An industry and its potential

PULP AND PAPER IN THE UPPER LAKES REGION

PULP-AND-PAPER is an economic mainstay of the upper lakes region. It is, for example, Wisconsin's leading industry in both employment and capital investment. In Minnesota, trees cut for pulpwood far outvalue other uses for the forest harvest; and nearly 6,500 persons find full-time employment in pulp and paper mills. Further, the economic activities generated by this industry are more widespread in area than are those of copper and iron mining (other important industries in the upper lakes region), because forests are "everywhere," while mines are concentrated in a few localities. The business of pulp and paper production is important to hundreds of communities in the region. Because of this diffusion, the outlook for the industry is of special concern to bankers

ACKNOWLEDGEMENT

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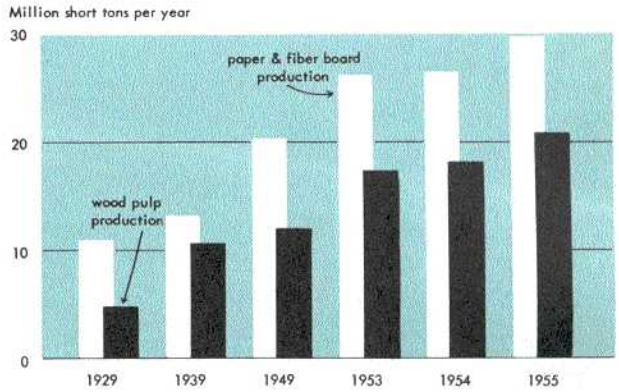
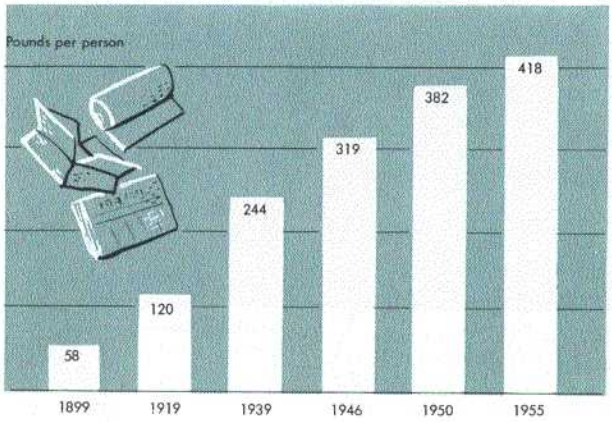
CHART 1 — PULP AND PAPER OUTPUT IN THE U.S.



Source: American Paper and Pulp Association

CHART 2 — U.S. PER CAPITA PAPER USE — GOING UP



Source: American Paper and Pulp Association, U.S. Bureau of Census

in and near the forest areas of the Ninth district.

The future of pulp-and-paper making here will be shaped in part by problems peculiar to the region. Some situations that our mills face, however, are held in common with mills in other parts of the country. One of the situations of nation-wide impact is a growing market. So—as a setting for our examination of the regional outlook, let's first see what expectations are for the industry as a whole.

Industry faces growing demand

Pulp-and-paper is the fastest-growing segment of the forest products industry. Making wood pulp is the first step in paper-making and provides the fibers from which nearly all paper and paperboard is formed. During the postwar period, 1945 to 1955, pulp-making capacity in the U.S. rose by an average of a million tons yearly, from 12 million tons to 22 million tons. Half of the increase was the product of 32 new mills built since 1946 (only two in this region). The remainder of the increase came from expansion of existing mills.

Twenty-five years ago production of paper in the U.S. (including paperboard and insulating products manufactured from wood pulp) totalled about 11 million tons annually; by the end of World War II it was something over 17 million tons; today it is nearly 30 million tons. This rapid growth is illustrated in chart 1.

We are using more paper per person today than in past years and this trend is expected to continue into the future. *New* uses for paper may become increasingly difficult to find, but those who study the subject seem to agree that the volume of paper-and-paperboard product used in the U.S. will grow at a faster rate than will our population. The results of two studies on this subject are cited in chart 3. Both suggest that considerable expansion lies ahead.

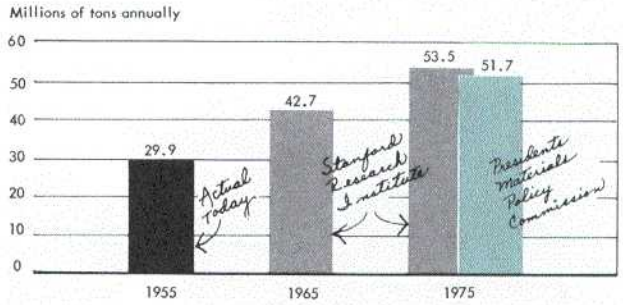
One study on usage was prepared in 1954 for the Weyerhaeuser Timber Company by the Stanford Research Institute. It projects an 84 percent increase from 1952 to 1975 in this country's use of paper and paperboard. The other study appeared in the President's Materials Policy Commission report of June 1952. The PMPC predicted a 25 percent increase in the population of the U.S. between 1950 and 1975*, a 50-60 percent increase in the total materials stream and an 80 percent increase in the use of paper and paperboard.

Both studies are in rather close agreement. Both would call for an average annual expansion of 1 million tons in paper supply. Such an expansion would be simply a continuation of the yearly growth of consumption since World War II. Needless to say, use of some types of paper will grow much more rapidly than others—this figure is only an average. The term, *paper*, unless otherwise modified, will be used in a general sense in this report to include paper, paperboard of all forms, and insulation products manufactured from wood pulp.

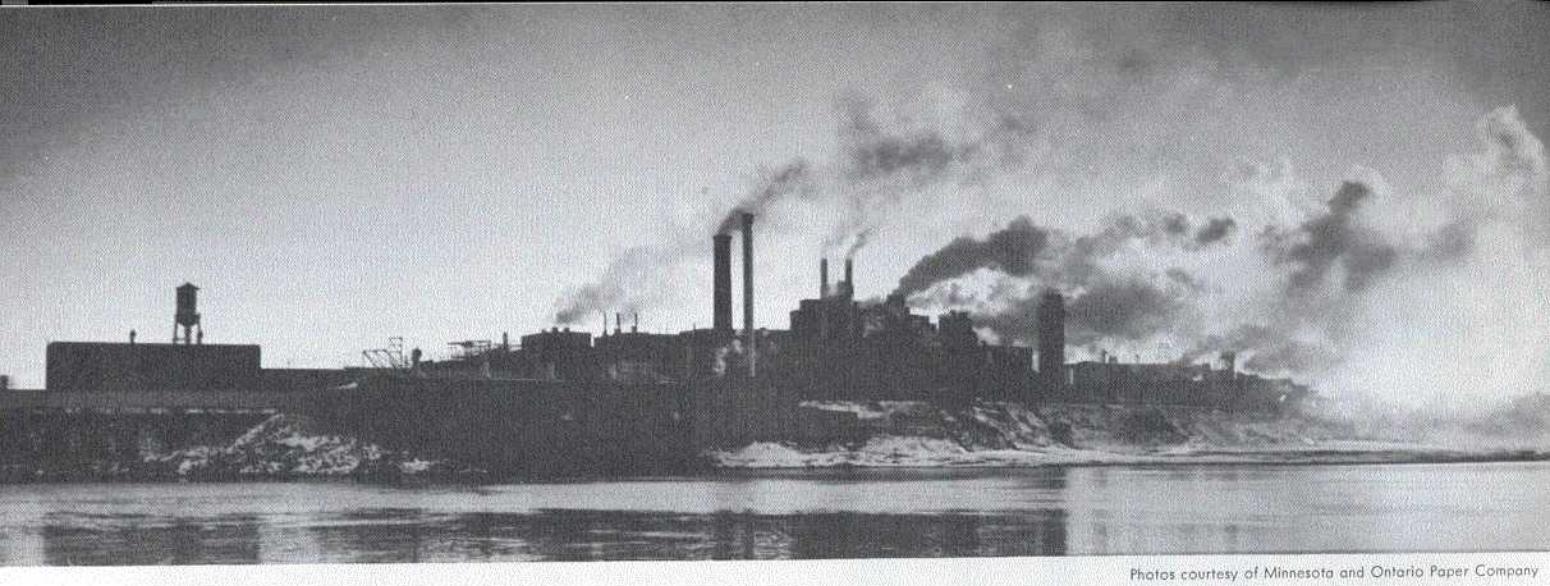
With this over-all outlook as a background, we turn now to consider the problems that could act to limit expansion of this region's pulp-and-paper industry and suggest some possible solutions to these problems. But first, let us take a closer look at the industry itself.

*Which would now be too low—i.e.: the lowest of four more recent projections by the U.S. Census Bureau suggests nearly a 40 percent increase between 1950-1975.

CHART 3 — PROJECTED CONSUMPTION OF PAPER IN THE U.S.



Source: American Paper and Pulp Association; PMPC; SRI



Photos courtesy of Minnesota and Ontario Paper Company

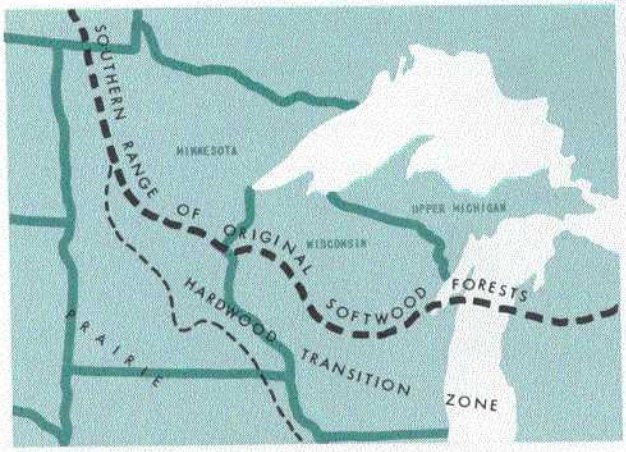
The industry here;

some recent changes

Pulp-and-paper plants were first established in the upper lakes region to take advantage of ample raw materials. Dense forests that at one time covered nearly 100 million acres in the three states of Michigan, Minnesota and Wisconsin, held great volumes of spruce and fir. The fibers of these softwood trees were in prime demand for pulp making.

On the following map is indicated the approximate southern extension of this district's softwood forests (the cone-bearing "evergreens"). To the west is prairie, to the south scattered hardwood stands on lands now mostly in farms. To the north these forests continue into Canada, losing their commercial significance near Hudson Bay where they give way to the stunted growth of the tundra. These growth patterns were dictated by a combination of climate factors. North and east of the original softwood limits remains an area where agriculture is of relatively little importance and where most of the land is best used for growing forests.

CHART 4 — RANGE OF ORIGINAL SOFTWOOD FORESTS



The original forests were lumbered heavily toward the end of the 19th century. Around 1900, when the area's peak timber output was reached, these forests were the country's chief source of lumber. But the cutting as practiced proved shortsighted. The land was soon cleared of nearly all its original stands and left to regrow as it would. At least half of the cutover area was subsequently burned over, further reducing the quality and stocking of new growth.

Today, there remain about 53 million acres of "commercial" forest land in the three states, most of this in the form of second-growth forests. The present commercial forest area coincides rather closely with the original extent of softwood forests as indicated on the map of chart 4. Most pulp-and-paper mills in the region are located in this area, or within an hour's trucking distance of its southern limits.

Specific locations of the mills within the region have been restricted to the rivers and watercourses that could supply the great quantities of water (and power) needed in pulp-and-paper-making processes. Then, too, in earlier days rivers were the chief avenues for transportation of pulpwood logs. Accessibility of markets was also a factor, which accounts in part for the greater density of mills in the southeastern part of the region. From here, Chicago,

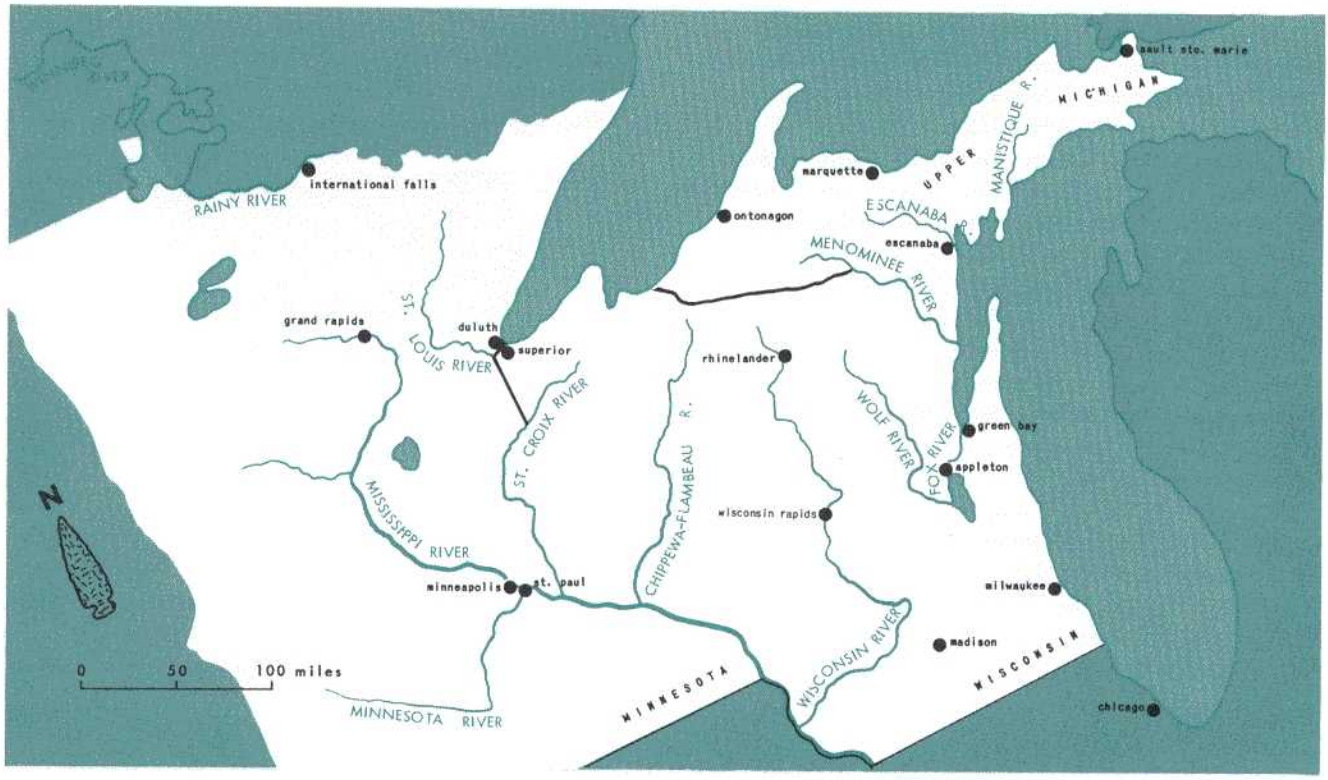


CHART 5 — CHIEF RIVER SYSTEMS IN THE UPPER LAKES REGION

Cleveland and other of the larger markets are closer at hand. The delivered price of industrial fuel, especially coal, was also a factor in mill locations.

