United States
Department of
Agriculture

Forest Service

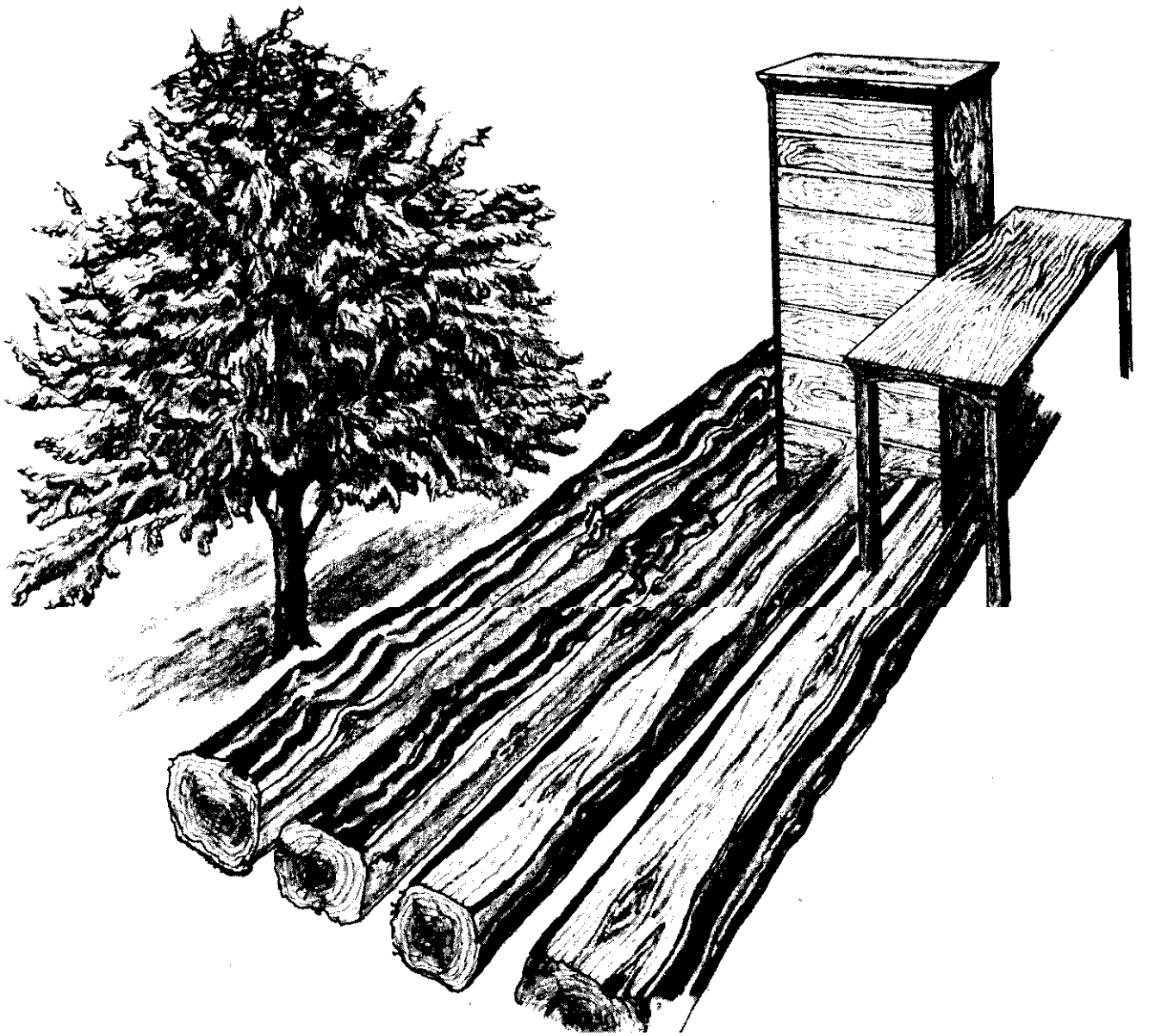
Forest
Products
Laboratory

Research
Paper
FPL-RP-525

Lumber Recovery From Pacific Yew Logs

An Exploratory Study

Stephen P. Loehnertz
Eini C. Lowell
William T. Simpson
Kent A. McDonald



Abstract

In the past several years, thousands of Pacific yew trees were stripped of their bark from which the cancer-fighting compound taxol is obtained. Research has determined that the wood from the Pacific yew does not yield enough taxol to supplement the supply from the bark. Thus, the objectives of this study were to assess the quantity and quality of lumber that could be produced from debarked yew logs. A sample of good-quality yew logs were chosen, sawn, edged, and graded, and the volume and quality of the lumber were determined. Although the yew logs contained drying splits, spiral grain, and internal decay, and often were fluted and knobby, the lumber produced from these logs is considered attractive and suitable for specialty uses.

