BULLETIN 1 AUGUST 1947

SALVAGE LOGGING

in the Douglas-Fir Region of Oregon and Washington

By
Elmer E. Matson
John B. Grantham

Oregon Forest Products Laboratory
OREGON STATE COLLEGE
Corvallis

THE Oregon Forest Products Laboratory was established by legislative act in 1941 as a result of active interest of the lumber industry and forestry minded citizens. The program is associated with the State Board of Forestry and the School of Forestry at Oregon State College. The Dean of the School of Forestry is the Director. An advisory committee composed of men from representative interests guides the policy of the program which is pointed directly at fuller utilization of Oregon's forest resources.

The committee is comprised as follows:

EARL SNELL, Governor . . . Chairman

H. J. COX . . . . West Coast Lumbermen's Association

PAUL M. DUNN . . . School of Forestry

CHARLES W. FOX . Oregon Plywood Interests

J. ALFRED HALL . . Pacific Northwest Forest and Range Experiment Station

ALBERT HERMANN . Western Pine Association

C. WARD INGHAM . . Willamette Valley Lumbermens Association

N. S. ROGERS, State Forester . . Secretary

Bulletin 1 August 1947

SALVAGE LOGGING

in the Douglas-Fir Region of Oregon and Washington

By

Elmer E. Matson

Forester, Pacific Northwest Forest and Range Experiment Station,
Forest Service, U. S. Department of Agriculture

and

John B. Grantham

Associate Professor of Wood Products,
Oregon State College

A joint research project of the
Pacific Northwest Forest and Range Experiment Station
and
The Oregon Forest Products Laboratory

TABLE OF CONTENTS

	Page
Introduction	3
Amount of Logging Waste Available	4
Distribution by Class of Material	7
Distribution by Size of Material	8
Systems of Salvage Logging	8
Prelogging	8
Clean Logging	11
Relogging	11
Relogging Equipment and Methods	12
Yarding Equipment	12
Loading Equipment	17
Transportation Equipment	20
Sawmill Equipment for Salvaged Logs	21
Measurement of Salvaged Material	28
Relogging Costs	29
Time of Relogging	32
Uses of Salvaged Wood	34
Benefits of Closer Woods Utilization	36
Recommendations	37
Summary	39
Bibliography	40

SALVAGE LOGGING

in the Douglas-Fir Region of Oregon and Washington*

ONLY ABOUT ONE-THIRD of the potentially usable wood in a timber stand emerges as lumber from a combined logging and milling operation. This is a matter of considerable concern to loggers, lumbermen, foresters, and laymen. Of the two-thirds not converted to lumber, roughly one-half is left in the woods and one-half is lost at the mill. Actually, 80 per cent of the so-called loss at the mill is used, either for the generation of power, for domestic fuel, for pulp, or for the production of a host of smaller products such as lath, furniture parts, pickets, handles, and shade rollers.

No such utilization of the portion left in the woods has been achieved. Although the wartime demand for lumber created greater profit margins and resulted in better utilization in the woods, it has only served to indicate the possible advantages of still closer utilization.

Following a study of the material left on the ground after logging in the Douglas-fir region during the years 1926 and 1927, A. H. Hodgson of the United States Forest Service reported that this "logging waste" amounted to 19.66 per cent of the original timber stand and averaged 21 thousand board feet per acre (*3*)†. That is, this amount of residual wood was potentially usable at that time.

A Forest Service survey of the potentially usable material left on the ground in 1944 revealed that the logging waste then amounted to 27 per cent of the original timber stand although it averaged only 10 thousand board feet per acre for the region as a whole.

Thus, as the available old-growth timber diminishes, the standards of utilization change. Hodgson's estimate included very little material containing rot. The 1944 estimate included the sound portion of pieces with as much as 75 per cent rot. While it is granted that all of the material included in the 1944 estimate of logging waste cannot be recovered economically at this time, a few operators have adopted such standards of utilization. Furthermore, the inclusion of all of this material indicates the magnitude of the utilization

* This study was a cooperative project between the Oregon Forest Products Laboratory and the Pacific Northwest Forest and Range Experiment Station. Data on logging waste were furnished by the Division of State and Private Forestry, United States Forest Service, Portland, Oregon. The assistance of the several members of the experiment station and regional office staffs who reviewed the manuscript is gratefully acknowledged.

† Italicized numbers in parentheses refer to the BIBLIOGRAPHY on page 40.

problem and the immensity of the challenge to the forest products industries.

Still closer utilization in the woods through increased prelogging, clean logging, or relogging offers several benefits to the forest products industries.

1. Closer woods utilization will help to maintain production while the region converts its mature forests to sustained yield. This should be of particular benefit to plants that are not well located with respect to the present timber supply.

2. The recovery of more material from old-growth stands will augment the supply of clear and fine-textured lumber that plays a vital part in selling all grades of West Coast lumber in eastern markets.

3. The closer utilization of old-growth stands should reduce the tendency to cut young timber stands prematurely.

4. Close utilization of the stand provides a reduction of the fire hazard with considerable savings to the operator and encourages earlier establishment of the next timber crop.

The benefits listed above can have far-reaching effects on the forest economy of the Douglas-fir region, particularly with respect to the establishment of sustained yield cutting budgets. Closer utilization by these means can come only through a more thorough understanding of the factors involved.

It is the purpose of this bulletin to acquaint the logging and lumber industry with the latest available information on the costs, equipment used, and economic factors having a bearing on prelogging, clean logging, and relogging.

To date only relogging can provide information based on actual practice. This aspect of the problem has been stressed, since prelogging and clean logging are still in the experimental stages. As new information becomes available, however, it will be published.

AMOUNT OF LOGGING WASTE AVAILABLE

The several surveys which have been made of the material left on the ground after logging all reveal a large per acre volume of potentially usable wood. The most recent survey of logging waste, made by the Forest Service, found that for the year 1944 the logging waste in Western Oregon and Washington amounted to 87 cubic feet (1 cord equals approximately 90 cubic feet) per thousand board feet of lumber produced, while the national average was 69 cubic feet per thousand board feet.

The logging waste data for this survey were obtained by National Forest personnel from 295 plots located on the west side of the Cascade Range from the Canadian boundary to the California line. Material was tallied by two classes of measurement: (1) Scribner log scale in board feet for standing trees, snags, down trees, and log material that would produce a sawlog with a minimum top diameter inside bark of 8 inches and a minimum length of 8 feet, containing at least 25 per cent sound wood suitable for lumber production; and (2) volume in cubic feet for all material standing or down to a minimum volume of one cubic foot of sound wood and not less than 25 per cent sound material in each piece.

In the Douglas-fir region it was found that approximately 30 per cent of the total net standing cubic-foot volume to a 4-inch top was left in the woods, or about 27 per cent of the total net board-foot volume of trees to an 8-inch top was left. On the basis of the board-foot volume removed as commercial log material the volume of waste amounted to a little over 36 per cent. The actual volume of logging waste left on the ground averaged 10 thousand board feet per acre of logs and trees, having a minimum size of 8 feet in length and an 8-inch top. In western Oregon the material averaged 8.5 thousand board feet per acre while in western Washington it was 11.6 thousand.

On the basis of 9.9 billion board feet of logs cut in 1944, it is estimated that the total volume left in the woods that year amounted to 3.6 billion board feet log scale. Sixty-four per cent of this volume was in Oregon and 36 per cent in Washington. For the 20-year period, 1925 to 1944, inclusive, it is estimated that the volume left on the ground approximated 2.8 billion board feet annually for the western portion of Oregon and Washington. This figure is based on an average sawlog production of 7.6 billion board feet per year for this period.

On a cubic volume basis, the total volume left in the woods in 1944 amounted to approximately 989 million cubic feet. Of this amount 672 million cubic feet were left on western Oregon cut-over lands and 317 million cubic feet on western Washington lands. Converted into cords, on the basis of 90 cubic feet to one cord, the logging waste amounted to 7½ million cords in Oregon and 3½ million in Washington, or a total of 11 million cords. In comparison, the total

Figure 1. BEFORE RELOGGING. This area, cut over in 1945, illustrates the type of material available for salvage in much of the region. This area is at 2,600 feet elevation in western Washington.

Figure 2. AFTER RELOGGING. A portion of the same scene illustrated in Figure 1, following the recovery of approximately 20 thousand board feet per acre. Lumber tally was made by the Log Gang Mill Company.

pulpwood production for the entire United States for this same year amounted to approximately 15½ million cords. The percentage of logging waste by species is shown in Table 1.

