brief History of the Christmas Tree Industry in the United States

Although the custom of the Christmas tree has been a part of the nation's holiday season almost since the birth of the nation, it did not originate here. Most sources agree that the custom was introduced by Hessian soldiers fighting for the British during the Revolutionary War (50).
Commercial sales of trees for Christmas use did not take place for nearly a century after the introduction of the custom. The birth of commercial sales of such trees seems to have been in 1851. In that year Mark Carr brought several sled loads of trees from the Catskill mountains and sold them in New York (23). No figures are available as to his monetary return, but the business has been carried on in New York every season since that time (50).

New York today consumes about one-tenth of all the trees sold during the Christmas season. Other important markets are located in the larger cities, such as Chicago, Philadelphia, and Los Angeles. Foreign markets are also fairly large consumers of American Christmas trees, Central America, Cuba, Jamaica, on the east coast, and Hawaii and oriental ports on the west coast using most of these trees (14)(32).

No accurate record of the first sales of trees from western forests is available, although the industry has attained its present status fairly recently. At the present time nearly half the trees sold in Chicago are produced in Montana and Washington and are shipped by rail to eastern points (33)(45)(51).

Magnitude of the Industry

Estimates as to the number of Christmas trees sold
throughout the nation show some variation since they are not based upon accurate records. The figures available show variations of from 9,000,000 trees to 20,000,000 trees sold annually. The United States Forest Service estimated sales to be 10,000,000 trees in 1936. Other estimates approximate these figures, so we may assume that the industry is concerned with the sale of about 10,000,000 trees per year (2)(10)(14)(19).

Rapraeger gives 1,967,350 Christmas trees as the number shipped out of Montana in 1939, and 2,338,350 trees as the number in 1940, practically all being Douglas-firs. He estimates the total production of the United States to be 12,000,000 trees annually (45). Statistics for Oregon indicate a yearly production of about 400,000 trees. The state forester of Washington showed the following out-of-state shipments for 1935, 1936, and 1937 (33):

<table>
<thead>
<tr>
<th>Year</th>
<th>By Rail</th>
<th>By Boat</th>
<th>By Truck</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1935</td>
<td>1,319,592</td>
<td>35,922</td>
<td></td>
<td>1,355,514</td>
</tr>
<tr>
<td>1936</td>
<td>1,569,723</td>
<td></td>
<td>11,829</td>
<td>1,572,552</td>
</tr>
<tr>
<td>1937</td>
<td>1,492,207</td>
<td>2,009</td>
<td>13,707</td>
<td>1,508,423</td>
</tr>
</tbody>
</table>

These statistics, particularly those by truck, are probably not complete. There is also a considerable number cut and sold within the state.

However, if we use 1,500,000 as the average production of Washington, 400,000 as the average production of
Oregon, and 2,000,000 as the average production from Montana, the total of 3,900,000 trees per year is roughly one-third of the total produced in the nation.

Value of the Industry

Again, the return from this industry can only be estimated. Figures range from a yearly return of $10,000,000 to $20,000,000. Fitz (14), Batchelor (4), and others estimate the yearly return from this business as $10,000,000. Arnold (2) estimates the return as $15,000,000 per year, and Creamer (10) gives $20,000,000 as the estimated figure.

The records of Bapraeger show that 84 per cent of the 2,358,350 trees produced in Montana in 1940 came from private lands. Of the remainder, 12 per cent came from national forests and four per cent came from state lands. The average price paid for the trees cut from national forests was 2.8 cents per tree, while those cut from state forests averaged 3.4 cents per tree (45). However, these figures do not show what the trees brought when sold to the consumer, and the estimates on the value of the industry are based upon the retail sales. An average figure of 25 cents per tree may be used for returns from such trees in the Pacific Northwest, making a total of about $1,000,000 per year.
Prices vary for the different species of trees used and for the different sizes. One set of figures shows a range of sale price from 25 cents to $25 with an average of 75 cents (2). Another set of figures show that large jobbers in the east get from $1 to $2 for a bundle of eight trees two to three feet high. Larger trees six to four per bundle bring about $3 per bundle. Single trees 10 to 12 feet tall may bring $2.50 while the tallest trees, used for community purposes, may bring $1.25 per lineal foot (51).

Owners raising trees in plantations get 15 to 30 cents per tree when the buyers come and get them, and receive 50 cents to $1.25 per tree when they are sold by mail (9).

Shasta red fir trees produced in southern Oregon may bring 10½ cents per lineal foot to the national forests, while Douglas-fir trees bring only a few cents per tree.

A plantation owner in Ohio received an average of $1 apiece for trees which he sold from his Christmas tree plantation. In Michigan, a plantation owner sold his trees at an average price of 30 cents each (15).

Still another set of figures showed an average
selling price of 5.3 cents per tree paid to the Eldorado National Forest. These trees sold at retail for an average price of 81 cents for one to three foot trees, $3.75 for four to 10 foot trees, $9.38 for 11 to 15 foot trees, and $25 for 16 to 25 foot trees. The greatest number were in the one to three foot size, 51.9 percent, while the four to ten foot size yielded 46.1 percent (20).

In all cases, the prices vary from year to year. There is no set system for selling the trees, and one city may have a large surplus at Christmas time, while a neighboring city may have far too few trees, and this causes considerable variation in price (50).

Species Preferred for Christmas Trees

The species of tree preferred for Christmas tree use varies with the region. In the east the balsam fir (Abies balsamea (L.) Mill.) is preferred. White spruce (Picea glauca (Moench) Voss.) is second in line in the east, while other species such as Scotch pine (Pinus sylvestris L.), and some species not native to the region are raised in plantations in the eastern portion of the United States.

The Douglas-fir (Pseudotsuga taxifolia (Lamarck.) Britt.) is the favorite in the west and is grown to some
slight extent in eastern plantations.

The balsam fir and Douglas-fir make up by far the largest percentage of Christmas trees sold, while spruce, pine, etc. make up only about 30 per cent of the total. Most of the balsam fir and Douglas-fir trees grow wild (2).

A good Christmas tree should possess the following characteristics: Good color, symmetrical form, good needle retention and abundance of foliage. Both balsam fir and Douglas-fir possess these attributes to a high degree. One man who operates a large Christmas tree plantation in New Jersey has made these observations on several species of trees grown for Christmas trees on his plantation (9):

(a) Balsam fir (Abies balsamea (L.) Mill.) Practically ideal.

(b) Norway spruce (Picea excelsa Link.) Makes good growth, has good color on favorable soil, is easy to grow. Its weaknesses are that it drops its needles quickly and develops poor color on unfavorable soil.

(c) White spruce (Picea glauca (Moench) Voss.) Is superior to Norway spruce in some ways. Has a beautiful color, develops a more shapely form, and is not as subject to gall aphid. Its weaknesses are that it is much slower growing, and planting stock costs more.

(d) Colorado blue spruce (Picea pungens (Parry) Engelm.) Has a beautiful form and color. It cannot compete with weeds, and is too expensive to raise.
(e) Scotch pine (Pinus sylvestris L.) Is good, having good color, good needle retention, fast growth, and is inexpensive. It needs shearing to produce compact growth.

(f) Douglas-fir (Pseudotsuga taxifolia (Lamarck) Britt.) Is worthy of consideration in the east. Has good color, compact, shapely growth, needs little pruning, and holds needles as well as balsam fir.

(g) White fir (Abies concolor Lind. and Gord.) Shows possibilities, but is not suited to clean cultivation.

Nature of the Industry

The Christmas tree industry is of a seasonal nature, the season of sale lasting only from about Thanksgiving time until the day before Christmas. After Christmas day any stock of trees remaining on hand is practically worthless. New York City at one time had a surplus of over 100,000 trees which were wasted (50).

Most of the trees sold as Christmas trees are trees which grew wild. In the northeast, most of the trees come from old pasture lands and cutover lands in states bordering Canada. A great many trees also come from the Maritime Provinces of Canada (9). In New Hampshire and northern New England many trees are cut from mountain pasture lands on which they are enroaching.

Many people are distressed by the seeming waste of
trees at Christmas time. There is actually no danger of a shortage as millions of potentially productive acres are lying idle. Many trees come from tops of trees cut in lumbering or in pulp production. The cutting of trees for Christmas usage need not be harmful to timber production if most of the trees cut are limby and unsuited to timber usage. There is need of more systematic and less wasteful cutting and marketing (3). Notwithstanding the fact that by far the greatest percentage of trees comes from wild trees, there are many produced on private plantations.

Wild Trees - Cutting

The operators or wholesalers who sell the majority of the trees in the larger cities go out into the producing areas and contract with farmers and others for the buying of trees. This is done in August or September as a rule. Later the wholesalers send cutting crews into the areas to cut the trees, sort them, and haul them away in trucks.