Keywords: Pacific yew, taxol, lumber recovery

August 1993

Loehnertz, Stephen P.; Lowell, Eini C.; Simpson, William T.; McDonald, Kent A. 1993. Lumber recovery from Pacific yew logs: an exploratory study. Res. Pap. FPL-RP-525. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 7 p.

A limited number of free copies of this publication are available to the public from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398. Laboratory publications are sent to more than 1,000 libraries in the United States and elsewhere.

The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

The policy of the United States Department of Agriculture Forest Service prohibits discrimination on the basis of race, color, national origin, age, religion, sex, or disability, familial status, or political affiliation. Persons believing they have been discriminated against in any Forest Service related activity should write to : Chief, Forest Service, USDA, P.O. Box 96090, Washington, DC 20090-6090.

Lumber Recovery From Pacific Yew Logs

An Exploratory Study

Stephen P. Loehnertz, Research General Engineer
Forest Products Laboratory, Madison, Wisconsin

Eini C. Lowell, Research Forest Products Technologist
Pacific Northwest Research Station, Portland, Oregon

William T. Simpson, Research Forest Products Technologist
Kent A. McDonald, Research Forest Products Technologist
Forest Products Laboratory, Madison, Wisconsin

Introduction

The bark of Pacific yew (*Taxus brevifolia* Nutt.) contains the compound taxol, which has been shown to be effective in treating ovarian cancer. Hauser Northwest,[1] affiliated with Bristol-Meyer Squibb, has been harvesting Pacific yew bark from trees on federal, state, and private lands throughout Oregon and Washington since 1990. This material is being used for extraction of taxol and continued testing of the drug. It takes about 40 lb of green bark (20 lb dried) to provide two to three average doses of taxol (Chabner 1991) (See metric conversion Table 1). On average, one tree will yield this amount of bark (Richardson 1991).

Table 1—SI conversion factors[a]

English unit	Conversion factor	SI unit
board foot	0.002	cubic meter (m^3)
foot (ft)	0.305	meter (m)
cubic feet (ft^3)	0.028	cubic meter (m^3)
inch (in.)	25.4	millimeter (mm)
pound (lb)	0.45	kilogram (kg)

[a]ASTM 1989.

In 1991, 825,000 lb of bark was collected from federal lands and an equivalent amount from private lands. Some bark was removed from trees while in the forest, leaving the stems behind. From April to September, Pacific yew bark can be stripped in the woods using hand tools because the bark is loose. Mechanical debarking is necessary the rest of the year (Jans 1992). A number of large logs and branches were removed and transported to Hauser Northwest's debarking facility in Cottage Grove, Oregon, to allow investigation of the potential for extracting taxol from the wood. In 1992, the USDA Forest Service, Forest Products Laboratory (FPL), in Madison, Wisconsin, determined that the wood of Pacific yew does not yield enough taxol to supplement the supply from the bark (Obst and Atalla 1992).

Thus, it was decided to do exploratory research on possible uses for the stockpiled, debarked, yew stems and to address concerns about utilization of this material. Hauser Northwest cooperated in these research efforts by providing logs for this study.

[1]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

The Tree, Wood, and Common Uses

The Pacific yew grows mainly from northern California to Alaska, with some trees found in Idaho and Montana. The Forest Service lists the Pacific yew as a miscellaneous or noncommercial species. Trees are typically small, 12 to 15 in. diameter at breast height (dbh), and slow growing. About 10 percent of the trees are larger than 10 in. dbh. Heights range from 20 to 60 ft. In general, large trees grow at low elevations and are few in number; these trees tend to be on private land. National Forests are at high elevations where greater numbers of small diameter yew trees are found. Typically, these trees have poor form and taper rapidly. The best quality trees may be found on the Umpqua, Rogue River, and Williamette National Forests. In Idaho, the yew trees are small, and in Montana, shrubs are harvested (Bolsinger 1992).

