THE MENOMINEE FOREST OF WISCONSIN: A CASE HISTORY IN AMERICAN FOREST MANAGEMENT

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THE MENOMINEE FOREST OF WISCONSIN:
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By

James G. Newman

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ABSTRACT

THE MENOMINEE FOREST OF WISCONSIN: A CASE HISTORY IN AMERICAN FOREST MANAGEMENT

by

James G. Newman

Because of its comparative youth, American forest management has had limited opportunities to judge the long-term effects of applied management practices.

This study concerns an analysis of a forest property which has been under management for a long period of time, with the aim of determining trends and results that have developed. On the basis of these trends and results, recommendations for future management are made.

The study involves the Menominee Forest, a 225,000-acre forest in northeastern Wisconsin, formerly the major portion of the Menominee Indian Reservation. Its status as a reservation brought the forest under management at its inception in 1854. This study considers the period from 1854 to 1964.

Information was derived from annual records and reports compiled by the Indian Service and Menominee Enterprises, Incorporated, the current forest managers. These records and reports were supplemented by correspondence and commentaries which concerned the management program. A "before and after" comparison involved the first forest inventory

made in 1914, and the most recent survey made in 1962.

It was found that (1) the Menominee Forest contains a great volume of sawtimber, primarily northern hardwoods, hemlock, and white pine, a situation atypical of general Lake States forest conditions, (2) the most influential factor in creating this unique feature was the conservativeness of the allowable cut which had been prescribed by legislative decree, (3) the management practices used, other than the size of the allowable cut, closely paralleled those generally used in the Lake States, (4) the historical review did not permit a satisfactory comparison of the long-term results of various cutting methods because 80 years of severe fire damages masked the effects of cutting, (5) the heavy cutting practices benefitted the intolerant species but not to the exclusion of the more tolerant species, whereas the tolerant species, especially sugar maple, have dominated successional trends on areas given light cuttings, (6) the timber species and types which present the greatest silvicultural problems are hemlock, yellow birch, Hill's oak, and swamp forest types in general, and (7) the management program has been structured around the needs of the one processing plant on the forest, the sawmill, and thereby has not efficiently used the raw material flow, most of which receives little or no processing in the communities which are dependent on the forest.

On the basis of these findings, it is recommended that (1) the annual allowable cut be increased to approximately 50 million board feet as compared to the current 40 million

cut and the former 20 million legislative limit, (2) the cutting guides now being used for the sawtimber types be continued with more emphasis on group selection to benefit the less tolerant but more valuable species, (3) even-aged management be applied to the 105,000 acres not involved directly in the sawtimber management program with the objective of producing material on fairly short rotations for processing in a facility such as a particle board plant. This would allow for more diversification and efficient use of the raw material base, and (4) the recreational potential should be capitalized upon through the development of facilities that would take advantage of the wilderness environment that characterizes the forest. This would necessitate modifying cutting practices in those areas where recreational use would have high priority.

ACKNOWLEDGEMENTS

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INTRODUCTION

The development of sound forest management practices in the United States has been hindered by a lack of background information concerning the results of treatments on extensive forest areas. This situation can be traced to the comparative youth of American forestry, and to the early influence of European practices which postponed the evolution of techniques more applicable to the conditions found in this country.

American forest science had its birth in the waning years of the 19th century, about 70 years ago, a period less than one rotation of sawtimber growth in most parts of the United States. This birth was largely supervised by three European-trained foresters, Bernhard Fernow, Gifford Pinchot, and Carl Schenck. It is readily understandable why, under their guidance, European practices were relied upon as an early basis for American forest management. This is exemplified by a statement made by Henry S. Graves in 1911 in his book "Principles of Handling Woodlands":

> "We are using today methods in vogue in Europe many years ago, when market conditions were similar to those now common in this country. With the increasing value of timber and larger returns from forestry, better and more intensive methods will be used. In the long run the application of forestry in this country will resemble very closely that in Europe, with such modifications as are required by the peculiar characteristics of our species and our climate."

As Davis (1960) stated in American Forestry: Six Decades of Growth, American conditions did not respond to European

principles for the most part, and so new approaches had to be improvised. These improvisations have been great in number, and their comparative values have been difficult to ascertain. And, as Davis indicates, results over a considerable period of time are the only real test; otherwise, one method cannot realistically be used to check another of equally dubious applicability. This "considerable period of time," however, is a luxury not yet available to the American forester in very many cases.

Opportunities to do case histories on forest lands in this country which have been under long-term management are rare. One exception is the property of the Menominee Enterprises Incorporated of Neopit, Wisconsin. This 234,000-acre unit was first brought under some type of management control shortly after the area was made the Menominee Indian Reservation in 1854. Various cutting restrictions were imposed, until an act authorizing an annual allowable cut of 20 million board feet was passed by Congress on June 12, 1890. This was the first federal law regulating the cutting of timber on government-managed land in the United States.

Not only does the forest have a comparatively long history of management, but it possesses a representative variety of the timber types found in the Northern Hardwood-Hemlock-White Pine forest region. Another attribute of the area for analysis purposes is the fact that several silvicultural systems have been used as well as many harvesting procedures.

It is believed, therefore, that a critical review of the

events that have transpired on the Menominee Forest lands will provide some insight as to those measures which have proven to be most successful in the forest types involved, and to determine those measures which necessitate adjustment or elimination.

The specific objectives of this study include:

(1) the determination of the factors which have resulted in much higher volumes on this forest compared to those on other forest areas in the Lake States.

(2) the determination of the effects various cutting methods have had on successional trends and stand growth.

(3) the determination of practices which have resulted in the most efficient use of growing sites in view of ultimate utilization.

(4) the formulation of recommendations for management procedures which appear to be conducive to upgrading the productivity of the forest.

PROCEDURE

This study has been enhanced by virtue of the requirement by the Bureau of Indian Affairs that annual reports be submitted from Indian reservations, including progress reports on forestry and grazing activities. The forestry reports presented a multiplicity of information, sometimes only in the form of tabular information, but at other times a very helpful descriptive narrative was included.

The exploration of these records has formed the backbone of this study. Cutting maps had been maintained which tie the cut to specific areas, and when correlated with the harvest, have provided excellent data on area-volume relationships.

There is one regrettable fact in this approach. The study was initiated after federal supervision of the reservation had been terminated; consequently, records became decentralized as they were shipped to various federal offices. As a result, there are some gaps in information.

Another source of information was old correspondence, providing subjective glimpses of the management process not otherwise perceptible through facts and figures. There were also two classic reports written by top forestry experts, giving opposite views of the management on the area for one period.

A recent soil survey for Menominee County was just compiled, providing excellent and varied information concerning the forest. The chapter concerning upland vegetation was

especially valuable since it involved an ecological inventory which supplemented the traditional forest inventory. A recently completed Ph.D. dissertation (Harkin, 1966), concerning economic aspects of the county, analyzed the stocking levels on the forest. The historical background in the present study, coupled with the ecological analysis and information from Harkin's study, provides a broad perspective of the forest.

To ascertain trends, a "before" and "after" relationship was desired. To accomplish this, the most recent inventory information, collected in 1961-62 from continuous forest inventory plots, was adjusted to the same basis as the information from the initial inventory, conducted as a ten-percent strip cruise in 1914-15.

The 1914 data were tabulated by species and specific products on a per section basis. The Continuous Forest Inventory (hereafter referred to as CFI) data in stock table form, by species and timber type, were expanded by blocks rather than by sections, since the block organization was not used until 1938.

To put the stock table information on a section basis, the area of each timber type in a section had to be determined. This was done by the use of timber type maps derived from aerial photographs taken in 1955, and interpreted and ground-checked by Wisconsin Conservation Department foresters. The methods employed in the construction of the maps resulted in an uncontrolled mosaic. Despite uncorrected scale variations, the maps were considered adequate for forest management purposes,

and were used in this study.

Approximately 25 percent of the 360 sections in the forest were randomly selected for timber type area determination. These were later supplemented by additional sections in order to include sections which had received cutting treatments not utilized on the areas initially sampled.

Timber type acreages determined by dot-grid counting were used to expand the stock table information. The sawtimber volume was then totalled by species, while the smaller material was totalled as hardwood and softwood cordwood, as was done in the 1914 tabulation.

It is realized that the standards and procedures used in the two inventories were different, and comparisons must be made with caution. However, it was believed that general trends would certainly be evident, and no alternative was available to distinguish long-term trends. Those sections which received the same kind of treatment throughout the management period were given the most emphasis since only the one kind of treatment would have been involved in any changes that took place.

Finally, the historical review was organized on the basis of management periods to distinguish between the various management approaches used, and the reasons for the variations. The identification of the management periods most homogeneous in nature was relatively simple. The factors which were the most helpful in this regard included the transportation system and the silvicultural treatment.

The first period was characterized by river driving which permitted the harvesting of softwoods only, primarily the highest quality pine, which was driven to off-forest mills. The second period was ushered in by the construction of a sawmill and the introduction of railroad logging. This permitted the harvesting of hardwoods. Silviculture was dictated by the need to continually salvage residual stands, the heavy investment in the railroads and the cutting systems commonly used then in the Lake States. This period, therefore, earned the title of the "clear-cutting" period.

The third period was introduced by the first widespread attempt at selection logging. This was truly a transition period since the railroad was slowly phased out as truck logging assumed dominance. As this was taking place, the experiences with partial cutting were resulting in a trend towards lighter cuts. This period was terminated by a series of blowdowns which brought the need to concentrate all efforts in salvage cuttings.

A return to normalcy was accompanied by the formulation of a relatively sophisticated management plan. Truck hauling and a 30 percent selection cut were the dominant forces in this period.

The most recent period has been governed by a revision of the management plan, permitting more mobile and flexible harvesting equipment, which in turn allowed even a lighter selection cut. Towards the end of this period, several aspects of the plan were altered because federal control was

terminated. The most important was the increase in the allowable cut. Enough of the management plan was retained, however, to include the few years since termination of federal control as a part of the period.

A picture of the most recent phase of management was obtained from discussions with the current forestry staffs of the Menominee Enterprises and the Wisconsin Conservation Department. These discussions were supplemented by the very comprehensive Plan for Continuous Forest Control of Menominee Enterprises, Inc., Lands, prepared in 1961.

THE MENOMINEE FOREST

Location

The Menominee Forest makes up most of the 234,000-acre Menominee County in northeastern Wisconsin. The county consists of ten townships: Township 28 North, Ranges 15 and 16 East; Township 29 North, Ranges 13, 14, 15, and 16 East; and Township 30 North, Ranges 13, 14, 15, and 16 East.

The Great Lakes ports of Green Bay and Marinette lie 45 miles to the southeast and east (Fig. 1.). The cities of Milwaukee and Chicago are within three and five hours driving time by auto, respectively. Numerous wood-using industries are located in close proximity in all directions.

The surrounding counties are characterized by both agricultural and forest lands. The Nicolet National Forest shares ten miles of the northern boundary of the county. These surrounding forests are generally in a low state of productivity, consisting primarily of second growth hardwoods and aspen. The agriculture of the area is predominantly dairying and potato growing. From a vegetational standpoint, the forest is in the Northern Hardwoods-Hemlock-White Pine Forest region.

Soils, Land Use and Climate

The forest is underlain by Precambrian granite. The bedrock is present at the surface in many areas, especially along the streams. The remainder is covered to varying depths by glacial till and water-laid deposits (Soil Survey Bulletin of Menominee County, 1967). The entire area is characterized

Fig. 1.--
Menominee Co.,
Wisconsin

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by an undulating to rolling to hilly topography with a range in elevations from 800 to 1,425 feet. The elevation at Keshena Falls is 834 feet above sea level, and 994 feet at Neopit.

The five northwestern townships are primarily covered by loam and silt loam soils, while the five eastern and southeastern townships are characterized by sandy loam and sandy soils. The sandy soils, the result of glacial outwash, are mostly concentrated in the lake region in 28-16[1] and to a lesser degree in south central 29-16 (Note soils map, Appendix III). The entire forest is interlaced with peat swamps, with and without forest cover.

The forest contains an estimated 330 miles of trout streams, and 116 lakes, of which 42 are larger than 20 acres. Most of these larger lakes are located in 28-16. The Wolf River and its tributaries, the West Branch, the Little West Branch, the Evergreen and the Red, drain about four-fifths of the county to the south, while the South Branch of the Oconto River drains the northeastern one-fifth of the forest to the east.

The Wolf River has numerous waterfalls and rocky formations along its course, making it a river of extraordinary beauty. It is undeveloped for the most part on the forest, and is a potentially great recreational asset. Table 1 lists

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[1] 28-16 refers to T28N, R16E. This designation of townships will be used in all subsequent portions of this report.

a summary of the land use areas.

Table 1. Land use, Menominee County, Wisconsin, 1961.

Land use or conditions	Area, acres
Commercial forest:	
Sawtimber	131,312
By-products (non-sawtimber products)	45,440
Restocking	36,378
Non-stocked	5,065
Total commercial forest area	218,195
Other areas:	
Muskeg and rock outcrop	2,642
Agriculture and grassland	5,664
Industrial and residential	1,372
Major roads	1,756
Water	4,097
Miscellaneous	176
Total other areas	15,707
Total area	233,902

Source: A Plan for Continuous Forest Control, 1961.

The average annual temperature in the general area is about 50 degrees F., with a minimum of 40 degrees below zero and a maximum of 105 degrees. The average frost-free season is about 126 days.

The annual precipitation ranges from about 18 to 38 inches, with an average of 30 inches. The great range in precipitation has its greatest impact during the spring and fall fire seasons. Excessively dry fire seasons occur often enough to be of great concern.

The average annual snowfall is about 47 inches. Snow covers the ground approximately 110 days of the year (Soil Survey of Menominee County, 1967).

The People

Even more than in most communities, the nature of the Menominee forest residents has played a very significant role in the management of the resource. The boundaries of the forest encompass the former Menominee Indian Reservation, and the forest today is still owned by those people who were legally registered members of the tribe at the time federal termination was initiated in 1954. Each member received one share. Thus, from the inception of the reservation in 1854 until the present, the wishes and desires as well as the labor of the people have been strong influences on the type of management that has prevailed.

According to Keesing (1939), the tribe numbered a little over two thousand when the reservation was formed. Various factors, principally disease, caused an early decline in population. The Annual Report of 1869 listed the population as 1,500 and declining, and by 1885 the census indicated a population of 1,308. In the early 1900's, an increasing trend began, until recently, the population has been fluctuating slightly above 2,500. Temporary jobs outside the area cause residents to move into and out of the county. The county labor force, which is almost completely woods and sawmill oriented, is composed of Indians wherever possible. The number

of full-bloods is very low; a University of Wisconsin Co-operative Extension Service Report (1956) indicated there were only 82 in 1950.

The forest residents have never been oriented to agricultural pursuits. Early Indian agent reports emphasized the lack of initiative in this direction. The 1883 Report indicated that farms were neglected in favor of logging dead and down-timber material, and that very little agricultural advancement had taken place in the past 20 years. As the logging program increased, this pattern became even more evident, and present-day agriculture is negligible.

The residents enjoyed the routine of winter logging and summers spent fishing, berry picking, and fern-gathering. Their philosophy of life differed, and still does to some degree, from the more routine-demanding and efficient approach of the white man. As a result, the reports and correspondence of the agents, woods superintendents and foresters over the years have been characterized by complaints concerning the work habits and attitudes of the people. This reaction, however, was not one-sided. Thus, the management of the Menominee Forest has been influenced not only by traditional silvicultural and economical considerations, but also by some very strong institutional factors.

An important liability to the community is the low level of education attained by the residents. According to the U. S. Census of 1960, the median completed years of school

for persons 25 years and older was only 7.9 years. There were only 83 with high school educations and four with some college training, but none with college degrees. One important reason for this, or at least a closely related factor, is the low income status of the residents. Clarence Grieber, state vocational education director, reported (1964) that the average income of county residents amounted to only $2,300 a year, less than half the average for the state. It is likely that the high time preference rate in regard to income from the forest that characterizes the forest stockholders and the main labor force will certainly continue to have a great bearing on forest management decisions and the future of the Menominee Forest.

Early Description of the Forest

The Menominee Forest was inventoried for the first time in 1914-15. Any descriptions of conditions before this time were subjective in nature. The earliest comprehensive assessment was made just a year before the creation of the reservation. This description was made in conjunction with the original land survey in 1853. Two townships, 28-15 and 29-15, were not surveyed until 1890-91. On the basis of these records, some idea of the 1854 forest conditions were determined as follows:

T 29 N,R 13 E: This township was characterized by dense stands of mature hardwoods in the northern sector, and by aspen (*Populus tremuloides*[2] and *P. grandidentata*) and paper birch

[2]Scientific names are taken from Little, (1953.)

(Betula papyrifera) thickets interlaced with conifer swamps in the south. The hardwoods were dominated by elm (Ulmus americana, U. rubra, U. thomasi), sugar maple (Acer saccharum), hemlock (Tsuga canadensis), and basswood (Tilia americana). The swamp forests were primarily cedar (Thuja occidentalis) and tamarack (Larix laricina) in composition.

T 29 N, R 14 E: The aspen-birch thickets of southern part of 29-13 apparently extended into the southwestern portion of this township. The northern two-thirds were covered by dense stands of mature hardwoods with the same dominant species as those in 29-13. The township also had several tamarack and spruce (Picea glauca, P. mariana) swamps.

T 30 N, R 13 E: This township apparently lacked any noticeable acreage in pioneer species. The area was covered by conifer swamps and dense, mature hardwood stands similar to those in 29-13.

T 30 N, R 14 E: This township resembled its neighbor to the west except that the swamps contained primarily cedar. It was also noted that hemlock and white birch were found along the margins of swamps.

These four western townships were dominated by hemlock and hardwood with white, red, and jack pine (Pinus strobus, P. resinosa, P. banksiana) occupying a lesser role as compared to the eastern six townships.

T 30 N, R 15 E: This area was heavily timbered, with considerable good pine scattered throughout.

T 30 N, R 16 E: Swamps were noted as being few in number in

this township and the area was again described as heavily timbered. The southeastern portion contained a large amount of pine valuable for lumbering purposes.

T 28 N, R 16 E: This township, along with its neighbor on the north, was in the poorest condition on the entire area. The many lakes in this area were described as having very little timber on their banks. The timber elsewhere was reported as scattered, and described as pine, oak (Quercus ellipsoidalis) and aspen openings.

T 29 N, R 16 E: This township was similar to 28-16 except that a swamp of considerable extent occurred in the southern half. A possible reason for these conditions in 28-16 and 29-16 was offered in the Indian Agent's Annual Report of 1870, which indicated that a windstorm had reportedly swept the area in 1810. The damages from blowdown were compounded by fire, and the area still bore evidence of these catastrophes 60 years later.

T 28 N, R 15 E: This township and 29-15 were not surveyed until 1890-91; therefore, conditions prior to the survey are unknown. These two townships were probably the first ones logged after 1854, because the mill was located at Keshena Falls in 28-15, making these units the most accessible.

The principal timber in 28-15 was pine although there was an abundance of hemlock, cedar, tamarack and aspen. The hardwoods were confined to the hills and consisted of sugar maple, yellow birch (Betula alleghaniensis), beech (Fagus grandifolia), oak (Quercus borealis, Q. alba), and white ash

(*Fraxinus americana*). It was also noted that an area, once called "plains" by the old settlers, was then covered by 40- to 60-foot white pine, young oak, aspen, and dense underbrush. T 29 N, R 15 E: This area was much like 28-15. Thousands of acres of aspen were reported. Also, the pine in Sections 5 and 6 was noted as being the finest on the reservation.

From the above description, it is readily apparent that with the exception of 28-16 and 29-16, the forest presented a potentially great resource for forest products industries as well as other forest-oriented activities. The foremost challenge facing a forester at that time was quite obviously the overabundance of mature to overmature timber which covered most of the reservation.

HISTORICAL REVIEW OF MANAGEMENT BY PERIODS

Period I: 1854-1908

With the creation of the Menominee Indian Reservation in 1854, there was no provision for cutting or selling timber for use off the property, so the government bought the mill located at Keshena Falls. It had been constructed in 1845 and according to the Indian Agent Report of 1865, was about rotted at that time. It was put into good running order in 1867.

Timber cutting was first authorized on a year-to-year basis by the Indian Commissioner or the local agent for sawing and consumption by the Indians. The amount of cut varied. For example, in 1865, 300,000 feet were cut, while in 1866, nothing was cut. For the ensuing 20 years, the amount cut by this mill never appeared to exceed the 1865 output.

A new mill was constructed in 1885-86, powered by water with a capacity of 15,000 feet a day. On such a forest, this cut was negligible. However, during this period, supervision of the reservation was inadequate. The agent's office was not moved from Green Bay to Keshena until 1871-73. As a consequence, timber trespass was very common. Flagrant thefts were noted in the agent's reports of 1865, 1870, and 1874.

The great pressures from outside and within the reservation to sell the valuable pine was almost irresistable. In fact, several authorizations had to be made by Congress to legalize sales of timber which had already transpired (Acts

of April 25, 1876, March 22, 1882, and March 31, 1882.) According to Kinney (1945), approximately one hundred million feet of logs were sold in the period 1871-90, excluding local consumption. Until 1890, the cut consisted of trespass timber, reservation-used material, and the above-noted sales. The management plan so far was simply a restriction against indiscriminate cutting, and it did serve to limit the timber drain somewhat.

