PROBLEMS OF REHABILITATING
THE TILLAMOOK BURN

by

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A THESIS
submitted to
OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF FORESTRY

June 1953
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Date thesis is presented  April 6, 1953

Typed by Jeannette L. Hallett
ACKNOWLEDGMENT

The writer wishes to express his appreciation to the Oregon State Board of Forestry and members of the staff for use of manuscript material and other data in preparing this thesis. He is indebted to Lynn F. Cronemiller, Assistant State Forester, for much of the early information. Acknowledgment is also due Dr. Walter F. McCulloch for his helpful suggestions and criticisms and to Dr. George H. Barnes for his council and guidance.
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PROBLEMS OF REHABILITATING THE TILLAMOOK BURN

INTRODUCTION

The Tillamook burn as it is known today is the result of three catastrophic fires in northwest Oregon. It totals 360,822 acres within which lie 5,946 acres of green timber.

The first and most disastrous fire occurred in 1933 (12, pp. 65-67). It was a hot afternoon, August 14, when logging operations were closing down because of the low relative humidity. An operation in Gales Creek canyon was bringing in one more log before the shut-down. According to history, the fire started when this last log was being pulled in to a spar tree. Friction of either the log or the line against a windfall is reputed to have started the fire that was destined to burn unchecked over one of the finest stands of virgin timber remaining in the state.

The logging crew was delayed about 15 minutes in taking action on the fire because their fire tools were at the landing. Even so, the fire was trailed when less than an acre in size. However, flames had crept up into a snag which had not been felled in the small fire area and the dry east winds caught up burning brands and carried them into the adjoining slash. Additional spot fires started and spread at an extremely rapid rate.

In less than an hour the fire was over 30 acres in size. The woods crew of 35 men was vainly trying to keep the fire from spreading in the surrounding slash. By nightfall almost 500 men were battling the flames, but the fire continued to advance. The following afternoon a spot fire two miles south of the main blaze was reported by Hoffman
lookout located to the north. Towards evening a patrolman discovered a second spot fire seven miles south of the main fire near the summit of the coast range and south of the Wilson River. North winds veering into the east were the cause of these spot fires. As the spots became larger and the main body of the fire moved southward, crowning out in the heavy timber as it went, fire camps were abandoned and the men moved to safety just ahead of the advancing flames.

From August 16 to 19 weather conditions were slightly more favorable. This was probably the only period during which the fire might have been controlled. Over 1,500 men were working on the fire but extremely rough topography, lack of roads and trails, and distance made strategic deployment of the men almost impossible.

A sudden drop in relative humidity on August 20 and a shift in the wind to the northeast resulted in the fire crowning again. Saddle Mountain lookout was destroyed in this second upsurge of the fire which continued to burn on in the tree tops through the night. Winds continued to blow from the northeast and fire made a steady advance to the south and the west over country untouched by road or trail.

By August 24 winds were increasing in velocity and swinging into the east. Fuel moisture content had dropped to a low of five percent. East winds of 26 miles per hour coupled with the dry condition of the forest caused the fire to spread with explosive force. Seventy five per cent of the total acreage was burned from midnight August 25 to noon on the 26. The fire raged over a front of 25 miles and traveled to the west in distances of 7 to 12 miles.
A moist blanket of air coming in from the Pacific Ocean caused the fire to cease crowning. The spread of the fire from that time on was slight. Rains beginning on August 28 and continuing for several days finally quenched one of the worst fires in Oregon's history. More than 2,500 men composed of loggers, sawmill men, CCC boys, and district fire crews had fought the fire for two weeks.

It was estimated in 1933 that the Tillamook fire covered 239,695 acres and killed 11,828,712,000 board feet of timber.

The second fire occurred in the summer of 1939 (20, p.1). It started at 2 p.m. August 2 in a salvage logging operation within the 1933 burn area. Flames spread to the tinder dry limby snags and despite the efforts of district fire crews and loggers, 189,660 acres reburned, including 28,180 acres of green timber which had escaped the 1933 fire. This second blaze was very destructive for it killed much of the seed source which had restocked the area and burned over the reproduction that had come in since 1933 (6, p.13).

Fire visited the area for a third time in July of 1945 (13, pp.17-18). A blaze started in a logging operation in a canyon of the south fork of the Wilson River and raged up the steep snag covered slopes not far from where the original 1933 fire started. A tremendous force of fire fighters composed of regular fire fighting personnel, high school students, army service troops, sailors, loggers, and sawmill men battled the fire for six weeks. A virtually unlimited supply of bulldozers, pumps, and fire fighting tools were available to combat the blaze. Miles of fire trails were built with bulldozers and fire fighting crews. Thousands of gallons of water were pumped on the
blaze. The fire on the ground was stopped several times and was held where the snags were scarce, but wherever the flames had climbed into the unbroken sea of snags, they spread at will with every gust of wind. The fire continued to burn from snag to snag until finally controlled by the fall rains.

Here again losses were not only sustained in timber destroyed but also in scattered seed source and reproduction. The fire had covered 180,130 acres in a period of six weeks.

The Tillamook burn now covers an area of 354,936 acres (Figure 1). More than 13 billion board feet of green timber were killed. It is estimated that the total value of the timber at pre-war prices was $20,000,000. At today’s market prices it would bring over $100,000,000. The several counties involved in the burn were faced with a decreasing tax base due to the three fires. Records indicate that the fires caused a total loss in assessed value of six to seven million dollars and an annual tax loss of about $240,000, $200,000 in Tillamook County and the balance in Washington and Yamhill Counties.

Lands within the boundaries of the burn are suitable for the continuous growing of timber. At least two-thirds of it is highly productive and the remaining one-third is of above average productivity (21, p.7). The area supports some of the finest timber growing lands in the United States.

Reasonable public demand that something be done to prevent further fires and to bring these lands back to full timber production was finally brought to a head by the occurrence of the 1945 fire. Prompted by this demand the late Governor Earl Snell appointed a
THE THREE TILLAMOOK FIRES

- - - 1933 FIRE BOUNDARY
- - - - 1939 FIRE BOUNDARY
- - - - - - - 1945 FIRE BOUNDARY
special forestry committee to make a study of the problem and to offer recommendations for its solution, including a program of financing. After holding public hearings throughout the state, the committee offered two major recommendations to the 1947 State Legislature (4, pp.3-5). One called for a special use or severance tax on forest products to finance a general forestry program; the other, a general bond issue to furnish funds for a forest rehabilitation program. The 1947 State Legislature, after considerable deliberation, passed a severance tax law but limited the use of funds derived therefrom for research purposes only. A house joint resolution was referred to the people calling for a constitutional amendment to permit the general bond issue. Approval was given by the voters in the 1948 general election.

The State Forest Research and Experimental Tax Act calls for a five cent per thousand board feet severance tax on timber or other forest products harvested in Oregon (16, pp.84-90). The first 25,000 board feet logged in any one year is exempt. The Oregon Forest Products Laboratory at Corvallis, Oregon receives 60 per cent of the revenue for research in the utilization of waste resulting from the harvesting, processing, and manufacturing of forest crops. The remaining 40 per cent is used by the Oregon State Board of Forestry at Salem, Oregon for research to develop techniques in forest management, silviculture, fire protection and forest rehabilitation.

After the constitutional amendment was approved by the people, the 1949 Legislature passed an enabling act which took care of the necessary facilitating legislation. Under the law, bonds may be issued
in an amount not to exceed three-fourths of one per cent of the assessed valuation of taxable real property in Oregon. The issuance of bonds in any one year is limited to $750,000 (16, pp. 78-80).

The Oregon Forest Rehabilitation Act limits the scope of the program to protection and rehabilitation of state owned forest lands. Therefore, within the Tillamook burn area of 360,882 acres, only the 252,964 acres presently in state ownership can be rehabilitated. If additional lands within the burn are acquired, these also may be reforested under the act.

It is estimated that fifteen years and approximately ten million dollars will be required to complete the necessary protection developments and to reforest all non-stocked lands in state ownership. Intensely careful planning and a well coordinated program of timber salvage, fire protection and reforestation are essential to achieve such a goal in the face of the many problems that are being encountered.

The program has become a major function of the State Board of Forestry and each of the three operating divisions of the department has been assigned a phase of the work. The research division, which was highly instrumental in developing the Tillamook burn program, is conducting a continuing intensive research program to develop and test new techniques in forest protection and reforestation.

The management division has been assigned the task of gathering information pertinent to the program, developing the overall plan of reforestation, and supervising aerial seeding operations.
The protection division is responsible for the planning and putting into effect of forest protection developments and tree planting project work.

PROBLEMS OF REHABILITATION

There are a number of problems that complicate the planning and coordinating of the Tillamook burn program. The most important of these are land ownership, long term timber contracts and salvage logging operations, land status, extreme fire hazard and rough topography, weather, manpower, and increasing brush cover.

To facilitate solution of these problems and development of the overall rehabilitation plan for the Tillamook burn the area has been divided into eight reforestation units (Figure 2). These units are laid out on the basis of major stream drainages, main ridges, and state ownership boundaries. Such a delineation lends itself well to the manner in which logging is conducted and forest protection developments are taking place, thus permitting the most rapid reforestation of logged-over lands. Each of the eight reforestation units has been assigned a number to aid in its identification and does not indicate priority. These eight units have been further subdivided into planting and seeding blocks based on adaptability.

An analysis by reforestation units has been made of the Tillamook burn dealing with the problems set forth above. Each of these problems is discussed and the solution offered. Since the solutions set forth here are of a general nature, they may be amended
FIGURE 2

REFORESTATION UNITS - TILLAMOOK BURN

UNIT BOUNDARY
BLOCK BOUNDARY
UNIT III Reforestation Unit
PI PLANTING BLOCK
SI SEEDING BLOCK
as more information on the problems is obtained and as actual application of the plan goes forward.

