A Michigan Pine-Pole Industry
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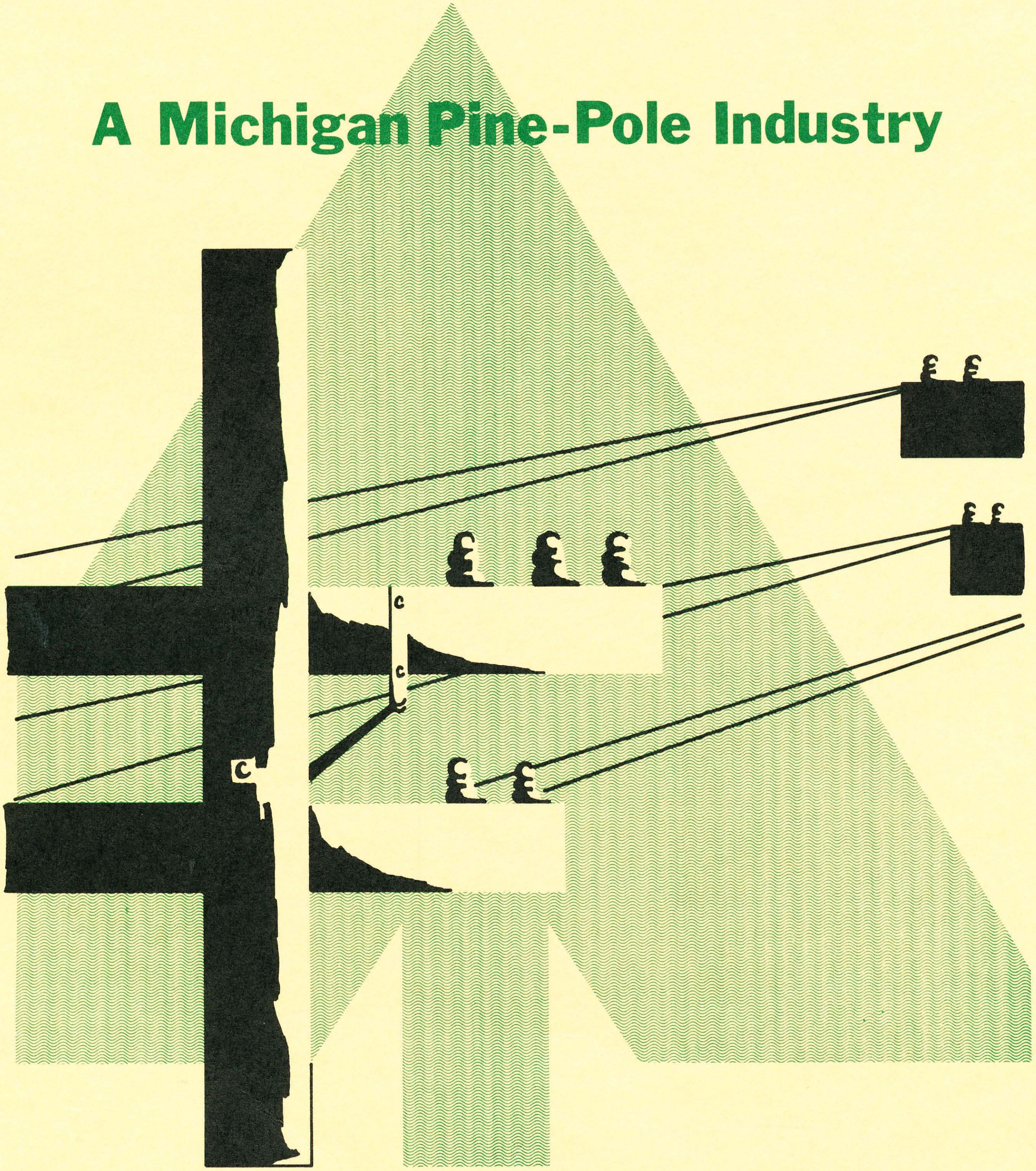
A Michigan Pine-Pole Industry



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A Michigan Pine Pole Industry[1]

By ELDON A. BEHR,[2] HENRY A. HUBER,[3]
MICHAEL MASSIE[4] *and* KIM O. WILKINS[5]

PREFACE

The authors extend their appreciation for support of this project to the Committee on Economic Development of the Michigan House of Representatives, under the chairmanship of Representative (now Senator) Gilbert E. Bursley, and to the Department of Economic Expansion under its Director, Mr. Bernard M. Conboy.

We thank the users, producers and processors of wood poles who provided information on which part of this report is based. Special appreciation is extended to those plants who allowed examination of their operations.

The interest of Drs. Milton D. Muelder and Laurence L. Quill of the Office of Research Development of Michigan State University is appreciated.

The interest and financial assistance of Consumers Power Co., the Detroit Edison Co., and Michigan Bell Telephone Co. is greatly appreciated. Thanks are also due the Michigan Conservation Department for their assistance in providing data on forest resources and on poles cut from their lands.

This report tries to be as inclusive as possible without becoming too detailed. It is written so that some one with little knowledge of the wood pole industry can use it as a starting point in deciding whether to go into this business or to expand an existing pole treating business.

While we do not expect this report to answer all the questions concerning the Michigan pole industry, much information is presented that was previously unpublished. Anyone willing to risk the capital would likely wish to delve a bit deeper into some aspects before entering this venture.

INTRODUCTION

After an era of exploitation of forests in Michigan, as well as in other states, an era of conservation was entered. During this period there has been improved protection of the forests from fire and decreased cutting of some species of trees. There has also been extensive planting of red pine. The result, in 1966, of these influences and practices is a concern for effective utilization of the trees rather than worry over an ample supply of wood. The concern is not only for uses but for upgraded use—something above the price level of pulpwood for the larger trees.

Another condition to be reckoned with is the low level of industrial development and employment in the very parts of the state where most of the coniferous trees grow.

With this combination of economic conditions existing it seemed desirable to investigate the possibility of large scale production and preservation of red and jack pine poles in Michigan. Such an industry would mean jobs and income for the state. There are treating plants already in existence in Michigan, but they have not shared extensively in the market that exists here. This study was also designed to give additional information on red pine and its potential markets that might lead to expansion of existing facilities or increased business for them.

AVAILABLE TIMBER SUPPLY

Of primary importance in the establishment of a wood preservation plant is the amount, availability and size of the trees that would make suitable poles.

The main estimation procedures were based on the continuous forest inventory records kept on the state forests of Michigan. Private and federal estimates, derived from the Timber Resource Reports of the Michigan Forest Survey, were revised and adapted to the relationships and trends established concerning the resource; as indicated by an analysis of the state data.

Number of Stems

Print-out IBM sheets containing Continuous Forest Inventory (CFI) information for each State Forest in Michigan were scanned. Each red pine stem was recorded, along with its current d.b.h. measurement and the measurement of the same stem at the time of the previous inventory (in general seven years

[1]Funds for the completion of this study and the preparation of the report were made available to the researchers by the State of Michigan under the direction of the Michigan Department of Economic Expansion as authorized by the following law: Section 16 of Act No. 230 of the Public Acts of 1963 (Approved by House Concurrent Resolution No. 15).

[2]Associate Professor, Department of Forest Products, MSU.

[3]Assistant Professor, Department of Forest Products, MSU.

[4]Former Graduate Student, Department of Forestry, MSU. Now with College of Business, Economics and Government, University of Alaska.

[5]Former Graduate Student, Department of Forest Products, MSU. Now with National Association of Home Builders, Rockville, Maryland.

TABLE 1—Number of red pine stems in State Forests

Dia. Class (inches)	UPPER PENINSULA Lake Superior (1961)	East U.P.[(a)] (1961-62)	West U.P.[(b)] (1963)	Total U.P. (1961-62 & 1963)	LOWER PENINSULA Western and Central Forests[(c)] (1959)	Northern and Eastern Forests[(d)] (1955-58)	Total, Northern Lower Peninsula (1955-58 & 1959)[(e)]
5.0- 5.9	480,872	914,991	68,128	938,119	262,938	249,777	512,715
6.0- 6.9	393,714	692,902	72,847	765,749	191,322	174,844	366,166
7.0- 7.9	327,594	575,993	77,014	653,007	126,019	202,092	328,111
8.0- 8.9	339,616	489,315	55,946	545,261	102,547	133,971	236,518
9.0- 9.9	234,425	399,782	56,742	456,524	55,648	120,347	175,995
10.0-10.9	183,332	331,936	46,515	378,451	82,189	74,933	157,122
11.0-11.9	132,240	236,293	32,220	268,513	77,219	77,204	154,423
12.0-12.0	117,212	185,192	22,197	207,389	35,380	49,955	85,335
13.0-13.9	63,114	131,023	37,228	168,251	54,292	59,038	113,330
14.0-14.9	54,098	115,531	34,739	150,270	27,424	49,955	77,379
15.0-15.9	54,098	123,072	35,648	158,720	49,865	65,850	115,715
16.0-16.9	30,054	59,482	20,503	79,985	38,331	38,602	76,933
17.0-17.9	24,044	42,015	8,594	50,609	49,238	34,060	83,298
18.0-18.9	3,005	14,839	21,194	36,033	23,881	27,248	51,129
19.0-19.9	3,005	10,021	15,187	25,208	32,686	20,436	53,122
20.0-20.9	—	4,398	2,122	6,520	7,225	11,354	18,579
21.0-21.9	—	—	5,507	5,507	3,647	6,812	10,459
22.0-22.9	—	2,199	1,061	3,260	3,647	4,541	8,188
23.0-23.9	—	2,199	2,678	4,877	—	4,541	4,541
24.0-24.9	—	—	1,061	1,061	—	4,541	4,541
25.0-25.9	—	—	1,061	1,061	—	—	—

(a) Manistique River, Lake Superior, Munuscong, Grand Sable, Mackinac
(b) Sturgeon River, Michigamme, Escanaba River, Baraga, Iron Range, Menominee
(c) Au Sable, Houghton Lake, Fife Lake
(d) Hardwood, Black Lake, Thunder Bay, Pigeon River, Alpena, Ogemaw
(e) One State forest surveyed in 1955, two in 1957, three in 1958 and three in 1959.

earlier). Thus, an estimate of the total number of red pine stems on Michigan State Forests, an estimate of ingrowth (trees moving into the 5.0-5.9 inch class, below which no measurements are taken), and an estimate of growth in the form of increased numbers of stems in any size class was obtained.

The results of the stem counts are shown by one-inch diameter classes in Table 1. For the Upper Peninsula an arbitrary east-west division was made through the Hiawatha National Forest in Alger and Delta Counties. For the Lower Peninsula, the division shown resulted from tabulations already made by the Forestry Division of the Conservation Department.

Future numbers of stems can be estimated on the basis of increases since the previous forest inventories seven years ago. These estimates will be slightly conservative, considering the fact that for red pine annual growth generally exceeds annual cut. Figure 1 depicts the method by which future numbers of stems can be estimated. The results are shown for the previously mentioned state forest divisions in Table 2. As trees under 5.0 inches are not measured and may increase up to the 8.0-8.9 diameter class in seven years, estimation can only be made for the 9.0-9.9 class and larger. Due to limitations on growth information for the few randomly occurring large trees, future estimates for trees above the 19 inch class also were not made. Mortality was adjusted for in the original stem count figures taken from the records.

Federal and Private Forests

The numbers of stems on federal and private forests can be estimated over large areas by using volumes of sawtimber (in thousands of board feet) and pole-timber (in cords) as listed for each county in the

Fig. 1. Michigan State Forests, growth by diameter class movement (a) in percentage groupings (b).

Column Number / Inches, diameter	0	1	2	3	4
5.0- 5.9	21	32	29	18	—
6.0- 6.9	11	46	27	15	1
7.0- 7.9	20	48	20	11	1
8.0- 8.9	17	52	26	4	1
9.0- 9.9	11	72	15	2	—
10.0-10.9	14	72	14	—	—
11.0-11.9	18	73	9	—	—
12.0-12.9	5	74	18	3	—
13.0-13.9	10	68	22	—	—
14.0-14.9	3	82	15	—	—
15.0-15.9	25	58	17	—	—
16.0-16.9	13	64	23	—	—
17.0-17.9	13	62	25	—	—
18.0-18.9	10	80	10	—	—
19.0-19.9	20	60	20	—	—
20.0(c)					

(a) Based on 800 tree samples from several forests. Will not be accurate for specific forests, only combined area.

(b) The figure is applicable, for example, as follows: the 10.0-10.9 inch diameter class seven years in the future will be composed of 1 percent of the present 6.0-6.9 inch class, 11 percent of the 7.0-7.9 inch class, 26 percent of the 8.0-8.9 inch class, 72 percent of the 9.0-9.9 inch class and 14 percent of the 10.0-10.9 inch class stems that did not advance into a forward class.

(c) Sample becomes inadequate; an estimate for trees over 19 inches is one size class.

TABLE 2—Number of red pine stems by diameter class, estimated seven year projections in state forests

	UPPER PENINSULA			LOWER PENINSULA		
Dia. Class	East U.P.[(a)] (1968-69)	East U.P.[(b)] (1970)	Total U.P. (1968-70)	Western and Forests[(c)] (1966)	Northern and Eastern Forests[(d)] (1965)	Total, Northern Lower Peninsula (1965-66)
9.0- 9.9[(e)]	517,600	61,700	579,200	113,300	149,500	262,900
10.0-10.9	531,800	77,900	602,900	94,000	156,000	250,000
11.0-11.9	366,800	49,200	417,700	86,800	93,300	180,100
12.0-12.9	241,100	31,400	273,900	71,800	73,100	144,900
13.0-13.9	171,400	23,000	194,500	38,600	49,800	88,400
14.0-14.9	125,900	30,400	156,200	44,100	50,600	94,700
15.0-15.9	159,900	46,200	206,100	48,000	71,900	119,900
16.0-16.9	96,400	28,600	125,000	38,000	50,700	88,700
17.0-17.9	64,500	20,300	84,800	39,400	40,300	79,700
18.0-18.9	41,200	12,200	53,400	41,700	32,700	74,500
19.0-19.9	24,400	22,100	47,800	38,000	34,400	72,400

(a) Manistique River, Lake Superior, Munuscong, Grand Sable, Mackinac.
(b) Sturgeon River, Michigamme, Escanaba River, Baraga, Iron Range Menominee.
(c) Au Sable, Houghton Lake, Fife Lake.
(d) Hardwood, Black Lake, Thunder Bay, Pigeon River, Alpena, Ogemaw.
(e) The 5, 6, 7 and 8 inch class cannot be validly estimated as in-growth is not known (i.e. trees under 5.0 inches, for which no estimates are available, may move as far as the 8.0-8.9 inch class in seven years.)

Michigan Forest Survey (12). The analysis of the State data indicated that for large numbers of stems over several forests, a curvilinear relationship existed between the number of stems by diameter class and the volumes of sawtimber and poletimber inherent in these stems. Some variation was noted for individual forests and small numbers of stems, but for several forests and large numbers of stems only very minor variation occurred. Thus, diameter class distributions could be formulated for private and federal forests on the basis of known volumes of saw- and poletimber.

These distributions, again, would be accurate only for large areas and large numbers of stems. The weak point in this method is the fact that state forest land growing red pine timber might not accurately reflect aggregate diameter class distributions occurring on federal and private land. This is highly unlikely due to intermingled ownership, a variety of soils, application of different forest management techniques, plantation establishment variation, etc., which occur on state land and will occur similarly over large areas of private and federal land. However, all state lands on the average might be slightly lower in site quality due to deteriorated lands which were returned to state ownership through tax deliquency. Little evidence is available to indicate lower average growth rates, and several state forests are known to be increasing in red pine growing stock at over 5 percent per year. If, however, average higher growth rates are applicable to private and federal land, the estimated diameter class distributions will lag or indicate slightly lower numbers of stems in each diameter class. Thus, the number of federal and private stems might be slightly underestimated.

Estimates of the number of stems on private and federal forests, together with state forests (if not given previously and in some cases further broken down), and the resulting tabulation of all commercial forests and shown in Table 3. Figure 2 shows the regional geographic divisions for which the number of stems were estimated. Pole supply estimates appearing later will also be applicable to these divisions.

TABLE 3—Number of red pine stems

	UPPER PENINSULA						NORTHERN LOWER PENINSULA		
	PRIVATE AND FEDERAL FORESTS			ALL COMMERCIAL FORESTS			NORTHERN COUNTIES[(b)]		
Dia. Class (inches)	U.P.[(a)] (1963)	West U.P. (1963)	Total U.P.[(a)] (1963)	East U.P. (1963)	West U.P. (1963)	Total U.P. (1963)	State Forests (1963)	Federal and Private Forests (1958)	All Commercial Forests (1958)
5.0- 5.9	1,363,336	1,177,933	2,541,269	2,278,327	1,246,061	3,524,388	237,288	938,162	1,175,450
6.0- 6.9	997,779	968,136	1,965,915	1,690,681	1,040,983	2,731,664	148,617	525,581	674,198
7.0- 7.9	800,630	715,460	1,516,090	1,376,623	792,474	2,169,097	151,569	506,442	658,011
8.0- 8.9	655,682	295,954	951,636	1,144,997	351,900	1,496,897	87,081	235,253	322,334
9.0- 9.9	517,318	171,928	689,246	917,100	228,670	1,145,770	74,615	127,784	202,339
10.0-10.9	422,886	131,637	554,523	754,822	178,152	932,974	44,210	76,566	120,776
11.0-11.9	296,311	84,739	381,050	532,604	116,959	649,563	43,234	75,798	119,032
12.0-12.9	228,527	53,939	282,466	413,719	76,136	489,855	26,476	47,047	73,523
13.0-13.9	159,062	83,018	242,080	290,085	120,246	410,331	29,519	53,240	82,759
14.0-14.9	137,944	70,520	208,464	253,475	105,259	358,734	23,478	43,051	66,529
15.0-15.9	144,486	65,236	209,722	267,558	100,884	368,442	28,974	54,115	83,089
16.0-16.9	68,642	33,420	102,062	128,124	53,923	182,047	15,826	30,179	46,005
17.0-17.9	47,645	12,289	59,934	89,660	20,883	110,543	12,942	25,266	38,208
18.0-18.9	16,531	26,069	42,600	31,370	47,263	78,633	9,536	19,122	28,658
19.0-19.9	10,963	15,643	26,606	20,984	30,830	51,814	6,539	13,524	20,063
20.0-20.9	4,723	1,761	6,484	9,121	3,883	13,004	3,292	7,060	10,352
21.0-21.9	3,478	3,469	6,947	3,478	8,976	12,454	1,771	3,963	5,734
22.0-22.9	2,274	456	2,730	4,473	1,517	5,990	1,044	2,460	3,504
23.0-23.9	2,229	616	2,845	4,428	3,294	7,722	1,044	2,278	3,322
24.0-24.9	—	32	32	—	1,093	1,093	386	1,048	1,434

(a) Includes half of Alger and Delta counties, with half of the Hiawatha National Forest.
(b) Emmet, Cheboygan, Presque Isle, Charlevoix, Antrim, Otsego, Montmorency, Alpena.