Table 1. PERCENTAGE OF WASTE BY SPECIES

Species	Western Oregon		Western Washington		Region	
	Cubic foot volume	Board foot volume	Cubic foot volume	Board foot volume	Cubic foot volume	Board foot volume
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Douglas-fir	60.0	62.4	40.2	37.7	53.6	53.4
Western hemlock	22.8	22.8	33.9	34.1	26.4	26.9
Western redcedar	4.0	2.5	19.2	21.3	8.9	9.3
White fir	2.6	2.7	4.1	4.3	3.1	3.3
Port Orford cedar	2.9	2.7	....	....	2.0	1.7
Sitka spruce	2.5	1.6	.4	.6	1.8	1.3
Other	5.2	5.3	2.2	2.0	4.2	4.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0
Average volume per acre..	2,422	8,519	2,801	11,601	2,543	9,982

Distribution by Class of Material

The logging waste was grouped into the following classes of material: (1) standing live trees; (2) snags, including pulled over trees and down snags; (3) sawlogs to a minimum size of 8 feet in length and 8 inches in top diameter; and (4) unclassified material, such as chunks, large limbs, and other material not fitting into the

Figure 3. A typical deck of pulp species salvaged for the Soundview Pulp Company.

other three classifications. Pieces in any of the four classes that were less than 25 per cent sound were not included in the tally. Table 2 shows the percentage breakdown by the four classes.

Table 2. CLASSES OF LOGGING WASTE

Class of material	Western Oregon		Western Washington		Region	
	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet	Board feet
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Standing trees	9.6	10.4	6.8	8.2	8.7	9.6
Snags	8.1	9.3	5.1	6.4	7.1	8.2
Logs	52.8	80.3	64.5	85.4	56.6	82.2
Unclassified	29.5	....	23.6	....	27.6	....
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Distribution by Size of Material

Size of the sawlog material is of importance in planning a relogging operation. Therefore, the logging waste data were analyzed for representative areas in Oregon and Washington to give the size distribution which is shown in Table 3.

Table 3. AVERAGE SIZE DISTRIBUTION OF LOGGING WASTE

Diameter class	Volume	Logs	Average net volume per log
Inches	*Per cent*	*Per cent*	*Board feet*
8-12	27	57	60
13-20	40	32	159
21-30	24	9	364
31+	9	2	492
TOTAL	100	100	127

SYSTEMS OF SALVAGE LOGGING

Closer woods utilization may be achieved by prelogging, clean logging, or relogging. Each of these systems has a goal of recovering material that would be left in the woods following a normal logging operation. As such, each may be termed a salvage system. These systems achieve closer woods utilization by recovering material in the form of tops, defective logs, broken chunks, snags, windfalls, and small understory trees, knocked down or left to die shortly after logging.

Prelogging

For the purpose of this discussion, prelogging is defined as the removal of a part or all of the understory trees in a timber stand very shortly before the main logging operation. This system permits a more complete utilization of the understory trees by minimizing breakage of the small trees. It is most generally employed for the removal of small cedar since this class of material suffers the greatest breakage in one-step logging. Prelogging has been advocated also for the removal of an understory of pulp species, such as hemlock or true fir.

Figure 4. Portable steel spar and D7 tractor with double drums used for prelogging by the Weyerhaeuser Timber Company.

Without question stands containing an appreciable amount of cedar poles should be prelogged. The desirability of prelogging pulp species is debatable and depends upon several factors, such as the topography, the size of the trees in the overstory, and the size and density of the understory.

Some of the general considerations to bear in mind in choosing between prelogging and relogging are:

1. Topography which permits tractor or horse logging makes prelogging easier since the standing overstory trees offer less interference to the removal of the understory trees by these methods.
2. A heavy understory helps to obtain a favorable yarding cost for the prelogging operation.

3. More breakage of high-value overstory trees may result if the understory trees are prelogged. Not only do the small stumps contribute to breakage but there are no understory trees to cushion the fall of the larger trees. An increase of 2 per cent in breakage of large trees may be much more serious than a 5 per cent breakage in the understory trees, especially where the understory trees are to be used for pulp.
4. Breakage of the understory trees is not great unless the understory is very dense in relation to the overstory. Most of the short chunks observed on cut-over land are from overstory trees rather than from understory trees.
5. Relogging costs may be less than prelogging costs, especially if the high lead system is used for either of these operations. Although bucking costs may be higher in relogging, falling costs should be low, and the total cutting costs should be lower for relogging.
6. Some material from the tops of overstory trees may be uneconomical to take in the main logging operation. Where understory trees are removed by relogging an opportunity is provided for the recovery of the usable portion of large tops.

Figure 5. A setting "clean" logged in 1946 by the Fischer Lumber Company.

Thus far, most operators have preferred relogging to prelogging. In fact operators in the Douglas-fir region have acquired little experience in prelogging. It should be noted that the current preference for relogging is based partially on a desire to salvage material from older cuttings—cuttings made without thought of either prelogging or relogging.

Clean Logging

Some operators are experimenting with clean logging in an effort to obtain maximum woods utilization in one operation. It is to be expected that somewhat more material would be left following one operation than where two separate operations are employed. However, certain areas may lend themselves to a one-step operation, for example:

1. Where the timber is uniformly large, the material normally left after logging is chiefly defective logs—logs requiring salvage yarding equipment as heavy as that used in the first operation. It is advocated that wood logs, long butts, windfalls, and snags of large size be taken in the first operation. This practice may eliminate the need for a secondary operation in many cases.
2. If the timber is of a small enough size to permit the use of light yarding equipment in the first operation, no salvage operation may be needed, for light yarding equipment can recover the small logs at a reasonable cost.

If all of the material is destined for the same mill or market (eliminating a need for segregation), if the topography is favorable, and if the distance is short, the chances of doing a good utilization job in a one-step operation are improved.

Relogging

Probably one of the first attempts at utilizing logging waste through relogging was made by the Crown Zellerbach Corporation in 1919. This same company has made periodic attempts to utilize this type of material, but until recently it was unable to salvage any sizable quantity. The company is now removing several million board feet a month from its logged-over lands.

In 1943 and 1944 the British Columbia Forest Service, in cooperation with the Comox Logging and Railway Company and the Powell River Company, made a detailed study of costs and methods of relogging the small-sized material left by the usual logging operation. A report of this study entitled, "The Ladysmith Experiment in Salvaging Pulpwood From Logging Waste" has been published (*5*).

The study covered an area of 260 acres that originally had been stocked with a stand of 230- to 250-year-old timber. In the original operation the timber was utilized to a 9- or 10-inch top, and 30½ thousand board feet were removed per acre. The salvage material from the relogging operation consisted of small logs which averaged 6.1 inches in top diameter and 34 feet in length. An average of 133 pieces was removed per acre with a total volume of 1,550 cubic feet. This volume was equivalent to 24 per cent of the original sawlog volume or 19 per cent of the total utilized stand. A description of the equipment and a summary of operating costs for this study are included on pages 14 and 30 of this report.

During the past year some very encouraging progress has been made in the utilization of logging waste. Several companies are now engaged in relogging and others are making plans for this type of operation. Since this type of logging operation is new, there is no basis for determining the best method for handling this type of material. Operating improvements must, therefore, come through trial and error alone. Systems will have to vary according to size of material to be salvaged, topography, markets, and transportation systems.

RELOGGING EQUIPMENT AND METHODS

In general, the methods used for salvage logging have followed the methods used for the initial logging. Furthermore, the bulk of the waste material recovered thus far has been salvaged with conventional logging equipment. The customary practice has been to use the same methods and equipment but to employ lighter machines and smaller crews.

However, relogging is still in the experimental stage and several companies are testing specialized yarding equipment. In addition, several companies are experimenting with original plans for the utilization of logging waste, particularly from a standpoint of converting the waste into lumber or clear cants in the woods. Since the equipment and methods representing a departure from conventional practice will be of the greatest interest, only these are described in detail.

Yarding Equipment

Conventional equipment used for salvaging material from cutover land has included both tractors and high lead yarding machines. Tractor sizes used for relogging vary from approximately 20 horsepower such as D 2's to the 113-horsepower D 8's, depending upon the sizes of the logs to be salvaged. The most common practice is to use a 55-horsepower tractor, such as a TD 14, without an arch.