The characteristics of yew wood make it desirable for value-added products. Some known uses include specialized items such as carvings, bowls, and archery bows. Native Americans in the Pacific Northwest used yew for making bows because of its strength and toughness; it is comparable in strength to white oak It has appeal for cabinetry because of its attractive color. The logs for our study had a narrow band of light-colored sapwood. The heartwood was an attractive orange with an occasional purple or rose-red streak The occasional high-quality log is in high demand, and some are exported to Japan. This suggests that the best contribution that processing research could make is to upgrade the uses of the medium-quality material.

Objectives

The objectives of this study were to assess the quantity (volume recovery) and quality (grade recovery) of lumber sawn from debarked yew wood.

Materials and Methods

Sampling

The USDA Forest Service, Pacific Northwest Research Station (PNW), conducted an assessment of the yew logs stockpiled at the Hauser Northwest facility in Cottage Grove, Oregon. They measured log diameter, length, and surface moisture content and noted checks, end splitting, sweep, crook, and knots. Most logs had some type of defect, such as knots, rot, ring shake, or spiral grain. A sample of 86 logs from 3500 in the yard gave an average surface moisture content of 15 percent, small-end diameter of 9 in., and a length ranging from 8 to 29 ft. Fluting or twisting, which are common features of yew, occurred in some of the beat quality logs.

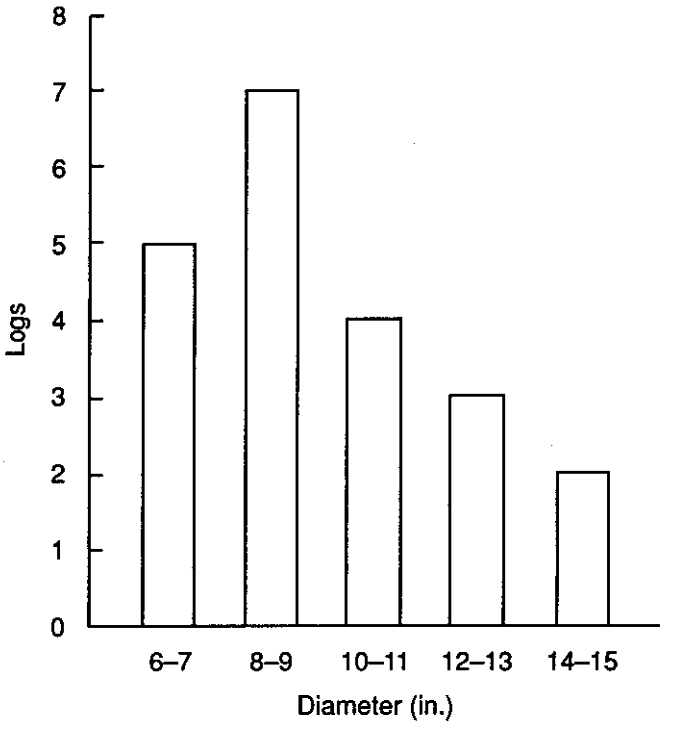


Figure 1—Diameter distribution of sawlogs.

Hauser Northwest classified yew logs into three categories, defined as follows:

1. High grade: half the log must have knots no larger than 2.5 in.; no minimum diameter but generally around 10 in. at the butt.
2. Pole/Post: sound piece of material, generally 4 to 10 in. on the small end.
3. Firewood: log does not meet the requirements of high grade or pole/post.

About 10 percent of the logs in Hauser Northwest's yard were classified as high grade. Sixty percent of the logs were pole/post material. The remaining 30 percent was firewood. There are no formal log grading rules or volume tables for Pacific yew, and the logs are usually not scaled.

Hauser Northwest personnel assisted in selecting 48 logs for the study, divided equally between high grade and pole/post. The study logs were better than the general population of yew in two respects: the sample logs were divided equally between high grade and pole/post, and the pole/post selected were the better ones present in the yard. All logs had been in the yard from 6 to 18 months. Log length varied from 12 to 20 ft. The small-end diameters were 6 to 15 in. and their distribution is shown in Figure 1. Smooth stems were rare, and most had surface checking. End checks typically penetrated 2 in. inward from the surface. About one-third of

Figure 2—Some Pacific yew logs used for study.