TABLE 3—Continued

Dia. Class (inches)	NORTHERN LOWER PENINSULA: WEST-CENTRAL COUNTIES (a)			NORTHERN LOWER PENINSULA: EAST-CENTRAL COUNTIES (b)		
	State Forests (1959)	Federal and Private Forests (1959)	All Commercial Forests (1959)	State Forests (1959)	Federal and Private Forests (1959)	All Commercial Forests (1959)
5.0- 5.9	158,761	205,275	364,036	135,716	843,159	978,875
6.0- 6.9	107,867	130,232	238,099	111,570	484,986	596,556
7.0- 7.9	66,008	73,179	139,187	113,099	329,587	442,686
8.0- 8.9	49,612	49,294	98,906	90,885	161,896	252,781
9.0- 9.9	25,809	24,006	49,815	73,953	71,049	145,002
10.0-10.9	37,297	35,045	72,342	67,593	61,858	129,451
11.0-11.9	34,269	32,540	66,809	67,977	59,252	127,229
12.0-12.9	15,347	14,732	30,079	38,417	31,890	70,307
13.0-13.9	23,008	22,335	45,343	52,154	41,218	93,372
14.0-14.9	11,348	11,145	22,493	36,383	27,369	63,752
15.0-15.9	20,135	20,015	40,150	55,566	39,771	95,337
16.0-16.9	15,094	15,194	30,288	37,712	25,672	63,384
17.0-17.9	18,897	19,271	38,168	41,665	26,963	68,628
18.0-18.9	8,926	9,227	18,153	26,096	16,039	42,125
19.0-19.9	11,891	12,466	24,357	27,634	16,133	43,767
20.0-20.9	2,556	2,719	5,275	9,850	5,456	15,306
21.0-21.9	1,253	1,354	2,607	5,650	2,967	8,617
22.0-22.9	1,217	1,336	2,553	4,505	2,241	6,746
23.0-23.9	—	—	—	2,543	1,197	3,740
24.0-24.9	—	—	—	1,295	576	1,871

(a) Benzie, Grand Traverse, Kalkaska, Manistee, Missaukee, Wexford, Leelanau.

(b) Alcona, Crawford, Ogemaw, Oscoda, Roscommon.

TABLE 3—Continued

Dia. Class (inches)	NORTHERN LOWER PENINSULA: SOUTH-EAST COUNTIES (a)			NORTHERN LOWER PENINSULA: ALL COMMERCIAL FORESTS	
	State Forests (1959)	Federal and Private Forests (1959)	All Commercial Forests (1959)	South-West Counties[(b)] (1959)	Total, Northern Lower Michigan (1958-59)
5.0- 5.9	3,446	279,350	282,796	103,097	2,904,254
6.0- 6.9	5,909	160,576	166,485	71,190	1,746,528
7.0- 7.9	10,872	145,182	156,054	44,371	1,440,309
8.0- 8.9	9,887	69,450	79,337	34,055	787,413
9.0- 9.9	14,405	31,903	46,309	18,236	461,761
10.0-10.9	9,718	19,115	28,833	26,727	378,129
11.0-11.9	10,785	18,922	29,707	24,918	367,695
12.0-12.9	7,478	11,744	19,222	11,286	204,417
13.0-13.9	9,428	13,289	22,717	17,248	261,439
14.0-14.9	8,477	10,745	19,222	8,644	180,640
15.0-15.9	11,833	13,505	25,338	15,592	259,506
16.0-16.9	7,322	7,531	14,853	11,890	166,420
17.0-17.9	6,802	6,304	13,106	15,150	173,260
18.0-18.9	5,713	4,771	10,484	7,288	106,708
19.0-19.9	4,489	3,374	7,863	9,894	105,944
20.0-20.9	2,608	1,761	4,369	2,168	37,470
21.0-21.9	1,632	988	2,620	1,085	20,663
22.0-22.9	1,133	613	1,747	1,067	15,616
23.0-23.9	1,179	568	1,746	—	8,808
24.0-24.9	612	261	873	—	4,178

(a) Arenac, Clare, Gladwin, Osoco, Midland

(b) Lake, Mason, Mecosta, Newaygo, Oceana, Osceola (Note: South-West counties entered here as they cannot be broken down into Federal and Private).

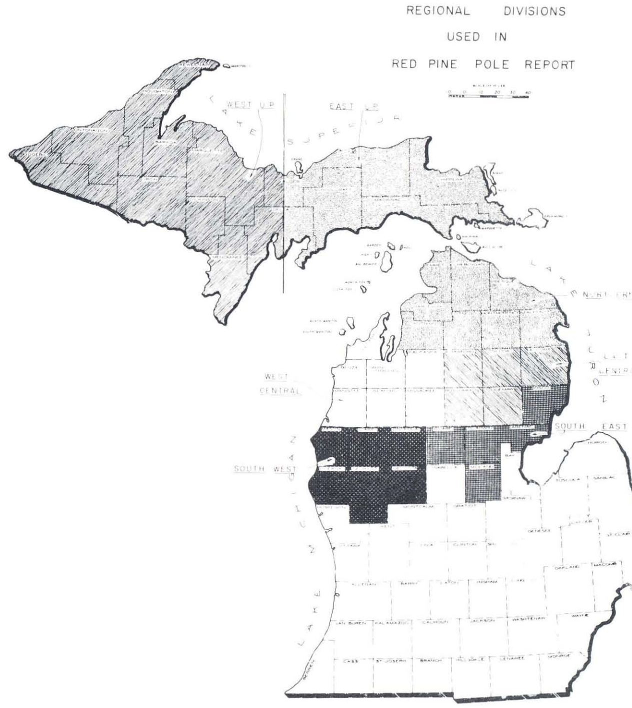

Fig. 2. Regional divisions used in red pine pole report.

Number of Stems Meeting Pole Specifications

In order to esimate poles from number of stems, size specifications are necessary as are criteria to denote numbers of stems that will be acceptable with respect to limbiness, knots, crook and other defects. Table 4 indicates the necessary size of standing red pine by field "DBH" to meet the indicated American Standards Association (ASA) pole class for the heights indicated. This table was derived from ASA specifications (2). Circumferences six feet from the butt were translated into diameters at 4½ feet; including an allowance for stump height. Adjustments for taper, bark thickness and peeling are included in this Table 1. Information regarding the number of stems acceptable as poles, considering stocking levels and defects, was taken from Guilkey (9).

TABLE 4—Estimated field 'DBH' for Michigan red pine to comply with ASA size specifications for red pine utility poles (The following is the minimum 'DBH' for the standing tree in the field to meet the pole class and height indicated in the following table) (a)

Pole Height	Class 4	Class 5	Class 6	Class 7
25	(NA)	(NA)	9.5	8.8
30	11.5	10.7	10.1	9.5
35	12.2	11.4	10.6	9.9
40	12.8	12.0	11.2	(NA)
45	13.3	12.5	(NA)	(NA)

(NA)—Not Applicable.

(a) Data to establish the diameters shown in Table 4 were collected in the field and were also supplied by the Forestry Division, Michigan Conservation Department, and by Consumers Power Corporation.

First, it can be seen from Table 4 that the desired field diameter classes approximates the diameter range commonly classified as small sawtimber. For this reason, all estimates were given on the basis of the small sawtimber range (9.0 inches to 14.9 inches). Secondly, three estimates were considered for stems meeting pole specifications.

From Guilkey's work (9) it was found that up to 90 percent of the stems in a very open grown or low basal area stand could be rejected for limbiness. Also, the acceptance rate for stems 9.0 inches and larger was low for low basal areas. This rate did not reach 50 percent until very high basal areas (about 160 square feet per acre) are attained. In general, he found a high rate of rejection, over 45 percent regardless of basal area. Even a basal area of 60 square feet per acre yielded only 10 percent acceptance. This acceptance rate did not increase beyond 30 percent until high (125 square feet per acre) basal areas were attained. These relationships can be seen in Fig. 3.

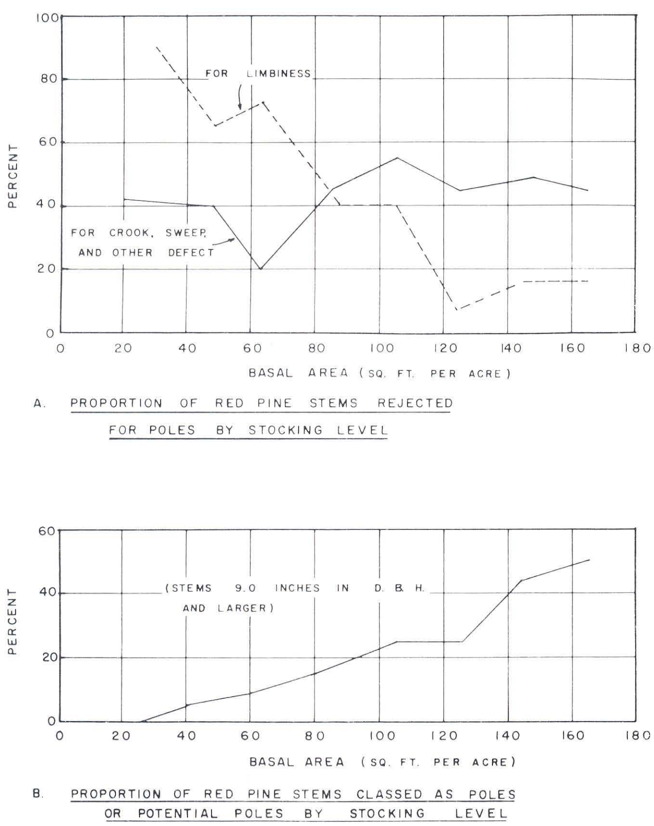

Fig. 3. Dependence of acceptability of trees for poles or percent rejected for poles upon basal area.

While specific forest areas may have high or low basal areas, any estimate for a region could only be in the moderate basal areas. Limited evidence is available to indicate some of the state forests are in the 20 percent class, and that areas of the Lake Superior Forest in the Eastern U.P. are in the 30 percent class. Personal observation indicates some areas would have well over 30 percent of the red pine suitable for poles. However, existing large areas of open stands indicate that 10 or 20 percent is the most feasible estimate for regions of any size, and that the 10 percent estimate could be considered a minimum.

Estimates for the 20 percent category are shown in Tables 5 and 6. Under the assumption of increasing average stand density, the 20 percent estimate would seem most useful for future projections for the years 1965-66 and 1970. The 10 and 30 percent estimates are available but not included here.

TABLE 5—Estimate of number of stems of red pine meeting ASA pole specifications in Upper Peninsula of Michigan on all commercial forests—20 percent of all stems

Diameter Class	Eastern		Western		Total	
	1963	1963	1970	1970	1970	1963
9.0- 9.9	183,400	245,000	45,800	104,600	229,200	349,600
10.0-10.9	151,000	246,400	35,600	75,800	186,600	322,200
11.0-11.9	106,600	167,200	23,400	41,200	130,000	208,400
12.0-12.9	82,800	107,000	15,200	24,400	98,000	131,400
13.0-13.9	58,000	76,600	24,000	15,800	82,000	92,400
14.0-14.9	50,600	55,800	21,000	19,800	71,600	75,600

TABLE 6—Estimate of number of stems of red pine meeting ASA pole specifications in 1965-66 in the Lower Peninsula of Michigan on all commercial forests—20 percent of all stems.

Diameter Class	Northern Counties	West-Central Counties	East-Central Counties	South-East Counties	South-West Counties	Total
9.0- 9.9	84,600	24,100	65,000	20,500	7,800	202,000
10.0-10.9	65,200	17,800	48,600	15,400	6,200	153,200
11.0-11.9	31,600	15,400	30,400	7,600	5,600	90,600
12.0-12.9	23,000	12,400	24,000	5,600	4,600	69,600
13.0-13.9	14,600	6,600	14,600	3,800	2,400	42,000
14.0-14.9	14,300	7,400	15,600	3,900	2,800	44,000

Allowable Cut

The number of stems meeting pole specifications on commercial forest land does not indicate an allowable cut. The *minimum* allowable annual cut derived from the Michigan Forest Survey is shown in Table 7. The actual cut is not meeting the allowable sawtimber cut in any of the regions indicated (Table 7), and the residual could be cut in poles without encountering any competition for the resource. If competition should develop in the future, pole material would have the added advantage of being a high value product in the small sawtimber class—which is less desirable than large sawtimber as far as competitors are concerned.

TABLE 7—Minimum allowable annual cut of red pine stems for poles (Base: 1955-1964)

	UPPER PENINSULA			
	Sawtimber Volume (MBF)			Number of Poles in the Residual Sawtimber Volume
	Allowable Cut	Actual Cut	Residual	
West U.P.	2,235	1,380	855	9,100
East U.P.	5,165	300	4,865	51,900
Total U.P.	7,400	1,680	5,720	61,000
	LOWER PENINSULA			
Northern Counties	1,200	400	800	8,500
West-Central Counties	500	220	280	3,000
East-Central Counties	2,000	600	1,400	14,900
South-East Counties	600	200	400	4,300
South-West Counties	300	—	300	3,200
Total Lower Peninsula	4,600	1,420	3,180	33,900

Figure 4 indicates graphically the minimum available number of "pole" stems (10 percent of the actual stems in each region) and the minimum annual cut in each region that would be available. However, two points should be noted concerning the number of poles available annually. First, poles as a raw product have a relatively high value compared to other forest products. Therefore, it can be assumed that should poles be allowed to compete with sawlogs for a portion of the annual cut, the number of poles available each year could be increased and that the quantity of small sawtimber going into saw logs would be reduced proportionately. Secondly, in spite of the principal of sustained-yield, there are valid economic arguments for harvesting "pole" stands before the crop reaches the ultimate maturity of large sawtimber. Here, net value received would have to be more than that received if the stand were allowed to continue to grow with the harvest being made as large sawtimber. This would of course, in both cases, include the costs of regeneration or of replanting the area.

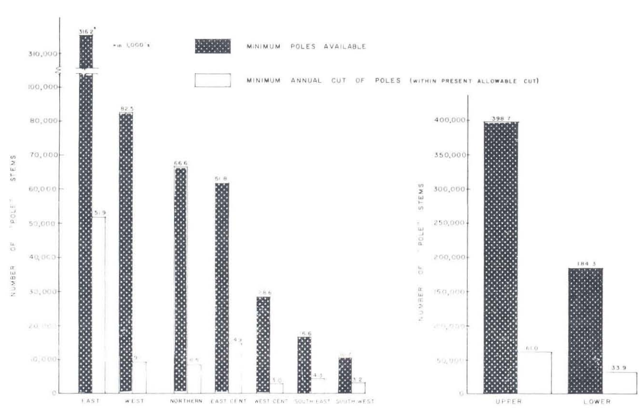

Fig. 4. Michigan pole supply.

Future Supplies

The information gathered in Part I points to increased supplies of "pole" stems in the future and to an increased annual cut. Stems available for poles, even based on the conservative 10 percent estimates, are more than adequate in each region to supply an increased annual cut. Increases in future supplies then will be dependent on future increases in the allowable annual cut of red pine sawtimber. Here sustained-yield, alternate uses (i.e. recreation), and value and other economic criteria, will all be factors in determining the actual allowable cut.

Findell, *et al.*, (8) indicate that Michigan's red pine growing stock was increasing at a rate of over 5½ percent annually in 1955. The annual allowable cut given in the Michigan Forest Resource Reports varied by county and district, but approximated 2 to 3 percent of the growing stock for the period 1955-1964. Also, industry was not fully utilizing this allowable cut at the start of the period and limited evidence indicates that this has not changed to date. Thus, justification for an increase in the allowable cut is apparent for a future period, if the resource has been under-utilized and additions to capital growing stock have been allowed to accumulate.

Red pine plantations are not an important source of supply at the present time, but will become a major source of poles within the next 10 to 20 years. Little information is available concerning the Upper Peninsula, but Stone and Chase (22) indicate pertinent information concerning the Lower Peninsula. The most extensively planted species is red pine. Altogether over 250,000 acres have been planted prior to 1957. Plantations of pole timber red pine (5.0-9.9 inches) in 1957 were estimated to be over 17,000 acres. From growth information previously indicated it can be seen that by 1965 much of the plantation acreage will be in the small sawtimber class.

In 1957 over 70 percent of all Michigan's forest plantations were in public ownership and it is estimated that over half the growth occurring from 1957 to 1966 in these plantations will be in red pine. The estimated annual allowable cut of red pine is 9,300 cords per year. However, only a small portion of this volume would be in trees suitable for utility poles. If one considered a cut of 1,000 cords of such trees annually, this volume would yield about 5,000 poles.

While no exact estimates of the future annual cut of poles can be made, all available evidence indicates an increase of 50 percent over the minimums estimated for the present cut. Under this assumption the following numbers of poles would be available annually in the late 1960's and early 1970's.

ANNUAL POLE AVAILABILITY

UPPER PENINSULA		
West U. P.	13,650	
East U. P.	77,850	
Total U. P.		91,500
LOWER PENINSULA		
Northern Counties	12,750	
West-Central Counties	4,500	
East-Central Counties	22,350	
South-East Counties	6,450	
South-West Counties	4,800	
Total Lower Peninsula		50,850

Red pine planting in northern Lower Michigan on state and federal land has remained at a high level up to the 1950's. During the 1940's and the 1950's sharp increases were noted in private planting. Also, state foresters indicate that there has been a sharp increase in natural regeneration of red pine in both the Upper and Lower Peninsula. Present available information all points to increases in future supplies of red pine at least to the year 2000; large quantities of the resource will meet the specifications for utility poles, and increasing emphasis will probably be placed on distribution of plantation stock. Beyond such time, without further increases in planting programs or natural regeneration, supplies could decrease.