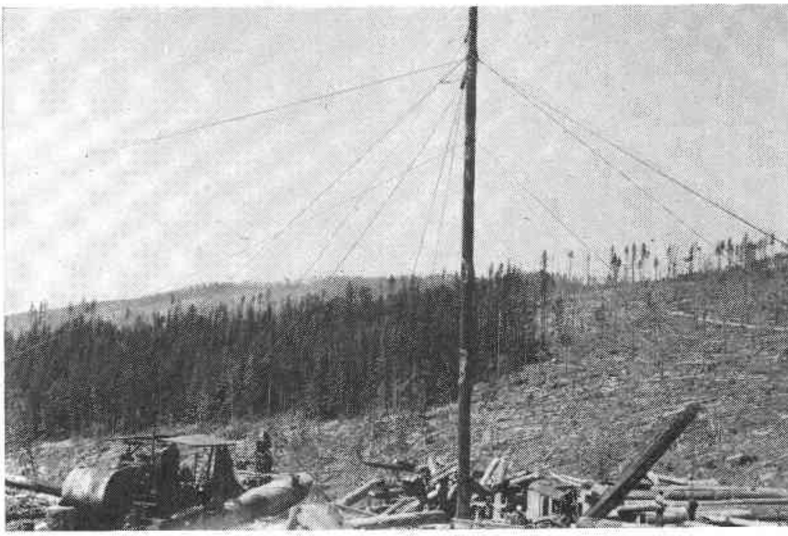

Figure 6. A relogging operation showing the conventional logging equipment that is often employed when large logs are salvaged.

Some salvage operators have used arches with the larger tractors, and two have employed a tractor and triple drums for high lead yarding.

The only departure from conventional tractor yarding has been made by the Crown Zellerbach Corporation which has employed a so-called "bunching" tractor (*6*). This unit consists of an old 75 Caterpillar tractor with an 11-foot A-frame attached to the rear end. A single $\frac{5}{8}$-inch yarding line with a flat hook on the end is carried on the free-spooling haulback drum and the line is pulled out by hand. With an average yarding distance of 100 feet, a four-man crew has bunched as high as 80 thousand board feet of logs per day. Since heavy tractors and arches often waste valuable time in collecting turns of salvaged logs, a tractor of the above type might be used to bunch the turns and thus increase the efficiency of the operation.

A large portion of the material salvaged thus far has been recovered by high lead logging using conventional but light machines. The majority of the machines have been converted loaders powered by 85 to 100 horsepower gasoline engines. Ordinarily, the original spar trees have been used. External yarding distances have ranged up to 1,200 feet where there was a heavy concentration of wood. The consensus among salvage operators is that the yarding distance should be limited to from 500 to 600 feet even where the original spar tree is used. As the maximum size of the waste material is reduced by coordination of the primary and secondary logging, the yarding distance in the salvage operation will be reduced. This in turn will necessitate a change in the over-all logging plan to permit the recovery of material at the back end of the larger settings.

There have been more developments in the field of specialized high lead yarding equipment than in any other phase of salvage operations. All of these pieces of specialized equipment have been designed for increased mobility in yarding small, scattered material with small crews. They are not heavy enough to handle the large defective logs found in some areas but are well adapted to doing a thorough recovery job. Whenever relogging plans are made prior to the initial logging, it will be customary to leave only material of small diameters for the secondary operation. This practice should increase the need for these types of flexible yarding machines.

One of the first yarding units developed especially for yarding logging waste was the Comox Logging & Railway Company's "peanut picker," consisting of a 28-foot A-frame, drums, and engine mounted on an old 5-ton truck (*8*). A 9/16-inch mainline and 5/16-inch haulback line were used to facilitate the yarding of the small scattered logs. The average yarding distance for this flexible unit was only 260 feet, yet the yarding costs were lower than those obtained with a light yarding machine using the original spar trees and an external yarding distance of 590 feet. Man-day yarding production with this unit and a three-man crew averaged 3.1 cords during periods of relatively high efficiency. This production was obtained on salvage material averaging only 6 inches in diameter and 34 feet in length with a relatively low waste accumulation of 8 thousand board feet per acre.

The Crown Zellerbach Corporation is at present employing a tractor-mounted steel tower for cold decking salvaged wood in Clatsop County, Oregon (*6*). The over-all height of the tower and tractor is approximately 55 feet, and the maximum yarding distance is between 500 and 600 feet. Since this unit is so readily moved and rigged, however, a yarding distance of 300 to 400 feet is generally used. The flexibility of the unit is due in part to its ability to move over cat roads, and in part to its self-tightening guy lines. Each guy line is attached to a separate drum near the base of the tower and power may be supplied to any drum from an auxiliary gasoline engine mounted at the base of the tower. The unit can be moved and rerigged in one to two hours' time.

The $\frac{7}{8}$-inch mainline, $\frac{5}{8}$-inch haulback, and $\frac{3}{4}$-inch chokers handle the salvage logs satisfactorily. The $\frac{3}{4}$-inch chokers facilitate choking

Figure 7. Tractor mounted tower used by the Crown Zellerbach Corporation in Clatsop County, Oregon. The tower is hinged in the center and at the point of attachment to the tractor. It is lowered when the unit makes a long move.

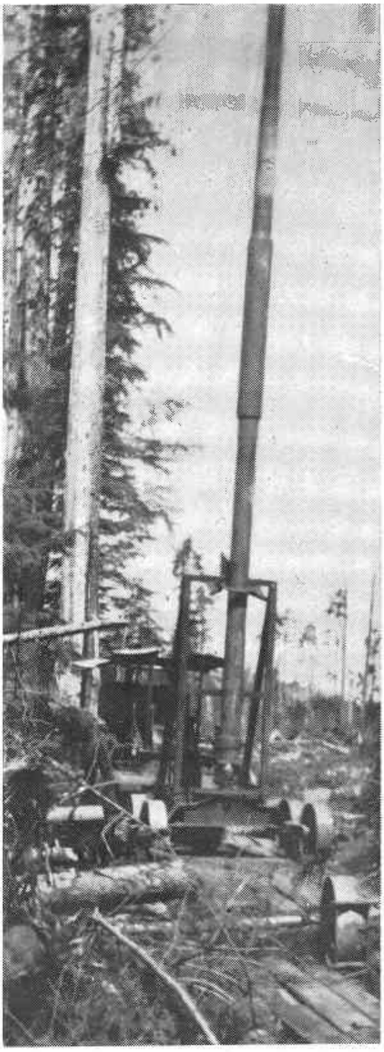

Figure 8. Portable steel spar, shown in its operating position, was developed and used by the Soundview Pulp Company to salvage pulp species. (For moving position, see Figure 9.)

small logs while the light lines facilitate rigging up, road changing, and yarding. A six-man crew is employed with this unit, as experience has shown that this number gives the highest man-day production. Two choker setters, the machine operator, and chaser perform their usual duties. The rigging slinger assists the choker setters to maintain a high rate of production. The hook tender is left with sufficient time to choose new settings, to coordinate decking and swinging, and to supervise the selection of salvage material. Either the hook tender or rigging slinger takes over the whistle punking duties when the choker setters are not visible from the landing. The six-man crew works to particular advantage during the frequent moves which the unit makes. Production varies from 40 to 50 thousand board feet per day depending upon the size of the average piece yarded.

A 50-foot portable spar constructed by the Soundview Pulp Company of Everett, Washington, is working out very well for yarding small logs. The spar is made of 12-inch tubular steel, and the main line passes through the inside of the tube to a sheave at the

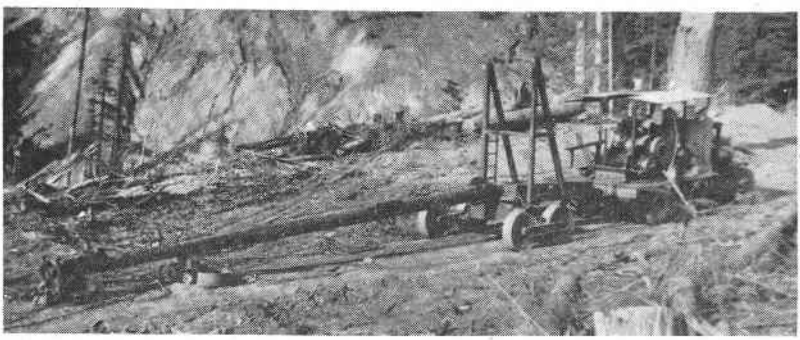

Figure 9. Portable steel spar lowered for moving. Note the fifth wheel that will be attached near the top end. (For operating position, see Figure 8.)

top. On the top there is also a swivel ring for attaching the guy lines. The spar is swiveled at the base and mounted on four armored wheels. In moving the spar is lowered and a fifth wheel is attached near the top.

Light rigging is used on this unit. The yarding distance is about 600 feet and at this distance a 3-man crew can yard 15 to 18 cords per day. This company expects to have eight 3-man crews salvaging pulpwood for its mill during 1947 with six of these crews employing the specially designed tubular towers. Most of these crews will be supplied with company-owned, truck-mounted, Skagit yarding machines powered with Ford V-8 motors.

The Simpson Logging Company at Shelton, Washington, has developed an A-frame on a sled that is being tried out for salvaging large-sized logs. The sled is 60 feet in length and the A-frame is 55 feet long. A Caterpillar "75" with triple drums furnishes the power. In moving, the A-frame is lowered, and the "cat" moved off the sled. The same "cat" is used to pull the sled and A-frame to the next setting. When operating, the A-frame is held by five guy lines.