**Land Ownership**

The pattern of land ownership in the Tillamook burn consists of private, county, public domain, O. & C., municipal, State Highway Commission, State Land Board, and State Board of Forestry lands.

The bulk of private ownership lies in three bodies of land. The first is located in the northeast corner, the second in the east central portion, and the third in the southeast corner of the burn. Small private ownerships are scattered throughout the area. State Highway Commission ownership consists of highway right of way, rock quarry sites and state parks, all lying along the Wilson River highway.

The State Land Board owns two small tracts within the burn. Tillamook county has retained ownership of some lands chiefly along rivers and streams to insure public use for recreational purposes. These lands may yet be acquired by the state, thus permitting their reforestation under the rehabilitation act and at the same time continuing to insure public use. Municipal watersheds comprise but a small portion of the burn. The Bureau of Land Management administers the Oregon and California revested grant lands which are located in the extreme southern part of the burn and public domain lands generally scattered throughout the southern half. Board of Forestry lands constitute the greatest ownership and are fairly well blocked.
Lands now owned by the Board of Forestry were acquired under Oregon's forest land acquisition law. Original legislation goes back for more than two decades, but only during the past ten years have laws been enacted that made possible a practicable land acquisition program. The 1941 act, together with the 1945 amendments, resulted in a fairly satisfactory and workable law under which the Board had by the close of 1952 acquired some 640,000 acres of forest land throughout the state of which 252,964 acres are in the Tillamook burn.

The state is authorized to acquire lands through purchase gift, devise, or exchange. The exchange may be on the basis of land for land or timber for land. County courts are authorized to transfer title of county forest lands to the state. The law also permits land owners to make timber or other reservations when passing title to the state.

Table 1 gives the acreage in each type of ownership in the Tillamook burn. Figure 3 affords an excellent picture of the land ownership pattern. Land ownership information was obtained from the forest patrol assessment records of the State Board of Forestry.

The problem of land ownership is of vital importance in the rehabilitation program, since use of funds is restricted to state lands. From the standpoint of forest protection, land ownership is of the greatest importance. Fire prevention measures such as the construction of snag-free firebreaks and access roads, are restricted to state lands even though a more effective corridor might be established on private lands. Reforestation activity is affected by land
## TABLE 1

**LAND OWNERSHIP - TILLAMOOK BURN**

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<tr>
<th>Land Owner</th>
<th>Acreage</th>
<th>Per cent of Total</th>
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<td>Private</td>
<td>78,721</td>
<td>22</td>
</tr>
<tr>
<td>County</td>
<td>6,652</td>
<td>2</td>
</tr>
<tr>
<td>Federal</td>
<td>17,360</td>
<td>5</td>
</tr>
<tr>
<td>Municipal</td>
<td>3,696</td>
<td>1</td>
</tr>
<tr>
<td>State</td>
<td>254,453 *</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>360,882</td>
<td>100</td>
</tr>
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</table>

*Includes State Land Board and State Highway Commission ownership.*
LAND OWNERSHIP – TILLAMOOK BURN

- PRIVATE
- COUNTY
- FEDERAL
- MUNICIPAL
- STATE
ownership only in so far as the necessary protection developments influence the speed with which reforestation can be conducted.

To overcome the problem of varied land ownership, a program of land acquisition and exchange is being followed. If lands cannot be purchased and are in a strategic location with reference to fire-break construction, the land owner may be prevailed upon to take the necessary steps to complete the corridor construction on his lands. Should such a procedure fail, the snag-free corridor will be established in the best location possible on state lands and the width of the corridor made sufficient to be effective.

**Timber Contracts**

The administrative and forest management procedure of the state has been greatly affected by the fact that many land owners have made timber reservations on lands prior to passing title to the state. This is particularly true in the acquisition of county lands and has resulted in the designation of two separate classes of lands which require individual treatment in the matter of timber sales and contracts. One class is designated as "75-25" lands and the other as "90-10" lands.

The former are lands on which the state owns both timber and land. Under the acquisition law each of the counties in which the lands are located receives 75 per cent of the gross income from the lands, providing the state expended no funds in the purchase. The state receives 25 per cent of the gross income for administrative costs. This applies to all lands acquired directly from the counties and those
secured through gifts or devise. If the state purchases the land, the purchase price must first be refunded through future income from the land and thereafter they take the 75-25 status (16, pp.115-124).

The 90-10 lands developed from a management problem that arose when some of the counties reserved the timber for a ten-year period in transferring title to the state. The counties had a twofold purpose in deeding the land to the state and retaining the timber. With the land in state ownership the Board of Forestry administers timber sales and can reforest the area under the rehabilitation act. By reserving the timber, contracts made by the county with private companies or individuals are not affected and the county receives a greater percentage of the gross income.

The Attorney General for Oregon has given his approval to cooperative forest management agreements with the counties which authorized the state to take over all timber sales procedures. This includes timber cruising, appraisals, advertising of sales, selling, collection of payments, looking after legal requirements for logging, slash disposal and conservation act observance. The agreements further provide that the state will retain 10 per cent of the gross income for reimbursement of administrative costs and the balance of 90 per cent will be paid to the county.

The administrative procedure outlined above has succeeded in solving the larger part of the timber sales problems, but has not furthered the progress of the rehabilitation program. This is due to the fact that during the time the counties held both timber and land they entered into several types of long term agreements with private
After the Tillamook fire of 1933, legislation was enacted permitting the counties to adjust and settle tax claims against timber lands within the fire area (17, pp.574–575). The law was amended in 1941 to permit the counties to accept deeds to tax delinquent lands and in return give timber cutting contracts to the former land owner (18, p.236).

Many contracts were entered into between Tillamook county and timber companies or private individuals. Duration of contracts varied but all carried an option for renewal. Some timber deeds were given and the county retained title to the land. These deeds cover periods of 20 to 25 years; some have renewal clauses.

The state is faced with the problem of not only administering its own timber sales contracts but also those of Tillamook county. The nature and duration of the county agreements permits logging to be conducted on the basis of market values. With higher prices, greater demand for lumber products and closer utilization, logging will continue for an indefinite period in the future. Many contract holders have logged their timber areas twice or more and have then subcontracted logging rights to smaller operators who in turn have taken more volume from the area. There are instances in the records showing four successive logging operations on the same tract. Only the continual increase in the price of timber products and good utilization can account for such intensive recovery.

It is evident that the continued relogging within the Tillamook burn is having a great influence on the progress of the
rehabilitation program. It is also apparent that as much value as possible should be realized from the burn before logging ceases. Logging obviously reduces the snag concentrations in the burn, thus partially alleviating the fire hazard. This aids the rehabilitation program. On the other hand, successive logging of the same area limits the work of reforestation.

The logical solution to the problem seems to be the orderly logging of each area as an operation commences and is carried to a close. All salvable volume should be removed so that when the operation ceases no further logging is necessary. Then, as adjacent tracts are logged, an area of sufficient size will be developed that can be reasonably well protected from fire and reforestation work can go forward. The above program of logging is required under state timber sales contracts, which at the present time cover 32,375 acres or 12.5 per cent of state ownership in the Tillamook burn. County contracts and timber deeds have no such time limitation. Only completion of logging to the point where it is no longer economically feasible will consummate the timber contracts. Timber deeds that have an option for renewal fall into this same category. Where no option for renewal is stated, timber deeds will expire on the date stated. On January 1, 1953, 133,125 acres or 52.6 per cent of state ownership were under some form of county timber agreement.

The state has no jurisdiction over the county agreements. As long as the holder of a county contract conducts his operation in accordance with the requirements of the agreement, he can continue his salvage logging as he sees fit. Should log prices continue to advance
the operator might again go over the lands he has under contract or he might engage a subcontractor to conduct the operation. Here the problem of obtaining orderly and complete logging becomes more acute. It seems advisable that in areas where logging is nearing completion on state timber sales that holders of county contracts in the vicinity be contacted and prevailed upon to complete logging at least on those lands lying adjacent to the state sale area. With the whole-hearted cooperation of the operator, rehabilitation work could go forward first on the areas supporting the least amount of salvage and move towards the areas of greatest snag concentrations as logging progresses.

Several operators holding county contracts have been approached and this problem discussed. Through the cooperative efforts of the state and one operator an area of over 5,000 acres of state land under county timber agreement was aerial seeded. It is very likely that many more such arrangements can be made, thus solving the problem of timber contracts and salvage logging to a certain extent.

Land Status

The problem of land status is a difficult one, since the presence or absence of salvageable timber on a given area has a direct bearing on the progress of both forest protection developments and reforestation. It is further complicated by timber contracts and deeds which have been discussed under a previous section.

To determine the actual condition of the Tillamook burn with reference to the total acreage bearing natural reproduction, the area supporting salvageable timber, and the land that has been salvage logged
and is non-stocked, an aerial survey was conducted. In the summer of 1951, the entire burn plus surrounding lands were photographed from the air with both panchromatic and infrared film. Photographic scale was 1:12,000 or 1 inch to 1,000 feet. The two types of photography were executed simultaneously so that both sets of pictures could be used interchangeably in the analysis of the burn.

The panchromatic photography permitted a rapid and accurate snag count. Snag density was divided into four classes: (1) open, 0-4 snags per acre, (2) light, 5-9 snags per acre, (3) medium, 10-17 snags per acre, (4) heavy, 18+ snags per acre. Classifications and limits were developed on the basis of various degrees of salvage logging. For example open areas will probably not be relogged again, light snag areas will support a small salvage operation of short duration and medium and heavy snag densities will support a large salvage operation for an indefinite period of time. Snag counts were made on the aerial photographs with the aid of lens stereoscope, 4-power magnifying glass and a circular one-acre plot scribed on transparent plastic. Sufficient one-acre samples were taken within an area that appeared to be homogeneous on the photos to establish the snag density. Then a type line was drawn around the area and the information transferred to a planimetric map of four inch to the mile scale using the proper legend. Through such a procedure, the effective area on each photograph was studied and snags counted. The resultant densities were delineated on photo and map.
Following completion of the office work, field checks were made to test the accuracy of snag typing. Where variations in type line location were observed on the photos and maps from the actual conditions in the field, adjustments were made to correct the error in classification. This was done by making actual sample snag counts on the ground and comparing the count with the classification applied in the office.