Jack Pine Resources for Poles

Although most of this report concerns red pine, jack pine should also be considered for poles. In some places it is favored over red pine. Consequently, jack pine can be included in the potential supply of poles for a treating plant. Some areas of the state might be marginal in supply of available pole trees if only red pine were to be taken, but might be satisfactory locations if both species were to be treated.

Jack pine does not grow large enough to supply some of the longer poles that could be produced in red pine. In addition the demand for jack pine for pulpwood is much greater than any demand for red pine. This demand for jack pine is likely to grow. In spite of these limitations it could supply a considerable part of the pole market presently held mainly by southern pine.

If the assumption is made that at least 5 percent of the jack pine resource, on a volume basis, would meet ASA pole standards and that jack pine would be managed for some other uses in addition to pulpwood, the supply in the future can be estimated. A very conservative estimate would show somewhat less than half as many jack pine of pole size and quality as red pine in the Upper Peninsula and almost as many in the northern Lower Peninsula in the 1960's. These jack pine are located in about the same areas of the state as the red pine. There are 62,000 acres of pure jack pine plantations and 168,000 acres of mixed red and jack pine plantations. Approximately 70 percent of these plantations were established before or during the 1930's.

Summary and Conclusions

Michigan has an excellent resource base available in red pine, including large quantities of stems meeting specifications for small utility poles. Much of the resource occurs in the Upper Peninsula, but a heavy concentration also occurs in the northern Lower Peninsula. Distribution occurs among a diversity of ownerships (federal, state and private). To date, the resource base has only been utilized to a minor degree, and at present the annual rate of increase in growing stock by far exceeds the annual drain.

Estimates of the number of stems meeting the specifications for utility poles were made for the Upper Peninsula and the northern Lower Peninsula. This was for pole classes 4, 5, 6 and 7, and heights of 25, 30, 35, 40 and 45 feet. Based on a low level estimate of 10 percent acceptability of all stems the number of pole trees in the northern Lower Peninsula for 1958-59 was estimated to be 185,300 and by 1965-66 this will increase to some 300,700. The corresponding figures for the Upper Peninsula were 398,700 in 1963 and 589,800 in 1970.

If a 20 percent level of acceptability were taken there would be double the numbers of trees shown for the 10 percent estimate. On the basis of actual and allowable cut information it was further estimated that 33,900 of these pole trees could be harvested annually in the northern Lower Peninsula in early 1960's and that this cut could be increased to 50,850 poles in the late 1960's and early 1970's. The corresponding figures for the Upper Peninsula were 61,000 in the early 1960's and 91,500 in the late 1960's and early 1970's.

Geographically, the majority of the pole supply in the Upper Peninsula is located east of the Hiawatha National Forest within a 50 mile radius of Seney and Newberry. The heaviest area of available supply in the Lower Peninsula is in the East-Central region (Crawford, Oscoda, Alcona, Roscommon, and Ogemaw Counties), but the northern region (Emmett, Cheboygan, Presque Isle, Charlevoix, Antrim, Otsego, Montmorency and Alpena Counties) had a slightly larger total supply of pole stems. The center of the over-all supply area is estimated to be between Grayling and Mio, and the majority of the pole stems in the northern Lower Peninsula would be within a 50 mile radius of either of these towns.

PART II
MARKETING AND PRODUCTION

Markets for Communication and Power Poles in Michigan

The largest potential market for red pine poles in Michigan is for support of electric and telephone lines. At present this market is being satisfied by southern pine poles produced in Georgia, Alabama, Florida, Mississippi, Louisiana and Arkansas and by western red cedar poles produced in British Columbia, Idaho and Washington. In Michigan the proportion is approximately: southern pine 79 percent, western red cedar 17 percent, northern white cedar 4 percent. The northern white cedar are largely produced in the state. The long poles are western red cedar, but some 30 and 35 foot poles of this species are also bought.

Estimated purchases in Michigan of all pole line owners in 1963 were 88,000 poles. Table 8 shows the species and preservative for these. As might be expected, on the basis of population distribution in the state, 93.5 percent of these were bought for use in the Lower Peninsula. Also, the investor owned utilities, both power and telephone, accounted for about 85 percent of the pole purchases, the other 15 percent being bought by REA, municipal or cooperatives.

The class and length distribution of poles purchased are of interest because the producer and seller can determine where the biggest demand lies. Table 9 shows this distribution for western red cedar poles purchased for use by electric power companies in the Lower Peninsula, and Table 10 for southern pine poles by investor owned electric power companies in the Lower Peninsula.

TABLE 8—Pole purchases for one year (1963 or 1964) for all pole line owners in Michigan representing 99.4 percent of all pole lines

Species	Preservative							
	P.C.P.	Creo	Creo BT	Creo or PCP	Unknown	None	Total	%
Southern Pine	20,095	26,758		19,000	3,843		69,696	79.4
Western Red Cedar	11,473		1,411		1,669		14,553	16.6
Northern White Cedar	1,510					1,924	3,434	3.9
Western Larch	112						112	.1
PERCENT	37.8	30.5	1.6	21.6	6.3	2.2		—

Abbreviations: P.C.P.—Pentachlorophenol (5%) in oil.
Abbreviations: Creo—Coal tar creosote, also includes 2 percent P.C.P. in creosote.
Abbreviations: Creo BT—Butt treated with creosote.
Abbreviations: Creo or P.C.P.—Not designated as to which preservative was used.

TABLE 9—Western red cedar pole purchases annually in 1963 or 1964, by class and length, by electric utilities in the Lower Peninsula

Length Feet	Class									Total	Percent
	1	2	3	4	5	6	7	8	9		
25					5	15	15	20		55	0.5
30				55	129	525	406	100		1,215	10,6
35			184	1,054	432	984	538			3,192	27.8
40		295	293	453	255	90				1,386	12.0
45		191	288	162	60					701	6.1
50		50	206	1,326	5					1,587	13.9
55	362	526	201	65						1,159	10.1
60	384	520	165	39						1,108	9.6
65	326	301	81	21						729	6.3
70	130	86	7							223	1.9
75	53	16	8							77	0.7
80	26	10								36	0.3
85	21	7								28	0.2
TOTAL	1,302	2,003	1,433	3,179	886	1,614	959	120		11,496	
PERCENT	11.3	17.4	12.5	27.7	7.7	14.1	8.3	1.0			100.0

TABLE 10—Annual purchases in 1963 or 1964 of southern pine poles, by class and length, by electric utilities in the Lower Peninsula

Length Feet	Class									Total	Percent
	1	2	3	4	5	6	7	8	9		
25	40	6	69	22	207	209				553	1.5
30	54	18	107	180	719	3,159				4,237	11.6
35	61	62	40	1,699	2,479	7,004	1			11,346	31.2
40	94	270	366	5,365	2,637	5,356				14,088	38.6
45	255	114	436	3,832	799					5,436	14.9
50	83	180	227	258	25					773	2.2
TOTAL	587	650	1,245	11,356	6,866	15,728	1			36,433	
PERCENT	1.6	1.8	3.4	31.2	18.8	43.2					100.0

The purchasers were asked to estimate their future purchases. Only about half of those returning a tabulation of pole purchases made an estimate, but those buying over 60 percent of the poles felt their usage would increase, while those buying 26 percent of the poles looked for a decrease.

Even though the majority of pole users feel that they will need more poles in the future than they are buying today, there are some threats to a larger pole industry in Michigan. In many subdivisions, electric and telephone lines are now placed underground. Due to the President's beautification program, the presence of poles and wires has received some criticism. Also, new technical advances in materials and methods may also change the need for poles. For example, telephone companies are going underground now, not only in congested areas, but also on long distance lines.

Markets for Line Poles in States Near Michigan

The total market for line poles in Michigan and for electric line poles in all of Wisconsin, and the northern parts of Illinois, Indiana and Ohio is estimated to be 247,000 per year. Details of species and preservatives for these poles are shown in Table 11. The proportion of each species for this market area is not greatly different from that of Michigan. There is a little more southern pine and a little less western red cedar bought. The total usage given above is a projected value based on 77.7 percent of the pole lines in the area investigated.

In northern Indiana the estimated annual purchases by investor owned electric utilities is about 34,000 poles, all of which are treated with creosote. These are 96.5 percent southern pine and 3.5 percent western red cedar. The cedar poles are 60 feet and longer. Contrasted to this usage in this Indiana area is that of R.E.A. borrowers. Their projected use per year is about 11,700 poles. Again, most of these are southern pine, but 35 percent are treated with pentachlorophenol.

As far as preservative used is concerned, the picture in Wisconsin is quite different from that in northern Indiana. Nearly 90 percent of the poles purchased are treated with pentachlorophenol solution. A much larger portion of the poles, however, are western red cedar (30 percent) than is the case in northern Indiana. There is also a 2 percent usage of jack and red pine poles.

Western red cedar poles are purchased in short as well as long lengths. For example, 63.2 percent of all the cedar bought by electric companies (investor, municipal and REA) was in lengths from 25 to and including 40 feet. Again, the largest market is with the investor owned utilities (telephone company purchases were not investigated). Their purchases account for about 78 percent of the total for this group.

Ohio's pole purchases for the electric group, in an area extending south to Columbus and east to Canton, are about 36,000 annually. Again, well over 90 percent are southern pine treated with creosote. About 82 percent are bought by the investor owned utilities.

Our examination of the Illinois market included the northern part of the state, excluding Chicago, as far south as Moline and a strip on the eastern part of the state extending from the Indiana line to include Champaign and Mattoon. The purchases are about 23,000 annually for the electric group and are predominantly southern pine. The REA's account for approximately 12 percent of the total.

It is of interest to note that only a very small percentage of locally grown poles are purchased in the area considered. Several thousand red and jack pine

TABLE 11—Pole purchases for one year (1963 or 1964) for electric and telephone lines in Michigan and electric lines in Wisconsin and northern parts of Indiana, Illinois and Ohio (represents 77.7 percent of pole line miles in these areas)

	Preservative							
Species	P.C.P.	Creo	Creo Bt	Creo or P.C.P.	Unknown	None	Total	Percent
Southern Pine	57,781	77,534		19,352	3,843		158,510	82.7
Western Red Cedar	23,134	926	1,571		1,669		27,300	14.2
Northern White Cedar	1,510					1,924	3,434	1.7
White Pine	1,807	55					1,862	1.0
Jack and Red Pine	524	100					624	0.3
Other	192						192	0.1
TOTAL	89,948	78,615	1,571	19,352	5,512	1,924	191,922	
PERCENT	44.3	41.0	0.8	10.0	2.9	1.0		

Abbreviations: P.C.P.—Pentachlorophenol (5 percent) in oil.
Creo—Coal tar creosote, also includes 2 percent P.C.P. in creosote.
Creo BT—Butt treated with creosote.
Creo or P.C.P.—Not designated as to which preservative was used.

NOTE: This table includes poles bought by stockholder owned utilities, municipal electric systems, REA coops, and telephone companies.

poles and northern white cedar poles are produced and treated each year in Michigan and Wisconsin. Most of these are going to purchasers other than those included in our investigation of the communication and power group. The buyers are either outside the five state market area or are building contractors or users other than the power-communication agencies and firms.

The most popular lengths of poles purchased by investor owned power and communication firms in Michigan are 30, 35 and 40 feet, and the classes 4, 5 and 6. Among the REA's the same lengths are purchased most frequently, but the classes are 5, 6 and 7. Municipal electric systems buy classes 2, 3 and 4 most frequently.

Markets for Building Poles in Michigan

Since the second World War, the market for poles used to support the roofs and walls of buildings has grown rapidly. This concept of building eliminates the need for continuous footings or conventional foundations, thus reducing the over-all cost of construction.

Collection of market data is not simple, as there is no trade organization of pole builders. The largest number of these buildings is reportedly built by a farmer's organization, and a few contractors. Many others are constructed by individual carpenters or local building supply dealers. The biggest market is in the southern part of the Lower Peninsula.

While rigid specifications of the American Standards Association are followed for most utility poles and specifications of the American Wood Preserver's Association, R.E.A. or those of the Utility are used for preservative treatment, none are consistently followed for building poles. The builders require "one straight side" and specify the species and retention of preservative. Fewer poles will satisfy this requirement in the longer lengths than will be the case of utility poles.

It is estimated that 30,000 poles are used in Michigan for this purpose each year by builders; not including the poles sold by lumber yards, builder's supply firms and the like. At present, the majority of the poles is southern yellow pine, although some red pine grown in Michigan, and treated at St. Clair, is finding its way into this market.

Our survey of pole building construction in Wisconsin, Indiana, Ohio and Illinois indicates that the market is probably larger in those states than in Michigan.

Our present estimate is that 70 percent of the poles used in these buildings are actually squared timbers such as 4 x 6, 6 x 6, 6 x 8, 8 x 8. Fourteen to 20 foot long pieces are the most frequently purchased. Some are southern pine, others are Douglas fir. Several Wisconsin builders express a preference for southern pine poles and a dislike for red pine, based mainly on strength of the wood and fewer knots in southern pine. It is obvious, though, that the trend is to squared timbers or slabbed poles because of the time and expense saved in construction, with their use. In the future most barns in higher labor cost areas will be supported by square edge timbers rather than round poles.

Miscellaneous Markets

There are many miscellaneous markets for poles. The size of these is difficult to estimate because of the diversity and lack of concentration. Poles are commonly used to support outdoor advertising signs. Unless Michigan is able to pass restrictions on erection of such signs near interstate highways, the building of these will continue along present highways and along those planned. The present market absorbs about 2,000 poles a year in Michigan and a total of 4,500 for Indiana, Ohio and Wisconsin. Most are 30 feet long.

Other places where poles are used are outdoor light standards, lath houses for plant nurseries, marinas, harbor installations, and outdoor theater screen supports. It is estimated that this market would require 1,000 poles or piles a year in Michigan. Piles are poles of a low class number, but different rules are used in their inspection, specification and sale. Considerable numbers are used in support of building and bridge foundations. Here, red pine would be in competition with hardwoods as well as other pines and steel or concrete. There are, undoubtedly, many other uses for poles or piling that have yet to develop.

Ever changing technology may create new markets for poles as well as eliminate others. For example, cable TV cannot at this time be adequately evaluated as a potential pole user. Every indication has shown that it will be important in the future and will utilize a smaller class and size of pole. There is an over abundance in Michigan of the 25 foot poles and this is the size contemplated for this use. One mid-Michigan firm estimates 1,000 to 5,000 poles annually could be used by them depending on economics. However, market estimates for this use have not been included in this report.

Marketing

Poles are sold through what might be called normal distribution channels. Since well over 99 percent of all poles used in Michigan are treated with a wood preservative, the marketing is largely handled by the wood preserving firms. Large treaters generally have their own salesmen, and often maintain sales offices in cities away from their plants. Smaller treating plants may sell their output through commission men or lumber firms. Still others take orders or rely on submitting bids for government business.

Some treaters with a steady, long established pole business, maintain stocks of treated poles of the more popular sizes that can be furnished on short notice. Although the larger users now maintain their own stocks in strategic places, there is a tendency for treaters to establish and maintain these stocks as a competitive measure. Where new lines are constructed or large replacements are made, poles are delivered to the general area without passing through a storage yard.

More usual, however, is the situation where poles are ordered with only a few weeks notice for a specific job. This type of purchasing means (a) a treater must have available "white" poles of the size range desired that are in a state of drying that they will accept the specified treatment and (b) a treated stock of poles cannot be maintained because the poles may not be framed or bored to specifications or they may not be treated to meet the specifications of the purchaser, especially of the larger utilities.

The larger utilities and R.E.A.'s generally purchase their poles on a specification by competitive bidding. The year's purchases may be contracted for at one time. In this case, a treater can spread his work more evenly in spite of the possible concentrated time of need by the utility or builder. Usually, however, poles are bought a carload or two at a time. In the North more poles are likely to be used in the months of milder weather, especially in the building category.

Since most of the poles used in Michigan and the surrounding states are southern yellow pine, this species sets the standard for prices that a Michigan treater will have to meet. To give equal strength a red pine pole has to be somewhat larger in diameter than a southern pine pole. Thus, the volume and quantity of preservatives used per pole is higher for red pine.

Western red cedar poles sell for more than pine. Cost of production and shipping distances are greater. These reasons, of course, would not justify a higher cost to the users. Some use cedar because they have had good success. Others like this softer wood because it is easier for the linemen to climb. Red pine is also softer than southern pine and should, therefore, be easier for linemen to climb.

Another reason for favoring cedar is the clean surface, which makes for better public relations in congested areas. However, since the advent of full length treatments, cedar poles are no longer as dry or clean as when they were only butt treated. On the other hand, the more careful treating with creosote by pressure and use of pentachlorophenol has brought pine and cedar closer together on this score. In fact, clean pole surfaces are specified by many purchasers. Since Western red cedar is available in larger sizes and lengths than southern pine, it will always be able to keep this market, although in the large sizes, steel is a competitive factor.

Prices are usually quoted on a delivered basis. Prices at which buyers in Michigan and neighboring states obtained poles in 1963 and 1964 are shown in Table 12. The zones of the state listed in Table 12 refer to Fig. 5.

