Possible demands for eastern hardwoods resulting from harvest restrictions in the Pacific Northwest

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Abstract

Efforts to conserve the habitat of the northern spotted owl in the Pacific Northwest have placed softwood timber supplies under a great deal of pressure and driven up the price of softwood lumber. Hardwoods could meet some of the demand for products that have previously been manufactured from softwood species. Hardwood structural lumber may soon become an economically feasible alternative to softwood lumber. Oriented strandboard is likely to gain a greater share of the structural panel market. Opportunities also exist for treated hardwood lumber and treated hardwood shakes and shingles. Hardwoods might also be used to make increasing proportions of many secondary wood products such as moulding, millwork, and flooring.

Hardwood timber supplies have been expanding steadily over the last several decades. There are abundant supplies of both select and nonselect hardwood species. Forest resource and industry analysts predict the consumption of hardwoods will increase dramatically over the next several decades (15, 16). These predictions were made before the preservation of the northern spotted owl became an issue in the Pacific Northwest (PNW). Softwood supply restrictions imposed to protect the northern spotted owl could open new markets for hardwoods and stimulate the hardwood industry to adopt new processing technologies. Thus, the importance of hardwoods in the United States could increase substantially during the next decade.

This report 1) summarizes the estimated impacts of the owl conservation strategy detailed in previous studies; 2) highlights forest resource and industry data for the three-state "owl region" (Washington, Oregon, and California); and 3) discusses new market opportunities for eastern hardwoods.

Estimated harvest impacts of the owl conservation strategy

Parallel studies were conducted in 1990/ 1991 by the USDA Forest Service and the Bureau of Land Management (BLM) (33), the University of Washington (U of W) (21), and the American Forest Resource Alliance (AFRA) (10) to assess the impact of the Interagency Scientific Committee's (ISC) proposed owl conservation strategy (30). Each study estimated the reduction in federal timber harvest volume in the owl regions of Washington, Oregon, and California will be approximately 52 percent for 1995 to 2000 compared to 1983 to 1987 (Fig. 1). The U.S. government's *Forest Plans,* announced on July 1, 1993, could, in fact, lead to an even more drastic (76%) reduction in federal timber harvest volumes in these owl regions.

Not all plans to curtail harvesting on federally managed lands in the PNW have been imposed on the Forest Service and BLM through external mandates. A harvest reduction of approximately 12 percent was planned by the Forest Service and BLM prior to the introduction of the northern spotted owl conservation strategy (33). This planned reduction in harvest volume represented an early attempt by federal timber managers to incorporate owl conservation measures into their resource management plans.

Forest Service harvest volumes are already exhibiting this downward trend. Compared to 1983 through 1987 levels, 1991 Forest Service harvests were down 29 percent across all regions of Oregon, California, and Washington (31). Harvest levels were down an additional 27 percent in 1992 (vs. 1991) across this same region (32). The volume of timber offered for sale

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Forest Prod. J. 43(10):51-57.

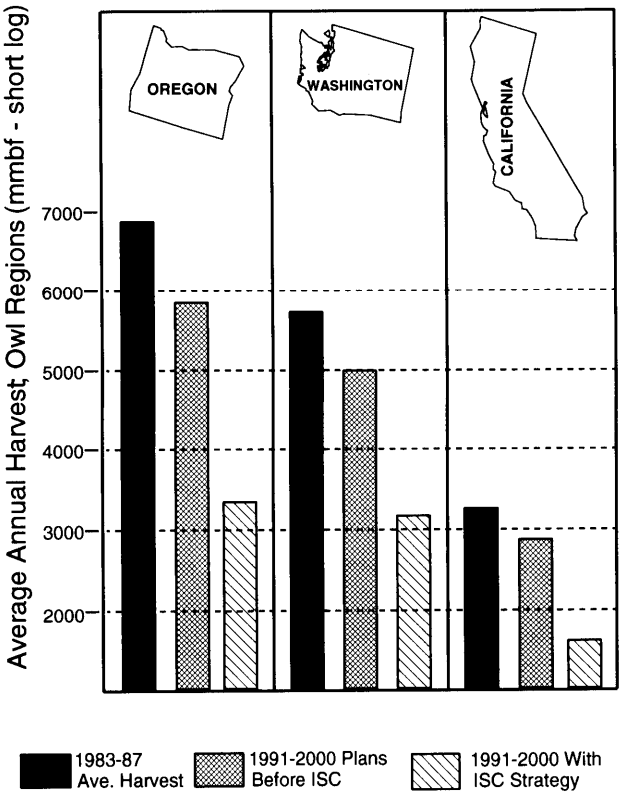

Figure 1. — Estimated harvest impacts of the Interagency Scientific Committee's northern spotted owl recovery plan. Source: (10).