The unit is equipped with a $\frac{7}{8}$-inch main line and $\frac{1}{2}$-inch haulback line. The maximum yarding distance is about 600 feet.

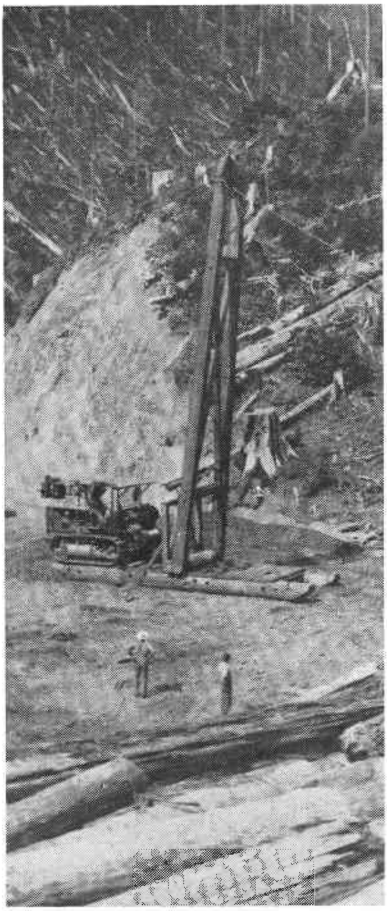

Figure 10. This sled mounted "A" frame was built by the Simpson Logging Company to facilitate the salvage of large-sized logs such as those shown in the foreground.

Loading Equipment

Nearly every type of standard loading equipment has been used in an attempt to determine the most economical system of loading salvaged wood. Loading time and loading costs are generally high due to: (1) the small size of some of the material, (2) the variation in lengths, (3) the low net scale as compared with average sawlogs, and (4) the small volume loaded at each landing.

Where the salvaged wood is in large sizes, standard loading systems such as crotch line, McLean boom, crane, or shovel may be employed to fair advantage. Shovel and crane loading have been the most popular because of their greater flexibility. However, these loaders are expensive and require high daily production to obtain reasonable loading costs.

Where much of the salvaged wood is of small size, the need

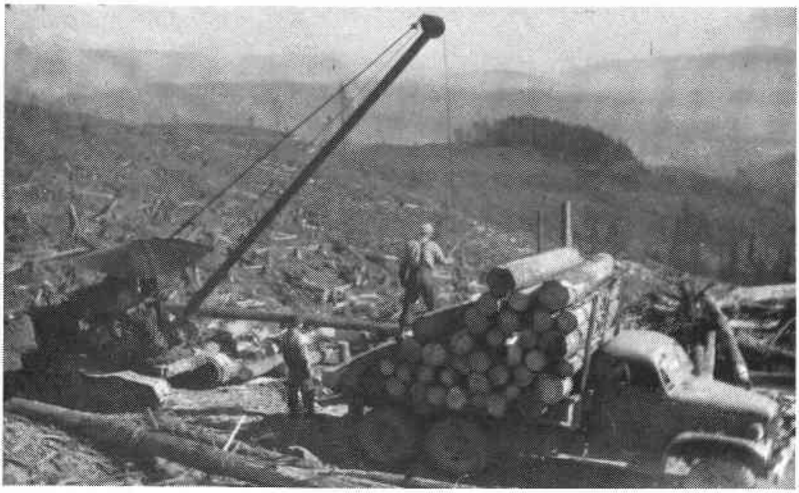

Figure 11. Shovel loader used for yarding small logs short distances and loading 8-foot pulpwood.

Figure 12. A-frame loader used for yarding small logs and for loading 8-foot wood. The A-frame and small donkey engine are mounted on the same sled.

Figure 13. Heel-boom shovel loader used for loading medium-sized salvage logs.

for new, more flexible loading equipment is most acute. The Comox Logging & Railway Company tested a conveyor loader on the "Ladysmith" experiment but was not completely satisfied with the results obtained (*5*).

Pulp companies have given considerable attention to a plan for bucking logging waste into 8-foot bolts at the landing and then making up cord bundles for transporting to the mill. The Crown Zellerbach Corporation is now bundling 8- to 16-foot wood in a special cradle. The one-cord bundles are then loaded on flat bed trucks by a motorized crane. Further experiments are planned in an effort to devise methods for building larger loads.

A bundling system was tried and abandoned by the Soundview Pulp Company chiefly on account of the necessary amount of rehandling at the landing. In rough topography, as was the case in this operation, landings are usually small with little room for decking logs and wood. The machine cost of handling the material from the log deck to finished bundles loaded on trucks was too high for the amount available each day at these small landings. The company, therefore, adopted a system which appears to have many advantages. At the landings the random length logs are now loaded on trucks and hauled to the regular railroad reload point. Here the salvage logs are run through a small mill arrangement where they are cut into 8-foot lengths and then loaded mechanically into gondola cars. This mill is very simple and consists of the power plant, a short log conveyor, and a swing cut-off saw.

Wheel-mounted cranes or shovels, equipped with heel booms, may well prove to be the best type of loading equipment for larger relogging operations, but even here some alterations are needed to

Figure 14. Small shovel with goose-neck heel boom used to load prelogged pulp species by Weyerhaeuser Timber Company.

speed the loading of small logs and chunks. One logging superintendent has suggested a shovel on which the boom can be lowered or raised as it swings. This would avoid the time lost when the boom must be swung over the log and then lowered almost to the ground to pick up a short log or chunk. Another man familiar with relogging problems has suggested a heel-boom shovel equipped with jaws rather than with tongs. Here again, attention should be given to a provision for lowering and raising the boom rapidly.

Loading costs on salvaged material could be decreased by some system of preloading. False bunks, extra trailers, or other devices might be employed to avoid lost time with trucks. The prebundling system employed by the Crown Zellerbach Corporation accomplishes a similar result. Since it frequently requires an hour or more to build up a load of salvaged logs, preloading offers greater savings in the handling of salvaged logs than in the handling of ordinary logs.

Transportation Equipment

So far salvaged logs have been transported almost entirely on standard log trucks and trailers. The exception has been where portable mills were set up in the woods so that only lumber or cants were trucked out.

The only adaptation made to standard trucking equipment for facilitating the loading of small diameter pieces and random lengths has been the addition of stakes. The use of stakes has been dependent upon the average size of the salvaged logs. Thus, on one

Figure 15. Conventional log truck and trailer equipped with 36-inch stakes to facilitate the loading of salvaged logs.

relogging operation where only 5 to 20 pieces are required to make up an average load of 24 tons, no stakes are used. On another operation where as many as 35 pieces may be required to make up a 20-ton load, 36-inch stakes, used on the truck and trailer bunks, give a marked reduction in loading time. On the "Ladysmith" experiment, where as many as 150 pieces were required to make up a load, provision was made for additional stakes. This was accomplished by underslinging a timber from the truck and trailer bunks on each side and using these timber sticks to support extra bunks (*8*). All bunks were then equipped with stakes.

Where salvaged logs have been transported by water, it has been customary to bundle the truck loads with heavy wire or metal straps before the load is dumped. Provision may then be made for dumping the loads as a unit by means of a bridge crane or an unloader equipped with one stationary and one movable A-frame. Bundling not only permits the loads to be handled as a unit in booming and rafting, but avoids the loss of sinkers and short pieces.

Sawmill Equipment for Salvaged Logs

Although pulp companies have taken the lead in the salvage of forest waste, increasing quantities of this salvaged material are being used for lumber production. The lumber industry has adopted three approaches to the problem of utilizing salvage logs:

1. Salvage operations closely resembling initial logging operations with the bulk of the salvaged logs going to established

sawmills. Most of the current salvage operations have taken this form where the waste material has been in large sizes—principally Douglas-fir wood logs.

2. Salvage operations involving the conversion of forest waste to lumber in the woods. Direct yarding to the mill eliminates high loading and transportation costs on small logs, permits full pay loads of lumber or cants, and encourages the closer utilization of woods waste.
3. A reduction in the amount of logging waste by closer initial logging. This approach is especially adaptable where the bulk of the waste is in the form of large defective logs and where the transportation distance to the main mill does not exceed 10 to 15 miles.

The first approach to the problem may be regarded as a temporary expedient designed to salvage material from lands that were logged before the utilization of defective material was considered feasible. Ordinarily this system does not accomplish a thorough utilization job because the salvage equipment must be designed to handle the largest waste material present.

Figure 16. Salvaged logs ready to be made up into a pulp mill raft.

Although the bulk of the salvaged logs cut for lumber has been sawn at established sawmills, experience records are lacking because of the practice of mixing salvaged material with other logs.