The importance of each river system in terms of pulp-making capacity is indicated in the following table.

TABLE 1 — PULP AND PAPER MILLS BY RIVER SYSTEM, 1955

river system	number of mills				pulp capacity tons/ 24 hours
	paper only	pulp only	both	total	
wisconsin r.	3	1	9	13	1,692
fox-wolf r.	12	2	9	23	1,460
rainy r.			1	1	687
st. louis r.			3	3	538
mississippi r.	1		5	6	460
chippewa r.			4	4	390
menominee r.		1	3	4	313
all other	3		6	9	593
total	19	4	40	63	6,133

Charts 6 and 7 show the location and size of pulp-and-paper mills in the region. Of the 63 mills, 40 are integrated in the sense that they produce both pulp and paper, while 19 produce only paper and 4 produce only pulp. Although the bulk of the mills have both operations at the same plant, pulp-making capacity and paper-making capacity are shown on separate maps.

Total capacity of mills in this region is about 9,448 tons of paper and fiber products a day and some 6,133 tons of pulp a day. The reason there is less pulp produced than paper is partly due to the fact that it doesn't take quite one ton of pulp to make one ton of paper. In the case of some kinds of boxboard, for example, half a ton of pulp will do. Clay and various other materials make up the rest of the board. Over-all average requirements for this region might run around 85 tons of pulp to each 100 tons of paper.

Another factor in the discrepancy between pulp output and paper output is the fact that some wood pulp is purchased from mills in Canada and from other parts of the U.S.

Of course, the total mill-capacity figures given above cover a great variety of paper and fiber products—from

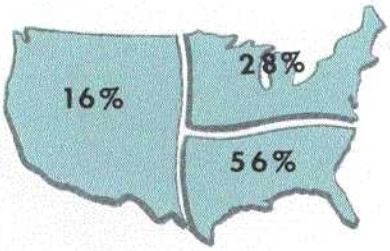
napkin tissues to house sheathing—and several different pulping processes. (Newsprint paper is not produced in quantity in the upper lakes region—in fact most of the U.S. supply is imported from Canada.)

How does this production capacity compare with other areas? In strictly quantitative terms, these mills represent 10 percent of the nation's total paper-making capacity and 11 percent of total pulp capacity. Dividing the nation into broad sectors, the distribution of pulp-making capacity is as follows: The southeast quarter of the nation has 56 percent of the pulp capacity, fairly well dispersed throughout the southern states; the northeast quarter (including the upper lakes region) has 28 percent of the pulp capacity; the western half has 16 percent, nearly all in the Pacific Northwest.

A typical pulp mill in the upper lakes region is considerably smaller than, for example, many in the South. Some recent southern pulp-and-paper plants are very large. One in South Carolina can turn out close to 2,000 tons of pulp a day and, ignoring differences in quality, this amounts to nearly a third of the total tonnage of our 44 pulp-producing mills.

Changes that have taken place in the region's pulp-and-paper making capacity during the postwar decade are of special interest, so we've summarized some of the essentials in the tables on page 8. Between 1945 and 1955

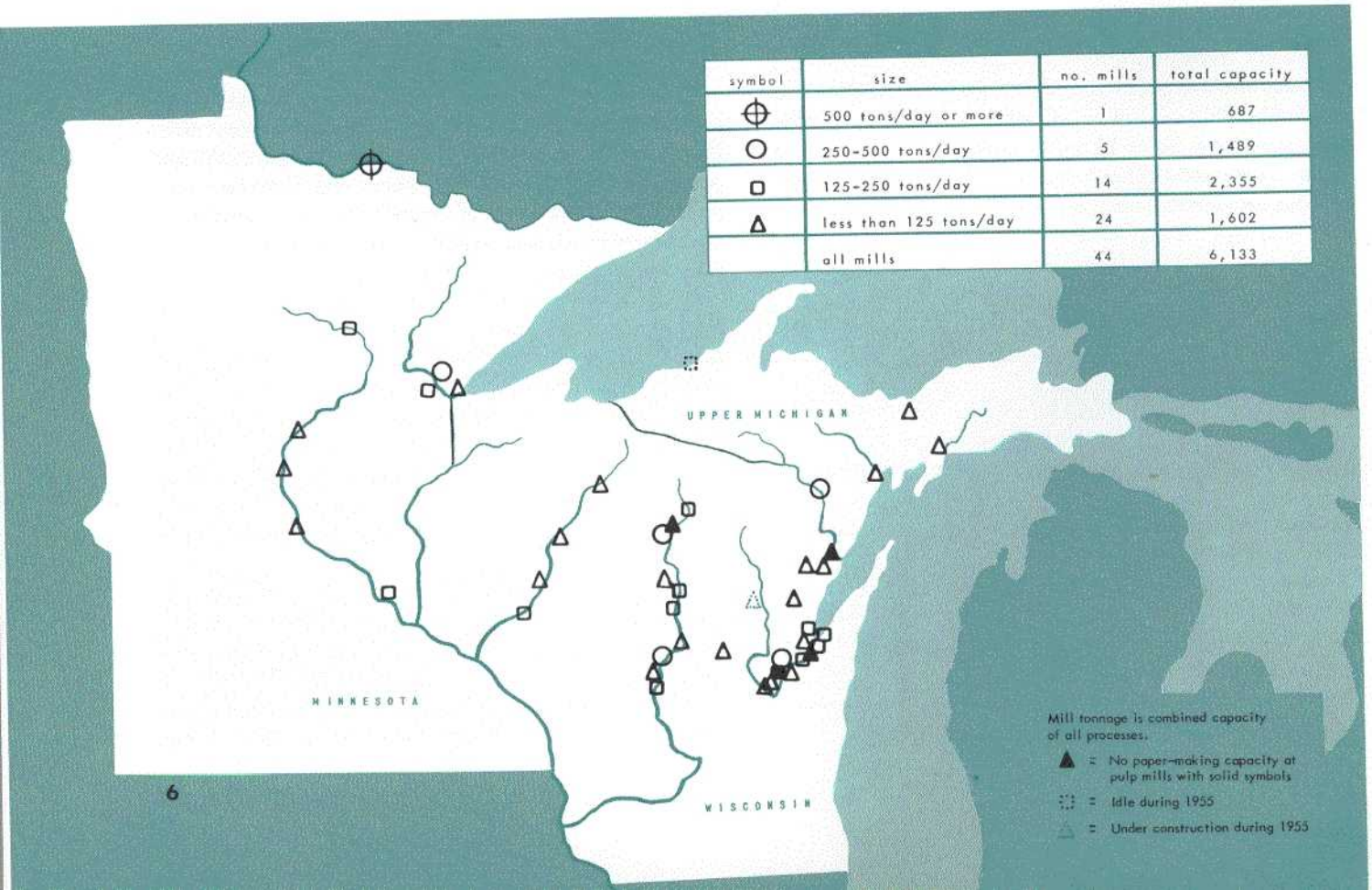
CHART 8 — DISTRIBUTION OF PULP-MAKING CAPACITY IN THE U.S., 1955



Source: American Paper and Pulp Association

CHART 6 — PULP MILLS, UPPER LAKES REGION, 1955

Source: Lockwood Directory; author's survey, 1955



symbol	size	no. mills	total capacity
⊕	500 tons/day or more	1	687
○	250-500 tons/day	5	1,489
□	125-250 tons/day	14	2,355
△	less than 125 tons/day	24	1,602
	all mills	44	6,133

paper-making capacity here grew by 45 percent, somewhat below the over-all national increase of 52 percent. Changes in pulping capacity show an even greater contrast: our increase was 34 percent, or less than half the national increase of 86 percent.

Some types of paper making showed considerably more expansion than others. Among the broad product groups listed in the table, the greatest increase occurred in the output of house sheathing and fiber insulating products; output of these products, measured in square feet, increased 176 percent. Plants in this region producing wrapping and boxing papers, and those producing tissue, also showed a relatively large growth in output capacity, averaging 50 and 58 percent respectively. Capacity of mills producing finer papers (book, writing and printing grades) experienced the least increase. Plants producing a variety of pulp products or special types of paper not included in the foregoing, expanded output, as a group, by 33 percent.

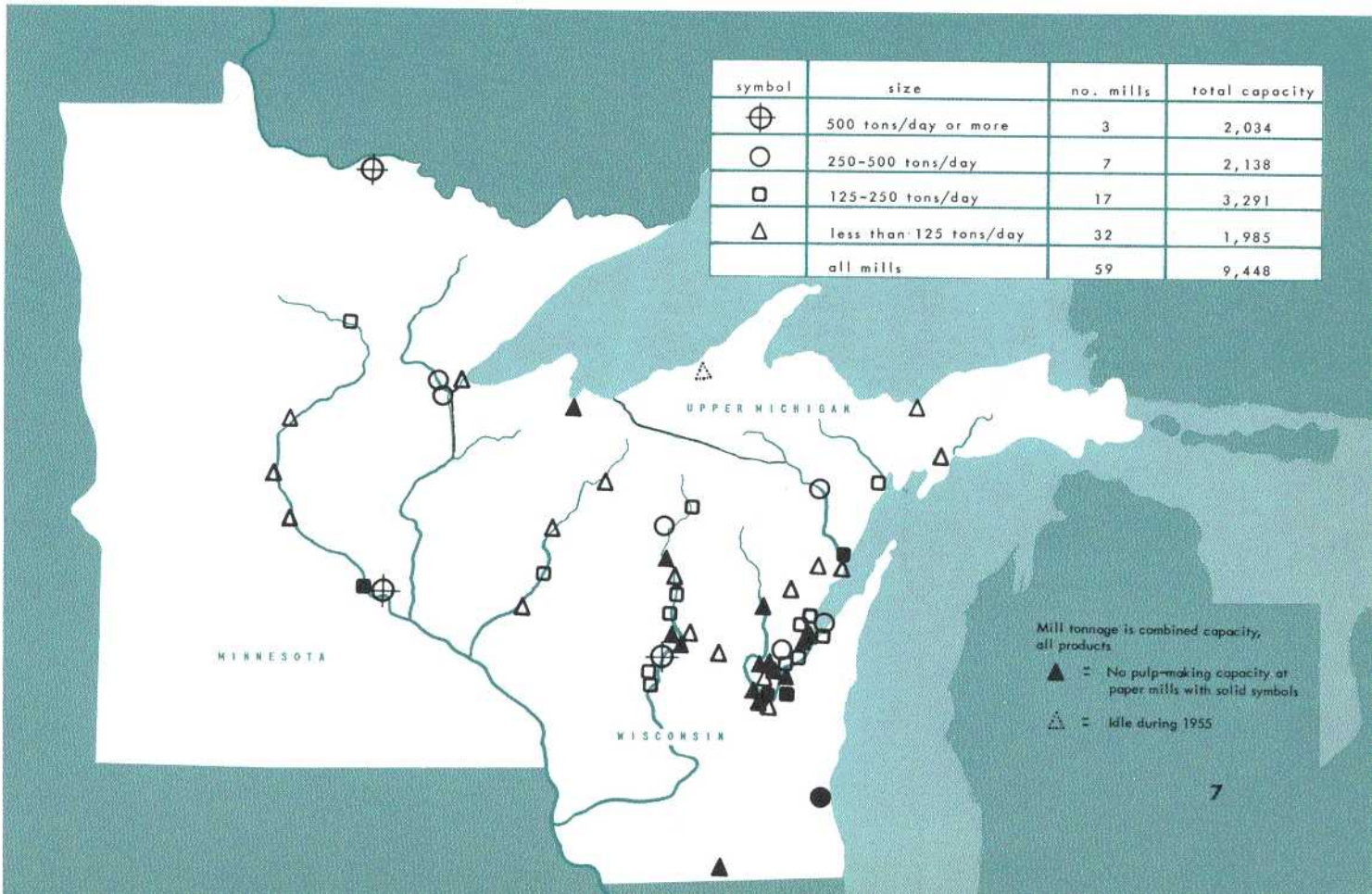
Of course, these figures show only tonnage changes. Most mills will verify that their product has also undergone improvements over the period so that quality has been upgraded. A few mills made radical changes in the type of paper produced. These factors must be kept in mind when interpreting the figures in tables 2 and 3.

Important changes occurred in pulping processes too. *Sulfite* pulping and *groundwood* pulping, the leading processes in this region, showed the least percentage growth. *Semichemical* pulping has shown the most striking increase, accounting for more than half of the growth in this region's total pulping capacity. The difference between pulping methods is significant and will be discussed later.

State-by-state comparisons in the tables reveal that the rate of increase in total paper capacity was equally shared. However, a substantial part of the increase for mills in Minnesota is accounted for by sheathing and insulating type products, the output of which is ordinarily measured in square feet. The estimated fiber tonnage equivalent of these items was about 710 tons per day in 1955. Excluding this type of product, paper capacity in Minnesota has increased by only 26 percent over the 10-year period.

CHART 7 — PAPER MILLS, UPPER LAKES REGION, 1955

Source: Lockwood Directory; author's survey, 1955



symbol	size	no. mills	total capacity
⊕	500 tons/day or more	3	2,034
○	250-500 tons/day	7	2,138
□	125-250 tons/day	17	3,291
△	less than 125 tons/day	32	1,985
	all mills	59	9,448

During this decade, however, a number of the mills in Minnesota were rather completely rebuilt so that the 1955 capacity figure represents a substantially changed product line.

One other feature that stands out in the state-by-state comparisons, is the very low rate of increase in pulp capacity in Upper Michigan.

A few miscellaneous statistics not shown by the tables are these: during the period 1945 to 1955, some 9 or 10 plants have undergone a change in ownership as evidenced by a change in name, one mill burned down (never rebuilt), and one mill closed for financial reasons and was subsequently dismantled. During the 10-year period, two completely new pulp-and-paper mills were built, and during 1955 one new pulp mill of 20 tons daily capacity (associated with an existing paper mill) was under construction. One mill in Upper Michigan remained idle during 1955.