The infrared photography proved excellent for the stocking study, since it furnished such a great contrast between hardwoods and conifers. The stocking study was concerned with the typing of all coniferous growth from mature timber down to the smallest seedlings discernible on the aerial photographs. After considerable study and field examination it was determined that the smallest seedling discernible with any degree of accuracy was six to seven feet in height. This, of course, does not include all seedlings that may be present on an area, since many might be growing beneath the brush cover and not be visible on the photos. However, it is possible to determine degree of stocking on many acres where coniferous growth is fairly well advanced, thus eliminating the need for ground surveys. Lands adequately stocked need no reforestation measures and correspondingly reduce the acreage to be planted or seeded. As the snag count was made from the panchromatic photos the corresponding infrared photos were examined and the stocking indicated on the same maps. Field checks on the accuracy of the stocking survey made from the photos were conducted at the same time that snag densities were tested.
The results of the land status study give a fairly complete picture of the present condition of the burn. Lands supporting moderate to adequate stocking, areas that have been logged and are non-stocked and areas that support salvable timber have been delineated on aerial photos and transferred to maps. Seeded and planted acreages must also be considered in the land status study. Acreages for each classification have been determined and are set forth in Table 2.

Whenever natural reproduction is present in sufficient quantities and logging has been completed, no reforestation work is necessary. However, fire control developments required under the forest protection plan for the Tillamook burn must be carried out. In some areas merchantable snags may be scattered through the reproduction. Where these are logged it will be necessary to conduct preplanting surveys to determine if any damage to reproduction was incurred. Land on which stocking has been reduced will have to be brought up to full stocking through planting or seeding.

Logged over forest lands that are non-stocked and fall into an open or light snag classification are ready for reforestation provided that forest protection is adequate and contiguous areas are of sufficient size to justify setting up a reforestation project. These are the lands that will receive first priority for planting or seeding.

Lands that support merchantable snags of medium to heavy density with very few exceptions have not been logged or are in the process of being logged, (Plate 1). No reforestation activity can take place on such areas until the majority of the salvage has been removed.
<table>
<thead>
<tr>
<th>UNIT</th>
<th>Acres Open</th>
<th>Acres Light Snags</th>
<th>Acres Med. Snags</th>
<th>Acres Heavy Snags</th>
<th>Acres Reproduction</th>
<th>Acres Seeding and Planting</th>
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<td>38,486</td>
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<td>40,148</td>
<td>1,143</td>
<td>49,280</td>
<td>252,964</td>
<td></td>
</tr>
</tbody>
</table>
PLATE 1

AREA AWAITING TIMBER SALVAGE - TILLAMOOK BURN
The 29,695 acres that are naturally stocked and the 49,280 acres that have been planted and seeded can be deducted from the total state ownership in the burn. The balance is composed of 65,109 acres of land classified as open, 69,296 acres of light snag density, 38,486 acres of medium density, and 1,096 acres of heavy snag density. It would appear that 65,109 acres at the present time are ready for reforestation. However, due to the scattered nature of these lands over more than 500 square miles of the burn, it is difficult to plan a seeding or planting project without taking into consideration the adjacent lands which may be covered with dense snags and support active logging operations. In many cases work could not be conducted because of fire hazard. Existing salvage logging would have to reach a point where reforestation would be a reasonable risk. Timber sales would have to be made on lands not under contract and logging thereon also carried to a similar degree of completion.

A well coordinated plan of forest protection developments and timber sales will aid greatly in solving this problem. The land status survey set forth herein will facilitate the selection of areas in the vicinity of which work along these lines should be concentrated.

**Extreme Fire Hazard and Rough Topography**

It is common knowledge that the Tillamook burn constitutes one of the greatest areas of fire hazard in the nation. The high hazard fuel types such as the vast expense of snags, heavy debris on the ground and flashy vegetative ground cover, coupled with the rugged terrain, make the area one of the most difficult to protect from fire.
The 1939 and 1945 fires attained their disastrous proportions simply because nothing could be done to stop them. Initial action was delayed because of incomplete detection and lack of access roads. Any attempts to control these fires, which had leaped into the snag tops and were traveling with the wind, met with no success (Plate 2).

The Tillamook burn can be made a reasonable risk through the development of improved detection facilities, the installation of additional properly equipped and strategically located fire suppression crews, the construction of access roads, and above all, through the establishment of snag-free fire breaks along which fire fighters could make a stand.

Reforestation activity must be closely correlated with protection developments. It would be difficult to justify planting large areas that could not be reasonably well protected from fire. On the other hand, if logging has reached a point where reforestation could take place but protection developments are not complete, it might be possible to aerial seed such areas provided the lands were adaptable to such a medium of reforestation, were accessible from the standpoint of fire control and not adjacent to high hazard areas. The cost of aerial seeding operations would be approximately one-fourth that of planting; therefore, the investment would be low. Taking such a calculated risk would permit progress in the regeneration of the burn in years when completed protection developments lagged behind reforestation activity.

Topography in itself presents a problem for both planting and seeding. It is generally accepted that results of aerial seeding on
PLATE 2

CROWN FIRE IN SNAGS - TILLAMOOK BURN
south slopes with little or no cover are poor. Survival of planted
trees on south slopes is usually lower than that obtained on more
favorable exposures; however, there is a good possibility that results
from planting will be better than those from seeding. If it were
possible to pursue a program of planting the most adverse site and
seeding the balance, the problem might be solved, but other factors
enter in that complicate the situation. For example, topography may be
so steep as to preclude economic planting of the area, access may be
unsatisfactory for winter travel or the forest growth on the area may
have been below standard prior to the original fire. Here, it seems,
is the logical place to employ aerial seeding on an adverse site. Cost
of the operation compared to planting would be negligible and but a
short time would be needed to complete the work. True, such areas
should be low on the priority list for reforestation; however, when such
factors as salvage logging and lack of adequate forest protection devel-
opments eliminate the possibility of advancing the program at an
acceptable rate, less desirable areas should be reforested as they are
available.

Weather

Planting activity is carried on from the first of November to
the end of March. During this period at least one month is lost because
of snow; more than two months have been lost in some planting seasons.
Normal snowfall and severe rain and wind storms are taken into consid-
eration in laying the planting plans for the season. Should abnormal
snowfall occur or prolonged periods of rain and high winds prevail,
production will be curtailed. The only means of making up for lost
time is through recruiting sufficient labor to finish the job as soon
as the weather moderates.

Weather also increases the problem of tree lifting at the
nursery. Heavy soils make digging almost impossible during prolonged
wet spells. Tree lifting completely stops during snow periods. To
solve the problem of tree availability a cold storage plant capable of
holding three million 2-year old Douglas-fir seedlings was constructed.
Trees can be dug and stored over and above stock normally required to
maintain the planting schedule, thus eliminating the need to shut
down planting operations because of lack of trees.

Summer weather conditions can also work to the detriment of
the program. An outstanding example is the fire season of 1951. Snag
falling crews, road construction crews, and other project personnel,
in addition to the regular fire suppression crews, found themselves
almost continuously involved in fire fighting from the latter part of
April to the latter part of September. Such seasons are unusual; yet,
they do occur and as a result progress is slowed down. To remedy this
problem from the standpoint of personnel would be almost impossible.
Sufficient manpower is not available and costs of maintaining such a
large suppression force would be out of reason. Sound fire prevention
measures practiced by all logging operators within the burn and in-
tensive inspection service on the part of the state, would do the most
toward solving this problem.
Manpower

All phases of the rehabilitation program are affected by the shortage of skilled men needed for snag falling and road construction. They are difficult to secure and hold because of the wage differential between government and industry. To overcome this problem an attempt is made to maintain a nucleus of experienced personnel that is capable of training inexperienced young men interested in snag falling and road construction. Snag falling operations are contracted to private individuals following competitive bidding in order to further the progress of fire break construction.

Seasonal fire crews are usually composed of high school seniors and college men, so no great difficulty is experienced in filling such jobs. Procurement of experienced foremen to lead these crews is a serious problem. Year around work is available for men with supervisory experience. They can serve as planting crew foremen in the winter and fire crew foremen in the summer. The problem of supervision is partially surmounted by being able to furnish steady employment.

One of the more critical personnel problems has been the procurement of sufficient tree planters during the planting season. Weather is for the most part disagreeable during the planting period, wages are low, and the period of employment variable because of weather conditions. A few individuals alternate from fire suppression activities to tree planting but most of these men are foremen; therefore, the bulk of the planting crews must come from seasonal labor sources. Very few people who work in the woods apply for tree planting jobs.
since, if they are interested in work furnished by the rehabilitation program, they can obtain snag falling contracts.

In the first year of the program a tree planting contractor was engaged to augment state crews and to assure completion of the work in the first planting season. The work of the contractor was quite satisfactory and was the deciding factor in getting all the trees in the ground. It was found, however, that planting could be conducted for less cost with state crews, so the use of contractors was eliminated the following year when more time was available to recruit personnel.

The 1951 State Legislature passed a law permitting the establishment of a forest work camp, men for which were to be furnished by the state penitentiary. In November of the same year the camp was activated. Fifty men plus penitentiary supervision in camp make up the camp complement. The addition of this crew to the tree planting program has greatly relieved the manpower problem. Since they are now available through the summer months for fire break construction and fire suppression work, personnel problems during fire season have also been reduced.

Brush Cover

The brush problem is the final effect of all those complications that slow up reforestation. Every delay due to logging, fire hazard, bad weather, or lack of manpower means an increase in brush cover. Various measures have been recommended as a partial solution to this problem.
It has been suggested that controlled burning be carried out prior to planting or seeding. Such a procedure would be questionable since most burning weather would also be high hazard weather and foresters would be reluctant to attempt the job. Men and equipment would have to remain on a standby basis all through the operation in the event that the fire might escape the area in which it was to be contained. At its best such a method of brush control would be costly and dangerous. The area has been visited by fire at least three times and there is a possibility of further depleting the already seriously deteriorated soil by controlled burning.