Logs salvaged from the Crown Zellerbach Corporation's lands in the Molalla area have been sorted on the Willamette River and thus far more than one-half of the recovered material has gone to sawmills. Material salvaged from the same company's land in Columbia County, Oregon, has been divided between the company's Camas pulp and paper mill, a shingle mill at Vernonia, and two small sawmills operating in the vicinity of Vernonia. Although the latter two mills receive only the poorer salvaged logs (all No. 2 and better sawlogs going to the river), they have been operating profitably from this source for more than a year.

Data on lumber grade recovery from salvaged logs are very limited. The quality of the lumber will vary greatly according to the original timber type and quality and according to the degree of utilization in the original operation.

A mill study made on 54,318 board feet (lumber tally) of logs salvaged from the west slope of the Cascades in 1944 indicates the expected grade recovery where the original logging was in a heavy stand of bastard fir (*8*). The grades by percentages were:

Grade	*Per cent*
B and Better	1.7
C Select	1.7
Select Structural	8.6
Select Merchantable	6.1
No. 1 Common	6.3
No. 2 Common	42.4
No. 3 Common	25.5
No. 4 Common	7.7

The second method of converting salvaged material into lumber —milling logging waste in the woods—is an approach requiring a departure from standard mill arrangement if not in equipment. At least three types of mill arrangements have been used in an effort to determine the most efficient way to accomplish this job; others are being planned. Experience is still too limited to indicate the most satisfactory type.

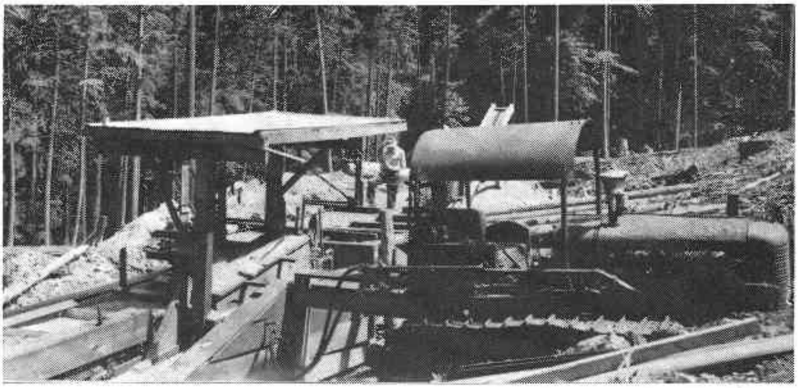

Figure 17. Small sled-mounted sawmill and power unit used in the Dwyer Lumber Company's salvage program.

The Dwyer Lumber Company has built and operated a portable mill designed for milling salvaged logs at each landing. By eliminating the edger the company was able to mount an American Economy circular sawmill on a 10 x 64-foot, steel-shod sled. This mill, powered by an HD 14 tractor (108 horsepower), is equipped with a hydraulic log turner and with live rolls to speed production.

In a three-day test run this mill sawed 203 Douglas-fir, hemlock, and cedar logs, including 23 culls, and produced 20,460 board feet of lumber with a 5-man mill crew. Reported data for the study were as indicated in the following list and in Table 4.

Log condition—sapwood nearly all decayed
Net log scale, total—16,860 (Columbia River)
Net log scale per log—83 board feet
Lumber per log—100.8 board feet
Lumber per overrun—21.3 per cent
Hourly production—951.6 board feet

Table 4. RECOVERY BY GRADE AND SPECIES IN RELOGGING TEST BY DWYER LUMBER COMPANY

Grade	Douglas-fir		Western hemlock		Western redcedar	
	Board feet	*Per cent*	*Board feet*	*Per cent*	*Board feet*	*Per cent*
B and Better	82	1.0	....	....	96	1.3
C	....	....	....	....	53	.7
D	229	2.7	....	....	80	1.0
No. 1	2,531	30.2	2,326	52.9	3,410	44.4
No. 2	1,628	19.4	904	20.5	1,970	25.7
No. 3	3,356	40.0	1,058	24.0	1,821	23.7
No. 4	555	6.7	112	2.6	249	3.2
TOTALS	8,381	100.0	4,400	100.0	7,679	100.0

Because of the difficulty encountered in hiring an experienced sawmill crew to operate this mill in the woods and because of the problem of disposing of slabwood, the Dwyer Lumber Company is planning a different approach to the problem of waste recovery. The company's alternate plan is discussed on page 28 of this report. Although the alternate plan may prove eventually to be more profitable for this particular company, it is believed that the portable mill just described would prove practicable for many operators. The company will continue the operation of the portable mill, on a contract basis, until its log gang mill is in production.

The Relogging Forest Products Company is sawing salvaged logs in the woods with a considerably different mill. This company's mill is a double circular mill, complete with edger and green chain. The principal parts of the mill are mounted on two 10 x 60-foot sleds with the log haul and green chain set up separately.

Figure 18. Salvage sawmill operated by the Relogging Forest Products Company.

During the first few months of operation this mill produced an average of 17 thousand board feet of lumber per day with a crew of 17 men. Since this mill is more difficult to move than the one described above, the operators hope to yard at least 2 million feet of logs direct to the mill at each setting. On the first setting the waste recovery has amounted to 8 thousand board feet per acre, meaning that 250 acres or more should be relogged. It is planned to cover up to 400 or 500 acres in this first setting by sending the D7 tractor and arch out a maximum distance of 3,000 feet.

Proper selection of the logs to be salvaged has been a serious problem on this operation. The fact that the lumber output has averaged No. 1 Common, however, indicates that this matter of log selection is now receiving careful attention.

The Victoria Lumber Company of Chemainus, B. C., is experimenting with a skid-mounted 18-inch log gang saw manufactured by Heaps Engineering Limited of New Westminster, B. C., for the milling of salvaged logs in the woods. This mill, operated by a 6-man crew, has maintained a production of 15 thousand board feet per day on logs ranging from 6 to 15 inches top diameter. Mechanically the mill has proved to be very efficient but the operating company has encountered two problems: (1) some salvaged logs are too large for the mill; (2) the production rate of the mill is so high that it is difficult to coordinate the yarding and milling operations on salvaged logs. The company wishes to avoid the additional handling costs entailed by cold decking.

A. P. MacBean, who has been in direct charge of this salvage experiment, states that the company is now considering a plan to set up this log gang mill and a double circular mill at the reload pond. Salvaged logs then can be sorted in the pond with logs up to 14 inches in diameter going to the log gang mill and larger salvaged logs going to the circular mill. A sufficient reserve of salvaged logs would be stored in the pond to insure the continuous operation of both mills.

The Log Gang Mill Company of National, Washington, is operating a 24-inch, log gang saw mounted on a sled. This mill was first set up in the center of a 60-acre, cut-over setting. In approximately 20 operating days the mill cut 300 thousand board feet of lumber with a 20-man woods and mill crew. Six to twenty-four inch logs have been sawn in 8- to 20-foot lengths. Thus far, the company has been obtaining approximately 20 thousand board feet of 1-inch Douglas-fir, hemlock, cedar, and white pine lumber from each acre relogged.

After sawing, the lumber is edged and stacked in one of six pockets, each of which is designed to hold one carrier load. A crane is used to swing lumber out of the pockets to high piles or onto

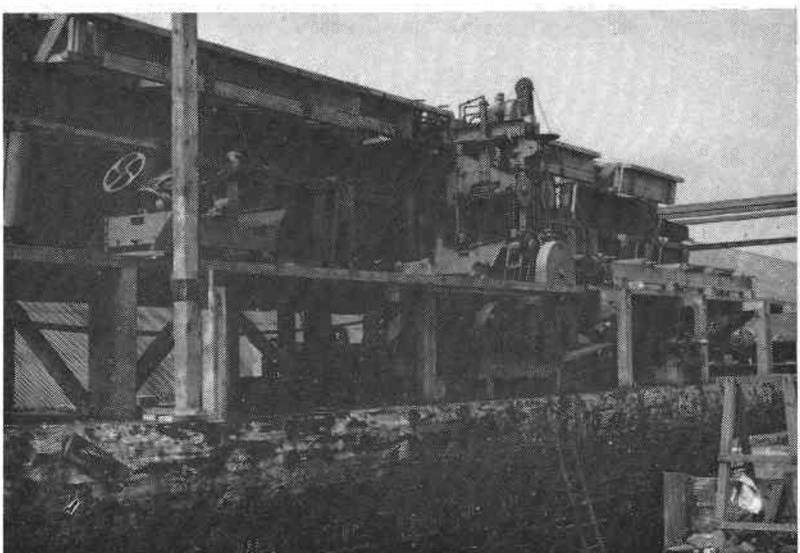

Figure 19. A portable, round, log gang sawmill manufactured by Heaps Engineering Limited. The platform with folded up roll cases and trimtable is shown. The unit is mounted on a railroad flat car.

trucks for the 7-mile haul to the railroad. The entire output is sold as No. 2 Common or better.