TABLE 2 — CHANGES IN PAPER MILL CAPACITY, UPPER LAKES REGION, 1945-1955

	no. of mills	capacity in tons per 24 hours			
		1945	1955	increase	percent
by product					
book, writing, printing, "fine"	21	2,245	2,990	745	33%
wrapping, boxboard, "heavy" papers	13	1,803	2,704	901	50%
tissue, toweling	9	633	1,000	367	58%
other types and diversified	15	1,535	2,044	509	33%
subtotal	58	6,216	8,738	2,522	41%
structural, insulation (in square feet)	2	1,460MSF	4,025MSF	2,565MSF	176%
total*	59	6,506	9,448	2,942	45%
by state					
Wisconsin	45	4,206	6,110	1,904	45%
Minnesota with*	10	1,820	2,638	818	45%
without*	9	1,530	1,928	398	26%
Upper Michigan	4	480	700	220	46%

*Including estimated fiber-tonnage equivalent of square-foot items. One of the two mills producing insulation-type products is also included in the subtotal.

Source: Lockwood Directory, author's survey, 1955

TABLE 3 — CHANGES IN PULP MILL CAPACITY, UPPER LAKES REGION, 1945-1955

	no. of* pulp units 1955	capacity in tons per 24 hours			
		1945	1955	increase	percent
by process					
sulfite	19	1,809	2,065	256	14%
sulfate	6	770	975	205	27%
groundwood	21	1,696	1,870	174	10%
semichemical	7	—	808	808	greatest absolute
all other	6	286	415	129	45%
total	59	4,561	6,133	1,572	34%
	no. of mills				
by state					
Wisconsin	30	2,991	3,996	1,005	34%
Minnesota	9	1,135	1,685	550	48%
Upper Michigan	5	435	452	17	4%
total	44	4,561	6,133	1,572	34%

*Pulp unit is one process at one mill. Some mills have more than one process, hence more than one unit.

Source: Lockwood Directory, author's survey, 1955

TABLE 4 — COMPARATIVE REGIONAL GROWTH OF PULP AND PAPER CAPACITY, 1945 to 1955

	annual capacity in millions of tons		
	1945	1955	percent growth
pulp capacity			
total U.S.	12.1	22.5	86%
South	5.7	12.4	118%
non-South	6.4	10.1	58%
paper capacity			
total U.S.	20.3	30.8	52%
South	5.0	11.4	128%
non-South	15.3	19.4	27%

Source: American Paper and Pulp Association

The problem outlined

NOT ENOUGH PULPWOOD—OF DESIRED SORTS

THE PRIMARY factor acting to limit expansion of pulp-and-paper mills in the upper lakes region is the tight supply of the kinds of wood which the industry is geared to use. Even now the industry is forced to cover great distances to fill its pulpwood requirements. Take 1954, for example. About 3 million cords* of pulpwood were received by the pulp mills of Minnesota, Wisconsin and Michigan. Of this total about 2.3 million cords were supplied from forests within the three states. The remainder was brought in from Canada and the western U.S. (The wood supply analysis to follow will include both the upper and lower peninsulas of Michigan, since the necessary statistics are not available for Upper Michigan separately.)

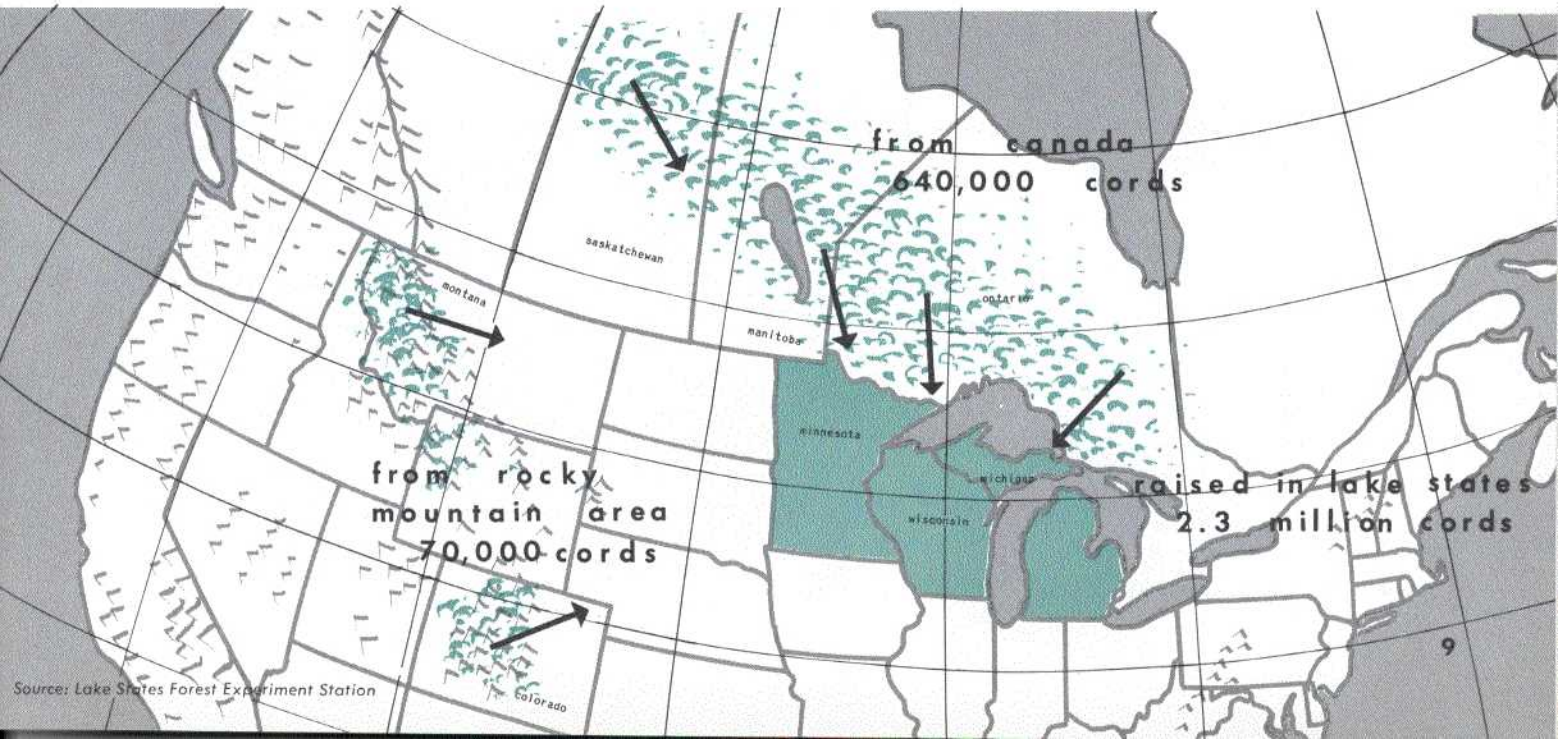
The map below, then, indicates the major forest areas drawn on for pulpwood by mills of the three Lake States. Only a small portion of this (about 6 percent) goes to the lower peninsula of Michigan, because of the relatively small amount of pulping capacity located there.

Imports to the three states, therefore, represent a little over one-fifth of the area's total current usage. On the surface this may seem to be a moderate volume of imports, especially since most of it comes from nearby Canadian forests. But a closer look reveals the problem to be one of considerable importance.

There are great differences between one type of tree and the next when it comes to pulping qualities. So it is essential to consider *type* of wood to really understand

*The three million cords referred to here are estimated on an unpeeled basis (with bark). One *cord* is equivalent to the volume of wood in a stack of 4-foot logs, tightly-packed in a pile four feet high and eight feet long. A cord may contain from 1½ to 2 or more tons of wood dry weight (green weight might run 2 to 2¾ ton per cord).

CHART 9 — GENERAL SOURCES OF PULPWOOD FOR LAKE STATES PULP MILLS, 1954



Source: Lake States Forest Experiment Station

the supply problem. For our purposes we will divide the many species of pulpwood into four groups, as follows: (1) *spruce-fir*, (2) *pine*, (3) *aspen*, and (4) *dense hardwoods* . . . not that these are the best possible breakdowns, but much information is readily available for these groupings that would be unavailable on some other basis.

The first two groups, spruce-fir and pine, together make up the *softwoods*—the cone-bearing evergreens. The last two groups, aspen and dense hardwoods, make up the *hardwood* family—these are all broad-leaved trees. Some important characteristics of the four groups of trees are shown in table 5.

TABLE 5 — SELECTED CHARACTERISTICS OF FOUR PULPWOOD SPECIES-GROUPS

	spruce-fir	pine	aspen	dense hardwoods
includes	spruces balsam fir cedar hemlock tamarack	red pine white pine jack pine	aspen (also called poplar or "popple")	birch beech maple oak, elm gum
chief uses in pulping	higher grades of paper, blending in newsprint	(jack only) printing, writing, book, bond, wrapping	corrugated and other boards, tissues, printing & magazine	boxboards, corrugated liners, blending in high grade papers
percent cellulose fiber	55-60%	55-60%	64%	60%
weight per cubic foot*	21-27 lbs.	20-27 lbs.	22-23 lbs.	29-36 lbs.
average fiber* length	2.8-3.7 mm.	3.5-3.7 mm.	1.2 mm.	1.0-1.5 mm.
typical price per cord, 1955, f.o.b. rail (peeled)	spruce $29 balsam $24 hemlock $21	jack $21	aspen $19	birch $18

*Source: Forest Products Laboratory. USDA, Technical Note Number 191, September, 1953

The spruce-fir group contains those tree types most in demand in this area for pulping. The reasons they are in high demand lie in the length and quality of the wood fibers they contain. These fibers are the structural basis for the end product, paper, and therefore they are important in determining the physical properties of paper.

Wood fiber is sometimes called *cellulose* fiber since it's made up largely of the chemical material, cellulose. Inside the living tree, cellulose fibers are fine, thread-like cells of plant matter bundled together to form the grain of the wood. Cellulose comprises from 50 to 60 percent of a typical pulpwood log (peeled). In chemical pulping processes, the *non-cellulose* material, as well as a fraction of the cellulose, is dissolved away and not used in the finished sheet.

Softwoods (such as balsam fir) generally weigh less per cord than do dense hardwoods (such as oak). Softwoods also tend to contain a lower percentage of cellulose. As a result of these two factors, dense hardwoods contain much more cellulose fiber per cord than do softwoods. For example, chemical pulping processes might extract 900 pounds of pulp from a cord of softwood, but up to 1,400 pounds of pulp from a cord of dense hardwood. Aspen, although technically a hardwood, is more nearly like the softwoods in its bulk weight and hardness characteristics.

In spite of their lower yield per cord, softwoods are favored for pulping. They are more homogeneous, easier to pulp and their fibers are of greater length. The longer fibers intermesh better to form a stronger sheet. These are among the qualities that place softwoods, and in particular the spruce-fir group, in high demand. The economic value of the various pulpwood groups to the pulp producer today may be gauged by the prices these mills are willing to pay for different pulpwood species. Relative strength of demand is reflected in these prices.

With these facts in mind about the differing merits of various types of pulpwood, let's take the 3 million cords used in 1954, sort it into the four type-groups, and see what portion of each was brought in from outside the region. This is done in table 6.

Notice the greater dependence on outside areas for softwoods. Indeed, close to forty percent of the trees in the spruce-fir group was imported.

Of course the situation may vary considerably from one plant to another. Some mills, depending on their particular location, timber-land holdings and type of product, can get all their wood needs locally. Others have bought wood from as far away as a thousand miles.

But taken over-all, these comparisons point to the conclusion that there is a shortage of the types of wood that pulp producers of the area most prefer. This shortage

TABLE 6 — PULPWOOD RECEIVED BY MILLS IN THE LAKE STATES, 1954 (in thousands of cords)

	spruce-fir	pine	aspen	dense hardwoods
total receipts at Lake States mills	1,350	500	1,050	120
receipts from non-Lake States sources	520	130	60	6
non-Lake States sources as percent of total	39%	26%	6%	5%

Source: Lake States Forest Experiment Station, USDA

seemingly poses an obstacle to expansion.

What can be done about it? The second half of this report will present some answers to this question. First, however, we will consider two more factors bearing on the supply problem—(1) the local distribution of forests within the region, and (2) an important situation concerning imports from Canada.

Distribution of forests in the Lake States

From one part of the region to another there are marked differences in the predominance of each tree species. The area of commercial forest land dominated by each species grouping is shown by state in table 7.

These acreages are, of course, not all in one block, but are to be found as various-sized stands of one or more species of trees scattered throughout the region. Some stands are sparse and scrubby, others dense and full grown. There is considerable mixing. The gross patterns of distribution are suggested, in a very generalized way, in chart 10.

Comparisons by state show some important features. About half the *spruce-fir* acreage is in Minnesota, while the bulk of the *dense hardwoods* is found in Michigan and Wisconsin—particularly in Upper Michigan.