The trees are usually sorted and baled, then shipped in refrigerated cars. The cutting work may start in the latter part of October in the east, and the bulk of such trees reach New York by December 10. In the west, cutting may start in September to allow for longer rail
shipments. In Washington the cutting starts in September. Crews go out into the woods and camp until the cutting season is over.

Most of the wild trees are cut from privately owned lands. In 1938 a group of farmers in New Hampshire conceived the idea of cooperative selling. They used colored twine to tie to the trees cards containing this message, "Christmas greetings from the mountains of New Hampshire. This tree brings a Christmas message from the great outdoors. Its cutting was not destructive." (23). This idea was further developed and the Forestry Products Association, Incorporated, was formed. Three grades of trees, fancy, standard, and ungraded, are now sold. The Association is now working on the cutting of tops from trees felled for pulp, which will result in saving trees, reducing fire hazard, and improving conditions for new growth. The members have planted 50 acres of balsam fir for each of the past five years previous to 1937.

In the Douglas-fir region the cutting is likewise done largely on private lands. The cut from the national forests of Region Six in Oregon and Washington is probably only about 25,000. Sales are made where a thinning will aid the timber producing potentialities of the area. As has been noted above, the cut from Montana
is 84 per cent from private lands, 12 per cent from national forests, and four per cent from state lands. The Forest Service found by experience in the Eldorado National Forest that the best system was to mark the trees to be cut, hire its own cutting crews, and deliver the trees to the buyer at the road. This practice eliminated improper cutting practices followed by contractors or buyers.

Usually in these cuttings of wild trees on private lands not much care is paid to the condition of the area after the trees are cut. The buyers know they can find other areas with plenty of trees, and do not take proper precautions. Many of the areas are old pasture lands which the farmers wish to have cleared, so they are not interested in a new crop.

The average size of wild trees is about five to seven feet in height, and the age is six to eight years. "Runts make the best Christmas trees." (10)

**Christmas Tree Plantations**

In addition to the trees cut from wild stock, many are cut from Christmas tree plantations. Such plantations are a specialized business such as dairying or fruitgrowing, and provide additional income for men engaged in vegetable or fruitgrowing, who are not very
busy during the month of December. Mr. Herbert R. Cox who has been a successful Christmas tree grower since 1928 at New Brunswick, New Jersey, has made several observations concerning his plantations (9). These and other notes follow:

Land

Land used for Christmas tree production should be good land, cleared preferably. The owner can afford to pay up to $100 per acre for desirable land. Loams or sandy loams are best, and should be well drained and with fair organic content. The presence of rocks is not important save for the difficulty in planting and cultivating them. Eastern or northern slopes are preferred.

Preparation

The land may either be cultivated or the trees may be planted in the sod. If preparation is to be undertaken, plowing and harrowing should be completed before trees are planted. If no preparation is intended, the sod is scalped and the trees are planted in the scalped area.

A compromise between no preparation and preparation followed by continued cultivation would be to cultivate the trees for one to two years.
after planting, then allow the weeds and grass to come in. This seems to have been the most successful of the methods tried.

Planting Stock

Transplants are usually preferred as they grow considerably faster. Either 2-2 or 3-1 stock is most commonly used. The practice of buying two-year-old seedlings from nurseries and setting them in transplant beds for two or more years may save $6 to $16 per thousand trees.

Species

Species preferred for plantations vary with the region. The most common species in eastern plantations has been balsam fir. The species previously listed under the main heading of "Species preferred for Christmas Tree Use" are all used in various places. It is usually a wise policy to raise several different species as the market may thus be more easily supplied.

Time of Planting

It is best to plant trees for Christmas production in the early spring after frost danger is over, but before growth has started.

Spacing

Spacing may vary from three by three feet to four feet, or wider. Usually about 3,000 to 5,000 trees per
acre are recommended. The spacing varies with the species of tree and the site. Some growers plan to remove half the trees and leave the other half to produce timber. In this case, spacing is three by three feet as a rule. Removing every other tree will leave enough trees to furnish a good stand for saw timber production.

Method of Planting

Trees are planted with dibbles, spades, or grub hoes as a rule and the method used is the same as that followed in any tree planting for the same region. The roots should be arranged properly and the earth packed firmly around them. The roots should not be left exposed to drying while being handled.

In the Pacific region, shovels or grub hoes are used because of the heavy soil.

Methods of Improving Growth

If the land is low in nitrogen content, the application of ammonium sulphate, sodium nitrate, or ordinary cottonseed meal gives good results. This practice has resulted in improved coloring of spruces and firs.

Cuttings of crown vetch (Coronilla varia) were planted between rows of spruce and fir when they were eight inches high on one plantation. Within two years the vetch obscured the seedlings, but at the end of four years the trees were four to six feet tall and showed
30 to 40 per cent more growth than neighboring trees with no vetch (4). Such experiments have not as yet proven themselves economically advisable in all cases.

**Rotation**

The length of rotation varies with the species, the site, the cultivation and other handling, and with the size of the tree preferred. Spruce and fir planted in sod reach a commercial size in eight to 15 years, while other species may be sold at four to eight years after planting. Trees one to three feet tall will be produced one to three years after planting, while Norway spruce trees four to seven feet tall will be produced in four to six years after planting (15).

An average rotation period could be estimated as six years.

**Hazards**

Fire is always dangerous, as it is to any forest enterprise. Deer and rabbits are the chief animal enemies, eating off many trees. The main insects causing damage are June Beetle grubs in the Northeast, and mound building ants in the South, but other forest tree insects may do some damage. Spruce is attacked rather severely by gall aphids in some cases.

An important consideration is the location of markets. It is the most difficult part of the business,
for the economic survival of the plantation depends upon sales.

Cutting the Trees

In cutting trees from plantations, the following steps have been suggested (50):

1. Find a market.
2. Pick out and sell trees which will show highest return.
3. Mark trees to be cut.
4. Mark deformed trees if there is a market for boughs.
5. Leave trees showing promise of developing into large and well-formed trees.
6. Cut trees off square at the butt.
7. Use a hand saw on larger trees and pruning shears on smaller trees.

One owner has experimented with leaving a whorl of branches six to eight inches above the ground and using one of these branches to develop into a new tree. In the spring following cutting, a large vigorous branch is staked upright and begins to grow into a tree. Results showed that Norway spruce produced a compact, symmetrical tree in four years. The experiment has not been carried out long enough to see how much this practice speeds up growth over a period of years (4).

Marketing the Trees

It is better to have plantations close enough to cities to allow buyers to come to the plantation. In this way their choice is better, and the owner is saved shipping expenses.
Many trees are cut and shipped in refrigerator cars, but most plantation produced trees are sold within a relatively short distance from the plantation.

Costs and Returns

These two factors vary widely with region, intensity of cultivation, and other considerations. A few examples may be presented to give an idea of the expected costs and returns.

Example No. 1 (50).

Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000, 2-1 transplants at $2.50</td>
<td>$7.50</td>
</tr>
<tr>
<td>Removing brush and logs</td>
<td>6.00</td>
</tr>
<tr>
<td>Planting 2 1/2 acres</td>
<td>9.45</td>
</tr>
<tr>
<td>Fencing (2 sides)</td>
<td>18.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$41.25</strong></td>
</tr>
</tbody>
</table>

Gross Returns at 6 years

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees planted</td>
<td>3,000</td>
</tr>
<tr>
<td>Less 5 per cent loss</td>
<td>150</td>
</tr>
<tr>
<td>Trees sold</td>
<td>2,850</td>
</tr>
<tr>
<td>2,850 trees sold at 50%</td>
<td>$855.00</td>
</tr>
</tbody>
</table>

Net Returns at End of 6 years

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of establishment</td>
<td>$41.25</td>
</tr>
<tr>
<td>Interest at 4 per cent, comp.</td>
<td>10.03</td>
</tr>
<tr>
<td>Taxes at $1 per acre per year</td>
<td>15.00</td>
</tr>
<tr>
<td>Cost of marketing</td>
<td>20.00</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td><strong>$87.18</strong></td>
</tr>
</tbody>
</table>

Net profit on 2 1/2 acres $767.32

This equals a profit of $51.19 per acre per year.
Example No. 2 (15).

A one-fourth acre plot in Ohio was plowed, harrowed, planted to 680 four year old transplants and cultivated for two years.

When half the trees were sold, the net return was about $1,058 for the plot.

These examples show that some plantation owners, at least, are getting a satisfactory return from Christmas tree plantations. Some operators have been in the business for 12 to 15 years.

Christmas Trees in Douglas-fir Forests

From the figures shown, Christmas tree production is a fairly large business in the Pacific Northwest. Eureka, Montana, is called the "Christmas tree capitol of the world," and Washington produces large numbers of trees. The Northwest as a whole produces about 4,000,000 trees per year.