The Mt. Jefferson Lumber Company, operating near Lyons, Oregon, has built a double circular mill that will cut logs up to 45 inches in diameter in 8-foot lengths. The mill, complete with edger and small green chain, is mounted on two sleds for portability over woods roads. The difficulty of selling 8-foot lumber is avoided by selling this lumber together with the output of the company's main mill. Provision has been made to cut logs of large diameter because much of the usable wood volume is in the form of large defective logs containing valuable clear material.

The Long-Bell Lumber Company and Owen Dixon, who is milling salvaged logs under contract to the White River Lumber Company, have built circular sawmills on steel frames for transportation on railroad cars or flat-bed trailers. These mills should be in operation by August 1947, and it is expected that they will be moved from landing to landing. The Fall Creek Lumber Company of Fall Creek, Oregon, recently placed a sled-mounted, 24-inch log gang sawmill in operation on a woods road. Salvaged logs will be trucked a distance of approximately one mile from the company's relogging operation.

The operation of a portable mill in the woods by the Oregon Pulp and Paper Company might be mentioned at this point although the mill is set up to cut 8-foot cants for pulp production from salvaged hemlock and true firs. This company plans to have two more of these mills in operation by August 1947.

In salvaging logs for lumber production by "clean logging," the usual run of logs as well as the salvage material is removed in one operation. Unless the logs are sorted prior to manufacture, some adjustment is needed in the sawmill. Provision must be made for handling small logs and short logs without reducing production. Furthermore, provision should be made for the improved utilization of the low quality material that will accumulate—namely, No. 3 and No. 4 Common lumber, and decayed or shattered wood. Companies with cut-up mills may well utilize the low grades of lumber to fair advantage by producing clear or sound cuttings in short lengths. Developments which would permit the use of even some decayed wood for the production of molding powders or board products have been discussed but offer no immediate promise for large scale utilization. A more immediate use might be for fuel where the bulk of the sound wood was used in the manufacture of salable products.

A mill test on approximately 250 thousand board feet of Douglas-fir wood logs indicates the values obtainable from these grades of logs. In this test the lumber tally amounted to 70 per cent of the gross log scale:

Grade	*Per cent of total lumber*
B and Better VG	1.5
B and Better FG	4.7
C Select	5.8
D Select	6.9
Shop VG	2.5
Shop FG	3.5
Select Structural	.4
Select Merchantable	5.1
No. 1 Common	3.9
No. 2 Common	16.4
No. 3 Common	40.4
No. 4 Common	8.9
	100.0

Since wood logs are ordinarily in large diameters, they normally should be taken in the initial logging operation. The taking of these defective logs in the first operation may or may not leave enough material for a secondary operation depending upon the character of the original timber stand.

One company that is planning specific mill changes to permit *clean* logging is the Dwyer Lumber Company. Since most of this company's salvage material is in the form of small sound logs, the company plans to install a log gang saw at its Portland mill. It is expected that the higher production and higher overrun attained with a gang saw, plus the outlets for fuel in the Portland market, will enable the company to pay the relatively high loading and transportation costs on salvaged logs. The adoption of this plan should provide an outlet for logging waste salvaged by other operators in the vicinity of Portland.

MEASUREMENT OF SALVAGED MATERIAL

Relogging operators are selling their salvaged material on a basis of cubic feet, tons, or board feet lumber tally. Pulp companies may measure their recovery in cords. All of these bases are equitable for either small or large logs. The importance of using some such basis of measurement for small logs is emphasized by the fact that the wood recovered by the Comox Logging and Railway Company in the "Ladysmith" experiment was equivalent to 2 million board feet of logs for pulp production but would have scaled only 1.06 million feet under established scaling practices (*5*).

The system of selling salvaged wood on a weight basis has much

Figure 20. This 24-inch, sled-mounted, portable, log gang mill is moved into logged-over settings so that logs can be direct-yarded to the mill. Production is 14 to 15 thousand board feet per day with a 20-man woods and mill crew.

to recommend it from the standpoint of simplicity, although the loads must be checked at some point for cull material.

An equitable system of measuring waste material must be applied not only at the time of sale but to all steps of the recovery operation if the operator is to have a satisfactory basis for determining production costs and the proper selection of material.

One encouraging step in the direction of a more equitable system of measuring small logs is the regional adoption of the Sorenson cubic foot rule for logs 13 inches or less in diameter. Small logs may now be bought or sold by the cubic foot or by the board foot. During the latter part of 1946, a 10-inch log, 32 feet long was valued at $3 based on the Sorenson cubic-foot rule and $2.07 based on the Columbia River board-foot rule.

RELOGGING COSTS

Complete cost records are available for only one relogging operation—the "Ladysmith" experiment which was conducted in British Columbia in 1943 and 1944 (*5*). The reported costs and production rates are reproduced in Table 5.

While it is not possible to report the costs of any other individual relogging operation, information gathered from several contractors engaged in relogging makes it possible to set up an approximate cost comparison between average initial and average secondary

Table 5. RELOGGING PRODUCTION COSTS PER 100 CUBIC FEET (Ladysmith Experiment)[1]

Item			Cost[2]	Man-days
Cutting, labor and compensation			$ 0.849	0.0622
Scaling			0.174	0.0159
	Cost	*Man-days*		
Measurements	$0.158	0.0141		
Computation	0.016	0.0018		
	$0.174	0.0159		
Yarding (A-frame method)			2.940	0.2795
	Cost	*Man-days*		
Operating (labor, compensation, gas, and repairs)	$2.549	0.2795		
Wire rope	0.210	....		
Blocks, etc.	0.055	....		
Machine depreciation	0.126	....		
	$2.940	0.2795		
Additional branch roads			0.352	0.0109
Loading			2.957	0.1994
	Cost	*Man-days*		
Roading (labor, compensation)	$0.655	0.0760		
Tractor, fuel	0.810	....		
Loading (labor, gas, and repairs)	1.051	0.1142		
Machine depreciation	0.203	....		
Landings	0.238	0.0092		
	$2.957	0.1994		
Hauling			2.386	0.0391
	Cost	*Man-days*		
Labor and compensation	$0.424	0.0391		
Truck, fuel, etc.	1.962	....		
	$2.386	0.0391		
Booming			0.457	0.0294
	Cost	*Man-days*		
Unloading	$0.054	0.0072		
Making rafts	0.097	0.0130		
Wire, labor, and material	0.306	0.0092		
	$0.457	0.0294		
Insurance			0.178	....
	Cost	*Man-days*		
Felled, bucked, and yarded wood	$0.152	....		
Machinery	0.026	....		
	$0.178	....		
Miscellaneous equipment			0.018	....
TOTAL (based on woods scale)			$10.311	0.6364

[1]Report, Part I, "The Ladysmith Experiment in Salvaging Pulpwood from Logging Waste." A cooperative project conducted by the Comox Logging and Railway Company, the Powell River Company, Ltd., and the British Columbia Forest Service. 1943-44. Page 11.

[2]100 cubic feet equals 538 feet board-measure (British Columbia log scale) for normal hemlock-balsam pulp logs.

logging operations in 1946. This cost comparison is shown in Table 6.

Table 6. A COMPARISON OF THE ESTIMATED AVERAGE COSTS OF RELOGGING AND INITIAL LOGGING—1946

Cost item	Cost per thousand net log scale	
	Initial logging	Relogging (contract)
Stumpage	$ 5.00	$ 1.00
Falling and bucking	4.00	2.15
Yarding (including repairs)	3.35	4.10
Loading (including repairs)	1.65	2.55
Road construction	1.60	......
Road maintenance	.25	.30
Trucking (30 miles)	5.50	6.00
Payroll taxes	.80	*
Depreciation	.90	*
General expense	2.05	1.50
Booming and scaling	1.00	1.50
Fire protection, snag falling, and slash disposal	.50	.10
TOTALS	$26.60	$19.20

* Included in falling and bucking, yarding, and loading costs.

No claim is made for the accuracy of the cost bases used in arriving at the tabulated relogging costs shown in Table 6. The cost bases do, however, represent the best estimates that could be made following conversations with several reloggers.

Labor costs were the average of wages paid by three salvage contractors. The hourly rates were approximately the same as the going rates for western Oregon. As relogging experience was too limited to permit an accurate determination of operating and ownership costs of the equipment used, certain assumptions were made as follows:

1. Ownership costs
   - Depreciation—20 per cent per year, straight line
   - Interest, insurance, taxes—10 per cent of average value*
   - Uninsured risk—5 per cent of average value
2. Current operating costs

Item	*Cost per 8-hour day*
Fuel (actual cost)	$1.50–$2.50
Oil, grease, filters, etc.	1.00
Wire rope and rigging	
Tractors	2.00
Yarders (converted loaders)	7.00–12.00
Washington loader	7.00
Shovel loader	2.00
Maintenance and Repairs	
Tractors	8.00
Yarders	4.40–7.20
Washington loader	4.40
Shovel loader	16.00

* Average value = $\frac{\text{Cost} + \text{annual depreciation}}{2}$

The above figures seem low when compared with average logging costs, but consideration has been given to the fact that relogging operations involve lighter logs and lower production.