Since the pressures for selling timber were so great, Congress finally acted to legalize past and current questionable practices by passing the Act of June 12, 1890 (26 Stat. 146), which specifically authorized the cutting of logs for sale. This Act set an annual allowable cut of 20 million board feet. The basis for this cut has not been determined, but it certainly was a reasonable amount even though it was later proved to be conservative. With no volume or growth data as guides, it was a providential decision, at least for those early days. This Act, as pointed out earlier, was the first law regulating the cutting of timber on federally managed land in the United States.

This period of management was based almost entirely on restriction of the cut; otherwise, practices that prevailed in the surrounding country were also found here. As already noted, there were no inventories or growth determinations, there was no organized forest protection program, silviculture was largely ignored, and sustained yield was not an objective for most of the people involved.

The factors which were most influential in the manner by which the forest was cut were the river drive system of transportation, the strong pine market, and a "high grading" silvicultural system.

River Drive Logging- Almost the whole area was accessible to driveable streams through the use of sleigh hauling in the winter. The areas that were cut, however, were those where pine predominated. These areas were primarily in the north-central and northeastern portions of the reservation (Fig. 2). The timber which was cut in the vicinity of the South Branch of the Oconto River was floated to the mills at Oconto. The remainder was driven down the Wolf River to Oshkosh and other mill towns south of the reservation.

The hardwoods were largely ignored at this time because the market was devoted almost exclusively to pine, and the weight of the hardwoods made it impossible to use river driving, the only transportation method then available on the reservation. As a consequence, much of the western four townships, and large portions of 30-15 and 30-16 were left untouched. Other areas by-passed for the most part were those lands claimed by the state. There included Section 16 of each township, which were claimed for school purposes, and all the swamp lands. The latter restriction was not as closely observed as the former.

High-grading Silviculture- Prior to the Act of 1890, cutting was supposed to be restricted to dead and downed timber. Much of this material was hemlock, and was probably defective. Therefore, there began an illegal practice of

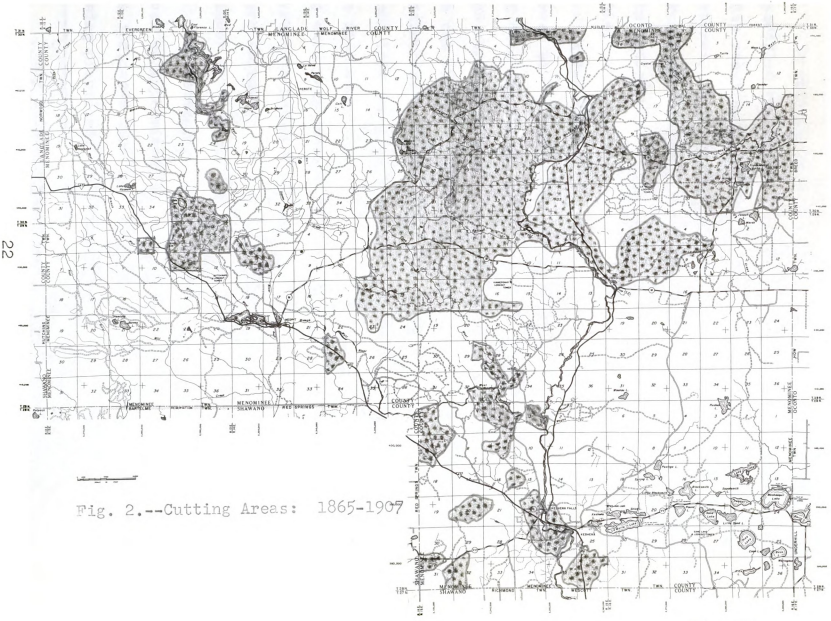

Fig. 2.--Cutting Areas: 1865-1907

burning to reduce good standing timber to the desired condition of being dead.

In effect, salvage cutting was the silvicultural method specified by Congress and the Bureau of Indian Affairs, but this resulted in purposely-created salvage material. In general, then, no particular pattern of cutting was followed except that the cut was concentrated on pine, and probably that which was of the highest quality and most easily accessible.

After the Act of 1890, J. A. H.[3] (1907) reported that green pine and hemlock were utilized almost to the exclusion of dead and downed material. Chapter 418 of the Act required that only pine and hemlock be cut, and that all areas were to be cut clean of these species. J. A. H. indicated these regulations were not followed. He was dissatisfied when many trees were left uncut on various cutting areas; this included trees in good condition. He also described how the agent attempted to encourage jobbers to cut clean by emphasizing the pulpwood market in Shawano. In conclusion, he stated that the loggers were following a practice of selecting the most accessible timber which would cut out the biggest logs.

In reviewing this situation, Libby (1949) described the lack of supervision of cutting operations during this period. He indicated that this resulted in undesirable silviculture being practiced. In 1894, the agent reported that about 20

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[3]Only initials were used in source, name unknown.

percent of the pine remained on the cutover lands.

Forest enemies- During this period, the two destructive forces which received the most attention were fire and windstorms. The agency report in 1882 described the forest as being rapidly destroyed by wind and fire. Incendiarism was mentioned as prevalent all during the 1880's. These fires burned primarily in the cutover areas. In 1894, the agent reported that the 20 percent residual stand on the cutover areas was destroyed by fire, probably due to lack of slash disposal methods.

According to Kinney (1945), probably two-thirds of the area within the six eastern townships had been burned over one or more times prior to 1908. J. A. H. (1907), also reported fires doing great damage on the forest, citing little or no slash disposal as a prime reason.

With the great volume in mature to overmature timber, windstorms were and still are a great hazard to the Menominee forest. In a letter to W. W. Morris in 1909 concerning marking recommendations, E. E. Carter described the Menominee forest as being, like most of the timber lands in the Lake States, in the path of severe windstorms. He believed that windfall was the greatest enemy of the forest.

This belief was borne out by the historic blowdown in 1810, the chronic blowdowns from year to year, and the blowdown of 1905 which eventually signalled an end to this management period.

Blowdown of 1905- This storm occurred July 16, and blew

down approximately 40 million board feet of hardwoods and hemlock in the western part of the reservation (Fig. 3). J. A. H. (1907) described the area as Sections 1 through 18 in 29-13, 30 through 36 in 30-13, and Section 6 in 29-14, a total of 25 sections. He reported that the uprooted hardwood, which was the condition of most of the downed timber, was still as sound as when standing. However, this material was too heavy to river drive for sale and eventual sawing off the reservation. There was no railroad on the reservation, so the Act of 1890 was not a vehicle for disposing of this material. Since the distance to Keshena Falls was too great and the mill there too small, the necessity to saw logs on the reservation demanded new legislation.

Several bills were proposed, and the Act of June 28, 1906 was passed, providing for portable mills to be set up and to manufacture lumber on the reservation. The Act placed a limit of $3.50 per thousand that would be paid for this sawing. The price was apparently unrealistic for no one bid on the sawing jobs. The failure of this Act was followed by other legislative efforts, but these were met with resistance from various sources. Finally, a bill sponsored by Senator Robert LaFollette of Wisconsin was passed as the Act of March 28, 1908 (35 Stat. 51).

The Act authorized the cutting of timber, the manufacture and sale of lumber, and the preservation of the forests on the reservation. The second provision authorized the building of one or several sawmills on the reservation. The third provision was quite general in its wording, and it was later to

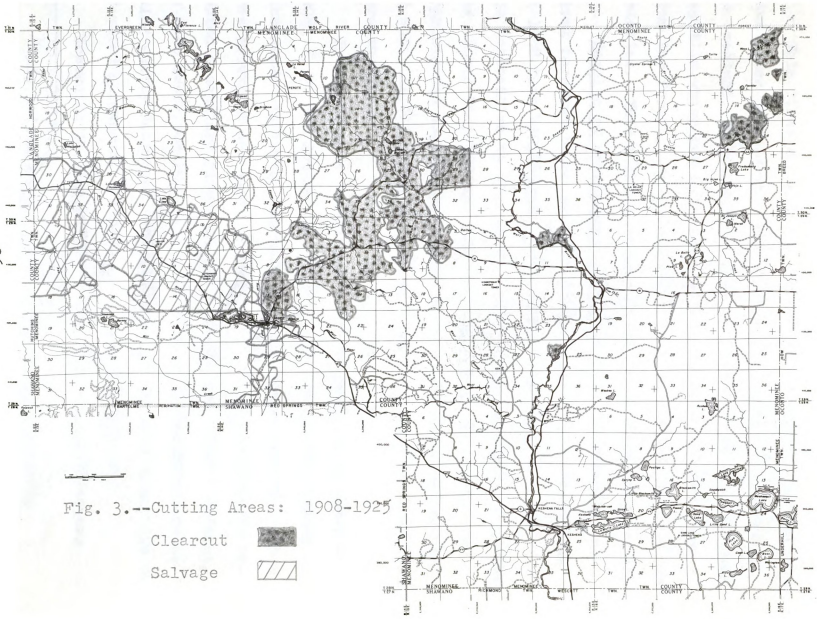

Fig. 3.--Cutting Areas: 1908-1925

Clearcut

Salvage

create a great deal of controversy concerning silvicultural and managerial concepts.

This piece of legislation put the reservation in the sawmill as well as the tree growing business. As can well be imagined, this brought a howl of protest from the existing sawmills which had been able to monopolize the timber flow from the forest, and therefore, to control prices for this raw material. This marked the end of the first management period.

Results of management: 1854-1908- E. A. Braniff, the first forester to be assigned to the reservation, determined in 1908 that 439,785,000 board feet of logs had been sold on the reservation to that date. This volume excluded, of course, the timber lost through undiscovered theft. The areas cut approximated 40,000 acres, indicating an average per acre cut of about 11,000 feet. No estimate was made of the timber lost through fire.

In a letter to Senator Robert LaFollette on December 9, 1908, J. F. B.[4] indicated that an inspection of the former pine areas disclosed them to be largely barren wastes without tree growth of any kind. He attributed this situation to repeated incendiary fires as well as legal and illegal cutting. He also described the great pine forests of the Menominee as being mostly destroyed, but that five or six full townships of mixed hardwoods, hemlock and pine still remained.

According to Kinney (1945), who came on the Menominee

[4]Only initials were used in source, name unknown.

scene in about 1910, an area roughly equivalent to five townships had only scattered timber on it in 1908, bore only young growth that had come in on areas that had been logged, burned, or subjected to heavy windthrow, or was open barren plains. The remaining timber on areas roughly equivalent to five townships was principally hemlock and hardwoods; the hemlock constituted about 50 percent of the entire stand. He also reported that the more valuable pine had been removed from most of the hemlock-hardwood areas. These appraisals were subjective in nature since there was no cruise involved, and travel on the forest was limited because of inadequate access.

Of the nearly 440 million feet cut during the 1854-1908 period, 294 million feet were cut in the 17 years from 1890-1907. Under the Act of 1890, which set an annual allowable cut of 20 million feet, approximately 17 million feet per year were cut. Thus, the main provision of the law was observed.

Later growth studies have indicated a gross annual increment per year per acre slightly in excess of 200 feet on the average for the forest. In retrospect, the growth and acreage data would indicate gross annual growth of about 40 million feet. But this volume would have to be decreased greatly in determining net growth, because of the high mortality in the overmature stands and the burned areas. Therefore, the 20 million foot limitation was probably consistent with the conditions prevailing at that time. Fire, not cutting patterns, was the greatest deterrent to forest renewal. Of the eight townships that were covered by dense timber at the beginning

of this period, three had been greatly diminished in their forest resource.

Period II: 1909-1925

Development of the Sawmill- The Act of 1908 stated that one or more mills should be built on the reservation for the purpose of sawing lumber. The responsibility of determining how many mills and where they or it should be located was placed in the hands of E. A. Braniff, the forester in charge of the reservation. Braniff was a member of the recently formed U. S. Forest Service. In the wording of the LaFollette Act, it stated that the operation should be supervised by the "forestry service." Since the Indian Service had no such division, the U. S. Forest Service in the Department of Agriculture assumed this responsibility. This arrangement continued until 1918 when the Indian Service initiated its own forestry division.

The original idea was to use three small mills to do the sawing at three locations where the logs from the blowdown area were being decked. However, Braniff made the decision to build one large mill. This mill was constructed on the West Branch of the Wolf River just east of the blowdown area. The present mill is still located on that site. The mill and a modern town, Neopit, were completed the winter of 1908-09.

The mill was very modern; it possessed two band headsaws and all the necessary accessories. The West Branch was dammed to form a mill pond. Approximately 100,000 feet of lumber

could be sawed in a 10-hour shift. On the basis of two shifts a day, a 5-day work week, and a 50-week year, the mill could produce in excess of 40 million feet a year, which was the stated capacity. In view of the fact that the Act of 1908 continued the cut of 20 million feet specified in the Act of 1890, the mill apparently was too large. According to Chapman (1957):

> "This large mill, which Congress had not contemplated, saddled future operations under the Act with an unnecessary financial burden, since the restricted output of 20,000,000 feet per year would be required to bear fixed overhead charges incidental to a plant that was twice as large as necessary. It motivated subsequent administrations to seek to avoid the restrictions upon cutting contained in the 1908 Act."

Transportation- The move to include hardwoods in the harvesting program that resulted from the 1905 blowdown necessitated a change in log hauling methods. The only other means available at that time was the railroad, since automotive travel was in its infancy.

The Wisconsin and Northern Railroad first constructed a line to Neopit from Shawano. In the fall of 1908, a branch logging road was built to the western boundary of the reservation, terminating near the town of Phlox. The railroad system was later expanded as the logging operation moved to the central and northern parts of the reservation. This expansion was a cooperative effort between the Wisconsin and Northern Railroad and the U. S. Forest Service. Stream driving was used to float lighter material from the 1905 blowdown area. For this purpose, the Little West Branch and West Branch had been improved, but,

after this effort, railroad logging dominated the operation completely. The heavy investments in the mill and the railroad system greatly influenced managerial decisions during this period.

Silviculture- The early part of this period was dominated by salvage cuttings on the blowdown area and the first attempts at selection silviculture. A large number of operators were put in the blowdown area with the objective of removing the dead and downed material. Because of the long period between the blowdown and the construction of the mill (over three years) a great deal of material was lost due to fungi and insects. This loss was part of the damages cited in a suit instigated in the 1930's by the Menominee tribe against the federal government, and was finally decided in 1954.

The salvage objective was not followed very closely; J. F. B. (1908) indicated that all the jobbers had cut timber which was forbidden to be cut and left timber they were requested to cut. The estimate of the blowdown volume ranged between 35 and 40 million feet, yet the volume cut from this area in the years 1905-11 amounted to more than 103 million feet. Some of this was from the selection cutting area just northwest of Neopit in Sections 7 and 18 of 29-14.

Selection silviculture, necessitating the marking of timber, was an innovation in this part of the country. Raphael Zon had just initiated the experimental station program for the U. S. Forest Service in the Lake States region, so that recommended procedures resulting from research were

not yet available.

A letter from E. E. Carter (1909), assistant forester in the U. S. Forest Service, to William Morris, one of the timber markers on the forest, discussed the challenge of marking on the Menominee:

> "The law requires the Forest Service merely to mark the timber which, in its opinion, should be removed for the good of the forest, and you must adhere to the letter and the spirit of this law, leaving all other matters, such as the selection of the areas to be cut, methods and seasons of logging and transportation of logs, disposal of brush and similar matters, to the discretion of the officer of the Indian Office in charge of logging operations on the Menominee.
>
> The aim which I believe must be the prevalent one, is to make an improvement cutting which will leave enough trees on the ground, sufficiently close together to protect them against windfall, to form in themselves a sufficient basis for a second cut, and at the same time to reseed the ground for future crops with the most valuable species on the reservation.
>
> The other method of marking applicable to the Menominee is to cut clear with the purpose of securing quickly a second growth sprout forest."

He indicated that marking had to be justifiable both from silvicultural and economic standpoints. He went on to describe that individual trees of poor vigor or in danger of windthrow should be marked. An interesting remark which he made was that elm and basswood were the most valuable species on the forest; he was probably referring to the hardwood species only.

The question of how to properly handle these stands was complicated by the deterioration of rapport between the Departments of Agriculture and Interior, probably as a result of the Pinchot-Ballinger dispute. The actual marking of timber was time-consuming, so that when charges of "light" marking ensued,

the quicker method of designating timber was substituted. The previously mentioned areas of Sections 7 and 18 of 29-14 were the only examples of actual accomplished marking. In his reports of experimental selection cutting the mid-1920's, L. O. Grapp (1929) reported that these areas marked by the U. S. Forest Service were in excellent condition at that time. He, therefore, recommended a return to this type of treatment which amounted to about a 70 percent removal cut. Since the marked area was in close proximity to the mill, there was no transportation difficulty.

An extremely severe fire season occurred in 1910, which, along with the factors already mentioned, changed the method and area of operation. The most destructive fire burned the southern half of 30-15, the northern half of 29-15, and the eastern part of 29-14 (Nicholson, 1910). Most of this area had been cut during the river driving days, so the fire further contributed to the poor condition of the area. The western sector of the burn involved a good timber area, and so a salvage cut became necessary. The entire operation, therefore, moved from the blowdown and selection areas to the southwestern corner of 30-15 and the northwestern corner of 29-15 (Fig. 3).

An example of the marking rules that were prevalent at that time was issued in 1912 for portions of Section 31, 30-15, and Section 25, 30-14.

> "Old growth timber in all forest types, including the pure hemlock type, the mixed hemlock, hardwoods and pine, and the swamps, should be designated for cutting as follows:
>
> 1. All merchantable hemlock trees, except

those in groups covering an area of more than one-eighth of an acre, in which from 70 to 80 percent of the trees are of unmerchantable size.

2. All merchantable hardwood trees except shortbodied basswood, yellow birch, and rock elm (Ulmus thomasi) which contain only one merchantable 16-foot log or less.

3. All merchantable pine trees 15 inches and over in diameter at breast-height, standing on the N/2 of Sec. 31, T. 30 N., R. 15 E and 20 inches and over on the NE/4 and the N/2 of the SE/4 of Sec. 25, T. 30 N., R. 14 E. This variation of diameter limits has been made for experimental purposes in order to determine a method to cut white pine in these forest types, which will be practicable and at the same time will provide for leaving a reasonable number of pine seed trees for reproduction purposes. Wherever necessary for protection against wind, and it appears feasible, small groups of trees should be left around pine seed trees.

4. All merchantable trees in swamps."

A review of the cutting procedures used at this time was made by E. H. Frothingham, forest examiner, in the fall of 1914. His observations included the following:

(1) Brush was piled during and after logging, and burned when dry the following spring. The heat was so great that the fire often spread and practically nothing of value remained. This was not done on all areas; where piling and burning took place during or soon after logging, good fire control was the result. (2) Marking rules seemed to have been carried out reasonably well. He believed that there were so few one-log or less trees to be left that this portion of the rules could be eliminated. In effect, he was recommending a commercial sawlog clear-cutting procedure in regard to hardwoods and trees in swamps. He found very little pine left, but he concluded it probably was not present before the cutting, rather

than the cutters ignoring the rules and cutting the pine illegally. Only groups of pole sized timber were given consideration for leaving.

At this point, it is well to consider the unique situation involved in timber management on Indian reservations. Reservations are really private lands, but they are administered by the federal government. The returns from the Menominee lands were invested by the U. S. Treasury, with the Indians receiving 4 percent interest on these monies. In a short time, the Menominees were one of the richest tribes in the United States. The Indians also benefitted from the wages provided as woods workers and mill workers.

The residents and the mill and woods superintendents were, therefore, very much interested in operating at a profit, just as any private business is. From the woods operation standpoint, this meant that logging costs should be kept down. It was believed by some foresters (Chapman, 1957) that the U. S. Forest Service foresters were not given enough responsibility in the total picture and so were somewhat apathetic to the silvicultural aspects. They, therefore, deferred to the economic motivations of the logging superintendents who were not particularly concerned with silviculture. This was exemplified in a letter to A. S. Nicholson, the reservation superintendent, from E. J. Brigham, the logging superintendent, on October 2, 1914. He asked for authority to cut on various portions of 30-14 for the chief reason that the area contained mature timber of a class in which the Menominee Indian Mills were then deficient,

and that it would be necessary to make this cut to achieve a good, well-balanced commercial stock of lumber. Nowhere in the letter did he make reference to silvicultural considerations.

This program, which amounted to a clear cutting operation, was continued under the cooperative agreement between the U. S. Forest Service and the Indian Service until 1918 when the Indian Service formed its own forestry division. At this time the marking rules were completely eliminated and clear cutting prevailed unrestricted.

The most common reasons given for this procedure were the high investment in the railroad, and the necessity to return to salvage the residual stands which were killed by exposure or fire. This situation prevailed until L. O. Grapp was allowed to experiment with selection and seed tree cutting in the mid-1920's. This change in the program was supported by J. P. Kinney, the chief forester of the Indian Service. As a result of recommendations from Grapp, Kinney and William Heritage, the clear cutting practice was terminated, bringing to a close that phase of management on the forest.

Tree Planting- During this period, the need for a planting program was noted. E. A. Braniff instigated the development of a forest nursery at Neopit in 1912. It was eventually moved to Keshena in 1925. The planting program fluctuated in size from year to year (Table 2).

The program proved to be a frustrating experience due to various problems on the forest, chiefly fire and rodents. The nursery was finally terminated in 1933, and it was 20 years

Table 2. Species and areas planted on the Menominee Indian Reservation, 1914-1954.