Planting heavy brush areas can be done by taking advantage of all small openings, and by scalping away patches of low heavy brush such as salal. This method would probably produce under-stocked areas but would serve its purpose in that trees would begin to take over, eventually overshadow the brush and perhaps furnish seed source to complete the stocking.

A third alternative is aerial seeding. It is quite conceivable from results of experiments and actual project work that by increasing the quantity of seed per acre, satisfactory stocking can be obtained on areas of fairly heavy brush cover. Further study needs to be made of this possible solution to the problem before any large scale projects are undertaken on areas of heavy cover.

Some minor problems have been encountered such as nursery expansion and seed procurement but these have been met successfully and will be discussed under the reforestation section.
RESEARCH

One of the great contributing factors to the development of a sound and progressive rehabilitation plan has been the State Board of Forestry research program. Out of the research projects that had a bearing on the regeneration of burned over forest lands came the development of techniques in rodent control, aerial seeding, tree planting, snag-free fire break construction, and forest protection surveys.

Before the passage of the Forest Research and Experimental Tax Act of 1947 the Board of Forestry, in cooperation with the Fish and Wildlife service, began experiments in direct seeding and rodent control. Following the 1945 Tillamook fire, aerial seeding and rodent control techniques which had been developed were tested. Satisfactory results were obtained on an area located on the northeast edge of the Tillamook burn. Rodent bait used was thallous sulphate ($\text{Tl}_2\text{SO}_4$) treated Douglas-fir seed which was distributed at the rate of one-fourth pound per acre. Douglas-fir, Port Orford white-cedar, Sitka spruce and western hemlock seeds were used in the experiment. Application was made by fixed wing aircraft (22, p.10).

In 1947 and 1948, after the passage of the Forest Research and Experimental Tax Act, these techniques were refined. New types of rodenticides were tested using wheat as the carrier. The poison wheat was dyed green to make it less visible to bird life. The helicopter was used for application of bait and seed instead of fixed wing aircraft (1, pp.1-7).
Through these additional experiments, the Board was ready to undertake reforestation by aerial seeding on a project basis when the Tillamook burn rehabilitation program was inaugurated in 1949.

Tree planting experiments were conducted on the Tillamook burn to determine tree species best adapted to the area following the three fires. Different planting patterns or spacings were used to determine the most economical method of planting in relation to number of trees per acre. Various types of planting tools were employed experimentally in an effort to select the best type for planting on rough, precipitous and rocky ground. The selection of the planting spot for each tree was studied in an attempt to determine its effect on the ultimate survival of the plantation (7, p.4). Results of these experiments have aided measurably in the conduct of the present planting program.

A method of conducting and analyzing forest protection surveys for general use throughout Oregon was developed under the research program. Techniques developed proved excellent in the forest protection analysis of the Tillamook burn. The basic planning for snag-free breaks and needs in supplementary forest protection were evolved from these studies. Research was carried on in the burn to determine the methods to be employed in snag falling and to ascertain the widths of fire breaks that could be considered adequate under varied conditions of topography and fire hazard.

The information furnished by these several research projects is not only applicable to the Tillamook burn, but also to any large
forest area that has been denuded by fire, where problems of fire control and reforestation are present.

PLANS AND SURVEYS

The two major factors to be considered in plans and surveys were forest protection and reforestation. The effect of timber salvage on the two major factors had to be recognized in all stages of planning. Adequate protection improvements and facilities must first be established and timber salvage completed before reforestation can proceed. Therefore, forest protection plans and surveys will be discussed first.

Forest Protection

From the protection analysis made of the Tillamook burn it was determined that a system of snag-free corridors was necessary to offer reasonable protection to the burn and to permit reforestation of state-owned lands as rapidly as logging is completed (14, pp.18-19). Supplementary forest protection in the form of lookouts, fire crews, and fire fighting equipment was also needed.

Fire Break and Access Road System

The extremely high hazard fuel types that occur in the Tillamook burn because of the tremendous amount of fire killed timber, down trees, brush cover, and precipitous topography make up a critical fire control problem. The vastness of the burn and the lack of effective natural fire breaks add to the difficulties of forest protection.
The construction of fire breaks and access roads should in some measure reduce the magnitude of this critical problem.

The complete system of primary and secondary fire breaks will cover a distance of 200 miles. Center line roads will be built down each of these snag-free corridors. Present logging roads and new construction will serve as access to the corridors. The plan for snag-free fire breaks or corridors as shown in Figure 4 has been initiated.

**Supplementary Detection and Suppression**

The protection funds derived from the fire patrol tax, the Clarke-McNary act and the state general fund are not sufficient to finance adequate protection for the Tillamook burn, especially with the contemplation of heavy investment in reforestation activities. In recognition of the need for more protection facilities a supplementary forest protection plan was developed.

It has been recommended that five new lookouts be constructed on prominent points within the Tillamook burn to augment the present detection system (Figure 4).

Fire wardens and suppression crews normally available for initial fire action are unable to cover the entire burn efficiently. The addition of five more initial action crews to be strategically located throughout the burn (Figure 4) will aid materially in reducing travel time to any fires that might occur. Each of the suppression crews will be equipped with a one and one-half ton tank truck complete with fire pump and hose, two portable radios and all necessary hand
FOREST PROTECTION DEVELOPMENTS - TILLAMOOK BURN

- SNAG-FREE FIRE BREAKS
- ▲ LOOKOUTS
- ▼ GUARD STATIONS
tools and auxiliary equipment. Crew quarters are presently available or will be constructed at the five new guard station sites.

At the outset of the program it was contemplated that all new installations would be completed during the first five years. The progress that has been made will be discussed in a later section covering project activities.

**Reforestation**

Reforestation plans are closely keyed to the forest protection plan and to the progress of salvage logging. A reforestation schedule has been developed which encompasses all state lands within the Tillamook burn. It has been worked out in conjunction with the division of the burn into the eight reforestation units shown in Figure 2. Through such a procedure a logical sequence is set up in the plan. First, logging is completed, second, forest protection developments take place where needed and third, reforestation measures are carried out.

Certain types of surveys must be conducted on lands that are available for reforestation prior to the time the actual work takes place. These are boundary surveys and preplanting surveys.

Plans had to be made for expansion of nursery facilities to accommodate the needs of the reforestation program.
Boundary Surveys

The rehabilitation act limits the use of funds to state owned lands, so it is necessary that state forest boundaries be established in advance of the construction of a fire break or the conduct of reforestation work.

Boundary surveys are conducted by regular survey parties composed of transitman or compassman, two chainmen, and sometimes a flag man. One survey party is permanently employed while a second is maintained through the summer survey season only. Duties of the surveyors consist of line running, recovery and reestablishment of section corners that have been destroyed by fire or logging, posting of state forest boundaries and road location.

Preplanting Surveys

Before it is possible to designate the type of reforestation to be employed on a given area it is necessary that a preplanting survey be conducted. By thorough ground survey important items such as natural stocking, seed source, cover type, fuel type, soil condition, degree of burn, snag concentrations, and topographic features are examined (8, pp.3-29). Through these preplanting surveys it is possible to determine the reforestation needs and the adaptability of specific areas to aerial seeding or tree planting.

Aerial photographs of the lands under survey aid greatly in speeding up the work and correspondingly reduce the cost. From the photos can be taken such information as natural stocking, trees as small as six feet in height, seed source, snag concentrations, and
topographic features. This reduces the field work by about one third.
Aerial photographs used are 1:12,000 scale or one inch to 1,000 feet.

Preplanting surveys are normally conducted one or two years
in advance of actual reforestation. On lands where it is known that
considerable stocking exists, surveys will be conducted as soon as pos-
sible so that the nursery schedule can be coordinated with the planting
program.

Nursery Expansion

Plans for regenerating the Tillamook burn through tree plant-
ing and aerial seeding necessarily require that the Oregon Forest
Nursery be enlarged to provide sufficient planting stock and storage
facilities. The nursery seed bed area has been increased by 23 acres;
five million two-year old Douglas-fir seedlings can be supplied annu-
ally (Plate 3). A cold storage and tree packing plant has been con-
structed which is capable of holding three million seedlings at 35°
Fahrenheit and furnishes facilities for packing 125,000 seedlings daily.
A special "zero" room with a capacity of eight tons of forest tree seed
is also housed in the building. The maintenance of this "seed bank"
permits the continuance of reforestation work during poor seed years
when a current supply of forest tree seed is not available.

The Overall Plan

It is the policy of the Oregon State Board of Forestry to
proceed with the rehabilitation of the Tillamook burn as rapidly as
local conditions and legal and financial limitations permit. The
PLATE 3

PART OF THE FIVE MILLION DOUGLAS-FIR SEEDLINGS GROWN ANNUALLY FOR THE REHABILITATION PROGRAM.
progress of timber salvage operations will directly control the progress of the rehabilitation program. Salvage logging will be expedited on those areas which will require reforestation. Timber sales will be closely coordinated with rehabilitation activities.

Completion of protection developments will be given first priority and planned in a manner to prepare individual areas for reforestation as rapidly as possible. As soon as fire risks have been reduced sufficiently in individual areas reforestation will proceed without delay. Since aerial seeding is the fastest and least expensive reforestation method available, it will be employed wherever conditions offer reasonable assurance of satisfactory results. Other lands in need of reforestation will be planted.

**PROJECT ACTIVITIES**

The project activities being carried on in the rehabilitation of the Tillamook burn can best be shown by describing the work that has taken place thus far.

**Forest Protection**

The various forest protection activities cover the establishment of snag-free fire breaks, the construction of fire break roads and access roads, and other measures such as additional detection and suppression facilities.