Practically all these trees are Douglas-firs, and nearly all of them come from private lands. The Christmas tree industry is mentioned as a minor industry in many of the counties of Oregon and Washington. Other counties in these states and in the Douglas-fir areas of western Montana have large areas in trees which could be used for Christmas tree production. Many of
these areas are so heavily stocked that thinnings would materially aid growth of residual trees. Christmas tree plantations are quite rare in this region, most of the trees being cut from areas stocked naturally.

The sale of trees for the most part has been from the poorer and less productive areas, because open grown trees and slower growing trees have better form and are therefore more salable. Many such areas, and other areas cut over and burned are reverting to counties for tax delinquency.

It would seem that further development of the Christmas tree industry in the Pacific Northwest on a more substantial and cooperative basis would result in better prices and less wastage. If trees could be cut from immature stands, the money obtained should be sufficient to pay the cost of taxes on the land up to the time of harvesting the main timber crop. Areas on which growth is not very rapid will produce Christmas trees in 10 to 15 years after logging. If taxes could be paid by Christmas tree crops, the problem of tax delinquency in many areas could be partially solved, at least. It must be realized, however, that there is not too much room for expansion in the industry, and gains made should come from better organization and more efficient marketing.
Chapter Three

RED ALDER

Introduction

Red alder (Alnus rubra Bong.) is the most important hardwood in the Pacific Northwest in so far as commercial value is concerned (39). Its use for the manufacture of low priced furniture, veneers, and wooden novelties has increased considerably in recent years. The use of this tree for furniture and novelties has been well described by McComb (29), and its commercial possibilities on the Nestucca Drainage of the Suislaw National Forest in Oregon have been presented by Aufderheide (3) and by Holland (24).

Because red alder, the most important hardwood of the Pacific Northwest, occurs in pure stands or in mixture with Douglas-fir as well as with other trees of the Northwest, its value as a subsidiary crop in these Douglas-fir forests should be considered in this paper. A description of the tree, a short explanation of operations in harvesting the tree, and other notes on the alder industry will be included along with information as to the value of the alder in Douglas-fir forestry.
Part I

THE RED ALDER TREE

General Notes on the Tree

There are nine species of *Alnus*, six of which attain tree size, native to the United States. Red alder is the only one of the western species which attains commercial size and abundance, however. The genus *Alnus* belongs to the family *Betulaceae*, the Birch family, which is made up of *Betula*, the birches, *Alnus*, the alders, *Carpinus*, the hornbeams, *Carya*, the hop hornbeam, and *Corylus*, the hazel.

Basis of Commercial Importance

The commercial importance of red alder is based upon the wood which is used in making furniture and novelties. The furniture in which it is used sells at a moderate price. The chief usage is in cross binding and cores of plywood which are faced with oak, walnut, mahogany or other more expensive woods. In lower priced furniture it may be exposed, as in office desks, tables, chairs, and turned legs. Novelties include wooden plugs, buttons, woodenware, etc.

Locally the wood is used for firewood and may occasionally be used for fence posts although the wood is only
of fair durability. It has some value as a firebreak in many stands more susceptible to fire because it grows largely in moist valleys along streams.

**Distribution of the Tree**

*Alnus rubra* is found from Sitka, Alaska, south through the island and coastal forest regions of British Columbia, Washington, and Oregon to Santa Barbara in California. Its commercial range, however, is limited to the moist areas along the western parts of Oregon, Washington, and southwest British Columbia. It seems to grow best in the Puget Sound region. Pure stands fairly large in extent occur on the western slopes of the Coast Range in Oregon. This region is centered near Otis, Oregon, and extends northward to Tillamook and beyond. It is the chief tree in the Siuslaw National Forest in many places.

Red alder occurs in pure stands and in mixture with Douglas-fir, western hemlock, Sitka spruce, western redcedar, and with hardwoods such as cottonwood, bigleaf, maple, vine maple, and Pacific dogwood. It comes in thickly in many burned over or logged over areas, but is eventually taken over by coniferous species such as Douglas-fir.
Description of the Tree

Size

Mature trees of red alder vary from 80 to 130 feet in height, and from 10 to 36 inches in diameter. The majority of the trees in the commercial areas do not reach the maximum size, since they are not yet of sufficient age.

The following technical description of Alnus rubra is taken largely from Barlow and Harrar (21).

Age

Red alder is relatively short lived, reaching maturity in 60 to 90 years.

Form

The form of this tree varies with the conditions under which it grows. In dense stands it has a clear, symmetrical, slightly tapered bole, and a narrow, dome-like crown. Under open grown conditions, the crown is broad and conical and may reach nearly to the ground. The bole is much more tapered under such conditions, and height is decreased.

Leaves

The leaves of red alder are deciduous, three to six inches long, 1\(\frac{1}{2}\) to three inches wide, with doubly serrate-dentate margins, glandular teeth, acute apices
and rounded bases. They are dark green in color, with a pale or rusty pubescence on the midrib and on the main veins below.

**Flowers**

The flowers of red alder are preformed, the staminate aments 1/4 to 1 1/2 inches long. They are monoecious.

**Fruit**

The fruit is a persistent semiwoody strobile or cone, ovoid and pendent, with two to four orbicular nutlets per scale. The nutlets are about one-sixteenth inch in diameter. The cones are about one-half to one inch long.

**Buds**

Buds on this tree are stalked, the terminal buds being one-third to two-thirds inch long and covered with two to three red, scurfy-pubescent scales. The lateral buds are somewhat smaller, and are slightly divergent.

**Bark**

The red alder bark is grayish white, pale gray, or blue gray at the surface, and bright reddish brown on the inner side. It is smooth or covered with small, warty excrescences, breaking up into large flat plates of irregular contour.
**Roots**

The roots of red alder are shallow and spreading. There are nitrogen fixing nodules attached to the roots.

**Wood**

Red alder wood is diffuse porous, uniform in texture, light reddish brown or golden in color, straight grained and moderately light in weight. It turns well, will take a fair polish, holds glue well, and can be stained to resemble more expensive woods. If handled properly it does not check or shrink greatly, and is considered to be as desirable as yellow poplar, red gum, or basswood. It is fairly durable in contact with the ground (24)(29).

**Silvics of Red Alder**

**Soil and Moisture Requirements**

Red alder makes its best growth on moist, rich, loamy bottom lands, slopes, and benches. It will reach tree size on dry gravelly or rocky soils. The tree appears commonly on cutover or burned-over areas, the seed germinating well on either organic or mineral soils.

**Tolerance**

Seedlings of this tree are moderately tolerant, but the tolerance decreases with age. It is still tolerant when older and is the most tolerant of the tree alders.
The best commercial growth is in stands which are moderately dense.

**Enemies of Red Alder**

Fire is a hazard to red alder, but most of the stands grow in moist sites to the extent that the stands often serve as useful firebreaks. Certain rots affect the tree at maturity but younger trees are not seriously affected.

The worst insect enemy seems to be the tent caterpillar which often defoliates entire stands.

Heavy damage was inflicted on coastal alder stands by a severe ice storm or "silver thaw" in January, 1942. Heavy accumulations of ice broke many limbs and tops out of the trees. Rots will probably become established in such damaged trees.

**Growth and Reproduction**

Red alder grows rapidly and the rate of growth holds up fairly well throughout the life of the tree. Trees of commercial size, over 13 inches in diameter at breast height may be 35 to 50 years of age.

This tree will sprout from the root collar, but such sprouts usually are not long lived, nor do they attain large size.

Red alder produces large amounts of seed, beginning at a fairly early age. The seeds are small, taking
amount 360,000 to make a pound.

Part II
THE RED ALDER INDUSTRY

Amount of Red Alder Available, and Amount Cut

The volume of red alder growing in the Northwest has been estimated in 1936 as 1,498,343,000 board feet. Of this total, about three-fourths is confined to the coastal forests of Oregon. No figures are available as to merchantable supply, but estimates place it at 1,000,000,000 board feet. The commercial area is estimated at 75,000 acres, most of which is within 30 miles of the coast. The growth in the coastal forests of Oregon has been estimated at 40,500,000 board feet per year (29).

The production of alder lumber has varied from year to year. Cutting has not been carried on for much over 25 years in the most important alder region of the coast. The estimated cut in 1929 from Oregon and Washington was about 17,000,000 board feet, of which about two-thirds came from Washington and one-third from Oregon.

According to the United States Department Bulletin No. 1437 the uses of red alder in 1923 were (39):
<table>
<thead>
<tr>
<th>Use</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture</td>
<td>9,653,000 board feet</td>
</tr>
<tr>
<td>Chairs and chair stock</td>
<td>2,410,000 board feet</td>
</tr>
<tr>
<td>Woodenware and novelties</td>
<td>560,000 board feet</td>
</tr>
<tr>
<td>Veneer</td>
<td>280,000 board feet</td>
</tr>
<tr>
<td>Paper plugs</td>
<td>250,000 board feet</td>
</tr>
<tr>
<td>Fixtures</td>
<td>105,000 board feet</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>133,000 board feet</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,456,000 board feet</strong></td>
</tr>
</tbody>
</table>

Another source showed the following estimated volumes cut (29):

- 4,734,000 board feet in 1932
- 12,724,000 board feet in 1933
- 7,050,000 board feet in 1934

A recent letter from the Three Rivers Alder Company of Tillamook, Oregon, estimates the total yearly cut of alder at about 12,000,000 board feet. Probably this latter figure is as close as any, and shows that this production is not large. The volume cut has held fairly even for the past few years (11).