Year	White pine	Red pine	Spruce	Misc.	Total area planted	Planted area abandoned
	acres					
1914	45				45	
1919	17				17	17
1920	24				24	24
1925	61				61	40
1926			4		4	
1927	170				170	170
1928	133				133	133
1929		240			240	238
1930		208			208	
1932	25				25	25
1933	22				22	22
1935		7			7	
1940				3	3	
1941		5		1	7	
1942	10	40	4	16	70	16
1943		37			38	
1944		53			53	
1945		81			81	
1946		75			75	
1948		35			35	
1949		25			25	
1950		7			7	
1951		12			12	
1952	15	60			75	
1953	12	85		1	99	
1954	39	69			108	
Totals	573	1039	8	21	1644	685

Source: A Plan for Continuous Forest Control on the Menominee Indian Reservation. June, 1954. Lee Winner.

before a planting program of any size was resumed.

Forest enemies- Fire had a great impact on cutting practices and areas cut during this period. The 1910 fires led to the heavy salvage cut which later degenerated into the large-

scale clear-cutting program. The inadequate slash disposal methods made fire a chronic problem, and this resulted in a very negative impact on the reproduction and residual timber on the designated areas, and on the reproduction in the clear-cut areas.

In 1949, John W. Libby, forest supervisor, reviewed that period, stating:

> "During most of the period of heavy cutting, that is from 1909 to 1936, fire protection was inadequate. The heavy cuts left heavy slash accumulations on the ground, drying of the site was excessive, the detection system was poor and accessibility was difficult. The inevitable result was disastrous fires that reduced much of the clearcut areas to brush lands. Block 13 in the center of the reservation is mute testimony of this."

He went on to describe the cutting areas that escaped fire:

> "At the same time, areas that escaped burning are today well-stocked with advanced reproduction and bear testimony to the fact that inadequate fire protection rather than poor silviculture is the primary reason for the present condition of much of Block 13."

Another problem appeared in 1918 when white pine blister rust (Cronartium ribicola) was first reported near Keshena. It continued to spread after this first report until an intensive blister rust control program was initiated in the 1930's.

The effects of partial cuts on hemlock were very drastic. Exposure-killed hemlock was noted early, and discouraged many foresters from leaving any hemlock that would be opened to potential drying and excessive sunlight. Along with fire and windthrow salvage, the necessity to return for dead hemlock caused logging costs to increase and further encouraged clear-cutting.

Forest inventory- It was not until 1914 that the first forest inventory was conducted on the Menominee Forest. Previous to that date, only subjective estimates of volume were made, and most of these were concerned only with the sawtimber sized pine. In 1911-12, the estimated volume was 1,750,000 M board feet, and stumpage value was set at $6,787,173.

The 1914 cruise (Table 3) provided more tangible information concerning the state of the forest. This inventory was a 10 percent strip cruise conducted by experienced timber cruisers. The results showed a total volume of 1,146,608 M board feet which included 242,544 M board feet of posts, poles, and cordwood, and 849,000 M board feet of sawtimber. The sawtimber volume was listed as 53 percent hemlock, 20 percent pine, and 21 percent hardwoods. The average volume was just under 5,000 board feet per acre.

The result from this cruise was the only comprehensive information available until another cruise was made in the early 1940's. The information was compiled on a species and section basis.

New Sawmill- A final incident in this period was the burning of the sawmill in 1925. A new mill was built promptly, with a capacity of about 20 million board feet a year, which made it more realistic considering the allowable cut on the forest. This change-over resulted in a very low cut of 5,866 M board feet in 1925.

Results of Management 1909-26- In this period of 18 years, almost 400 million board feet were cut from the blowdown

Table 3. Summary of Timber Estimates - Menominee Indian Reservation, 1914.

Twp. & Range	Volume - M Board Feet																
	White Pine	Norway Pine	Hemlock	Birch	Red Oak	Maple	Ash	Bass-wood	Elm	Tam-arack	Jack Pine	Spruce	Bal-sam	Beech	Cedar	Misc. Hdwd.	Total M.B.F.
29-13	23416	145	30379	6686	2276	13981	366	11258	10133	174		6	96		144	52	99112
30-13	6044	6	55583	11109	11	14115	149	10237	12673	967		96	7		1312	3	112312
29-14	23677	2080	62956	4631	766	2980	274	2999	1364	224		114	15	47		33	102160
30-14	26811	481	162849	18393	95	12126	328	17744	7384	1626		33	10	12		13	247917
29-15	6878	642	15382	498	434	994	377	1036	328	11		4		608	75		27267
30-15	12926	326	70642	8269	36	7569	102	5250	4754	411		1		1908	3	1	112198
29-16	9888	2063	830	138	4	48	50	3	11		13	2	1	8			13059
30-16	11674	57	34584	5949	3401	6380	346	1644	243	360		12		777	1442	28	66897
Total	121314	5807	433205	55678	7023	58193	1992	50171	36890	3773	13	268	129	3360	2976	130	780922
28-16	3680	12360		180	10	60				60	75						16425
28-15	6878	642	15382	498	434	994	377	1036	328	11		4		608	75		27267
Total	131872	18809	448587	56356	7467	59247	2369	51207	27218	3844	88	272	129	3968	3051	130	824614*

Twp. & Range	Other Forest Products				
	Cedar		Cordwood-No. of Cords		No. of R.R. Ties
	No. Poles	No. Posts	Hard	Soft	
29-13	9656	74500	43817		18610
30-13	5538	5880	19275		48237
29-14	14789	30600	13762		34697
30-14	63733	9388	53403	4630	57452
29-15	7608		12854	90	98542
30-15	14170	7500	32901	1000	40989
29-16	415	7150	2003	4230	46311
30-16	11424	27988	2784	620	42267
Total	127333	163006	180799	10570	387107
28-16	415	7150	2003	4230	46300
28-15	7608		12854	90	98542
Total	135356	170156	195656	14890	531949

*Adjusted to 849,000 M board feet because it was believed the inventory was too conservative.

Source: Menominee File, Federal Records Center, Chicago.

area and the "clearcut" areas. This amounted to approximately 22 million feet a year, or in excess of the legislated allowable cut. The years of excess cutting were primarily in the 1909-15 period when salvage of blowdown and fire-killed timber prevailed.

The 103 million board feet of blowdown salvage was cut from 14,327 acres, for an average cut of about 7,000 board feet per acre. This area had received very little attention in previous cuttings so it probably was in essentially virgin condition. The early land survey appraisal had indicated abundant timber in the area. The 1914 cruise data indicated an average per acre residual volume of about 5,000 board feet on the blowdown area. The cruise data were considered conservative (Libby, 1949), so it is reasonable to estimate the average pre-blowdown volumes were about 15,000 board feet per acre. This would mean that the cut removed 50 percent of the stand, a light cut for that period. The present condition of the area and the fact that most of it has been cut once or twice since, indicate the salvage cut was probably a much-needed thinning.

The clearcut areas, however, did not present such a desirable condition. An appraisal of the cutting map for this period, and a correlation of volume cut to area cut provide a picture of the heavy cutting that ensued during the 1912-25 period. For example, in the salvage year of 1912, an area of 1,489 acres was cut with the volume removed totalling 37,068 M board feet. This amounted to an average cut of 25,000 board

feet per acre.

The completeness of this cut was demonstrated by the results of the 1914 cruise over that area. Section 29, 30-15, which was completely cut in 1912, contained only 20 board feet per acre according to the cruise data. Section 30 in that same township was almost completely cut over in 1911-13, and the subsequent inventory showed no timber to be present.

The total area cut in this fashion from 1911 to 1925 was 14,826 acres, for a total of 294,313 M board feet. The average cut per acre equalled just under 20 thousand board feet.

A large discrepancy appears when the high cut per acre is compared with the 1914 cruise volumes. Sections that were completely cut over in this fashion were indicated by the cruise data to have had less than 10,000 board feet per acre just prior to cutting. The cruise volumes were probably low, but a large part of this discrepancy can probably be traced to the volume picked up as salvage from cutover areas or areas not part of the designated cutting areas.

Clear-cutting, as it was being practiced at that time, combined with an inadequate fire control program, resulted in little or no survival of natural and planted reproduction. Sustained yield was not being achieved; therefore, management policies had to change. This situation led to the experimentation in partial cuttings by L. O. Grapp, and to the eventual adoption of such cutting methods.

Period III: 1926-1937

Transportation- In the previous management period, railroad logging was practiced almost exclusively. Two state highways were developed on the reservation in the mid-1920's. The east-west Route 47 followed closely a path that had wound from Keshena to the settlement of Zoar near the west border. The north-south artery was built on the site of the old military highway along the eastern shore of the Wolf River. Both roads were hard-surfaced.

These roads were utilized for some truck hauling relatively early in this period. The logging operations were being carried on by government camps and jobbers. The government used railroad logging, and extended spurs to most of the jobber areas. However, jobbers working in the northeast and east began to utilize trucks.

This development of roads on the reservation had a great impact on the manipulation of the forest. The expansion of the road system followed the upgrading of automotive equipment in general, but most important was the development of units which could handle heavy materials such as sawlogs. By virtue of these factors, there was a continuing transition from railroad to truck logging until in 1936, it became a truck operation completely.

The low cost of road construction compared to railroad construction was a major consideration, but the flexibility of movement that the trucks provided had the greatest impact.

The tracks had to be picked up and used in the most strategic places so as to obtain the greatest return from the investment. The truck roads eliminated this problem; they could be installed with very little effort. A minor difficulty was the seasonal limitation on the use of roads built on finer textured soils.

Silviculture- This period was characterized by several silvicultural practices. The first year marked an attempt at seed tree cutting. This was followed by a selection cut which removed 70 percent of the stand. Finally, the transition to a lighter 50 percent cut was interrupted by the necessity to conduct major salvage operations.

The Moshawquit Lake district in the southeastern corner of the reservation was the scene of the seed tree cut. This area was described by the early land survey as "plains" or "barrens" with scattered pine, aspen and oak. The 1914 cruise indicated the area contained only scattered pine of low quality and some small groups of fair quality timber.

In 1925, the area burned over. L. O. Grapp (1926) decided the only plausible course of action was to salvage most of the timber and to leave as many seed trees as possible in hopes of getting natural reproduction (Fig. 4). He, therefore, marked 386 trees on 3,114 acres as seed trees. The remaining merchantable pine was removed, resulting in a volume of 4,719 M board feet and 118,090 lineal feet of piling. This amounted to about 1,500 board feet per acre. These volumes indicate the low stocking per acre on the area.

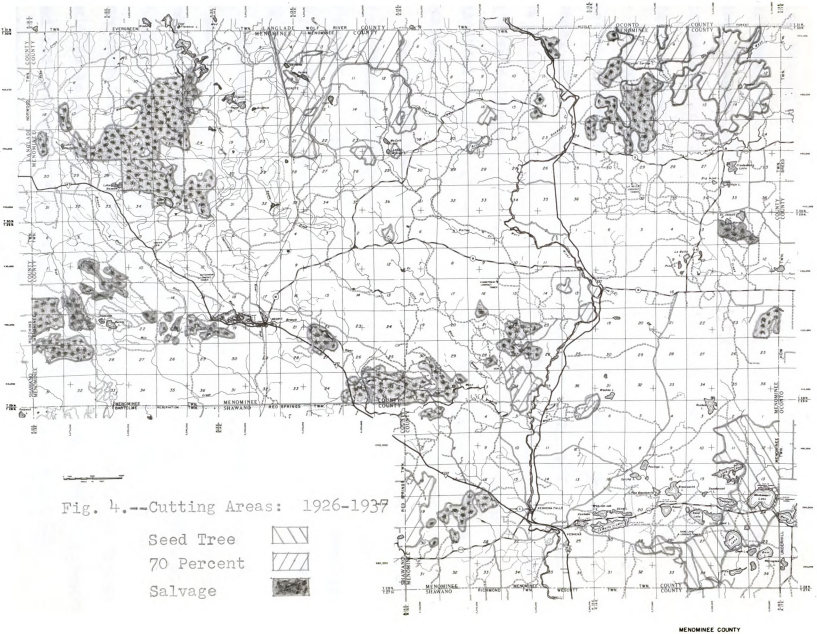

Fig. 4.--Cutting Areas: 1926-1937

Seed Tree

70 Percent

Salvage

The cutting would have left an average of about one seed tree for every 8 acres; however, many of the seed trees were also cut in the harvesting operation. The problem of obtaining complete cooperation from the loggers in regard to the finer aspects of silviculture was and still is an important limitation to achieving the objectives of good forestry on the Menominee Forest.

As a result, the reduced seed source was inadequate for the reproduction that followed to cope with the competing brush, grass, and scrub oak (Quercus ellipsoidalis). In the law suit which developed later, the Court of Claims apparently also considered that the number of seed trees left was insufficient, for it categorized this area as having been clearcut.

In the mid-1920's, Grapp (1929) had been given permission to experiment with diameter limit cutting. The limits were 12 inches at the stump and 10 inches at breast height. Results on 720 acres cut in this fashion were satisfying to Grapp and his cohorts.

One specific area in the study was the northwest quarter of Section 3, 30-14, composed of a uniform stand of mixed hardwoods with a very small percent of hemlock. It was found that if cutting were regulated by taking all trees above the 14-inch diameter class, about one-fourth of the merchantable timber would be left. Grapp believed that this would provide sufficient seed and protection for the site, and that the danger from windthrow would be minimal. To use this method, he thought

would require the cutting over of an additional area each year amounting to a little over one-fourth of the area which would be harvested by clear-cutting. He also stated that the stands which were primarily hardwoods would be adaptable to the selection system, but warned that the stands of timber on the forest varied a great deal so that no one method could be applied universally. His economic justification for moving, at least partially, to selection cutting was three-fold:

(1) Hemlock was being logged and manufactured at an average loss of $1.03 per thousand board feet. Under the selection system, less hemlock would be taken, removing only the high risk trees and concentrating most of the cut in the hardwoods. (He believed that hemlock would increase in value over the years, a fact which has failed to materialize.)

(2) Selection cutting would not take the low value small logs that were so prevalent from clear-cutting operations. He considered the 14-inch diameter as the optimal cut-off point; above that size, the area necessary to get the allowable cut would be too great from a cost standpoint. This of course, was still in the railroad logging period.

(3) Under the clear cutting system, artificial regeneration was necessary. He believed the high cost of planting could be eliminated by dependence on natural regeneration which could be obtained under the selection system.

By virtue of this line of reasoning, selection cutting was begun during 1927 and some form of selection cutting has dominated the Menominee picture ever since.

This transition was also aided by the fact that the Goodman Lumber Company of Goodman, Wisconsin had just switched to "selective" logging on a commercial basis. This gave reinforcement to Grapp's idea and provided him with the necessary cooperation to launch the program.

The marking rules as devised by Grapp for use in 1927-28 were as follows (Grapp and Heritage, 1929):

1. Use 14 inches as a guide to leave.
2. Attempt to achieve an even distribution of crown cover.
3. Mark hemlocks in preference to hardwoods.
4. Mark both leaning and supporting trees.
5. Along streams mark only twenty-inch and over trees one hundred feet on either side.
6. Leave rock elm 18 inches or less if well-formed for square timber.
7. Mark all low vigor, overmature, dead and defective trees even if not merchantable.
8. Leave at least one extra tree (14 inches and over) on each acre for seed purposes until logging is completed. If the residual stand is adequate, then remove the extra tree.

The 70 percent cut was restricted primarily to the north-central and northeastern portions of the reservation (Fig. 4). This allowed the use of the existing deployment of the railroad.

A review of this program in the Annual Report of 1931 indicated that the cutting was heavier than believed to be desirable. An average of 10,484 board feet per acre or 71 percent of the stand was being cut. The residual stand totalled about 70 trees or 4,949 board feet per acre.

It was found that the great abundance of over-mature timber still presented a problem. Another troublesome element was the damage inflicted on the residual stand during harvesting

operations. A study made in 1931 showed that 43 percent of the non-merchantable trees were lost during logging, plus some of the unmarked merchantable trees. This initiated a policy of first marking and harvesting the hemlock, and then cutting the hardwoods to the desired density.

As a result of selection silviculture, the 1931 report indicated that there were some noticeable trends developing. After cutting in the hardwood types, it was found that sugar maple and beech were assuming dominance. In the pure hemlock type, a conversion to a mixed hardwood-hemlock type was taking place, since hemlock was not reproducing.

Another negative result of partial cutting was the reaction of some species to exposure, a situation that had been noted 20 years earlier. Hemlock and yellow birch suffered severe mortality from this situation. The actual physiological response causing this mortality was and still is unknown. A regular pattern of returning to cut-over areas within a few years to salvage dead and dying trees was necessary. For example, in 1933-34, 2,671 acres were given a selection cut.

The 1931 report also included a brief description of the forest. The timbered area was located in the western four townships and a strip along the north boundary to the northeastern corner of the forest. There were small scattered areas of second-growth timber and mature pine, but the majority of the area in the eastern part of the reservation was covered with young reproduction composed of aspen, sugar and red maple (Acer rubrum), elm, birch, and scrub oak with a scattering of

white and red pine seedlings. Quite a large area in the southeastern part of the forest was covered with scrub oak reproduction, with old pine standards scattered singly and in groups throughout.

As pointed out previously, the heaviness of the 70 percent cut was being questioned. Therefore, in 1934, the Commissioner of Indian Affairs appointed a committee of local lumbermen including R. B. Goodman of the Goodman Lumber Company to study the situation. This committee recommended, in June of that year, that thereafter, 50 percent of the volume should be retained. The objective of the heavier residual stand was to reduce the mortality resulting from blowdown and exposure. The Goodman Lumber Company had been using this policy successfully, both from financial and silvicultural standpoints.

The 50 percent program had received only a brief effort in 30-16 when a series of extremely severe windstorms disrupted the practice. It was still utilized where feasible, but the main effort then turned to a salvage operation which occupied the center of attention until 1938.

When it was again possible to return to selection silviculture, the transition to truck logging had been completed, allowing an even lighter cut to be instigated. The introduction of the 30 percent cut in the management plan prepared by Richard Delaney in 1938 signalled a new era of management on the forest.

Sterling Report- In 1934, E. A. Sterling (Chapman, 1957),

made a survey of forest conditions as a consultant for the Menominee Tribe. His main objective was the evaluation of the clear-cutting practices that were applied prior to this period. He found that if the clear-cutting practice had been maintained at the 20,000 M board feet per year pace, the virgin timber would be depleted by about 1968. This would amount to 680,000 M board feet, or an amount in excess of that carried on the books at that time for the entire forest. Consequently, Sterling believed that since inadequate regeneration conditions had been prevalent on the areas cut during the river driving and clear-cutting periods, the occurrence of prompt and adequate reproduction beginning in 1934 would still result in a 50-year or longer gap after 1968 until rotation age (110 years) stands would be ready for cutting. Since fire control was still inadequate in 1934, even this prospect was unrealistic.

Sterling's study also showed that 23,013 acres or 10 percent of the reservation had been clearcut. Of this, he considered 19,776 acres to be in an unproductive condition. He attributed 14,095 acres of this area to cutting after 1911, which would place the remainder as having been clearcut during the river driving days.

Forest Enemies- The year 1934 marked the occurrence of the last disastrous fire on the forest. The development of a comprehensive road system together with the erection of adequate lookout towers as a part of the Civilian Conservation Corps (C.C.C), Indian Division, program, made effective fire control possible. This program was followed closely by the

development of the Forest Protection Division of the Wisconsin Conservation Department which presently provides fire protection for the forest. As a result of their efforts, there has not been an extra period fire in Wisconsin since 1937. The early part of this period was plagued by large fires.

From 1928 to 1930, the area burned was .32 percent of the area protected, which, although it was above the desired maximum of .2 percent, was quite low as compared to areas burned in 1931 and 1934. Those two years saw 17,350 and 12,512 acres burned over, respectively. The fires were primarily in areas classed as open, but approximately 600 acres of timber were burned each of the two years, resulting in timber losses of about one million board feet each year, and greater losses, by value, of reproduction. After 1934, losses of timber to fire were neglible.

Two other factors which created greater problems than fire during this period were a long term drought and the aforementioned series of blowdowns. The drought continued from 1930 to 1938. It had an unmeasurable but very noticeable impact on overmature timber, especially hemlock. The lack of moisture not only contributed directly to mortality but acted indirectly to reduce vigor and thereby created better conditions for other forest enemies. Foremost among these was the hemlock borer (Melanophilla fulvoguttata) which contributed to the excessive mortality and consequently to a need for more salvage cutting.

In his Annual Report on Forestry Activities in 1937,

Richard Delaney stated:

> "Aided by drought the Hemlock bark borer developed strongly and added Hemlock mortality. Activity of the insect was particularly healthy in the Camp 24 (29-13) and Camp 26 (30-13) areas with undeveloped virgin areas suffering equally heavy although less noticeable losses. Drought damage was by no means confined to Hemlock. Overmature stands of most other species, particularly White Pine experienced visible injury."

More dramatic in their impact were the blowdowns of this period. The first storm occurred on June 8, 1933 and the resulting blowdown was concentrated in Sections 8 and 17 of 30-16. This storm was followed by one of greater magnitude on August 18, 1934, in the neighborhood of the 1905 blowdown in 29-13. The wind damaged approximately 30 million feet over a 6,500-acre area. Of the area affected, 2,017 acres had been cut over following the 1905 blowdown, and 2,980 acres were classed as virgin timber.

