Proceedings of the National Northern White Cedar Conference
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PROCEEDINGS OF

NATIONAL NORTHERN WHITE CEDAR CONFERENCE

Department of Forestry

February 1976

OBJECTIVES OF NORTHERN WHITE CEDAR CONFERENCE
Escanaba, Michigan - April 24, 1975
Henry Huber - Forestry Department
Michigan State University

I. A large amount of Northern white cedar is grown in Michigan and it ranks as one of the largest in quantity when compared with other soft wood species.

II. USE - It is an important wood in the manufacture of fences and vacation homes, and has many unique properties not found in other woods.

III. It provides unique food and habitat for wildlife.

IV. It has the lowest density (weighs least per cu. ft.) of any commercial domestic wood. These physical properties will be discussed later, but they contribute to the unique usefulness of this species.

V. Northern white cedar heartwood is one of the few woods that has a natural resistance to decay and insect attack. This property alone is important to many of its uses such as fences, posts and building construction.

This report calls attention to the importance of Northern White Cedar as a species and particularly points out its usefulness for things other than wildlife habitat. Because so little has been published on this species, this report is a necessary contribution to the literature as a reference for White Cedar's important properties.

HOW MUCH CEDAR IS THERE GROWING by Allen Boelter, Staff Forester, and Jack Zollner, Utilization Forester, Michigan DNR, Lansing, Michigan

GROWING MORE CEDAR by Dr. W. Johnston, USDA Forest Service, Grand Rapids Minnesota

SPECIAL PHYSICAL AND CHEMICAL PROPERTIES by Dr. Eldon Behr, Professor, Department of Forestry, Michigan State University

THE RESISTANCE OF CEDAR TO DECAY, INSECTS AND STAIN by Dr. Eldon Behr, Professor, Department of Forestry, Michigan State University

PRESERVATIVE TREATMENT OF CEDAR by Richard Leinfelder, McGillis & Gibbs, Milwaukee, Wisconsin

DRYING AND MACHINING OF CEDAR by Dr. Henry A. Huber, Extension Specialist in Forestry, Michigan State University

THE CEDAR FENCE INDUSTRY by Gene Peterson, Peterson Brothers Manufacturing Co., Carney, Michigan

THE CEDAR VACATION HOME INDUSTRY by John Walbridge, American Timber Homes, Escanaba, Michigan

PARTICLEBOARD by James Homilton, Michigan Technological University, Houghton, Michigan

OIL by Jerry Hagen, Cory Laboratories, Menominee, Michigan

BOUGHS by W. Teal, Teal Evergreens, Bark River, Michigan

PULP by Lynn Sandberg, Mead Corporation, Escanaba, Michigan

MICHIGAN DRAIN DATA BY-PRODUCT

by
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Facts relating to cedar drain are not as specific as I'd like to report; and in the case of cedar, I'm afraid this is more pronounced than with most other commercial species. I certainly hope that one of these meetings will be a recognition of the accomplishments and need for better drain data and better cedar resource data, and meaningful action to obtain both.

Michigan's most recent timber drain survey was made at the end of calendar year 1972; the report of this survey provides the best data available. The previous survey was made for calendar year 1969. The next one is planned for calendar year 1975. The 3 year interval is coincidental. I think this information should be developed annually. I have some reservations about the 1975 survey -- it will produce some very untypical information -- but it's tied in with North Central Forest Experiment Station's work plan to develop 1975 drain data for the Lake States area of Michigan, Minnesota and Wisconsin. This will be the first time all three states will have made a survey for the same year. It makes sense, because the using industry does not recognize state boundaries.

The timber harvesting industry, like so many others, reflects the mood of the economy. Those of you in the cedar-using industry need look back to when all the pleading and begging and cajoling in your power to get raw cedar produced barely enough. In some cases it wasn't enough, because substitute species were often used when acceptable. Today the situation is quite the opposite. Quirks in our economy have a significant impact on the status of the timber resource and northern white cedar is no exception.

Here are drain figures that I feel have most significance to this conference.

In 1972, our best timber drain collection efforts showed that 5,300,000 cubic feet of northern white cedar were harvested from Michigan forests. Only 662,000 cubic feet came from the Lower Peninsula. In the Upper Peninsula, the so-called eastern block of seven counties (Alger, Delta and Menominee are the west boundary counties in this block) yielded the major volume - 4,085,000 cubic feet or almost 80% of the state total. The Upper Peninsula western block yielded 553,000 cubic feet, slightly less than the Lower Peninsula volume.

A breakdown of this total volume into major product categories reveals the interesting fact that until 1972, no white cedar had been reported cut for pulpwood. In 1972, 4,000 cords are reported to have entered the pulpwood market. Interesting, yes - significant, I'm not sure. Regardless of how we view it, I bring it to the attention of the cedar using industry with the implication that other species can be used for pulpwood, but they cannot be substituted for northern white cedar fences.

Cedar sawlog production increased from a statewide total of 2,981,000 board feet in 1969 to 8,514,000 board feet in 1972. This is an increase of 5,533,000 board feet. In other words, the 1972 production of cedar sawlogs was nearly three times what it was in 1969. This is certainly a significant increase, and one that would certainly concern forest managers and the cedar-using industry if it showed signs of maintaining that growth. But, what will the '75 figure be? I'll let you know about a year from now.

Statewide cabin log production was 508,000 board feet. The Lower Peninsula is credited with 200,000 board feet; the eastern Upper Peninsula block with 250,000 board feet; and the western Upper Peninsula block with 58,000 board feet. Similar production ratio by area applies to poles. Statewide pole production was 16,478 pieces. The Lower Peninsula produced 278 pieces; the eastern Upper Peninsula block produced 16,033 pieces; and the western Upper Peninsula block produced 167 pieces.

Statewide post production was 2,912,000 pieces. This time both Upper Peninsula blocks yielded more than the Lower Peninsula. The Lower Peninsula production was 216,000 pieces; the eastern Upper Peninsula block was 2,396,000 pieces; and the western Upper Peninsula block was 300,000 pieces.

Within the Upper Peninsula, the five leading cedar producing counties, in order of descending production are: Menominee, Delta, Chippewa, Mackinac and Dickinson -- Marquette is almost the same as Dickinson. In the Lower Peninsula, it should be no surprise that Alpena leads; followed by Presque Isle, Roscommon, Cheboygan and Antrim. The 1972 survey did not attempt to determine drain by land ownership. We know this is desirable information, and we are considering making it a part of our 1975 survey. I might add that even now, this information could be obtained. Both DNR and Forest Service, the major public land owners, keep current timber cutting records. The sum of these two, subtracted from the total, will give the volume removed from private ownership.

This last category (posts) provides the timber drain gatherer with his biggest dilemma. We're certain that a significant volume of cedar is moved by producers whose operations are small and/or seasonal, or not a part of a company that we contact. We do not have a handle on this segment of the cedar producing industry, and don't know how to cope with it. This is the part of the industry that includes the farmer producing posts for road-side sale to those selling to relatively local retail outlets, to those sending truck loads out of state. It is possible that the reporting of drain information will be part of a state forest practices act. We know we're going to have a Forest Practices Act - EPA says every state will. In fact, it as much as says it will provide one where the states don't do it on their own.

I'd like to point out another dilemma. You heard me quote units of measurement from cubic feet to pieces, with cords, cabin logs and board feet in between; in addition, we also get production reported in lineal feet and tons. That's seven units of measurement, not considering that a pole is a lot different "piece" than is a post. We use conversion factors to arrive at a common unit of measurement. But how nice it would be for us charged with the task of developing drain data to have it all reported in the same unit of measurement.

I'd like to raise another issue. While visiting a mixed species timber sale with one of our area foresters last year, we asked the logger why he was procrastinating about cutting the cedar. Markets were available, yet he was passing up the cedar, at least for the time being. The logger's answer was that in checking out the markets for the range of diameter sizes he would produce, there was such a combination of diameter to length specifications that to explain them to his cutters would be nearly impossible. This certainly is true, but just as certainly not a condemnation of cedar users. However, since it does apparently create some confusion on the part of the log cutter, changes, where practical, might be instituted. One of these might be buying tree or long log length by weight.

Northern white cedar is one commercial species we consider to be in surplus quantity in Michigan. Detailed analysis of the Forest Service and State figures, coupled to those which might be developed for private land only through much effort, would provide specific measurement of available cedar some people would like.

This leads me back to the first figure I mentioned. Our latest timber harvest survey shows that statewide 5,300,000 cubic feet of northern white cedar were cut from Michigan forests in 1972. I think this is a purely academic comment; certainly land managers need information like this to relate growth to drain, but why are cedar trees cut? Very simply, to create wealth. What does the harvest and processing of 5,300,000 cubic feet of cedar mean to Michigan's economy? Here is an indication, and I state these figures with considerable reservation. I arrived at them, using my own conversion factors, and I welcome advice and assistance in arriving at better figures. The value of this raw material at the processing plant - the fence plant, the cabin plant, the treating plant - is $1,730,000. Processing at the plant into a salable product increases this raw material to an in-plant value of $6,920,000. The value at the time it reaches the consumer is $13,840,000. I feel these figures are conservative; however, they very emphatically portray the economic significance of Michigan's northern white cedar industry.