The *pine* area on the other hand, is rather equally

CHART 10 — GENERALIZED FOREST DISTRIBUTION IN THE LAKE STATES

Source: Lake States Forest Experiment Station, USDA

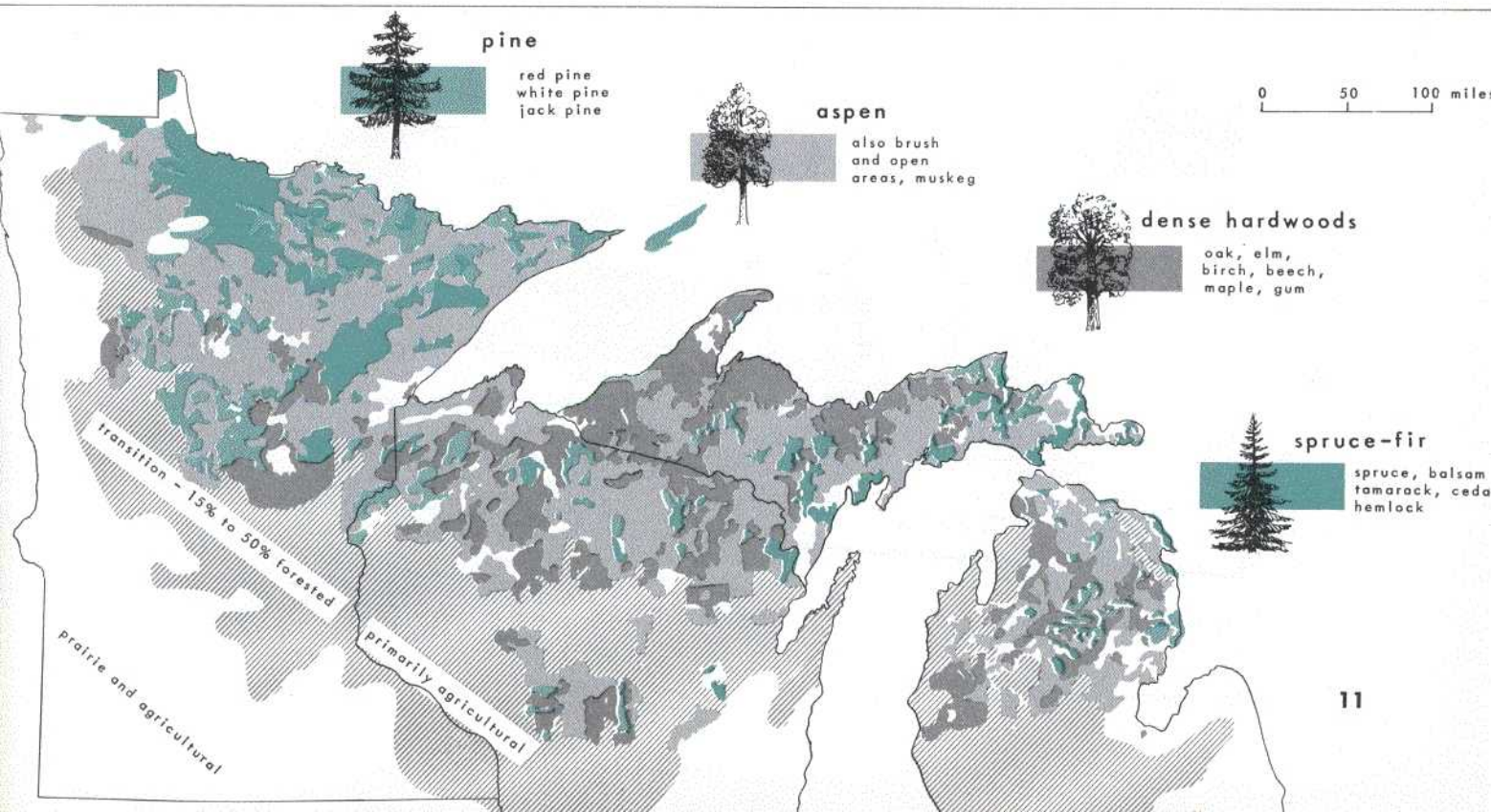


TABLE 7 — DISTRIBUTION OF COMMERCIAL FOREST AREA* IN THE LAKE STATES, 1953 (in millions of acres)

	spruce-fir	pine	aspen	dense hardwoods
Minnesota	5.1	1.7	7.0	4.3
Wisconsin	1.8	1.1	5.9	7.5
Michigan	3.1	1.6	5.6	8.6
Lake States total	10.0	4.4	18.5	20.4

*Eliminates non-productive forest land as well as parks and reserve areas that cannot be cut, but includes 10.4 million acres of non-stocked (deforested) land requiring some planting.

Source: Lake States Forest Experiment Station, USDA

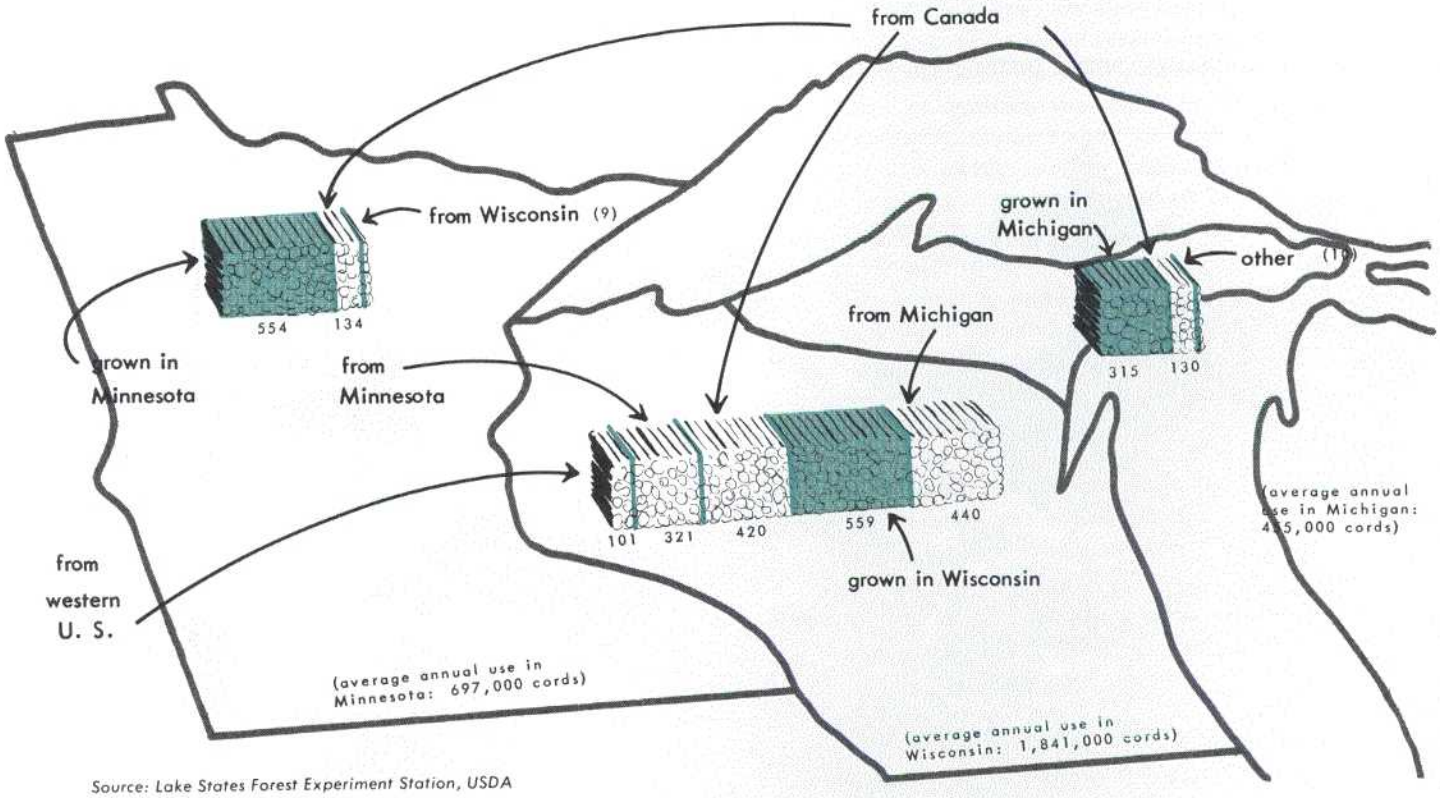
divided between the three states. However, the only member of this softwood group currently cut for pulping in this region is *jack pine*, and there is a somewhat greater concentration of this tree in Minnesota.

Hemlock, which we lumped with the spruce-fir group of trees, is commercially important only in Michigan and Wisconsin—chiefly the upper peninsula of Michigan. Hemlock made up slightly less than 7 percent of pulpwood of the spruce-fir group used in the Lake States during 1954.

'Logistics' and cost

Despite these intraregional differences in species, the over-all forest volume is almost equally divided between the three states. However, because of the greater density of pulp mills in Wisconsin (about two-thirds of the pulp-making capacity of the three-state region is located there), the problem of pulpwood supply in that state is more intense. Both Minnesota and Michigan ship substantial tonnages of pulpwood to Wisconsin. Wisconsin pulp mills use greater quantities of wood from Michigan than

CHART 11 — AVERAGE ANNUAL RECEIPTS OF PULPWOOD OF ALL TYPES AT MILLS IN THE LAKE STATES, 1950-54
(figures are thousands of cords)



Source: Lake States Forest Experiment Station, USDA

do mills in Michigan themselves. Chart 11, showing pulpwood consumption in each state and the sources from which the wood came, graphically indicates the scope of each state's supply deficit.

Elaborating on the source-of-supply data of the preceding diagram, chart 12 shows four selected species separately. These charts verify that Wisconsin, with the greatest pulpwood demand, also has the largest deficit of pulpwood. Further, they reveal that the deficit is much more marked in the case of higher grades.

The data we have just discussed provide a quantitative measure of the raw materials problem faced by this region's pulp-and-paper industry. Large tonnages of preferred-quality pulpwoods must be moved substantial distances merely to keep the present mill capacity supplied. This, of course, adds to costs. Whereas rough spruce may sell for $24 a cord and rough aspen for $12 a cord (FOB freight cars), the freight alone from Ontario may run $10 to $12 per cord, and the freight charge on shipments from the Rockies in the western U.S. exceeds $15 a cord.

Taking a hypothetical locality in northern Wisconsin, here are some calculations designed to show, in a rough way, how important these freight charges can be in the cost of a ton of pulp. Assume we are using a certain species of spruce pulpwood to produce *bleached sulfite* pulp. We would need about 2⅛ cords of wood (unpeeled) to produce a ton of pulp, which we could then sell (or buy) for about $150 at current prices.*

The 2⅛ cords of spruce would cost about $56.95 at source loading points.[1] To this we add transportation costs.

In the case of truck delivery from within 40 miles of the mill, this might bring our total wood costs for the 2⅛ cords to about $59.50.[2]

For rail distances of about 150 miles (reaching about half way to the extremities of the Lake States from our hypothetical central point) the total wood cost would run about $69.50.[3]

From the extreme corners of the Lake States and from nearby Ontario, net wood costs for the ton of pulp would be $82.60[4]; while imports from the Rocky Mountain

[1] $26.80 per cord on cars, including average commissions.

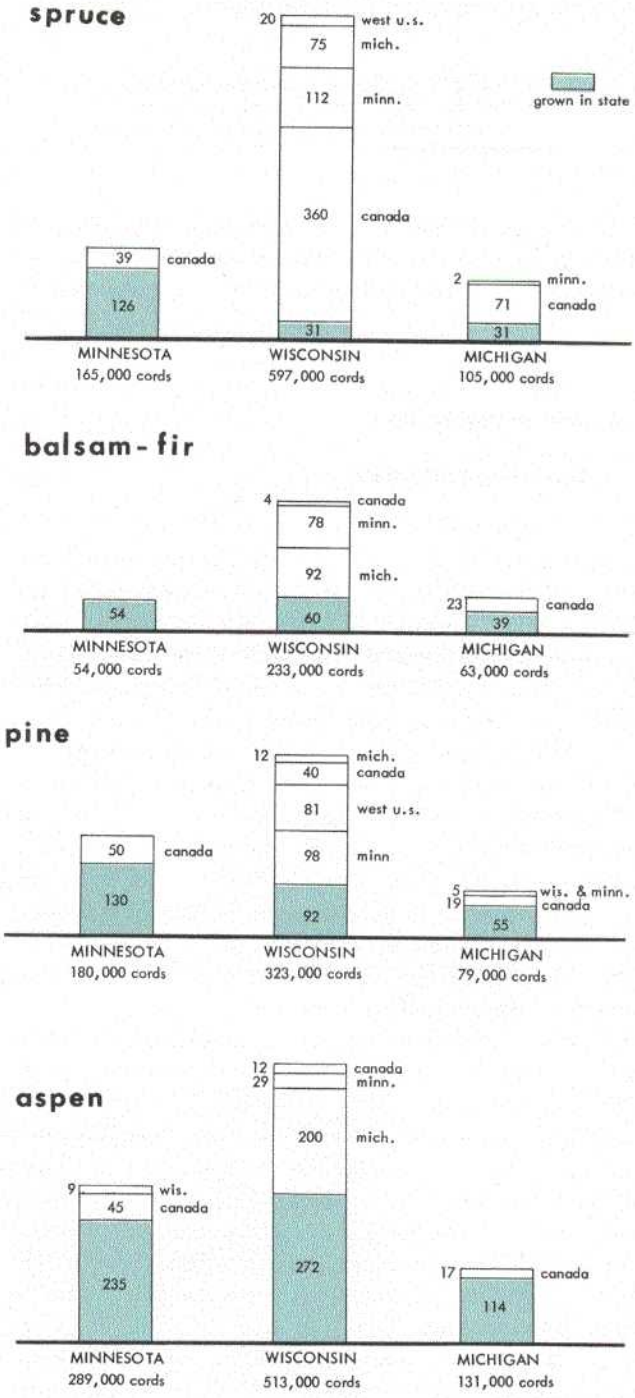
[2] $28.00 per cord delivered to mill by truck, including average commission.

[3] $26.80 per cord for wood and $5.90 per cord for freight.

[4] $25.00 per cord for wood and $14.00 per cord for freight (just under 400 miles from mill).

*Sulfite pulps are currently quoted at $150 per ton bleached and $130 unbleached; sulfate pulp at $155 bleached and $117 to $130 unbleached; groundwood pulps are quoted at $80 to $85 per ton. Source: *Daily Mill Stock Reporter*, April 28, 1956.

CHART 12 — AVERAGE ANNUAL PULPWOOD RECEIPTS, BY STATES, 1950-54, FOUR SELECTED SPECIES SHOWING SOURCE OF WOOD



Source: Lake States Forest Experiment Station, USDA

region and western provinces of Canada would cost, per ton of pulp, from $32.00 to $46.25 for freight alone[5]. Because of lower on-car wood prices at these latter points, the delivered cost of wood would be the same as that from the extremities of the Lake States.

[5] From points in southeastern Manitoba, about $15.00 per cord for freight; from Central Saskatchewan, $22.00 per cord for freight; from Colorado, $15.95 per cord for freight.

Before considering ways to overcome this deficit of locally grown raw materials, there is one additional factor to be mentioned that could greatly intensify the problem.

Export policy of the Ontario government

The pulpwood shortage could be made more acute by virtue of the Ontario provincial government policy regarding the disposition of wood cut on Crown lands (province-owned forests). The bulk of the Lake States' imports from Canada are cut in Ontario, and somewhat over half of it comes from Crown lands.

In 1947 Ontario placed a scaled embargo on exports of pulpwood cut on Crown lands. Under the province's program, exports of pulpwood were to cease entirely in 10 years, declining at a rate of one-tenth of the original volume each year. There was this provision: for each cord of wood processed to pulp stage in the province, a company would be permitted to export one cord of pulpwood. The object of all this was, of course, to stimulate construction of pulp mills in Ontario.

Had this policy been carried out as originally set forth it would have by now sharply reduced this region's pulpwood imports from Ontario. However, as the situation developed certain exceptions were made to the original program. When a number of companies in the Lake States turned to other sources for their wood, unemployment developed in some logging centers in Ontario. To prevent undue distress at these localities the Ontario government granted exceptions, permitting large-volume exports to continue.

While these exceptions are still in effect, the basic policy has not been "repealed." There is no guarantee that pulpwood will continue to be available to mills of this region from forests of Ontario on the same basis as in the past, and the likelihood remains that the original objective will be carried out. In the event the original policy is pursued, the spruce-fir supply situation could indeed become critical. A dependable source of perhaps 300,000 cords or more a year would be needed to offset the complete elimination of Ontario Crown lands as a source of supply.