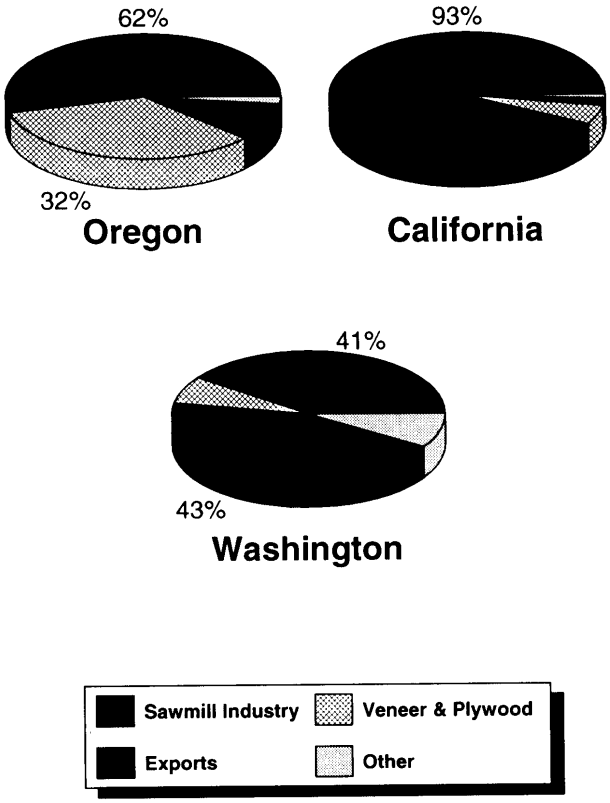

Figure 2. — Log consumption by PNW forest products industries. Sources:(18-20).

by the Forest Semite in California, Washington, and Oregon in 1992 was 78 percent lower than the volume offered in 1990 (32). CROWS Newsletter (8) reports that harvests from both Forest Service and BLM lands for the five-state region comprised of Washington, Oregon, California, Idaho, and Montana were down 34 percent in 1991 compared to 1990 and 48 percent compared to 1989.

The Forest Service and BLM, U of W, and AFRA studies all assume a change in the stumpage price for softwood logs and incorporate this into their estimates of log supply shifts. As part of the Customs and Trade Act of 1990, log export restrictions were expanded to include restrictions on the export of logs originating on state lands (12). This legislation should have a mitigating effect on the increase in softwood stumpage prices in the PNW because logs that were previously exported will now be available as part of the domestic supply. Despite this, the Forest Service and BLM study estimates an average softwood stumpage price of $89.03 per thousand board feet (MBF) ($1967) by the year 1995 for the western Oregon and Washington supply region. This represents a 109 percent increase over 1988 price levels. Over the same period the price of softwood stumpage in the South is expected to increase to $54.02 per MBF ($1967), a 36 percent increase.

Using the Forest Service's Timber Assessment Market Model (TAMM), economists estimate that private landowners in the PNW will respond to increased stumpage prices by increasing harvests by an amount equal to one-half the anticipated federal harvest reduction in the three-state region (33). The private harvest response is expected to last for less than 10 years; private reserves of merchantable timber will be drastically reduced by the year 2000. The anticipated depletion of the private timber inventory in the 1990s is likely to lead to a total harvest reduction by the year 2000 in the three-state owl region that is 10 percent greater than the levels attributed to federal set-asides alone (33).

In response to the harvest reductions in the PNW, both the South and Canada are likely to increase their production of softwood lumber and panel products dramatically. The volume of softwood lumber imported from Canada in the year 2000 will be approximately 16 percent higher (3 billion BF higher) with implementation of an ISC-type strategy (33). The change in the South's softwood lumber production will be smaller than that of Canada's; the increase in production is expected to be on the order of 0.3 to 0.5 billion BF.

The outlook for the PNW forest products industry

Oregon, California, and Washington are the largest softwood lumber producing states in the United States. In 1991, Oregon produced about 20 percent of the nation's softwood lumber, California produced 13

percent, and Washington produced 12 percent (adapted from (34)). Oregon also ranks first in plywood production, producing 30 percent of U.S. total plywood footage (17). Washington produces less than 6 percent of the national total (adapted from (20)), and California less than 2 percent (adapted from (19)).