THE CEDAR RESOURCE

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This is a look at the northern white cedar resource from many aspects to determine the quality and volumes that may be available to cedar-using industries. Industries presently use this resource to produce posts, rustic fence, cabin material, and lumber. Lesser amounts are used for poles, piling, lagging and other specialized products. Recently, small amounts have been used as pulpwood.

How much cedar is growing? As a resource, cedar has not been emphasized as much as other species. Cedar is often included in summaries as mixed softwoods or as other softwoods. The most recent state-wide resource information is contained in North Central Forest Experiment Station Resource Bulletin, N.C. 9, 1970, The Growing Timber Resource of Michigan 1966. Several large private ownerships have had continuous forest inventory remeasurements since the publication. Data from these inventories have been used to indicate trends.

There are 1,014.2 million cubic feet or 12.8 million cords of cedar growing on 2.445 million acres in Michigan; included are 1.9 million board feet of sawlogs. This is the total commercial volume present regardless of its availability. Included in the volume is sound wood in the bole from the stump to a minimum 4-inch top diameter outside bark.

This acreage can grow in excess of 20 cubic feet per acre per year. Many acres of swamp conifer and cedar types are capable of growing 20 cubic feet--they presently do not because of poor or non-existent management practices.

What is the condition of the resource? Not good! Cedar is undercut in most acreas, form is generally poor, and the wood is of low quality with poor growth rates.

One-third of the cedar type is classified in site index class under 30 at age 50. An additional one-third is classed between 30 and 40.

Surveys indicate that 95% of the area conditions are less than favorable. Favorable area conditions exist where stands are at least 40% stocked with desirable trees. Desirable trees are growing stock trees with no serious defects in quality to limit present or prospective use, and of relatively high vigor with no pathogen that might result in death or serious deterioration before rotation age.

The type must be cleaned up to increase growth by creating younger, high quality, vigorous stems. Intensive cedar management on the better sites should be initiated to grow a quality product. Eighty-four percent of the growing stock is in trees under 9 inches in diameter breast height, the remaining 16% is in trees over 9 inches.

Data summarized indicate that generally acreage of cedar type is declining after cutting. The trend will continue unless more intensive management favors cedar regeneration.

Annual allowable cut. Right now an estimated 225,000 acres of cedar type is overmature, beyond the recommended 100 year rotation age. Allowable cut, for present use, is very difficult to determine because of many factors such as type of ownership, economics, size and grade of material, changing patterns of land use and regulations. Cedar is adequately cut in Menominee and Alpena counties and in portions of Delta, Dickinson, Schoolcraft, Presque Isle, Montmorency and Alcona counties. The better quality material, good logging chance, and closeness to markets influence these areas. Surplus cedar is found in the northern Lower Peninsula and the Upper Peninsula.

Allowable annual cut in the cedar type to a variable top diameter of 4 inches outside bark is estimated to be 461.8 thousand cords which includes 100 million feet of sawtimber, for next decade.

With the surplus of resource, why does the industry have problems in securing products? The type is difficult and expensive to log; there is more economic benefit to operate in other species and types, where the cost per unit removed is cheaper. Stumpage rates, quality and quantity of material in the stand, markets, selling price, and accessibility all help determine how the resource is harvested. Many stands have spruce and balsam removed, but no cedar. Why?

Survey standards include all cuts over three cords per acre and all material must be useable. Sawlogs are defined as trees over 9 inches in diameter at breast height, containing one 12-foot log with a 7-inch top with less than 50% deduction for rot and sweep. At present, many of the stands which meet these standards are not commercially operable and probably will not be soon.

It is predicted that 50% of the pole-sized material and 60% of the sawlog sizes would not be marketable if the areas could be harvested.

No projection has been made as to how much of the commercial forest land in the cedar type can be harvested with the present economic structure.

Conclusions. Michigan has an abundance of cedar that should be harvested and the type should be perpetuated to maintain healthy, cedar-based industries. Many cedar stands will not be removed until more economic logging and marketing systems can be developed.

GROWING BETTER CEDAR FORESTS

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ABSTRACT

Some important silvical characteristics of northern white-cedar need to be known to grow better forests for timber and deeryards. Present silvicultural practices are not too reliable, but available information indicates that it may be possible to rapidly reproduce "cedar" by clear-cutting mature stands of 40 acres or more, broadcast burning the slash, and direct seeding. Immature stands should probably not be thinned below 150 square feet of basal area per acre.

SILVICS

To grow better "cedar" forests for timber and deeryards, we first need to know the life history of northern white cedar and what environmental conditions favor its growth. Such information is summarized in the silvics handbook published by the USDA Forest Service (3). I'll briefly review some important silvical characteristics of this tree.

Most commercial stands of cedar occur in swamps. Growth rate increases as the organic soil becomes more decomposed and better drained. Cedar is also found on uplands where it usually grows faster than in swamps. Cedar does form pure stands, but more commonly grows in swamp conifer stands along with such trees as balsam fir, black spruce, tamarack, and black ash. It's generally thought that cedar perpetuates itself in pure stands, whereas other trees may gradually replace it in mixed stands, particularly after disturbances.

Cedar usually grows more slowly than its common tree associates and lives longer--up to 400 years or more in swamps. It can survive in the shade of other trees for several years and yet responds well to release at nearly all ages. So, depending on their history, cedar stands vary from young and even-aged to old and uneven-aged.

The relatively shallow root system of cedar makes it susceptible to uprooting where trees are exposed to the wind. Cedar is also easily damaged by fire because of its thin, resinous bark and shallow roots. Short trees and reproduction are often severly browsed by deer and hare.

Good seed crops are produced every 3-5 years. Germination and early growth are best on moist seedbeds such as rotten wood, moss compacted by skidding, and burned soils.

SILVICULTURAL PRACTICES

The most intensive silvicultural practices that have been developed for growing cedar forests should be applied on the best available sites where growth potential is greatest. However, the best sites require the most effort to manage because they usually have more slash and competing vegetation than less productive sites. Unfortunately, present practices are not too reliable, but I'll summarize what information is known from previous and current research.

Mature Stands

Silvicultural research in upper Michigan indicates that clearcutting of small areas[1] is the best harvesting method if even-aged natural reproduction of cedar is desired (1). Other research in the same region indicates that cedar forests arranged in large even-aged blocks of different age classes are best for deeryards (8). Therefore, harvesting mature stands by clearcutting 40

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[1]Blocks 130 feet square and strips 75 feet wide were the only shapes and sizes used.

acres or more in two steps, using alternate strips to provide natural seeding, has been suggested to reproduce cedar for timber and deeryards (8). Removal of the initial strips has been widely practiced in upper Michigan, generally with east-west strips about 130 feet wide and no slash disposal. In most cases, however, the remaining strips have not been removed to form the large open blocks that are essential to protect young cedar from deer and hare browsing.

To reproduce well-stocked stands of cedar rapidly, effective ways must be found to dispose of slash and control brush after clearcutting. If pure stands of cedar (at least 80%) are desired, advance reproduction and seeding of associated trees must be eliminated, followed by successful direct seeding of cedar where natural seeding is inadequate. A new cooperative study by the Forest Service's North Central Forest Experiment Station and the Michigan Department of Natural Resources (DNR) is underway to compare reproduction after both natural and direct seeding on clearcut areas where slash was either broadcast burned, removed by full-tree skidding, or left on the areas (7). Sound recommendations for rapidly reproducing cedar after harvesting cannot be made until the results of this study have been evaluated and pilot-tested under different conditions.

Some information is already available from this new study and from related research and experience. Vegetative reproduction of hardwoods, especially the very competitive root suckers of balsam poplar (balm-of-Gilead), can probably be controlled best by harvesting or otherwise killing such trees about 5 years before the stand is clearcut. Natural seeding of cedar's main tree associates can be greatly reduced by clearcutting large blocks (40 acres or more) whose interiors exceed the effective seeding range of these trees (at least 260 feet) (7). Advance conifer reproduction can be killed completely and the above-ground parts of hardwoods destroyed by broadcast burning the slash. This practice can be done safely in swamps without adverse public reaction. Further, slash disposal by either broadcast burning or full-time skidding appears to be as successful in cedar stands as it has been in black spruce stands (4, 6). The resulting seedbeds should be more favorable than those covered by deep accumulations of slash, which are common with no slash disposal. Burning may have an important advantage on the best sites if, as expected, it initially reduces brush competition more than skidding does. Finally, recent trials of direct seeding cedar after burning have produced preliminary results that are promising in some swamps.

Therefore, it may be possible to rapidly reproduce well-stocked stands of cedar by clearcutting, broadcast burning (or perhaps full-tree skidding), and direct seeding. In addition, a clearcutting system that produces open blocks of 40 acres or more in a few years offers important advantages over other silvercultural systems. Browsing damage to young cedar would be minimal because deer (8) and hare tend to avoid such areas due to the lack of protective cover. Any browsing that does occur should be light due to the great amount of food present in young stands (8). Complete harvesting of sizable areas in a short time should also minimize timber losses caused by wind damage, as well as reduce harvesting and management costs.