The salvage operations were hampered by inclement weather, heavy snows, and rains which temporarily broke the drought, so that this phase of the program was continued into 1936. Since truck hauling was being used, the condition of the roads during the various seasons had become a concern. The harvesting operations were now concentrated in the hardwood-hemlock areas, which are characterized by finer textured soils with good water-holding capacities. Precipitation, therefore, caused and still causes hauling problems in these areas.

Tree marking during the salvage program was confined primarily to damaged and dying trees, and isolated individuals that were likely to be windthrown or die from exposure. An

average of four to six thousand board feet per acre was removed, leaving about three thousand board feet as the residual stand, with higher densities being left in the virgin stands. Chapman (1957) indicated that the blowdown on the selection cut areas was comparable to that on the virgin areas.

The completion of salvage operations in the 1933-34 blowdowns appeared to be in sight when a third storm occurred on July 11, 1937. Its effects were noticeable all over the forest, but it struck most intensely on 6,000 acres in 30-13. The main damage was done on a strip from Section 11 to Section 27. It was estimated that 20 million board feet were blown down.

The cutting operations, therefore, were still largely confined to downed material. There was some non-salvage cutting, but on a relatively small scale. This was necessary to acquire materials to maintain balanced species inventories and to retain markets for certain species. White pine and red oak were notable examples of this situation. These species were not abundant in the blowdown areas, and had to be cut elsewhere.

The 1937 salvage operation covered 5,175 acres and yielded almost 30 million board feet. The cut per acre varied from complete removal to a very light cut, averaging four thousand board feet. By 1938, the salvage job was largely completed, and the opportunity was developing again to return to selection silviculture.

Results of Management, 1926-1937- With the exception of the seed tree cutting in 28-16 in 1925-26, most cutting was confined to the northern and western townships on areas which

were virgin in nature, except for the cutting done on the 1905 blowdown area. A total of 29,488 acres was cut, yielding 227,943 M board feet or 7,700 board feet per acre. The cut per acre varied from clear-cutting to very light salvage cuts.

The annual cut averaged 19,000 M board feet with a low of 3,681 M board feet in 1933 and highs of 31,548 M board feet and 29,844 M board feet in 1936 and 1937. The low volume cut in 1933 was the only noticeable effect of the great economic depression on the cutting program. Actually, the reservation was in better economic condition during the depression than the surrounding country. This attracted many non-Indians to the reservation at that time. The high volume cut in 1936 and 1937 were the result of the heavy salvage cuttings in the blowdown areas.

L. O. Grapp's effort in the Nicholson-Grapp plan of 1931 is generally considered as the first attempt at a management plan for the forest. In many situations, uncontrollable factors arise which force either abandonment or drastic adjustments in a forest management plan. In this case fire, blowdown, and drought combined to frustrate the proposed program. Unlike the easily observed effects of clear cutting, the effects of the cutting during this period were much more subtle and appeared later. Aspects of these effects will be discussed in a later section.

In the 1936 Annual Report, some comments were made concerning the earliest selection cutting area on the forest in the northern half of Section 18, 29-13. Grapp (1929) also

discussed this area in his selection research report.

The 1936 Report indicated that a sample of 18 one-fifth-acre plots was taken in the area to assess the 1936 cut. The yield that year amounted to 4,000 board feet per acre with a residual merchantable stand of 3,500 board feet per acre. The area was well stocked with saplings, poles and reproduction. It was observed that a large amount of defect from breakage and scraping existed in the stand. Wolf trees were numerous, but growth appeared to have been excellent. Many of the maple stumps that were examined showed a diameter increase of six to seven inches in the 25 years since the original cut.

Period IV: 1938-1950

Transportation- A comparative study of truck logging costs and former railroad logging costs was presented in the Annual Report of 1938. The study concerned railroad logging from Camp 23 in fiscal years 1931, 1932 and 1933, and truck logging from the same camp in 1938. The railroad operation removed 70 percent of the volume, or slightly more than 10,000 board feet per acre over a 2,000-acre area. The truck logging removed 4,000 board feet per acre over a 2,575-acre area, which amounted to a 30 percent cut. Various differences concerning maintenance and repair were believed to offset each other in the two operations. Broadly, then, the entire logging chance, save for lighter cutting, was deemed similar.

The results indicated that the truck operation produced logs for $2.79 less per thousand board feet than was possible

with the railroad system. It was pointed out that $1.74 of this amount was saved before actual transportation began. This was mostly accounted for by the fact that larger logs in general were being handled in the lighter cuts made possible by truck logging which resulted in less time per thousand for the felling, bucking, and skidding. The 1938 cut showed an average of eight logs per thousand board feet as against eleven per thousand board feet for the earlier years. The move to truck logging was now complete.

New Management Plan- The forest was subdivided into 13 blocks prior to 1937. The lines were established along topographic features, old cutting boundaries and blowdown areas (Fig. 5). The blocks were developed as the units for controlling the area of the cut.

Richard Delaney revised the 1930 Nicholson-Grapp management plan in 1938 and introduced the concept of the cutting cycle into his plan. The cutting budget from this plan is presented in Table 4. The new plan was, therefore, premised on the legislative allowable cut of 20 million board feet and a 10-year cutting cycle which was controlled on an area basis through the block system. However, the plan was still based on the information gathered in the 1914 cruise. Some additional plots were taken for supplementary information, but the total inventory carried on the books was the 1914 volume less the cuts of the succeeding years, without making adjustments for growth. For example, the 1938 Annual Report showed a total commercial timber (sawtimber) volume of only 497,766 M board feet, approximately half of the volume indicated

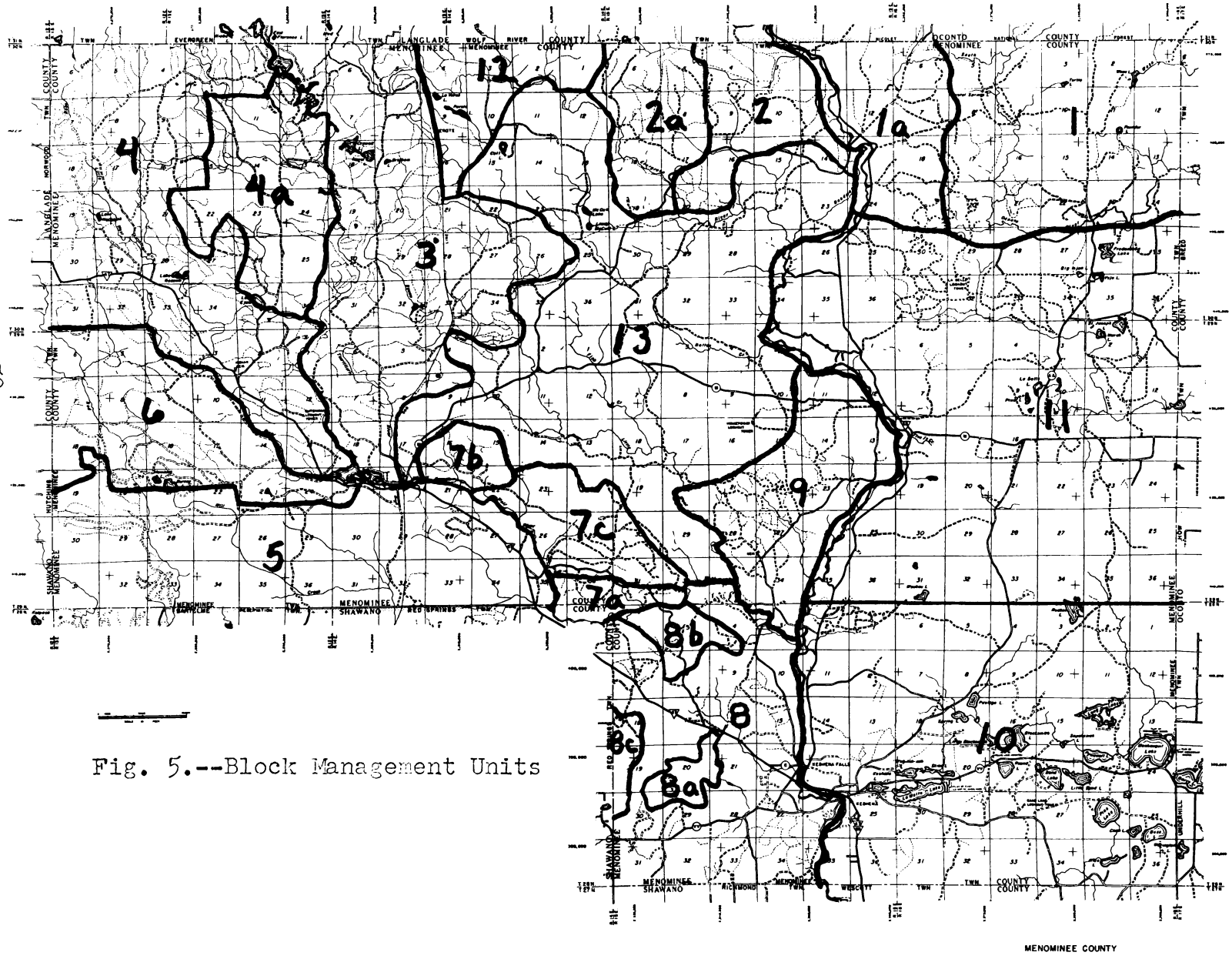

Fig. 5.--Block Management Units

in the inventory 23 years previously.

Silviculture- Primarily because of the switch to truck logging, the forestry division of the Indian Service recommended a further reduction of the volume removed in selection cutting. The recommended maximum cut was 30 percent of the volume present, which made the average cut approximately 3,000 board feet per acre (Libby, 1949).

The following instructions for marking were to be used during the period, and were listed in the Annual Report for 1942:

1. Dead hemlock will be marked, but if merchantable will be tallied.
2. Tree must have at least one merchantable log to be marked.
3. High risk trees should be marked, if desired volume to be cut can be achieved in dead or defective trees; do not cut healthy trees.
4. Minimum size limit guides for healthy trees (in inches);
   - Beech. 18
   - Birch. 20
   - Maple, Basswood. 24
   - Pine. 36
5. Mark hemlock as lightly as possible, marking only high risk and stunted individuals. In mixed stands, attempt to leave hardwoods.
6. As a rough guide, 7-10 trees per acre should be cut.

Salvage cutting continued to play a very important role in the silvicultural program. In some years, more volume was cut in salvage operations than by selection. An example of this occurred in 1949 when 13,295 M board feet of the total of 21,312 M board feet were the result of salvage cuttings.

The salvage material resulted from many frustrating causes. Small scale blowdowns, some fire damage, insect and disease victims, logging damage, and the reaction of hemlock and yellow

Table 4. Cutting budget for the Menominee Indian Reservation, 1938-1949.

Year	Location of cut	Area acres	Volume to be cut, M board ft.	Total Vol. for period, M board ft.
1937-38	Camp 23	2,500	10,000	
	Dead Man Lake		3,000	
	Camp 28 Blowdown		4,000	
	Misc. Salvage		8,000	
				25,000
1938-39	Dead Man Lake	8,640	50,000	
1939-40	Op. 28 Blowdown	6,000	18,000	
1940-41	Misc. Areas &			
1941-42	Salvage		30,000	98,000
1942-43	West of Soo	10,880	60,000	
1943-44	Askenett	2,560	20,000	
1944-45	Misc. Areas &			
1945-46	Salvage		12,000	92,000
1946-47	T30, R.13	17,280	60,000	
1947-48	Misc. Areas &			60,000
1948-49	Salvage			
	Total			275,000

Source: Delaney (1938).

birch to partial cuttings--all contributed to the problem.

As this period of management progressed, the task of maintaining the selection program of harvesting the high risk trees and keeping up with the salvage demands, while still remaining within the legal limits of the allowable cut, became almost intolerable to the people in charge of administering the forestry program. In the 1948 Report, John W. Libby, Forest Supervisor, indicated his concern after receiving the first reliable growth data that had become available from a 2-year remeasurement of the first plots established on the

forest.

He found the loss from mortality to be extremely high, and yet the curtailment of the salvage program was necessitated by the limitation of the allowable cut. He also stated that some of the salvage operations were quite light, thereby increasing the harvesting cost per unit of volume. This discouraged a more complete salvage program. Libby believed that with the mobile logging techniques available, there was no longer a justification for an annual loss of perhaps two million board feet or more because the salvage areas were "too light". He, therefore, made the following recommendations: (1) To manage old-growth hemlock and birch stands on the Menominee Forest, remove all old-growth trees as rapidly as possible and still maintain adequate ground cover to prevent excessive drying and consequent deterioration of the site. This means removing the old-growth with a succession of partial cuts, deferring the final cut as long as practicable. The frequency of cut will depend entirely on the rate of mortality: probably every two years during dry periods, possibly every five years during wet periods. (2) Regardless of volume or frequency of cutting hemlock stands, operate in hardwood and other types on a 10-year cutting cycle, the volume of cut to be as dictated by good silviculture, rather than by an archaic law that has outlived its usefulness.

He realized that the cut might exceed the growth for a period of years, but since there was little or no net increment, this concern was only academic. Such a period would

probably be followed by one requiring a reduced cut until the forest became more "normal" in its structure.

That same year, Walter Ridlington, forester, indicated another area of question, that of the stocking which should remain after selection cutting. He reported:

> "I have heard said that our stands should never be reduced to a net volume of growing stock less than 5,000 feet per acre. Someone also came out with a figure of 100 square feet of basal area to be the minimum to which we should cut. What our minimum should be is still uncertain and I believe it may vary from one type to another. Perhaps our growth study plots will give us the answer to this question."

Both of these reports indicate that during this period, the foresters were still handicapped by a lack of information concerning the forest itself as well as research results in regard to handling the forest types present, and by legislative and economic pressures.

Planting- The planting program on the forest, begun in 1912, was terminated in 1933, primarily because of almost complete loss of the plantings due to various destructive agents, mostly fire.

By 1942, it appeared that the fire threat had been sufficiently reduced to encourage the resumption of planting. The program begun that year was largely a token project, consisting of a "Tree Planting Day", in which men, women and children participated.

Annual areas of 82 acres or less were planted during the remainder of this period. Dwindling interest resulted in a continual decline until only seven acres were planted in 1950.

A total of only 385 acres was planted from 1942 to 1950.

Red pine was used almost exclusively, and was obtained from the U. S. Forest Service since the forest nursery was not re-established on the Menominee. The almost complete success of the plantings during this period motivated the establishment of a full-scale planting program starting in 1952.

By-products- Practically all the forests in the Lake States had been cut over twice by 1938. First the pines had been removed in the late 1800's; then, from 1900 to about 1930, the hardwoods had been harvested. These operations, plus fire, had reduced the forest resources to aspen and second growth hardwoods and pine. With few exceptions, the big sawmill was a thing of the past. The Connor mill at Laona, the Goodman mill at Goodman, and the Menominee mill at Neopit were among the few large mills left.

There was (and still is) very little diversification at the Menominee mill; the chief endeavor was the manufacturing of lumber. Therefore, unlike most woods products industries, it was strictly oriented to sawtimber. Unlike the situation in the surrounding area, any trees that could not be considered in terms of board feet were of minor importance.

Pole-sized timber and swamp conifers that could be utilized as posts, poles, ties, pulpwood, shingles, etc. were blanketed under "by-products," as opposed to sawtimber and veneer trees.

This roundwood material returned very little stumpage after all production costs were deducted. Therefore, this phase of timber production was minor, and the forest types

consisting of this material received little attention. Despite the fact that these types made up a sizeable portion of the forest, it was not until comparatively recently that inventories have been concerned with these areas.

The sawtimber types were estimated to cover about 132,000 acres in 1950, which indicates that about 90,000 acres would have contained by-products materials. Yet in 1949, of the 22,700 M board feet reported cut, only 784 M board feet was not scheduled for processing at the mill.

Inventory Program- Because almost 30 years had passed since the only inventory of the forest, a cruising program was begun in 1941. The method was a line-plot system with 20 one-fifth-acre plots tallied per forty for a 10 percent cruise. The objective was to cover an area each year comparable to the area cut over that year. As indicated in the 1948 Report, it was hoped that the forested area of the Menominee would be completely cruised by the end of the second cutting cycle.

In 1946, Parker Arthur, the forester directing the inventory program, called upon Cal Stott of the U. S. Forest Service for advice concerning the establishment of a permanent inventory plot system. As a result, a continuous forest inventory program was begun. This program resulted in the establishment of 387 permanent plots considered to be representative of 132,000 acres of old-growth hardwood and white pine sawtimber. I. B. M. mark sensing cards were used in compiling the data. The plots were pre-stratified in regard to timber type. The first remeasurement was made in 1954 (Stott, 1954).

By the end of this period, 65,096 acres were covered by the 10 percent cruise, 16,640 acres by the permanent plot cruise, and 16,000 acres in Block 5 by a light "one-shot" cruise. The total area covered was 97,736 acres, supporting a volume of 900,713 M board feet, or an average volume per acre of about 9,200 board feet.

The portion of the forest left uncruised was reported to be 77,264 acres, with an estimated 180,087 M board feet. The combined cruised and estimated volumes would have put the total volume of the forested area at slightly over 1 billion board feet. This volume compared favorably with the 1914 cruise total of 850,000 M board feet and was slightly more than double the volume of 497,766 M board feet listed at the beginning of this management period in 1938. So, despite cutting, blowdowns, fire, and other losses, the forest was apparently more than holding its own in volume.

Forest Protection- Fire damages during this period were comparatively slight. Suppression costs plus timber and reproduction losses exceeded $1,000 in only three years, 1946, 1947 and 1949. The spring of 1946 was reported as the driest in 56 years, and the fire season the worst in 10 years. This was the only year that a noticeable loss of timber was reported aggregating 130,000 board feet of white and red pine in the Keshena and South Branch areas. This reduction in fire damages was due to a general upgrading and updating of the entire fire control program, and the access made possible by the expanding road system.

New forest insects made their appearance during this period. Walking sticks (Diapheromera femorata) began causing injury, especially to the red oaks in 1943. The populations seemed to peak during odd-numbered years with increasing intensity. The area involved amounted to about 2,500 acres, primarily in the eastern part of the reservation. Direct mortality due to insects was not great, but the weakening effects eventually led to mortality from recurrent attacks or other factors. A spraying program was developed in the latter part of the management period.

Saratoga spittlebug (Aprophora saratogensis) was noted for the first time in 1944 in young jack pine and red pine plantations. LeConte's sawfly (Neodiprion lecontei) began making its appearance in red pine plantations in 1949, but its presence on the reservation had been noted many years before. The hemlock borer continued to be a problem as a result of the long term effects of the 1930-38 drought. These problems were kept within bounds by a spraying program which varied as insect population intensities fluctuated.

The largest control program on the forest, aside from fire, was for white pine blister rust (Cronartium ribicola). Despite the heavy cutting of the river driving days, and later cutting, white pine remained an important component of the forest, making up close to 20 percent of the volume.

Blister rust was first noticed in 1918 and, according to R. W. Dickinson (1951), a Ribes eradication program was inaugurated in 1921 on a limited scale, and was expanded in 1931.

By 1950, almost 28,000 acres of young white pine were under protection. The mechanical removal of Ribes was eventually replaced by the use of herbicides such as 2-4-5 T. The program was confined mostly to the six eastern townships, especially the southeastern four townships (Fig. 6). The Annual Report of 1949 reported that blister rust was under control.

Mortality continued to be high in hemlock and yellow birch as well as in overmature individuals of other species. Yellow birch "die-back" was a major problem, and its cause was unknown. In 1948, an experimental sanitation cut on 40 acres in Sections 15 and 16, 29-14 was made. Nothing of consequence resulted from this project.

In the Annual Report of 1948, foresters reported their frustration in dealing with hemlock. After years of field experience and extensive research literature concerning hemlock, there was still inadequate information as to how to mark hemlock for a light selection cut. A modified group selection was considered the most applicable, since even the vigorous trees would windthrow or succumb to disease if exposed considerably.

Windthrow was also a problem in this period, even though there were no blowdowns comparable to the 1905 event or those of the 1930's. For the most part, mortality from this cause was a chronic nagging problem. A storm on October 10, 1949, caused a general blowdown in small pockets throughout the forest, necessitating a general salvage cut. Even before this incident, the salvage program became so great that special

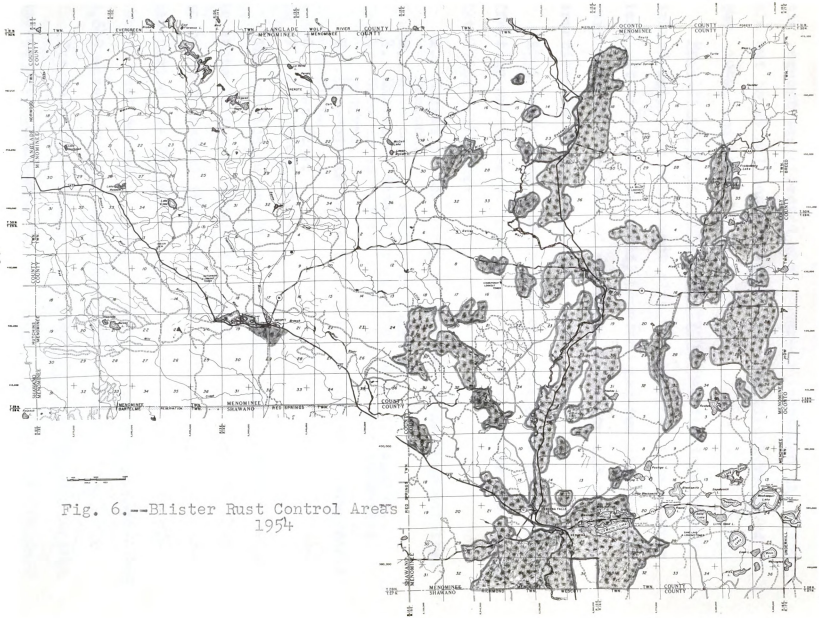

Fig. 6.--Blister Rust Control Areas 1954

legislation was requested to increase the allowable cut to maintain the cutting schedule and cope with the salvage job. This request was approved when Congress increased the allowable cut to 25 million board feet for the fiscal years of 1949, 1950, and 1951.