TABLE 12—Range of prices paid for treated poles in 1963 or 1964

Place of Delivery	Species	Class-Length	Delivered Price (Dollars)
Michigan A	N.W.C.	5-30	18.20-18.50
Michigan A	N.W.C.	5-35	26.52-30.37
Michigan A	W.R.C.	4-35	26.06-34.75
Michigan A	W.R.C.	3-55	56.01
Michigan B	W.R.C.	4-30	18.50
Michigan B	W.R.C.	5-30	20.85
Michigan B	W.R.C.	5-35	31.00
Michigan B	W.R.C.	4-45	42.74-46.00
Michigan C	W.R.C.	6-30	22.00
Michigan C	W.R.C.	6-35	24.85-32.76
Michigan C	W.R.C.	4-40	39.55-43.25
Michigan C	S.Y.P.	6-30	15.09-16.43
Michigan C	S.Y.P.	5-35	27.18
Michigan C	S.Y.P.	5-40	30.40-33.62
Michigan D	W.R.C.	5-30	25.00
Michigan D	W.R.C.	4-35	39.85
Michigan D	S.Y.P.	7-30	12.30-12.70
Michigan D	S.Y.P.	5-35	25.88
Michigan D	S.Y.P.	6-40	24.65-30.76
Michigan E	W.R.C.	6-30	22.00
Michigan E	W.R.C.	7-35	23.14-23.41
Michigan E	W.R.C.	5-45	48.91
Michigan E	S.Y.P.	7-30	11.95-12.73
Michigan E	S.Y.P.	5-35	23.73-24.31
Michigan E	S.Y.P.	6-40	24.04
Michigan F	W.R.C.	7-35	24.75-24.85
Michigan F	W.R.C.	4-35	39.85
Michigan F	W.R.C.	4-40	52.50
Michigan F	S.Y.P.	7-30	12.87
Michigan F	S.Y.P.	5-35	23.20-26.60
Michigan F	S.Y.P.	6-40	24.61
Michigan G	W.R.C.	4-35	32.00-39.85
Michigan G	W.R.C.	4-40	52.50
Michigan G	S.Y.P.	6-30	15.60-18.59
Michigan G	S.Y.P.	6-35	18.00-21.00
Michigan G	S.Y.P.	5-35	25.80-27.56

TABLE 12—Continued

Place of Delivery	Species	Class-Length	Delivered Price (Dollars)
Ohio, Northern	W.R.C.	7-30	16.80
Ohio, Northern	W.R.C.	5-40	41.50
Ohio, Northern	S.Y.P.	7-30	12.05-13.64
Ohio, Northern	S.Y.P.	5-35	22.70-28.05
Ohio, Northern	S.Y.P.	6-40	22.37-27.41
Indiana Northern	S.Y.P.	7-30	12.07-13.00
Indiana Northern	S.Y.P.	5-35	24.50-26.50
Indiana Northern	S.Y.P.	6-40	23.27-26.45
Indiana Northern	W.R.C.	5-35	33.85
Indiana Northern	W.R.C.	4-40	45.95
Illinois Northern	S.Y.P.	6-30	13.74-14.40
Illinois Northern	S.Y.P.	7-30	12.25
Illinois Northern	S.Y.P.	5-35	23.40-25.65
Illinois Northern	S.Y.P.	6-40	27.03
Wisconsin	W.R.C.	7-30	15.15-17.40
Wisconsin	W.R.C.	5-35	33.20-33.70
Wisconsin	W.R.C.	4-40	43.85
Wisconsin	S.Y.P. or R.P.	7-30	11.90-13.95
Wisconsin	S.Y.P. or R.P.	5-35	24.00-28.99
Wisconsin	S.Y.P. or R.P.	4-40	33.00-41.50

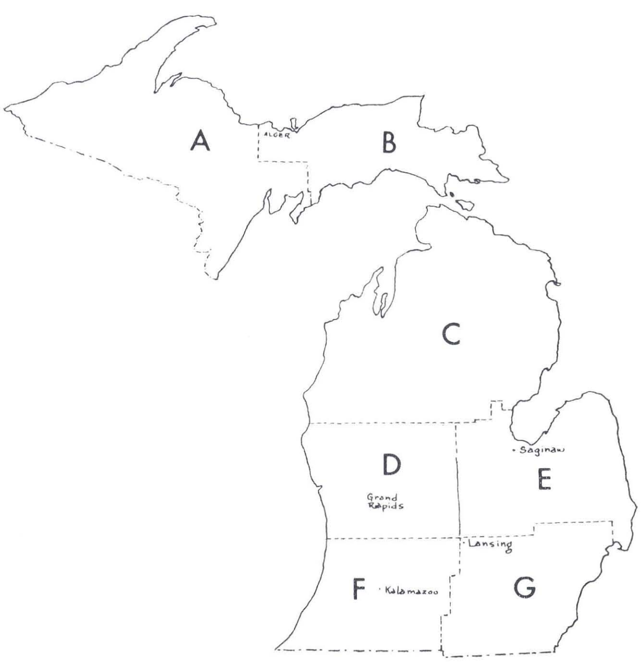

Fig. 5. Pole destinations in Michigan as referred to in Table 12.

It is of interest to note the location of wood preserving plants already established. Figure 6 is a portion of a map of the United States with wood preserving plants numbered. One plant in Michigan has been omitted. It is between plants 344 and 380 and is a commercial non-pressure plant. As can be seen the greatest concentration of plants is in the gulf coast states. These are the plants shipping most of the poles into Michigan.

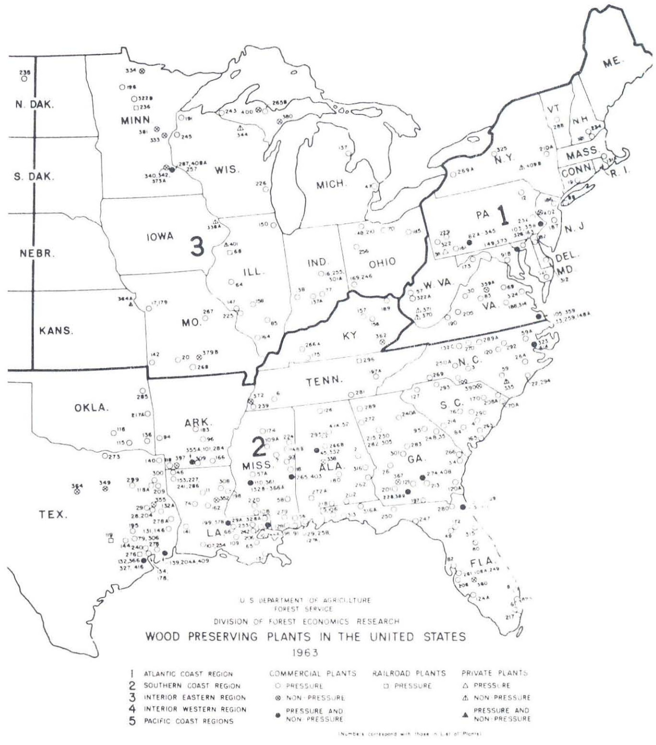

Fig. 6

In the Great Lakes area four plants are treating red pine or jack pine poles. Other pressure plants in the area are either using water-borne compounds, largely unsuited for utility poles, or are treating mostly cross ties. An exception is plant 150 which treats southern pine poles which originate in the South.

Production of Poles

Only about 4,000 red pine poles were cut in Michigan in 1964. However, in other sections of the United States, poles are being produced in large numbers, and it can be fairly safely assumed that the methods and procedures found practical there could be used in Michigan.

Ownership of stumpage may be private (by the wood treater or by farmers, paper mills or utilities) or public (by state agencies such as the Department of Conservation, as in Michigan; or by the U. S. Forest Service). For pole size red pine trees the ownership in Michigan at present is about 59 percent on private and Federal lands in the Upper Peninsula and 41 percent on State owned lands. In the Lower Peninsula's northern counties, the ownership is about 57 percent on private and Federal lands and 43 percent on State lands.

On what might be called a typical pole production operation a logger will select the pole stock, cut some trees for sawlogs, and sell tops and thinnings as pulpwood. Where there is an established treating plant, the trees intended for poles might be sent to a concentration yard for debarking and drying or they might be shipped green with bark to the treating plant to be debarked and stacked for drying in the yard or by kiln.

Poles would be cut within 75 miles of the debarker-concentration yard, where they would be seasoned. In the event they were to be debarked and seasoned at the treating plant, they might be shipped as far as 250 miles from the point of cutting to the point of preservative treatment.

In Michigan, for example, under a comparable set of conditions a treating plant at Grayling would be about 200 miles from the center of the red pine area between Newberry and Seney and 35 miles to the best red pine area in the Lower Peninsula.

In the northeastern part of the United States, piling producers are generally sawmill operators who cut piling as a part-time operation. If the market conditions are favorable, appropriate trees are sold for this use or for poles. If not, these trees are sold for saw logs.

In the production of poles or piling a crew of four to six men operates in the woods. There would be two or three cutters who fell and limb the trees, a truck driver or two, and a tractor-loader-operator. Fellers must be able to tell if a tree will meet ASA standards before cutting it. Equipment might consist of a truck, semi-trailer, loading device, tractor for skidding (rubber tired and of sufficient power to skid the largest poles), and chain saws.

In most areas, wood preserving plants do not produce poles on their own lands. At least in the South, treating plants seem to be able to obtain all the treating stock they need from the trees growing on others' lands. Of course, control of the raw material source is an important facet in any industry. In spite of the large forested land areas owned by paper mills, there is no shortage of poles.

Pole Trees Per Acre

A question which logically is raised in regard to the selectivity needed in pole harvesting is: How many pole trees per acre constitute an economic operating basis if only the pole-suitable trees are to be cut? There is, of course, no one answer to this question because it depends on the price of the poles, the expense of logging, and distance to loading point. It is possible that only five trees per acre would be enough to make cutting attractive to a producer if logging conditions were good—level land, no bothersome swamps or streams—and the loading point 20 miles or less away. If there are more poles than five per acre the logger can operate for less and can afford to pay more for the poles. Good pole producing land in the South would have more than 25 percent of the trees suitable for poles, or somewhere between 10 and 20 trees per acre of sizes 35 feet and up that would make poles conforming to ASA standards.

A producer in Canada cutting in red pine-jack pine areas states that 15 poles per acre is about the number obtained from lands on which they operate.

A potential operator in Michigan should satisfy himself that this concentration of suitable trees exists in any area selected as the site of a concentration yard or treating plant.

Stumpage

The price of red pine stumpage of pole quality is still a bit unsettled in Michigan because of small activity in this field. Prices set by the Michigan Conservation Department in mid 1964 are presented in Table 13.

TABLE 13—Prices set by Michigan Conservation Department in 1964 for red pine stumpage

Pole, length, feet	Selling price per pole (Dollars)
20	.40
25	.50
30	1.20
35	1.75
40	2.40
45	3.15
50	4.00

These prices do not consider the top diameter. The assumption is that other products would be removed besides poles.

Price schedules proposed in mid 1963 by the Michigan Department of Conservation for utility poles and building poles take the top diameter into consideration. For equivalent sizes building pole stumpage is below utility pole stumpage in price. This may be unrealistic because suitable poles are more difficult to find than utility poles because of the need for a straight side. Table 14 shows these proposed prices.

TABLE 14—Michigan State forests (1963), stumpage schedule for building (B) and utility (U) poles

Length feet	Top Diameter (Inside Bark) and Class									
	3.5″—None		4.5″—10		5.5″—6		6.5″—5		7.5″—3	
	(price in dollars)									
	B	U	B	U	B	U	B	U	B	U
10	.05	—	.06	—	.07	—	.09	—	.10	—
12	.07	—	.09	—	.11	—	.13	—	.15	—
14	.09	—	.12	—	.17	—	.20	—	.25	—
16			.20	—	.25	—	.30	—	.45	—
18			.25	—	.30	—	.40	—	.50	—
20			.30	—	.40	.45	.50	.55	.55	.65
22			.40	—	.50	.65	.55	.80	.65	.90
25			.50	—	.55	.86	.60	1.00		1.20
30					.60	1.20	.70	1.50		2.00
35						2.00		2.50		3.50
40						3.50		4.00		4.80
45						4.80		5.20		5.50
50						5.00		6.00		7.00
55								7.00		8.80
60										10.80

Prices paid by treating plants are quoted on many different bases. They may buy them delivered to the plant but not peeled, delivered and peeled, for pick up at roadside, or f.o.b. cars or trucks. Thus, comparisons are difficult to make.

Prices paid for red pine poles delivered to a yard unpeeled, as of mid 1963, are shown in Table 15. Since these are all short lengths they would be used for barn poles.

TABLE 15—Dollar prices paid for red pine delivered to a Northern Michigan yard-unpeeled (July, 1963)

Length feet	Top Diameter, Minimum, Inches			
	4.5	5.5	6.5	7.5
	Top Circumference, Minimum, Inches			
	11.0	17.6	20.4	23.6
	(dollars)			
10	.45	.69	.88	1.08
12	.46	.77	1.04	1.30
14	.61	1.10	1.45	1.80
16	.68	1.26	1.51	1.90
18	.89	1.48	1.83	2.30
20	1.20	1.80	2.05	2.50
22	1.51	2.10	2.49	
25	1.55	2.28	2.62	
30		3.25	3.48	

If these prices for 4.5 inch poles are assumed to be realistic, those for the 6.5 inch are too high when the stumpage is considered. For example, a 10 foot pole is 6 cents if 4.5 inches and only 9 cents if 6.5 inches but the difference in the price paid at the yard is 40 cents. This can hardly be justified on the basis of transportation or logging costs.

On the other hand, if the prices of larger sizes are more carefully set, then the prices for the smaller sizes are too low. Based on 1959 prices for pulpwood (which may have been higher than 1964 prices) the 4.5″ x 10′ piece, as pulpwood delivered, would bring 26.6 cents and the 6.5″ x 10′ piece would bring 55.9 cents. The figure for converting price per cord for pulpwood to a cubic foot price is 90 cubic feet equals one cord.

Another set of Michigan prices for red pine poles delivered, but not peeled, current in 1964 is shown in Table 16. The top measurement is that of the peeled pole.

TABLE 16—Prices paid, dollars (1964) for red pine poles delivered

Length feet	Top Diameter or Circumference		
	5″D—15.7″C	6″D—18.9″C	7″D—22″C
	Class		
	7	5	4
	(dollars)		
20	2.25	—	—
25	3.25	—	—
30	5.00	—	—
35	—	6.50	—
40	—	7.75	—
45	—	—	9.25
50	—	—	11.75

Compared to the 1963 prices shown these are more generous, but may reflect greater hauling distances. The above 1964 prices were judged to be too low by a contractor ordinarily engaged in pulpwood operations. This view would appear to be unjustified unless his unfamiliarity in handling and hauling long poles added unnecessarily to his costs.

Some 1959 prices for red pine poles delivered, but probably not peeled, are available for Minnesota and Wisconsin. Stumpage has declined from 1959 to 1965, but other costs have risen. Whether these would balance and result in comparable delivered-pole prices in 1965 is a moot question. However, the chances are good that the 1965 prices would not be greatly different from those shown below in Table 17.

TABLE 17—Red pine pole prices, delivered to treater, 1959, dollars

Length feet	Top Diameter in Inches						
	4″ Wis.	6″ Minn.	5″ Wis.	7″ Minn.	6″ Wis.	7″ Minn.	7″ Wis.
	Dollars						
20	1.25	1.10	—	—	—	—	—
25	1.50	1.93	—	—	—	—	—
30	—	—	3.00	3.55	—	—	—
35	—	—	7.00	5.79	—	—	—
40	—	—	—	—	9.00	9.25	—
45	—	—	—	—	—	—	11.00

Some figures are also available on an experimental run of 700 poles that were cut in Michigan in 1963 and treated for use by utilities. Prices were not broken down for classes but only for length of poles. The lowest prices quoted for a 35 foot pole excluding stumpage but loaded on a truck at the woods was $2.40 and for a 40 foot pole $3.10. If stumpage prices proposed by the Michigan Conservation Department were added, the price would be $4.15 for a 35 foot pole and $5.50 for a 40 foot pole. It should be noted that no class is shown. Most pole buyers pay quite different prices for various classes of poles.

There is value in comparing these costs with those from southern pine producing areas, since southern pine is the species red pine will have to displace if a market is to be found in Michigan and surrounding areas.

Table 18 shows the prices for rough-peeled poles loaded on cars at South Carolina points in 1963.

Stumpage prices on southern pine for poles in Virginia in 1963 are contained in Table 19.

Southern pine piling stumpage prices paid in Virginia in 1963 are listed in Table 20.

Some Virginia prices on southern pine construction poles are given in Table 21. These are prices for poles delivered to the treating plant.

The most recent prices available for stumpage from a State producing poles with which Michigan red pine would be competing are shown in Table 22. These prices are averages from various areas in Louisiana for the third quarter of 1964. They are for poles, unpeeled on board cars or trucks.

TABLE 18—Prices offered for rough-peeled poles, f.o.b. cars, South Carolina points (1963)

Length feet	Class 1	2	3	4	5	6	7	9	10
	Dollars								
25						2.00	2.00	1.85	1.25
30		4.30	3.50	2.90	2.60	2.30	2.15	1.95	
35	6.70	6.70	6.00	5.55	5.20	2.65	2.45		
40	9.30	9.30	9.30	7.80	6.70	4.70			
45	12.50	11.65	11.20	9.00	7.15				
50	18.00	18.00	12.50						
55	24.00	24.00	20.00						
60	28.75	28.75	25.75						
65	34.50	34.50	33.25						
70	43.05	43.05	41.50						
75	53.50	53.50	48.50						
80	72.50	65.45	58.45						
85	87.15	79.05	70.15						
90	90.00	85.00	80.00						

TABLE 19—Prices for southern pine stumpage, Virginia 1963

Length feet	Class 1	2	3	4	5	6	7	8
	Dollars							
25						1.57	1.41	1.17
30					2.50	2.27	1.60	
35	6.82	6.27	5.78	5.00	4.57	3.07	2.40	
40	8.85	8.69	7.75	7.10	5.20			
45	12.18	11.44	9.90	7.34	5.80			
50	14.90	12.45	11.44					
55	15.25	13.75	12.50					
60	19.50	16.75	15.50					
65	22.50	20.13	19.25					
70	27.25	24.38	23.37					
75	33.50	30.75	27.00					
80	38.75	33.25	28.75					
85	50.00	41.50	35.50					
90	50.00	50.00	50.00					

TABLE 20—Stumpage prices for southern pine suitable for piling, Virginia, 1963

Length feet	Diameter, Inches: 8-10″ Butt 6″ Top	10-12″ Butt 8″ Top	13″-3′ Butt 7″ Top	12″ - 2′ Butt 7″ Top
	Dollars			
30	3.00	4.00		
35	3.50	5.00		
35-39			5.00	
40	4.00	6.00		
40-44			7.50	5.00
45	4.75	7.00		
45-49			9.00	6.00
50-54			10.00	8.00
55-59			12.50	10.00
60-64			15.00	12.50

TABLE 21—Southern pine pole prices delivered to plant, Virginia, 1963, dollars

Length feet	Diameter, Top, Inches: 5.5-6.5	6.5-7.5
	(Dollars)	(Dollars)
12	.85	—
14	1.00	—
16	1.50	2.00
18	2.00	2.50
20	2.25	2.75

TABLE 22—Southern pine pole prices in dollars, Louisiana 1964, unpeeled, f.o.b. R.O.W.