**Prices Paid for Alder**

Prices paid for red alder stumpage vary from year to year as does the cut. One set of figures shows that in 1923, good sized alder stumpage sold for $2.00 to $3.50 per thousand board feet. Green lumber brought $35.00 to $35.00 per thousand board feet at that time. Recent figures show the prices paid the mill for No. 2 and better grade ranges from a low of $32.00 per thousand for green
lumber to a high of $55.00 per thousand for kiln dried lumber. The retail price of such lumber in Los Angeles, California, the largest alder market in the United States, varies from $57.00 to $70.00 per thousand (11) (48).

**Operations Cutting Alder in Oregon**

The commercial cutting in Oregon is for the most part confined to the coastal region in the vicinity of the Nestucca rivers.

In the earlier days of alder production, the greater share was sawed by small, independent mills which shipped green lumber to manufacturers.

At the present time, many manufacturers buy alder logs and do their own sawing and kiln drying. Other mills ship kiln dried lumber to the various markets.

One mill at Tillamook, Oregon, is permanent, cutting and kiln drying alder and selling both dried lumber and some manufactured products. Another mill at Beaver, Oregon, operates when the Boernbecher Furniture Company in Portland is operating. This mill ships alder in carload lots to Portland (1).

The number of small and portable alder mills in the Tillamook region is fewer than it has been in the past. One operator a few miles north of Otis, Oregon,
started to cut alder in the winter of 1941-42. His mill is capable of cutting 2,000 board feet per day, cutting logs averaging about 16 inches in diameter. All logs cut are eight feet long, and lumber is cut into 1 1/8 inch boards to be one inch when planed. He uses teams in logging and hauls the logs to plank roads where they can be hauled to the mill by truck. He hauls the logs not over one-eighth mile by the teams, confining his logging to the narrow valleys on his farm. According to this operator, the price for alder lumber was $10 per thousand higher in 1941-42 than in the year before. He was getting $27.00 per thousand board feet for green lumber in Portland, shipping carload lots. This operator was cutting in his spare time, and was employing four or five men to help in the woods. Only two men were used in the mill. He had previously worked six years in the mill at Beaver, Oregon, but was cutting his own alder because the price had gone up.

A Representative Idea of the Alder Industry in the Northwest

Aulderheide in "A Plan for Management of Red Alder in the Nestucca Working Circle" describes the alder cutting operations in that area and gives much useful information concerning rotation, size of tree to cut,
etc. The bulk of the material which follows under this heading is drawn from this source (3).

The area involved in this plan covers 8,615 acres of "productive" alder land, and 51,345 acres of "non-productive" alder lands, for a total of 69,960 acres. The plan itself is concerned only with the "productive" lands, of which 5,679 acres belong to the Siuslaw National Forest and 2,936 acres belong to private holdings. The private holdings are scattered and of small acreage.

This "productive" land is of a site quality which produces loggable alder during the current rotation period, or cut-over or burned areas expected to produce commercial alder in the future. Such areas extend up the valleys in "shoestring" fashion, seldom being over 1000 feet in width. Considerable "productive" land exists in the Tillamook burn area, and on cutover lands around Tillamook.

"Non-productive" areas are largely made up of mixed stands of conifers and alder.

At the time of the report, 1939, three operators were cutting in the area, two of them owning portable mills. The permanent mill was located at Tillamook, Oregon. The location, capacities, and yearly cuts were:
The lumber produced went either to Portland or to Los Angeles.

The mill at Tillamook used 28 men in the mill and 18 to 22 men in the woods, operating about 250 days out of the year. One of the portable mills used four men in the mill, five men in the woods, and operated seasonally over a period of about 150 days. The other used five men in the mill, nine men in the woods, and also operated about 150 days seasonally.

From 1927 to 1936 only one small operator was cutting in the area, cutting about 500,000 board feet per year. The cut since 1937 has averaged about 2,000,000 board feet per year.

The first government timber was cut in the area in 1939, when 700,000 board feet were cut.

The average volume on "productive" lands was estimated at about 5,000 board feet, based on trees 13 inches in diameter and larger, allowing for defect and breakage.

The logging was largely done by the use of horses, as it is today. One operator used a small crawler type tractor.

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity</th>
<th>Yearly Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Rivers</td>
<td>500,000 bd. ft.</td>
<td>400,000 bd. ft.</td>
</tr>
<tr>
<td>Cedar Creek</td>
<td>750,000 bd. ft.</td>
<td>600,000 bd. ft.</td>
</tr>
<tr>
<td>Tillamook</td>
<td>2,000,000 bd. ft.</td>
<td>1,500,000 bd. ft.</td>
</tr>
<tr>
<td>Beaver</td>
<td>1,500,000 bd. ft.</td>
<td>Not cutting</td>
</tr>
</tbody>
</table>
The cutting practice followed was to take all 13 inch trees and the more accessible 12 inch trees. This left a partial stand, but was nearly equal to clear cutting near the streams, and tapered off as the distance from the streams increased and the site quality decreased.

Recommendations made Under the Plan by Aufderheide

Aufderheide's plan and study showed that it was not profitable to log in stands of less than 5,000 board feet per acre. Clear cutting was advised, as alder does not produce well under shade. Trees 13 inches in diameter and larger should be cut, and smaller trees if it is profitable. No slash disposal is necessary as alder rots rapidly. Fire is not a serious hazard, because alder acts as a good firebreak.

Costs and Returns of the Three River Alder Company - 1940

The following table of costs and returns for alder production in the Three Rivers Alder Company mill at Tillamook, Oregon, gives an idea of costs and returns for the industry (24):

Per Thousand Board Feet

Selling Value (No. 2 Finished)
At $34 to $55 - average..... $45.00
Costs

<table>
<thead>
<tr>
<th>Costs of logs at pond</th>
<th>$12.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling Costs:</td>
<td></td>
</tr>
<tr>
<td>Sawing at $4.35-$5.60, average</td>
<td>$5.00</td>
</tr>
<tr>
<td>Kiln drying</td>
<td>2.40</td>
</tr>
<tr>
<td>Planing</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8.40</strong></td>
</tr>
</tbody>
</table>

Freight by rail to Los Angeles | 11.50
| **Total** | **$31.90** |

Net Returns | $13.10

More recent figures show that the costs of production at this mill are $27.40 per thousand board feet, log run. The portable mills may produce green lumber for $14.00 to $15.00 per thousand board feet (39).

Value of the Industry

Using an estimated yearly production of 12,000,000 board feet, and a selling price of $2.50 per thousand board feet for stumpage, the industry yields about $20,000 per year to the grower. If the net of approximately $13 per thousand by the Three Rivers Mill is used as an average, the industry yields $156,000 net to the operators in the Pacific Northwest.

It has been estimated that the alder industry in the Nestucca working circle yields $50,000 to the community in mill wages, logging wages, and stumpage. This area at the time the estimate was made cut about 2,400,000 board feet for the year, or about one-sixth
of the total from the Northwest. This would make the alder industry worth about $300,000 to the Northwest.

In any event, the alder industry is not large. Unless the war disrupts the industry, the yearly cut should stay at about the 12,000,000 board feet figure shown. This yearly return from areas not yielding other returns is therefore valuable and worth maintaining.

Part III

NOTES ON FUTURE POSSIBILITIES IN THE RED ALDER INDUSTRY

Costs of Establishing a Crop

No efforts have been made toward establishing red alder stands. It has come in naturally following fires and logging in former coniferous stands. In many cases the tree has been a weed. There should be little trouble in reproducing red alder stands. Clear cutting, as suggested by Aufderheide will give the best results. Reproduction of alder will probably not be desired save in certain restricted areas along the coast.

Rotation Period

Alder attains merchantable size in about 35 to 50 years. It seems to make its best growth in the period from 50 to 55 years of age. A rotation of about 60 years would seem to be about average.
Carrying Costs

Carrying costs of red alder would vary with fire protection costs, taxes, and interest rate. A five cents per acre per year cost for fire protection, five cents per year per acre for taxes, and interest rate of three per cent would give a carrying cost of $16.31 for a 60 year rotation, if no regeneration cost is figured.

Returns

If stumpage were valued at $3.00 per thousand, and the average stand were 10,000 board feet at the end of 60 years, the gross return would be $30 per acre, and the net would be $13.38 per acre for the period.

These returns are based on estimates and cannot be considered very accurate.