TIME OF RELOGGING

The time elapsing between the original logging and the relogging operation is an important factor in determining the volume of material that can be salvaged. Operators are finding that they can salvage profitably large old-growth material that has been dead for several years. On the other hand, small material that has been down for only 2 or 3 years usually proves to be of negative value. The older slashings contain more material than do areas cut over recently as present favorable markets allow more material to be logged at a profit.

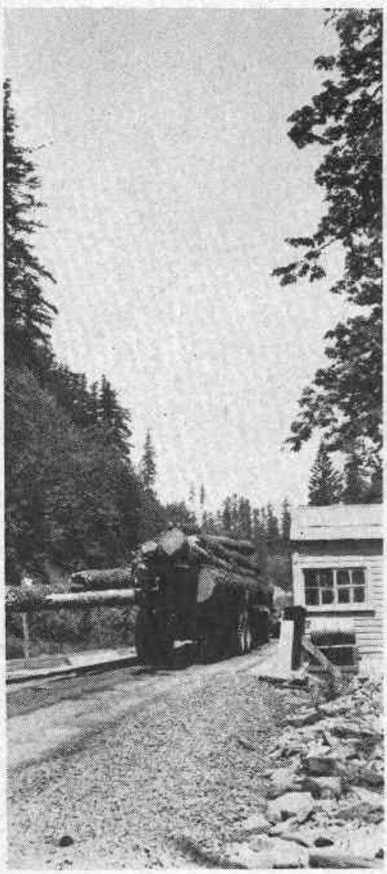

Figure 21. A load of 15 salvaged logs on the scales. The relogger will be paid by the ton for this material.

With the large volume of old slashings available for relogging, the question is often raised as to the length of time this material will continue to have a commercial value.

The two most important factors affecting the time dead material will remain merchantable are the size and species. Deterioration of the sapwood is very rapid for all species while there is a wide difference in the rate of decay of the heartwood. Redcedar heartwood is very decay-resistant and will remain marketable for many years. Heartwood of old-growth Douglas-fir also will remain sound for several years while the heartwood of spruce, white firs, and hemlock decays rather rapidly. In fact, there is little difference in the rate of decay between the sapwood and heartwood of these species. It is, therefore, apparent that the so called "pulp" species and all small-sized material that contains a high percentage of sapwood must be salvaged at an early date.

A study was made recently by J. W. Kimmey of the Division of Forest Pathology and R. L. Furniss of the Bureau of Entomology and Plant Quarantine to determine the length of time that fire-killed Douglas-fir remained sufficiently sound to have a value for lumber (*4*). This study found that sapwood deterioration is very rapid. Blue stain and beetles attack the tree the first year after it is dead, and by the end of the third year the sapwood is entirely deteriorated. The process is slowed down when the heartwood is reached, although not greatly in young-growth trees. It was found that large scale salvage operations of Douglas-fir were carried on for approximately the following periods after being killed by fire: 1 to 2 years in second-growth stands, 4 to 7 years for bastard fir, and 5 to 10 years or more in old-growth "yellow fir."

The Division of Forest Pathology carried on studies for several years in the large wind-blown timber area on the Olympic Peninsula of Washington, caused by the storm of January 29, 1921. Much information was obtained that can be used as a guide in determining how long the various species can be expected to have a commercial value. The following is quoted directly from the report of 1940 by T. S. Buchanan and G. H. Englerth (*1*):

> The high-grade, high-value lumber is manufactured from the sapwood and adjacent heartwood of logs. This zone was the first to be invaded by decay, and data were taken to show the relationships between decay and the sapwood. Western hemlock and silver fir, the two species having the highest percentage of sapwood and the least durable heartwood, decayed most rapidly. Sitka spruce did not decay so fast as these species but much faster than either Douglas-fir or cedar. The sapwood of Douglas-fir decayed rather rapidly, but the heartwood showed a high degree of durability. Western red cedar, with its narrow ring of sapwood and highly durable heartwood, suffered least from decay.
>
> The data indicate that if wind-thrown trees of the spruce-hemlock and Douglas-fir old-growth types of the Washington and Oregon coast are to be salvaged before suffering any decay loss, it must be done within 1 or 2 years following blow-down. Douglas-fir trees decay rather rapidly until at least the bulk of the sapwood is destroyed, but the heartwood decays very slowly. Trees of this species still contain considerable merchantable volume even 15 years after being blown down. Most of this sound volume, however, is found in trees over 30 inches in diameter. In Sitka spruce trees little difference is found between the rate of decay in sapwood and heartwood. Thus decay progresses at a uniform rate and practically all sound wood, irrespective of tree size, is destroyed within 15 years. Both western hemlock and silver fir trees, irrespective of size, are rendered worthless by decay within 8 years after being blown down. Even after

lying on the ground for 15 years the decay loss in western red cedar does not exceed the original sapwood volume. Indications are that heartwood of this species will remain sound for many years to come.

Using information from this Olympic Peninsula study, Table 7 has been prepared showing the percentage of decay in 1926 or 5 years after the timber was wind-thrown.

These studies and the experience of local operators indicate that salvage operations in second-growth fir or in any of the pulp species are not practical after the third year. Large Douglas-fir stands can be relogged for a period of 10 years, but during this time all of the small logs and much of the clear material in the outer portion of the big logs will be lost. Therefore, to get maximum returns the salvage operation should follow the original logging as soon as practicable.

USES OF SALVAGED WOOD

The present use of salvaged material is about equally divided between pulp mills and sawmills. A small amount, chiefly cedar, goes into other uses such as shingles, posts, and poles.

Most of the pulp mills are being equipped with hydraulic barkers, thereby greatly improving the pulp market for small-sized logs that were formerly too expensive to peel. The pulp mills, however, are limited in the amount of relogged material they can use as all species are not acceptable. Most of the pulp capacity in Washington and Oregon is in sulphite mills which use hemlock, spruce, white fir, and little or no Douglas-fir.

Douglas-fir makes up the biggest amount of the logging waste. As shown earlier in this report, 53½ per cent of the logging waste is Douglas-fir while 31½ per cent is hemlock, spruce, and white fir. Sulphate mills utilize Douglas-fir as well as the other pulp species, but their capacity is only about one-half that of the sulphite mills. In 1944, the pulp mills in Washington and Oregon used about 1½ billion board feet log scale of which only about 6 per cent was Douglas-fir. The balance was chiefly hemlock.

Sulphate pulping capacity is now being increased in this region. This trend should expand the market not only for relogged material but also for material from thinnings and for the large amount of sawmill waste that is now being produced in cutting the present defective Douglas-fir stands.

Pulp mills probably will continue to offer the best markets for the small logs from salvage operations. However, much of this material will be used by sawmills, particularly those with log gang saws.

The larger logs, if they contain enough sound material to justify transportation costs, will continue to be hauled to sawmills. If the

Table 7. DECAY LOSSES FOR TIMBER FIVE YEARS AFTER BEING WIND-THROWN

D. B. H. Class in Inches	Douglas-fir		Western hemlock		Sitka spruce		Silver fir[1]		Western red cedar	
	Board foot volume	Cubic volume	Board foot volume	Cubic volume	Board foot volume	Cubic volume	Board foot volume	Cubic volume	Board foot volume	Cubic volume
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
10	....	....	96	70	92	64	85	57	....	....
14	....	....	96	69	89	67	92	71	22	20
18	35	31	96	63	88	66	98	70	17	17
22	....	....	96	61	83	60	90	53	18	15
26	45	26	94	53	73	57	89	53	11	14
30	33	24	90	51	68	52	93	57	17	14
34	29	18	84	51	59	40	86	55	19	11
38	25	18	87	46	39	30	77	46	15	12
42	24	18	....	....	58	41	59	40	12	10
46	24	18	72	43	42	34	55	32	7	11
50	22	17	....	....	49	33	67	38	6	7
54	21	16	....	....	41	30	33	30	15	10
58	25	16	....	....	38	28	28	23	5	7
62	20	16	....	....	43	41	....	....	5	6
66	18	16	....	....	32	26	....	....	3	4
70	17	14	....	....	49	36	....	....	3	5
AVERAGE	34	17	94	55	59	22	83	45	8	9

[1]Abies amabilis.

logs contain a large amount of defect, the practice of cutting out the sound portion with portable mills and hauling the cants to a permanent mill for further manufacture is expected to increase. These large defective logs contain much high-grade material that can be utilized for slicing cants, flooring stock, and shop lumber.