Summary of the problem

Let's summarize briefly what has been established in the first half of this report.

Nationwide demand for paper is expected to continue its recent rapid growth—and result in an expansion of 70 to 80 percent over the next 20 years.

The pulp-and-paper industry of the upper lakes region, with currently about 10 percent of the nation's pulp-and-paper-making capacity, has shown a sizable growth in plant capacity over the past decade, but at a rate below the national average. The regional showing in paper-capacity expansion has been relatively better than its showing in pulp capacity.

Trying to assess how this area's mills will respond to further increases in demand brings into focus certain regional factors that will exert strong influence on the final outcome. A major obstacle to expansion here was identified as the apparent shortage of long-fibered pulpwood. In this connection the local shortages lie primarily in the better grades of wood and geographically speaking are most accentuated in the more densely-industrial central Wisconsin.

Finally, the pulpwood export policy of the province of Ontario is of potential significance. The latter introduces no new problem in a long-run sense but does seriously increase the urgency of measures to boost the volume of usable wood fibers available locally. The supply problem will, of course, affect each company differently, but we are speaking here of the over-all scale of operations in the upper lakes region.

We turn now to evaluating possible solutions to the problem, thus, to advancing an answer to our original question: *To what extent will the pulp-and-paper industry of the upper lakes region share in the predicted national expansion?*

The solutions considered

THROUGH MULTIPLE APPROACHES—

PLENTY OF EXPANSION POTENTIAL

IF METHODS are found to increase the effective volume of usable wood fiber that is available locally, then the industry in this region may be able to expand its production to match the national growth in demand. Four general approaches to this problem are: (1) grow more spruce-fir and pine in forests of the Lake States, (2) use more of other kinds of wood for pulping, (3) introduce changes in technology that increase yield or reduce costs, and (4) expand without the use of local wood.

(1) Grow more spruce-fir here

The big question is, can we?

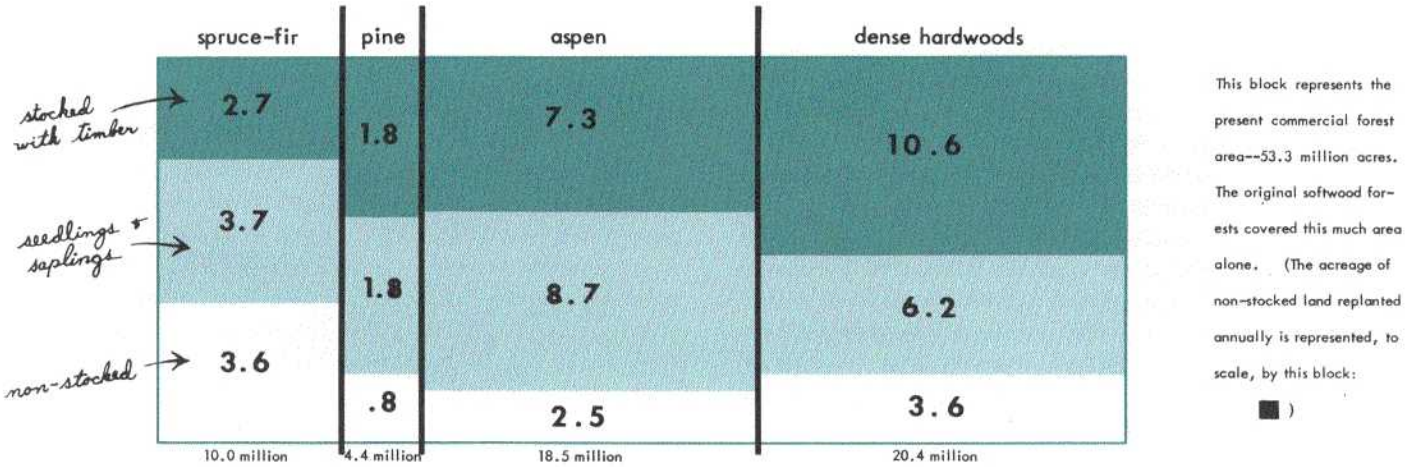
A century ago we had 97 million acres of forest land in the three-state region, with over half this acreage in softwoods. Pine covered 24 million acres, while spruce-fir types occupied 27 million acres. After the forests had been thoroughly cut over, much of the area originally in softwoods came back in aspen, dense hardwoods and brush.

Today about half of the original acreage is permanently converted to non-forest uses (agriculture, industry, residential) but about 53.3 million acres remain classified as commercial forest land—an area larger than either of the Dakotas. This land is best suited for growing trees but much of it is now far below its potential for tree growth.

Chart 13 depicts this forest land, showing, in millions of acres, the area to be found in each of the four species-groupings, and also indicating condition of growth. As you can see, a sizable fraction is in a poorly stocked or deforested condition, especially in the spruce-fir category.

There are two apparent ways in which spruce-fir output

CHART 13 — COMMERCIAL FOREST LAND IN THE LAKE STATES, BY SPECIES-GROUP, 1953 (figures are millions of acres)



Source: Lake States Forest Experiment Station, USDA

could be increased. One is for the stands now in seedlings and saplings to continue their natural growth and begin yielding pulpwood. Over a period of years, other things being equal, this will happen. Another way would be to actively revert some of the aspen or hardwood acreage that originally supported spruce-fir into the needed long-fibered softwood forests.

As a matter of fact, a desirable distribution of species on the region's commercial forest land would call for considerably increased areas in softwoods. Estimates of potential forest land—based on original type and present suitability of land—have been made by forest authorities. A "desirable" distribution of species on our 53 million acres of forest land is as follows:

TABLE 8 — PRESENT AND "POTENTIAL" FOREST AREA IN THE LAKE STATES (in millions of acres)

	spruce-fir	pine	aspen	dense hardwoods
present (1953)	10.0	4.4	18.5	20.4
potential	12	12	8.5	17.5

Source: Forest Resources Report Number 1, USDA, Forest Resources of the Lake States Region, 1950, Lake States Forest Experiment Station

Considering the area available, then, we have currently 6.4 million acres of productive spruce-fir forests, less than half of which has reached pulpwood size. There are 3.6 million acres too poorly stocked to be productive, and another 2 million acres, presently in aspen or other hardwoods, that are better suited to spruce-fir production. (About half of the 12 million acres of present and potential spruce-fir land is in Minnesota.)

If this acreage were devoted to spruce-fir, and growing at a rate of 0.30 cords per acre per year, we could raise and cut at least 3 million cords a year on a sustained basis. The contrast between what we do now and what we could do is illustrated in chart 14.

Therefore, enough land is available—and ideally suited for growing trees of the spruce-fir group—to permit the production of at least 50 percent more pulpwood of this type than we are currently consuming *including all imports.* This is about 2½ times our present production.

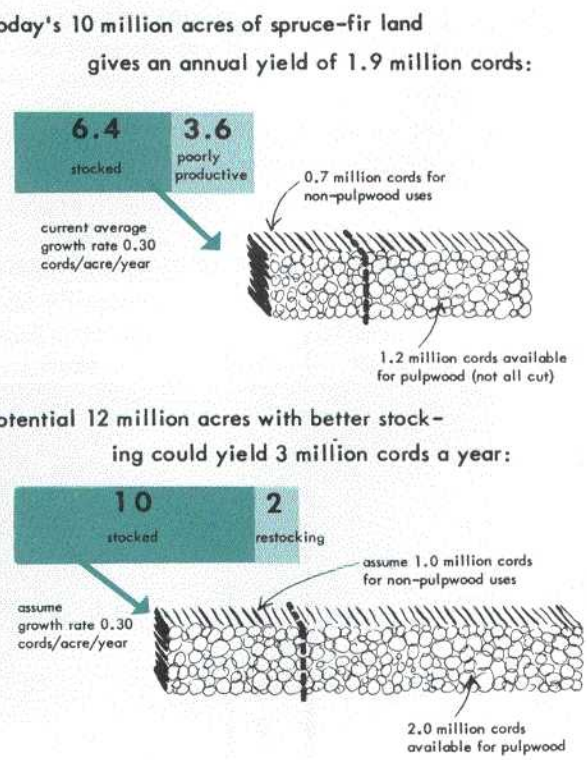
Now comes the crucial question: *How soon can this be done?*

First of all, man's efforts to replant the 10 million acres of Lake States forest now poorly stocked or deforested, reach an average of about 50,000 acres a year—most of this is pine plantings. Actually, the total deforested acreage hasn't changed much over the past 15 years. All of the planting since 1945 has done little more than offset destructive cutting that took place during World War II.

Natural conversion is the most potent agent in regenerating forests. To illustrate: a single acre of balsam trees will turn out 2 to 3 million viable seeds a year. If, on the average, only a hundred of these "take", the resulting balsam "births" far outnumber the total of man's 40 million or so plantings of all species in the Lake States annually. Man's most significant role then is to aid the process of natural conversion by timely and wise cutting, and, where appropriate, to adopt other measures such as *disking* by which forest soil is broken up to promote germination of tree seeds.

Planting is, of course, necessary on unstocked lands. But tree growth is a very long-term proposition in this part of the country. It takes 80 to 100 years for a stand of spruce trees to reach pulpwood size; balsam fir and

CHART 14 — PRESENT vs. POTENTIAL SPRUCE-FIR YIELD



Source: Basic wood statistics from Lake States Forest Experiment Station, USDA

jack pine require about 50 years; aspen may grow to size in 40 years—all of this on the better sites. (Early thinnings of planted stands would begin to yield some pulpwood at about one-half to two-thirds of the "rotation" ages cited here.)

The full potential acreage pictured in chart 14 is not an attainable goal over the next 20 years. In fact, an estimated 100 years would be required under a program of large-scale reforesting—a program more comprehensive than anything carried on at present.

The natural course of forest growth will, however, produce greater quantities of spruce-fir pulpwood in the immediate future. More intensive management of existing woodlands could, quite reasonably, increase production of softwood stands by 20 percent inside of 20 years. (The necessary management would involve maintaining proper stand density and quality through such measures as thinning, more frequent but light cuts, cutting at the proper time with respect to "rotation" age, and properly timed salvage and sanitation cuts.) This added production—of the order of 300,000 to 400,000 cords of spruce-fir a year on a sustained basis—could handily replace the present volume of softwoods coming from Crown lands in Ontario; or, in the absence of restrictions on exports from Ontario, could provide enough additional long-fibered wood to permit pulp mills of the upper lakes region to expand output by about 10 to 12 percent.

At very best, therefore, increased growth of spruce-fir pulpwoods in the region can sponsor only a small part of the 75 percent expansion called for by the predicted demand increase.

Let's turn to the second possibility.

(2) Use more of other species

Let's consider now the forests as they exist today. Chart 13 depicts the forest area currently devoted to the four main species-groupings, showing the relative areas that are now productive and non-productive. Applying regional average growth rates to these areas results in an estimate of the current *annual yield* or *realizable growth.* This is the amount of wood that could be cut each year and yet not deplete the forest or its productive capacity for future years. A certain amount of this wood (how much depends on the species) is taken for uses other than pulping, but after deducting this amount, we obtain an estimate of the net cordage of the wood of each type available for use as pulpwood.

The chart on page 18 carries out these computations step by step for each species group to demonstrate the current pulpwood supply and demand situation internal to the three-state region.

The analysis in Chart 15, based on the forests as they exist today, measures the region's net "deficit" of softwoods and indicates the size of the region's very large surplus of hardwoods. This brings us to some rather interesting further points . . . consider, first, the use of aspen.

If all of the annual "surplus" of aspen growth were used for pulping, the pulp output of this region could be expanded by something in the order of 60 percent or more (depending to some extent on the particular processes chosen to pulp the aspen). The importance of this possibility arises from the fact that an increasing use of aspen, along with the technological improvements that have made it possible, has been a marked characteristic of this region during the past decade. Therefore, the momentum is strong for further progress in that direction.

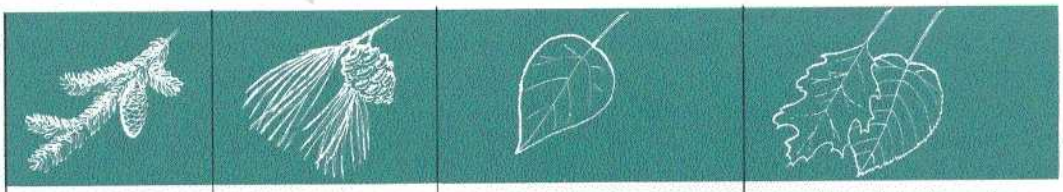
Some uses for aspen pulp are now over 40 years old. For instance, structural insulating board was developed at the International Falls mill of Minnesota and Ontario Paper Company as early as 1914. Shortly thereafter aspen pulp became the basic raw material. The popularization of aspen has made great strides since World War II. It has been found that aspen pulp can be used in some degree in the manufacture of higher as well as lower grades of paper and pulp products.

For lower grades of products such as corrugated boxboard, insulation and sheathing, pulps may be made entirely from aspen or a mixture of aspen and other hardwoods. For example, the plant of the National Container Corporation at Tomahawk, Wisconsin, which formerly produced kraft wrapping and specialty papers, now devotes production exclusively to corrugated boxboard using 25 percent aspen and 75 percent dense hardwoods, all of which is obtained within an 80-mile radius of the mill.

In higher grades of papers, aspen is generally blended with long-fibered softwood pulps. An example is the product of the Rhinelander Paper Company of Rhinelander, Wisconsin, which manufactures a special type of paper called "glassine" (candy wrappers, envelope windows). The company is now using about one-fourth aspen pulp in glassine whereas four years ago none was used. Blends of this nature are widely employed now. Once methods are perfected and customer acceptance is gained, the blended pulp generally has been found to produce sheets as satisfactory as those from all-softwood pulps.

Aspen pulp is not without its limitations, in spite of the fact that things are now being done with pulp made from aspen logs that would not have been considered practical

CHART 15 — CURRENT FOREST GROWTH IN THE LAKE STATES AVAILABLE FOR PULPWOOD



	spruce-fir	pine	aspen	dense hardwoods
forest area stocked in type or in seedlings and saplings	6.4 million acres	3.6 million acres	16.0 million acres	16.8 million acres
average growth rate; cords per acre per year*	.30	.33	.23	.31
estimated current annual yield *(not necessarily cut)*	1.9 million cords	1.2 million cords	3.7 million cords	5.2 million cords
available for pulpwood after allowing for current volume of non-pulpwood uses	1.2 million cords	0.55 million cords	2.9 million cords	2.5 million cords
average annual consumption, 1950-54, including imports	1.4 million cords	0.6 million cords	0.9 million cords	0.1 million cords
COMPARISON: Lake States current consumption of pulpwood to current growth of pulpwood	DEFICIT 200,000 cords	DEFICIT 50,000 cords	SURPLUS 2,000,000 cords	SURPLUS 2,400,000 cords

*The regional average growth rate is actually greater than shown here, but part of it (primarily in saplings) is unavailable for use at this time. The estimated current annual yield, in round figures, is the *realizable growth* or *allowable cut*. This should increase in the future.