Length feet	Pole Class 1	2	3	4	5	6	7
	Dollars						
30					3.30	2.95	2.55
35				6.50	6.15	4.00	3.10
40				9.15	8.20	6.00	
45			12.50	10.85	9.25		
50		16.35	15.00	13.85			
55		21.90	19.35	17.35			
60		33.55	30.00	25.00			
65		43.40	39.65	30.50			
70		53.35	49.35	42.50			
75		65.35	58.70	52.00			

TABLE 23—Percentages of southern pine poles by length and class, according to frequency of use, 1956 (includes utility, barn, building and other uses)

Length feet	Class 1	2	3	4	5	6	7	9	10	Total by length
16						0.46	0.27	0.55	0.71	1.99
20						0.83	1.32	1.82	2.06	6.03
25						2.81	4.72	5.64	2.25	15.42
30			0.92	1.48	2.71	4.49	7.50			17.10
35			1.80	4.96	8.80	8.70	3.72			27.98
40		1.05	2.18	6.49	8.16					17.88
45		0.58	1.63	2.74	2.16					7.11
50		0.50	0.99	0.89	0.16					2.54
55	0.29	0.33	0.58	0.38	0.05					1.63
60	0.08	0.29	0.42	0.31	0.02					1.12
65	0.06	0.17	0.25	0.15						0.63
70	0.05	0.11	0.12	0.06						0.34
75	0.05	0.09	0.07	0.02						0.23
Total by class	0.53	3.12	8.96	17.48	22.06	17.29	17.53	8.01	5.02	

Source: Jour. Forestry, 56:350, 1958.

A comparison of 1964 prices for untreated southern pine poles with those of 1956 indicates that the f.o.b. car price has risen for some sizes and fallen for others. If the change is calculated for all the pole sizes shown in Table 23 from 1956, it is found to be only about 1.4 percent. Thus, over the past eight years delivered pole prices, before treatment, have been quite stable. As a forecast, it may be safe to say that likewise, Michigan red pine prices should be stable for the forseeable future. Prices for treated poles, on the other hand, have decreased some over the past 10 years.

Pole Sizes Most Frequently Purchased

Table 23 shows the frequency of order of southern pine poles in 1956. These figures will probably be valid for red pine, too. The demand for 40 and 45 foot poles might also shift downward by five feet where joint use regions are involved. Most telephone companies are moving lines underground so poles that were or would be jointly used by power and telephone companies can be reduced in length, if only to be used for power lines.

The percentages for barn construction pole sizes such as 25 and 20 feet would also be somewhat higher today because in 1956 pole building construction was not as prevalent as it is today.

Production Costs

For many wood preserving plant operators, the cost of pole production is academic, if they are buying their treating stock from a logger or pole producer. However, costs of pole production and what influences them, are contributing factors to the final price of the pole on the market. In view of this, production costs deserve some attention.

The most important part of pole production costs is labor. Exact figures on labor expenses are difficult to obtain, but some are available in the 1962 Census as reported by states. The break-downs for industries probably cover more than just pole or piling wages, but those listed for "Logging Camps and Logging Contractors" should apply to woods work and transportation of poles; those shown for "Sawmills and Planing Mills" may apply to work around a treating plant such as operation of a pole shaving machine, lift trucks or cranes, framing and boring or slabbing machines, and the treating plant.

Of course, local situations such as extent of unionism, nearness of a plant paying high wages, amount of unemployment, attitude of labor, etc. can alter the wage scale from the averages of the census. In Table 24 are listed the wages paid in the logging and sawmill industries for Michigan, Wisconsin and several southern states from which a large proportion of the utility poles used in Michigan and neighboring states are now coming.

TABLE 24—Wages paid in 1962 to workers in Wood Industry, according to Bureau of Census (excludes self-employed)

Location	Units Reporting	No. of Employees	Taxable payroll Jan.-mid March	Ave. Rate of pay
			(Dollars)	($/Month)
MICHIGAN				
A. Logging Camps and Logging Contractors	405	1,899	1,006,000	210
B. Sawmills and Planing Mills	275	3,306	2,744,000	332
WISCONSIN				
A.	251	1,009	649,000	257
B.	222	2,964	2,534,000	342
ALABAMA				
A.	668	3,884	1,580,000	163
B.	550	12,570	7,983,000	254
MISSISSIPPI				
A.	302	1,542	567,000	147
B.	352	9,193	5,608,000	245
ARKANSAS				
A.	439	2,562	1,126,000	176
B.	481	13,144	9,339,00	285
LOUISIANA				
A.	386	2,105	1,125,000	214
B.	201	8,390	6,174,000	295

From Table 24 it can be seen that Michigan wages are higher than in all the southern states shown except Louisiana. Wisconsin, which is close to much of the red pine, however, is even worse off from a competitive standpoint. Increased production or the economical use of labor saving machinery would be possible answers to this southern competition.

Under what appeared to be ideal operating conditions in Mississippi a four man crew was able to fell, trim, load and haul 150 or more 30 to 40 foot poles to a concentration yard in a day. Although the potential pole cut was about 30 per acre only 5 per acre were marked for felling. The woods workers were paid $1.75—$2.00 per hour.

Pole producers are usually independent contractors who obtain orders from the treating plant for poles of certain sizes and various specifications. Although they could produce more than 150 poles per day, the particular treater in question spreads the orders among several producers and limits purchases to 150 poles per producer. The producer buys the stumpage where he can and at a price which will bring him a reasonable profit. After the pole has been shaved it is inspected for conformance to specifications. The rejects are not paid for and it is up to the producer to dispose of them. In some cases an acceptable pole might result by trimming a reject; such poles are bought by the treater at adjusted prices.

At the concentration yard the poles were debarked, inspected, sprayed with antistain solution, sorted, and stacked. The required number of poles was loaded and shipped to the treating plant from the stacks within a two week period of cutting.

About 300 poles per day could be processed by the concentration yard. The yard was equipped with a pole shaver peeler, powered conveyor rolls, spraying device, locomotive crane, and necessary skids and railroad trackage. Ten men were required for this operation.

In the experimental red pine pole treatments mentioned earlier, prices quoted for felling and bucking a 35 foot pole ranged from $1.20 to $2.50 and for a 40 foot pole from $1.45 to $2.50 each. Skidding was quoted at $0.85 to $3.50 for a 40 foot pole from $1.45 to $2.50 each. Skidding was quoted at $0.85 to $3.50 for a 35 foot pole and $1.00 to $3.50 for a 40 foot pole. Loading on a truck in the woods was bid in a range of $0.25 per pole to $1.25.

Costs such as those just cited, would depend on several factors and result in somewhat different pole production costs in different locales. Skidding prices or costs would depend on how far the felled tree was from the road. Felling and trimming costs would depend on how dense the stand was, and the number of pole trees per acre.

Transportation

Since loggers are not common carriers they have no published rates. In the experimental run, the lowest rate for hauling from the woods to a rail shipping point or treating plant was about 25 cents per hundred pounds (cwt.) for a distance of 60 miles.

A regular pole buyer in Michigan as of 1964 will haul poles from woods to his yard or treating plant for about 17 cents per cwt. for a 30 foot pole over a 100 mile distance. This would seem to be a low rate.

A published rate exists for an irregular route carrier for transportation of poles between points within 45 miles of Roscommon and between such points and other Michigan points. Their rates are shown in Table 25.

TABLE 25—Rates of S & L Trucking Company Tariff MPSC No. 2, Item 220 for transportation of poles and posts in Michigan: Column A—Shipments requiring use of a single axle tractor with a tandem axle semi-trailer. Column B—Shipments requiring use of a tandem axle tractor with a 3 axle semi-trailer

Miles	Charge Per Trip A	Charge Per Trip B	Miles	Charge Per Trip A	Charge Per Trip B
	Dollars			Dollars	
1-5	40.00	60.00	31-35	64.00	96.00
6-10	44.00	66.00	36-40	68.00	102.00
11-15	48.00	72.00	41-45	72.00	108.00
16-20	52.00	78.00	46-50	76.00	114.00
21-25	56.00	84.00	Over 50	50 miles charge plus $6.00 for each additional 10 miles or fraction	
26-30	60.00	9.00			

Examples of these rates would be: A 5-30 red pine pole freshly cut would weigh about 500 pounds, and 64 could be hauled on a tandem axle and 78 on a 3 axle trailer. For a 30 mile distance the charges would be 94 cents and $1.15 per pole. For a distance of 60 miles, using a tandem axle the charge would be $1.30.

Rail rates are considerably lower provided a 50,000 pound minimum weight is shipped. Rail rates on untreated poles for certain Upper Peninsula points are given in Table 26.

TABLE 26—Railroad rates for untreated poles to Quinnesec, Michigan from various points, in cents per hundred pounds

From	50,000 lb. Minimum	75,000 lb. Minimum
Sault Ste. Marie	24	20
Trout Lake	21	17
St. Ignace	23	19
Newberry	22	18

At present most poles that are treated and sold within Michigan are shipped in trucks belonging to the treating plant. A specialized motor carrier has been authorized to haul treated poles from Akron, Michigan to points within Michigan up to 200 miles from Akron. Their rate is 70 cents per loaded mile, with a minimum charge of $31.50. With a load of 32,000 pounds being transported for 100 miles this would amount to a rate of about 21 cents per cwt. Rail freight rates on treated poles are shown in Tables 27 and 28 from points where treating plants are presently located, or where they might logically be located, on the one hand and points of delivery on the other.

The rail rates, where no present plant exists and hence no movement, would be combination rates. They would be subject to negotiation if a treating plant were built in one of these places and a steady tonnage could be promised the railroad.

TABLE 27—Rail freight rates from Upper Peninsula points on treated poles

Destination	Rates in Cents per Hundred Pounds McMillan A	B	C	Quinnesec A	B	C
Detroit	52¼	–	38½	67	58½	42½
Grand Rapids	52¼	51½	36½	59½	51½	36½
Jackson	52¼	–	41½	65½	58½	42½
Lansing	52¼	–	38½	65½	54½	38½
South Bend	65½	58½	42½	65½	57½	41½
Fort Wayne	59½	–	43½	65½	60½	43½
Toledo	57½	–	42½	67	60½	43½
Canton	68	–	53½	70	–	54½
Paulding	59½	–	43½	67	60½	43½
	D	E	F	D	E	F
Chicago	46½	42	38	37½	31	27
Milwaukee	45½	35	31	37½	24	20
La Crosse	49½	42	38	44½	31	27
Eau Clair	–	40	36	–	27	23
Appleton	45½	28	24	31½	19	15

Column letters refer to minimum weights as follows:

A—34,000 lbs. D—30,000 lbs.
B—36,000 lbs. E—50,000 lbs.
C—60,000 lbs. F—70,000 lbs.

TABLE 28—Rail freight rates on treated poles from Lower Peninsula points to various destinations, in cents per hundred pounds (minimum 50,000 lbs.)

Destination	Cadillac	Grayling	St. Clair	East Tawas
Detroit	38½	38½	22½	33½
Grand Rapids	30½	38½	34½	34½
Jackson	38½	39½	31½	34½
Lansing	33½	34½	31½	31½
Toledo, O.	39½	40½	31½	31½
Canton, O.	50½	50½	40½	47½
Paulding, O.	42½	45½	38½	40½
South Bend, Ind.	39½	45½	40½	40½
Chicago, Ill.	42½	47½	45½	45½

Poles vs. Sawlogs as an End Use of Trees

Monetary return, in large measure, is the deciding point in whether or not a timber owner is willing to sell his trees for poles or would rather sell them, after more years of growth, as sawlogs.

The red pine trees suitable for poles are also the ones which will grow into the best sawlogs or possibly veneer logs, if that industry ever develops in Michigan. To determine the most profitable market for red pine stumpage, a common basis of measurement must be used. The International Log Rule is best since it is used in the red pine areas of Michigan for measurement of saw logs. Table 29 shows the volume in board feet of red pine poles, based on this scale. Its construction was based on a taper of 0.5 inches in diameter in 4 feet as was Rothacher's (17). Measurements made on some of the red pine poles used in this test indicate that this is a good average, at least for classes 5, 6 and 7.

TABLE 29—Volumes of red pine poles, International ¼ Inch Rule, board feet

Pole Length	Average Top Diameter, Inches 8.9	8.3	7.6	7.0	6.4	5.7	5.1	4.8	4.3
	Class 1	2	3	4	5	6	7	9	10
16					22.5	18.0	12.5	10.5	8.5
18			41.5	34.5	28.5	21.0	16.0	13.0	11.0
20	68.0	59.0	47.5	39.5	32.5	24.5	19.0	16.0	12.5
22	77.0	67	55	45.5	37.5	28.5	22	18.5	14.5
25	94.0	80.5	66	56	45.5	35.5	27	23.5	18.5
30	120.0	105	89	76	61	49	38.5	33	
35	152	132	111	96	80	64	52		
40	188	164	138	120	105	83	66		
45	226	199	170	146	126	104	85		
50	269	240	207	179	154	128	107		
55	317	285	245	213	184	153			
60	367	330	288	253	219				
65	425	373	330	294					
70	485	440	382						
75	550	500							

Since the circumferences required at the ground line by ASA tables are only slightly larger for red pine than southern pine, it seemed valid to multiply the values in Rothacher's tables by the ratio of circumferences. For example, a class 5-35 foot southern pine pole contains 77 board feet. By ASA tables this pole as a southern pine is 30 inches in circumference at the ground line and as a red pine 31 inches. Thus, a red pine might have 31/30 x 77 = 80 board feet.

To be precise, though, a volume table should be made for red pine, based on actual measurements. This has been done (13) but the diameters shown are outside bark. For selection of the best market, such measurements are not usable since the board foot yield can't be determined accurately.

To reach a decision, purely on a monetary return basis, to sell a tree for a pole now or as a saw log later, the prices of each kind of stumpage must be known. Take, for example, a tree that would make a class 6-30 foot red pine. This would be worth 49/1000 x \$25.85 = \$1.24 as a saw log under average prices for red pine saw log stumpage in the northern Lower Peninsula of Michigan.

In the Upper Peninsula the price is only about \$8.20 for red pine stumpage, but some of this is low grade—cull trees and thinnings—which reduces the average price. A 5-40 red pine pole, to give another example, would contain 105 board feet and be worth 105/1000 x \$25.85 = \$2.72 as a saw log.

Prices shown earlier in the report as 1964 figures set by Michigan Department of Conservation for red pine pole stumpage are \$1.20 for a 30 foot pole and \$2.40 for a 40 foot pole. Since these prices do not distinguish between classes, it is not possible to judge their level. It would appear, though, that the 30 foot price is almost right based on present Lower Peninsula saw log stumpage, for class 7 and 9 poles, and the 40 foot price is in line for class 7 poles.

This is not a criticism of state prices; some inducement may be necessary to encourage the harvesting of red pine as poles from state lands. However, private and Federal timber owners may require a larger difference in pole vs. saw log stumpage price to induce them to sell their stumpage for poles.

It is possible, too, that the board foot yield for such long objects as poles is not quite what the figures shown in Table 29 indicate. The lumber cut from the tip end would be of poor quality. In fact, sawmills might not even want logs of pole size trees because of the low yield in the higher class numbers.

Thus, the real basis for decision of sale of a tree, now, as a pole or retaining it to sell later as a saw log depends on what the future market and prices for red pine stumpage as saw logs will be.

In the future the supply of red pine saw logs appears to be so large that the price for stumpage is more likely to decrease than increase. All predictions point toward a lessening need for lumber and more need for converted wood products such as plywood, particle board, insulation board and hardboard, all of which, except plywood, can use cordwood as a raw material source.

It would seem, then, that a timber owner in Michigan would find it to his advantage to sell his stumpage for poles at current prices rather than retain it for saw logs. The viewpoint that saw logs are the ultimate to shoot for in timber management is no longer valid. There must be a satisfactory market, and it may not exist in its present make-up in years to come.

Williston (26) quotes a forester engaged in buying poles for a southern treating plant as follows: "Currently 35, 40 and 45 foot poles are worth 50 percent of the f.o.b. cars price for rough peeled poles if 3 to 5 poles are produced per acre and provided a rail point is within reasonable distance; i.e. 25-40 miles, depending on the condition of the road.

"Excellent returns can be realized at this stumpage price from trees of sizes which usually contain a rather high percentage of low grade lumber. Trees cut in thinning small saw log sized stands under these price conditions can very profitably be marked as poles." Trees of large circumference usually are better sold as saw logs, however, because they make a class 1 pole and demand for such large diameter poles is small.

Predicting Class of Red Pine Poles

Another problem confronting a timber producer and owner or contractor engaged in producing poles is what trees will yield what class pole. Since class is determined in part by the circumference of the top and this part of the tree is unmeasurable until the tree is cut, there is a need for knowing what this top size will be from some measurements that can be taken from the ground.

This information has been provided in a bulletin by Stiell and Von Althen (21). Table 30 from their bulletin gives the tree diameter outside the bark at breast height necessary for a certain class pole to result when trees of various heights are cut. This table might give slightly different figures from those required by American Standards because it is based on Canadian Standards Association 015.3—1960 which lists circumference in a fiber stress grouping of 6000 psi, the same as for ponderosa pine poles in ASA specifications.