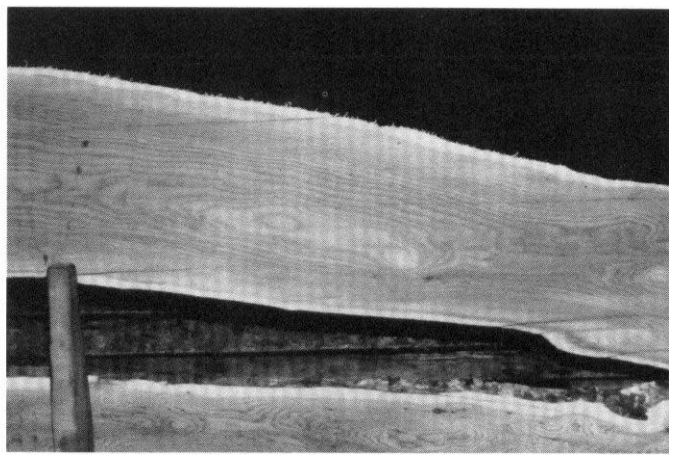


Figure 3—A clear board with splitting and spiral grain.

Table 2—Age, diameter, and specific gravity from disk samples cut from Pacific yew

Disk sample	Approximate age (years)	Approximate diameter (in.)	Specific gravity
1	91	15.1	0.56
2	100	8.8	0.64
3	150	9.8	0.61
4	160	11.6	0.58
5	180	9.6	0.62
6	185	14.3	0.63
7	215	9.8	0.67
8	320	11.5	0.65

the logs had readily apparent spiral grain. Some logs were round but many had an irregular shape, being fluted or knobby (Fig. 2).

Cross-sectional disks cut from eight logs, which seemed to be typical of the logs in terms of diameter and shape, were used to determine age and specific gravity. Ages ranged from 91 to 320 years. Specific gravity values were 0.56 to 0.67 with an average of 0.62 for all disks (Table 2). This is in agreement with reported values (Summit and Sliker 1980).

Sawing

Of the 48 logs selected, 3 were initially sawn to determine the cutting pattern. Another 24 logs were used for the. actual lumber recovery study. Logs were bucked to 8-ft lengths, and their diameter was measured every 16 in. to use in calculating cubic volume.

The logs were live sawn using a Woodmizer horizontal hand saw, which travels on rails. The log is fixed into position on the frame of the machine; however, this was difficult as a result of the. irregular shape of the logs. This led to the decision to square two adjacent sides of the log by taking light surface cuts before cutting boards. Target thickness of the lumber was 1-3/16 in. Because Pacific yew is a dense wood, frequent saw blade changes were necessary to ensure consistent lumber sizes. The blade would occasionally deflect as much as 0.25 in. near knots.

About one-third of the logs had noticeable right spiral grain, and it seemed more common in logs with larger diameters. A clear board with splitting and spiral grain is shown in Figure 3. Another common defect was internal decay. The extent and location of the rot indicated that it had been present in the. standing tree. Figure 4 shows a log with decay being sawn. Small diameter, high-grade logs were less likely to have decay and spiral grain.

Pole/post logs less than 6 in. in diameter at the small end were sawn in to cants 2.75, 3.125, 3.5, and 4.25 in. square. We chose the largest dimension obtainable from each log, rather than standardizing to one value. Lumber cut from these small logs did not meet the grading rules but would have potential for furniture blanks.

Edging

We used a Diehl straight-line rip saw to do the edging. Edging decisions were difficult because no grading rules are available for Pacific yew. Figure 5 shows boards before edging from high-grade (logs 1 and 3) and pole/post (log 2) logs. We eliminated all decay and visible splits.