Harvest impacts on primary industries

Sawmill industry. — Harvest reductions on federal lands in the PNW will have the largest volume impact on the sawmill industry. Approximately 62 percent of the logs harvested in Oregon, California, and Washington were consumed by the sawmill industry in 1988 (Fig. 2) (18-20).

In 1988, 49 percent of the logs consumed by the sawmill industry in these three states were from federal lands (Fig.3) (18-20). In the western regions of Oregon, 16 of the 73 largest sawmills were more than 67 percent dependent on the National Forest log supply in 1988 (18). In northern California in 1988, 6 of the 36 largest sawmills were more than 67 percent dependent on the National Forest log supply (19).

Because "suitable owl habitat" consists predominantly of old-growth timber, the historical dependence of the various industry segments on the old-growth resource serves as an indicator of the potential impact of the timber set-asides on these segments. The PNW sawmill industry processed 56 percent old-growth timber (> 100 yr.) in 1988 (Fig. 4) (18-20).

Other industries. —The veneer and plywood industry of western Oregon consumed one-third of the log volume of the region in 1988 (Fig. 2) (18). It was slightly more dependent on federal timber than was the western Oregon sawmill industry (Fig. 3) (18). In contrast, the veneer and plywood industries of northern California and western Washington consumed only 5 percent of their region's logs in 1988 (19,20). They have tended to be less dependent on the federal log supply than has been the Oregon veneer and plywood industry. The veneer and plywood industries of Oregon, California, and Washington processed 71, 39, and 44 percent old-growth timber, respectively (18-20).

The Washington shake and shingle industry, which consumed less than 1 percent of the state's log volume in 1988, consisted of 92 manufacturers processing predominantly western redcedar (20). The shake and shingle industry in Washington depends heavily on federal timber and old-growth timber (Figs. 3 and 4) (20).

Log exports have been significant for Washington but not the other two states. preliminary data compiled by Larsen (20) for the year 1988, indicate that 41 percent of the logs consumed went to the export market. Seventeen percent of these logs came from state lands that have since come under export restrictions (20). This volume of newly available logs off state lands nearly equals the volume expected to be lost from the state's National Forests. This suggests that the impact of the reduced federal harvest volumes may not be as devas-

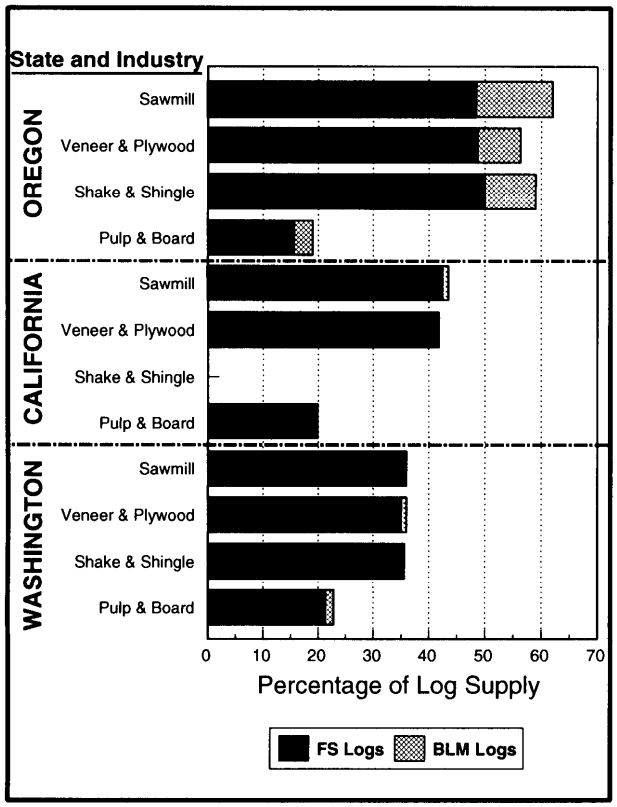

Figure 3. — Dependence of PNW forest products industries on the federal log supply. Sources: (18-20).