Part IV

THE PLACE OF RED ALDER IN DOUGLAS-FIR FORESTRY

Red alder occurs in commercial stands largely along the coastal regions of Oregon and Washington. It has become established in many areas formerly in Douglas-fir, or in other coniferous stands. In certain areas, as in the Nestucca working circle, it may be more profitable to grow alder and not try to get Douglas-fir back into the areas formerly growing this species.
In other portions of the Douglas-fir region, it would probably not be advisable to try to grow red alder in conjunction with Douglas-fir, although no experiments have been carried on with Douglas-fir growing under red alder stands.

No work has been done as yet in planting red alder, the reproduction all coming in naturally. Therefore no results can be presented, and little is known of what would happen if alder were planted in plantations.

It would appear that for the time being red alder is confined to a minor role in lands formerly in Douglas-fir.

Alder never forms a permanent forest, but does prepare the soil for other species. The root nodules fix nitrogen and therefore make the soil more suitable for other species. It may be that red alder will improve many of the now denuded lands along the coast so that coniferous stands will again grow well.

The red alder industry is a minor one, returning only a fraction of the money that Douglas-fir returns for the region as a whole, although the per acre return may be larger in some cases. The return, however, is a valuable adjunct to the income of the residents of the Pacific Northwest.
Chapter Four

THE SWORD FERN INDUSTRY

Introduction

Within the past few years the harvesting of sword fern (Polystichum munitum (Kaulfuss) Presl.) has developed into a thriving local industry in many towns along the Pacific Coast in Washington and Oregon. This chapter will present pertinent information concerning this fern and the industry built around it.

Part I

THE SWORD FERN

General Information

The sword fern of the Pacific Coast gains its common name from the swordlike appearance of the leaves or fronds. There are several so-called sword ferns in the eastern part of the United States, but the only sword fern of the Pacific Coast is Polystichum munitum (Kaulfuss) Presl. The generic name of this fern comes from the Greek "poly" meaning many, and "stikes" meaning in a row, referring to the arrangement of the pinnae or leaflets on the rachis (40). The species name of this
fern comes from the Latin "munire", meaning to fortify, apparently because of the leathery character of the fronds.

It is sometimes called Christmas fern because of its resemblance to the Christmas fern of eastern United States, _Polystichum acrostichoides_ (16). However, sword fern is the most common name and will be used throughout this thesis.

**Description of the Fern**

Sword fern is an evergreen, there being fronds of the growth of two seasons to nourish the plant at all times (35). The fronds, or leaves, arise in clusters with an average of about 35 fronds per healthy, vigorous plant (27). They may reach a height of six feet in the most favorable sites, with an average height of about $3\frac{1}{2}$ feet.

Before fall rains set in, it is easy to tell the fronds of the current year as they are much more erect, are lighter green in color, and have a pubescence on the base and along the back. After fall rains set in, the leaves turn darker, are beaten down by the rain, and lose much of the pubescence. A detailed description of the plant follows (14):
Leaves or fronds:

Evergreen; rigidly ascending; 12-72 inches long; linear-lanceolate; short acuminate; pinnately one-compound; coriaceous when mature, tender when immature.

Leafstalks:

Two to 24 inches long; with bright glossy brown, often dark centered scales, small ones laciniate-ciliate.

Blades:

10 to 48 inches; two to 10 inches wide; little contracted at the base; widest at base to middle, often very chaffy beneath.

Fachis:

Scaly like the leafstalk.

Pinnae:

Subfalcate; linear attenuate; base strongly surculate above and cuneate below; margins sharply doubly serrate to incised; teeth recurved, rigidly long-aculate; sori close, nearly equidistant from midvein and margin when in a row, sometimes in several crowded rows; indusia papillose-dentate to long ciliate.

Rhizomes:

Underground rhizomes are present, so that the plant can survive even under difficult conditions.

Roots:

Fibrous roots arise from the rhizomes.
Distribution of the Fern

This fern is for the most part a fern of the Pacific Northwest. It is found along the coast from Alaska to California, and occurs inland as far as Montana and Idaho. It attains its best growth in the "fog belt" of the coast, and its commercial range is practically confined to that area. In Oregon the chief commercial range is located near the Nestucca river, Neskowin, Yachats, the Alsea river, and Coos Bay (37). In Washington the fern picking industry is centered around Chehalis and Castle Rock.

Basis for Commercial Value of the Plant

The commercial value of this plant lies in the evergreen fronds which are used by florists in the making of wreaths, bouquets, the lining of graves, and for general decorative purposes. Only the more perfect fronds are utilized, and it has been estimated that under the present commercial classification only about 10 per cent of the leaves of a current year are marketable (28).

Growth Characteristics of the Sword Fern

Soil and Moisture Requirements

Sword fern thrives best in soggy soil which has
some drainage. It also requires a humid atmosphere and thus reaches its best development in the "fog belt" of the coast. When the plant grows in dry air, strong light, and dearth of moisture it may grow leaves of what is known as the variety imbricans.

Slope seems to have little effect on the growth of this plant so long as the other requirements are met. Some pickers believe that better ferns are to be found on northeast or southeast slopes where the plants are shaded in the afternoons (43).

Light Requirements

Shaded areas are favored by the sword fern which reaches its best development under such conditions. It will grow in the open if there is sufficient rainfall, but plants grown under such conditions are not salable because of discoloration resulting from exposure to light. The plant will not grow under completely closed canopies, as a certain amount of light is necessary for growth.

Enemies of the Fern

Little has been learned concerning the enemies of this fern. Certain insects do considerable damage, spoiling many of the fronds for commercial use, but as yet the species of insects responsible have not been discovered. This depreciation in value is noted particularly
after mild winters which seem to favor the insects. No diseases affecting the fern have been discovered.

The mountain beaver is apparently fond of the young and immature fronds, for the author has noted these rodents carrying fronds at night when surprised by headlights of an automobile. Fronds have been noted at the entrance of burrows of these rodents. If the beavers are plentiful, the sword fern will be severely damaged. Cruisers claim that deer and elk will eat the leaves, but this damage is apparently slight for the leaves are tough when mature and do not appear to be very palatable.

Damage by weather is at times severe. During the past winter considerable damage was done by the heavy ice storm in January, 1942. The coating of ice broke down many fronds and rendered them unsuitable for picking.

Fire is a serious factor in this industry as it is with any forest enterprise. The plants must have a forest overstory for the production of commercial fronds, and fires which destroy this overstory thus ruin the ferns. The plants themselves are fairly resistant because of their underground rhizomes so are not killed out entirely by fire, but are spoiled for commercial usage. However, since the ferns most useful for picking grow in moist sites, fire is not too great a hazard.
Man himself causes most harm to the ferns. Overenthusiastic picking which removes too many of the fronds leaves the plant without sufficient food manufacturing capacity and as a result it starves to death. This type of picking has been common near large cities, so that good plants are now rare in such locations as compared to 15 years ago.

Experiments on Effect of Picking

The Pacific Northwest Forest and Range Experiment Station became interested in learning the damage done to sword ferns by picking, with particular reference to the time of cutting as it affects vigor, and the proportion of the fronds that can be cut without plant deterioration (36).

A beginning was made on such a study in the spring of 1937. Three plots were established in an area of good sword fern under a 90 year-old western hemlock stand. Each plot was 26.4 feet square and contained about 40 sword fern plants. All plants were staked and all the new and old fronds were counted. One plant was left as a check, one was lightly picked (13 percent), and one was more heavily picked (40 percent), taking old ferns only. The results of this experiment
were not conclusive, and further study was planned. Under a later and more comprehensive study according to a "Working Plan for Study of the Effect of Harvesting Sword Fern Fronds on Plant Vigor" by Thornton T. Hunger of the Experiment Station, two plots were established in the Cascade Head Experimental Forest (36). The first was laid out on July 7, 1938, and the second on July 12, 1938. Each plot contained 44 mil-acres, and each plot was subdivided into 22 quadrats which were approximately 13.2 feet by 6.6 feet. The plots were located on a northerly exposure with moderate slope and at an elevation of about 400 feet in a deep sandy loam soil well covered with duff. The forest cover was 90 year-old, even-aged Douglas-fir, western hemlock, and Sitka spruce. The ground cover was mainly sword fern, with deer-fern, bracken, miner's lettuce, chickweed, Solomon's seal, oxalis, trillium, huckleberry, fool's huckleberry, elderberry, vine maple, grass and moss.

The picking was of four intensities, namely 25, 50, 75, and 100 per cent of the living fronds of the current year. The dates of picking were July 15, September 1, October 15, December 1, and February 15. Later, certain plots were given a 10 to 15 per cent pick on each date much as is done by pickers in actual practice.
Four check plots (two mil-acre each) were given no treatment except for measuring the height and counting the number of current year's fronds.