Immature Stands

Little experience is available on managing immature cedar stands. Probably the best information is from a 20-year thinning study in a Wisconsin swamp stand (2, 5). When the study began, the stand was essentially even-aged cedar about 65 years old with a few balsam fir and black spruce. Plots were thinned to residual basal areas averaging 90, 110, 130, and 150 square feet per acre and after 10 years were rethinned to the same levels. Uncut check plots averaged 181 and 224 square feet per acre at the time of the first and second thinning, respectively.

Results indicate that middle-aged stands can be initially thinned to a residual basal area of 130 square feet per acre and then rethinned 10 years later to at least as low as 90 square feet without affecting growth or mortality. Further, good diameter growth of cedar can apparently be maintained through repeated thinnings that favor dominant and codominant trees. The results also indicate that advance tree reproduction and shrubs grow little unless the stand is rethinned to less than 150 square feet per acre.

Therefore, it would seem best to not thin below 150 square feet of basal area per acre. This would provide an opportunity to improve the quality of the final harvest and to increase total yield without producing an undesirable undergrowth of balsam fir and shrubs, for example. Such thinning would also make it easier for deer to move about than in some extremely dense, unthinned stands (5) and yet it would maintain fairly good shelter.[2]

CONCLUSIONS

More intensive management of "cedar" forests seems inevitable if the demand for their timber and for deer continues to increase. All of us concerned with managing and using cedar should coordinate our objectives so that the maximum overall benefit is obtained. This conference should be a good start.

Fortunately, the silvicultural practices that I've discussed are compatible with the comprehensive management system proposed for swamp conifer deeryards by Louis J. Verme of the Michigan DNR (8). Therefore, these practices should generally be suitable for enhancing both timber production and deer habitat. Except for improving cedar markets in some localities, the most important need for intensifying management is to develop effective and economical ways to rapidly establish new cedar forests after clearcutting. Research now underway by the North Central Forest Experiment Station and Michigan DNR should help fulfill this need in a few years.

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[2] A basal area of 200 square feet per acre provides excellent shelter for deer according to Louis J. Verme, Michigan DNR. This basal area would be obtained about 10 years after thinning to 150 square feet per acre (2).

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SPECIAL PHYSICAL AND CHEMICAL PROPERTIES OF NORTHERN WHITE CEDAR

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Physical Properties

Of all the commercially important woods of North America northern (or eastern) white cedar on average has the lowest specific gravity. Western red cedar is slightly heavier (sp. gr. .34 vs .31 per N.W.C. based on oven dry volume). Because of its low density white cedar is also the weakest in most strength properties.

Because of white cedar's position in strength comparisons with other softwoods, applications must be aimed towards using its low density. White cedar is a knotty wood. This characteristic must also be considered in designing with cedar where strength is important. Tables listing average values for physical properties of cedar apply to clear, straight grained wood. Strength of the typical cedar board will be less than values shown.

White cedar's strength properties can be better evaluated if they are compared to other construction woods and those with high natural durability. Table 1 lists some of the commonly compared strength values. Values given are for wood of 12% moisture content. If the wood is drier it will be stronger, if wetter weaker (up to about 25%, then constant).

There are some differences in values found at Canada and United States Forest Products Laboratories, but they are not of much consequence in selection for applications. White cedar has much less stiffness when used as a beam than any of the other species as shown by its low modulus of elasticity. On the other hand it has a higher shear parallel to the grain than balsam fir. It compares favorably with western red cedar and redwood except in modulus of elasticity, and compression parallel and perpendicular to the grain.

Shrinkage of white cedar is the lowest in all three values of any softwood whether in radial or tangential grain directions or volumetric. A comparison with white spruce is revealing. White cedar shrinks 75% less than spruce tangentially in drying from green to oven dry condition.

Certain properties are important in the use of wood but a quantitative value cannot easily be assigned. For these a classification ranging from 1 = best in the property to 5 = worst is used. Northern white cedar is classed as 1 for ability to stay in place, 2 in workability, 5 in nail holding, 2 for ease of gluing and 1 in ability to hold paint.

More detailed ratings have been made on gluing as a result of work done at the Canadian Forest Products Laboratory. White cedar is rated in "easiest to glue" class for animal and casein glue and in the next class, "moderately easy to glue" using urea or resorcinol resin adhesives.

A substantial portion of white cedar is used in round form as a fence post or utility pole. Since the whole trunk section is used as a unit instead of boards or timbers cut from it, strength comparisons are different.

Tests of 22 or more poles of white cedar, jack and red pines at the Ottawa Laboratory of the Canadian Forest Service indicated that jack pine poles had a modulus of rupture 2.06 times as great as white cedar while red pine poles had a value 1.82 times as great. If the top reactions of the poles are compared at maximum load cedar rates 100 while jack pine rates 113 and red pine 103.

For small clear wood test specimens jack pine has a modulus of rupture 1.85 times white cedar and red pine 1.66 times. Thus, cedar compares less favorably in support of breaking load with these two pines when used as a pole than as a beam.

However if top reactions are compared cedar is only slightly weaker. A summary of strength and physical properties of white cedar shows that it is easy to glue, has favorably small shrinkage, holds paint well, is light in weight, but is weak in compression and bending and has low nail-holding ability.

Chemical Properties

As far as chemical composition of extractive-free wood is concerned, white cedar does not differ greatly in composition from other softwoods. A typical analysis would show 55% cellulose, 31% lignin, 13.5% hemi-celluloses and .5% ash. Thus, white cedar is not distinctive in composition of wood but rather in its extractive component.

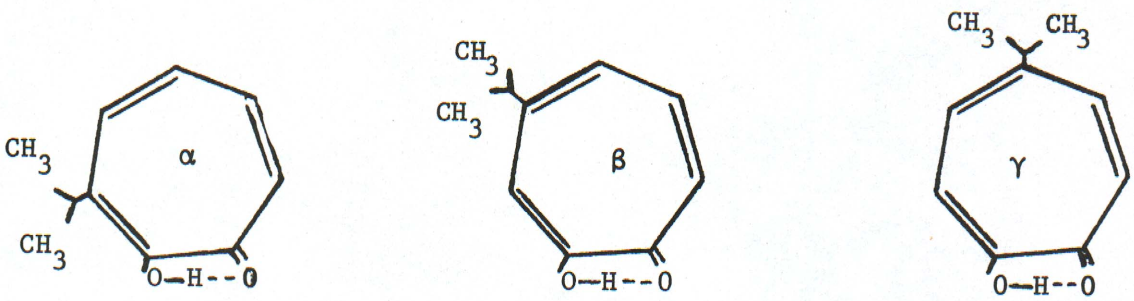
Analytical data on white cedar are scarce and based on hit-or-miss sampling. This is probably a result of most of the work having been done before the variability of extractive content from tree to tree and from one part of the wood to another was recognized. An analysis of extractive content on white cedar from Wisconsin conducted at the Madison Forest Products Laboratory is as follows:

Solubility in alcohol-benzene	6.0 %
Solubility in ethyl ether	1.4 %
Solubility in one percent sodium hydroxide	12.9 %
Solubility in hot water	5.3 %
Volatile oil	1 - 1.5 %

Obviously the designation, extractive content, depends upon the solvent and procedure used. These values, while useful for some purposes, do not reveal the nature of the extractives. Heartwood contains most of the extractives. More sophisticated methods are needed to identify the compounds present.

If cedar wood is ground and steam distilled an essential oil is removed. At room temperature it becomes a reddish semi-solid.

The most important extractives from the point of contribution to natural durability of white cedar are the tropolones. These compounds have seven carbon atoms in a ring. They are found in a wide variety of woods in the cedar or cypress family. Thujaplicin is the name given to the tropolones found in white cedar. Three thujaplicins are known, alpha, beta and gamma as shown below:



Chemists who have studied these extractives differ in their opinions on which are present in white cedar. Trees of *T. occidentalis*, northern or eastern white cedar, grown in Sweden were found to contain .08% alpha, .008% gamma, and no beta thujaplicin. On the other hand, trees grown in Japan contained alpha and beta but no gamma. Trees grown in North America contained beta and gamma but no alpha thujaplicin. If more extensive testing were done, results might be different.

Tropolones will form chelates with iron or copper salts. This reaction is the basis of detection of heartwood in cedar where ferric ammonium oxalate is brushed on end grain. Because tropolones in white cedar will react with iron or copper when water is present the wood can cause corrosion of digesters in pulping. They also corrode nails when cedar is used as shingles or construction timber where water is often present. Resin coated nails or other rust resistant nails or fasteners should be used.

The thujaplicins have melting points in the 34-82° range. They are soluble in water which is unfortunate because when they are leached from cedar the wood is no longer as decay resistant.

Thujaplicins are highly toxic to a variety of wood-destroying fungi. Rennerfelt, a well known Swedish scientist, considered them to be of the same order of activity as pentachlorophenol. This chemical, however, is nearly insoluble in water so it remains in wood longer in wet applications.