The possible use of logging waste for building hardboard production has received attention as the fiber requirements are not as stringent for hardboard products as for most paper products. At present the chief deterrents to such use are: (1) the large plant investment required for hardboard production, and (2) the unavailability in some areas of unused mill waste which can be purchased at a low cost.

On the basis of the estimated costs shown in Table 6, logging waste would cost approximately $18 per thousand board feet log scale for a 30-mile haul direct to the mill. Since in average salvaged logs one cubic foot is equivalent to approximately six board feet, gross Spaulding or Scribner scale, the above cost would be equivalent to $10.80 per 100 cubic feet of solid wood. Or, since 100 cubic feet of Douglas-fir would weigh 2,700 pounds when bone dry, the cost would be approximately $8.00 per ton of bone-dry wood. This cost is not prohibitive but does exceed the cost of solid mill waste such as slabs and edgings.

Recovered woods waste has recently found use as raw material for box covers. The fine-grained, clear wood obtainable from many defective logs is highly valued for box tops and at least two companies are salvaging logging waste for this purpose. Similarly, the clear material present in woods waste may find some use for battery-separator stock as the desired peeler grade logs become scarcer.

Despite the need for expanded markets for salvaged wood, markets are not at present the chief deterrent to increased production. Most of the salvage material is suitable for use by the pulp and sawmills, provided the cost of production can be decreased. This means that operating improvements are needed, both in the woods and the mills, so that the cost of the finished product will not be far out of line with similar products produced from the usual run of logs.

BENEFITS OF CLOSER WOODS UTILIZATION

The present encouraging progress toward better utilization of logging waste is due primarily to excellent market conditions and a decreasing supply of available timber. The future trends of salvage operations will depend chiefly on their financial soundness. There are, however, many points other than the present dollar value of the salvaged logs that should receive consideration in analyzing the worth of this type of operation. Such things as increasing the life of the manufacturing plant, minimizing slash disposal costs, improving conditions for the regeneration of a new stand, and the possibility of decreasing the original logging costs through an integrated operation, should all be taken into consideration as benefits accruing from relogging operations.

Many plants are now confronted with the problem of an inadequate timber supply for a continuous operation. Plants with a heavy initial investment such as in the pulp industry may find it advantageous to undertake relogging on a large scale even though the cost of the wood is slightly higher than the present open market price of similar material. This salvaged wood may decrease depreciation and similar costs per unit of product to such an extent that a slight loss can be absorbed in the wood procurement. Also, as the timber supply decreases, there will be a general "increase in stumpage prices." This will provide another incentive for closer utilization of the available timber.

Relogging minimizes the fire hazard on the area by reducing the volume of combustible material and by removing obstacles that interfere with fire control. The amount of hazard reduction will depend upon the volume and character of the material removed. If only the large logs are removed the hazard will be reduced but little. On the other hand, if the small logs are removed also, the amount of slash will be reduced to such an extent that slash burning may not be required. This would not only permit a saving in operating expense but would avoid the destruction of advance reproduction and other young growth, promoting the earlier establishment of the next timber crop.

Relogging causes an additional exposure of the mineral soil and thereby offers a better opportunity for reproduction to become established. If the relogging is postponed for a year or more after the original operation, some of the established seedlings will be destroyed. This is another reason the relogging should follow the initial logging as closely as practicable.

RECOMMENDATIONS

1. **Integrated operation.** In many instances the total logging cost can be reduced if relogging is anticipated when the logging plans are drawn. The heavy logging equipment used in the first operation should remove the large logs of all grades and leave the small logs of all grades for the secondary operation. This would (1) avoid the

high cost of handling small logs in the initial operation, and (2) permit the use of equipment especially adapted to small log recovery in the secondary operation.

2. **Contracting.** Contracting the relogging offers several advantages. Contracting the work normally will result in (1) lower costs through reduced overhead, (2) greater interest on the part of the crew and consequently a better selection of the material to be salvaged, and (3) a desirable separation of the initial and salvage operations.

3. **Prompt relogging.** Relogging operations should follow the original operation as soon as practicable. Studies have shown that blue stain and insects attack the wood within a year after it is dead, and that ordinarily the sapwood is entirely valueless by the end of the third year. The heartwood is less affected but the loss of only the sapwood will place a large volume of the small logs in the negative value class, and will lower the unit value of the big logs.

4. **Woods milling.** Milling salvaged logs in the woods has advantages and disadvantages, but should have a place in the utilization plans of many operators. Woods milling avoids the high loading and transportation costs on small logs. Unit packages of lumber can be loaded more quickly and hauled more economically. Woods milling permits a separation of the usable sound wood (often of high value) from the decayed or shattered portion of large defective logs. Thus, only usable material is hauled out. Finally, woods milling can be expected to encourage a more thorough job of waste recovery.

The disadvantages of milling in the woods include: (1) the difficulty of keeping the mill supplied with logs since cold decking ahead involves additional handling costs, (2) the difficulty of keeping an experienced mill crew on the job in the woods, (3) the problem of waste disposal since open refuse fires are prohibited during the fire season, (4) the problem of streamlining the mill for frequent moves at low cost, and (5) the problem of finding sufficient space for lumber sorting at mill sites in the woods.

5. **Stumpage values.** In many cases it may be both desirable and necessary that logging waste carry a stumpage value. Whenever the adoption of an integrated logging program requires the leaving of small logs of all grades for the secondary operation, these small logs must carry a fair stumpage value. However, it must be remembered that high stumpage values on the average class of logging waste will restrict or halt salvage operations. Thus, the difference between $1 and $2 or $3 stumpage on 10 thousand board feet per

acre might mean not only the loss of the $10 per acre that could have been realized, but the loss of all benefits accruing from relogging.

6. **Improved equipment.** Most of the present relogging is being done with conventional logging equipment and methods. Much improvement is needed, both in woods equipment and in mill equipment, for more efficient handling of small-sized material and defective logs.

SUMMARY

In the average logging operation in the Douglas-fir region of Oregon and Washington, approximately 27 per cent of the net board foot volume of the standing timber is being left to rot or burn. Closer utilization of this material, which amounts to 10 thousand board feet of saw-log sized material plus some 10 cords of small material per acre, would further conservation of timber resources and permit an increase in the sustained yield cutting budget of the region.

The timber industry has for many years been aware of the enormous volume of logging waste, but all efforts to salvage it proved uneconomical until the present favorable markets improved the profit margin. A good start has been made in salvage logging, but as yet the surface has only been scratched.

Relogging now is in the development stage and recovery costs are higher than will be the case when the most efficient methods have been determined. From meager data available, it appears that relogging will be less costly per thousand board feet of logs than for the original operation. This is due primarily to the fact that salvage stumpage is at present of but nominal value, and that the relogging operation takes advantage of the roads previously constructed. Log grades, however, will be lower on the salvage operation.

Relogging has other advantages which should be given serious consideration in planning a salvage operation. These include lengthening the life of the plant and thereby reducing unit depreciation and similar costs, minimizing the fire hazard with a corresponding reduction in slash disposal costs, and of assistance in getting a new stand established.

With the decreasing supply of available standing timber, the corresponding increases in stumpage prices, and continued good markets, it is expected that relogging operations will become increasingly important to the forest products industries of the Douglas-fir region.

BIBLIOGRAPHY

(*1*) Buchanan, T. S., and G. H. Englerth. *Decay and Other Volume Losses in Wind-thrown Timber on the Olympic Peninsula, Washington.* U. S. Department of Agriculture Tech. Bul. 733, Dec., 1940.

(*2*) Grantham, J. B. "Recovery of Forest Waste." *Timberman,* 46:8-10, June & Aug., 1945.

(*3*) Hodgson, A. H. "Logging Waste in the Douglas-fir Region," *Pacific Pulp & Paper Industry and West Coast Lumberman,* 1930.

(*4*) Kimmey, J. W., and R. L. Furniss. *Deterioration of Fire-killed Douglas-fir.* U. S. Department of Agriculture Tech. Bul. 851, Sept. 1943.

(*5*) MacBean, A. P. *The Ladysmith Experiment in Salvaging Pulpwood from Logging Waste.* British Columbia Forest Service, Victoria, B. C., 1945.

(*6*) Richen, C. W. "Some Problems in Relogging Cut-over Lands." *Pulp & Paper Industry,* 20:2:58, Feb., 1946.

(*7*) "Conveyor Loader for Salvaged Wood." *British Columbia Lumberman,* 28:4, May 1944.

(*8*) "Increased Utilization of Timber Stand Subject of Discussion at Logging Congress." *British Columbia Lumberman,* 28:1:25, Feb., 1944.