Source: Basic wood statistics from Lake States Forest Experiment Station, USDA

a few years ago. The nature of aspen fibers puts physical and economic limits on the extent to which blending can be carried and still produce a satisfactory sheet of high-quality paper. Reduced strength due to shorter fibers often introduces a critical limit to hardwood usage. Improved pulping processes, some now available and others under development, may raise this limit very significantly.

What about the dense hardwoods? This side of the hardwood family also has an impressive potential. If just half the dense hardwood cordage available for pulping could be used, the upper lakes region could increase its pulp output by more than 50 percent. Dense hardwoods are just beginning to rise to importance as pulping stock in this area, although they are used fairly extensively in other regions—especially the East. In New England nearly one-fifth of all pulpwood consumed in 1952 was dense hardwood.

Prior to 1947 or 1948, dense hardwoods were a negligible component in Lake States pulping—a fraction of one percent of all pulpwood used. Since that time they have exhibited a more or less steady upward climb in usage to a high of 5 percent last year—a trend that seems destined to continue with great significance for the upper lakes region.

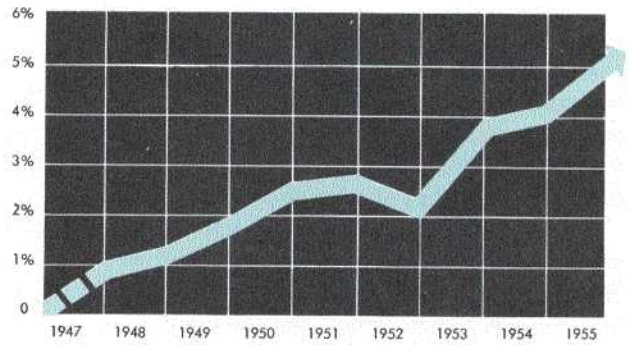
In some respects commercial pulping of dense hardwood poses a more difficult economic hurdle than did aspen. Much research and a number of commercial trials have been conducted on dense hardwoods in this region. Elsewhere their use is well established for certain products and processes.

While many problems remain to be solved in the commercial application of dense hardwoods, their technical suitability for many kinds of paper is an established fact. Expanded use of hardwoods does not necessarily mean lower average grades of paper. As a matter of fact, with the exception of corrugating medium (for corrugated boxboard), hardwoods are in general better suited to the higher grades or fine papers. Use of hardwoods, particularly in blends, can improve the quality of many grades by producing better formation, printing quality and certain other properties.

Two examples of industry "firsts" illustrate both the relative newness and the gradually widening uses of dense hardwood pulps in our area:

Nekoosa-Edwards Paper Company of Port Edwards, Wisconsin began sulfate pulping of oak pulpwood in 1954 on a trial basis, the first commercial-scale use of oak in this region. The trial was reported to be very successful, and the company is now using about 12,000 cords of oak per year—all taken from the immediate vicinity of the mill properties.

CHART 16 — DENSE HARDWOODS AS A PERCENT OF TOTAL PULPWOOD USED IN THE LAKE STATES



Source: Lake States Forest Experiment Station, USDA

In March of this year, Consolidated Water Power & Paper Company announced the successful completion of a trial run of mixed hardwoods at their Wisconsin Rapids mill. Some 700 cords of maple, oak, birch, ash and elm were pulped by the semichemical process, yielding "an exceptionally high quality pulp", and for the first time pulps of this kind were used in the manufacture of enamel printing papers. Dense hardwood pulp will be blended with other pulps for enamel printing papers. It is expected that 24,000 cords of dense hardwoods will be used annually.

While very few companies in this region have gone into dense hardwood pulping on any scale, it is clear that important first steps have been taken and that there is a considerable backlog of technology to be drawn upon. In a manner of speaking, dense hardwoods are in the same position today that aspen was 20 years ago. Based on past experience, then, further advances are almost certain.

This suggests some interesting possibilities. Successful use of dense hardwood pulps opens the biggest single reserve of new wood supply to mills of the Lake States—a reserve that will increase in volume over the next 20 years. (While the analogy should not be pressed too far, the tremendous pulp potential of the South lay dormant until expansion of the kraft pulping process in the mid-twenties unlocked the resinous southern pines to the paper industry.)

On the basis of this reasoning, the *amount* of local wood fiber as such no longer becomes a limiting factor to industry growth in this region since the tonnage of fibers available is well beyond any conceivable expansion in the next 20 years. The limiting influence is shifted then to the degree to which hardwoods can be incorporated into the materials-supply stream and yet permit pulp-and-paper mills to meet competitive demands.

Dense hardwoods have these things definitely in their favor: (1) They are locally available, which means considerable savings on transportation costs. (2) Dense hardwoods are a good deal cheaper per pound of cellulose than softwoods. In some locations in this region, hardwoods can be delivered at a cost of $12 to $15 a cord. This price, especially for the dense hardwoods, would appear to place such locations in an excellent competitive position with respect to other regions.

Yet there are limitations on the extent of use of hardwoods. They cannot be simply substituted *en masse*. Softwoods will always produce pulps superior in important respects to hardwoods. But the limits beyond which hardwood use becomes uneconomic are indefinite and subject to constant erasure by new methods and new products.

In the East, the South, and abroad, dense hardwoods (pulped by soda, sulfate, or semichemical methods) are used for such products as printing and other fine papers and food container board. Other modifications of pulping methods now available, and some promising new ones under development, point to improved hardwood pulps. Substitution of hardwood pulps for softwood *groundwood* pulps may be possible. A high-yield semichemical process has been developed which produces some hardwood pulps closely approaching the properties of spruce groundwood.

Of special interest in this connection is the development of the *chemi-groundwood* process which has just been introduced commercially by Great Northern Paper Company in Maine. The Maine installation is the first of its type for hardwoods. According to the company the process makes practical the large-scale pulping of dense hardwoods. Present input is about half aspen, half dense hardwoods, though the proportion of dense hardwoods will be increased. The resulting pulp is blended with other pulps to make newsprint paper.

Other promising possibilities include the very high yield semichemical pulps. These pulps are prepared by softening chips by a treatment with sodium sulfite or cold caustic soda liquor and passing them through a disc mill. The yield of pulp is about 90 percent. Some of these pulps closely approach the properties of spruce groundwood. Commercial installations to produce pulps of this type are being made in the East, the South and in Australia.

Thus, the ultimate role of dense hardwoods is difficult to assess. This generalization seems safe: within the next 20 years dense hardwoods will form a substantial part of this region's raw-materials input—perhaps a million cords a year—but will probably fall well under the total fiber tonnage available. We may postulate that the limitations of dense-hardwood fiber will make the task for technology increasingly difficult as the ratio of hardwood to softwood pulp increases.

Considering both aspen and dense hardwoods as currently available in quantity in the three Lake States, we conclude as follows: With a level of technological application such as may be reasonably attained within the next 20 years, fibers available from hardwoods could enable this region to more than double, on a tonnage basis, its present output of pulp.

(3) Improve yields; more wood pulp, less waste

There is no sharp boundary between the third approach —now to be discussed—and the preceding one. Both depend greatly on improved production technology. In the former, the emphasis was on the tremendous tonnage of wood fibers that presently go unused; here the emphasis is on things that could be done with the fibers used today.

Since this is primarily a problem of methods, we'll first sketch briefly the processes used by the pulp-and-paper industry of this region. Three main groups of processes, in order of their importance in the region, are: chemical, mechanical and semichemical. These are schematically illustrated in Chart 17.

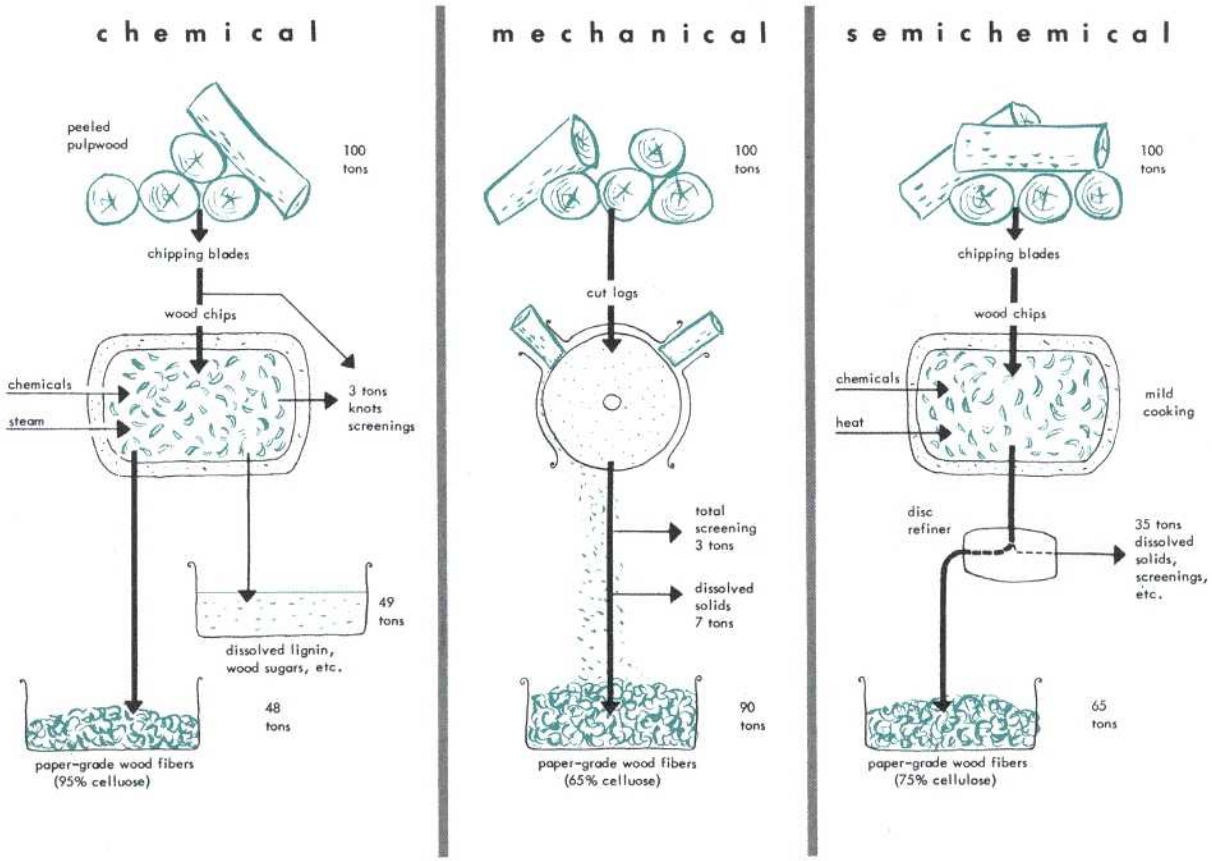
In chemical processing the wood is first de-barked and then cut into chips which are placed in a "digester." Here chemicals and steam under high pressure are allowed to act upon the match-book-size chips of wood. The cellulose part of the fiber, being highly stable and resistant, remains largely unaffected by its scalding chemical bath. Lignin and some assorted carbohydrates, the other main materials in the wood, quickly break down and are dissolved. The dissolved materials are drained away when the cooking process is completed.

The most common chemical process in use in this region is the *sulfite* or *acid* process. This is generally used with spruce and fir pulpwoods to obtain pulp for the highest grades of paper.

The other important all-chemical process in this region is the *sulfate* or *alkaline* process (also called the *kraft* process). This is used on such pulpwoods as jack pine or aspen and produces a light brown pulp. When unbleached it is used for wrapping papers, bags and boxboard. Some bleached sulfate pulp is used in bags, book, bond, envelope and writing papers, as well as in ice cream containers and milk cartons.

Mechanical or *groundwood* pulp is produced by pressing the pulpwood logs against rapidly revolving stone wheels until the wood is reduced to small fibrous shreds. No

CHART 17 — MAJOR WOODPULPING PROCESSES USED IN THE LAKE STATES



chemicals are used and nothing is dissolved away except water soluble substances, which will run 2 to 5 percent. Hence all the woody material eventually enters the paper machines except those pieces too coarse or too fine to be accepted in the various screening steps along the way. As a result, mechanical pulping has a higher *yield*, that is, a greater proportion of the pulpwood log is used in the pulp. Of course, part of this additional material included is lignin, the chief substance cementing cellulose fibers together in wood. Lignin tends to make paper stiff. While stiffness is desirable in some kinds of paper, lignin also tends to break down with age and turn paper yellowish when it is exposed to sunlight. Groundwood pulp goes into newsprint, building, wrapping, printing and specialty papers.

Finally, there is the *semichemical* process (technically called the neutral sulfite semichemical process). This is sort of an in-between method, the yield of which is greater than that of chemical methods, but less than that of straight mechanical methods. It has become increasingly used for pulping aspen. No semichemical capacity was recorded in this region 10 years ago, yet today it produces nearly as much wood pulp as does the sulfate (kraft) process, and accounts for about 13 percent of total pulp production in the Lake States. The method consists essentially of cooking the pulpwood chips in chemicals to soften them—though not nearly as severe a cooking as in the all-chemical processes—and then processing the chips in disc refiners to separate the fibers without material damage.

Table 9 summarizes the important pulping processes used in the region, their average yields, and output capacity.

Once the pulp is prepared by any of these methods, the paper-making process receives the fibers; rinses, screens and blends them; mixes them with water and any of a dozen other materials (clay, starch, rosin, dyes); beats the mixture to promote intermeshing of fibers; and feeds the resulting, highly-fluid pulp onto a rapidly moving screen to start its journey through the paper machine.

TABLE 9 — CHARACTERISTICS OF PULPING PROCESSES USED IN THE UPPER LAKES REGION

process	typical pulpwood used*	average yield by weight	upper lakes region 24-hr. capacity
sulfite	spruce-fir	50%	2065 tons
sulfate	jack pine	45-50%	975
soda		50%	70
total chemical		50%	3110
groundwood	spruce-fir aspen	90%	1850
semichemical	aspen, dense hardwoods	70-85% unbleached 55-65% bleached	958[a]

*Note: Any process can be used on any wood; certain practices tend to predominate. [a]Figure includes 150 tons of a modified semichemical process which was included under "other processes" in table 3.

Source: Lockwood Directory, author's survey, 1955

This general procedure is used on all papers produced in the region whether they be delicate tissues or bulky house-sheathing.