TABLE 30—Plantation red pine alternative pole utilization

Tree d b.h. (o.b.) Class	35′	40′	45′	50′	55′	60′	65′	70′	75′
				Longest pole available (pole class-length)					
5″	—	—	10-16′	10-18′	10-18′	—	—	—	—
6″	10-16′	10-20′	10-25′	9-16′	9-16′	9-20′	9-20′	—	—
				10-25′	10-25′	10-25′	10-25′	—	—
7″	10-20′	8-18′	8-18′	8-18′	7-16′	7-16′	7-16′	7-16′	—
			10-25′		8-18′	8-18′	8-20′	8-20′	—
		10-22	9-22′	9-25′	9-25′	9-30′	9-30′	9-30′	—
8″	—	6-16′	6-18′	6-18′	6-18′	5-16′	5-16′	5-16′	5-16′
		7-20′	7-20′	7-22′	7-22′	6-18′	6-18′	6-20′	6-20′
		10-25′	8-25′	8-25′	8-25′	7-22′	7-22′	7-22′	7-22′
					9-30′	8-25′	8-25′	8-25′	8-25′
						9-30′	9-30′	9-30′	9-30′
9″	—	—	5-18′	5-20′	5-20′	5-20′	5-20′	4-18′	4-18′
			6-22′	6-22′	6-22′	6-25′	6-25′	5-20′	5-20′
			7-25′	7-25′	7-25′	8-35′	8-35′	6-25′	6-25′
				8-30′	8-30′			7-30′	7-30′
10″	—	—	—	—	4-20′	3-18′	3-18′	3-18′	3-18′
					5-22′	4-20′	4-20′	4-22′	4-22′
					6-25′	5-25′	5-25′	5-25′	5-25′
					7-35′	6-30′	6-30′	6-30′	6-30′
						7-35′	7-35′	7-35′	7-35′

Pole S-16 of the group tested in Part III of this report was 9.7 d.b.h., o.b. and 58 feet tall, and became a class 7-30 pole. By Table 30 this would make an 8-35 pole. This pole was actually a class 6 by top circumference but was placed in class 7 because of insufficient circumference for that class at 6 feet from the butt, so it's likely that it would have made a 7-35.

Another example is Pole P-19, 10.5 inches d.b.h., o.b. and 59 feet tall. By Table 30 this tree would have made a class 6-30 and it did. A stump height of 6 inches is assumed in this table. Other comparisons are shown in Table 31.

TABLE 31—Comparison of predicted class and length of poles obtainable from red pine trees with those actually obtained

Pole Tree No.	Tree DBH OB (in.) Actual	Height of tree, Actual, feet	Predicted Pole Length and Class	Pole Class Ht. Actually Cut
P-1	10.5	53	7-35 or 6-25	6-30
P-11	10.5	55	7-35 or 6-25	6-30
P-19	10.5	59	or-- 6-30	6-30
S-1	9.95	55	7-35 or 6-25	7-30
S-16	9.7	58	6-25 or 8-35	7-30
S-26	10.35	54	6-25 or 7-35	7-30

There are no volume tables for red pine poles that show cubic contents for various classes and lengths based on ASA tables. The tables for southern pine pole volumes (26) are good approximations. However, if these are used, it should be borne in mind that there is plenty of room for variation because actual top and butt sizes are not used; only minimums or averages. In some comparisons of actual red pine pole volumes with the southern pine tables the largest difference was 20 percent less than predicted.

There is a table of red pine pole volumes in a specification (4) but the values found on actual pole measurements were, in some cases, even more out-of-line with the table values than when a southern pine table was used. In other instances the agreement was better. It would appear that for purposes of wood treating and estimates of weight of poles, actual measurements should be used until a suitable table of red pine volumes can be composed. Comparisons are show in Table 32.

TABLE 32—Comparison of actual volume of a 30 foot red pine pole with those predicted from southern yellow pine volume tables

Pole No.	Top Dia.	Butt Dia.	Vol./cu. ft. nearest ½"	Vol.	Class by Red Pine Table	Vol. by ACW hand-book	Vol. by Spec. W-12.55
P-1	6.44	10.42	.401	12.02	6	10	11.6
P-2	5.72	9.38	.337	10.10	6	10	11.6
P-3	6.12	9.60	.333	10.00	5	12	13.8
P-9	6.44	10.00	.337	10.10	5	12	13.8
P-10	6.20	9.85	.356	11.40	5	12	13.8
P-11	6.35	9.7	.353	11.20	6	10	11.6

See Reference List.

Shaving and Drying

When poles are received at the treating plant they are either peeled, may contain some bark as in rough peeling, or may be unbarked. Some wood preserving firms operate concentration yards near the logging operation where poles may be shaved. A few poles are still hand peeled because of this requirement by some utilities or because the poles may be too large to be handled by the shaver.

If the bark is still present, it must, of course, be removed before loss of appreciable moisture can take place from wood, a condition frequently required for impregnation of the wood with preservative. The poles are removed from the car or truck with a crane, fork lift, or special pole carrying machinery and placed on skids elevated about 2-3 feet from the ground. From this temporary storage area the poles are fed into a shaver, which can be set to remove only bark or varying amounts of wood. Many makes of machines are available.

The cost of hand peeling is higher than machine shaving where enough poles are being processed to utilize the machine amply. For a large operation (treating 50,000 poles a year) a new pole shaver might cost $35,000. Prices for hand peeling quoted by various Michigan loggers ranged from $2.50 to $3.50 for a 35 foot pole and from $2.75 to $4.00 for a 40 foot pole. Another figure was $2.64 for a 6-30 pole.

These figures are not costs, but prices quoted or charged, presumably allowing for contingencies and some profit. Information received from treating plants outside Michigan shows that cost per linear foot for peeling and shaving poles is as low as 3 cents per foot or 90 cents for a 30 foot pole. Some feel that their cost is even less if highly automated. It is not known how much of this cost is amortization of the investment in machinery.

After the poles are peeled, they are taken to the air seasoning yard, force dried, or treated green.

In Michigan, air drying is the most logical and probably the most economical method to use, if the cost of the pole, interest and the cost of artificial drying are considered. In urban areas of high land cost or where labor is expensive this might not be the case. Although drying time would vary some from year to year, four months of good drying weather are sufficient to season red pine poles. Three might be sufficient some years.

The smaller sizes should need three or fewer months. The four months should include May, June, July, August or September. Poles peeled and stacked in March, for example, would not lose much moisture during that month nor in April. In such a case three of the "good drying" months are needed plus the other months, here March and April, May, June and July. There is no definite moisture content at which it can be said that red pine is most readily treated; however until experimentation can give a better answer it would seem that 20 to 25 percent or less is about right.

Other methods of moisture removal might include vapor drying, kiln drying, and various modifications. There are several reports in the literature that describe these methods (10, 18, 19, 23). They are used largely in the southern United States because air seasoning is hazardous in so many of the plant locations. The poles become infected with decay fungi before they dry sufficiently. These methods are also useful because the weight can be reduced enough to make transportation of the untreated poles over long distances economical.

Kiln drying also aids faster filling of orders and, in effect, increases treating cylinder capacity. The majority of the southern pine poles are treated with little or no drying, largely because of the decay hazard accompanying the air drying, although kiln drying is now increasing. Such poles are given a pre-steaming period using temperatures up to 245° F. for a maximum of 17 hours for the higher class numbers and 20 hours for the lower class numbers.

It has been reported by an experienced treater, though, that red pine in green condition does not take treatment well enough to meet the pentration requirement of the Standards of the American Wood Preserver's Association, even though given the allowable preliminary steaming. A possible explanation is this: red pine has a thick sapwood—as much as 4.25 inches on a pole butt of 5.4 inches radius—and AWPA Standards require 3.61 inches minimum penetration in such a pole. On the other hand, only three hours of steaming at 240° F. is allowed for red pine. This is insufficient time to raise the temperature at a depth of three to four inches, that the preservative must reach, enough to reduce the viscosity to a value that will result in the required penetration.

It should be noted that poles may change in class number if dried below the fiber saturation point. A study (20) on Douglas fir and western hemlock showed 9 to 10 percent will drop one class number if dried a year, but this does not seem to be the case with southern pine, and presumably with red pine.

Preservative Treatment

The accepted method for application of preservative to the pines, be it southern, red, lodgepole or jack, is by forcing the liquid into the wood under pressure of a maximum of 200 p.s.i. (for southern pine). Western red cedar and northern white cedar are usually treated by the thermal process.

Some experiments have also been conducted on red pine. Poles treated by the thermal process are generally incised at the ground line area, and are covered full length in a tank of heated preservative. After a period of time, deemed ample to drive much of the air from the sapwood, the hot preservative is drained and cold preservative pumped in to replace it. The cooling of the wood causes contraction of air remaining in the wood with consequent entry of preservative into the sapwood.

After the appropriate treating schedule (see page 107 for examples) has been used the poles are withdrawn from the treating tank or cylinder. A tractor can be adapted for this work to avoid purchase of a special locomotive for pulling and charging the cylinder. Only about 30 minutes per day would be required to pull and charge the cylinder.

Most generally the treated poles require inspection. For AWPA specifications (7) a sample of 20 borings from 20 poles of a charge is taken for red or jack pine. These can be taken while the poles are still on the trams. If approved, they are usually loaded directly on cars or a truck for shipment. If not, they are retreated. Some specifications may require every pole to be tested. In such an event the trams must be unloaded before the borings can be taken. They are then spread on skids until approved or disapproved.

Power companies, R.E.A.'s and telephone firms generally specify that their poles be treated according to AWPA Standards (7) for wood preservatives and for the treating process. Some large power companies may have their own specifications. Pole barn contractors and distributors of poles for building may use AWPA Specifications, although some only specify the retention. The Bell Telephone System specifies 2 percent pentachlorophenol in creosote for preservative and has its own specifications for the treatment of the poles.

Limitations and requirements worthy of special note in the AWPA specification for treatment of red and jack pines are that the sampling zone for preservative retention determination is from 0.1 to 1.6 inches from the surface. The minimum penetration in the sapwood must be 2.5 inches or 85 percent for 6 and 8 pound per cubic foot retention and 3.0 inches or 90 percent for 10 pound retention of creosote. Some specifications require 100 percent penetration of the sapwood. This is difficult to meet and requires retreating of some charges. The trend seems to be toward more rigid specifications.

Inspection of the treated wood is generally done by employees of a large purchaser such a large electric utility or by an inspection firm hired by smaller purchasers. Many smaller purchasers, and especially buyers of building poles, require no inspection of the treated wood, but rely upon the reputation and integrity of the treater.

The Rural Electrification Administration has its own procedure. Since it controls the purchase of a substantial number of poles in Michigan each year, we set forth some of its requirements:

1. A treater or other producer of poles, stubs and anchor logs who wishes to sell to REA borrowers must apply to the Washington headquarters and be placed on the accepted list.
2. The treater or producer of the treated poles, etc., is responsible for furnishing material that conforms to the specifications. This responsibility remains even though a certificate of inspection may have been issued by an engineer or inspection agency.

Preservatives

There are three preservatives commonly used in the treatment of pine poles. These are (1) 5 percent pentachlorophenol dissolved in an aromatic gas oil, (2) coal tar creosote and (3) coal tar creosote containing 2 percent by weight of pentachlorophenol.

In order to obtain the business of any pole buyer in the Michigan-and-neighboring-states-area a treater might have to store all three preservatives. Extra storage and inventory would increase expenses. The alternatives are to select the preservative specified for the greatest number of poles and treat with it only or to try to convert users of one preservative to another to reduce the number of preservatives needed.

It might appear that all a treating plant needs to do is to have three storage tanks, each containing a different preservative. However, when certain oils and creosote mix, a precipatate forms that leaves an undesirable deposit on the treated wood. Accordingly, rather extensive precautions and extra piping, valves and pumps may be needed to reduce preservative mixing. A cylinder used for pentachlorophenol would have to be cleaned before switching to creosote if clean poles are to be produced.

Creosote is produced and sold by some of the steel manufacturers and by chemical companies. Large quantities are also imported from Europe, but largely to terminals on the sea coast. Specifications may be written by large users, by ASTM or AWPA. It is usually shipped in tank cars from point of origin to the treating plant. The price is relatively stable.

Producers can furnish analyses to show conformance with required specifications. However, after it has been used, the properties change and the treating plant may be required to show that the creosote still conforms to the specifications. Most treating plants maintain a small laboratory for such tests. In fact, many purchase specifications require that a treater provide laboratory facilities for the purchaser's inspection.

Pentachlorophenol is produced by several chemical manufacturers, including one in Michigan, The Dow Chemical Company, Midland. It is a flake solid that requires aromatic oil or oxygenated solvents for solution. The usual concentration used in pressure treatment of wood is 5 percent by weight. Although such solutions can be purchased from chemical firms, most treaters prepare their own. The firms which sell pentachlorophenol can provide a treater with a list of oils suitable as solvents. These oils must conform to standards of the AWPA.

In addition to the kind of preservative, the amount must be considered. Purchasers may specify 6, 8, 10 or more pounds of liquid per cubic foot or, in the case of pentachlorophenol, the actual amount upon analysis. Pole buyers are becoming more critical of the product and require more extensive inspection than formerly. It is desirable to have a technically trained person in charge of treating operations. Laboratory facilities are essential for inspection of treated wood.

Economic Study of a Pole Treating Operation

There are several facets to be considered in establishment of a successful pole treating operation. The supply and location of red pine and jack pine poles in Michigan has already been considered and appear to be adequate. Markets exist in Michigan and surrounding states to keep a medium sized treating plant busy. The next question to be answered is whether or not the treating plant can compete and return a good profit.

In the paragraphs that follow an attempt will be made to answer this question. All estimates are based on an output of 25,000 class 5-35 foot red pine poles.

Attempting to use logic, we might say we know red pine stumpage is the same or less in cost than southern pine. Most other treating and pole production costs for hypothetical locations in Michigan are the same as in the South. Therefore, a Michigan treating plant should certainly be able to compete for markets where the freight cost is less than from the South. This logic appears to be sound. However, most prospective treating plant operators want more facts and figures to base decisions on.

Cost of Untreated Poles

In a study of this kind many compromises and approximations must be used since there is a large variety of pole sizes and classes that would be treated and sold, and the origin and delivery is quite variable. As can be seen from an earlier discussion, the stumpage costs for red pine for poles are not well established, nor are the costs of other steps in conversion and transportation of the tree from forest to yard or plant. Estimates of the unpeeled delivered-to-plant cost of a 5-35 pole resulted in a figure of $6.50, constituted as follows: stumpage $2.50; felling, trimming and bucking $1.50; skidding and loading $1.00; and hauling to plant or drying yard $1.50 (estimated for 50 miles).

In the final calculations for pole cost a figure slightly higher than $6.50 is shown. This is a result of allowance for rejects and breakage.

Cost of Drying Poles Prior to Treatment

There are two main procedures that could be used for drying red pine or jack pine poles: (1) kiln drying and (2) air drying. A third method, vapor drying, is also being used in some parts of the United States, but was not included in the cost analyses.

Kiln drying requires an investment of $54,900 over an air drying yard. This additional capital requirement might be a deterrent. On the other hand, flexibility of operations and improved efficiency and delivery are considered benefits of kiln drying.

The cost of peeling, kiln drying and framing a 5-35 red pine pole is estimated to be $2.66. This includes fuel, electricity, direct labor and capital investments. The cost was arrived at as follows:

Land and site preparation, as below:		$22,000
Land, clearing and grading	$5,580	
Roadways	4,200	
Fences	8,360	
Pole storage racks	1,460	
Service building (for peeler)	2,000	
Drainage line	400	
Dry Kiln (direct fired) capacity 30,000 poles per year, building, fuel storage tank, and freight		61,500
Lift truck for poles and lumber (10,000 lb.)		22,450
Pole shaver		10,040
Blower and incinerator		12,500
Framing mill		4,950
Sorting conveyor		7,000
Installation		1,800
Freight on equipment		8,760
TOTAL		$151,000
Construction overhead (10%)		15,100
Contingencies (10%)		15,100
Kiln Investment, Grand Total		$181,200

Dry kiln labor	Hourly Wage	
1—Loader-operator	$1.80	
1—Loader-helper	1.50	
1—Pole shaver operator	1.80	
2—Laborers—shaver and framing	3.00	
1—Maintenance man	1.80	
1—Foreman-kiln operator	2.10	
Total	$12.00	
Yearly Labor		$24,000

Dry Kiln Manufacturing Overhead, Yearly Basis

Social Security	$ 870	
State and Federal Unemployment Tax	460	
Workmen's Compensation	870	
Repairs	600	
Supplies	600	
Insurance	4,470	
Property taxes	1,810	
Depreciation on kiln and equipment	10,310	
Electric power	2,120	
Fuel oil	11,040	
Interest at 6% on ($135,000)	8,100	
Miscellaneous	1,200	
Total		$42,450

Cost of Kiln Drying 25,000 Poles:

		Per pole kiln drying and shaving cost
Direct Labor	$24,000	
Overhead	42,450	
Total	$66,450	$\frac{66,450}{25,000} = \$2.66$

Compared to this figure the estimated cost of shaving, stacking, air drying and unstacking would be $1.96 per 5-35 pole.

Cost of Preservative Treatment

The total capital required for the treating plant is nearly $270,000, a good deal higher than for the other operating sections of pole production and processing. Details of how this figure was arrived at are as follows:

Site Preparation for Wood Preserving Plant

Land (20 acres), clearing and grading	$ 9,700	
Roadways	4,200	
Fences	9,200	
Storage racks	980	
Railroad tracks	6,270	
Fire protection system and sewer	40,400	
Buildings	23,000	
Effluent system	6,000	
Water, electric, telephone facilities	3,250	
Total	$103,000	$103,000

Treating Plant Equipment

Cylinder, 6 x 85, with quick opening door	$ 19,200	
Storage tanks, 2—50,000 gal.	12,600	
Working tanks, 2—24,000 gal.	6,700	
Fuel oil tank, 1—19,000 gal.	1,260	
Trams, 18 bolster and 14 regular	8,440	
Processing equipment	37,000	
Boiler	20,000	
Foundations	10,000	
Electrical and mechanical supplies	7,500	
Total	$122,700	$122,700

Freight and Installation is included in above.

Total Capital Investment, Treating plant

Site preparation	$103,000
Equipment	122,700
Construction overhead, 10%	22,000
Contingencies, 10%	22,000
Total	$269,700

Treating Plant Operating Costs

Direct Labor:	Hourly Wage	
1—Laborer	$1.50	
1—Technician—superintendent	3.00	
1—Mechanic—maintenance man	1.80	
Total	$6.30	
Yearly Cost		$12,600

Treating Plant Overhead

Manager's salary	$12,000
Social Security	750
State and Federal Unemployment Tax	200
Workmen's Compensation Insurance	900
Repairs and Supplies	1,200
Insurance	7,960
Property Taxes	3,240
Depreciation	5,670
Electricity	920
Fuel	2,700
Interest, 6% on $250,000	15,000
Miscellaneous	1,260
TOTAL	$ 52,000

Cost of Treating 25,000 Poles

Wood Preservative	$ 85,000
Overhead	52,000
Direct Labor	12,600
TOTAL	$149,600

Cost per 5-35 pole = $5.99

In addition to stumpage, logging, drying and treating costs there are several other items that need to be considered in assessing the feasibility of establishing a treating operation. The selling and administrative expenses are, therefore, taken up next.