Beta thujaplicin has been tested for bacteriological control, and has even been used in treatment of human diseases.

There are several other compounds that have been identified in white cedar extract, but they are of minor importance.

Although the thujaplicins have melting points below the boiling point of water they are not lost in appreciable amounts during kiln drying of lumber. Drying tests have been conducted on western red cedar but would probably apply to white cedar because of the similar structure of the two woods. Loss of thujaplicins during days in the kiln at a maximum temperature of 74°C was 10%. Drying at 142°C for 2 hours resulted in a similar loss. These results would indicate that extractive loss during kiln drying or particle board or plywood manufacture would not be important. The odor of western red cedar and possibly northern white cedar is attributed to methyl thujate, which is a poor fungicide.

TABLE 1. Average physical and strength properties of small clear specimens based on wood of 12% moisture content.

SPECIES	SPECIFIC GRAVITY ON VOL. @ 12% MC	STATIC BENDING			COMPRESSION		Impact Bending	HARDNESS	SHEAR	CLEAVAGE	SHRINKAGE Green to Oven Dry, %		
		Stress Prop. Limit (psi)	Modulus of Rupture (psi)	Modulus of Elasticity (1000 psi)	Parallel Maximum crushing (psi)	Perpendicular Stress at Prop. Limit (psi)	Height of drop of 50 lbs (in)	SIDE (psi)	Parallel to grain (psi)	lb/in. width 3" length (psi)	Radial	Tangential	Volumetric
N. white cedar[a]	.30	3,600	6,100	640	3,600	390	21	310	1,000	190	1.7	3.6	6.4
N. white cedar	.31	4,900	6,500	800	3,960	380	12	320	850	150	2.4	4.7	7.0
W. red cedar	.33	5,300	7,700	1,120	5,020	610	17	350	860	130	2.4	5.0	7.7
Redwood	.34	5,500	8,300	1,120	5,240	640	16	400	930	160	2.4	5.0	7.4
Balsam fir	.36	5,200	7,600	1,230	4,530	380	20	400	710	---	2.8	6.6	10.8
White spruce	.40	6,500	9,800	1,340	5,470	570	20	480	1,080	200	4.7	8.2	13.7
Douglas fir	.48	8,100	11,700	1,920	7,420	910	30	670	1,140	180	5.0	7.8	11.8
Loblolly pine	.51	7,800	12,800	1,800	7,080	980	30	690	1,370	270	4.8	7.4	12.3

(a) From Canada, Department of Forestry Publication 1104
All other figures from U.S. Dept. Agr. Tech. Bull. 479

RESISTANCE OF CEDAR TO STAIN, INSECTS, AND DECAY

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Northern white cedar or eastern white cedar in Canada (Thuja occidentalis L.) has the reputation of high resistance to decay. The nature of this resistance and its variability have not received much attention until now. This paper examines decay resistance of wood from various parts of trees, trees from different locations, trees of various sizes and insect resistance.

Durability of Round Wood and Rectangular Shapes

Cedar posts and poles have been used in treated and untreated conditions for many years. In fact, these constitute the greatest use of white cedar. Naturally the useful life of an untreated post depends upon place of exposure. In East Lansing, Michigan 4-inch top diameter cedar posts will last about 16 years untreated compared to 3 years for jack pine. Useful life in southern United States would be less, probably about 12 years. Larger diameter poles would have a longer life and this could be extended by preservative treatment.

Stakes, boards or timber of rectangular cross-section would be shorter lived than round forms because the former have a greater surface-to-volume ratio. All the tests of square cedar for decay resistance in soil contact have been conducted with 3/4 inch stakes 18 inches long. The average life of these is 3 to 6 years. Larger sizes would, of course, last longer.

Is All Wood in the Tree Equally Durable?

No sapwood resists decay very effectively. Stakes of white cedar sapwood will rot away in a year or less in southern Mississippi. Above ground the sapwood of a pole or post usually decays close to the heartwood causing it to break loose.

Both laboratory soil block decay tests and field stake tests on heartwood cut from inner and outer layers of butt, middle and top logs of trees lead to the same results. Experiments on cedar from the usual swampy site show that outer heartwood in the butt log is most decay resistant, top log next and middle log the least. On the other hand, top log inner heartwood is most decay resistant, middle next and butt inner heartwood least. The same relationships were found for heartwood from cedar grown in a well drained limy soil site.

If swamp-grown wood, collectively, is compared in decay resistance to that from well-drained locations, the former is somewhat more durable. Whether this would be borne out in practice is problematic.

How Much Variability Is There in Decay Resistance Between Trees?

Heartwood of some trees is more decay resistant than that from others. This seems to be an inherited characteristic rather than an effect of climate or soil. In laboratory tests the average decay weight loss from one tree might be as much as 18% while that of a tree growing 50 feet away in the same stand could be 1%. The differences in decay resistance between trees are more evident with inner heartwood than outer.

Unfortunately there is no way to identify trees that will yield the most durable wood. No aspect of the appearance of a cedar ree or of the heartwood gives any indication of its ultimate resistance to decay.

Effect of Place of Growth on Decay Resistance

Heartwood of cedar from five locations has been tested in laboratory and field. If all the wood of the trees from one locale is compared to that from others, practical differences have appeared only in field tests. Wood from the small trees cut near Powers, Michigan is less resistant. If inner heartwood from the five locations-Black Lake, Grand Lake, Baraga County, and Powers, Michigan, and Vermont is compared, that from Baraga and Powers is more susceptible to attack. However, this is likely a diameter effect.

There are greater differences in average weight loss between trees in a location than between trees from different locations. Thus, location of growth does not seem to affect durability.

Effect of Log Diameter and Radial Position

If outer heartwoods of butt logs from 5 to 20 inches in diameter are compared, the smallest show significantly more decay weight loss. Comparing inner heartwoods I find that the smallest and very largest are more decay susceptible than the others. In trees large enough to cut standard 1-inch samples from several distances from tree center toward sapwood there is a gradual increase in durability.

Regardless of tree size, outer heartwood in butt logs is equal or better than inner heartwood in decay resistance. this would indicate that the two kinds should be separated and the outer used for more hazardous applications.

Consistent high humidity and/or water contact would contribute to decay hazard. For example, boat dock members, shakes, flooring screeds, and furring strips below grade should be of higher durability while siding, fence boards and house trim could be of lesser durability. Soil contact where rainfall is considerable, possibly above 35 inches, constitutes the greatest hazard for wood.

Cedar Compared To Other Woods and Preserved Wood

White cedar must compete with other durable woods and with chemically treated woods in the market place. In soil contact cedar heartwood is, of course, far longer-lived than sapwood of species such as pines, spruces, fir, hemlock and any others. It is somewhat less durable than heart redwood and considerable less durable than pine sapwood pressure treated with 0.15 pcf of CCA (copper, chromium, arsenic) preservative.

How Termite Resistant Is White Cedar?

All evaluations of cedar for resistance to termites have used North American subterranean kinds. Their vigor of attack is less than that of several tropical sorts, and drywood termites commonly found in Florida, California and the Carribean region have not been involved.

Stakes driven into the ground are subject to both decay and termite attack. Termite resistance just about parallels decay resistance for cedar and some other species. Because of appreciable water solubility of the extractives of cedar, termite resistance is likely to be reduced in a ground stake more than in an above ground exposure. This can be seen in different types of samples exposed in Florida. Cedar is quite resistant to termites if protected from heavy rainfall and soil contact.

When wood samples are exposed in a test plot to minimize decay but allow termite attack, white cedar, redwood, western red cedar and Alaska cedar show about equal resistance. Southern pine pressure treated with 0.17 pcf of CCA is superior, and untreated white spruce is heavily attacked.

Effect of Heart Rot on Durability

Decay in center heartwood of cedar is prevalent in old trees. In fact, nearly all of those from Baraga County, which averaged 200 years, contained decay. About 50% of the bog grown trees of average age (74 years) contained decay. Fortunately decay present in the heartwood of the living tree does not continue after the tree is processed into lumber. Laboratory test specimens of heartwood cut close to decay were no more or less susceptible to decay than wood from rot-free trees. Field tests lead to the same conclusion about decay and termite attack of the wood near heart rot.

Stains and Discoloration

Unlike most heartwoods, white cedar can be infected with fungus stain. This stain is unusual because it infects heartwood in standing trees, probably gaining entrance through dead branch stubs. Since it grows in streaks rather than throughout the wood it may go unnoticed. Other than its identification, not much is known about it. In termite resistance tests I have observed what appears to be a preference for stained heartwood. Termites will usually eat the stained wood before attacking surrounding heartwood.

Cedar sapwood does not become infected with stain fungi as readily as do pines and several hardwoods during air drying. Nevertheless, it will stain when kept moist and under high humidity as in untreated, unpainted boards exposed to rain. Much of the gray to black discoloration of exposed cedar sapwood is caused by mold growth with attendant spores. Stains grow throughout the wood while molds are a surface phenomenon. Both lead to what is usually considered an undesirable appearance.