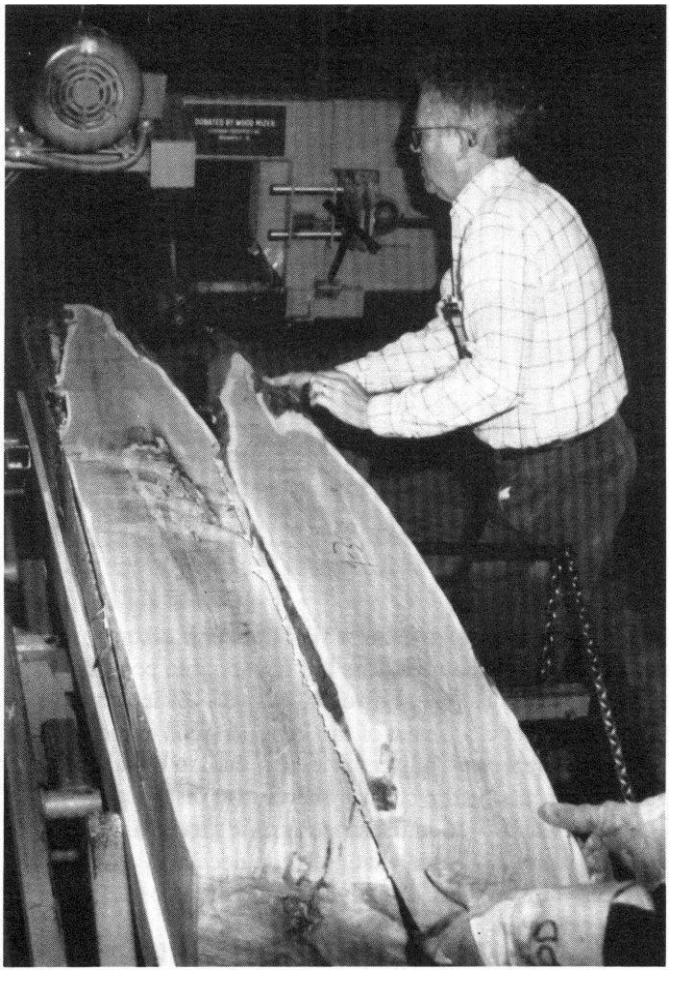


Figure 4—Sawing a yew log containing decay.

Figure 5—Boards as sawn, before edging.

Grading

We felt that yew lumber was more suitable for value-added products that would compete with the hardwood lumber market, and therefore graded the lumber according to National Hardwood Lumber Association rules (NHLA 1990). The lumber was graded twice: first using three grades (No. 1 Common, No. 2 Common, and No. 3 Common) and the second time using four grades, which allowed the additional grade No. 2 Sound (No. 1 Common, No. 2 Common, No. 2 Sound, and No. 3 Common). The No. 2 Sound permits stain, worm holes, and larger checks.

Results

The average moisture content of the logs, based on readings from the boards, ranged from 14 to 33 percent. Unknown factors relating to the variation in moisture content levels include time since harvest and original green moisture content, reported to be 44 percent in standing green trees (Summit and Sliker 1980). The lumber was not kiln dried.

The color of the boards was a light orange, with occasional pink or purple streaks. Many boards contained pith because of the small log diameter and poor log form, but in the opinion of the grader, pith did not affect the lumber grade recovery. The width of the widest beard sawn was 11 in.

Lumber Grade Recovery

Table 3 shows the lumber grade recovery for each log for the grading system that allowed No. 2 Sound. From the high grade, only 2 percent (7 board feet) of No. 1 Common lumber was produced. Twenty-four percent (82 board feet) was No. 2 Common; 38 percent (131 board feet) was No. 2 Sound; and 47 percent (129 board feet) was No. 3 Common.

The logs that were classified pole/post produced no No. 1 Common boards; 2 percent (3 board feet) of the total volume was graded No. 2 Common. About 24 percent (33 board feet) of the volume was graded No. 2 Sound, and the majority of boards, 74 percent (100 board feet), was graded No. 3 Common.

When we looked at the data where the No. 2 Sound was combined with the No. 3 Common, 75 percent (260 board feet) of the lumber volume from the high-grade logs fell into No. 3 Common (Fig. 6). In the pole/post log category, 98 percent (133 board feet) of the lumber sawn was No. 3 Common (Fig. 7). Some of the higher grade, widest boards came from the outer portion of logs with rot. Unfortunately, some outer boards often contained drying splits or checks which lowered their grade.