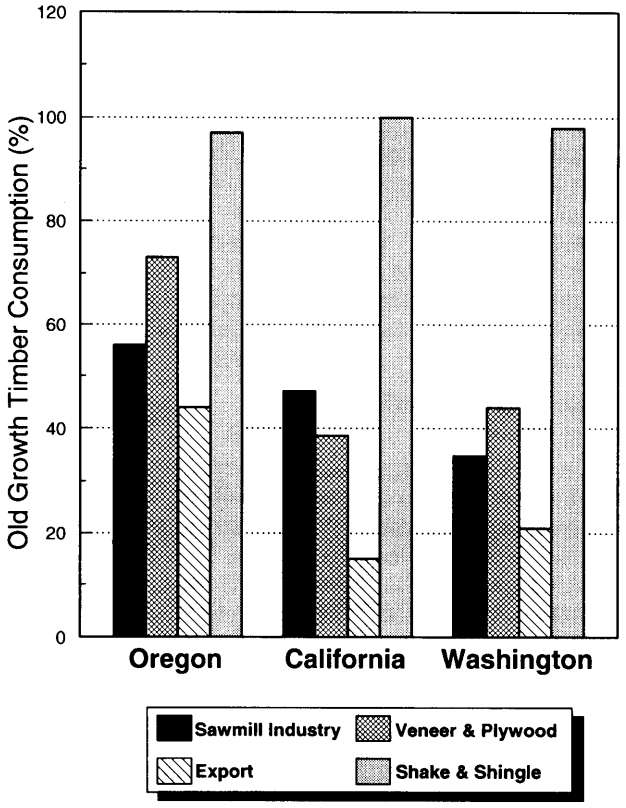

Figure 4. — Dependence of PNW forest products industries on old-growth timber (>100 yr. old). Sources: (18-20).

tating to Washington's forest products industry as might be the case for the other two states (20).

Secondary wood products impacts

Approximately 17 percent of the lumber produced in Oregon, California, and Washington goes to a secondary processor for further manufacture (34). Most of this is softwood lumber. (Less than 3% of the lumber produced in these states is hardwood lumber.)

The secondary wood products industries in the states of Oregon and Washington are very dependent on softwood species located in the Douglas-fir subregion for many of their products. In these two states, 34 of 50 moulding/millwork/flooring producers use these softwood species as do 25 of 68 furniture/cabinet producers and 15 of 30 architectural millwork producers (24). In 1991, 17 percent of the lumber produced in Oregon and 14 percent of the lumber produced in Washington was shipped to secondary processors (34).

The secondary wood products industry in California is not as dependent on "owl-region softwoods" as is Oregon's secondary wood products industry. Only 8 of 135 furniture and cabinet producers, 17 of 25 architectural millwork producers, and 14 of 37 moulding/millwork/flooring manufacturers utilize the softwood species that will be the most affected by the harvest restrictions (adapted from (24)). The southern California furniture industry is heavily dependent on eastern hardwood species, especially red and white oak (23).

Markets for Eastern hardwoods — new opportunities

While the PNW log supply shortages may open up some West Coast markets to eastern hardwood products, the shortages will more likely lead to new market opportunities for eastern hardwoods in the East and Midwest. Increases in softwood product prices brought about by the log supply shortages should cause eastern U.S. wood products manufacturers and users to look at the feasibility of substituting hardwoods for softwoods in certain applications. Undocumented reports from some companies indicate that this conversion has already started.

Shakes and shingles and other exterior wood products

The shake and shingle industry, although a much smaller industry than the sawmill, plywood, and export industries in the PNW, will be hugely affected by the timber set-asides due to how heavily it relies on the old-growth timber resource. "Suitable owl habitat" consists predominantly of old-growth timber stands.

The more decay-resistant hardwoods lack certain characteristics possessed by western redcedar, the dominant shake and shingle species (95% of the market; (26)). Locust, osage-orange. and white oak are all very heavy woods that are not as easily worked as western redcedar. Black walnut is too expensive and also too heavy to be used in shake and shingle production.

Yellow-poplar siding has been shown to weather well when pretreated with chromium oxide and finished with acrylic latex paint (13). Hardwood species such as aspen, cottonwood, basswood, and soft maple are relatively light in weight and easily worked but lack decay resistance. The Hardwood Research Council has identified the need for research into preservative treatment of hardwood products to prevent decay (22). Borate compounds, used in Australia and New Zealand to treat hardwoods, are the current focus of research efforts in hardwood products treatment (22). The southern yellow pine (SYP) industry recently entered this market, promoting treated pine shakes and shingles.

The redwood lumber industry in California will also be greatly affected by the spotted owl conservation strategy. Approximately 22 percent of the lumber produced in California is redwood lumber (adapted from (34)). A large percentage of redwood sawmills depend on a timber supply from private and state lands. California's redwood log supply will be under tremendous pressure because a large percentage of the redwood lands have been identified as Spotted Owl Habitat Conservation Areas. The state of California's spotted owl conservation guidelines will play a large role in determining the degree to which the redwood sawmilling industry in the state will be transformed.