In the various steps along the production path of materials from the forest to the finished sheet it is easy to visualize where mechanical "leaks" of some of the fibers could take place. At points of sawing, de-barking, cutting, chipping or washing, some amount of fibers and other usable material is lost—losses that may total overall from one to several percent. Tightening up on these "leaks" will, in effect, expand the raw material supply. There are both physical and economic limits to the reduction of these losses, but over a period of years improved machinery and methods can be expected to add perhaps a few percent to the total of fibers going into the finished sheet.

The yield differences that are most striking, though, are those between the various processes used for pulping. Chart 17 and table 9 illustrate these differences. In the groundwood process, for example, 90 percent of the peeled log goes into pulp; in the sulfite process, only 50 percent of it. If yield could be improved in the latter process, a greater tonnage output of pulp and paper for a given input of spruce and balsam would result. This would be especially significant for our area because of the relatively high proportion of sulfite pulping here compared with other areas. Work is now being done on the so-called "high-yield sulfite process." Reportedly this would increase sulfite pulp yield from its present average of 50 percent to a possible 75 percent. This it would do by increasing the proportion of cellulose fibers retained in the finished pulp (some cellulose is broken down under present processes) and by including additional "near-cellulose" material and some lignin that is ordinarily dissolved away in the sulfite process.

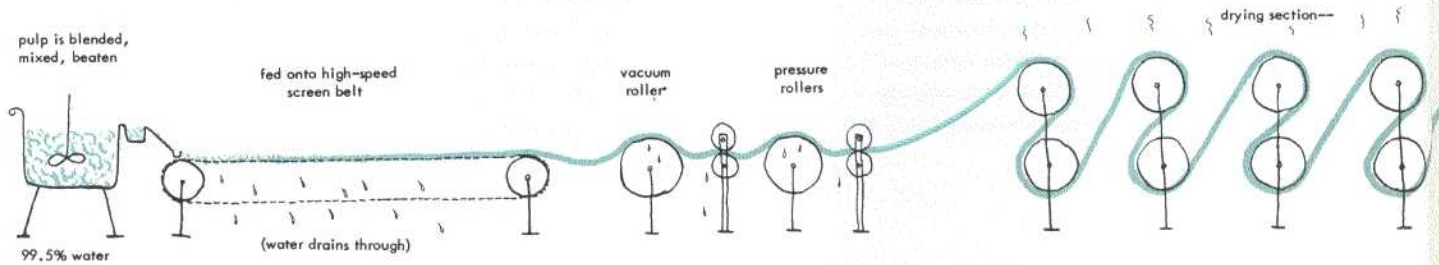
If the 75-percent-yield figure were actually attained by all sulfite pulp mills in the region the output of sulfite wood pulp would be increased by half, adding about 1,000 tons of pulp a day (or nearly 16 percent) to present pulp capacity in the upper lakes region.

Therefore we conclude that process improvements, applied to the same volume and same types of pulpwood we are using today, can sponsor a substantial increase in paper output from this region.

Waste disposal

On the topic of yield, one final point that is of special interest concerns the residues from the chemical pulping processes, especially sulfite. Chart 17 illustrates the fact that for every ton of paper-grade cellulose fibers produced by chemical pulping processes, there is one ton of dissolved solids (lignin compounds, wood sugars, near-celluloses, other carbohydrates, resins and minerals). Nearly 4,000 tons a day of these substances are produced

CHART 18 — GENERALIZED PAPER-MAKING PROCESS (FOURDRINIER MACHINE)



when mills in this region are operating at capacity. Chart 19 indicates the importance of these residues in the over-all flow of materials through pulp-and-paper mills of the upper lakes region.

It is important to do something about these materials for a number of reasons. In the first place, they represent a considerable chunk of the raw material bought. The freight rate alone paid on discarded portions of pulpwood may run $5 a ton or more. It therefore becomes of concern to the mill operator as "money down the drain."

For another thing, to reduce the quantity of the residues discharged into streams, state authorities have required other disposal measures in some areas. The expense of disposal equipment has spurred efforts to find uses for the waste materials.

In the case of sulfate pulping, the problem is much less pressing. This is because a routine part of the process involves evaporation and burning the dissolved materials in the so-called "spent liquor." Then, by appropriate processing of the burned ash, a certain portion of the original cooking chemicals is recovered and re-used in digesting fresh pulpwood chips. In the burning process, incidentally, a certain amount of steam is generated which is used to supply all or at least an important part of the mill's steam requirements.

With the sulfite process the story is different. Historically, spent sulfite liquor has been discharged into the stream from which the mill drew its water supply. The wastes themselves are not toxic—they consist for the most part of such things as fine bits of wood fibers, wood sugars and other organic wood residues. Stream pollution arises from the fact that these materials undergo slow oxidation as they are carried downstream—they are broken down by taking oxygen from the stream. When the dissolved oxygen in the stream falls below about 2 parts per million, desirable stream life, including fish, cannot live normally. (At 2 parts per million dissolved oxygen, stream life can continue to survive; however, life becomes sluggish and does not reproduce itself with normal vigor.) Further, certain types of micro-organisms able to flourish in an absence of oxygen can develop and evolve bad odors. So it's not the nature of the pulp mill discharge in itself to which objections are raised but the after-effects of reduced stream oxygen that too great a concentration of pulp mill residues can cause.

Where the stream volume is great enough in relation to the amount of organic material in the plant discharge, no problem exists. The material gradually dissipates without reducing oxygen content below a safe level. In parts of this region where mill concentration is great (along the Fox and Wisconsin rivers, for instance) pollution problems have received much attention. The Wisconsin State Board of Health has required control measures, and a variety of disposal methods have been adopted by sulfite mills.

For one thing, the dried liquor can be burned. Its heat value is around 7-8,000 BTU per ton—about two-thirds that of industrial coal. Three sulfite mills in Wisconsin currently handle their dissolved solids in this way.

Lignin (in the form of lignosulfonic acid) dominates the waste liquor. In the tree this substance performed the function of cementing together the wood fibers, and the properties it gives to the thickened liquor makes the latter useful as a road binder, especially where road-construction gravels contain clay. Currently, 13 Wisconsin mills haul away waste liquor for use as a road conditioner.

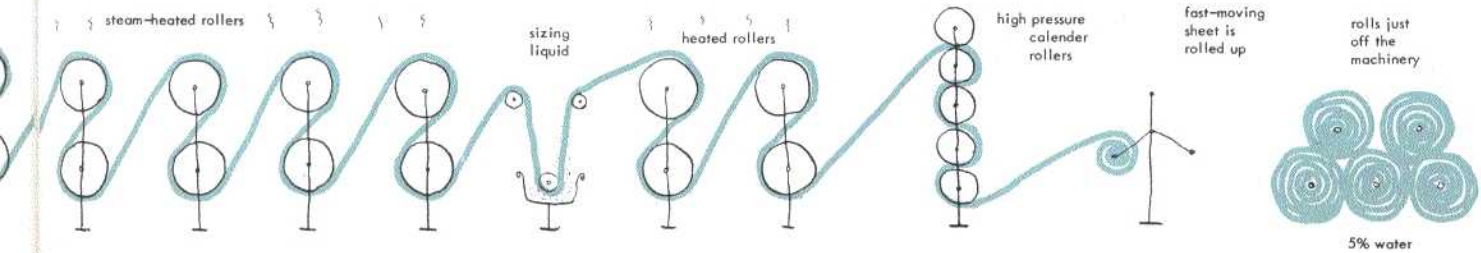
The liquor will also yield a variety of organic chemicals, substances usable in plastics and rubber as an extender, in leather tanning, or in the production of vanillin (from which comes the artificial vanilla extract of household use). One Wisconsin paper company currently operates a chemical recovery plant.

Seven Wisconsin mills presently "lagoon" the waste, allowing soil to act as a filter before the water rejoins surface streams.

Finally, use is also being made by two Wisconsin mills of the dissolved wood sugars. A type of yeast organism cultured on these residues produces torula yeast. The yeast (or its derivatives) may be used as a dietary supplement for both animals and humans.

Some of the programs undertaken to reduce sulfite pollution involve substantial capital outlays. For example:

Charmin Paper Mills, at Green Bay, Wisconsin, last year completed a $2.8 million yeast plant, where torula yeast organisms are put to work consuming



wood sugar. In the process from 20-25 percent of the solid material is removed from the liquor. This primary grown torula yeast will be sold as feed yeast, or food yeast, and pharmaceutical products by the Red Star Yeast and Products Company of Milwaukee.

For some companies the sale of products from sulfite wastes may cover the costs of handling them—or may even result in a slight addition to profits. For most companies, however, pollution control is simply an added cost of operation. Because the sulfite pulping process is the chief one in this region, current research efforts to find an economic outlet for the 2,000-tons-a-day or more of waste solids is especially important. While these measures, as such, will not increase the volume of fibers produced from the region, their effects on costs make them a significant factor in the ultimate over-all scale of operations in the region. The most that can be said at the present time is that handling the waste material is generally uneconomic to the individual firm. Only slow, step-at-a-time progress is expected from research efforts.

It is also of interest that disposal of semichemical waste liquor still awaits discovery of a generally satisfactory method—although the potency of such liquor in using up stream oxygen is only about one-third that of sulfite liquor for a given tonnage of pulp output.

(4) Expand without added local wood

So far we've been primarily occupied with ways to increase the volume of locally grown and economically usable wood fibers going into pulp; in this way to reduce the region's dependence on distant areas. More specifically, we wanted to determine whether the quantity of locally available fibers would be enough to support a growth in production for the region comparable to the growth in consumption forecast for the nation. From the argument of our three approaches to the problem discussed so far, this would seem well within possibility. This fourth solution to the problem represents a change of pace.

Here, we want first to consider the possibility of continuing or even increasing the current level of long-distance imports of wood. In other words, continuing to operate with wood costs relatively higher than other regions.

Assume a particular mill here pays $30 a cord for pulpwood delivered while a large mill located in the South pays only $16. In addition, the southern mill may be able to grow trees to pulpwood size in 30-35 years (in contrast to 40-80 in the Lake States). It may keep inventories of only 1 to 3 months in its woodyards instead of the 5 to 12 month supply dictated by climate in the Lake States. Finally, it may be a large, newly-constructed mill with high-speed machines and low unit costs.

Those facts alone do not make the southern mill competitive with our hypothetical Lake States mill. For one thing, most of the pulp turned out by southern mills is kraft pulp from southern pines and is used for boxboard, wrapping stock and similar grades of papers. If a mill in this region produces, for example, high-quality sulfite paper, it may find its market entirely untouched by the southern mill because of the dissimilarity of product.

For another thing, the mill here may operate as a specialty mill, to produce small quantities or special orders. Such an operation may make subtle changes in blend for customers willing to pay a premium for this service. On the other hand, a large, high-speed machine working on low unit costs may not be handled profitably on that basis. It is obvious that when a mill sells its product for $300 a ton instead of $150, the difference between $30 pulpwood and $16 pulpwood becomes decreasingly important. The successful specialty mill in this region could then doubtlessly continue to draw its wood supply from half way across the continent and still operate profitably, because of the higher price it can command for its product.

This is not suggested as a general outlet available to any company working in this region, but simply illustrates a factor which can operate in some instances to permit relatively high wood costs. A mill does not easily acquire the merchandising and technical staff necessary to produce as a specialty mill. Much of the permissible expansion in these fields likely will be made by mills already doing this kind of work or by mills literally forced into it in order to survive.

Up to this point, alternatives have been discussed in terms of their influence on the future growth of pulp-making in this region. However, local paper-making is not completely dependent on local pulp-making. As chart 19 illustrates, three other "streams" of material enter the final paper output. So, to round out our consideration of paper-expansion possibilities in the upper lakes region, these other streams of materials will be introduced briefly.

Many mills here buy part or all of their pulp needs from outside the region. Pulp (shipped in the form of baled, dry sheets that look like crude, thick paper) is brought in from such areas as Washington, Ontario, Quebec and Georgia. Commonly, a mill may make its own groundwood pulp and buy its requirements for long-fibered chemical pulp. The general flow of materials illustrated in chart 19 indicates that purchased pulp is a relatively significant part of our region's materials supply. It was

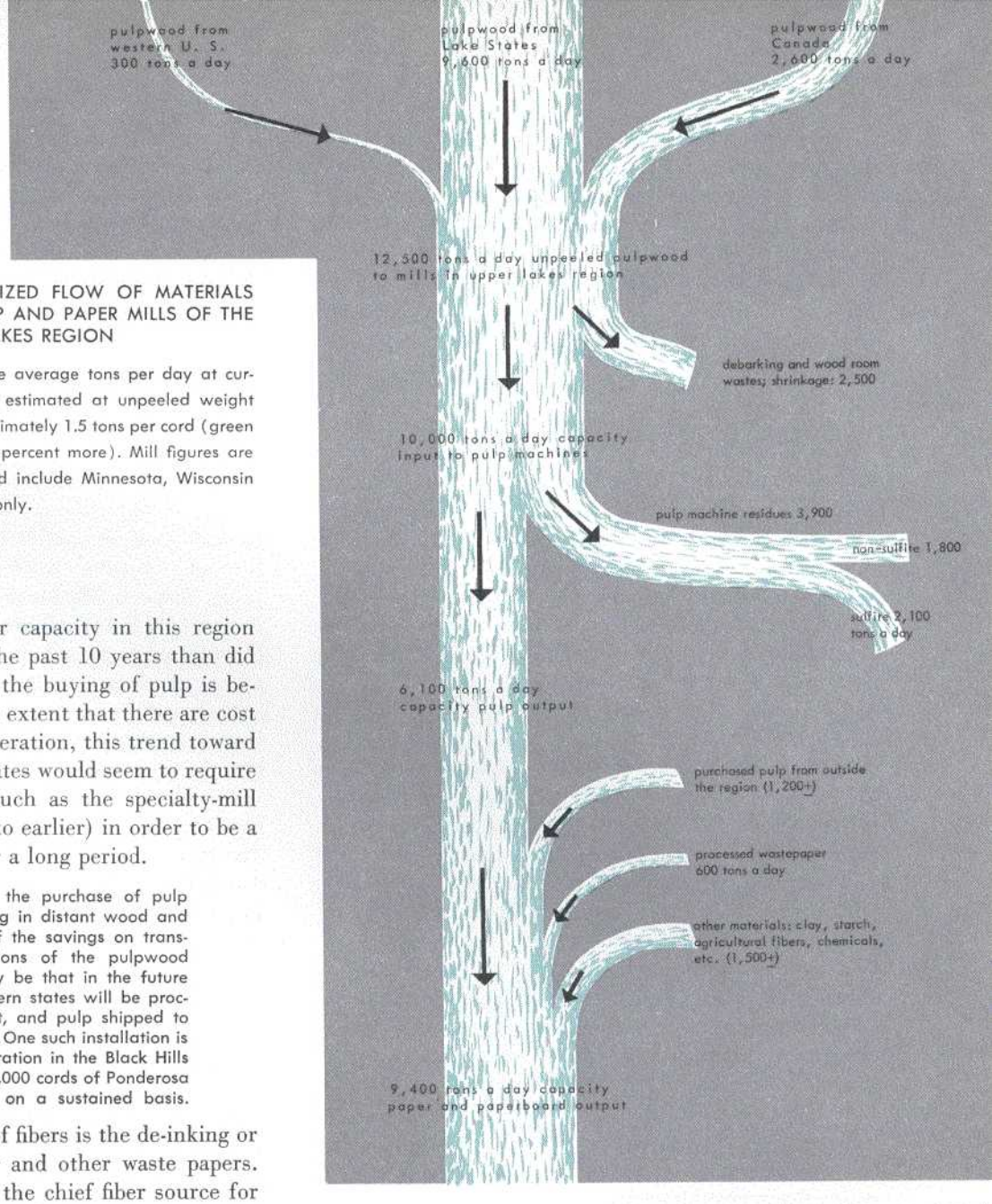


CHART 19 — GENERALIZED FLOW OF MATERIALS FOR PULP AND PAPER MILLS OF THE UPPER LAKES REGION

Figures given here are average tons per day at current rates. Pulpwood estimated at unpeeled weight on a dry basis, approximately 1.5 tons per cord (green wood may weigh 20 percent more). Mill figures are at capacity rates, and include Minnesota, Wisconsin and Upper Michigan only.