Project activities of this nature are being carried out by the Northwest Oregon District of the Oregon State Board of Forestry. Headquarters are located at Forest Grove.
Snag-Free Fire Breaks

General standards for construction of fire breaks were drawn up early in the program. Corridor widths may vary from a quarter mile to one half mile dependent on topography, snag concentrations and other physical features. The center line of the fire breaks generally follows the highest ground along the ridge on which the fire break is located. It is actually an improved fire trail within which has been constructed a road for the movement of fire fighting equipment. Debris in the form of felled snags, down logs, limbs, and bark is bulldozed away from the center line road for distances of 75 to 150 feet to either side, dependent on topography. All snags within the fire breaks are felled. A maximum stump height of five feet is allowable along the center line of the corridor graduating to greater stump height towards exterior boundaries. Permissible stump height away from the center line is dependent on topography. Reconnaissance work on corridor location is done by forest protection personnel familiar with fire behavior and actual conditions in the area.

Where access to proposed fire break sites is not available via present protection roads or logging roads, construction of access roads takes place prior to snag falling. Such roads also furnish summer access for fire suppression crews and equipment and winter access where snag falling and tree planting is carried on.

Center line roads along fire breaks are constructed in advance of snag falling whenever feasible (Plate 4). If access is available, and awaiting construction of center line roads will delay
Snag falling, break construction will go forward without the center line road. Road construction will then take place as soon as possible.

Following completion of center line road and snag falling (Plate 5), a salvage timber sale is held on the corridor, if any merchantable timber is present. Consequently some monetary return is realized from the construction of the break and the amount of inflammable material on the ground is reduced. The remaining heavy debris on the corridor is bulldozed away from the center line. A definite hazard reduction program is being carried out to eliminate the debris (Plate 6). If good burning conditions are available in the late fall without the threat of severe fire weather, the concentrated debris is burned. Other concentrations of debris within corridors are also burned.

Snag Falling

Three different types of crews have been employed in snag falling operations; state snag falling crews, convict crews, and independent contractors.

Where state crews and convict crews are utilized less preparation of the area in advance of snag falling is necessary. After the fire corridor has been located, center line established, and width determined, snag falling begins. Work is supervised by a foreman who knows which snags are to be felled to maintain proper fire break width. Diameters of snags felled are recorded so that costs can be determined on a square foot basis or a per snag basis.
PLATE 5

CORRIDOR NUMBER 3, AFTER SNAG FALLING
PIECE 6

CORRIDOR NUMBER 3, AFTER BURNING
Snag falling costs by these two methods include salaries, camp operation, power saw depreciation and maintenance, transportation and supervisory overhead. Costs of convict crew snag falling are lower than those for contract snag falling. Costs of state crew snag falling will usually run slightly higher than contract falling. However, a number of advantages are gained by utilizing state employed fallers. In areas where snags are sparse, contract fallers are not interested because of the amount of saw carrying involved. State crews are used in conjunction with road construction. A considerable amount of felling and bucking is required along road rights of way preparatory to actual construction. After snag falling is completed on corridors, some snags may show up that should have been felled in the initial operation. State crews are used to good advantage on such clean-up work. Contract falling does not lend itself to such activities.

During the summer months the men can be moved quickly to any fires occurring within the Tillamook burn. This advantage is of major importance with the increasing investment in planting and seeding that is taking place within the burn.

The third method of snag falling, through independent contractors, is the most efficient. Certain additional steps; however, must be taken in preparing a corridor for contract falling.

Following the location of the corridor and establishment of the center line, marking crews tally in two-inch diameter classes all snags to be felled. Each snag is marked by encircling the bole using a paint gun loaded with yellow timber marking paint. Snags along exterior and interior block boundaries are marked with an "X". Corridors
are divided into blocks containing sufficient snags to keep the average contract faller busy for a month. The center line road may or may not be constructed in advance of falling. If supplementary access is available in the form of logging roads or if road construction is lagging behind, falling may take place first.

After the fire breaks have been properly laid out for contract falling, invitations to bid are prepared. The blocks are identified by letters and the number of the fire break in which they are located: "Firebreak 5, Block B", for example. A brief description of the area is given. All snags within the block are listed in two-inch diameter classes. A number of general requirements are enumerated such as, no falling into roadways or reproduction, observation of Oregon Forest Laws, et cetera. A time limit is stated as to when falling must be completed.

Notices are published in local papers and in a paper of state-wide circulation so that any individuals interested in bidding are notified. Prospective bidders obtain forms at the Forest Grove headquarters of the Oregon State Board of Forestry and are required to examine the snag falling blocks before their bids will be accepted. Sealed bids are opened on a date designated in the prospectus. The lowest qualifying bidders are notified of their success and arrangements are made to sign contracts.

Independent contractors are usually two or three man partnerships. Such organizations do not employ persons and are therefore not required to post a 100 per cent performance bond before commencing.
work (19, pp. 791-801). Partnerships are required to post a ten per cent bond in the form of certified cashiers' check or surety bond.

When contracts have been signed, felling may begin. A check scaler inspects the contractors' felling at periodic intervals to see that all marked snags are being felled and that other requirements are being met. After all work is completed, final inspection takes place and payment is made.

Some difficulties have been experienced in obtaining reliable contractors, but on the whole results have been very satisfactory. A minimum amount of supervision is required to maintain acceptable progress. No investment in camp facilities, equipment, or transportation is required, since independent contractors are self-sustaining in all respects.

Table 3 shows comparative costs for snag felling by convict crews and independent contractors. State crew costs are not shown because their snag felling activities are so diversified that no true comparison can be made. Costs are listed on a per snag basis and a square foot basis. Snag felling costs on a per mile basis vary with the number of snags. They vary from a low of $1,732.69 per mile of corridor supporting 10 small snags per acre, to a high of $11,129.60, per mile containing 1½ large snags per acre. The average cost per mile so far is approximately $5,000.00.

Road Construction

Fire break roads and access roads are constructed by state personnel operating state owned equipment. Bulldozer equipped tractors,
# TABLE 3

**COMPARATIVE COSTS - SNAG FALLING, 1952**

<table>
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<th>Type of Falling</th>
<th>Number of Snags</th>
<th>Cost per Snag</th>
<th>Basal Area Sq. Feet</th>
<th>Average No. Sq. Feet per Snag</th>
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<td>Independent Contractor</td>
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motor graders, air compressors, power loaders, and dump trucks are used in these operations.

Road specifications vary somewhat. Corridor roads adhere as closely to the center of the fire break as is feasible. There may be grades present that cannot be negotiated by loaded tank trucks. Fire break roads of this type have access in locations that will permit downward travel for heavily loaded vehicles or permit them to avoid the steep grades in upward movement.

Access roads may be constructed for various purposes, those that pertain specifically to fire control and those that serve as access for year around activities.

Roads used exclusively in forest protection do not meet the same standards required for year long use. They are usually one-way roads with turnouts; curves can be negotiated by tank trucks and crew trucks. Grades are held to maximum of 14 per cent except where impracticable due to terrain.

In areas where winter activities such as snag falling and tree planting are taking place, road construction must meet higher standards. In addition to requirements for forest protection roads greater care is exercised in the installation of initial drainage systems. Roads are rocked and winter maintenance is practiced to insure continuous access.

While road construction work of all types is being carried on, special notice is taken of any streams that might furnish a water hole for use of portable pumps and tank trucks. Development of water holes is accomplished in conjunction with the road construction program.
With the construction and use of numerous access roads, fire breaks, fire break roads and water holes comes the problem of arriving at trouble points in as short a time as possible. Directional signs have been installed to facilitate the rapid movement of fire suppression crews and equipment. All types of roads, and of course the fire breaks, are given numbers and properly signed.

**Supplementary Forest Protection**

The normal protection organization operating within the burn has been supplemented by additional detection, guard stations, fire crews and fire fighting equipment under the rehabilitation program.

Detection

Recommendation of the supplementary forest protection plan called for the construction and manning of five new lookouts. Two of them, Windy Point and Hembre Ridge have been in service. Windy Point lookout service has been discontinued because of a shift in logging activity to the west. Another secondary lookout will be constructed in 1953 to take its place. The new location is on the southern edge of major logging activity.

It is contemplated that construction of the remaining three lookouts will take place as soon as proper sites can be chosen. A number of sites have been recommended in the supplementary protection plan. New lookout sites must be selected not only from the standpoint of effective detection, but also from the standpoint of greatest logging activity.
Suppression

Plans for the addition of five separate fire crews at separate locations were changed somewhat by the introduction of the 60-man forest work camp into the rehabilitation program. The present plan is more effective than the original, since the entire crew of the South Fork Camp is available in case of fire emergency.

Currently during fire season, individual five-man suppression crews are stationed at Murphy Guard Station and Sunset Guard Station. Each is supervised by a foreman and is equipped with tank truck, pumper, necessary hand tools and mobile radio in the truck.

The three other fire crews set up in the plan are made up of six men each from the forest work camp. One crew serves as the unit that would have been located at Jordan Creek Guard Station approximately ten miles west of the South Fork Camp. The second crew has taken over the duties of the Windy Point unit. The third crew has replaced the Blue Lake unit which is located approximately 15 miles north of the forest work camp. New buildings will be constructed at Blue Lake during the summer of 1953. After completion of buildings a resident suppression crew will be located at the site.

All crews from the South Fork Camp are equipped similarly to the other two crews. They are constantly on call and have radio contact with their main camp and the Forest Grove headquarters at all times.

Original costs during the construction period of detection and suppression facilities were estimated at approximately $21,000.00 per year and annual cost of operation thereafter of approximately
$19,000.00. These costs include construction, rolling stock, fire fighting equipment, radios, salaries, operation and maintenance. Full utilization of personnel in the forest work camp should reduce these costs substantially.

Reforestation

As salvage logging is completed and snag-free fire breaks are being established, reforestation work is going forward. Some lands are being hand planted; the bulk of them are being aerial seeded by helicopter.