Table 3–Lumber grade recovery

Log category	Log small diameter (in.)	Lumber grade volume (board feet) No. 1	NO. 2	No. 2 Sound	NO. 3	Total
High-grade	7.6	0	3	0	9	12
	9.4	0	3	5	20	28
	9.5	0	0	10	9	19
	10.5	0	3	32	0	35
	11.0	0	4	11	5	20
	11.3	0	11	14	12	37
	12.0	0	5	21	12	38
	12.4	0	5	2	29	36
	12.6	0	7	3	0	10
	15.1	7	34	3	22	66
	15.4	0	7	30	11	48
Total		7	82	131	129	349
Pole/post	6.2	0	0	6	5	11
	6.8	0	0	0	11	11
	7.0	0	0	8	6	14
	7.1	0	0	4	8	12
	7.3	0	0	0	10	10
	8.0	0	0	6	11	17
	8.3	0	0	2	11	13
	8.8	0	3	3	0	6
	9.1	0	0	0	18	18
	10.2	0	0	4	20	24
Total		0	3	33	100	136

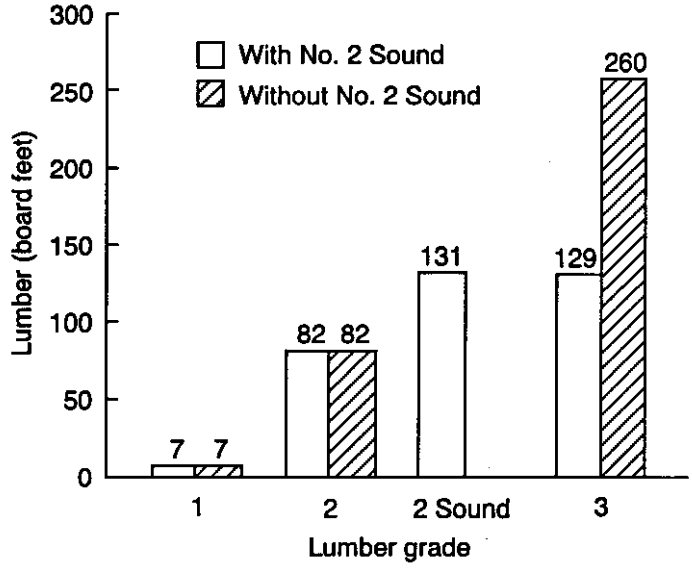


Figure 6—Lumber grade recovery from high-grade logs.

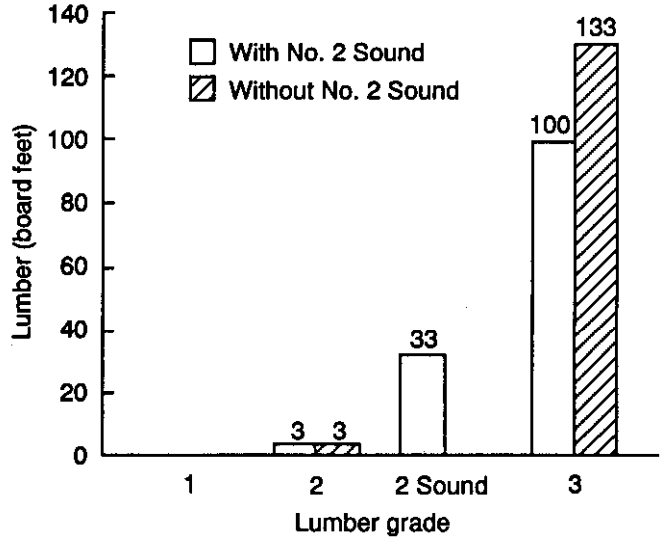


Figure 7—Lumber grade recovery from pole/post logs.

Lumber Volume Recovery

One objective of this study was to determine the lumber volume recovery from the logs. A total of 24 logs were sawn yielding 485 board feet of lumber from 130 boards. Gross log scale was computed by three scaling systems: cubic, International 1/4, and Scribner Decimal C. Cubic volume was calculated by the following:

cubic feet = 0.005454 x diameter 2 x length

Diameter was average of six readings (inches), and length was in feet.

The gross log scale was 615 board feet by the International 1/4 system, and 555 board feet by the Scribner Decimal C system (Table 4). Of the 485 board feet of lumber sawn, most was No. 3 Common. The large amount of taper in the logs inflated the percentage recovery based on the International and Scribner scales, because these are based on small-end diameter. Recovery was inconsistent for the large logs, because of the occurrence of decay.