Redwoods natural durability makes it popular as an exposed building material for siding, patio and garden furniture, stadium seats, posts, and fence material. Redwood lumber is also remanufactured into millwork and dimension. Treated SYP competes with redwood in most of these markets. Higher value markets exist for many of the more decay resistant hardwood species. Again, research activity in the area of hardwood preservative treatment could make some of the more underutilized hardwood species available for exterior applications.

Veneer, plywood, and board products

In Oregon, where 30 percent of U.S. softwood plywood is manufactured, the short-term impact of the harvest restrictions will be very noticeable. Plywood and veneer manufacturing processes in the PNW rely on large-diameter logs, most of which come from trees that are over 100 years old. Over time, the plywood industry may adapt to processing small logs in the PNW as it has in the South. It would then be competing for timber with the region's sawmill industry.

Plywood's share of the structural panel market has been decreasing for a couple of decades. This decline will accelerate in the next decade due to new technologies in replacement board products and harvest restrictions associated with the spotted owl habitat conservation strategy. A sign of things to come is given in CROWS weekly letter (2), which reports on the closure of an Oregon plywood facility, "Citing the lack of available timber from Willamette National Forest as the sole reason behind its decision, Willamette Indus-

tries has announced that it will close its plywood plant in Lebanon, Oregon."

Yellow-poplar and sweetgum have been used in combination with SYP in the manufacture of structural plywood since the performance standard was established in the mid- 1980s. Use of hardwoods should continue to grow as SYP plywood producers look to expand into markets formerly served by the western softwood plywood industry.

Waferboard and oriented strandboard (OSB), the new generation of panel products, have been eroding plywood's position as the dominant structural panel form since their introduction in the 1960s. These products are typically manufactured from small-diameter and low-grade logs. In 1978, waferboard and OSB held only 3 percent of the total U.S. structural panel market (11). Their market share increased to 8 percent in 1983 and 24 percent in 1989 (9). OSB has recently been introduced as an alternative material for shingles.

OSB is the more highly valued of the two flakeboard products because the orientation of the strands on alternating layers gives it high strength. OSB gives much higher log yields from a lower cost log resource compared to plywood. The American Plywood Association estimates that expansion in structural panel production capacity will come almost exclusively from added OSB capacity in the foreseeable future (2). Soft hardwoods and softwoods are the preferred raw materials for OSB. Yellow-poplar, sweetgum, soft maple, basswood, and birch are eastern hardwood species that are being used or have been suggested for use in the OSB manufacturing process. The cost of shipping these panel products to more distant markets can be more readily justified if the price of PNW softwood plywood goes up due to increased stumpage costs.

Structural lumber

The three states most directly affected by the timber harvesting restrictions associated with owl habitat conservation efforts are the top three softwood lumber producing states in the country. Over 80 percent of the softwood lumber manufactured is sold/used as structural building material. The major products competing with PNW structural lumber for a share of the structural lumber market are Canadian spruce-pine-fir and SYP.

Two alternative products that have been researched and developed but are not being produced on a large scale are yellow-poplar framing lumber and laminated veneer lumber (LVL) made from yellow-poplar. The Hardwood Research Council has identified the need for research into the economics and marketing aspects associated with yellow-poplar structural lumber production (22); many of the technical questions in the production of hardwood framing lumber have been resolved. The hesitancy of eastern sawmillers to produce yellow-poplar framing lumber is due in large part to the hardwood sawmill industry's lack of product knowledge and marketing experience, and uncertainties about the relative profitability of producing structural lumber.

During the next several years the financial incentive to try manufacturing yellow-poplar framing lumber should be much stronger than it has been in the past. CROWS softwood lumber price report bulletin shows the price of green Douglas-fir studs and SYP studs rose from May 1990 to May 1991 by $57/MBF and $10/MBF, respectively (2). Between May 1991 and May 1992, the price of Douglas-fir studs rose an additional $25 and the price of SYP studs rose another $33 (2-7). These price changes are likely due in large part to the tightening of the softwood log supply. CROWS weekly letter (2) reports "lack of log supplies is causing a number of mills to maintain one-shift production schedules, even though they would like to run two or three." As the housing market starts to recover, the increased demand for structural lumber should cause the price of studs and dimension lumber to escalate at an even faster rate.