Source: In part estimated by author; sources of basic data previously cited

pointed out earlier that paper capacity in this region expanded more rapidly over the past 10 years than did pulp capacity, indicating that the buying of pulp is becoming more prevalent. To the extent that there are cost advantages in an integrated operation, this trend toward less integration in the Lake States would seem to require some offsetting advantages (such as the specialty-mill type of operation we referred to earlier) in order to be a stable economic situation over a long period.

Under some circumstances the purchase of pulp may be cheaper than bringing in distant wood and pulping it locally, because of the savings on transportation of discarded portions of the pulpwood log. In this connection it may be that in the future more of the wood from western states will be processed to pulp near the forest, and pulp shipped to mills in the upper lakes region. One such installation is reported to be under consideration in the Black Hills area, where an estimated 100,000 cords of Ponderosa pine are available annually on a sustained basis.

Another significant source of fibers is the de-inking or repulping of waste newspaper and other waste papers. This process, interestingly, is the chief fiber source for the largest single paper plant in the region in terms of tonnage paper output—that of the Waldorf Paper Products Company at St. Paul, Minnesota. (Its 24-hour capacity: about 720 tons.) This process is particularly appropriate to large population centers where ample supplies of wastepaper are available. Three other mills in the region have some amount of de-inking capacity.

Inspection of chart 19 will show one final factor that could cause a difference between the rate of pulp expansion and the rate of paper expansion, and that is the amount of non-fiber material (such as clay and starch) used in the finished sheet of paper or board. If the region shifts, on the average, toward production of types of paper which use more non-fiber matter per ton of product, then pulp output need not grow at as fast a rate as paper output.

These situations are mentioned to show that paper production in itself is not directly dependent on the existence of local pulping capacity. Therefore, a given expansion in the region's paper capacity may require more or less expansion in pulp capacity depending on how extensively mills shift to or from alternative supplies or non-fiber ingredients. (These shifts would change the relative sizes of the four streams of materials entering the final paper output in chart 19.) Such changes will be the result of decisions of many mills. Predicting their net

direction is unnecessary for the purpose of this study. At most they will modify the relationship between local pulpwood supply and paper output, but local pulp production is still the "backbone" of the industry and will set the general limits to paper expansion.

Conclusions

In spite of the current regional deficit of softwood pulpwoods (which have traditionally been the preferred species) the pulp-and-paper industry of the upper lakes region can respond favorably to future growth in demand. National demand for paper products is forecast to increase by at least 75 percent over the next 20 years. A somewhat proportionate expansion in the region's raw-materials base would seem to be required if our region is to fully share in the expected national expansion.

The analysis presented in this report leads to the following conclusion: Through a combination of approaches to the problem of expansion, the volume of wood fibers locally available and economically usable should be sufficient to enable this region's pulp-and-paper industry to expand output over a 20-year period by a figure that approximately matches the forecast increase in demand.

Three positive solutions to the problem of making more local wood fiber available are:

- Grow more spruce-fir and pine pulpwoods on the forest lands of the Lake States. If managed properly, within 20 years the forests of this region can produce annually enough additional spruce-fir pulpwood to replace a possible loss of the supply that has in recent years come from Crown lands in Ontario. Without such Canadian loss, spruce-fir and pine growth over that period could supply enough additional fiber to enable the region's mills to expand pulp output by some 15 percent. The task of growing more softwoods receives added significance in connection with hardwood use, since additional softwoods, by providing long fibers for blending, will permit an even greater expansion into short-fibered hardwood pulping. The opportunity for more intensive management of forests to increase yields is of basic importance.
- Use more aspen and dense hardwoods for pulping. This is the most potent approach from the standpoint of the sheer tonnage of fibers it makes available. It doubtless will be the chief factor, in terms of bulk, operating in our regional expansion over the next 20 years. In fact, hardwoods today will provide over twice the tonnage of fibers that would be required for a 75-percent expansion in pulp output. Over a 20-year period, the annual yield of hardwood could be greatly enlarged, if forests are properly managed. There is little doubt that the future will provide an excellent opportunity to more fully utilize the wood resources of the region.
- Improved pulping methods can also contribute over the next two decades to the expansion of paper output. The shift toward higher yielding processes could add at least 10 percent to the region's product while improvements in process and the reduction of losses should contribute further to the expansion of paper output for a given pulpwood input.

Paper output is not completely dependent on locally-made wood pulp, so that paper output might be expanded to some extent without use of local pulpwood. Paper may be made with pulp purchased from other regions and also through "re-using" wood fibers via re-pulping of wastepaper. But it is difficult to foresee the net effect of these factors over the next 20 years. The use of wastepaper can be expected to contribute an additional portion of fibers to our product. On the other hand, the region may actually reduce the proportion of pulp imported, depending on how successfully hardwoods are incorporated into the materials stream.

The outside limits to the region's expansion set by the foregoing considerations are obviously very liberal ones. The industry's growth on this base of physically abundant fiber supplies will be tempered by the cost of other things entering into paper production in this region (fuels, waste disposal, marketing costs and the like). The real economic test will be the combined effect of these factors on the profitability of individual plants which must compete on an individual basis in the market place.

Cursory observation of conditions outside the district would indicate that considerable growth potential for paper-making still exists in the South, as well as the Pacific Northwest and Alaska. As a result, while it eludes quantitative statement, the actual rate of expansion that will take place here may well be somewhat less than the national average. This experience would, of course, parallel to some degree the experience of the past decade. Yet again, a "technological breakthrough" in hardwoods could give this region a much stronger showing over the coming decades than it made in the recent past. Over a longer period, with proper forest management here, renewed softwood production could play very strongly to this region's advantage.

Because of the high density of pulping plants in this district, and the slow rate and developmental nature of entry into hardwoods use, future expansion in this region can be expected to occur primarily through additions of facilities to existing mills. This likewise parallels the experience of the past decade.

This report has attempted to give a comprehensive outlook for the pulp-and-paper industry of the upper lakes region. Individual companies vary greatly in their situations and problems. Each firm's response to changes to come will likewise be an individual thing. Over the coming decade some mills will likely change hands—or even go out of business entirely. Some will grow very rapidly; others very little. Such changes occurred in the past decade.

The foregoing conclusions are based on data and observations that seem currently appropriate. As more accurate or more complete data become available, the particulars will be subject to revision. But the general picture, felt to be a reasonably accurate one, is most promising. The industry shows great growth prospects. Its dynamic quality marks it as, perhaps, the leading major industry in the upper lakes region in terms of long-run growth potential.

Postscript — about the bankers' basic role

At the outset we mentioned that the size and dispersion of the pulp-and-paper industry in the upper lakes region make future prospects for the industry of special concern to bankers located in and near the forested areas of our district. Whether the industry expands its output by, say, 50 percent over the next 20 years or, on the other hand, grows very little, are alternatives that will make a real difference in the level of operation of many banks in the lakes region.

But the banker is more than just a passive observer of the situation. He is, in fact, in a front-rank position to do things about it. In our conclusions we emphasized that the most satisfactory long-run solution to the pulpwood supply problem was to increase the growth of softwoods in our forests. Some of this, as forestry people point out, will take place naturally without man so much as lifting a finger. Much of it, however, will be dependent on wise handling of the natural growth of forests—and by this we mean the way trees are cut and protected. Then too, some replanting of deforested areas (and of areas now stocked in less desirable species) will be required. In these measures the banker has an important role.

Careful management of our forests weighs heavily in the pulp-and-paper industry's future. Many pulp-making companies in the region have large forest holdings under planned management. But these holdings supply only a small fraction of the wood cut in the Lake States. Over half the region's cut comes from other private sources —mostly small woodlots.

Most forest land in our region is the property of the small landowner. Obviously, what the small woodlot owner does or does not do with his land will significantly affect the future availability of pulpwood. Commercial companies as well as public and private organizations have directed programs of education and assistance toward this group of landholders. But the individual banker, as the financial counselor of many of these small woodlot owners, is in a strategic position to exert a constructive influence.

Today the bank has a new tool in this respect that it did not possess a few years ago. An amendment to the Federal Reserve Act in August 1953 permits national banks for the first time to make loans on standing timber. The Amendment, quoted here in part, states . . .

> ". . . (national banks) may make real estate loans secured by first liens upon forest tracts which are properly managed in all respects . . . The amount of any such loan shall not exceed 40 per centum of the appraised value of the economically marketable timber offered as security . . . (and) at no time shall the loan balance exceed 40 per centum of the original appraised value of the economically marketable timber then remaining. No loan shall be made for a longer term than two years; except . . . for a term not longer than ten years if the loan is secured by an amortized mortgage . . . under the terms of which the instalment payments are sufficient to amortize the principal of the loan within a period of not more than ten years and at a rate of at least 10 per centum per annum . . ."

Credit of this nature can add new *liquidity* to the assets represented by standing timber. Trees were formerly a resource that could be converted to immediate cash only by cutting and marketing the timber. Now an operator who properly manages his forest tract can borrow money using timber as security, while that same timber continues to grow and appreciate on his land.

This potential lending power (or borrowing power, if

you prefer) is important from two standpoints. First, trees are most productive during their "middle years." That is, during a period prior to maturity they add the greatest volume of new wood each year. Furthermore, its quality is higher. If trees are cut before these years are reached, the woodlot owner is simply deprived of the period of greatest return on his investment. By deferring the cut, and culling out certain of the trees for marketing at intervals, the total return on the tract may over a long period be two or three times that which a single premature cut would have brought. Hence, the new forest-credit tool permits the operator to take better advantage of the tree's natural growth while at the same time he may acquire *today* the money he needs for special expenses, to make improvements on his land, or to add to his holdings.

At the same time that the borrower gains these benefits from the use of credit, the banker is pursuing good "bank business" via a special kind of commercial loan. The loan is structured around physical assurance that, over the period of repayment, sufficient timber will be available to easily cover the payments. As such, it is a self-liquidating loan similar in many respects to other types of commercial loans and on which all the usual credit considerations apply.

But perhaps of even greater significance than the business benefits of credit is the fact that in order to take advantage of the loan provisions, a timber tract must be "*properly managed in all respects.*" An interpretation of the meaning of the term, "properly managed," as given by the Comptroller of Currency is quoted in full:

> 2795. Loans secured by first liens upon forest tracts which are properly managed in all respects.
>
> Proper forest management in all respects is the application of suitable and economically sound forestry principles relating to protection, utilization and reproduction of forest tracts, and the following are indicative of such management:
>
> a. Organized protection against forest fires is provided by the State Forest Service or other protective public or private fire protection agencies. Such protection should include provision for prompt detection and suppression of forest fires and, where considered necessary by local foresters, presuppression measures such as construction of fire-breaks and fire roads.
>
> b. In cases where hazards from attack by insects or diseases are unusually high, protection is provided by an effective public or private organization, or existing roads and logging conditions are such as to make salvage of killed timber feasible.
>
> c. Any cutting conducted during the period of the loan is of such nature as to insure reproduction and continued growth of timber tracts. Where a borrower follows the advice of a qualified person in timber marking for example, this would ordinarily indicate acceptable cutting practice.
>
> —June 1954

Therefore, in order to qualify for forest credit under section 24 of the Federal Reserve Act, the woodlot owner must bring his holdings substantially under the kind of management that would do the most toward upgrading the region's forests. Should the use of the credit facility become at all widespread among woodlot owners in the region, it is apparent that a powerful influence toward constructive management of forests would be brought into play.

But bank loans on standing timber are new—and in this region practically untried. In the South, where trees grow more rapidly, lending on forests has been carried out for a number of years by insurance companies and, more recently, by banks. The proper place of longer-term forest credit in banks is a question which will receive much attention in the future.

While long-term lending on timber will, at best, be slowly introduced in banks of this region, the extension of seasonal credit for the cutting of wood is already common, even among the smaller banks.

Direct lending is out of the question, however, when it comes to planting of unstocked lands. The period of time required from the planting of seedlings until money-return starts may be 30 or 40 years. Obviously this is too long a term to be an attractive business investment to the individual. And even to corporate firms the cost of planting acreages, when compared with the returns to be anticipated, class the venture as a rather long-range investment from a strictly business standpoint.

As a result, much of the planting activity has been subsidized in part by public and private sources. Some of the larger paper mills have planted many thousands of acres, including abandoned farm lands, especially land within truck haul of the mill.

Bankers have demonstrated considerable interest in these efforts and many have been community leaders in tree-planting programs, especially programs that stimulate tree planting by the owners of small forest properties. Several bankers in the district have purchased tree-planting machines and donated them to their communities.

Yet there remain many difficulties that hamper progress toward improvement of small forest holdings. Some bankers indicate that present methods of taxation act to discourage the smaller owners from converting land to the growing of trees. The leadership of bankers, individually and through their associations, can be of considerable value in correcting these and other problems.

By his position in the community, therefore, the banker has both a business interest in the growth of the pulp-and-paper industry, and a basic set of tools for influencing —from the forestry side—the future expansion of the industry in this region.