Heartwood gradually loses the extractives that give its color and also prevent microbial growth. The wood becomes gray on the surface and eventually darker if infected with molds in wet climates.

Cedar's Insect Enemies

Subterranean termite attack has already been mentioned. Standing cedar trees are sometimes attacked by carpenter ants. They usually infest trees that contain heart rot and erode more of the wood for nests. Cedar is not a special target of attack as these ants will seek out any wood, especially if already decayed, when seeking a place for nesting.

Dying and recently felled cedar trees are the preferred host of the cedar tree borer (*Semanotus ligneas* (F)). This is a long-horned beetle that can bore into the sapwood and sometimes the heartwood. Bark must be present on the logs for attack to occur, and after the wood has dried a few months it is immune. However, it can be damaged while lying in a log yard awaiting processing in late spring and early summer.

Summary

Cedar heartwood is one of the most decay-and subterranean-termite-resistant softwoods in North America. It is not as durable in soil contact as adequately treated pine, however. Area of growth has little effect on durability of cedar heartwood. Although decay and termite resistance varies from tree to tree, outer butt heartwood is the most durable portion.

Stains are of minor importance in cedar. Cedar is not subject to much insect damage except for termites, cedar tree borers and carpenter ants.

Cedar has not been the subject of much research. Many properties need to be investigated for increased utilization.

PRESERVATIVE TREATMENT OF CEDAR

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Cedar is most highly esteemed for its natural resistance to decay and insect attack. Cedar has been used in the form of posts, poles, timbers, shingles, lumber, and totem poles, with no preservative or coating applications. Due to naturally occuring toxicants it will far outlast other less durable species. For example, R. D. Graham and D. J. Miller in their "Service Life of Treated and Untreated Fence Posts - 1960 Progress Report" of the Oregon Forest Research Center, report the average service life of untreated posts as follows:

Species	Years
Alaska	18
Incense Cedar	14
Port Orford Cedar	20
Western Red Cedar	22
Osage Orange	30+
Pacific Yew	28
Redwood	23
Douglas Fir	6
Mountain Hemlock	3
West Coast Hemlock	6
Western Larch	7
Lodgepole Pine	4

In the Wood Handbook of the U.S. Forest Service, cedar is defined as being "Resistant or Very Resistant." In spite of this natural durability, however, there are situations where the natural durability of cedar should be supplemented with additional preservation. The reason for this is that these durability citations are based on experiments done with heartwood. The sapwood is not durable and will decay considerably earlier than will the heartwood; and decay which starts in the sapwood will eventually progress into the heartwood (particularly in the case of wood in contact with the soil) and overcome the natural durability. This has been widely observed to be the case in fence posts and utility poles where decay entering at the area of the groundline causes the member to fail in time.

The primary use for preservative treated cedar is the manufacture of utility poles. The first poles used by electric and telephone companies were untreated cedar, redwood, and chestnut, due to their long life in ground contact. Chestnut was widely used hroughout the Eastern States; however, the introduction of chestnut blight from Europe virtually caused the extinction of this species. Redwood poles, though still in service in California, were found less economical and durable than creosoted pine or fir. Northern White Cedar poles were still being set untreated by telephone and power companies as recently as 15 years ago in the Lake States and Central Canada; however, with increased replacement costs, it was found that the additional service life gained from preservative treatment far more than justified its additional cost. It is interesting to note that in many areas such poles gave 25 to 35 years of useful life with no treatment compared with pressure treated creosoted Southern Yellow Pine, which lasts about an equal period.

As a point of interest, since the subject of recycling of resources of everything from paper to beer cans is now considered to be very much in the national interest, cedar utility poles have long been recycled by two midwestern utilities, Northern States Power and Detroit Edison. After 25 to 40 years of service, old butt treated cedar poles removed from lines due to obselence are returned to a pole yard where the untreated sapwood above the treated groundline invariably shows sap rot and is shaved off. The top may also be badly eroded due to decay and weathering, hence the top is usually cut back 5 feet. After this, the entire pole is re-treated and returned to service. A report by Northern States Power based on a recycling of 19,833 butt treated cedar poles 25 to 40 years old indicated an incidence of decay of only 6.2%; truly remarkable when one considers that some poles probably had undetected internal decay at time of treatment. Neither utility feels that a similar reclamation project would be feasible on other species such as pine or fir due to their lack of natural decay resistance.

Although white cedar poles were prevalent throughout the north central and northeastern United States, use is minor today. In 1973 cedar made up only 3.6% of all poles produced. Northern White Cedar specifically accounted for only 0.02%. This is principally due to the increased size required for electrical poles today which are not found in the remaining stands of Northern White Cedar, and the conversion by the telephone companies to buried distribution and microwave transmission systems.

Western Red Cedar is available in very large sizes; poles up to 120' are routinely available. This species is primarily used on the higher voltage transmission lines where individual pole life is important and such poles command higher prices than fir or pine. Such poles now are principally available from British Columbia.

The preservative treatment of cedar is relatively difficult due to the make up of the vascular systems. Preservatives, however they are applied, must move radially into the wood in the case of round sections. The easiest means of this movement in softwood species is through wood rays and resin canals which occur within the wood rays and run as narrow intercellular openings forming an intercommunicating system of passages both radially and vertically. These aid the movement of preservative throughout the wood. In pines the diameter of these is relatively large, often discernibly with the unaided eye, and account, in part, for the good permeability of the wood. In fir and larch, they are considerably smaller, hence these woods are commensurately harder to penetrate. In cedar they do not occur at all and hence penetration must take place through the trachieds or rays, which means the preservative liquids must make their way through pits that occur between adjacent cells and the journey is much harder to make.

In many softwood species, the heartwood is virtually unpenetrable, due primarily to obstruction caused by hardened resins, extraneous matter, and closed pits. Fortunately, in the case of cedar, some of these extractives account for its decay resistance.

TYPES OF PRESERVATIVES

Preservatives are chemical substances which when applied to wood render it resistant to attack by fungi, insects, marine borers, or fire.

They vary in their effectiveness and suitability for various applications. Only the more common ones will be touched on here.

CREOSOTE

This was originally patented for use as a wood preservative in Great Britain by John Bethell in 1838. It is still the most widely used preservative. It is a distillate obtained during the coking process of bituminous coal and is actually a by-product combining a variety of hydrocarbons, tar acids, and tar bases. Their proper combination is defined by industry standards to yield a more-or-less uniform product. Creosote produces a black or brown product which, while acceptable in piling and railway timbers, has been losing favor to cleaner treatments that are at least as effective.

PENTACHLOROPHENOL

This is a synthetic chemical formed by the reaction of chlorine and phenol. It occurs as a solid crystal and must be dissolved in a solvent to apply it to wood. The most common solvents are aromatic oils, which give the wood a significantly lighter brown color than creosote. If desired extremely light, colored solvents such as mineral spirits will render the wood virtually colorless. Recently, techniques using liquified gas and chlorinated solvents, which are reclaimed from the wood, result in the pentachlorophenol being left in the wood with no discernible effect on the wood's appearance.

COPPER NAPHTHENATE

This preservative, though no longer widely used, is a mixture of naphthenic acid by-products of petroleum refining reacted with copper. It is then dissolved in petroleum oil for application. It is not in use today by the commercial treating industry, but is available in cans and drums for brush or dip application.

WATER-BORNE PRESERVATIVES

The primary ones used are mixtures containing combinations of copper and arsenic which are effective on both fungi and insects. The common ones used commercially are Chromated Copper Arsenate (C.C.A., Boliden Salts, K-33) and Ammoniacal Copper Arsenite (A.C.A. Chemonite). When properly applied, they perform every bit as well as pentachlorophenol or creosote. They utilize water rather than oil as a carrier and render the wood green in color.

APPLICATION TECHNIQUES

1. Brush on
   This is the least effective technique and should be considered only for wood not in contact with the ground. Many formulations of pentachlorophenol are available as a ready-to-use or concentrate and also in conjunction with stain and water repellents.

2. Cold Soaking
   This process is far more effective than brushing, and if dry material is immersed long enough will extend the life of posts and poles greatly, depending upon species.

For fence posts or poles, a 24 hour butt soak in 5% pentachlorophenol and oil would be a good treatment for cedar. This procedure, however, should in no way be considered equivalent to the treatment that can be accomplished in a commercial treating plant. Pentachlorophenol is preferred over creosote due to its lower viscosity and hence better penetration at ambient temperatures.

3. Pressure Treatment
This requires sophisticated equipment. The use of heat and pressure enables the wood to be penetrated more certainly and quickly than soaking and where maximum retention and penetration is required is to be recommended over mere cold soaking. Due to the resistance of cedar to penetration, the critical groundline area of the pole is normally perforated with a pattern of incisions 1/2 inch. This increases the penetration and retention in the vulnerable groundline area. While pressure treatment is in wide use for treatment of pine, fir, and other species, very little cedar is treated in this fashion. One problem is the relatively low pressures that must be used on cedar to avoid structural damage and the other is the greater efficiency of the thermal treatment method described below.