Selling Expenses

2—Salesmen and expenses	$ 30,000	
Bad debts	1,300	
Advertising	1,200	
Adjustments on claims	1,300	
TOTAL	$ 33,800	$ 33,800

Administrative Expense

Clerical and stenographic	$ 6,000	
Office supplies	2,400	
Telephone	1,800	
Accounting fees	3,000	
Consulting fees and retainers-legal, tech.	3,000	
Miscellaneous	1,600	
TOTAL	$ 17,800	$ 17,800
Yearly Total, Selling and Administrative		$ 51,600
Selling and administrative cost per pole	= $2.06	

If the various costs are summarized in an income statement the following results for the hypothetical 25,000 poles per year.

INCOME STATEMENT

	Kiln Drying	Air Drying
Total Annual Sales	$530,750	$530,750
Cost(a) of Materials and Processing	381,800	366,600
Gross Income	$148,950	$164,150
Selling and Administrative Expense	$ 51,600	51,600
Michigan Business Activities Tax	1,260	1,420
Michigan Corp. Franchise Tax	2,250	1,610
Net Income before Federal Income Tax	$ 93,840	$109,520
Allowance for Federal Income Tax	45,000	52,500
Net After Taxes	$ 48,840	$ 57,020
Reinvestment—retirement of loans	25,000	25,000
Net Income	$ 23,840	$ 32,020

(a) Includes poles, preservative, direct labor, interest on capital investment, utilities, plant overhead, operating overhead, depreciation.

CAPITAL INVESTMENT

	Kiln Dried	Air Dried
Drying yard or kiln and handling machinery	$181,200	$ 52,900
Preservation Plant	269,700	269,700
TOTAL	$450,900	$322,600

COSTS PER 5-35 POLE

Pole, felling, trimming, hauling to plant	$6.58	$6.74
Drying, shaving, framing	2.66	1.96
Treating with preservative, loading	5.99	5.99
Selling and administrative expense	2.06	2.06
State Business Taxes	.14	.12
TOTAL	$17.43	$16.87

The higher cost of $6.74 for the pole is a result of adding the interest charge of the pole inventory for the period they are air drying. Competition determines the selling price. It varies a good bit depending upon freight cost to destination. Based on known prices and freight rates a selling price of $21.23 f.o.b. treating plant seemed like a reasonable figure on which to calculate profits.

The following profit picture emerges then:

PERCENT RETURN

	Kiln Dried	Air Dried
Before Federal Tax, based on sales	17.7	20.6
Before Federal Tax, based on capital invest.	20.8	33.9
After Federal Tax, based on sales	9.1	10.8
After Federal Tax, based on capital invest.	10.8	17.7
After allowance for reinvestment, based on sales	4.4	6.0
After allowance for reinvestment based on capital investment	5.3	9.9

A figure obtained for treating southern yellow pine in a southern plant is $10.41 for a 5-35 size. This includes shaving, drying, treating, preservative and loading for shipment. It is not known if this figure includes selling and administrative expense. If it does, the costs in this plant treating southern pine and the hypothetical plant treating red pine are comparable.

A perusal of the preceeding figures indicates that red pine, and no doubt jack pine, can be produced and treated in Michigan at a profit and reasonable return on investment. The break-even point for a plant equipped with kilns is about 12,500 poles per year, while for a plant using air drying it is about 10,500. Figures 7 and 8 show these points. They also show how net income rises with increased production.

There is a definite limit to which these lines can be projected because the capacity of treating cylinder, lift trucks, shaver, kiln or drying yard cannot be exceeded. The maximum number of poles that could be handled in a 6 by 85 foot cylinder is somewhere between 35,000 and 40,000. The other equipment such as lift truck and shaver could handle more and so could the kiln, especially if some pre-air drying to reduce moisture content were practiced. An increase in cylinder size would also necessitate larger storage tanks and boiler, but likely the additional income per dollar investment for these increases would be well worthwhile. This is something to consider in the establishment of a treating plant. In drawing the lines on Figs. 7 and 8 only two points were used to define each line, which could lead to slight error.

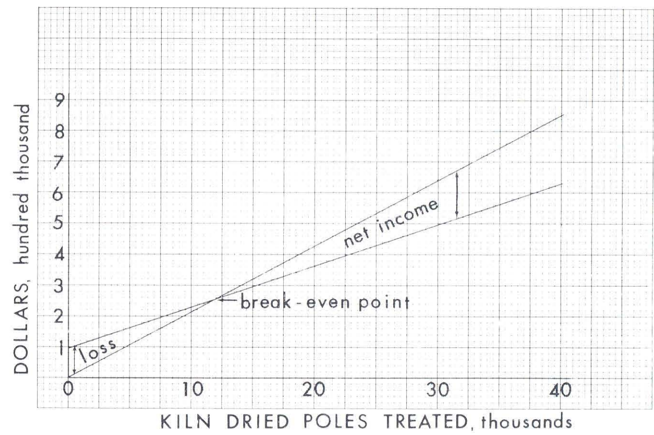

Fig. 7. Relation between loss or net income before Federal income taxes and number of poles treated kiln dried.

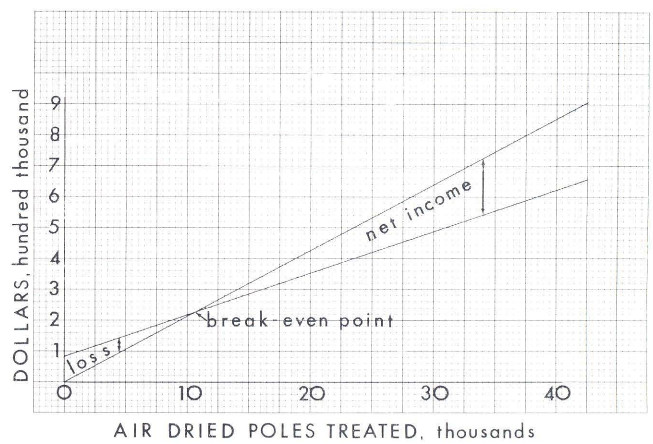

Fig. 8. Relation between loss or net income before Federal income taxes and number of poles treated airdried.

Selection of Treating Equipment

Cost of the treating cylinder is dependent upon thickness of steel, kind of alloy, and type of door closing device. There have been reports of severe corrosion of cylinders and other steel parts by creosote-pentachlorophenol solutions, especially when moisture is present. More resistant steels, even though more costly, might be better suited for such use. Treating

If red pine suffers a strength disadvantage compared to southern yellow pine, resulting in greater preservative cost, it has an advantage in lower shipping weight. Reference (1) shows the weight of a 5-35 southern pine pole containing eight pounds of creosote per cubic foot as 862 pounds. A red pine pole of the same class and size also treated with eight pounds per cubic foot of preservative would weight about 534 pounds, based on a specific gravity of 0.38. There would thus be 328 pounds less to ship for a 5-35 pole.

Table 35 shows differences in weights for a selected number of classes and lengths. It is not known what amount of moisture the southern pine poles contained. The red pine weights are for poles of about 15 to 20 percent moisture content whereas the southern pine weights are likely to apply to poles that were steamed and treated green.

TABLE 35—Weights of red pine and southern yellow pine poles treated with eight pounds of preservative per cubi cfoot, based on reference (1)

Class & Length	Weight in Pounds		
	Southern Yellow Pine	Red Pine	Difference
9-25	289	171	118
7-25	344	209	135
7-30	454	276	178
6-35	742	447	295
5-40	1,059	624	435
4-45	1,444	872	572

TABLE 36—Comparison between treated weights of air dry southern pine poles and air dry red pine poles containing eight pounds of preservative per cubic foot

Class & Length	Weight in Pounds		
	Southern Yellow Pine	Red Pine	Difference
9-25	234	171	63
7-25	278	209	69
7-30	367	276	91
6-35	600	447	153
5-40	856	624	232
4-45	1,167	872	295

PART III
TECHNICAL INFORMATION

Test and Service Records

Anatomically there is so little difference between jack pine, red pine and other hard pines that it is logical to assume they should perform about the same in a field exposure if treated with preservatives. Nevertheless, the available post test and service records have been collected and are shown in Tables 37 and 38.

Most of these tests on posts are for jack pine. Untreated, this species has a life of about 6.2 years in Minnesota and Wisconsin. There are no round, untreated red pine posts shown. This life should be about the same as for jack pine. Jack pine treated by soaking for 18 to 40 hours in a 5 percent solution of pentachlorophenol in an aromatic oil-kerosene mixture shows an estimated life of at least 28 years. This might be termed a minimum treatment, as pressure treated wood would be expected to last even longer.

TABLE 37—Service records of poles

Species	Preservative	Treatment	Absorption of Preservative PCF	Location	Years of Service at Last Inspec.	No. in Test	Poles Removed D or T %	Ave. Life, Yrs.
Jack Pine[a]	50% Creosote, 50% Petroleum	Pressure	6	Minnesota	8	47	0	
Jack Pine[a]	50% Creosote, 50% Petroleum	Pressure	6	Wisconsin	8	47		
Jack Pine	Creosote	Pressure	6	Sask. & Alberta	24	240	7.5	
Jack Pine	70% Creosote, 30% Coal Tar	Pressure	6	Quebec	17	64	0	
Jack Pine	70% Creosote, 30% Coal Tar	Pressure	6	Ontario	21	1,045	0	
Red Pine[a]	50% Creosote, 50% Petroleum	Pressure	6	Minn. & Wisc.	8	6	0	
Red Pine[b]	Creosote	Pressure	8	Ontario	34	200	15 (not known what proportion due to decay)	
Red Pine	Creosote	Pressure (Steamed)	5.37	Gulfport, Miss.		12	91.7	15.9
Red Pine	Creosote	Pressure	5.65	Gulfport, Miss.		6	100	14.9

(a) Data from Kulp, John W., (1962) Service Life of Poles in REA Financed Electric Systems. USDA, Forest Service, Forest Products Lab. Report 2240.

(b) Data from the Hydro-Electric Power Commission of Ontario.

Source: Various Proceedings of the American Wood Preservers' Association unless otherwise shown.

TABLE 38—Service records of posts

Preservative	Treatment	Ave. Absorption of Preservative PCF	Form	Location of test	Years of Service at Last Inspec.	No. in Test	Posts Removed, D or T %	Ave. Life, Yrs.
		Jack Pine						
Penta. 5% in A.O. & K.	Cold Soaking B-18, T-6	2.52	Round	Cloquet, Minn.	18	29	0	–
Penta. 5% in A.O. & K.	Cold Soaking B-18, T-6	2.42	Round	St. Paul, Minn.	18	19	5	–
Penta. 5% in A.O. & K.	Cold Soaking B-18, T-6	1.74	Round	Waseca, Minn.	18	19	11	28
Penta. 5% in A.O. & K.	Cold Soaking B-40, T-8	2.28	Round	Cloquet, Minn.	18	29	0	–
Penta. 5% in A.O. & K.	Cold Soaking B-40, T-8	2.93	Round	St. Paul, Minn.	18	17	0	–
Penta. 5% in A.O. & K.	Cold Soaking B-40, T-8	2.82	Round	Waseca, Minn.	18	19	0	–
Untreated	None	——	Round	Cloquet, Minn.		29	100	6.1
Untreated	None	——	Round	St. Paul, Minn.		20	100	5.0
Untreated	None	——	Round	Waseca, Minn.		20	100	8.8
Chromated zinc chloride	End diffusion	.76	Round	Madison, Wisc.	13	10	20	17
Chromated zinc chloride	End diffusion	.75	Round	Madison, Wisc.	12	25		
Copper naphthenate, 2% Copper, in Mineral Spirits and Water Repellent	Brush	.48	Round	Madison, Wisc.	12	25	72	11
Copper naphthenate, 2% Copper, in Mineral Spirits and Water Repellent	Seasoned 4 months, and cold soaked 48 hours	2.8	Round	Madison, Wisc.	12	25		
Copper naphthenate, 2% Copper, in Mineral Spirits and Water Repellent	Seasoned 12 months, and cold soaked 48 hours	2.5	Round	Madison, Wisc.	12	25		
Copper Sulfate	End diffusion	.75	Round	Madison, Wisc.	12	25	40	14
Creosote, Coal-Tar	Brush	.58	Round	Madison, Wisc.	12	25	76	11
Creosote, Coal-Tar 50%—No. 2 Fuel Oil, 50%	Seasoned 7 months and cold soaked 48 hours	3.8	Round	Madison, Wisc.	12	25		
Creosote, Coal-Tar, 50%—No. 2 Fuel Oil, 50%	Seasoned 12 months, and cold soaked 48 hours	4.0	Round	Madison, Wisc.	12	25		
Creosote, lignite	Pressure	6.7	Round	Madison, Wisc.	21	83	3.6	
Nickel sulfate-sodium chromate	Double diffusion (butts)	2.21	Round	Madison, Wisc.	13	10		
Nickel sulfate-sodium chromate	Double diffusion (butts)	1.2	Round	Madison, Wisc.	13	9		
Nickel sulfate-sodium chromate	Double diffusion (butts)	1.3	Round	Madison, Wisc.	13	9		
Nickel sulfate and sodium dichromate	Butt steeping	.95	Round	Madison, Wisc.	13	10	10.0	20

There are no equivalent test data for red pine posts. However, all of 526 of this species pressure treated with creosote to a retention of six pounds per cubic foot are still unattacked after 15 years in Connecticut. Decay hazard in this state would be about the same as in Michigan.

The best service records for jack pine poles are from Canada. Although a test line in Alberta and Saskatchewan shows 7.5 percent removals after 24 years, a more impressive record is presented by 1,045 poles in Ontario all of which are sound after 21 years of service. This is especially remarkable since the specified absorption was only six pounds of a 70-30 creosote-coal tar mixture per cubic foot.

The most noteworthy record for treated red pine poles is that of the group of 200 poles in Ontario, pressure treated with eight pounds of creosote per cubic foot. Only 15 percent have been removed although the rest have been in service for 34 years at the last inspection. All of the longer service records for jack pine and red pine are for creosote or creosote-coal tar mixtures as the preservative.

Notwithstanding these records, a large portion of the poles of these species today are treated with a 5 percent solution of pentachlorophenol in an aromatic oil. Since this preservative only began to see large use in the 1950's there are but few published records of the service life of such poles. There are many thousand southern pine poles treated with pentachlorophenol, however, going back as far as 1941 which are giving excellent service. The Hydro-Electric Power Commission of Ontario has more than one million jack pine and red pine poles in their lines. Prior to 1953 these were treated with creosote and since with pentachlorophenol.

The Rural Electrification Administration has made studies of pole condition and pole replacements in their lines throughout the United States. The greatest installation of these poles has been made since World War II. Some of the observations made indicate that the country can be divided into six areas of different decay hazards.

Michigan and the portions of neighboring states most likely to be market areas for Michigan poles, are in Zone 3 by this classification—about in the middle of the decay hazard tabulation. They also observed that coal tar creosote and 5 percent pentachlorophenol in oil are about equal in effectiveness based on observations of 11 year duration.

In this study by far the greatest number examined were southern pine, 2,167,443. As of December 31, 1955, 1.3 percent had been replaced or stubbed. Jack pine and red pine are combined and reported as *northern pine* with only 5,278 poles and only 0.04 percent replaced. In the same study western red cedar poles have been replaced or stubbed in amount of 0.49 percent and northern white cedar 2.02 percent.

These figures are not closely comparable because the average age of the groups of species is not shown. It may be an indication, however, that jack and red pine are species of long service life.

The creosoted red pine installed in Gulfport, Mississippi, do not show as long a service life as might be expected of poles. However, the retention of 5.37 to 5.65 pounds of preservative per cubic foot of wood is much less than the 8 or 10 pounds usually specified in southern United States.

In summary, it can be said of service life, that jack pine or red pine poles treated adequately with creosote or pentachlorophenol can be expected to be the equivalent of southern pine or the cedars.

Strength of Plantation Grown vs. Second Growth Red Pine Poles

One of the growth characteristics of trees that could influence strength of poles is both the size and numbers of knots. It is quite possible that trees arising from natural regeneration could have a different knot distribution than those growing in plantations. Certainly the number, size and distribution of knots is related to the spacing of trees in either type of tree-growth situation. General observations of the two kinds of trees indicate that there are more branches per whorl in planations than in natural stands. There is also the likelihood that average branch diameter is larger[24] because initial stocking is usually smaller in plantations than in natural stands.

Other variables are the number, size and location of overgrown knots in the two kinds of poles. Unless a pole were shaved so that a large amount of wood were removed, such knots are not visible on the pole surface. The two types of stands may have been stocked so that one produced more branches than the other, eventually leading to overgrown knots. This might lead to strength differences. Possibly, the plantation grown poles could have more overgrown knots.

Because of these uncertainties surrounding knot patterns and size in poles from plantations, certain pole users are reluctant to accept them on the same basis as poles from natural stands. The usual basis for purchase of poles (in the unpreserved condition) is the standard published by the American Standards Association (2). In Canada the publication of the Canadian Standards Association is used (3).

Previous Strength Tests of Poles

In the most extensive test program of full length poles reported to date (27) no definite conclusions were reached on the effects of knots on strength. Although several species of pine were included, red pine was not tested. Several poles with large knots were tested in that study, but the exact influence on strength was not clearly determined. For example, where knot sizes were above the maximum permitted by ASA 05.1—1963 poles failed at only 71 percent of the average modulus of rupture (or ultimate bending strength) value for the species-specific gravity group as might be expected. In contrast, some poles having maximum knots (as permitted by ASA 05.1—1963) in the top portion failed in clear wood or at smaller knots near the ground line.

This report (27) suggested that the size of the largest knot in ratio to half the circumference of the pole at that point or the cumulative size of knots in a whorl in relation to the full circumferences should be considered in selection of poles. Thus, a four inch sum of knot diameters in a pole of 24 inches circumference would reduce the pole strength over a clear one by 4/24 or 16.7 percent. If this hypothesis were valid, the largest knot or the maximum knot diameter total in a whorl would be more important in predicting pole strengths than total numbers or total diameters of all knots in the whole pole or in one foot sections.