Results of Management, 1938-1950- At its inception, Richard Delaney's management plan was designed as a 10-year plan. It had to be extended, however, for two additional years primarily because of excessive mortality and the conservativeness of the 1914 cruise data.

At a conference held in 1950 concerning the problems affecting practices on the forest, forester Walter Ridlington listed the following:

1. Excessive mortality in decadent timber, especially hemlock.
2. High cost of scattered logging.
3. Excessive damage to reserve stands by logging.
4. Unbalanced species production disrupts marketing program.
5. By-products harvest is going on without a management plan.
6. Lost logs.
7. Log deterioration.

The cutting during the period took place mostly in virgin areas in the northwestern part of the forest and along the northern border (Fig. 7). The total cut during the 12-year period was 231,654 M board feet, an average of 19,304 M board feet per year. This cut was spread over approximately 50,649 acres, for an average of 4,570 board feet per acre.

The selection cutting areas were covered by a 30 percent removal cut. The necessity to salvage cut-over areas as well

as areas damaged by fire, wind, etc. certainly obscured the relationship of the 30 percent cut guide to the 4,570 board feet cut per acre.

Statements from the Annual Reports of this period indicate that the selection cut was conservative. For example, the 1942 Report indicated an average leave volume of 10,850 board feet per acre and an average cut of 4,000 board feet. Other Reports (1945, 1946 and 1950) indicate cuts of between 3,000 and 4,000 board feet per acre. It would seem logical to conclude that the cut averaged more than a 30 percent removal due to salvage.

A review of the cutting systems and their effects on the forest was made by John Libby in 1950 (Libby, 1950). The following description is taken from the cutting budget prepared by him.

Block 1

Today there is little apparent difference between the 50 percent and 70 percent selection-cut areas. Reproduction is well established and considerable popple (aspen) is interspread through much of the area. The mature timber present is largely decadent. A number of formerly State-claimed forties are well stocked with good stands of largely overmature hardwood and hemlock. Silvicultural treatment of these so-called State forties is overdue, and the residual stand in the rest of the area must be harvested in the not too distant future if it is not to be lost.

Block 1A

This area was covered by a light selection cut in 1938. Periodic salvage of dead hemlock in hemlock and hemlock-hardwood stands has continued ever since. Today many places in this stand resemble the area mentioned above in Block 1, except that the reproduction is not as well established or as advanced in growth. The pine and red oak stands are in very good condition as are some of the other mixed hardwood

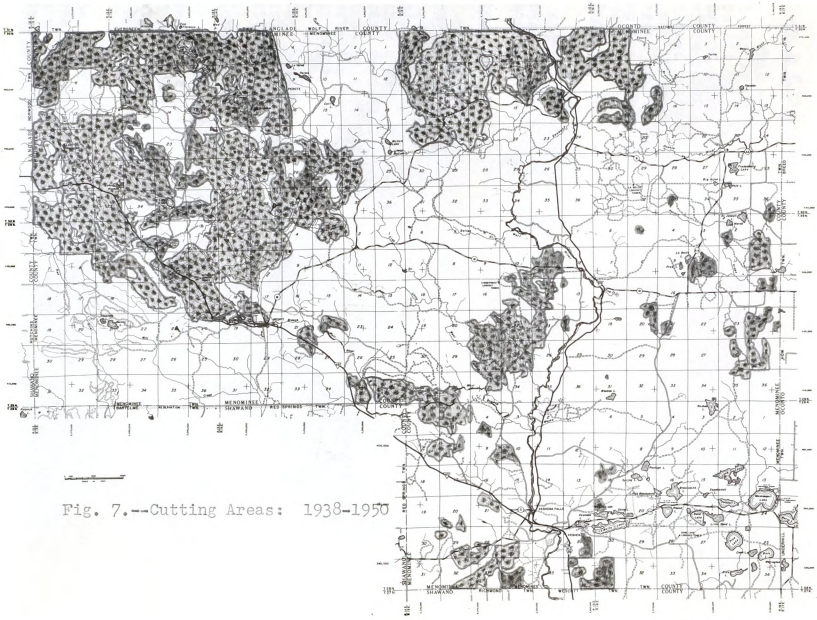

Fig. 7.--Cutting Areas: 1938-1950

areas. On the other hand some of the selectively cut hardwood areas are poorly stocked with low quality stands of beech and maple.

Block 2 (Including 2A)

This stand is generally in better condition than 1A. It was selectively cut in 1939 to 1941. A part of this area was hit by a sporadic windstorm in 1943 which leveled several limited areas of timber. Scattered blowdown resulted over a considerable area. In addition more or less continuous salvage of dead hemlock and birch has been necessary throughout the H and MH types. Today much of this latter area presents a ragged appearance and the mature timber still remaining is rapidly deteriorating.

Block 3

This area presents the same general picture as Block 2 and the same logging pattern has developed. Originally covered with a selection cut in 1941 to 1945, it has been recovered twice with salvage operations.

Block 4

Selection cutting has proceeded in this Block from 1945 to date, and will be completed by June 30, 1950. Mortality has not been as severe as was anticipated, probably because of a generally heavier soil than is found in other areas. Some blowdown has occurred and this together with moderate mortality of hemlock and birch has necessitated light salvage operations. The big problem here has been mortality too scattered to provide an attractive logging chance but still heavy enough to constitute a considerable loss in the aggregate. The timber stand as a whole is in good condition, however, and it is hoped that heavy salvage will not be required between now and the time this area is scheduled for cutting during the 2nd cycle.

Block 4A

This area was hard hit by blowdown in 1936. Most of the area was covered by salvage operations in 1937 and the rest of it by a light selection cut in 1939 and 1940. A small part of the block was recovered with a light cut in 1946 and a small area in 1949.

The area is in remarkably good condition considering the rough treatment it has had. While much of the blowdown area has little merchantable timber remaining, reproduction is well established throughout and a good part of it still bears merchantable volume sufficient to provide for one or

more cuts in subsequent cutting cycles. Selectively cut areas are in much the same condition as other such areas in adjacent blocks.

Block 5

This is for all practical purposes, a virgin stand of timber, covering some 16,000 acres. It is well stocked with an estimated volume of nearly 250 million feet, of which approximately 60 percent is white pine. In many parts of the block, the stand is too dense and the first cut will be largely a cultural operation to thin and to remove defective or otherwise undesirable trees.

Block 6

This block, too, was devastated by blowdown. Part of it was hit in 1905 and most of it again in 1934. Part of the area was accordingly logged in 1908-1910 and practically the entire area in 1935 and 1936. A cruise of the area is currently being made and the volume now present is proving to be in excess of expectations. Here as in most of the other blowdown areas, reproduction is well established over most of the area. Considerable areas that were not too hard hit by the 1935 blowdown are in good condition and ready for a light selection cut during the next cutting cycle. Other areas present a poor appearance with mature trees, left during salvage operations, deteriorating rapidly. One such area, around Burney and Hemlock Lakes is scheduled for cutting during the current fiscal year, to harvest this decadent timber while it is still merchantable and at the same time release the reproduction undergrowth.

Block 7A

This area was hit by blowdown and drought in 1935. Mortality in hemlock was heavy and salvage was effected in 1936. Subsequent salvage operations in succeeding years culminated in a final or release cut over most of the block in 1947 to 1949. Today the area is covered with reproduction from whip-sized saplings to young merchantable hardwood. No further cutting is contemplated in the major portion of this block for at least thirty years when a light cut should be feasible over a considerable part of the area.

Block 7B

This area is a small block of hemlock and hemlock-hardwood which has followed the pattern of similar stands in other blocks. It was originally logged with a light selection cut in 1941 to 1943. The entire area was recovered in 1947 with a salvage operation. It presents the same picture today as

stands in Block 3 and elsewhere.

Block 7C

This stand is practically a virgin stand, similar in composition to Block 5. There is damage from fire where it borders Block 13 on the north and damage from exposure where it borders Block 7A on the south. Generally however, the stand is in good condition but overdue for silvicultural treatment.

Block 8

This block is a conglomeration of timber types and conditions. Parts of it were logged in 1928 and 1930; another area in 1936 to 1938, and still other areas in 1940 to 1945. There remain other areas still in need of cutting and some of those cut between 1928 and 1945 are ready for another cut.

Block 9

Some cutting occurred in this block in 1923 and 1927. Starting in 1945, a selection and improvement cut was started in the area and has been conducted progressively since. The area of merchantable timber will have been completely covered by June 30, 1950. Except for a few hemlock forties, the stand will be left in good condition and can be partially recovered during the second cycle. A considerable part of it, however, has had what amounts to a release cut and will not be ready for another cut for at least 20 years and it might well be left alone for 40.

Block 10

There has been no systematic cutting program in this block. The Meshoquit Lake area was given a seed tree cut in 1926. Subsequent fires have kept back reproduction on much of the area. Soil and moisture conditions are such that establishment of natural reproduction could be expected to be slow under the most favorable circumstances. The soil is extremely light and dries rapidly. A series of wet growing seasons coincident with a good seed year would be necessary to establish any appreciable amount of natural reproduction. At the same time, much of this area is covered with scrub oak that affords strong competition to the sun-loving Norway pine seedlings.

The north and west sides of the block present a somewhat more favorable picture. There is a considerable area of relatively young pine south and east of Keshena. Part of this stand has been and is being covered with an improvement

cut to effect a thinning where needed and remove defective or otherwise undesirable trees.

Further north in the block, small blocks of pine together with scattered individuals are gradually seeding in a considerable area. Most of such areas are now receiving protection from Blister Rust and will eventually make up an important part of the commercial stand.

Block 11

Block 11 is an area of variegated conditions. At first glance, much of it appears near worthless from a timber production standpoint. Some few such areas are, but many others are seeding in quite well to white pine. A large swamp area in the southeast corner bears little of present commercial value over most of its area. Interspread through this swamp, however, are belts and islands of pine, both white and Norway, together with some hardwood and hemlock, that adds up to a considerable volume. Some of these areas have been covered by an improvement cut. Some excellent stands remain to be treated.

In the vicinity of LaBelle Tower there are some 2,000 acres of timber waiting to be cut. A large part of this is virgin timber, which will go as high as 30 M ft. per acre. The rest of this stand is a two-aged forest of hemlock, throughout which veteran white pine, thirty or fifty inches in diameter at breast height, occur singly or in small groups.

The west side of the block is spotted with white pine of all ages, occurring singly or in small blocks. Much of this area is seeding in to white pine reproduction and, if protected from fire and blister rust, will eventually comprise a considerable area of good pine forest. Many of the existing stands, such as the one at the mouth of Minnow Creek, are in need of thinning and improvement cutting.

Block 12

This block was logged during the period from 1922 to 1930, and most of it was covered with a 70 percent cut. Today we have no real data on the present timber stand, but random inspections indicate that much of the original, residual stand has disappeared and that the remainder is no more than holding its own. On the other hand, there is a considerable area in the block that bears an excellent stand of young hardwood with a scattering of mature trees throughout.

An early cruise of this block is planned and it is anticipated that a cut will be made therein during the second cutting cycle. The type and volume of cut cannot be definitely

determined until the cruise has been made. However, the indications are that part of the block will have to be covered with a final or release cut to remove the remnant of the original stand still present and merchantable, while the remainder will be covered with a light selection cut. In this latter case, it is hoped that the area so cut can be fitted into the regular working circle.

Block 13

This block lies in the center of the reservation and is of little present importance from a timber production standpoint. There are isolated patches of mature timber within the boundaries as well as some areas of well established and well-stocked hardwood poles. Also there are several areas where white pine is seeding in quite well and which will eventually form commercial stands assuming, of course, that it is protected from fire and blister rust.

For the most part, however, Block 13 is covered with immature popple and pin cherry (Prunus pennsylvanica). Some of this popple appears to be of fair quality and should ultimately produce a considerable volume of box bolts or small saw logs. Most of it, however, is of low quality, is cankerous and slow growing and will, at best, produce nothing but pulpwood, excelsior bolts or similar products.

The site over most of the block is definitely poor as the result of repeated fires during the period from 1917 to 1934. Some of the area is open and could (and probably should) be planted. The popple and brush cover is too thick over most of it, however, to make for good conditions and the cost of establishing plantations under such conditions would be prohibitive, at least from the strictly economic viewpoint.

At this point, with the exception of Blocks 10 and 13, the forest was in fair to excellent productive condition. Block 10, due to its very light soil, had not recovered from pre-reservation blowdown and fires. Block 13 had received the most punishment during the river driving and clear-cutting periods, primarily due to fires following the logging.

Libby also pointed out that experience gained during the 1938-50 period in selection cuttings in overmature stands indicated that a change in approach had to take place. It was

recommended that the 10-year cutting cycle be supplanted by a light to moderate selection cut over a 15-year period in the hardwood and pine stands. At the same time, the hemlock type would be handled by a 5-year cutting cycle. The general objective was to liquidate the old-growth hemlock as rapidly as possible with mortality kept at a minimum. This was the first noticeable attempt to manage the varying timber types with different treatments.

Period V: 1951-1964

After the first cutting cycle of the 1938 management plan was completed two years later than the 10-year length first prescribed, experience dictated that some alterations be made in the next cycle. Some of these changes have already been mentioned in Libby's summary of the management situation in 1950.

Essentially, the objectives that evolved were (1) a lighter cut in the hardwood and pine types allowing more complete coverage of the forest in 15 years, the time period chosen for the cutting cycle; (2) a 5-year cutting cycle in the hemlock type to most efficiently salvage mortality which occurred as an aftermath to cutting operations in the type; and (3) the inclusion of the by-products cut in the cutting budget in a more organized fashion. Along with these aims, a stepped-up planting program, an improved protection program, and the introduction of timber stand improvement prescriptions were vital components of the plan.

The 1951 plan was simple, little more than a cutting budget, but it was kept flexible to cope with changing economic conditions and physical factors which might necessitate alterations in the operation, a desirable requirement of any forest management plan. During this period, however, an event occurred which resulted in drastic alterations of the plan before the cycle was completed.

Termination- On September 3, 1935 (49 Statute 1085) Congress had granted and conferred jurisdiction on the U. S. Court of Claims to hear a case involving the Menominee Tribe of Indians and the United States. The Tribe asked for damages which were alleged to have occurred from mismanaging the Menominee forest. The points of concern were (1) the loss suffered when the timber blown down in the 1905 windstorm was not salvaged for three years or longer, and (2) the use of "clear-cutting" from 1911 to 1925 which was alleged by the plaintiff to be in opposition to the dictates of the Act of 1908.

On January 9, 1951 the Court awarded the tribe $896,208.78, a compromise lump sum settlement based on the damages and interest deemed to have accrued. In 1953, the tribe asked Congress to authorize a $1,500 per capita payment. The Senate, however, had reservations concerning this request. There was a philosophy prevalent at that time in Congress that the reservation status of all Indian Tribes should eventually be terminated. To set a precedent in this direction, the Senate agreed to support the per capita payment if the Tribe would

agree to the removal of federal responsibility on the reservation. The Tribe agreed and so the termination act (Public Law 399, 83rd Congress) was passed on June 17, 1954.

The original date set for termination was December 31, 1958, but it was later changed to December 31, 1960. After considering many alternatives, well described by Harkin (1966), the reservation became Menominee County. Almost all the assets of the county were placed in the newly formed Menominee Enterprises, Incorporated. The stockholders were the enrolled members of the Tribe at the time the termination act was passed. Each member was granted one share. These assets, of course, included the sawmill and the forest. By virtue of this action, the administration of the forest by the Bureau of Indian Affairs was ended, and all Congressional restrictions were lifted.

Forest management, therefore, was open to complete overhaul if desired. The only qualification present was one demanded by the Tribe, which was added as an amendment to Public Law 399, requiring that the forest be operated on a sustained yield basis.

The state of Wisconsin recognized that the new county had many obstacles to overcome because of its unique features, such as its almost complete dependence upon the forest resource and the sawmill. Because of this, the state conducted comprehensive studies to determine the needs and potentialities of the county.

The Wisconsin Department of Taxation made an appraisal of the Menominee lands, its forest and other resources for tax

and legislative purposes in 1957 (A Plan for Continuous Forest Control of Menominee Enterprises, Inc. Lands 1961). This resulted in a total assessed value of about $35,000,000. The Wisconsin Conservation Department interpreted and field-checked aerial photographs from which a complete cover-type map was made.

The state became involved in the management of the forest, and state forestry personnel worked closely with foresters hired by Menominee Enterprises, Inc. This responsibility of the state arose from the special tax computation methods required for forest lands obligated by federal law to be managed on a sustained yield basis.

The following is a pertinent excerpt from the statutes which defines the term "sustained yield management" (Section 70.335 of the Wisconsin Statutes.):

> "Sustained-yield management means that land taxed under this section shall be operated in a manner which will provide for a continuous annual harvest of high quality forest products on a permanent basis. Cutting practices used shall be such as to improve the quality of the residual stand and increase the production capacity of the lands on a permanent basis. The average annual cut shall be determined on the basis of studies of present volume, growth, degree of maturity of the forest, and it will include normal mortality, which is that timber which normally dies or is damaged each year as a result of natural causes. . . . . It is recognized that under sustained yield management the amount of timber cut will vary from year to year, but it shall not exceed the average annual allowable cut as specified in the forest management plan by more than 7 percent for any one year, or by more than 3 percent for any 5-year period, or by more than 2 percent for the cutting cycle."

The termination, therefore, resulted in changes in the

management plan during this period, as well as in the administrative staff and its philosophies. The cutting cycle and enough basic considerations were maintained in the changeover, however, to consider this period as a unit for discussion.

Transportation and Logging- The improvement in logging equipment during this period allowed for much more flexibility in the management program. Portable loaders replaced A-frame loaders in the early part of the period, and these in turn were replaced by loading units on the trucks themselves. Increased logging damage created problems in the transition period as new forms of logging equipment were being introduced. Power saws, originally tried with little success in the early 1940's, became standard equipment during this period. Increased skidding power also contributed to offsetting increased logging costs. The logging costs were increasing partially because of the trend towards harvesting smaller logs since the overmature stands had nearly all been covered by at least one cut. This trend was reversed somewhat, however, as the lighter cuts made it feasible to cut only the larger trees (Table 5.).

Table-5. Trends in Log Size, 1945-1952

Year	Logs per M board ft.	Year	Logs per M board ft.
1945	8.70	1953	11.05
1946	9.60	1954	11.38
1947	9.40	1955	11.78
1948	9.50	1956	10.94
1949	11.25	1957	10.22
1950	10.22	1958	9.96
1951	10.93		
1952	11.02		

Source: Annual Report (1952).

The trends in increased logging costs were, by comparison with lumber prices, very minor. From 1939 to 1951, logging losts increased by 98 percent (up from $11.64 to $23.06 per M board feet), while in the same interval lumber prices climbed 178 percent (up from $28.04 to $78.18 per M board feet). Present logging costs have increased to $33 per M board feet and the average lumber prices to $94.54 per M board feet. The latest percentage increase in lumber prices was more than double the logging cost increase.

Regulation of the Cut- Ever since the original Congressional edict which set the allowable cut of 20,000 M board feet in 1890, the job of forest regulation had been largely eliminated except for locating the cut on the ground. Traditional methods of determining the allowable cut over the years were not needed, and new pragmatic programs that could have been developed for the local situation were also avoided. The only deviations from the arbitrary allowable cut volume were minor and short-termed, and even these had to receive a congressional stamp of approval.

The first year of this period was still affected by one of these modifications, the 3-year increase to 25,000 M board feet which was passed so the forest administration could eliminate a backlog of salvage material. The 1951 cut totalled 24,238 M board feet, of which 8,773 M board feet were considered as salvage. The following year the regular cutting maximum of 20 M board feet was restored.

From increasing amounts of growth data provided by the

CFI system, it was becoming more and more evident that the 20,000 M board feet allowable cut restriction was too conservative. Although the foresters on the Menominee believed this to be true earlier, the CFI data provided real evidence for requesting an increase. Therefore, in 1957, the allowable cut was increased to 20,000 M board feet of sawtimber and 2,000 M board feet of by-products. These allowable cut volumes were followed until termination.

By-products continued to be a problem in this period as described in the 1958 Annual Report by Lee Winner, the Forest Manager:

> "Our primary shortcoming, and it may be one for which we will have no detailed or reinforced answer by termination, is in the matter of a by-products management plan. If this should happen, it will be because there is not now and never has been either a sound market for sale or a sound program for harvest. Volumes, areas, and expected yields we can now report; a schedule for harvest remains a mystery."