4. Thermal Treatment
This method is the one most commonly used for treatment of cedar accounting for 85% of all cedar poles treated in 1973. In the thermal process, penetration is achieved by a differential of temperatures. In this treatment, either pentachlorophenol-petroleum or creosote solution at a temperature of between 190° F and 235° F is pumped over the wood to be treated so that the wood is completely immersed. Rectangular tanks are used and the oil heated either through steam coils or by use of a heat exchanger. This hot cycle is maintained for 6 hours or more which heats the wood and expands the air within the cell cavities resulting in expulsion of air; at higher temperatures cell moisture is turned into steam and also expelled. Under severe weather conditions where poles may have picked up considerable moisture due to rain, sleet, or snow, the hot cycle may be extended to 10 and 12 hours or even 14-16 with no adverse effect. Specifications leave this period to the discretion of the treater since results type specifications assure adequate treatment.

At this point a lower temperature solution replaces the hot oil. This can be done in two ways. The most common method is to pump off the hot oil and replace it with the lower temperature solution. This must be done very rapidly so the wood does not cool appreciably during the change. Since commercial plants use tanks holding 20,000 to 30,000 gallons, high capacity pumps are required to effect a change over time of between 15 and 20 minutes.

Another technique is simply to allow the hot oil to cool down to 130° F; however, in commercial plants, this is seldom done due to the wastefulness of having to reheat the oil back to higher temperature.

The so-called cold oil causes the air remaining in the cells to contract and any steam to condense resulting in a partial vacuum enabling atmospheric pressure to press the solution into the wood. Most of the penetration, obviously, takes place during this cold cycle. The length of the cold cycle varies, but is about 2/3 the duration of the hot cycle. This method results in a full cell treatment of the sapwood (20 to 30 lbs. per cubic foot solution) hence the groundline area is normally incised to provide high retention while the above ground portions are not; a lighter treatment there will suffice and a dirty or bleeding pole is minimized.

This thermal treatment can be accomplished on any species, but is recommended only on thin-sapwood species. On thicker sapwood species such as red or southern pines ready penetration overtreats greatly making poles unsightly and uneconomic. The only exception is lodgepole pine which has a narrow band of sapwood and is frequently treated successfully in this manner. No incising is required on this species.

The water soluble C.C.A. treatments cannot be used in thermal treatment due to their instability when heated. A.C.A. (Chemonite) can be used for thermal treatment. In this case live steam is used for the hot cycle and a solution of A.C.A. for the cold. Very few water-borne chemicals are currently being applied thermally. Most water soluble salt treatments are best applied by pressure.

5. Supplemental Groundline Treatment
Inasmuch as many northern white cedar were set untreated throughout Michigan and Wisconsin, utilities have attempted to apply treatment to poles in place to prolong their lives. In this method, the pole is excavated to a depth of 1-1/2 feet and all decayed wood scraped off. A wood preservative grease is then applied to the area and wrapped with plastic coated paper before back filling. Such treatments have significantly increased the service life of the poles; however, it must be done before too much strength is lost.

CONCLUSION

Preservation of cedar is not as wide spread as in the case of less durable species, but should be considered where ground contact occurs and long life is desired. Utility poles and pole buildings certainly require the best treatment, either thermal or pressure.

KILN DRYING NORTHERN WHITE CEDAR

by
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This paper provides information on the kiln drying of Northern white cedar. Its physical properties influence kiln drying. Northern white cedar has excellent dimensional stability and because of this property, fast drying is possible without severe defects. It is possible to induce drying defects, particularly in the thicker dimensions, but in comparison with other refractory species northern white cedar is a very easy wood to dry.

For many outside uses, such as fencing, kiln drying is unnecessary. However, for building uses air drying is desirable and for interior use, such as furniture and trim, kiln drying is most desirable.

Drying wood removes the water, thus reducing the weight and lowering shipping and handling costs. Proper drying reduces shrinking and swelling to limited amounts. Kiln-dried wood machines easier, can be cut to more exact dimensions, and can be fitted and fastened more securely. The gluing of dried wood is facilitated and finishes and paint hold more securely to well dried wood.

In kiln drying wood the conditions of relative humidity and temperature are controlled and adequate air circulation is necessary to mix and produce the desired temperature and humidity condition in all parts of the kiln and lumber stacked inside. To dry wood, a kiln operator follows a recipe for drying called a "kiln schedule". The kiln schedule is a procedure describing wet and dry bulb temperatures that have worked satisfactorily in the past. Many operators will make adjustments depending on their experience and careful observations of the material being dried. The moisture contents shown are based on end coated wood samples placed in the kiln in specified locations and assured to be representative of the kiln charge.

The following are sample kiln schedules used by three different firms.

AMERICAN TIMBER HOMES, INC. - Escanaba, Michigan 49829

Old Dry Kiln Settings --- GREEN CEDAR AND PINE

TIME	RED (Heat)	GREEN (Moisture)	REMARKS
Start	130	120	
2nd Day	130	115	
3rd Day	130	105	
4th Day	130	90	Start checking 1" Cedar for removal at 8% after approx. 4 days.
5th Day	130	90	Start checking 2" Cedar for removal at 12% after approx. 6 days.
6th Day	130	90	Start checking 2" and 2 3/4" Cedar for removal at 12% after approx. 8 days.
7th Day	130	90	Start checking 2" and 2 3/4" Cedar for removal at 12% after approx. 8 days.
8th Day	130	90	Start checking 1" Pine for removal at 8% after approx. 10 days.
9th Day	130	90	Start checking 1" Pine for removal at 8% after approx. 10 days.
10th Day	130	90	Start checking 1" Pine for removal at 8% after approx. 10 days.
11th Day	130	90	Start checking 2" Pine for removal at 10% after 14 days.
12th Day	130	90	Start checking 2" Pine for removal at 10% after 14 days.
13th Day	130	90	Start checking 2" Pine for removal at 10% after 14 days.
14th Day	130	90	Start checking 2" Pine for removal at 10% after 14 days.

AIR DRIED CEDAR AND PINE

TIME	RED (Heat)	GREEN (Moisture)	REMARKS
Start	130	120	High moisture for 2 days to open wood for interior drying.
2nd Day	130	120	
3rd Day	130	115	Start checking 1" Cedar for removal at 8% after approx. 3 days.
4th Day	130	105	Start checking 2" Cedar for removal at 12% after approx. 4-5 days.
5th Day	130	105	Start checking 2 3/4" Cedar and 1" Pine for removal at 12% after approx. 6-7 days.
6th Day	130	105	Start checking 2 3/4" Cedar and 1" Pine for removal at 12% after approx. 6-7 days.
7th Day	130	105	Start checking 2 3/4" Cedar and 1" Pine for removal at 12% after approx. 6-7 days.
8th Day	130	105	Check 2 3/4" Cedar and 1" Pine for removal at 12% after approx. 6-7 days.
9th Day	130	105	Start checking 2" Pine for removal at 12% after approx. 11-12 days.
10th Day	130	105	Start checking 2" Pine for removal at 12% after approx. 11-12 days.
11th Day	130	105	Start checking 2" Pine for removal at 12% after approx. 11-12 days.
12th Day	130	105	Start checking 2" Pine for removal at 12% after approx. 11-12 days.

U.S. FOREST PRODUCTS LABORATORY - Madison, Wisconsin 53705

Northern White Cedar 4/4

MOISTURE CONTENT	DRY BULB	DEPRESSION	WET BULB
ABOVE 35%	160°F	7°F	153°F
35%	160°F	10°F	150°F
30%	170°F	15°F	155°F
25%	170°F	20°F	150°F
20%	180°F	25°F	155°F
15%	180°F	50°F	130°F

U.S. Forest Products Laboratory. Green to 6% for 4/4 in 8-10 days. Mixed hardwood and sapwood 55% start.

CANADIAN FOREST PRODUCTS LABORATORY - Ottawa, Ontario, Canada

MOISTURE CONTENT	DRY BULB	DEPRESSION	WET BULB
OVER 40%	160°F	6°F	154°F
40%	170°F	12°F	158°F
30%	170°F	20°F	150°F
25%	180°F	50°F	130°F

MACHINING OF CEDAR

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Very little is written specifically on machining of northern white cedar. Machining is cutting of the wood, most frequently done by sawing and planing or molding of wood parts.

Northern white cedar is a low-density wood with straight grain and numerous small knots. Because of its low density the power requirements for machining are not demanding in comparison with other species, particularly the denser hardwoods. However, because of its low density, other machining-related problems may occur such as feed roll indentation on the finished wood surface. These indentations occur because the spring-loaded corrugated feed rolls are set for harder woods and sink into the cedar deeper than material which is planed away. Also, the feed rolls may slip because of cedar's low strength. This causes jamming of the planer and molder.

Chip marks have also been observed on cedar. They are caused by the chips from the cutter head being pressed into the soft-surfaced cedar by the chip breaker and are more frequent in cedar because of its low density. These problems are not of major concern if the situation causing them is recognized and proper adjustments to the equipment are made.