Aerial seeding is employed on all extensive areas where ground and cover conditions are predominantly favorable to this method. Local failures in seeding projects are corrected by a second seeding or by hand planting. Planting is used in snag-free corridors, in areas too small for aerial seeding, along major highways, to fill in failures in seeded tracts, to interplant partially stocked lands and in areas too brushy, too rocky, or otherwise unfavorable to seeding (15, p.5).

Aerial Seeding

The proper selection of lands on which aerial seeding will be adaptable is of major importance. To insure the correct analysis preplanting surveys are conducted on all lands prior to deciding on the method of reforestation.

During the conduct of the preplanting survey items such as seed source, natural stocking, cover, soil condition, degree of burn, exposure and slope are examined and recorded.
Usually little or no seed source is present in the Tillamook burn; as a result, natural stocking is practically nonexistent. Cover is probably one of the most important factors influencing aerial seeding. Light to moderate cover seems to be the most favorable to seedling establishment and survival. The condition of the soil has considerable bearing on aerial seeding. If soil is generally favorable with no excessively large areas of talus slopes, rock outcrops, poorly drained or rocky soils, aerial seeding should be adaptable. Burned forest areas are examined and classified as to degree of burn. Hard burns are not adaptable to aerial seeding until lower types of vegetation have returned and some build up of the soil has taken place. Exposure will influence the establishment and survival of seedlings to a great extent. North exposures are most favorable, east favorable, west less favorable than east and south exposures (11, p.37), least favorable of all. Slope is a factor that is usually considered along with cover, soil condition and exposure.

Following completion of survey and compilation and analysis of data, it can be determined which type of reforestation should prove the most satisfactory. On lands that are adaptable to aerial seeding, a definite program of preparation is followed.

The lands to be seeded are properly divided into seeding blocks. Aluminum markers are used to delineate the ground area where physiographic features or roads will not suffice.

A great deal of care is taken in selection of tree seed species both from the standpoint of adaptability to the area and from the standpoint of seed origin, purity and viability.
Baiting to control rodents prior to seeding is an essential operation. Two types of bait are used in combination (10, p.5). These are 1080 (sodium fluoroacetate) treated wheat and thallous sulphate (Tl₂SO₄) treated wheat. The bait is prepared by soaking wheat in an aqueous solution of the poison. Wheat is dyed green to make it less attractive to bird life.

A rodent census is made before baiting so that the results of control can be measured. A trapping system using 120 baited snap mouse traps has proven satisfactory. The traps are set in a line at 22-foot intervals in the area to be baited and seeded. They are visited daily for three days and all rodents or other mammals caught are tallied (5, p.20).

Rodent control operations take place after pre-control census has been made. Time of baiting is normally in the latter part of September or early October. Distribution of bait is accomplished by a succession of single flights across the area with the helicopter. Baiting is completed at the rate of 24 acres per minute. The two types of bait mentioned earlier are applied at the rate of one-fourth pound each per acre for a total of one-half pound per acre. Baiting operations cover not only the area to be seeded but also a buffer strip one-fourth mile wide around it. Rodent drift from outside the seeding area is practically eliminated by this process.

Approximately two weeks after baiting a post-control census is made. The area is again trapped in the same manner as before. However, traps are set in a different location, since it is assumed that the mouse population in the vicinity of the first trapping has been reduced.
At the present time there are no positive estimates of the maximum number of mice and other seed eating mammals which will permit successful seeding. Results of several successful aerial seeding projects indicate that the population after baiting must be quite low (Table 4).

After it has been determined that the rodent population has been sufficiently reduced, aerial seeding operations may take place. Seeding is usually accomplished in early November. In any event work is not done until the fall rains have started. The ideal time is after the rains have commenced and before general leaf fall from broadleaf vegetation. This offers seed the best opportunity to find its way to mineral soil.

At the present time seed distribution is accomplished by cross-flying the area. One-half of the seed quantity per acre is applied at right angles to the other half. Such a procedure permits the best seed distribution pattern (9, p.25).

A power driven, centrifugal type, adjustable bait and seed disseminating mechanism is in current use (Plate 7). Douglas-fir seed describes a swath width of 132 feet. The helicopter flying at approximately 200 feet above tree top level and 60 miles per hour is capable of seeding eight acres of Douglas-fir seed per minute (Plate 8). This includes cross-flying of seed.

Various seed species have been used and different quantities of seed per acre have been applied since the beginning of the rehabilitation program. Methods, techniques, and equipment have improved considerably since the first project aerial seeding in 1949.
### TABLE 4

**POST-CONTROL RODENT CENSUSES**

<table>
<thead>
<tr>
<th>Project</th>
<th>Number Baited</th>
<th>Date</th>
<th>Number Trapped</th>
<th>Number Mammals Caught</th>
<th>No. Caught Per 100 Trap Nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit III, Block S1</td>
<td>15,844</td>
<td>10-49</td>
<td>348</td>
<td>1</td>
<td>.26</td>
</tr>
<tr>
<td>Unit III, Block S2</td>
<td>9,946</td>
<td>11-50</td>
<td>720</td>
<td>0</td>
<td>.00</td>
</tr>
<tr>
<td>Unit VI, Block S1</td>
<td>6,924</td>
<td>10-51</td>
<td>900</td>
<td>4</td>
<td>.44</td>
</tr>
<tr>
<td>Unit VII, Block S1</td>
<td>11,676</td>
<td>10-51</td>
<td>1,500</td>
<td>2</td>
<td>.13</td>
</tr>
<tr>
<td>Unit VII, Block S2</td>
<td>8,921</td>
<td>10-52</td>
<td>525</td>
<td>3</td>
<td>.57</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>3,993</strong></td>
<td></td>
<td><strong>10</strong></td>
<td></td>
<td><strong>Mean .25</strong></td>
</tr>
</tbody>
</table>
PLATE 7

BAIT AND SEED DISSEMINATING MECHANISM, SIDE VIEW
PLATE 8

HELIICOPTER SEEDING - TILLAMOOK BURN
Seeding done in 1949 was at the rate of one-third pound medium elevation Douglas-fir seed per acre on 8,602 acres and one-fourth pound high elevation Douglas-fir seed and one-fourth pound noble fir seed per acre on 1,099 acres ranging from 2,500 to 3,000 feet above sea level. No cross-flying was employed. The bait and seed disseminating device used at that time was of an air blast type quite inferior to the present day power driven, centrifugal type adjustable seed disseminating mechanism. Obvious skip areas appear in the stocking pattern on lands well adapted to seedling growth. Had a seed disseminating device of the type currently in use been available and had the seed been cross-flew there is no doubt that stocking would have been much better.

A preliminary stocking survey conducted during the summer of 1952 indicates an overall stocking by four mil-acre plots of 47.76 per cent or 415 trees per acre (2, p.20) and 22.25 per cent or 320 trees per acre by mil-acre plots (3, p.3). These figures include an insignificant number of natural seedlings that were established prior to aerial seeding. No noble fir seedlings were found. Costs of seed, bait, helicopter rental, and miscellaneous controls came to $4,065 per acre.

Aerial seeding operations since 1950 are quite similar. However the centrifugal type seed disseminating mechanism is required, all seed is cross-flew and seeding units and blocks are much better delineated and marked. The amount of Douglas-fir seed applied per acre has been increased from one-third pound per acre to one-half pound per acre. The increase was made to counteract the effects of heavier cover.
Tables 5, 6, 7, 8, 9, and 10 show cost of helicopter seeding operations since 1950. Stocking as indicated by transects is set forth in Table 11. No stocking information will be available on the 1952 seeding until the fall of 1953.

It will be noted that the number of trees per acre resulting from the 1950 seeding in Unit III is less than that for 1949 or 1951. This is due to the fact that the spring and summer of 1951 were extremely dry. Weather went from a cold-wet condition to a hot-dry condition in a very short period of time. Germination was retarded and survival sharply reduced by these extreme conditions. It is significant that 15 per cent of the stocking is from second year germination.

Results of the Unit VI seeding in 1951 were above expectation. The area seeded was the most favorable encountered since the beginning of the program. The 1933 and 1939 fires had not injured the soil to the extent they had elsewhere. Brush cover was fairly well advanced but not to the point where it hindered aerial seeding. Soil and exposure were generally favorable. No attempt was made to check the western redcedar seedlings, since they are too small for an accurate count in the first growing season.

The seeding in Unit VII covered the 8,393-acre April 1951 fire area. The fire occurred so early in the year that damage to the soil was generally light. Bracken fern, fireweed and other lower types of vegetation had not emerged so that a light to moderate cover was predominant over the area by the fall of 1951. The stocking does not measure up to that of Unit VI because of several reasons: soil
COST OF HELICOPTER AERIAL SEEDING, TILLAMOOK BURN REHABILITATION PROJECT, 1950

Township 1 North, Range 7 West

Unit III, Block S2

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir Seed(^1) 1/2 pound per acre</td>
<td>7,504</td>
<td>$28,777.84</td>
<td>$3.835</td>
</tr>
<tr>
<td>Bait(^2) 1/2 pound per acre</td>
<td>9,946</td>
<td>2,740.22</td>
<td>.365 **</td>
</tr>
<tr>
<td>Bait flying @ $.1862 per acre</td>
<td>9,946*</td>
<td>1,851.95</td>
<td>.247 **</td>
</tr>
<tr>
<td>Cross-flying seed @ $.3136 per acre</td>
<td>7,504</td>
<td>2,353.25</td>
<td>.314</td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>7,504</td>
<td>428.46</td>
<td>.057</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$36,151.72</td>
<td>$4.818</td>
</tr>
</tbody>
</table>

* Area baited includes 1/4 mile buffer strip around seeded acreage.