The New Management Plan- January 1, 1961 signalled the beginning of the opportunity to use more realistic methods for regulating the forest. Preceding this date, however, much work was done to prepare for this opportunity. The Bureau of Indian Affairs, the U. S. Forest Service, and the Wisconsin Conservation Department combined efforts to develop "A Plan for Continuous Forest Control of Menominee Enterprises, Inc. Lands."

The new plan continued to use the existing block system as the control for volumes to be cut and for the woods operators, although some boundaries were losing their identity.

The cutting budget was based on a 7-year program (1961-67) and was designed to apply to the area remaining in the 15-year cycle from the 1951 plan.

CFI data were the basis for determining the allowable cut of sawtimber. As the plots were tallied, the trees were classified into four cutting priority classes. Those trees in classes one and two were considered, on the basis of risk and vigor, to have high cutting priority. The volume of class one and two trees was expanded to a total forest basis. This volume was then increased by the total volume of overstocking, and this sum was then divided by 15, the number of years in the cutting cycle. By this procedure, an annual allowable cut of 30,297 M board feet of sawtimber was determined.

Until the post-termination plan was initiated, the regulation of the cut in by-products was pragmatic in nature. The combination of aerial photos, and a series of 100 permanent one-seventh-acre plots in by-products types provided necessary volume, area, and expected yield information upon which to build a sound program in the new plan.

The by-products types were characteristically even-aged, as described later in this section. Therefore, even-aged area control methods were recommended for those types which were not potential sawtimber areas, and uneven-aged volume control was recommended for the remaining types. The following is the portion of the 1961 management plan dealing with these types.

Even-aged Area Control- to be applied to Ox (scrub oak), Pj (jack pine), A (aspen), and A (saw) types.

1. Ox - this type to be liquidated, if possible, within 15 years. Total acreage divided by 15 years and cords per acre of stand applied to this annual harvest area.
$\frac{877 \text{ acres}}{15 \text{ years}}$ x 5.5 cd. eq[5]/A.= 323 cd. eq/yr. from 58 acres.

2. Pj - reserve 25 percent of area as being potential sawtimber stands. Remaining area less durable species to be liquidated in 15 years. This acreage, divided by 15 years and cords per acre of this species applied to this annual harvest area. Species considered for removal: white birch, aspen, balsam, and jack pine.
$\frac{(.75 \times 1,914 \text{ acres})}{15 \text{ years}}$ x 2.2 cd. eq/A.= 211 cd.eq/yr. from 96 acres.

3. A - reserve 25 percent of area as being potential sawtimber stands. Remaining area less durable species to be liquidated in 15 years. This acreage, divided by 15 years and cords per acre of this species applied to this annual harvest area. Species considered for removal: white birch, aspen, balsam and jack pine.
$\frac{(.75 \times 21,926 \text{ acres})}{15 \text{ years}}$ x 7.7 cd.eq/A.= 8,439 cd.eq/yr. from 1,096 acres.

4. A (saw) - aspen sawtimber area scheduled to be cut in the remaining seven years of this cycle. Divide area total by seven years and multiply resultant annual acreage by cord equivalent volume per acre (only 75 percent of white birch, all of balsam, and all of aspen--other species not included in this vol/A. figure, since they must generally remain for type conversion or at least upgrading). Volume per acre for cutting made up of 5"-12" DBH classes aspen, balsam, and white birch.
$\frac{13,794 \text{ acres}}{7 \text{ years}}$ x 4.8 cd.dq/A.= 9,456 cd.eq/yr. from 1,970 acres.

It will be noticed that this calculation involves 13,794 acres for a 7-year period rather than 18,758 acres previously shown as A (Saw) types.

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[5]cd. eq. = cord equivalent (2.2 cords/MBF for hdwd; 2.4 cords/MBF for conifers).

Areas determined from 1955 aerial photos established basic acreages for all types. However, some of this acreage has been treated since the beginning of the 1950 cycle.

The figure of 13,794 acres represents A (Saw) type remaining for treatment in this cycle from 1961-1967.

Uneven-aged Volume Control- to be applied to Cs (swamp conifer), NH (northern hardwood), SH (swamp hardwood), and P (pine) types. All species were considered for harvest in proportion to their existence in these types.

1. Cs - total area this type multiplied by .33 cds/growth/acre/yr. to be harvested annually during 15-year cycle.
$\frac{12,715 \text{ acres}}{15 \text{ years}}$ = 848 acres/yr. at rate of

$\frac{4,196 \text{ cds/yr}}{848 \text{ acres/yr}}$ = 4.9 cds./acre harvest

2. NH, SH, P - total combined area these types multiplied by .333 cds/growth/acre/yr. available for harvest annually during 15-year cycle.
8,008 acres x .33 cd. eq. gr/A./yr. = 2,667 cds. eq./yr. from

$\frac{8,008 \text{ acres}}{15 \text{ years}}$ = 534 acres/yr. at rate of

$\frac{2,667 \text{ cd. eq./yr.}}{534 \text{ acre/yr.}}$ = 5.0 cd. eq./acre/harvest

For the remaining years of the cycle, it is apparent that growth (Table 6.) was not used as a factor in determining the allowable cut except in the uneven-aged volume control portion of the by-products program.

Table 6. Net Annual Growth, 1953-1960

Timber type	Annual growth, board feet per acre
Hardwood	215.06
Hemlock	222.41
Pine	208.02
Aspen	236.78
Average per acre	220.57
Total forest	28,718 M

Source: A Plan for Continuous Forest Control, 1961.

The authors of the plan explained this policy as follows (p. 48):

> "It was felt that since omission of this growth accrual was in the direction of conservatism, it would help to offset a possible minus statistical error with which this sampling effort might unknowingly be plagued. Too, since the pattern of area designation for cutting is an orderly progression from the oldest cutting to the most recent cutting, it stands to reason that the higher limits of basal area range for an overstocked condition class will be cut first. Meanwhile, the most recently cut areas or lower limit of the basal area range for any condition class, will be deferred toward the end of the cycle. It is these areas upon which accrual growth will take place and, in fact, may serve to bring these deferred stands up to the average basal area level indicated in the stock and stand tables."

Most of the species involved in the by-products category are intolerant pioneer species. Because of their even-aged character, these forms were to be managed by even-aged treatments such as clearcutting and shelterwood. This prescription applied primarily to aspen-white birch, jack pine, scrub oak, and swamp conifer types. Other types in the by-products category, such as pole-sized pine and hardwoods stands, were to be controlled by basal area levels with the ultimate objective of developing sawtimber types.

The selection marking policies in the plan reversed a trend towards lighter cuttings, utilizing basal area as the indicator of desired stocking densities. The Bitterlich cruising method made this practice possible.

Optimum basal areas recommended per acre for the main types were:

Hardwood type----------70-80 square feet

Pine type----------130 square feet

Hemlock type---------- 90 square feet at re-entry.

In summary, understocked stands were marked primarily on a high risk, low vigor basis, while basal area became an additional guide in the overstocked stands.

In 1961, an area of pole-sized white pine in Section 30,29-14, was clearcut because of a high incidence of red rot due to an overstocked condition. This was a deviation from the recommended cutting pattern, and was not continued.

One general objective in the marking program was to favor the hardwood, white pine, and red pine components. Hemlock was definitely to be discriminated against, as it had been previous to this period. The low value of this species dictated this policy.

Inventory Program- The cruising program evolved into a complete dependence on the Continuous Forest Inventory system. By 1958, all CFI plots had been installed and at least the initial data computed. Approximately one-third of the plots in sawtimber types had been remeasured and the data computed for determination of allowable annual cut (Annual Report, 1958).

A new development in the inventory program was the use of aerial photos. Photo interpretation for the forest was begun by the Wisconsin Conservation Department in January, 1957. The interpretation and ground check were completed by May of that year. By August, the first complete and up-to-date cover type map of the forest was available. The 1958 CFI data were correlated with forest condition classes on the aerial

photo maps.

After some experience with the CFI results, it was found that the program was unsatisfactory. The plots had been located on a random basis, and this caused some difficulties as the CFI system evolved with use. Therefore, after termination, the CFI installation was redone under the guidance of Cal Stott, the Wisconsin Conservation Department, and the newly employed Menominee Enterprises Forester. This effort involved 950 one-fifth-acre plots located on a systematic basis, which were post-stratified according to timber type. This inventory resulted in some surprising information.

The present forest area (Table 7) is listed as 225,546 acres, with a sawtimber area of 144,495 acres, and pole-timber, 57,007 acres. The areas by timber type and condition class are listed in Table 8. The total volume was 1,527,381 M board feet and 1,973,000 cords. The volume is almost equally distributed between softwoods and hardwoods, 49.9 percent and 51.1 percent. The leading species by volume are hemlock, 24.1 percent, white pine 21.2 percent and sugar maple, 17.3 percent (Table 9). The overall average volume per acre is approximately 7,000 board feet and nine cords, or equivalent to about 11,000 board feet per acre.

Forest Protection- Previously strong fire prevention and control programs became even stronger when the responsibility for them was transferred to the Forest Protection Division of the Wisconsin Conservation Department in 1961. Total area burned in any year was less than 400 acres and with three

Table 7. Changes in Area by Land Use or Condition Classes Menominee Forest, 1930-1963.

Land Use or Condition	1939		1940		1955		1963	
	Area Acres	Per-cent	Area Acres	Per-cent	Area Acres	Per-cent	Area Acres	Per-cent
Sawtimber	91,623	39	93,973	40	131,312	56	144,495	62
By-products	32,891	14	79,878	34	45,440	19	57,007	24
Nonmerch.	96,323	41	46,986	20	44,085	19	24,044	10
Water	4,097	2	4,097	2	4,097	2	4,097	2
Agri. & Other Indust.	8,968	4	8,968	4	8,968	4	4,259	2
Total	233,902	100	233,902	100	233,902	100	233,902	100

Source: A Plan for Continuous Forest Control (1961) and current files of Menominee Enterprises, Inc.

exceptions, less than 200 acres. The total of suppression costs and damages did not exceed $3,000 in any one year. This situation was primarily the result of improved communications, hazard reduction programs, and cooperation of the public.

White pine blister rust continued to receive a great deal of attention in this period. The area of concern totals 25,375 acres. The cost for the white pine blister rust program far exceeds fire suppression and fire damage costs. Historically, the largest white pine grew in the river bottoms and along the margins of swamps, but these heavier soils areas are also the

more common Ribes sites. Therefore, most of the control efforts are diverted towards the areas with lighter soils.

The other major forest disease problems of the Lake States, Dutch elm disease (Graphium ulmi) and oak wilt (Chalara quercina), are either non-existent in the forest or of minor concern at the present time.

The insect problems are currently under control. These include the walking sticks in the low value scrub oak, Saratoga spittle bug and LeConte's sawfly in red pine plantations, and hemlock borer in the old growth hemlock. Modified cutting methods and aerial spraying have been the chief tools in the control program.

Trespass grazing by domestic livestock has created some problems in boundary areas. Since termination, the deer population has increased to the extent that tree reproduction is being adversely affected. The deer problem has developed because the residents who were allowed to hunt without restriction before termination have now come under Wisconsin hunting regulations. It is believed by many observers that the bountiful yellow birch reproduction on the forest is the result of the low deer population prior to federal termination. Wind, while still a nagging problem, has not resulted in any recent dramatic losses as in the past.

Timber Stand Improvement and Planting- Timber stand improvement work has been primarily restricted to plantations, and has included pruning, shearing, release work, and non-commercial thinning. The work has been done by student labor,

Table 8. Areas by Timber Type and Condition Class, 1963.

Type[1]	Total	Large Saw-Timber			Small Saw-Timber			Pole-Timber			Seedling & Sapling			Non-Stocked
		Good	Medium	Poor	Good	Medium	Poor	Good	Medium	Poor	Good	Medium	Poor	
						Acres								
W & R	31,229	14,127	5,700	4,213	248	1,487	1,487	496	744	1,239	744	496	248	
PJ	3,966	-	-	-	-	496	248	248	3,478	496	-	-	-	
SC	18,835	991	744	991	1,487	2,478	1,735	4,461	2,726	1,239	991	248	744	
HH	28,999	20,819	3,966	1,239	496	1,487	744	-	-	248	-	-	-	
NH	73,858	35,690	13,879	5,700	2,478	4,213	3,222	1,735	3,718	1,983	496	248	496	
SH	4,463	-	496	496	248	496	744	991	496	496	-	-	-	
A & B	47,835	248	248	496	496	2,726	4,213	8,675	9,418	8,675	3,470	4,709	4,461	
Ox	11,404	-	496	744	-	496	1,437	496	2,231	3,718	496	744	496	
TNP	3,470													3,470
PNP	1,487													1,487
TOTAL	225,546	71,875	25,529	13,879	5,453	13,879	13,880	17,102	21,811	18,094	6,197	6,445	6,445	4,457

[1] W&R - White and red pine
PJ - Jack pine
SC - Swamp conifer
HH - Hemlock-hardwoods
NH - Northern hardwoods
SH - Swamp hardwoods
A&B - Aspen and white birch
Ox - Scrub oak
TNP - Temporarily non-productive
PNP - Permanently non-productive

Source: Menominee Enterprises, Inc., Neopit.

Table 9. TOTAL VOLUME BY SPECIES--TOTAL FOREST, 1963.

	CUT			LEAVE			TOTAL			
Species	Bd. Ft.	Cord	Cull	Bd. Ft.	Cord	Cull	Bd. Ft.	Cord	Cull	%
White pine	77,819,338	31,532	755	246,256,662	54,153	1,335	324,077,000	85,685	2,090	21.2
Red pine	1,319,656	998	-	29,207,919	6,268	-	30,527,575	7,266	-	2.0
Jack pine	1,821,173	6,340	11	1,799,858	32,738	-	3,621,031	39,078	11	.2
Hemlock	66,913,737	62,032	1,697	300,989,754	142,205	1,216	367,903,491	204,237	2,913	24.1
White cedar	15,716,231	81,356	8,045	15,254,928	143,415	8,798	30,971,219	224,771	16,843	2.0
Black spruce	62,581	9.950	-	526,426	11,186	7	589,007	21,136	7	-
White spruce	257,802	313	-	2,554,550	5,004	12	3,512,352	5,317	12	.2
Balsam fir	400,148	8,802	14	387,507	30,112	24	787,655	38,914	38	.1
Tamarack	402,254	7,747	11	457,276	9,232	94	859,530	16,979	105	.1
Total Sft.Wd.	165,412,980	209,070	10,533	597,434,880	434,313	11,486	762,847,860	643,383	22,019	49.9
Hard maple	74,314,421	46,100	4,196	189,438,689	154,688	2,463	363,753,110	200,788	6,659	17.3
Soft maple	5,358,433	21,729	805	10,967,191	95,294	735	16,325,624	117,023	1,540	1.1
Yellow birch	38,680,474	25,154	6,540	66,942,737	71,454	6,061	105,623,211	96,608	13,601	6.9
Black ash	32,073,019	16,425	2,364	61,671,669	77,679	4,206	93,744,688	94,104	6,570	6.1
American elm	25,714,777	7,986	-	52,234,433	78,505	14	77,949,210	46,491	14	5.1
Rock elm	4,473,003	1,216	17	33.357,978	10,728	514	37,830,981	11,944	531	2.5
Red oak	16,936,067	5,559	1,124	53,007,714	82,409	476	69,943,781	87,968	1,600	4.6
White oak	9,723,127	56,942	732	4,967,207	29,157	25	14,690,334	86,099	757	1.0
Beech	5,909,395	8,541	1,915	21,309,313	24,158	1,907	27,218,708	32,699	3,822	1.8
Black ash	3,310,976	11,017	125	5,467,981	25,604	384	8,788,957	36,621	509	.6
White ash	2,567,810	2,059	275	2,775,257	18,090	5	5,343,067	20,149	280	.3
Cottonwood	87,490	380	-	327,280	1,447	29	414,770	1,827	29	-
Bitternut hkry.	-	1,409	-	861,389	10,726	-	861,389	12,135	-	.1
Black cherry	604,869	4,033	7	884,687	8,890	76	1,489,558	12,923	83	.1
Aspen	28,362,888	192,047	12,487	3,687,201	197,710	8,760	34,050,089	389,757	21,247	2.2
White birch	1,977,564	15,214	248	3,008,728	54,784	7	4,986,292	69,998	255	.3
Butternut	647,374	1,566	10	881,589	3,057	-	1,528,963	4,623	10	.1
Miscellaneous	-	2,220	20	-	5,640	192	-	7,860	212	-
Total Hd. Wd.	250,741,687	419,597	30,865	513,791,043	910,020	25,854	764,532,730	1,329,617	56,719	50.1
Total - All	416,154,667	628,667	41,398	1,111,225,923	1,344,333	37,340	1,527,380,590	1,973,000	78,738	100%

Source: Menominee Enterprises Inc., Neopit.

with the objective of providing constructive summer employment as well as improving the forest. When tribal funds were being used, this program was intermittent. After termination, however, Agricultural Stabilization and Conservation Service funds became available on a cost-sharing basis so that the continuing program, while not large, has had some consistency.

The planting program, phased out in 1933, and renewed in the 1940's as a token program, was re-established as a 10-year large-scale endeavor in 1952. Success in fire prevention and control was a major reason for the renewal of planting. Previous to 1952, 1,460 acres had been planted, and of these, 686 acres had failed. Most of the successful plantings were made in the 1940's. It was determined that 15,000 acres in abandoned farms, clearings and poorly stocked stands were in need of planting at the beginning of the 10-year program. The one-millionth tree was planted in the spring of 1959.

With the onset of federal termination, many cleared areas were claimed by residents for agricultural land. Therefore, the planting program shifted to clearing scrub oak land which, along with natural forest openings, provided the annual planting sites. Since 1952, the annual area planted has ranged between 80 acres and 150 acres. Most of this was planted with red pine. The management plan calls for the maintenance and possible expansion of the annual 100-acre planting program, on a 3 to 1 ratio of red pine to white pine. The planting has been concentrated largely in Blocks 13 (clearcut area), 10, and 11 (southeastern sandy soil area).

Results of Management: 1951-1964- Drastic change in management policies occurred during this period as a result of termination proceedings. More refined techniques in all phases of forestry made possible the development of a more intensive and sophisticated program on the forest. Protection methods had been successful in keeping damage within reasonable limits; inventory had provided the information necessary for the development of desirable regulation systems; harvesting techniques had become flexible enough to pursue any desired type of silvicultural system; and the Bitterlich cruising method had provided an efficient, accurate means to control stocking, whether even-aged or uneven-aged management was being pursued. It would seem that technically the control of the forest was, relatively speaking, well in hand.

The factors that still pose major problems are either economic or institutional in nature. These aspects will certainly influence the technical program as it continues to evolve. The cutting program was very widespread during this period, covering approximately 130,000 acres (Fig. 8). Block 13 was avoided completely, but, with the exception of large areas in Blocks 1 and 11, almost the entire forest was given some cutting. This acreage presented quite a different picture from the 1911-25 cutting area, when, over a similar period only 14,826 acres were cut.

The total volume cut during the period was 304,690 M board feet. This produced an average cut per acre of approximately 2,340 board feet. This per acre volume portrays the trend towards lighter cutting that characterized the major part of this period.

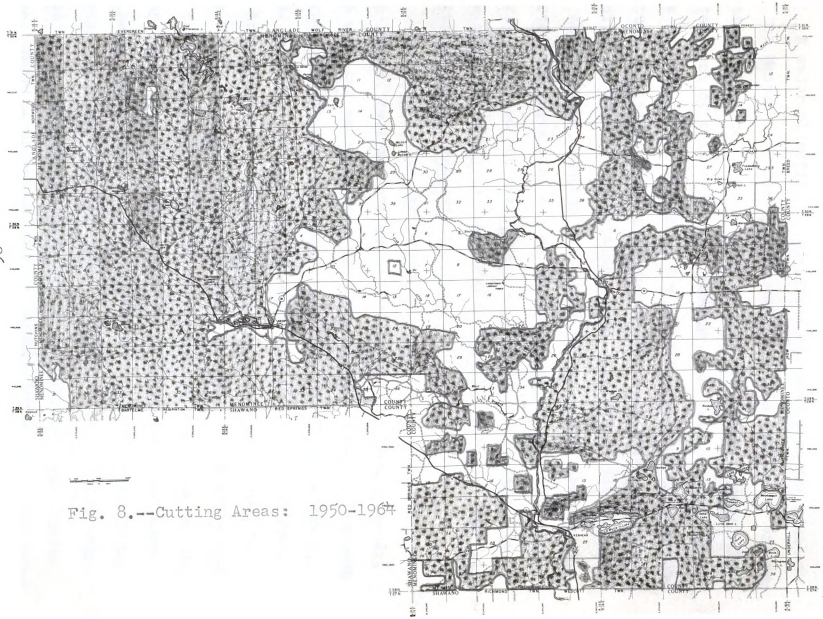

Fig. 8.--Cutting Areas: 1950-1964

MANAGEMENT RESULTS FOR 110 YEARS

A major objective in compiling and reviewing the history of the Menominee Forest was to determine the results of various cutting practices applied over a relatively long period. The attainment of this objective, however, has been hampered by the masking effect of fire. The first 80 years of governmental cutting restrictions were accompanied by inadequate fire control. The bulk of the cutting during this period took place on the somewhat droughty loamy sand soils. These areas supported the white pine and hemlock-hardwood stands, and, therefore, attracted the early softwood cutting. They were also the scene of the disastrous 1910 fire which initiated the "clear-cutting" period from 1910 to 1925.