Allison et al. (1) estimated the relative benefits of producing yellow-poplar framing lumber versus SYP framing lumber. They assumed: 1) a yellow-poplar stumpage cost of $50/ MBF versus $ 120/MBF forSYP; 2) a manufacturing cost of $85/MBF for yellow-poplar versus $75/MBF for SYP; 3) a residue value of $37/MBF for yellow-poplar versus a residue value of $56/MBF for Syp; and 4) a selling price for yellow-poplar framing lumber that was 10 percent less than the selling price of SYP lumber. The value per MBF for yellow-poplar logs ranged from $66 to $78 in this analysis. The value of SYP ranged from $42 to $43/MBF (l).

The failure of yellow-poplar to gain acceptance in structural lumber markets can be attributed, in part, to production scale problems (25,29). Given the small size of most hardwood mills, even moderate levels of demand for hardwood structural lumber could not be met in local markets unless multiple mills began producing yellow-poplar structural lumber at the same time. However, a larger softwood mill could produce hardwood framing lumber on a sufficiently large scale to provide a constant supply to several customers. Softwood lumber producers might look at this option if softwood log prices continue to rise (25). Numerous inquiries as to the availability of yellow-poplar structural lumber were received in the first quarter of 1992 when spruce/pine/fir prices spiked. [1]

Information on resource availability, building contractor perceptions, and manufacturing productivity and costs is needed in order to reduce the uncertainty that is acting as a barrier to the production of yellow-poplar framing lumber.

LVL has typically been constructed from SYP and western softwood species. Yellow-poplar and sweetgum have also been used in the manufacture of LVL. Resource analysts, pointing to the decrease in the availability of old-growth timber and an increased

[1]Muench. 1992. Personal communication.

reliance on managed forest timber, predict LVL will be a very important part of the structural lumber market in the near future. LVL is constructed of parallel layers of veneer that can be peeled from smaller diameter logs. It has strength properties that are more uniform and generally higher than the strength of sawn material from the same species (27). It is used for large structural wood members such as roof trusses, door headers, and flanges on wood I-beams (27).

Yellow-poplar LVL has been produced in only limited quantities to date. A wood I-beam manufacturer in North Carolina is using yellow-poplar in the construction of I-beam flanges. A company in Virginia that started operations during the summer of 1991 is using oak, yellow-poplar, and hickory to manufacture single-species LVL for export. The LVL will be used in the production of architectural millwork and furniture.

Secondary processing

A large percentage of the secondary wood processing mills in Oregon, California, and Washington buy softwood lumber species that will be less available and more expensive in coming years as a result of the spotted owl conservation strategy. Mills operating with healthy profit margins may be able to pay a higher price for their raw material. Industries that are operating with a narrow profit margin maybe more inclined to look for alternative, less costly raw materials. Furniture and cabinets, architectural millwork, moulding, millwork, and flooring are all secondary products that are regularly manufactured out of hardwoods as well as western softwoods and SYP.

Many of the more highly demanded eastern hardwood species are more expensive than Douglas-fir, western hemlock, etc. However, some of the underutilized hardwood species such as yellow-poplar and soft maple could be substituted for softwood species that are being used by secondary wood processors. A survey of 128 architectural millwork producers indicated that mouldings, paint-grade mouldings, miscellaneous paint-grade material, doors, trim, and cabinet parts were considered viable product lines for yellow-poplar (14). One survey respondent commented, 'We use poplar because it's about half the price of pine products and machines easier than soft maple." The shipment of East Coast hardwood lumber to West Coast secondary wood products manufacturers may become feasible if West Coast softwood lumber prices climb to anticipated levels.

PNW softwood lumber is also shipped to Eastern and Midwestern secondary wood products manufacturers for further processing. Approximately 15 percent of the mills east of the Mississippi River that produce architectural millwork, moulding, millwork, or flooring, process PNW softwood species (Douglas-fir, redwood, Ponderosa pine, western cedar (24)). When you look at this on a volume basis, softwood use in the moulding/millwork industry far exceeds hardwood use. Eastern hardwood lumber manufacturers are already experiencing increased demand from this market segment. The increased demand has contributed to the increase in the price of yellow-poplar lumber.[1]

West Coast furniture manufacturers use predominantly red and white oak and red alder. The continued production of red alder lumber at current output levels is uncertain because red alder and other hardwoods grow on sites considered to be prime softwood timberlands (15% of prime forestland in western Oregon (28)). Whether these hardwoods will be utilized on a larger scale given the softwood supply squeeze or tithe hardwood timber acreages on prime sites will be converted to softwood plantations is a question that remains unanswered. If timberland conversion to softwoods occurs, eastern hardwood species would be more in demand by the California furniture industry.