** Cost per acre of bait and bait flying based on seeded acreage.

1 Douglas-fir seed average cost per pound $7.67

2 1080 bait soaked cost per pound .82

1080 bait coated cost per pound .2045

Thallous sulphate bait cost per pound .65
COST OF HELICOPTER AERIAL SEEDING, TILLAMOOK BURN REHABILITATION PROJECT, 1951

Township 1 South, Range 6 West

Unit VI, Block S1

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.-fir Seed  1/3 pound per acre</td>
<td>460</td>
<td>$1,014.28</td>
<td>$2.2049</td>
</tr>
<tr>
<td>Western redcedar  2 1/3 pound per acre</td>
<td>460</td>
<td>$742.58</td>
<td>1.6143</td>
</tr>
<tr>
<td>Bait  1/2 pound per acre</td>
<td>$10 *</td>
<td>252.77</td>
<td>.5495 **</td>
</tr>
<tr>
<td>Bait flying @ $.39 per acre</td>
<td>$10 *</td>
<td>268.46</td>
<td>.5831 **</td>
</tr>
<tr>
<td>Cross-flying seed @ $.69 per acre</td>
<td>460</td>
<td>317.40</td>
<td>.6900</td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>460</td>
<td>78.75</td>
<td>.1712</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$2,674.24</td>
<td>$5.8130</td>
</tr>
</tbody>
</table>

* Area baited includes 1/4 mile buffer strip around seeded acreage.

** Cost per acre of bait and bait flying based on seeded acreage.

1 Douglas-fir seed average cost per pound  $6.615
2 Western redcedar seed cost per pound    4.843
3 1080 bait cost per pound                .82

Thallous sulphate bait cost per pound      .65
**TABLE 7**

COST OF HELICOPTER AERIAL SEEDING, TILLAMOOK BURN REHABILITATION PROJECT, 1951

Township 1 South, Range 6 West

Unit VI, Block S1

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. - fir Seed(^1) 1/3</td>
<td>3,587</td>
<td>$11,769.30</td>
<td>$3.2811</td>
</tr>
<tr>
<td>pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait(^2) 1/2</td>
<td>6,114 *</td>
<td>1,971.06</td>
<td>.5495 **</td>
</tr>
<tr>
<td>pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait flying</td>
<td>6,114 *</td>
<td>2,091.58</td>
<td>.5831 **</td>
</tr>
<tr>
<td>@ $.39 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-flying seed</td>
<td>3,587</td>
<td>2,475.03</td>
<td>.6900</td>
</tr>
<tr>
<td>@ $.69 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>3,587</td>
<td>614.09</td>
<td>.1712</td>
</tr>
</tbody>
</table>

* Area baited includes 1/4 mile buffer strip around seeded acreage.

** Cost per acre of bait and bait flying based on seeded acreage.

1 Douglas-fir seed average cost per pound $6.565

2 1050 bait cost per pound .82

Thallous sulphate bait cost per pound .65
COST OF HELICOPTER AERIAL SEEDING, TILLAMOOK BURN REHABILITATION PROJECT, 1951

Township 2 South, Range 7 West

Unit VII, Block S1

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. - fir Seed¹ 1/2</td>
<td>8,393</td>
<td>$27,538.27</td>
<td>$3.2811</td>
</tr>
<tr>
<td>pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait² 1/2</td>
<td>11,676 *</td>
<td>4,611.95</td>
<td>.5495 **</td>
</tr>
<tr>
<td>pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait flying</td>
<td>11,676 *</td>
<td>4,893.96</td>
<td>.5831 **</td>
</tr>
<tr>
<td>@ $.39 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-flying seed</td>
<td>8,393</td>
<td>5,791.17</td>
<td>.6900</td>
</tr>
<tr>
<td>@ $.69 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>8,393</td>
<td>1,436.89</td>
<td>.1712</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>8,393</td>
<td>$44,272.24</td>
<td>$5.2749</td>
</tr>
</tbody>
</table>

* Area baited includes 1/4 mile buffer strip around seeded acreage.

** Cost per acre of bait and bait flying based on seeded acreage.

1 Douglas-fir seed average cost per pound $6.565

2 1080 bait cost per pound .82

Thallous sulphate bait cost per pound .65
<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.-fir Seed 1/2 pound per acre</td>
<td>5,464</td>
<td>$17,361.65</td>
<td>$3.1774</td>
</tr>
<tr>
<td>Bait 1/2 pound per acre</td>
<td>7,612</td>
<td>$2,796.93</td>
<td>.5119 **</td>
</tr>
<tr>
<td>Bait flying @ $.345 per acre</td>
<td>7,612 *</td>
<td>$2,626.14</td>
<td>.4805 **</td>
</tr>
<tr>
<td>Cross-flying seed @ $.645 per acre</td>
<td>5,464</td>
<td>$3,524.28</td>
<td>.6450</td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>5,464</td>
<td>$1,503.70</td>
<td>.2752</td>
</tr>
<tr>
<td>Total</td>
<td>5,464</td>
<td>$27,812.70</td>
<td>$5.0900</td>
</tr>
</tbody>
</table>

* Area baited includes 1/4 mile buffer strip around seeded acreage.
** Cost per acre of bait and bait flying based on seeded acreage.

1 Douglas-fir seed average cost per pound $6.355
2 1080 bait cost per pound .82
Thallous sulphate bait cost per pound .65
COST OF HELICOPTER AERIAL SEEDING, TILLAMOOK BURN REHABILITATION PROJECT, 1952

Townships 1 & 2 South, Ranges 7 & 8 West

Unit VII, Block S2 & Unit VIII, Block S3

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Total Cost</th>
<th>Average Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western redcedar(^1)</td>
<td>940</td>
<td>$1,011.65</td>
<td>$1.0763</td>
</tr>
<tr>
<td>1/4 pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Orford cedar(^2)</td>
<td>940</td>
<td>1,014.30</td>
<td>1.0544</td>
</tr>
<tr>
<td>1/4 pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait(^3) 1/2</td>
<td>1,309 *</td>
<td>461.17</td>
<td>.3519 **</td>
</tr>
<tr>
<td>pound per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait flying</td>
<td>1,309 *</td>
<td>451.61</td>
<td>.3485 **</td>
</tr>
<tr>
<td>@ $.345 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-flying seed</td>
<td>940</td>
<td>606.30</td>
<td>.6450</td>
</tr>
<tr>
<td>@ $.645 per acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous controls</td>
<td>940</td>
<td>258.70</td>
<td>.2752</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$3,823.73</td>
<td>$4.043</td>
</tr>
</tbody>
</table>

\(^1\) Area baiteed includes 1/4 mile buffer strip around seeded acreage.

\(^2\) Cost per acre of bait and bait flying based on seeded acreage.

\(^3\) Seed cost per pound

<table>
<thead>
<tr>
<th>Seed Cost per Pound</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Western redcedar seed</td>
<td>$4.035</td>
</tr>
<tr>
<td>2 Port Orford cedar seed</td>
<td>4.508</td>
</tr>
<tr>
<td>3 1080 bait cost per pound</td>
<td>.82</td>
</tr>
<tr>
<td>Thallous sulphate bait cost per pound</td>
<td>.55</td>
</tr>
</tbody>
</table>
### TABLE 12

**STOCKING FROM AERIAL SEEDING AS INDICATED BY TRANSECTS**

<table>
<thead>
<tr>
<th>Year</th>
<th>Unit</th>
<th>Length of Transect</th>
<th>Date of Survey</th>
<th>No. 1/4 Mil-Acre Plots</th>
<th>Number No. Mil-Acre Plots Stocked</th>
<th>Number 4 Mil Acre Plots Stocked</th>
<th>% Stocking</th>
<th>Trees/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>Unit III Block S2</td>
<td>1 1/2 Miles</td>
<td>Nov. 1952</td>
<td>63</td>
<td>26</td>
<td>252</td>
<td>39</td>
<td>41.1</td>
</tr>
<tr>
<td>1951</td>
<td>Unit VI Block S1</td>
<td>1 1/2 Miles</td>
<td>Nov. 1952</td>
<td>53</td>
<td>38</td>
<td>212</td>
<td>64</td>
<td>71.1</td>
</tr>
<tr>
<td>1951</td>
<td>Unit VII Block S1</td>
<td>2 1/2 Miles</td>
<td>Nov. 1952</td>
<td>91</td>
<td>49</td>
<td>364</td>
<td>113</td>
<td>53.8</td>
</tr>
</tbody>
</table>
deterioration due to the fire, soil washing during the winter and reduced moisture holding capacity of upper soil layer. Germination in the two units was comparable but mortality of seedlings during the summer was much greater in Unit VII.

The area seeded in Units VII and VIII is bordered on the west by the south fork of the Trask River. Beyond the south fork lie unlogged lands and along it are numerous dwellings of people working in the burn. Baiting therefore was confined to the east side of the south fork. The use of Douglas-fir seed required a one-fourth mile buffer strip around the area to be seeded. This would leave a narrow strip of land along the river unseeded. To permit the reforestation of the buffer strip two small seeded species were used; western redcedar and Port Orford white-cedar. It was necessary that these small seeded species be used in the event that rodents might invade the buffer strip. Their seeds are so small that it would be difficult for rodents to find them.

Each species was seeded in a separate flight, since each described a different swath width. Western redcedar was seeded at the rate of one-fourth pound of seed per acre. It grew prolifically in the area prior to the fires so should do well. Port Orford white-cedar seed was sown at the rate of one-fourth pound per acre also. It was used for several reasons; the lands seeded are at the extreme west of state ownership, elevation is approximately 400 to 700 feet above sea level and the area experiences the greatest frost free period of any of the state ownership in the burn.
Tree Planting

An extensive tree planting program is carried on in the Tillamook burn during the fall and winter months (Plate 9). All lands ready for reforestation are planted, if they are unsuitable for aerial seeding, located within snag-free corridors, or along major highways. Planting blocks laid out within the eight reforestation units all fall into these major categories.