Special adjustments are sometimes necessary for other properties of wood, but northern white cedar has straight grain that doesn't cause problems like those encountered with wavy or interlocked grain. The cell walls of cedar contain some extractives, but these do not dull knives and tool life is considered quite good when cutting cedar.

Resin is encountered in the bark of northern white cedar and may stick to cutting tools when the bark is present. However, resin is not a problem in most cedar wood cutting. It does occur in other softwoods such as pine where it may cause gumming of the surface of the tools.

Small knots, often encased, are the major difficulty in machining or surfacing northern white cedar. This is a natural occurrence and little can be done other than selection of timber material to be used if the problem causes an objectionable defect.

The suggested cutting angle commonly used with kiln-dried cedar is about 5°. If the cedar has a higher moisture content the cutting angle may be increased to 10°. The cutting angle is the angle formed by face of the knife and a radial line drawn from the cutting edge through the center of the cutterboard.

A greater cutting angle is usually suggested for most other species and some compensation may be necessary if other species are machined at the same time.

The suggested grinding or sharpening angle for cedar is 30° for wet or dry wood. The sharpening angle is the angle between the face and the bevel on the back of the knife. This corresponds quite well with most other species.

The small cutting angle suggested for cedar was due to the low power requirements and lack of knife dulling. However, many species are surfaced on one machine, and a larger cutting angle will be necessary to accommodate all the requirements.

Because of its very low density and cutting ease, northern white cedar is used by wood carvers for making duck decoys. This is not an important commercial use, but illustrates the ease of cutting this material.

Conversations with various producers machining northern white cedar indicate few problems caused by this species. However, sawing problems have been encountered and extra effort is required if the logs are to be sawn. Northern white cedar is an exceptionally easy species to machine and for most current uses presents no problems.

THE CEDAR FENCE INDUSTRY

by
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Peterson Brothers Manufacturing Co.
Carney, Michigan

I've tried to scrounge up some factual material about cedar that might not be common knowledge. I want to tell you about one of the oldest cedar contracts known to man and about the importance of cedar, its price and its impact on the civilization of that day.

My source of information is unimpeachable--the Bible, a book in which I believe implicitly. Some additional information on the subject comes from National Geographic's "Everyday Life in Bible Times." This is one of the most interesting and informative complements to the Scriptures that I've ever had the pleasure of reading. All of the facts presented are corroborated by archaeology and related sciences.

In the fifth chapter of Kings I we read that King Hiram of Tyre had always been a great admirer of David, so when he learned that David's son Solomon was the new king of Israel, he sent ambassadors to extend congratulations and good wishes.

Solomon replied with a proposal about the Temple of the Lord he wanted to build. His father David, Solomon pointed out to Hiram, had not been able to build it because of the many wars going on, and he had been waiting for the Lord to give him peace.

"But now," Solomon said to Hiram, "the Lord my God has given Israel peace on every side; I have no foreign enemies or internal rebellions. So I am planning to build a Temple for the Lord my God, just as he instructed my father that I should do. For the Lord told him, 'Your son, whom I will place upon your throne, shall build me a Temple.' Now please assist me with the project. Send your woodsmen to the mountains of Lebanon to cut cedar timber for me, and I will send my men to work beside them, and I will pay your men whatever wages you ask; for as you know, no one in Israel can cut timber like you Sidonians!"

Hiram was very pleased with the message from Solomon. "Praise God for giving David a wise son to be king of the great nation of Israel," he said. Then he sent this reply to Solomon: "I have received your message and I will do as you have asked concerning the timber. I can supply both cedar and cypress. My men will bring the logs from the Lebanon mountains to the Mediterranean Sea and build them into rafts. We will float them along the coast to wherever you need them; then we will break the rafts apart and deliver the timber to you. You can pay me with food for my household."

As merchants of cedar we have a great heritage. Cedar was the first choice of the world's wisest and richest man for the paneling and beams of the temple he built to his Lord God and, incidentally, wherein he entertained the most glamorous Queen of Sheba.

THE CEDAR VACATION HOME INDUSTRY

John Walbridge

AMERICAN TIMBER HOMES, INC.
Escanaba, Michigan

My talk is billed as the Cedar Vacation Home Industry. Frankly, I'm not sure there is any such thing anymore. The oil embargo in the fall of 1973 and the mortgage crunch of 1974 just about dried up the market for vacation homes no matter what they were made of. However, there is a definite appetite in the primary housing market for cedar and, since most of the companies in the vacation home industry that are still around have changed over to making primary homes, I am going to expand my opic to include cedar in the housing industry in general.

Our company may or may not be typical of the industry, but I think it might be interesting to trace its development as it relates to cedar.

When we first went into business in 1961, the market we envisioned was slightly glorified log cabins with and without indoor plumbing. Our first model had 384 sq. ft. and retailed for $1,460. Over the years, as we gradually migrated into the primary housing market, the homes got larger and more elaborate. Our average home last year had almost 2,000 sq. ft. and cost just under $40,000. Our largest had 8,000 sq. ft., five bathrooms, and cost $250,000.

The increase in size, however, has not meant a corresponding increase in amount of cedar used. That first 16 x 24 ft. model was a cedar cabin from top to bottom. The subfloor was cedar, the walls were cedar, the trusses were cedar, the roof deck was cedar, the partitions were cedar. Even the doors were cedar. We were in the cedar business and were giving the customer a cedar house! While cedar was a remarkable material in many ways, it wasn't necessarily the best material for every application, as we learned. We found that pine was stronger and less expensive for roof deck material, and the combination of pine and styrofoam produced a stronger, better insulated roof at a lower cost. We found that plywood made a better subfloor than cedar lumber. We found that spruce and balsam made stronger trusses and that many species made better studs. But we have found nothing that matches cedar for the parts of the building that are exposed to weather. We believe that there is no species that enjoys the reputation in the marketplace for durability, insect and decay resistance, and freedom from maintenance that cedar enjoys. As we moved from vacation homes to primary homes, we found that the customer appeal of cedar was still important; but it is relatively less important than some other considerations such as architectural appeal, good floor plans, and total cost.

Our vacation home business had been founded on our dry spline Timber-Wall system. This system consists of solid cedar wall timbers 2 3/8" thick, grooved on each side to receive precisely machined splines. The wall imbers are kiln dried to a moisture content of 10% to 12% and treated with a water-repellent wood preservative. The splines are dried to 6% moisture content and sealed in plastic bags so that they can't pick up moisture from the air. When they are fitted into the grooves in the wall timbers, they swell and form a tight seal. This system has performed very well for many years in all kinds of climates, but as we moved into primary housing around the metropolitan areas, we bagan to encounter building code problems. To overcome this and to make it easier for our dealers to erect the homes faster, we developed a panelized wall consisting of 3/4 in. treated cedar siding, impregnated felt, 1/2 inv exterior plywood, 2x4 studs, 3 1/2 in. fiberglass, and interior finish wall of paneling or drywall. This system provides the benefits of a cedar exterior with the additional advantage of a very high "R" value, fast construction, and the opportunity for a variety of interior wall finishes. It also makes the cedar go three times as far.

The switch to the panelized wall system meant that instead of sawing 2 3/4 in. cedar lumber, we were sawing 1 in. One benefit of this is that we can use some lower grade old growth cedar and still get a reasonable yield of 1 in. lumber from outer parts of the logs even hough there is quite a bit of rot in the heart. When you have to saw for 2 3/4 in. lumber, you can't do this.

In closing, I would like to share with you one important piece of information about sawing cedar that we have learned over the years. It is expensive. By its nature, white cedar is a small tree and when it begins to get to reasonable size by sawmill standards, it develops all kinds of defects that you have to saw around. Our experience has been that we get about half the footage per shift sawing cedar as we do sawing other species, and it takes half again as many cords per thousand feet of usable lumber. This makes cedar lumber expensive but, used in applications that take advantage of its unique qualities, it is a good value and a salable one.

PARTICLEBOARD

by

Mr. James Hamilton
Michigan Technological University

Most particleboard in the past has been used in the furniture industry and for floor underlayment in house construction. However, it is now moving into a very broad field of structural panels now supplied by softwood plywood. A western company is building its first mill in Lewiston, Idaho, to make board for the housing industry from an aligned-type wood particle. We realize that the upper Great Lakes area has a large wood resource, so we were interested at Institute of Wood Research in determining whether we could contribute to this same basic industry in the form of a structural board. We have, I xhink, come up with a real good opportunity in the form of a press system that makes the board continuously. There have been continuous systems designed to make thin board. They cannot, however, make the thicker boards as required in the housing industry.

The development of a continuous press pilot unit at IWR has just been completed. This unit is now available for commercial implementation. Structural particleboard can be made from aspen or other low-density wood or combinations thereof, such as balsam, cedar, etc.

The idea of being able to cut off the panels to a specific size as they emerge from the press is a great advantage. As it is today, the housing industry buys stock panels, whatever they may be, 4 by 8, 5 by 8, 5 by 12, and some of them are now 8 by 24, for example. They still have to be cut back to whatever sizes are needed in their modular systems housing operations.

Other developments have to do with molded wood pallets. For two years we have been making them on a pilot operation.