"On picking dates the picker would count the number of current year's fronds on each plant to be picked, measure the length of the longest 10 per cent of fronds (longest picked by observation), pick the required percentage of the total number of new fronds (cutting fronds off to within two or three inches of stool), and record the data as each step was done. The most perfect fronds were picked from the group." (27)

A report by the Experiment Station after three years of study showed the following tentative results (27):

1. As the percentage of removal increased (from 25 to 100 per cent), the number of fronds and the length of fronds decreased from year to year.

2. There was definite indication that there is a greater reduction in both number and length of fronds when the picking is done in July instead of December.

3. The plots which were given a light pick several times a year for two years showed no definite effect of this treatment.

Part II

THE FERN PICKING INDUSTRY

History of the Industry

The fern picking industry started approximately 20 years ago when ferns were picked and shipped in small lots, one and two cases at a time (17). No definite statement can be made as to who started the picking and
shipping of fern on a commercial basis, because several firms have spent about the same length of time in this business.

Extent and Value of the Industry

The commercial area involved in the fern industry is centered in the coastal region. No figures are available as to the number of acres involved or the number of people engaged in the business. Several firms buy sword fern and ship to markets. The chief firms are: G. R. Kirk Company, Tacoma, Washington; Bribnow Brothers, Banks, Oregon; I. P. Callison and Son of Port Orchard, Washington. Probably a few others are engaged in this business.

The industry has been estimated as returning $1,250,000 to the Northwest in an average year. This figure is based on estimates as no accurate records have been collected for all the fern sold. The industry has shown a gradual increase during the last five years, but again no figures are available as to the size of this yearly increase (17).

Harrowing the Fern

Specifications

At present, merchantable fern fronds must be between 24 and 26 inches long, 4½ inches wide, six inches from the tip, and have three to five inches of the leafstalk
stripped of pinnae or leaflets. They must be green and in good condition, not stained or with part of the leaflets missing. Sporangia must not cover more than a certain percentage, usually 10 to 20 per cent, of the underside of the leaf. They must have a perfect tip for six inches (20).

Specifications may vary somewhat in different years according to the quality available. In 1931, merchantable fronds varied in length from 18 to 24 inches (25).

**Pickers and the Picking Process**

Fern fronds are picked by local residents of the coast areas and other commercial areas, there being few transient pickers. This is true largely because of the considerable experience needed before a picker can gather a quantity sufficient to pay for his work, and because the fern picking season is not a short, seasonal job as are many of the fruit picking jobs of the Pacific Northwest. Some of these local residents use income from sword fern to supplement farm income in slack times, while others derive practically their entire livelihood from their fern picking efforts.

An experienced picker working in an area of good picking will average 20 bunches of fronds per hour. These bunches are made up of about 52 to 54 fronds to
allow for discarding of two to four in the sorting process. Usually the picker will gather about half a bunch before stripping the leaflets from the base of the leafstalk. The fronds are tied with heavy cord furnished by the buyers. The picker holds the bunch between his knees with the stems extending to the front, spreads the stems, takes two wraps around them, spreads the bunch of stems, and puts the loose end through again. This holds the bunch of fronds firmly together without the necessity of tying a knot.

Some pickers break the fronds when picking them, but most cut them with a ring knife, which has a short, curved blade attached to a ring worn on the picker's finger.

Professional pickers may collect as many as 200 bunches per day, but about 100 is high for the average picker. As a rule, about six hours are spent in picking the ferns and two to three are required for packing in and out of the area and in sorting the fronds.

The amount of fern which may be picked from any given area naturally varies. In exceptionally good areas 40 to 60 bunches may be picked from an area one-fourth to one-half acre in size. Usually a much greater area must be covered to get a like amount. (37).
How Ferns Reach the Buyer

After the picker has stopped for the day he puts his ferns on a pack-board and carries them to the road where he has his car. There he puts them into boxes furnished by the buyers, and hauls them home or to a collection point. In certain areas, the buyers send trucks on a regular route to collect the ferns. One coast buyer sends a truck on a regular bi-weekly trip of over 100 miles.

Some pickers are not on a buyer's regular route so must haul their ferns to the buyer's packing plant.

Season of Picking

The fern picking season varies with locality and season, starting as soon as the growth of the current year hardens enough to prevent the fronds from wilting during shipment. This is usually June or July, and the season extends until April or May of the next year. Not much fern is picked during late August or early September when the fern spores ripen and are shed. May seems to be the month when the industry is at its lowest ebb because at this time new growth is at its tenderest stage.

The season lasts for about 10 or 11 months, so the industry is practically on a year-around basis.
Prices Paid Per Bunch

At the present time, the price paid to the picker is eight cents per bunch of 50. The average price over the past several years has been estimated at four to five cents \((30)(48)\). No figures are available for the prices received by the companies shipping ferns to the large markets.

Handling by the Buyer

The firms purchasing ferns from the pickers have cold storage plants in which they store the ferns until carload lots have been accumulated. The ferns are sorted and packed in boxes lined with wax paper, there being 50 bunches per box or case. These boxes are stamped with the trade name of the firm's product.

The cases are placed in the cold storage rooms, and are kept at a temperature of \(30^\circ F\) in cold weather, \(32^\circ F\) in warmer weather, and at \(28^\circ F\) when ferns are older. The average time the ferns are left in the storage rooms is about 90 days.

Practically all the crated ferns are shipped to eastern markets, and are carried in refrigerated railroad cars. New York is the largest market, but there are many markets, widely located from Newark, New Jersey,
to New Orleans, Louisiana. Some go to Los Angeles.

One large coast buyer estimates that about 2,500 cases are shipped per month by this firm (30).

**Choice of Overstory**

Most buyers prefer to buy fern which has grown under "cedar" if such fern is available. Fern grown under bigleaf maple or vine maple is the second choice if it is not spotted with disease. After these two types of overstory, the preference is usually for fern grown under western hemlock, Douglas-fir, and Sitka spruce in that order. The preference, however, varies among buyers and marketable fern can be found under any of these covers. Very little good fern is found under red alder (37).

**Predicted Future of the Industry**

On the basis of past figures, the sword fern industry should maintain itself at about the present level. The industry has shown a gradual increase during the past five years, as has been stated.

The chief hazards to the industry are forest fires and logged over land. After fires and logging several years must elapse before the new fern growth is suitable.
for picking. However, there exists no apparent danger of removal of the forest cover from the majority of the commercial area of the fern. So long as forests are reproduced after logging, the fern will apparently come back to commercial production. In the Cascade Head Experimental Forest near Otis, Oregon, a stumpage fee of one-fourth cent per bunch is charged the pickers, and the area is closed to picking from June 1 to October 1. This charge and closure is for a regulatory purpose to protect the forest from fire as well as to protect the fern. Thus the Forest Service is attempting to conserve this resource.

The effect of World War II on the industry can be but conjecture. It would seem that with the shortage of tires and gasoline now existing, and with the existence of higher paying jobs due to the war effort, fern pickers may become scarce in the future. As the nation goes on a full war time schedule, perhaps the use of this fern will slacken because occasions for its use will be curtailed.

Part III

RELATIONSHIP OF THIS INDUSTRY TO DOUGLAS-FIR FORESTS

On the basis of the monetary return from this industry, it is of little value as compared with
returns from the major crops, such as timber and piling, obtained from the Douglas-fir forests of the region. A return of $1,250,000 per year is quite small when it is realized that lumber production in the Douglas-fir region was about 4 1/2 billion board feet during the first six months of 1941. The average net sale value of this lumber was $27.21 per thousand board feet, making a gross return of about $122,000,000.54.

In addition, this industry is confined more to the "fog belt", in which Douglas-fir may not be the dominant forest type in many cases. The sword fern industry, therefore, may not be considered entirely a subsidiary crop of Douglas-fir forests. However, enough of the industry is practiced in regions in which Douglas-fir forests are the primary type to allow it to be considered a crop of Douglas-fir forests.

This industry is one which is dependent upon the maintenance of a good stand of forest trees at all times. Fires and logging which leave forest lands denuded permanently or covered only with brush ruin this industry. Such conditions are also detrimental to continued forestry as well. Thus reforestation aids both Douglas-fir forests and this subsidiary industry. There is some possibility that good sword fern may be
grown in planted stands of Douglas-fir, but this seems a possibility of the distant future as plenty of fern is now produced in more mature stands.

In any event, this industry does return $1,250,000 a year to the Pacific Northwest, it does not harm the forest itself, and it should be conserved as a minor but worthwhile adjunct to the harvests of our forest lands.
Chapter Five

WOOD OILS AND NEEDLE OILS

Introduction

Among the minor industries dependent upon the forests of the United States is the production of oils from the wood and foliage of trees. This industry in the western states of Oregon and Washington is concerned largely with the "cedars", although some of the other western conifers are used. As these "cedars" often occur in mixture with Douglas-fir, the industry will be treated in this chapter. Some information will be given on the scope of the "cedar oil" industry in the United States as a whole, the "cedar oil" industry in the Douglas-fir region, and the production of "Oregon Balsam" from Douglas-fir trees.