Coincident with the advent of adequate fire control in the 1930's, cutting shifted to a single tree selection basis, and with the exception of some heavy salvage cuts, it has been light, amounting to 30 percent of the volume or less. This, plus the fact that most of the light cutting has taken place on the more mesic, fire-resistant areas, has contributed to the better condition presently found on areas lightly cut than on those which were clearcut. A meaningful comparison of the long-term effects of light selection silviculture with those of heavy selection cutting or clear-cutting is more difficult because of fire influence, than it would be if we had to contend only with the ever-present variables of site and forest type. Despite these obstacles, comparisons are made, utilizing

the earliest (1914) and the most recent (1963) inventory information. The species and volume differences in the two inventories for sample sections were related to the number and types of cuts as determined from cutting maps.

Areas Cut During the River Driving Period- Some areas of the forest were cut only during the period before 1908. The cutting during that time was not based on any silvicultural system, but was "high-grading" at its worst. Clear-cutting and group selection are probably the cutting systems which resemble, somewhat, the activities of those early days. Adequate slash disposal methods were not common in the heyday of the Lake States pine logging period, and the unsupervised logging on the Menominee was no exception. Consequently, most of these areas were burned repeatedly, and have not produced a harvestable timber crop since. This situation is most prevalent in the north-central portion of the forest, especially in the southern half of 30-15, and the northern part of 29-15.

The 1914 cruise described Sections 30 and 33 (30-15) as having no timber, and Section 35 as having 30 M board feet of which 23 M board feet were white pine. The 1963 inventory showed that Section 35 now supports approximately one million board feet. The species making the best growth have been Hill's oak, red oak, and hemlock. Pole sized timber has also increased from an initial volume of 13 cords of hardwood pulpwood to 8,341 cords of hardwood and softwood. In Section 18 (29-15), white and red pine have shown the most resurgence. The "no timber" designation has been replaced by almost two million board feet,

of which three-quarters consists of pine, plus 2,700 cords of pulpwood. The areas discussed above were probably denuded by the fire of 1910, which means they have had 53 years at most to recover, and conceivably less time than that.

For the same two sections described above, the annual growth has averaged 150 and 100 board feet per acre net (based on 54 years of growth on 640 acres). The average volumes per acre of 7,500 board feet on Section 35 and 5,100 on Section 18 are now at or above stocking levels recommended by Harkin (1966) for the hemlock and pine types which most characterize these sections. He arrived at his recommended stocking levels through a marginal analysis of annual growth to growing stock volumes for the three major types on the Menominee Forest. He recommended levels per acre of 4,500 board feet for the hardwood type, 6,000 board feet for the hemlock type, and 5,000 board feet for the pine type.

These guides are at variance with the optimum stocking levels listed in the A Plan for Continuous Forest Control (1961). There the recommendations show 8,500 board feet for the hardwood type, 9,700 board feet for hemlock, and 17,700 board feet for pine.

Sections 25 and 35 (30-16) were both logged only in the river driving days; both are developing as pine types but at different rates. Section 25 now supports an average of 4,300 board feet per acre, while Section 35 has an average of only 2,300 board feet. The bulk of these volumes on both sections is in pole-sized timber, mostly aspen.

There are twenty sections cut prior to 1903 which have not been cut again. A sampling of the composition on these areas indicates that pioneer species are predominant, with white pine and aspen making up most of the current volume. The volumes are beginning to attain respectable levels in most instances.

In his vegetational analysis of the Menominee Forest, Goff (1966) found much of the aspen to be about 35 years old and of sprout origin. These stands apparently became established after the cessation of widespread fires. He found an understory of 15-to 20-year-old white pine to be quite common, indicating the successional trend. There are still extensive areas of upland brush found on this part of the forest, although some of them have been converted to plantations since 1952.

The area cut during the river-driving period has responded in varying ways, depending not so much on the type of cutting but on the number and intensity of the fires that followed. Where there were even just a few seed trees left, reproduction is making progress. Where the seed source was inadequate, Goff (1966) found that several generations of aspen sprouts have succeeded each other until degeneration to extensive openings has taken place. He believes that perhaps only one white pine seed tree per two acres would be adequate to assure regeneration of that species in this situation.

Productivity has been at a low level, but the major cause is quite evident. Those stands not making a comeback necessitate a helping hand in the form of planting or site preparation

and broadcast seeding. If white pine is the species to be considered for establishment, the influence of blister rust should be first weighed carefully.

Clear-cutting- The cutting practice from 1910 to 1925 was primarily a merchantable clearcut. From 1910 to 1919, this system was not actively pursued, but instead was considered to be a selection system. The marking rules, as described earlier, involved diameter-limit cutting or the leaving of groups of young trees. The uncut trees, however, suffered so much from fire, windthrow, and exposure that the salvage cuts that followed completed the removal of the residual stand. According to Kinney(1945), the total area clearcut by virtue of salvage, selection and salvage, and clear-cutting amounted to 14,025 acres.

A comparison of recent timber type maps with the cutting maps of the 1910-25 period show that the area in question is now dominated by low density pole-sized stands and medium to well-stocked seedling and sapling stands. Aspen predominates while a heterogeneous mixture of tolerant and intolerant species plays a secondary role. On the loams and silt loam soils, there is a greater concentration of northern hardwoods accompanying the aspen. Red oak is one of the chief members in this group.

Only two sections were clearcut in their entirety after the 1914 cruise. They are Sections 11 and 14 of 30-14. They were cut over by 1921. Section 11 supported 8,691 M board feet and 5,700 cords before the cut. It now has 631 M board feet and 5,684 cords. If the possibility that fire retarded growth

is ignored, approximately 40 years of growth has taken place with an average annual growth per acre of 25 board feet and .22 cords, or a total equivalent of 135 board feet.

Section 14 has not been as productive since it contains a much greater non-forested area. Formerly the section supported 12,301 M board feet and 2,260 cords, while today it supports only 257 M board feet and 2,111 cords. If the 160 acres of non-forest area are excluded, the average annual growth per acre for 40 years has been about 64 board feet. There is no doubt that a lack of seed source and a series of fires have contributed to the generally poor condition of the clearcut areas some forty years after the cut.

An interesting topic is the condition of areas which were clearcut without subsequent burning. This is of special concern because woods labor is becoming increasingly scarce in the United States. Any reasons for encouraging the clear-cutting system might bring it into wider use, along with its permissible greater mechanization and less need of manpower.

In defense of clear-cutting, Libby reported in 1949 that areas which had escaped burning were then well-stocked with advanced reproduction (Libby, 1949). He believed this indicated that the poor condition of the clearcut areas was due to inadequate fire protection rather than improper silviculture.

In his study of the vegetation on the Menominee Forest Goff (1966) analyzed four 1- to 2-acre plots taken in clear-cut areas that showed no evidence of fire. The original vegetation, determined from stumps, was primarily hemlock-hardwoods

with some large white pine. The present stands are characterized by a relatively pure hardwood overstory, primarily yellow birch and sugar maple, with hemlock and tolerant hardwoods forming the understory. These clearcut areas are located on fine textured soils which supported mesic conditions. The average diameters of the 55- 65-year-old trees on the plots ranged from eight to twelve inches.

On the basis of these findings, Goff concluded that yellow birch, a very desirable species commercially, requires near clear-cutting of hemlock-hardwood with a canopy reduction to 20 percent, but leaving a yellow birch seed source. Scarification would also enhance regeneration.

Menominee Enterprises and Wisconsin Conservation Department foresters stated that their experience with heavy cuttings, including clear-cutting, on the Menominee Forest was negative. Even with fire excluded, regeneration has not been dependable, or has tended to be of low value species or low quality hardwoods with a preponderance of one-log trees.

In discussing their unpublished research on even-aged management of northern hardwoods, Carl Tubbs and Rodney Jacobs, silviculturalists with the United States Forest Service's Northern Hardwoods Laboratory, agreed with the Menominee Foresters. Their results following strip clear-cutting on the Argonne Experimental Forest, located about 50 miles north of the Menominee Forest, have provided little support for this system. They indicated that Canadian efforts had been more successful in the more humid area east of the Great Lakes.

Their studies on the Dukes Experimental Forest also brought out the tendency of new trees to fork excessively following heavy cutting, thereby reducing the number of high quality logs. This they said was the most undesirable result of any cutting system which removes more than 50 percent of the stand, especially where sugar maple is a major component.

The varying results following clear-cutting on the Menominee Forest and in adjoining regions, especially in northern hardwoods, would appear to indicate that any return to the use of this method should be made on a conservative basis.

Seed Tree Cut- In the only purposeful attempt at use of the seed tree method in 1925-26 by L. O. Grapp, the operation was restricted entirely to 28-16, the least productive township on the forest. With the exception of a light selection cut over most of this township for improvement purposes in the 1954-63 period, the 1925-26 seed tree cut was the only harvest operation in this township. Since many of the trees marked by Grapp to be left were cut anyhow, the Court of Claims regarded this area as part of the clear-cutting.

The 1914 cruise showed very low volumes present on the sandy soils of this area. Most sections supported less than 300 M board feet of sawtimber and very little cordwood. Only six sections along the southern border exceeded this volume, and of these, only two had more than one million board feet. The average per acre volume for the entire township at that time was only 450 board feet and 0.3 cords.

A random sample of six sections out of the township showed

that there has been a reasonable increase in volumes according to the most recent inventory. The average per acre volume over these randomly selected sections equals 3,900 board feet and 6.2 cords, with a low of 260 feet and 3.7 cords on a section which contains a large area of non-forested land. This section was completely within the seed tree cut area. Red pine showed the greatest decline in volume.

A large part of the volume in the township is in Hill's oak and aspen, but in some areas, especially the western and southern portions, white and red pine are achieving some respectable volumes. The combination of recurrent fires, both before and during the management period, the xeric conditions, and the lack of adequate seed sources has resulted in the present low degree of productivity in this general area.

Where red and white pine seed sources were present, Goff (1966) found pine seedlings to be established in significant numbers. Perhaps if more of Grapp's marked seed trees had been left, the area would be in much better condition today, although the sandy outwash plain is a great fire hazard.

Heavy Selection Cut- This system was the first attempt at uneven-aged management on the forest with the exception of the brief trial in 1909-1910 just northwest of Neopit. The good condition of that area 17 years later prompted Grapp to emulate the cutting system, which amounted to a 70 percent removal on a selection basis.

This system was used for six years, from 1927 through 1932, when the heaviness of the cut was questioned, and the

move to truck logging allowed a reduction of the cut to 50 percent.

The harvesting program from 1927 to 1932 was restricted mostly to 30-14 and 13-16, with some scattered small areas further south, and involved roughly 16 sections. With the exception of some overlap with the river drive cutting area, most of the area was cut for the first time. Since the areas concerned have sandy loam to loam soils, they supported relatively heavy volumes, ranging from 9,000 to 15,000 board feet per acre.

The cutting maps indicate that even though most of the 70 percent area has been cut over once or twice since the initial cut, the types now present are primarily small sawtimber and large sawtimber size classes with medium to high densities. The 70 percent areas that appear to be in the poorest condition are located in the eastern part of 30-16, where outwash sands predominate and where some clearcutting had ensued in neighboring areas, a combination of factors conducive to serious fires. Also, granitic rock outcrops are prevalent in that area which would contribute to windthrow in stands cut by heavy selection.

To obtain a comparison between former and present volumes on areas that have received this heavy selection cut, conditions on Sections 1 and 2 of 30-14 were analyzed. They were both cut in 1928 or 1929, and both also received a 30 percent cut in the mid-1950's.

The volumes in 1914 averaged 11,500 board feet plus about five cords per acre. Current volumes average approximately

8,000 board feet and five cords per acre. It was reported earlier that an average of 10,484 board feet per acre was removed in this type of cut, indicating that approximately 15,000 board feet was the initial stocking. With an allowance for growth and the acknowledged conservativeness of the 1914 cruise, the volume before cutting compared favorably with the original volume. In the 30 to 35 years since the 70 percent cut, the sampled area indicates that despite the heavy cut on most areas, followed by a light (less than 30 percent) cut, a resurgence in volume has taken place, until present volumes amount to about 55 percent of those before initial cutting in 1927. The growth, excluding the light cutting of the 1950-1963 period, has averaged 100 board feet per acre per year. A large part of the area is ready for another cut, with the present volumes far exceeding Harkin's (1966) recommended economic stocking levels.

It would appear that much of the area has responded sufficiently well to this heavy cut to consider heavier cuttings in northern hardwoods and hemlock-hardwoods than those being made currently. The Northern Hardwoods Laboratory silviculturalists recommend a 50 percent cut in well-stocked stands. They believe that this puts more growth on fewer trees, thereby shortening rotation periods without jeopardizing quality.

Salvage Cuts- The 50 percent removal cut program never had the opportunity to really be used; the windstorms of the mid-1930's were the influential factors in interrupting this program.

A brief review of major salvage areas due to windstorm is made at this point to determine if any trends are apparent. This is difficult because of the lack of pattern in nature. A windstorm sometimes achieves the equivalent of a preparation cut in the shelterwood system, or clear-cutting in small to medium patches, or leaves only seed trees, but most often achieves effects equivalent to the selection system.

The four western townships suffered the most concentrated windthrow damage, although a rather large area in central 30-16 was also affected in 1933. A comparison of present type maps and the salvage cutting map shows that a great preponderance of the area is now in the large sawtimber-heavy density condition, either in northern hardwoods or hemlock-hardwoods. At least one, and in most cases, two light selection cuts have been made on these areas. With the exception of a minor amount of cutting during the river driving period, the salvage cuts were the first made on these areas and likely were much needed improvement cuts.

The Menominee Forest has been subjected to many windstorms in the past as indicated by the number of shallow pits and mounds, called "cradle-knolls" by Hole and Schmude (1959). G. A. Nielsen reported (Soil Survey of Menominee County, 1967) that the vegetation on silty soils in the four western townships is much more susceptible to windthrow than that on coarser textured soils. He counted an average of 141 cradle-knolls under mature hemlock-hardwood forest on the Menominee as compared to only four per acre under jack pine on sandy soils.

Windthrow brings about conditions different from those of a cutting in that not only are openings created, but a great deal of mineral soil is also exposed. This is conducive to the regeneration of hemlock and yellow birch, and to seedling regeneration more than to sprout growth. Ronald Perry, Menominee Enterprises forester, reported higher quality trees regenerating on areas opened by windthrow than on areas opened by heavy cutting.[6]

The comparison of species composition and volumes in 1914 and 1963 on almost all sampled sections shows a noticeable increase in the volume of all species. Most of this area had been cut shortly before the 1914 cruise to salvage the 1905 blowdown, so the volumes would have probably been at a low point. An exception to this was Section 14 in 30-13. This complete section was covered by a salvage cut that had been necessitated by the windstorm of 1937. This was followed by a light selection cut begun in 1954 and completed in 1957.

This section had a total of 4,740 M board feet in 1914, and now has approximately 3,500 M board feet. There is much more sapling aspen area in this section than in the surrounding sections, about 200 acres. This area reduces the volume total, since the remaining timber types are mostly large saw timber stands of medium to heavy density. The cordwood volume has increased by 5,000 cords, so the total equivalent board foot volume actually shows an increase.

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[6]Personal communication.

Light Selection Cutting- From 1938 to 1950, a program of light cutting ensued with the objective of removing approximately 30 percent of the volume in well-stocked stands and to make improvement cuts elsewhere. As the transportation system improved over the years, an even lighter cut was made.

In this final stage of development, all virgin portions of the forest received two cuts in most instances, and much of the remainder of the forest was cut again. A check of several sections cut only in this light fashion shows a much higher volume today than was listed in the 1914 inventory. In 29-16, an area of such poor condition as to exclude all but a limited amount of cutting for salvage purposes during the river driving days, much of the township was covered with one or two light cuts. Five sections cut only in this fashion show an average volume of 3,000 board feet today, whereas in 1914 they averaged only 900. The cordwood volumes also have increased tremendously, from an average of one-half cord to 5 cords. All species seem to have responded well to the light cuts.

In 29-13, the sampled sections increased from an average of 4,000 board feet to 14,000, and from two cords to almost nine cords per acre. On these heavier soils, sugar maple has shown the greatest increase as a result of this treatment. Hemlock and elm have also benefitted from the cuttings.

In 30-13, an average of 2,300 board feet per acre had increased to 14,500, an astounding increase since the area was cut over twice within the past 20 years. The amounts cut in

the pre-1950 30 percent era ranged from 2,000 to 4,000 board feet per acre according to Libby (1949). The more recent cut averaged about 2,300 board feet per acre.

The areas subjected to only these light cuts are still in a very heavily stocked condition, most of them far exceeding the available recommended silvicultural levels. The species which has benefitted most has definitely been sugar maple, although all species now exceed their early volumes. It is questionable whether these light cuts are justifiable from either silvicultural or economic viewpoints, especially when dealing with high density sawtimber stands.

Volume Distribution by Species on the Menominee Forest, 1914-1963- Table 10 provides an excellent picture of the effects of management on species composition over the past fifty years. In spite of the probably conservative nature of the 1914 inventory, and the possibility of bias against certain species such as aspen to the point that they may have been ignored, overall changes in species and total volumes are very marked.

The most impressive change is the gain in total volume. The 1963 sawtimber volume shows an increase of 70 percent over that in the 1914 survey. The pole-sized timber gained even more in this period, with the 1963 cordwood volume being almost 9 times as large as the 1914 volume. If the cord volume is converted to its equivalent in board feet (2 cords = 1,000 board feet), and added to the sawtimber volume, the net increase over the 50 years has been approximately 1,502,761 M board feet, or a net per acre annual increase of approximately 160 board

Table 10. Volume Distribution by Species, 1914 and 1963.

	Sawtimber			
	1914		1963	
Species	Volume (M board feet)	Percent	Volume (M board feet)	Percent
White pine	155,626	17.3	324,076	21.2
Red pine	20,131	2.2	30,528	2.0
Jack pine	102	-	3,621	.2
Hemlock	491,538	54.7	367,093	24.1
Cedar	3,630	.4	30,971	2.0
Spruce (black and white)	350	-	4,101	.2
Balsam fir	131	-	788	.1
Tamarack	4,904	.6	860	.1
All Softwoods	676,412	75.2	762,848	49.9
Sugar maple	62,597	7.0	263,753	17.3
Red maple			16,324	1.1
Yellow birch	60,738	6.8	105,623	6.9
Basswood	54,641	6.1	93,745	6.1
Elm (all)	28,998	3.2	115,780	7.6
Red oak	8,006	.9	69,945	4.6
White oak	-	-	14,890	1.0
Beech	4,046	.5	27,219	1.8
Ash (all)	2,590	.3	14,122	.9
Aspen	58	-	34,050	2.2
Miscellaneous	75	-	9,281	.6
All Hardwoods	221,749	24.8	764,732	50.1
Total	898,161	100.0	1,527,580	100.0

	Pole Sized Timber			
	1914		1963	
Type group	Cords	Percent	Cords	Percent
Hardwoods	208,152	92.0	1,329,617	67.4
Softwoods	18,165	8.0	643,383	32.6
Total	226,317	100.0	1,973,000	100.0

Sources: 1914 data - Menominee File, Federal Records Center, Chicago.
1963 data - Menominee Enterprises, Inc., Neopit.

feet. During this same period approximately 971,188 M board feet were harvested, for an average of 90 board feet per acre over the entire forest. Thus, net increase plus cut equals 250 board feet per acre per year, for an average annual production of approximately 56,000 M board feet.

The species showing the greatest changes over the years are hemlock and sugar maple. Hemlock volume decreased 123,635 M board feet, and its percentage of the total volume dropped from over half to less than one-fourth. Sugar maple increased by approximately 260,000 M board feet. The early cruises lumped sugar and red maple, but red maple probably played a small role in the earlier stands. Sugar maple increased from 7 percent to 17.3 percent of the volume. Among other species, white pine, red oak, elm and aspen have made considerable gains in volume.

Comparison With Surrounding Forest Area- To compare the results of management on the Menominee Forest with that of the surrounding forested area, the Eagle River district of the Nicolet National Forest was chosen. It is believed that the differences between the two areas, are predominantly due to cutting practices and fire, rather than other environmental factors. The Nicolet was formed in the 1930's, and therefore, has been under management approximately 30 years. The district is composed of about 110,000 acres, or approximately one-half that of the Menominee Forest.

According to Gary Koeppen, the district ranger, the allowable cut on the district is 10 million board feet.[7] Of this,

[7]Personal communication.

approximately one million feet is sawtimber, and the other nine million is pole-sized timber. The Menominee, with twice the land area, has an allowable cut four times greater than the district, and a sawtimber cut thirty times greater! The by-products cut is about equal.

The Eagle River district is fairly typical of the forest land in the northern Lake States which has been receiving some management, and therefore, this comparison shows that the Menominee Forest is an island of predominantly sawtimber in a region of second growth hardwoods and aspen.

CONCLUSIONS

(1) The history of the Menominee Forest very closely parallels the general history of forestry in the United States, especially the Lake States region. The sequence of events exemplified on the Menominee Forest was as follows:

(a) The pine cutting era was characterized by high grading and river driving.