Lumber volume recovery was similar for both high-grade and pole/post logs. The lumber recovery factor was about 4 board feet of lumber per cubic foot of log volume for both categories. The volume of boards sawn increased with log diameter, but the percentage of recovery was affected by the amount of internal rot. High-grade logs greater than 11 in. generally had recovery of less than 100 percent. Recovery for individual high-grade logs depended considerably on the amount of internal rot. Rot was most common in logs greater than 10 in. in diameter.

Table 4—Lumber volume recovery

Log category	Small-end diameter (in.)	Lumber tally (board feet)	International 1/4 Gross scale (board feet)	International 1/4 Recovery (percent)	Scribner Decimal C Gross scale (board feet)	Scribner Decimal C Recovery (percent)	Cubic Gross scale (cubic feet)
High-grade	7.6	12	15	80	10	120	3.5
	9.4	28	20	140	20	140	5.3
	9.5	19	30	63	30	63	6.0
	10.5	35	35	100	30	117	6.0
	11.0	20	35	57	30	67	6.5
	11.3	37	35	106	30	23	7.3
	12.0	38	45	84	40	95	7.0
	12.4	36	45	80	40	90	8.0
	12.6	10	55	18	50	20	9.8
	15.1	66	75	88	70	94	12.7
	15.4	48	75	64	70	69	11.8
Total		349	465		420		83.9
Pole/post	2	11	10	110	5	220	2.3
	6.8	11	10	110	10	110	2.4
	7.0	14	10	140	10	140	2.7
	7.1	12	10	120	10	120	2.6
	7.3	10	10	100	10	100	3.0
	8.0	17	15	113	10	170	3.4
	8.3	13	15	87	10	130	3.3
	8.8	6	20	30	20	30	5.3
	9.1	18	20	90	20	90	4.3
	10.2	24	30	80	30	80	5.0
Total		136	150		135		34.3

Conclusions

Our log sample should be considered of higher quality than the general log population of the Pacific yew.

Surface checking and splitting as a result of log drying in storage reduced the grade yield much the same as did internal decay. The option of producing veneer from these logs was eliminated, because the logs were too dry and contained too many checks to peel. Storing freshly debarked logs under a water spray would help prevent most surface checks and end splits. However, this would only be worth-while for the high-quality logs.

The small diameter logs in the pole/post category were less likely to have spiral grain and internal decay than were the large diameter logs. All but two of the sawlogs with internal decay were greater than 10 in. in diameter.

Lumber buyers and cabinetmakers who have seen the Pacific yew lumber have expressed favorable reactions. The only negative comment was regarding the presence of pith in some beards. English yew is similar in appearance to Pacific yew but slightly darker, tending toward light brown. English yew is marketed in Wisconsin at US$7 to US$9 per board foot. The consensus is that Pacific yew would fit well into a specialty wood class for marketing purposes.

References

ASTM. 1989. Standard practice for use of the International system of units. Philadelphia, PA: American Society for Testing and Materials.

Bolsinger, Chuck. 1992. Personal communication. July.

Chabner, Bruce A. 1991. Taxol. Principles and practice of onco1ogy. PPO updates. 5(9).

Jans, Neil A. 1992. Hauser's yew bark collection program. In: Pacific yew: a resource for cancer treatment; 1992 August 3-5; Oregon State University, Corvallis, OR.

NHLA. 1990. Rules for the measurement and inspection of hardwood and cypress. Memphis, TN: National Hardwood Lumber Association. 108 p.

Obst, John R.; Atalla, Rajai H. 1992. Concentration of taxol in the wood of Pacific yew. In: Pacific yew: a resource for cancer treatment; 1992 August 3-5; Oregon State University, Corvallis, OR.

Richardson, Sherri. 1991. Pacific yew: a miracle cancer cure? Forest Research West. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. April: 11-15.

Summit, Robert; Sliker, Alan, eds. 1980. CRC handbook of materials science. Vol. IV, Wood. East Lansing, MI: Michigan State University.

☆U.S. GOVERNMENT PRINTING OFFICE:1993-746-040-/80007