All previously reported strength tests of full size red pine poles have been conducted in Canada by governmental agencies. Several tests have also been run on jack pine. These results are summarized in Table 39. The average values of modulus of rupture given for various groupings of red pine poles range from 5,696 to 7,040 p.s.i. Since the moisture content for one group was below the fiber saturation point and above for the other three, a direct comparison of average strength values would not be meaningful. The variation of specific gravity would also make comparisons questionable.

All of these groups consisted of poles from natural stands so there was no opportunity to compare plantation and natural grown poles.

Since no red pine was included in the ASTM pole test (27) no change was made in the stress rating for red pine poles in the 1963 ASA Standards (2). Red pine was retained in the 6,600 p.s.i. group, possibly because of values found in the Canadian tests.

TABLE 39—Strength of poles, seasoned, treated, butt soaked and tested by cantilever or machine method

Species	Class & Length	Sp. Gr. Heartwood	R.P.I.	Age of Trees, Yrs.	Sapwood Depth, In.	Sapwood % of Cross-Section	Moisture Content (%) at Test: Butt	Sap Wood	Heart Wood	Ultimate Load, Lb.	Modulus of Rupture (PSI) At Ground Line	At Break	Test Method
TREATED POLES													
Red Pine (15)[a]	6-30	0.363	14	67	2.58	81	39.4	40.9	32.4	1,593	5,749	5,695	C
Jack Pine (14) (Armstrong, Ont.)	3-25	0.374	10	57	1.63	53.7	23.5	15.2	28.7	2,473	5,241	5,066	C
Jack Pine (14) (Lake Traverse, Ont.)	3-25	0.400	12	63	1.41	48.1	22.2	14.4	27.6	2,675	5,840	5,688	C
Jack Pine (14) (Foleyet, Ont.)	3-25	0.396	13	75	1.56	51.9	33.8	35.5	32.2	2,880	6,183	6,045	C
Red Pine (16) (Newcastle, N.B.)	3-25	0.356	12	58	2.7	82		P.F. 20	P.F. 38	T.R. 2,216		6,810	M
UNTREATED POLES		Sap and Heartwood											
Jack Pine (14) Machine Shaved (Foleyet, Ont.)	3-25	0.420	14	77	1.46	49.7	50.4	72.4	28.3	2,698	6,070	5,944	C
Jack Pine (14) Hand Peeled (Foleyet, Ont.)	3-25	0.420	13	71	1.37	47.0	59.9	91.4	28.8	2,744	6,096	5,938	C
Jack Pine (16) (Newcastle, N.B.)	2-25	0.392	14	72	1.6	50	P.F. 49	Top 21	P.F.H. 30	Top Reaction 3,124		7,490	M
Jack Pine (16) (Timmins, Ont.)	3-25	0.435	20	102	1.5	48	46	21	43	2,919		8,170	M
Red Pine (16) (Fr. Coulonge D.Q.)	3-25	0.356	9	47	3.5	91	99	40	34	2,279		6,770	M
Red Pine (16) (Newcastle, N.B.)	2-25	0.393	17	84	2.7	77	76	38	30	2,616		7,040	M

Abbreviations: C—Cantilever
M—Machine

P.F.—Point of Fracture
P.F.H.—Point of Fracture, Heartwood
T.R.—Top Reaction

(a) Source of information, see reference list at end of Part III.

Material of Test

A total of 64 poles were tested in this research program. Thirty-two were cut from a primarily red pine stand on lands owned by Consumers Power Company in Bloomfield Township, Missaukee County (near Walton Junction). This stand has good natural reproduction. The basal area of the stand was 90 square feet, there being 100 trees per acre at the time of cutting. Average age of the stand was 61 years.

The plantation grown group of poles were cut in Roscommon County about four miles south of Houghton Lake Village on State of Michigan lands. The basal area of this stand was 170 square feet—almost double that of the natural growth stand. There were 700 trees per acre which would mean about a nine foot spacing. The average age of the trees was 52 years, and the average height 56 feet.

Testing Procedure

Each of the 64 poles was tested in bending as a full scale cantilever beam in accordance with ASTM Standard D:1036-58. Prior to testing, the poles were cut to a 30 foot length. As received, the poles varied from 33 to 34 feet. One half of each group of poles was trimmed at the tip and the other half at the butt. Thus the class of pole as well as knot distributions were varied slightly. Details may be found in Wilkin's thesis (25).

Results of Tests and Measurements

The first visible sign of failure in the test poles was the appearance of localized compression failures across the fibers of the compression face at the knot whorls. This failure was generally followed by splintering of fibers on the tension face. Even though wrinkles on the compression face occurred early, at about one-third of maximum load, the appearance of tension failure occurred just before total failure of the pole. Of the 32 plantation poles tested, 13 failed at, or very near, knot whorls which included all nine of the brash failures. The second growth poles showed eight failures that appeared to be affected by knot whorls which included all four of the brash failures. Figures 9, 10, 11 and 12 show typical failures.

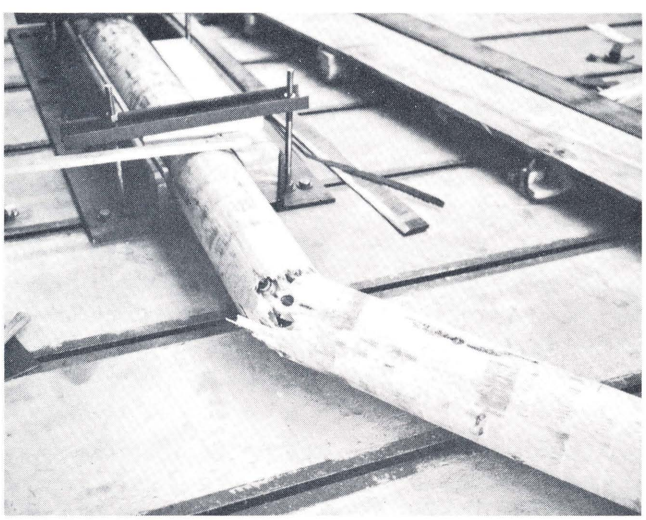

Fig. 9. Brash failure in red pine pole.

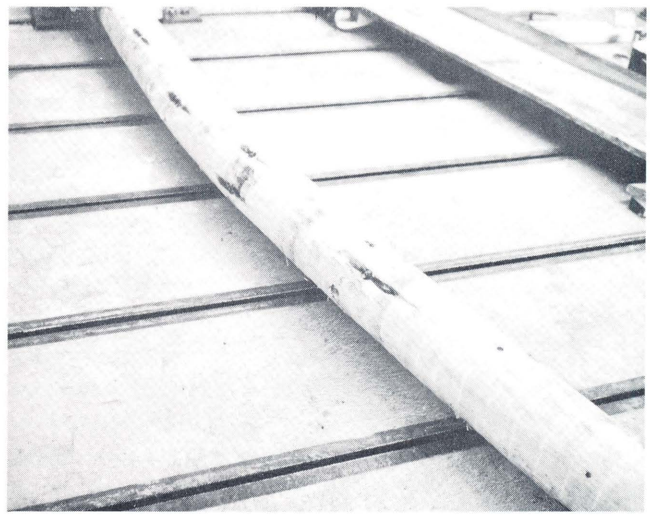

Fig. 10. Typical failure in red pine pole.

Fig. 11. Compression failure in pole P-9.

For all poles tested, failure occurred at knots in 30 percent of the cases. About 20 percent of all failures were brash in nature.

Most failures occurred in the middle half of the poles. The average sum of knot diameters larger than 0.5 inches, for this area, was 36.6 inches for plantation poles and 33.8 inches for second growth poles.

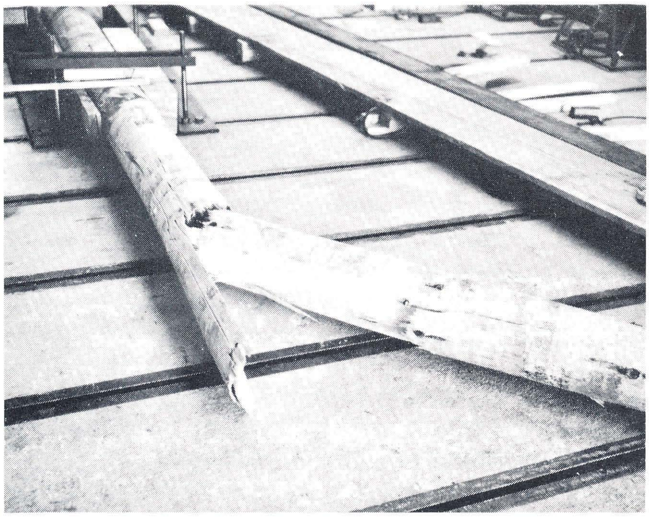

Fig. 12. Tension failure in pole P-10.

The average maximum fiber stress for plantation and second growth poles combined was 4860 p.s.i., which is 1740 p.s.i. below the fiber stress given by 05.1–1963 (2) for red pine poles. However, our poles were tested wet while the assigned stress values (5) are for dry poles. The average modulus of elasticity for plantation poles was found to be 842,000 p.s.i. and for second growth poles 873,000 p.s.i.

Discussion of Results

The average strength values of maximum fiber stress and modulus of elasticity for the plantation and second growth major tests showed no significant difference at the 95 percent confidence level as determined statistically by t and F tests. Analysis of the size and location of knots of these two groups showed no significant difference at the 0.05 level in either the sum of knot diameters in the entire pole or in the middle half.

If judged only on the basis of sum of knot diameters in each one foot section in various parts of poles there was no difference in plantation and second growth poles. Possibly the conclusion could then be drawn that there is consequently no difference to be expected in the bending strength of the two groups of poles. However, as yet there is no certain way to assess pole strength from knots.

If strength reduction by knots were investigated in accordance with the principle that cumulative knot diameters divided by circumference equals fractional strength reduction, the results would be questionable due to other important variables. It might seem that a pole would fail at the whorl where the largest sum of knot diameters were present or where the maximum size knot was present if knots are to be considered as the main source of weakening of a pole. However, in this research, only one pole, P-17 of both groups failed through the largest diameter knot zone.

The primary objective of this part of the study was to determine whether a difference in strength existed between plantation and second growth red pine. There was no significant difference between means of the maximum fiber stress at the ground line or failures of the two groups. Since all poles conformed to ASA Standards, perhaps this would be expected. However, the criteria of these standards were not originally based on test data, but on hypotheses. Some basis for selection has to be used in a test of this type or one group of poles might be biased in favor of the other.

Pole class as designated by the ASA standards can be misleading if the comparative strength of two individual poles is sought. For example, two poles might have identical circumferences six feet from the butt, but have top circumferences differing by four and one-half inches. One pole might be class 5, the other class 7 but the strength could be nearly the same. Pole P-24, for example, is 29.0 inches in circumference at ground line and 15.0 inches at top and P-26 measures 29.0-19.5. The former is a class 7, the latter a class 5 with modulus of rupture values of 4566 and 4796 respectively—a difference of only 230 pounds per square inch or about 5 percent.

Values for modulus of rupture are not as meaningful for poles or wood with defects as they are for clear specimens; accordingly, the formulae developed for calculation of this value are not as suitable in comparing pole strengths. Ultimate load could be a better parameter for group comparisons.

Hence, the regressions of ultimate breaking load for both plantation and second growth red pine poles on circumference at the ground line (5½ feet from the butt for a 30 foot pole) were calculated. Results are shown in equations (1) and (2) and graphically in Fig. 13.

$$Y = 141.7X - 2677 \quad (1)$$

$$Y_1 = 155.7X_1 - 3028.7 \quad (2)$$

where:

Y = ultimate load plantation pole, pounds per square inch.

Y_1 = ultimate load second growth pole, pounds per square inch.

X = circumference plantation pole, inches.

X_1 = circumference second growth pole, inches.

A relation between circumference and ultimate load has a real physical meaning. The stress distribution at a place where knots or defects exist, of course, is highly complex.

The correlation between load and ground line circumference was good for the plantation poles, 0.73. It was slightly better for the second growth poles, 0.88.

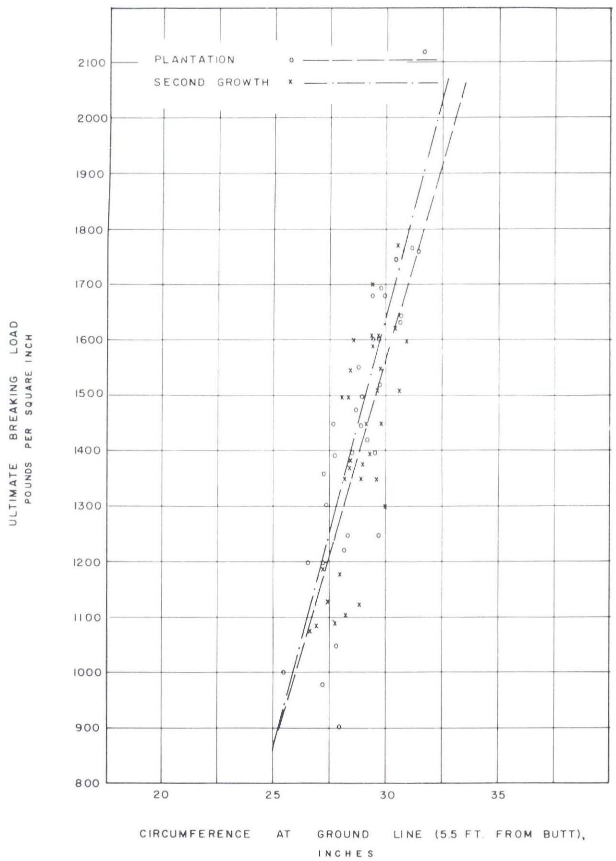

Fig. 13. Regression of ultimate load on circumference at groundline of red pine poles.

Considering the comparisons of knots, modulus of rupture, modulus of elasticity, and regressions of ultimate load on circumference at the ground line, we found no significant difference between the strength of plantation red pine poles and second growth poles of the same species (both groups selected to meet ASA Standards).

Lyman Wood, in the ASTM Wood Pole Research Program, stated, "It is difficult and probably impractical to make an adjustment of the strength values for moisture content in the air dry range (27)." The reasons for this were: first, as the poles dry, more strength reducing defects would occur and secondly, shrinkage during drying would reduce the bending strength because of a smaller radius. However L. J. Jacobi in referring to wet test poles reports that, "Poles used are drier and hence stronger than were the poles tested. Therefore, the stresses ultimately assigned may logically be higher than those shown for treated poles tested by the ASTM test (6)." The drying factor which Jacobi gives is 1.16 times the stress value of the poles tested above 30 percent moisture content.

The ASTM Wood Pole Report (27) refers to an REA report on the moisture content of 351 poles in use in Illinois, Indiana, Minnesota, eastern North Dakota and Wisconsin. This report shows that the moisture content six inches above the ground line was below 15 percent for about 85 percent of the poles tested. The Wood Handbook (6) states that the strength of clear red pine increases by 4 percent for every 1 percent drop in moisture content below the moisture-intersection point of 24 percent. All poles used in this study had a moisture content in excess of 30 percent during testing. As shown above, the moisture content of poles in use is generally below 20 percent. This would allow for the maximum fiber strength in bending to be increased by 24 percent - 15 percent x 4 = 36 percent. If the above adjustments were made, the values for fiber stress in this study would be as shown in Table 41. The fiber stresses for red pine as reported in other studies are listed in Table 42.

TABLE 40—Summary of results of comparative strength tests of full length red pine poles from plantation or natural stands

	Plantation		Second Growth	
	Ave.	S.D.	Ave.	S.D.
Maximum Fiber Stress at Ground Line	4800	501	4920	414
Maximum Fiber Stress at Break	4610	538	4780	475
Modulus of Elasticity (1000 psi)	842	98.5	873	120.5
Moisture Content %	127	—	118	—
Specific Gravity (Volume test weight Oven Dry)	.370	.018	.378	.020
Ultimate Load, pounds/square inches	1404	—	1440	—
Number of knots in entire pole	66.28	13.32	63.03	15.03
Number of knots in center half	36.56	8.44	33.84	7.93
Age	52	—	61.3	—

TABLE 41—Adjusted strengths of red pine poles in test

Method	Actual Fiber Stress	Adjustment Factor	Adjusted Strength
Jacobi	4,860	1.16	5,640
Wood Handbook (for clear wood)	4,860	1.36	6,610

TABLE 42—Maximum fiber stress for red pine as reported by other studies

Study Reporting	No. Tested	Fiber Stress (p.s.i.)
Ontario Hydro	125	5,749
Canada Forest Services No. 31 (as reported in 8)	About 64	7,830
Bell Telephone Systems Monograph (as reported in 8)	147	8,000
Weighted Average		7,060

In the past, most of the testing done has been on poles which have been butt soaked. This gave the butt section a moisture content of above 30 percent; however, the moisture content at the point of break was probably a much lower value as indicated by the REA study reported by the ASTM Wood Pole Research Program.

Conclusions

As a result of these full-scale pole tests the following can be concluded:

1. There was no significant difference in the bending strength of green red pine poles grown in plantations or in natural stands as second growth trees, if selected according to ASA 05.1-3-1963.

2. There was no significant difference in knot diameters in the two groups of poles selected under ASA 05.-1-3-1963.

3. Circumference at ground line was found to be a valid predicting parameter for pole strength.

GENERAL SUMMARY

Expansion of an existing treating plant or establishment of a new one to treat red and jack pine poles in Michigan and compete successfully with plants located in other states now enjoying the business, should be possible.

There is a plentiful supply of jack and red pine of sizes suitable for the most commonly used poles. The red pine supply is concentrated in the eastern part of the Upper Peninsula. There is another area of red pine supply between Mio and Grayling in the Lower Peninsula.

The largest potential market is with the stockholder owned utilities. In Michigan alone over 87,000 poles are purchased each year by all electric and telephone line owners. The next largest market is for pole building construction (about 30,000 poles a year), but this market is moving toward squared timbers. If line poles bought in neighboring states are included with Michigan the market potential is over 200,000.

An analysis of the business aspects of pole production and treating indicates that a good return on invested capital is possible. A plant capable of treating up to about 40,000 poles per year might require between $320,000 and $450,000. This does not include working capital.

Tests of strength of second growth and plantation grown red pine poles indicate that they are equal. In the future vast numbers of plantation grown trees will be available, thus there need be no fear of their inadequacy. Service tests and other strength tests indicate both red and jack pines make excellent poles.

Probably the greatest uncertainty is the effect of technology on the future need for poles, although electric utilities for the most part feel their need will grow.

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