The production of red alder lumber has already dropped off as a result of the northern spotted owl habitat conservation strategy. The reason for this more immediate response is that hardwood logs traditionally have been obtained for a very low price off softwood timber sale blocks.[2] The PNW hardwood sawmill industry is having a hard time adjusting to the idea that it now must pay higher stumpage prices for hardwood logs. This situation is likely to be remedied eventually, but for the short term it presents a hardwood timber supply problem in the PNW.[2] During this adjustment period, eastern hardwood lumber and products should be able to gain market share in PNW and California markets.

Increased utilization of West Coast hardwoods and/or increased shipments of eastern hardwood lumber to the PNW may be needed in order to sustain PNW secondary wood products operations that are presently dependent on a timber resource that will be less available and more expensive in the coming decade.

Summary and conclusions

The standing hardwood timber resource has been expanding steadily over the last several decades (15). Between 1952 and 1987, hardwood growing stock volume in the United States increased 69 percent while softwood growing stock volume increased only 5 percent (15). The hardwood sawtimber inventory increased by 85 percent over that same period (15). Forest resource and industry analysts predict that the consumption of hardwoods will increase by an estimated 79 percent from current levels over the next several decades while the consumption of softwoods will increase only 22 percent (15). These predictions were made before preservation of the northern spotted owl became an issue in the PNW.

Significant opportunities now exist for eastern hardwood lumber producers to step in and fill some of the demand for structural lumber. Research in this area has been underway for some time. It is now time for researchers to identify interested industrial cooperators with whom they can work to develop viable

[2]Haynes. 1992. Personal communication.

processing and marketing strategies for hardwood framing lumber.

Softwood log supply shortages will also have a major impact on Washington's shake and shingle industry and Oregon's softwood plywood industry. Research and development in the treating of hardwoods to promote durability could provide opportunities for eastern hardwoods in the shake and shingle market. The rise of OSB in the structural panel market that has occurred over the last decade should continue, and perhaps even accelerate, given the log supply problems being suffered by PNW plywood producers.

The opportunities for new hardwood products in markets formerly served predominantly, if not exclusively, by softwoods (e.g. moulding and millwork) will be most readily developed in the eastern United States. The cost of shipping PNW softwood products, combined with the added cost of producing the products owing to the increase in log prices, will give hardwood products a stronger cost-basis for competition. In addition, species familiarity might help attract eastern U.S. consumers to new hardwood products.

Softwood supply problems should stimulate the hardwood industry to move forward in the utilization of new technologies and the development of new markets at a much faster pace than would otherwise be expected. Eastern hardwood producers need to be acutely aware of the changes the PNW softwood timber supply shortage will mandate for the industry as a whole. Expanded market opportunities are not limited to SYP and Canadian softwood producers: they should be aggressively pursued by both East and West Coast hardwood manufacturers.