The reforestation plan calls for planting a maximum of five million seedlings per year. Should insufficient areas free of logging activity and fire hazard be available, the amount of stock grown in any one year would be reduced. Seedlings used at the present time are two-year old root pruned Douglas-fir. Stock is grown at the Oregon Forest Nursery, Corvallis, Oregon.

Trees are planted at a six by eight foot spacing or 905 trees per acre. However, the average number of trees planted per acre will run less when roads, streams, and unfavorable planting spots are deducted from the gross acreage planted. A short handled planting tool (Plate 10) developed by Board of Forestry personnel is used exclusively in planting activities. The tool is light, durable, and efficient. Planting operations usually begin in early November and continue until the end of March. Some planting has been done in early April when weather conditions have been favorable. Snow has been encountered as early as November and as late as March. It can be expected that during an ordinary winter at least one month will be lost due to severe weather conditions.
PLATE 9

TREE PLANTING - TILLAMOOK BURN
Since the first rehabilitation planting in 1949, 7,028 acres of land too brushy for aerial seeding have been planted, 2,156 acres have been planted along major highways, and 4,047 acres have been planted within 16 miles of snag-free fire breaks. Trees are planted within the corridors rather than employing aerial seeding because the planted trees have about a four-year advantage over the seeded trees. A two-year old nursery seedling is equal in size to the average four-year old natural seedling. The period of time elapsed in developing a green fire break will be less with planted trees than by seeding.

Planting has been accomplished by state crews, convict crews, and independent contractor. In 1949 only 500,000 seedlings were available at the Oregon Forest Nursery since a program of expansion had just begun in July. Plans were laid to employ sufficient tree planters to handle the stock available. Camp facilities, transportation, planting equipment and supervisory overhead were keyed to these plans. Later it was learned that both the Forest Industries Nursery at Nisqually, Washington and the State of Washington Capital Nursery would supplement the needs of the rehabilitation program with their surplus planting stock. A total of 1,500,000 seedlings could be made available from both sources. Two ages of stock were planted, 2-0 (two-year old, root pruned, not transplanted) and 1-0 (one-year old) seedlings.

The policy of the Board of Forestry from the beginning has been to reforest as much land each year as is possible with the materials and facilities at hand. To utilize all available planting stock, state crews were increased to capacity and an independent contractor engaged after competitive bidding.
State crews planted 1,867 acres at six by eight foot spacing during the planting season of 1949-50 at $16.25 per acre including planting stock. The independent contractor planted 980 acres at the same spacing for $15.85 per acre. Planting stock cost $3.00 per acre for a total cost of $18.85 per acre. Cost of contract planting was greater than that for state crew planting; however, without the services of the contractor it would have been impossible to utilize all trees available and plant the additional 980 acres.

Survival of trees planted by state crews was 69.5 per cent for 2-0 stock and 45 per cent for 1-0 stock. Seedlings planted under contract showed a 73.6 per cent survival in 2-0 stock and 41.75 per cent for 1-0 stock.

In the 1950-51 planting season all planting was conducted by state crews. Trees were supplied by the Oregon Forest Nursery and the Forest Industries Nursery. A total of 2,339,000 seedlings were planted. Cost of planting at six by eight foot spacing was $18.63 per acre. The increase in cost from the previous season was due to higher wages and greater distances to planting site. Survival averages 75 per cent for 2-0 stock and 44.2 per cent for 1-0 stock.

During the planting season 1951-52 state crews were augmented by the 50-man forest work camp which was established on the south fork of the Wilson River. The Forest Industries Nursery again supplemented stock grown at Corvallis. The two crews planted 3,977,800 seedlings on 4,437 acres. Cost of state crew planting was $16.18 per acre while cost for convict crew planting was $21.77 per acre. State crews planted an average of 743 trees per acre in brush areas while the convict crews
averaged 1,01/4 trees per acre on fairly open south slopes. Trees per
man day for state crews averaged 830; convict crews averaged 674.
Initial survival checks indicate an average survival of 67.5 per cent
for 2-0 stock planted by state crews, and 69 per cent for 2-0 and
53 per cent for 1-0 stock planted by convict crews.

There is a marked degree of difference in the survival of 2-0
and 1-0 Douglas-fir planting stock. Probably the main reason for this
is the fact that the two-year old root pruned seedlings have much
better developed root systems. The root-shoot ratio is well balanced.
A great deal of the planting has taken place on areas of heavy brush
cover. Seedling mortality on these sites has been high even though
care is taken in selection of planting spot.

The planting program for the 1952-53 season is considerably
more ambitious than previous ones. The state nursery has reached the
5,000,000 per year 2-0 seedling production. Fifty men from the forest
work camp plus forty men in civilian crews will complete the planting
of approximately 6,000 acres by the end of March. By the end of Janu-
ary 3,250,000 seedlings had been planted on 3,644 acres. Civilian
planting crew costs should be fairly close to those of the previous
season. Costs of convict planting crews should be lower, since most
of the men will have had some experience from the past season.

Provided sufficient planting area is available in future
years, 5,000,000 seedlings will be planted annually.
SUMMARY

The three Tillamook fires have burned over an area of approximately 355,000 acres. More than 13 billion board feet of timber were destroyed.

Following the third fire, which occurred in 1945, the late Governor Earl Snell appointed a special forestry committee which studied the Tillamook burn and other forestry problems. The committee offered two major recommendations to the 1947 Legislature. One recommendation resulted in the passage of the State Forest Research and Experimental Tax Act and the other in the passage of the Oregon Forest Rehabilitation Act. These two laws have made possible the rehabilitation of the Tillamook burn.

It is estimated that it will take fifteen years and approximately ten million dollars to complete the job of forest protection and reforestation. Many problems have been confronted in developing the plan for rehabilitation and execution of the plan in the field. The major problems have to do with land ownership, long-term timber contracts and salvage logging operations, land status, extreme fire hazard and rough topography, severe weather conditions, manpower shortage and brush cover. Each of these problems is discussed and a solution offered. Since these solutions are of a general nature they may be amended as plans are put into effect and project work goes forward.

Full advantage was taken of information developed by the State Board of Forestry research program. Development of a system of plans and surveys was made less difficult by use of this knowledge.
Two major factors were considered, forest protection and reforestation. The effect of timber salvage on these two factors had to be considered in all stages of planning.

The forest protection plan calls for a system of snag-free corridors totaling 200 miles and sufficient access roads to offer reasonable protection to the burn. Supplementary forest protection in the form of lookouts, fire crews and fire fighting equipment is also required.

The plan for reforestation is based on the division of the Tillamook burn into eight reforestation units, each of which is further subdivided into planting blocks and seeding blocks dependent upon land adaptability. Reforestation units adapt themselves well to the manner in which salvage logging is being conducted and forest protection developments are taking place. All state lands within the Tillamook burn have been placed in a reforestation schedule which is keyed to the progress of salvage logging and forest protection developments.

Boundary surveys and preplanting surveys are completed prior to reforestation so that ownerships are well defined and reforestation needs are determined in advance of project work.

Forest nursery facilities have been expanded to permit production of five million seedlings a year for the planting program. A cold storage and tree packing plant has been constructed in which can be stored both tree seed and planting stock.
Current project activities fall into the same two broad categories used in planning the program, forest protection and reforestation.

The establishment of snag-free corridors, construction of fire break roads and access roads and the instituting of supplementary forest protection measures are carried on under forest protection activities. Complete description of these activities is presented setting forth general specifications for corridors, snag falling, fire break roads and access roads. Functions of state snag falling crews, convict crews and independent contractors are discussed. Supplementary protection proposed and completed is described.

Reforestation activities embrace both aerial seeding and hand planting. Selection of lands to be seeded or planted is determined by conducting preplanting surveys.

A brief description of helicopter aerial seeding methods and techniques is given covering selection of area, layout, rodent control and seeding. The initial aerial seeding project carried out in the first year of the rehabilitation program is described. Results and costs of several projects are set forth in table form.

The tree planting program is outlined describing the various methods employed in getting trees planted. Per acre costs of planting by state crews, convict crews and independent contractors are shown.

The summary that follows outlines very briefly the progress made in the Tillamook burn rehabilitation program during the period July 18, 1949 to December 31, 1952.
Forest Protection

42 miles of fire breaks have been established.
165,000 snags have been felled.
110 miles of fire break roads and access roads have been constructed or improved and maintained.
5 additional fire crews and equipment are in operation.
2 of the 5 additional lookouts are in operation.
Water hole development for tank trucks and pumpers is being carried on.
Adequate fire control facilities in the form of lookouts, guard stations fire crews and fire fighting equipment are almost 100 per cent complete.
The 42 miles of snag-free corridors completed to date represent 21 per cent of the total planned.

Reforestation

167 miles of survey lines have been run.
258 section corners have been recovered and bronze monuments set in place.
103,714 acres of state land have been preplanting surveyed.
36,114 acres have been aerial seeded.
13,231 acres have been hand planted.
11,566,800 seedlings have been planted.

Through aerial photographs and preplanting surveys it has been determined that 12 per cent of state ownership is naturally stocked. Reforestation work has been completed on 22 per cent of the
area. At the present time $\frac{3}{4}$ per cent or approximately one-third of the tremendous reforestation job has been completed.

Future progress will be slower both in forest protection developments and reforestation. A good portion of the lands ready for rehabilitation have been treated; major salvage logging must be completed on additional areas before work can take place. Very little additional lands supporting natural stocking will be found, since all fringe areas have been surveyed. Even so it is estimated that the job will be done by 1964.
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3. The relationship of stocking per cent to number of trees per acre on artificially seeded areas. Research note no. 9. Salem, Oregon state board of forestry, 1952. 9 p.


9. and Dick Berry. Aerial seeding, the methods and techniques employed by the Oregon state board of forestry. Research bulletin no. 7. Salem, Oregon state board of forestry, 1953. 53 p.


BIBLIOGRAPHY (Continued)


APPENDIX
THE THREE TILLAMOOK FIRES

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**Recapitulation**

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### Volume of Timber Killed

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