Displayed are two types of pallets; we have three under development of which two are completed. Type 1 is a single deck, nestable pallet that weighs 26 to 27 lb. and can be considered to have a 1,000 lb capacity. By reversing that single deck pallet and fastening leg interface to leg interface, you have a double deck pallet, which supports 2,000 lb, but it is not nestable. However, it can be shipped from the manufacturer in single deck, nestable form and then assembled by the pallet user. The double deck pallet weighs 52 to 54 lb or double the 26 to 27 lb for the single face. Incidentally, 10 single deck pallets are only 11-1/2 in. in height when stacked. On a transport trailer, 80 pallets could be stacked, as compared to 17 conventional hardwood pallets. Now these molded pallets, as you can see, could be shipped as single deck and would, of course, save space in shipping.

The third ype of pallet we have in process is the rackable, nestable pallet--that's a part of our future development. It has the deeper leg section and the ribs are needed because if it's goind to be suspended in a rack across a 40 or 48-in. length, strength has to be developed since you don't have the beam effect that you have with the two pallets fastened together. This pallet has been tested and supported a static load of 9,950 lb of concrete block over a 30-day period with a little less than .243 in., less than a quarter-inch crushing, with this kind of a load. This is common practice; they simply deck pallets on top of pallets, as you have probably seen in storage or warehousing. We also had a dynamic test, where we dropped the pallet with the 2,000 lb load (like a forklift truck operator) 6 in. and 12 in. and it did not shatter.

Moisture resistance of the molded pallet is an important factor. To achieve this, two or three approaches can be used. One is to coat the entire pallet in some way. Another method is to treat just the surfaces. However, one of the things considered was the possibility of using northern white cedar with its good durability, which you have heard a lot about today.

Our development work is on a pilot basis at this time. We have made pallets of all cedar, cedar faces, aspen centers, another panel of cedar with an aspen center of a lower density, and all-aspen panels. And then we compared the water absorption. All pallets were sealed on the four edges with wax. We feel that in production of commmercial pallets we would probably seal the edges, because moisture is absorbed rapidly through the end grain. We measured water absorption on a 2-hr and 24-hr basis, and our results as of yesterday showed the all-cedar panel on a 2-hr absorption picked up 12%, the aspen-cedar panel picked up 12%, the lower density aspen-cedar panel picked up 13%, and the all aspen panel picked up 21%. This is indicative of the cedar providing a hydrophobic, less water-receptive surface, which is a good result. Work will continue in this area, but I would say that on the basis of these findings, I see no reason why cedar should not provide viable skin, surface layers for this type of pallet.

In summary, northern white cedar is an excellent particleboard material that shows promise of some unusual characteristics.

CEDAR LEAF OIL

by

Mr. J. Hagen
President, Cory Laboratories
Menominee, Michigan

I have been carrying a small bottle of cedar oil in my pocket and I now smell like a cedar tree. A couple of minutes ago I put a thin film on my finger and I noticed a few people wondered where it came from. The point is that it takes very little oil to make its effect.

There has always been some mystique and romance about the essential oil business but you can draw your own conclusions. Most people, especially in oriental countries, respond pleasantly to cedar leaf oil. I will explain why we are discussing it, what it can be used for, and the emphasis in utilization of cedar. Our business is concerned with environmental control. We are interested in conservation and in this area literally hundreds of tons of boughs go to waste. Many years ago, cedar leaf oil was used as a heart stimulant. It is no longer allowed internally because the very chemicals that prevent decay are not good for the body. It is used in various medicinals for smell, generally a camphoric odor. It does clear the nostrils for cold remedies. There is more use in the aroma. It is a very narrow and fragile type market. There are large producers and a lot of small farmers that go out and cut it with a family-type enterprise. A gentleman from Canada told me he knows a producer that uses an aluminum rowboat for a part of the condenser system. So you have a group of producers that are individually small. They can be thorny in the market because if they are getting a given amount of money and the price drops, they then make more oil to get the same amount of money. This will compound a bad situation and recently the price has moved up and down over quite a wide range. Last year the market took everything available which was not characteristic. The cedar oil market is fairly narrow and everyone knows where it comes from. It is easily disrupted by as little as 50 barrels. It is steady and has been growing. Production has been from 250 and 400 barrels per year in the world, most of it being produced in the northern hemisphere. Actually in terms of the market the swing in the market depends on production. Where it is grown, in the shade, causes a great difference especially in these trying times.

What is the oil? Alpha thujone gives it the odor, but there are other organics in the oil well known in the literature back to 1893, 1894, 1907 and 1927. Content in the oil does not have any economic drive. The content is measured by the test for thujone by refractive index, specific rotation, insolubility in alcohol and smelling. Brokers do have experts that can detect adulteration by smell. Separately, adulteration is something that has to be watched for. The name oil of thuja or cedar leaf oil is the correct name.

How Is It Produced?

It is conventionally produced by removing the oil that is in the greens. The greens are hogged, loaded into a still, and steamed for 6 to 8 hours. The steam passing through the bed is then condensed. Upon condensation the oil separates after it is dissolved to limited solubility in the steam.

The price ranged from $14 - $15.50 per pound last year, a historic high. It takes a lot of effort to make a barrel; accordingly, it is valuable. The thing that is of most significance to our area is the cedar resource we have and the large amount of boughs that do not have any other value except the possibility of conversion to cedar leaf oil. Although cedar leaf deer browse is obvious, the deer can't possibly eat enough to even begin to touch the quantity of cedar left in the woods in this area. That's the overview of cedar leaf oil.

CEDAR BOUGHS

by

Mr. W. Teal
Teal Evergreens
Bark River, Michigan

We are in the bough business, but it is not good so I will just make a few brief comments on it. The first example of cedar boughs being used in the floral industry was in the early 30's, when they found the keeping quality of the bough was very good. This bough has to be cut from a smaller tree up to 10 to 12 feet. Over that size the bough becomes brownish and the trade just won't accept it. These boughs are cut from 12 to 28 inches in length. They are baled in approximately 20 pound bales and placed in coolers awaiting shipment. Florists use these boughs for background for floral arrangements and to hold the flowers erect. Everything was going along smoothly until the early 60's when shipment out of the Upper Peninsula and the Lower Peninsula was approximately 200 tons per week. Foamed plastics took their toll and now business is down to about 50 tons per week where it is holding. We see no future growth in the bough business at this time.

CEDAR PULP

Lynn Sandberg
Mead Corporation
Escanaba, Michigan

An annual surplus of 20 million cu. ft. of northern white cedar was reported by the 1966 summaries of the forest survey of Michigan's Upper Peninsula. This converts to 260,000 cords of unused wood each year. The total volume of cedar growing stock was 7 million cords in 1966. That's a lot of cedar!

Why doesn't someone make use of this excess material for softwood pulp?

The Mead Corporation studied cedar when plans were formulating for the present Kraft Pulp Mill at Escanaba. As early as 1964 tests were made to determine the practicality of pulping this species and other Michigan softwoods. Again in 1968, laboratory work was conducted to measure the various pulping qualities of softwood species and rank them for guiding procurement plans.

Softwood fiber in general is longer and stronger than hardwood fibers. This long softwood fiber is added to the pulp mixture in forming the wet sheet on the paper machine and gives the sheet sufficient strength to carry the sheet intact through the paper forming and drying process. Strength characteristics of the various softwoods are important.

Other important characteristics are opacity, brightness, printability and cost.

Laboratory tests are designed to simulate mill conditions. Debarking, chipping, cooking, washing, bleaching and papermaking are all done on a small scale using times, temperatures, chemical mixes, etc., just as they occur in the mill.

How does cedar measure up against other Michigan softwoods?

Barking can be a problem because of the stringy nature and clogging tendencies of the bark. Mixed with other species in small percentages, there is little problem.

Chipping of the soft cedar wood produces large amounts of dust and fines and excessive undersized chips unless chipping equipment is kept in unusually good condition.

Cooking of very low-density wood like cedar can produce some fiber loss due to overcooking when the digester is scheduled for the more dense woods in a mixture or to achieve necessary brightness.

Washing and bleaching to achieve desired whiteness of the pulp is measured by a brightness scale. A measure of 89 brightness is desirable, but was not obtained with cedar even with additional chemicals. Brightness was not stable in cedar pulp tested, except when extracted with alcohol-benzene prior to the last bleaching stage.

Printability and opacity are excellent. The important characteristic, strength, was rated as good.

Overall in the tests, cedar rated third behind tamarack and jack pine. It was ranked last because of the bleaching difficulties.

The value of a cord of wood of various species is roughly proportional to the bone dry content of the cord. A cord of jack pine costing $30 delivered to a mill has about 44% moisture content and will produce 2400 lb. of bone-dry fiber at $12.50 per M lb. It will take 1.4 cords of cedar at 49% moisture to produce the same weight of bone-dry fiber. To be competitive, cedar must deliver at $21.40 per cord.

There is a good supply of cedar in Michigan's Upper Peninsula. With a few limitations, this species makes acceptable Kraft pulp. Before too long, new harvesting techniques and the economics of the wood market will utilize this resource.

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