Part I

THE "CEDAR OIL" INDUSTRY IN THE UNITED STATES

In the United States as a whole, most of the so-called "cedar oil" produced comes from the wood of the eastern redcedar (Juniperus virginiana L.). This tree is a member of the family Cupressaceae, the Cypress or Cedar Family which is represented in the United States
by five genera, namely, Libocedrus, Thuja, Chamaecyparis, Cupressus, and juniperus. Although the true cedars are included in the genus Cedrus of the Pinaceae, many species in the Cupressaceae are known at least locally by the name "cedar" (21).

Eastern redcedar is a tree 40 to 50 feet in height and 12 to 24 inches in diameter as a rule. It is widely distributed, the range extending over much of eastern United States and as far west as the Dakotas, Nebraska, and Kansas. It does not occur in the west naturally.

It has been estimated that 500,000 pounds of "cedar" oil are produced annually in the United States. Tests made by some of the larger companies interested in this oil indicate, however, that it is usually not pure and much of it may be oil of the northern white-cedar (Thuja occidentalis L.) (13).

This tree is generally 40 to 50 feet tall, 24 to 36 inches in diameter. Its fruit is an erect cone, while the fruit of the eastern redcedar is a berry-like cone. The range of the white-cedar extends farther north than does that of the eastern redcedar.

The oil for the most part is distilled from waste shavings in the lead pencil manufacturing industry which uses eastern redcedar. The oil from the northern white-
cedar is distilled from the foliage. Steam distillation rather than destructive distillation is used. The yield of oil from eastern redcedar varies from 2 1/2 to five per cent (41). No figures are available as to the yield of oil from northern white-cedar. Most of the work done on such oils was begun in the period from the middle of the nineteenth century to the beginning of the twentieth century (12).

This oil is used as a moth repellent, as a scent in the soap industry, and as a mask for other repellants and insecticides. In scientific use it is employed as an immersion oil for microscopes.

Part II

WOOD OIL PRODUCTION IN THE PACIFIC NORTHWEST

Western Redcedar Oil

Tests have been made which show that oil from the foliage of western redcedar (Thuja plicata D. Don) is comparable to the eastern oil for many purposes and uses. It is probably mixed with oil from foliage of Thuja occidentalis. About 50,000 to 75,000 pounds of these two oils are produced annually, bringing 35¢ to 75¢ per pound. No figures are available as to the percentage of each of these oils in the total.
Western redcedar oil is most commonly used in insecticides and liniments.

Western redcedar is a common tree on the Pacific coast, reaching 150 to 200 feet in height and four to eight feet in diameter in maturity. It is found on moist flats and slopes and may even be found in bogs. It is rarely found in pure stands, occurring with Sitka spruce, western hemlock, Douglas-fir, grand fir, Pacific silver fir, and hardwoods such as cottonwood, alder, and bigleaf maple.

The range of this tree extends from southeastern Alaska south along the coast to about 100 miles south of San Francisco Bay. In the American Rockies it is found through western Montana, and in the Bitterroot Mountains of Idaho, ranging south along the eastern slopes of the Cascades to southern Oregon (21).

Figures as to the volume produced are lacking. The oil is distilled from the foliage by local people, and sold to dealers. It is largely shipped to the eastern part of the United States.

Port Orford White-cedar Oil

The production of oil from the wood of Port Orford White-cedar (Chamaecyparis lawsoniana (A. Murr.) Parl) is a comparatively recent industry on the Pacific Coast.
This tree has a very narrow natural range, occurring in a strip about 200 miles long and 10 to 40 miles wide from the vicinity of Coos Bay, Oregon, south to the Mad River near Eureka, California. Scattered trees are found farther inland in the Siskiyou Mountains and on the southwestern slopes of Mt. Shasta. It grows best where considerable moisture is available in the soil and in the atmosphere. It has been planted, however, in areas far removed from its normal range and has grown well in many of these places. An example of this was furnished by planting on the watershed of the city of Aberdeen, Washington, which was described as follows (64):

In 1929, the Wishkah headworks of the watershed of the city of Aberdeen, Washington, was logged and the slash was burned in the fall of 1930, on an area covering about 80 acres. In the spring of 1931, the city water superintendent obtained seedlings of fir, cedar, and spruce from the Crown-Willamette nurseries near Cathlamet, Washington. He did not specify Douglas-fir, western redcedar, and Sitka spruce, but supposed he was getting these species. The spruce seedlings were three years old, and the others were two years old. The trees were planted at about 700 per
acre in rows 7 1/2 feet apart, one row being fir, one cedar, one fir, one spruce, and so on. About 20,000 firs and 10,000 each of the other species were planted. The survival was about 80 per cent by 1942.

Three or four years after planting, the superintendent gave the trees a closer inspection and found them to be Douglas-fir, Englemann spruce, and Port Orford white-cedar. The spruce did well at first, while the fir and cedar made only slow growth. Later the spruce declined and is now only scrub growth. The fir has grown quite well, while the Port Orford white-cedar has grown exceedingly well.

At the present time, spring 1942, there are Port Orford white-cedars in this plantation which are seven inches in diameter at the butt and over 30 feet tall. These trees are growing well on dry hill sides as well as in moist bottom lands. Three years ago these "cedars" produced seed which the water department planted in their own nursery. In 1941, they set out 12,000 seedlings of their own production. This region is several hundred miles north of the natural range of Port Orford white-cedar.

The above description shows that this tree has great possibilities outside its natural range. The
trees have not reached sufficient age to tell how they will do when mature, but this example and others seem to show great possibilities for this tree.

The Oil from the Port Orford White-cedar

The oil from the wood of this tree has different chemical properties than oil of eastern redcedar but has similar insect repellant properties. A small amount of this oil is used in the manufacture of germicidal soap in conjunction with mercuric iodide. Some orders were received from Europe before the World War II.

The price of this oil is slightly higher than that of eastern redcedar.

The first analysis of this oil was published in 1914 by Schorger. A second analysis was published in 1927 by Thurber and Roll. Dimick made an analysis of the oil at Oregon State College in 1939. All these analyses showed about the same results. This oil is water white and has a slight odor of cedar, after the turpentine has been removed.

So far as is known, the only production of this oil at this time is carried on near Coos Bay by the Port Orford Cedar Company of Marshfield, Oregon. Investigations into the possibilities of commercial
production of this oil were begun in 1924 when a plant having a capacity of 100 pounds of sawdust was installed in the department of chemical engineering at Oregon State College. From the results of this study, a commercial plant was developed. This plant, as installed at Marshfield, Oregon, is made up of three vats, each six feet in diameter and eight feet high. Conveyors carry sawdust from the mills to these vats, which open at the top. After a vat is filled, it is closed at the top and steam under 110 pounds pressure is admitted at the bottom. The steam passes through the sawdust taking the oil with it to the condenser, where oil and water are separated continuously. The three vats allow continuous operation for while one is operating, another is being filled and the third discharged. After the oil is removed the sawdust is returned to the mill and used as fuel for the furnaces. The steaming does not seem to hinder its use as fuel. The production of oil is about 1.6 per cent. One man operates the plant, which can produce 125 pounds of oil in eight hours. No exact figures are available as to the prices received for this oil nor the yearly production (43).
Douglas-fir Balsam

A substitute for Canada Balsam, the pitch from blisters in the bark of Abies balsamea, has been developed from the pitch of Douglas-fir, Pseudotsuga taxifolia.

The true Canada Balsam has about the same refractive index as optical glass and is useful as a cement for fine lenses and as a mounting agency for microscopic slides. It may sell for as high as $40 per gallon in the prepared form.

The so-called Oregon Balsam from Douglas-fir pitch is a fairly good substitute for true Canada Balsam. It is not as good as the Canada Balsam, but has found considerable use. The price of this Oregon Balsam may be as high as $8 per gallon in the refined state.

Lists published by the General Biological Supply House of Chicago, Illinois, dealers in oils and similar products, show the following prices for prepared products (65):

<table>
<thead>
<tr>
<th>Product</th>
<th>price per oz. 4 oz. pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil of Cedar for clearing</td>
<td>.30 .50 1.30</td>
</tr>
<tr>
<td>(Clears tissues from 95% alcohol without shrinkage)</td>
<td></td>
</tr>
<tr>
<td>Oil of Cedarwood for immersion</td>
<td>.40 1.75 2.75</td>
</tr>
<tr>
<td>Balsam, Canada, dry gum</td>
<td>.50 1.75 5.75</td>
</tr>
<tr>
<td>Balsam, Canada, Dissolved in Xylol</td>
<td></td>
</tr>
<tr>
<td>Paper filtered</td>
<td>.50 1.70 4.95</td>
</tr>
</tbody>
</table>
Part III
IMPORTANCE OF THE OIL AND BALSAM INDUSTRY IN DOUGLAS-FIR FORESTS

From the figures shown, the value of the oil of western redcedar may be 50 cents per pound. The production may be as high as 10,000 to 20,000 pounds per year. If an average of 15,000 pounds is used, the total value of this oil is only $7,500 per year.