(b) A switch to hardwood cutting took place after the bulk of the pine had been removed. This period lasted from about 1900 to 1930 and was dominated by clearcutting and salvage cutting. Partial cutting was practiced minimally, and research on this system and in northern hardwood management in general, was not begun until 1926 (Eyre and Zillgitt, 1953). The Goodman Lumber Company, of Goodman, Wisconsin, is given credit for first practicing sustained-yield. Under the Nicholson-Grapp plan of 1930, the Menominee Forest soon followed suit.

(c) Selection silviculture prevailed after 1930, and with the replacement of railroad logging by trucks, the cut became progressively lighter. The introduction of trucks and a widespread road system created better access, and with a greater public awareness of the damaging results of fire, effective fire prevention and control programs made positive forest management possible.

(d) During the past decade, the development of more sophisticated techniques and equipment for regulating and harvesting the forest has occurred. Basal area control using the

Bitterlich cruising system, growth determination by continuous forest inventory, stock and stand information provided by aerial photography, and management guides resulting from research, all have contributed to a more intensive management program.

(e) In the current period, Lake States foresters in general and the Menominee foresters specifically are in a state of soul-searching. The rising costs of management and harvesting, complicated by a labor shortage, have created an economic crisis which threatens to cause alterations in the biological aspects of the management program (Wambach, 1966). Increased mechanization with its lower cost per unit of volume produced has been necessary to offset higher labor costs and lack of manpower. Macon (1966) indicated that the necessity to mechanize would result in more clearcutting and prescribed burning, since the larger machines need more space for maneuvering and cause excessive damage to the residual stand.

(2) Despite a history somewhat similar to that of most Lake States forests, the Menominee Forest is unique in that well over 50 percent of the forest area, 144,495 acres, is in sawtimber types. The volumes and allowable cut are much higher than on any similar area in the Lake States. The overriding factor which has caused this situation was the conservativeness of the allowable cut over much of the forest's history. A fact which has been determined by hindsight.

The allowable cut from 1890 to 1960, set by Congress with no volume or growth basis, was 20 million board feet per year.

The net total of growth and cut determined by this study indicates a possible annual cut of 56 million board feet, while determination made on other bases by Toole (1957) and Harkin (1966), show long-run sustained yield possibilities that range from annual cuts of 35 million to 59 million board feet. The 1954 CFI program, replaced in 1961 because of its inadequacy, revealed that annual growth in sawtimber types was about 28 million board feet. When pole-sized stands are considered as well, the cut could be close to 40 million board feet (A Plan for Continuous Forest Control, 1961).

These data indicate that the 20 million board foot allowable cut was permitting the growing stock to build up, despite fire, windstorm and questionable silvicultural practices, which was a luxury the remainder of the forested areas in the Lake States did not enjoy.

(3) A historical review of the Menominee Forest did not permit an entirely satisfactory comparison of the long-term results of various cutting practices. The 80 years of uncontrolled, severe fires from 1854 to 1934 have modified very strongly the effects of the various silvicultural systems used during that time. The bulk of the pre-1934 cutting took place on the more xeric sites of sand and loamy sands. These sites are much more vulnerable to fire (Baxter, 1966). Most of the post-1934 cutting was done on sites with finer textured soils, which are more fire-resistant sites. The cutting prior to 1934 was, of course, dominated by the heavier cutting systems such as clear-cutting,

seed tree, and 70 percent selection, while the cutting since then has been a light selection for the most part.

(4) The species benefitting the most by the heavy cutting and subsequent fires during the early period were, as would be expected, the more intolerant pioneer species. Aspen, red oak, and white pine are examples. Red oak and aspen show the greatest increase from the initial inventory data on areas receiving this type of treatment. The species benefitting the most from light cutting in the later period has been sugar maple, which has increased its presence more than any other species. A continuation of the light cutting of the 1938 to 1960 period would only maintain or might even diminish some of the valuable intolerant species that occur on the forest.

(5) Several species and forest types still present complex silvicultural treatment problems. Hemlock has been reduced by over 50 percent from its initial inventory level. It formerly made up 57 percent of the forest volume; at present it composes only about 25 percent. Because of its low commercial value and its degenerating influence on a site (Baxter, 1966), its reduction can probably be considered as desirable. However, its aesthetic value, and its potential in the pulpwood market, as well as a probable upswing in the framing market[8] portend a more optimistic future for this species. If so, the decline in

[8]Personal report from Wayne Lewis of the Wood Products Laboratory, Madison, Wisconsin.

hemlock is a problem. Its sensitivity to exposure has always made it vulnerable following partial cutting, and yet its tolerance would seem to indicate that this type of cutting should favor its reproduction. Thus far, research has contributed little in regard to the management of this species.

Yellow birch still poses an enigma, and because of its value, is attracting more attention. To obtain regeneration, opening the stand and scarifying in the presence of a seed source is generally agreed to be the best practice. Foresters on the Menominee, however, still find that yellow birch reacts negatively to exposure in the same fashion as hemlock. Seed tree cutting, as recommended by Goff (1966) might be most realistic, since only a few trees would be left to suffer from exposure after their seed dispersal was accomplished. However, quality in the newly established stand might suffer from excessive forking.

Other forest types presenting problems are the scrub oak type in 28-16 and 29-16, and the swamp types. The former is a low value type dominated by Hill's oak that has been maintained by sprouting after the fires frequenting the outwash plain. The oak even out-competes the higher value aspen, and supplemented by Carex meadows, also prevents pine regeneration in areas where pine seed sources occur. This type, which covers 11,404 acres, should be converted to others which are more productive, such as red pine on the drier sites and aspen on the more mesic ones.

The swamp types, both hardwood and conifer, pose very

complex problems. These types occur on about 23,000 acres, or about ten percent of the forest, with conifers covering about 19,000 acres of this area. The Menominee Enterprises forestry staff has found the rates of growth in the swamp hardwoods to be so low that they are being by-passed in the present management plan. Swamp conifers have presented a problem in regeneration over the Lake States in general (McCulley, 1963), and from the comparison of inventories, it appears that the high valued spruce and balsam fir are not making much progress. Commercial clear-cuts in the 1930's, followed by partial cuttings, have not produced a desirable response according to Benzie (1963). His studies of various cutting systems lead him to recommend complete clearcut areas of a size that assures seed coverage from sources on the sides.

In the swamp conifers, cedar is responding the most vigorously. The comparative inventory data indicate this situation, and they are reinforced by statements made by the Menominee Enterprises forestry staff. The present economic plight of this species, however, is discouraging. This situation was made quite evident at the Swamp Conifer Management Seminar held by the Lake States Council of Industrial Foresters in Eagle River, Wisconsin in 1963.

(6) The primary objective of management has been the production of raw material for processing in the sawmill. Since the sawmill has a capacity of between 20 and 25 million board feet a year (with the use of portable mills, this capacity nears

the present day sawtimber allowable cut of 30 million), and the forest has a yield potential in excess of 40 million feet, this single-track program of management seems inefficient. This under-harvesting results in the building up of an already overstocked condition. This takes on added significance when the current cost-price squeeze on sawmill operators is taken into consideration (Church and Niskala, 1966).

RECOMMENDATIONS

The following recommendations, based on the preceding conclusions, emphasize the maintenance or alteration of current practices with the objective of gaining more efficient use of the wood fiber potential for Menominee Enterprises Incorporated. Adoption of these recommendations should upgrade the economic productivity of the forest without diminishing its silvicultural aspects.

(1) The first and most important recommendation is that Menominee Enterprises should diversify its program to obtain more benefits from the abundant and varied raw material base. This diversification should begin with an alteration in the management plan. The most obvious point in this regard is the desirable deviation from almost pure sawtimber management and processing. The forest productivity already exceeds the capacity of the Mill, and with an expected increase in productivity because of more intensive management and continued forest protection, the sawmill's production should be a major objective, but not the only one.

If the better sites, the silt, silt loam, and better sandy loam soils, were utilized for sawtimber production, the average growth per acre determined by the first CFI program of 218 feet per year could conservatively be raised to 250 feet (a value approximating the average determined from 50 years of growth and cut data). With this yield, only 120,000 acres would be needed for meeting the mill's needs including the portable

mills now in use.

This would leave approximately 100,000 acres for a shorter rotation program producing materials for a different processing plant. At present there is a by-products cut of 25,000 cords annually, as well as a 1½-ton residue per 1,000 board feet of sawmill production that is being sold as chip material. The latter category excludes the residue from hemlock, oak and basswood. This tremendous amount of wood fiber is providing the least possible return since stumpage is the only value involved in this exchange.

The 120,000 acres suggested as a sawtimber working group would involve roughly the four western townships plus the northern half of 30-16 and 30-15. The other half of the forest would be managed with other species and shorter rotations in mind.

The recommended processing plant would be of the particle board-fibreboard type. Wayne Lewis (1964), of the Forest Products Laboratory at Madison, Wisconsin, indicates this type of plant efficiently utilizes fiber and presents a minimal problem in regard to water pollution.

On the basis of the current by-products production, and the residue available from the mill, it would appear that the forest could support a 200-ton capacity board plant. With an estimated required investment of $3 million per 100 tons, this would necessitate an investment of about $6 million. Harkin (1966) has reviewed possible sources of capital for this type of development.

One difficulty in this suggestion is the heterogeneous grouping of species which the forest now has. Lewis and Schwartz (1965) indicate that practically all species can be used in this type of processing, but that an individual mill usually has to be fairly selective in the species it uses. This would seem to indicate a need for managing the short rotation area for two or three species only, probably aspen and pine. These are the logical species to produce on the sands and sandy loams of the eastern half of the forest from a silvicultural standpoint, anyhow.

A study of the particle board market in the North Central region by Duncan (1965) indicated a need for such plants. Most of the plants are located in the southeast or on the west coast and so are a considerable distance from the Lake States markets. Also, the study showed many firms to be interested in particle board as a substitute for current materials being used.

The sales force of the Menominee Enterprises would be in a better position with both lumber and particle board in its portfolio. For those materials not usable in the particle board plant, it is recommended that they be chipped before being sold to the pulp and paper industry. This can be done in the woods efficiently with advancement in technology, and thereby allow for the lowering of pulpwood quality standards (Macon, 1966). The result will be the conversion of currently submarginal stands into commercial assets.

(2) Silviculturally, it is recommended that the basal area

guides (Arbogast, 1957) now being used should be continued in the sawtimber working groups. These guides have resulted in cuttings as heavy as the 70 percent cuts of 1909 and 1927-1933. However, this is a desirable change from the light cuttings of the 30 percent and lighter "risk and vigor" days.

It is suggested that the guide, now in force, which allows cuttings up to one-fifth-acre in size be emphasized. Not only should this allow more mechanization such as using rubber-tired skidding equipment to keep costs down, but it will favor intolerant species like yellow birch to a greater degree. Group areas larger than this apparently have created problems in regeneration and subsequent tree quality. Groups not to exceed one-fifth-acre are probably the best answer to yellow birch regeneration and quality problems and its susceptibility to exposure.

Various forms of even-aged management should be used for the non-sawtimber working groups. Clear-cutting should be used in the aspen and swamp conifer types, seed-tree in the red pine type, and shelterwood in the white pine type.

The scrub oak, upland brush, and Carex meadows should be converted to more productive conditions as soon as feasible. This probably should be done by prescribed burning in the summer, as indicated by Buckman (1962), and by cutting where appropriate, such as in merchantable oak stands. If an appropriate seed source is lacking, planting will be necessary. Red pine is the logical species to plant at the present time.

(3) A great asset of the forest, which is still not meeting its potential, is its recreational value. At present, Menominee Enterprises charges fees for hunting and fishing, and is granting leases for summer cottages on a fee basis. Also, various programs for maintaining the Wolf River in its present form as a "wild river", and the acquisition of land along its shore for a state park are being discussed. The Wolf River Valley Planning Commission under the leadership of Gordon Bubbolz of Appleton, Wisconsin is attempting to upgrade the recreational potential through the training of county residents as guides and naturalists, as well as the development of a nature interpretation center.

This analysis would recommend a discontinuance of the summer cottage site leasing program. The valuable shore line property should be retained for publis use on a fee basis allowing for a greater turnover of users and flexibility for control. The nearness to population centers and the overcrowding of nearby public campgrounds indicate that well developed facilities would attract tourists and campers to the forest.

To realize the potential revenue attracted by the forest, Menominee Enterprises or forest residents should provide services such as grocery stores and service stations in concentrated areas so as not to lose the wilderness environment. Facilities such as that advocated by the Wolf River Planning Commission should be free or administered on a low fee basis so as to encourage the retention and return of visitors. Excessive prices would divert people to national and state facilities farther north.

To enhance the potential recreational use, silvicultural practices should be modified along all roads and bodies of water to maintain an environment that is consistently pleasant to the aesthetic sense. A single tree selection cut based on risk and vigor would be the logical system for such areas. Such a cutting system should be applied for a distance of approximately 200 feet on either side of a road, and for about 1,500 feet from a body of water. The roadside band would be wide enough to provide a "wilderness" atmosphere for sightseers in cars, while the wider zone along the river would diminish possible erosion from skid trails as well as to provide for more desirable side trips for canoeists taking respites.

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Appendix I. Volumes and Values of Timber Cut -1854-1964, and Areas of Timber Cut[1] -1908-1964

Fiscal Year	Area Cut Acres	Volume Cut MBF	Stumpage Value
1865		600	$ 1,800
1872		2,000	6,000
1873		2,500	7,500
1874		2,000	6,000
1875		5,000	15,000
1876		13,175	39,525
1882		5,200	15,600
1883		6,000	18,000
1884		4,000	12,000
1885		5,200	15,600
1886		300	900
1887		4,000	12,000
1888		8,300	24,900
1889		18,218	54,654
1890		25,692	77,076
1891		22,770	68,310
1892		20,000	60,000
1893		20,000	60,000
1894		13,330	39,990
1895		17,000	51,000
1896		17,000	51,000
1897		17,000	51,000
1898		16,000	48,000
1899		16,000	48,000
1900		15,000	45,000
1901		15,000	45,000
1902		15,000	45,000
1903		15,000	45,000
1904		20,000	60,000
1905		20,000	60,000
1906		12,500	37,500
1907	40,000[2]	17,500	52,500
1908		48,500	145,500
1909-11	14,327	54,609	245,740
1912	1,489	37,068	166,806
1913	1,795	36,940	166,230
1914	2,546	26,663	119,983
1915	1,054	22,911	103,099
1916	898	19,997	89,986
1917	504	19,190	86,355
1918	349	15,532	69,894
1919	406	18,421	82,894
1920	195	17,525	78,862

[1]Areas involve only non-salvage cuts; except for those years dominated by salvage.

[2]Approximate area cut: 1865-1907

Appendix I., Continued

Fiscal Year	Area Cut Acres	Volume Cut MBF	Stumpage Value
1921	2,017	17,800	$ 80,100
1922	1,669	10,070	45,315
1923	376	23,478	105,651
1924	982	22,850	102,825
1925	546	5,866	26,397
1926	5,787	12,859	57,865
1927	1,942	27,676	124,542
1928	1,672	20,111	90,499
1929	1,479	20,582	92,619
1930	1,184	14,876	66,942
1931	1,514	18,113	81,508
1932	1,548	17,903	80,563
1933	520	3,796	17,082
1934	1,624	18,182	81,819
1935	2,977	23,216	104,472
1936	3,416	31,548	141,966
1937	5,825	29,844	134,298
1938	2,755	27,479	279,736
1939	3,140	14,747	150,124
1940	4,160	20,801	211,754
1941	5,153	20,046	204,068
1942	5,211	20,309	142,979
1943	4,340	19,980	154,189
1944	5,142	20,181	187,063
1945	4,183	19,960	215,758
1946	3,486	20,735	228,068
1947	4,742	20,775	300,932
1948	5,435	17,556	411,733
1949	3,885	21,916	464,602
1950	6,760	23,671	421,550
1951	4,288	24,238	279,424
1952	7,200	18,658	415,227
1953	10,368	19,628	453,636
1954	8,080	19,890	465,345
1955	11,179	20,536	477,383
1956	8,930	20,103	489,642
1957	11,180	21,056	558,564
1958	10,027	21,459	532,700
1959	6,698	16,158	381,943
1960	6,901	21,871	532,528
1961	4,983	17,210	425,948
1962	6,540	25,428	629,343
1963	6,753	26,104	646,074
1964	9,971	32,351	800,687
Totals	270,101	1,600,257	14,624,667

Source: Annual Reports - 1865-1964.

Appendix II. Volume Comparison of Major Species (1914 and 1963) of Sections Receiving a Dominant Silvicultural Treatment.

Township and Section		White Pine MBF	Hemlock MBI	Y. Birch MBI	Red Oak MBF	Maple	Basswood	Elm	Cedar	Beech	Aspen	Total All Species	Hdwd. Pulp Cds.	Soft-Wood Cds.	Type of Cut and Years
29-15-18	1914	-	-	-	-	-	-	-	-	-	-	0	-	-	River driven: 1865-1907.
	1963	1,353	51	23	49	56	33	22	74	3	113	1,966	1,442	1,279	
30-15-35	1914	23	3	-	-	-	-	-	3	-	-	30	13	-	River driven: 1865-1907.
	1963	150	151	68	153	45	23	9	43	6	-	1,027	7,196	1,145	
30-16-25	1914	14	2	-	-	-	-	-	-	-	-	17	60	175	River driven: 1865-1907.
	1963	221	15	3	78	24	6	57	6	-	376	856	5,244	1,625	
30-14-11	1914	496	3,942	1,176	-	1,164	1,341	572	-	-	-	8,691	4,200	1,500	Clearcut: 1916-19, 1921.
	1963	28	14	5	80	81	21	11	2	-	353	631	5,014	670	
30-14-14	1914	1,326	8,600	1,198	2	252	813	77	-	-	-	12,301	2,260	-	Clearcut: 1918-19, 1921.
	1963	4	20	32	73	9	1	64	-	-	48	257	1,973	138	
29-14-10	1914	144	1,529	118	-	24	24	27	-	-	-	1,867	205	-	Clearcut: 1913-14, 1923.
	1963	21	26	34	53	84	18	22	56	6	79	479	2,745	930	
28-16-12	1914	328[1]	-	-	-							328	-	250	Seed tree: 1926.
	1963	87[2]	12	-	6	-	-	-	-	2	4	168	1,568	820	Selection: 1957-58.
30-14-1	1914	2,334	2,352	294	-	496	1,479	644	-	-	-	7,599	3,656	-	Selection (70%):1929
	1963	156	172	524	439	2,268	732	1,072	4	159	24	5,745	2,245	630	Selection(30%):1956-58.
29-13-8	1914	58	187	218	1	768	343	569	-	-	-	2,148	900	-	Salvage: 1908-11, 1935.
	1963	67	675	365	329	1,266	319	354	115	235	60	3,872	5,743	1,025	Selection: 1954-58.
30-13-14	1914	155	2,300	530	-	1,030	430	295	-	-	-	4,740	-	-	Salvage: 1937.
	1963	94	1,238	287	220	956	175	303	37	156	33	3,586	3,835	1,144	

[1]Red pine.

[2]Includes red pine, white pine, and jack pine.

Appendix II. (Cont.)

Township and Section		White Pine MBF	Hem-lock MBI	Y. Birch MBI	Red Oak MBF	Maple	Bass-wood	Elm	Cedar	Beech	Aspen	Total All Species	Hdwd. Pulp Cds.	Soft-Wood Cds.	Type of Cut and Years
	1914	40	783	158	-	95	116	264	4	-	-	1,480	1,530	-	Selection:
30-13-7															1945-46, 1955-64.
	1963	160	1,805	657	455	2,429	774	1,105	134	169	37	7,951	2,998	1,146	
	1914	121	8	-	-	-	-	-	-	-	-	169	260	70	Selection: 1944,
29-16-20															1949, 1950.
	1963	1,040	45	28	38	57	25	21	140	2	27	1,638	4,037	1,802	
	1914	1,186	11	4	-	-	-	-	-	-	-	1,455	35	340	Selection:
29-16-25															1943-44, 1946,
	1963	1,235	67	44	40	68	33	31	219	3	8	2,725	1,681	1,636	1954, 1957.
	1914	128	-	-	-	-	-	-	-	-	-	137	180	45	Selection: 1960
29-16-30															1963-64.
	1963	375	2	1	3	6	1	2	12	-	11	708	-	659	
	1914	159	-	-	-	-	-	-	-	-	-	175	20	-	Selection:
29-16-31															1958-59.
	1963	1,369	10	17	52	59	7	28	25	3	162	1,867	217	90	
	1914	217	-	-	-	-	-	3	4	8	-	256	34	-	Selection: 1955,
29-15-25															1963.
	1963	897	30	10	45	58	24	19	72	2	235	1,655	2,714	1,193	
	1914	2,332	357	35	6	-	8	-	-	-	-	2,881	105	-	Selection: 1958-
29-14-31															59.
	1963	7,791	1,080	314	335	791	356	329	63	58	53	11,869	2,790	2,785	
	1914	1,324	1,307	91	9	-	2	-	-	-	-	2,746	750	-	Selection:
30-16-31															1950-1954.
	1963	1,503	947	295	133	210	98	81	116	45	179	4,079	4,916	2,300	
	1914	80	4,907	460	-	303	480	401	-	-	-	6,611	805	-	Selection: 1943,
30-14-8															1959-61.
	1963	360	4,628	917	262	1,800	581	687	33	166	16	9,555	11,530	1,821	

Pocket has: Append. 3 & Append. 4

APPENDIX III.

APPENDIX IV.