Literature cited

1. Allison, R. C., E.L. Deal, and L.G. Jahn. 1987. Production and uses of yellow-poplar framing lumber. Forest Prod. J. 37(10):31-36.
2. Anonymous. 1991. CROWS Weekly Letter. May 17, 1991. C.C. CROWE Publications, Inc., Portland, Oreg.
3. _____ 1992. CROWS Weekly Letter. May 1, 1992. C.C. CROWE Publications, Inc., Portland, Oreg.
4. _____ 1992. CROWS Weekly Letter. May 8, 1992. C.C. CROWE publications, Inc., Portland, Oreg.
5. _____. 1992. CROWS Weekly Letter. May 15, 1992. C.C. CROWE Publications, Inc., Portland, Oreg.
6. _____. 1992. CROWS Weekly Letter. May 22, 1992. C.C. CROWE Publications, Inc., Portland, Oreg.
7. _____. 1992. CROWS Weekly Letter. May 29. 1992. C.C. CROWE Publications, Inc., Portland, Oreg.
8. _____.1992. CROWS Weekly Letter. October 9, 1992. C.C. CROWE Publications, Inc., Portland, Oreg.
9. _____ 1990. Forest Industries' Annual Panel Rev. April 1990. San Francisco, Calif.
10. Beuter, J.H. 1991. Social and economic impacts of spotted owl conservation strategy. Forest Res. Tech. Bull. No. 9003. Am. Forest Res. Alliance, Washington, D.C. 37 pp.
11. Chiang, T.I. 1985. Economics of oriented strand board production in Georgia. Rept. of Georgia Tech Res. Inst., Atlanta, Ga. 78 pp.
12. Darr, D.R. 1991. Impact of west coast set-asides on southern forests. *In: Proc.* of 1991 Southern Forest Econ. Workshop. Washington, D.C.
13. Feist, W.C. 1987. Weathering performance of finished yellow-poplar siding. Forest Prod. J. 37(3):15-22.
14. Flowers, J. C., C.C. Hassler, and W.G. Luppold. 1990. Utilization of yellow-poplar in the architectural moulding and millwork industry. Forest Prod. J. 40(10):35-38.
15. Haynes, R.W. 1990. An analysis of the timber situation in the United States: 1989-2040. General Tech. Rpt. GTR-RM-199, USDA Forest Serv., Rocky Mountain Forest and Range Expt. Sta., Fort Collins, Colo. 268 pp.
16. _____ and D.M. Adams. 1992. The Umber situation in the U.S.: analysis and projections to 2040. J. of Forestry 90(5):38-43.
17. Hill, D.S. 1989. Directory of Oregon Forest Products. Oregon State Dept. of Forestry, Portland, Oreg. 105 pp.
18. Howard, J.O. and F.R. Ward. 1991. Oregon's forest products industry: 1988. Resource Bull. PNW-RB-183, USDA Forest Serv., Pacific Northwest Res. Sta., Portland, Oreg. 91 pp.
19. _____ and F.R. Ward. 1991. California's forest products industry: 1988. Resource Bull. PNW-RB-150, USDA Forest Serv., Pacific Northwest Res. Sta., Portland, Oreg. 69 pp.
20. Larsen, D.N. 1992. Washington mill survey — 1988. Washington State Dept. of Natural Resources, Olympia, Wash. 147 pp.
21. Lippke, B., K. Gilless, R. Lee, and P. Sommers. 1990. Three-state impact of spotted owl conservation and other timber harvest reductions: a cooperative evaluation of the economic and social impacts. Contribution No. 69, Institute of Forest Resources, Seattle, Wash. 43 pp.
22. McLintock, T.F. 1987. Research priorities for Eastern hardwoods. Hardwood Res. Council, Asheville, N.C. 103 pp.
23. Meyer, C.J. 1991. Material use, product profiles and channels of distribution in the U.S. wood furniture industry. Master's thesis. Virginia Tech, Blacksburg, Va. 137 pp.
24. Miller Freeman Publications. 1989. Secondary Wood Products Manufacturers Directory. E.B. Mendoza, ed. San Francisco, Calif. 608 pp.
25. Muench, J. 1990. The future of yellow poplar structural lumber. Forest Industries 117(4):3-5.
26. Panshin, A.J. and C. deZeeuw. 1970. Textbook of Wood Technology. McGraw-Hill Book Co., New York. 705 pp.
27. Pierson, D. and G. Perry. 1988. Laminated veneer lumber and the resource. *In:* Proc. Structural Wood Composites: New Technologies for Expanding Markets. No. 47359, Forest Prod. Res. Society, Madison, Wis. pp 85-87.
28. Poppino, J.H. and D.R. Gedney. 1984. The hardwood resource in western Oregon. Resource Bull. PNW-RB-116, USDA Forest Serv., Pacific Northwest Forest and Range Expt. Sta. Portland, Oreg. 37 pp.
29. Smith, T.K. 1989. Opportunities for distributing yellow-poplar construction lumber. *In:* Symp. Proc. Yellow-Poplar Construction Lumber: An Emerging Development Opportunity for Southwest Virginia. John Muench, ed. Virginia Tech, Blacksburg, Va. pp. 49-57.
30. Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Interagency scientific Committee rept., USDA Forest Serv., USDI Bureau of Land Management, USDI Fish and Wildlife Service, USDI National Park Service, Portland, Oreg. 427 pp.
31. U.S. Department of Agriculture — Forest Service. 1992. Report of the Forest Service: fiscal year 1991. Washington, D.C. 107 pp.
32. _____.1993. Report of the Forest Service: fiscal year 1992. Washington. D.C. 217 pp.
33. _____ and U.S. Department of Interior — Bureau of Land Management. 1990. Economic effects of implementing a conservation strategy for the northern spotted owl. Tom Hamilton and Joe Zimmer. team leaders. Interagency Working Group rept. 65 pp.
34. Western Wood Products Association. 1992. 1991 statistical yearbook of the western lumber industry. Western Wood Prod. Assoc., Portland, Oreg. 33 pp.