Figures for Port Orford white-cedar oil are not available, but are said to be somewhat higher than eastern redcedar oil. Perhaps a figure of 60 cents per pound may be close. The production figures are not known, but the amount will probably not exceed a few thousand pounds. The return from this oil is approximately $1,000 to $2,000 per year.

The 500 barrels of Oregon Balsam produced each year at $1.00 per gallon would show a return of $25,000.

The total of these estimated values does not exceed $40,000 per year and may be considerably less. As a minor industry, these derivatives are therefore not important. Their future importance lies in the development of more places for their use, and in closer utilization of forest products. The oil of Port Orford white-cedar is saved from mill wastage, so is practically clear
profit. The oil of western redcedar may be gathered from foliage of trees cut in logging, and if this is the case, waste is prevented. If the oil is collected from foliage stripped from living trees, there is possibility of damage.

Some harm has been done to large old Douglas-fir trees by people boring with augers in search of pitch pockets, but this damage is probably not large. On the whole, these industries show little value at the present time. They may point toward additional sources of revenue in the future when forest products will be much more closely utilized.
Chapter Six

MISCELLANEOUS CROPS

In addition to the five main subsidiary crops discussed in preceding chapters, there are several which are of a lesser nature. Among these are evergreen huckleberry, Oregon grape, elk horn moss, digitalis, bitterroot, and gold seal (44).

Evergreen huckleberry is a small shrub, the foliage of which is used for decorative purposes. It is found along the coast, and is purchased by some of the firms dealing in sword fern. The volume of this product is not large, and the industry is confined to a relatively small region.

Oregon grape is also a small decorative shrub, and its foliage is likewise used in landscape work. Figures as to the volume sold are not available, but it is probably small. The roots of this plant are used for medicinal purposes.

Elk horn moss is used for decorative purposes.

Digitalis, or fox glove, is not native to western Oregon and Washington, but has been introduced as a weed and does quite well. It is used in medicinal preparations.
Bitterroot and gold seal are plants which grow in timbered regions and are used in medicines.

No figures are available as to the value of these crops to the people of the Douglas-fir region. Probably the return is only a few thousand dollars per year.

SECONDARY PRODUCTS FROM THE MORE IMPORTANT TIMBER PRODUCING SPECIES

It might be of interest to the reader to gain some idea of the value of the secondary products which come from the timber producing species occurring in the Douglas-fir region and in Douglas-fir forests. No attempt will be made to go into detail on these crops, as such a procedure would entail the writing of a second thesis confined to that particular phase.

The more important of these crops which come from these timber species are: poles, piling, fuelwood, fence posts, forest pulp wood (cut from smaller trees and corded), hewn ties and lumber, shingle bolts, excelsior bolts, and mine timbers.

Poles probably come largely from Douglas-fir and western redcedar, although some other species may be used, at least locally. Sizes vary, as does the price and quality.
Piling is almost entirely a Douglas-fir monopoly in this region, as this species is very well suited to the purpose. Western redcedar is used to some extent.

Fuelwood is cut from practically all the species growing in Douglas-fir forests. However, Douglas-fir is the main species used for this purpose. Some hardwoods such as oak and maple are utilized for fuelwood. White firs and western redcedar are not used for fuel to any great extent.

Fence posts may come from several different species. Western redcedar makes a very good post as it is quite durable in contact with the soil. Douglas-fir is widely used for this purpose, being treated with creosote in many cases. Probably most of the other species which grow with Douglas-fir have been used locally for fence posts.

Forest pulp wood, cut and corded, is a fairly large secondary crop. The white firs (Abies spp.) are widely used for this purpose, as is western hemlock. These species grow in mixture with Douglas-firs, and are cut out when still relatively small. The bark is peeled from the trees and the wood is stacked in cords. Probably the largest percentage of such pulp wood is cut on a "gyppo" basis, the small contractor hiring men
to cut and peel the logs, and then hauling the logs to the markets. Recently $3.50 per cord was offered for cutting and peeling such cord pulp wood. The greatest percentage of pulp is produced from large, mature western hemlocks which are logged and shipped to the pulp mills for this purpose.

Hewn ties and lumber make up a relatively small part of the ties and lumber produced in the west, but some small amounts are still produced.

Shingle bolts are cut for the most part from stumps of western redcedar, or from old trees left in logging as unfit for cutting. Small operators may go in and take out such products, and make a fairly good living.

Excelsior bolts are cut largely from cottonwood and aspens. The industry is not large, but utilizes these less important trees.

Mine timbers may come from several sources, Douglas-firs probably being the most important source at least so far as trees growing in Douglas-fir forests are concerned.

One source has estimated the yearly value of such secondary products to be (26):
These figures are for the states as a whole and include products coming from forests other than Douglas-fir forests. However, many of the products do come from the Douglas-fir forests, and the value of these is probably two thirds of the totals shown. These figures are based on estimates, so this fact must be kept in mind when using the figures.

Assuming that these so-called secondary crops do make up a total value of $10,000,000 from the Douglas-fir forest of the two states, the return is great enough to be a significant factor in forest practice in this territory.

As has been mentioned previously, Douglas-fir lumber production was about 6,000,000,000 board feet in the year of 1940, and the average selling price was $27.21 per thousand board feet, for a total gross return of over $160,000,000. This gross return of $160,000,000 overshadows the $10,000,000 from the so-called secondary
crops. However, the $10,000,000 is widely distributed among many people and contributes to the economic stability of forest communities.

Probably most of these products are cut from trees not suited to timber production either because they are immature, overmature or for other reasons. Some, such as poles and piling, may be removed as thinnings from a stand intended for future timber production. Fuelwood may be cut from overmature trees unsuited for lumber production because of knots or other defects. In such cases, cutting them for these minor products has been beneficial. It is when healthy, fast growing trees are cut for fuel wood, are cut for piling and are "long-butt ed" or left in the woods, that waste arises. The production of the secondary crops can be a useful adjunct to timber production, or can be a detriment, depending upon the manner in which it is handled.
Chapter Seven

SUMMARY AND CONCLUSIONS

Summary

A discussion of the more important subsidiary products produced in Douglas-fir forests was presented. Information as to the industries engaged in harvesting these products, the financial returns realized from the industries, and the importance of these industries in the problem of Douglas-fir forestry was given. The five most important crops, when listed in order of annual financial return to the Pacific Northwest, are: sword fern, $1,250,000; Christmas trees, $1,000,000; cascara bark, $300,000; red alder, $156,000; wood oils and extractives, $40,000. These figures are based upon estimates, so this fact should be considered when using them.

In addition to the five subsidiary crops listed, several more for which no estimates of value could be obtained at this time were set forth, including evergreen huckleberry, Oregon grape, elk horn moss, digitalis, bitterroot, and gold seal.

A few statistics concerning the value of secondary forest products produced from the major timber producing species growing in Douglas-fir forests were presented.
These products, poles, piling, fuelwood, fence posts, forest pulp wood, hewn ties and lumber, shingle bolts, excelsior bolts, and mine timbers, return an estimated total of $10,000,000 per year to residents of the Pacific Northwest.

The money obtained from the sale of these products is rather widely distributed among many people of the Pacific Northwest.

**Conclusions**

For a more complete set of conclusions concerning each product or group of products, refer to the latter part of each chapter.

The financial return from the five main subsidiary crops is not great at present, probably not exceeding $5,000,000 per year. This figure is quite small as compared to a gross return of about $160,000,000 per year from the Douglas-fir lumber industry. The importance of these crops seems to lie in the fact that they are crops which do not interfere to any great extent with timber production, and hence represent a revenue without depleting forest values. There seem to be possibilities for extending the production of some of these crops on lands now lying idle and reverting to
county ownership for tax delinquency. By a more complete utilization of land resources, the country will be materially bettered.

The less important subsidiary crops likewise show possibilities of increased revenue from timbered lands. Although little is known of the amount which these products return, it is nearly all profit, for their production has cost only labor.

Secondary products produced from the timber species growing in the Douglas-fir forests may come from trees which would have produced timber eventually, or from trees unsuited to timber production. The financial return from such products has been estimated at $10,000,000 per year, and is rather widely distributed among residents of the region. In many cases, the production of these products has not hindered timber production and may have aided it. In producing such products, care should be taken not to destroy possibilities of larger returns in the future. In other words, cutting for the Douglas-fir region as a whole should be so synchronized and developed that the proper percentage of timber trees are produced through taking out the needed secondary products as thinnings.
The residents of the Pacific Northwest should not overlook the possibilities of developing a more stable economic life through more complete stabilization of their land resources. Future study should be given to more widespread production of crops which are now unimportant.
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