HARVESTING SYSTEMS FOR MICHIGAN FORESTS

Extension Bulletin E-1799, May 1985 (New), Price 60 cents.
Cooperative Extension Service • Michigan State University
by Melvin R. Koelling and Russell P. Kidd, Department of Forestry

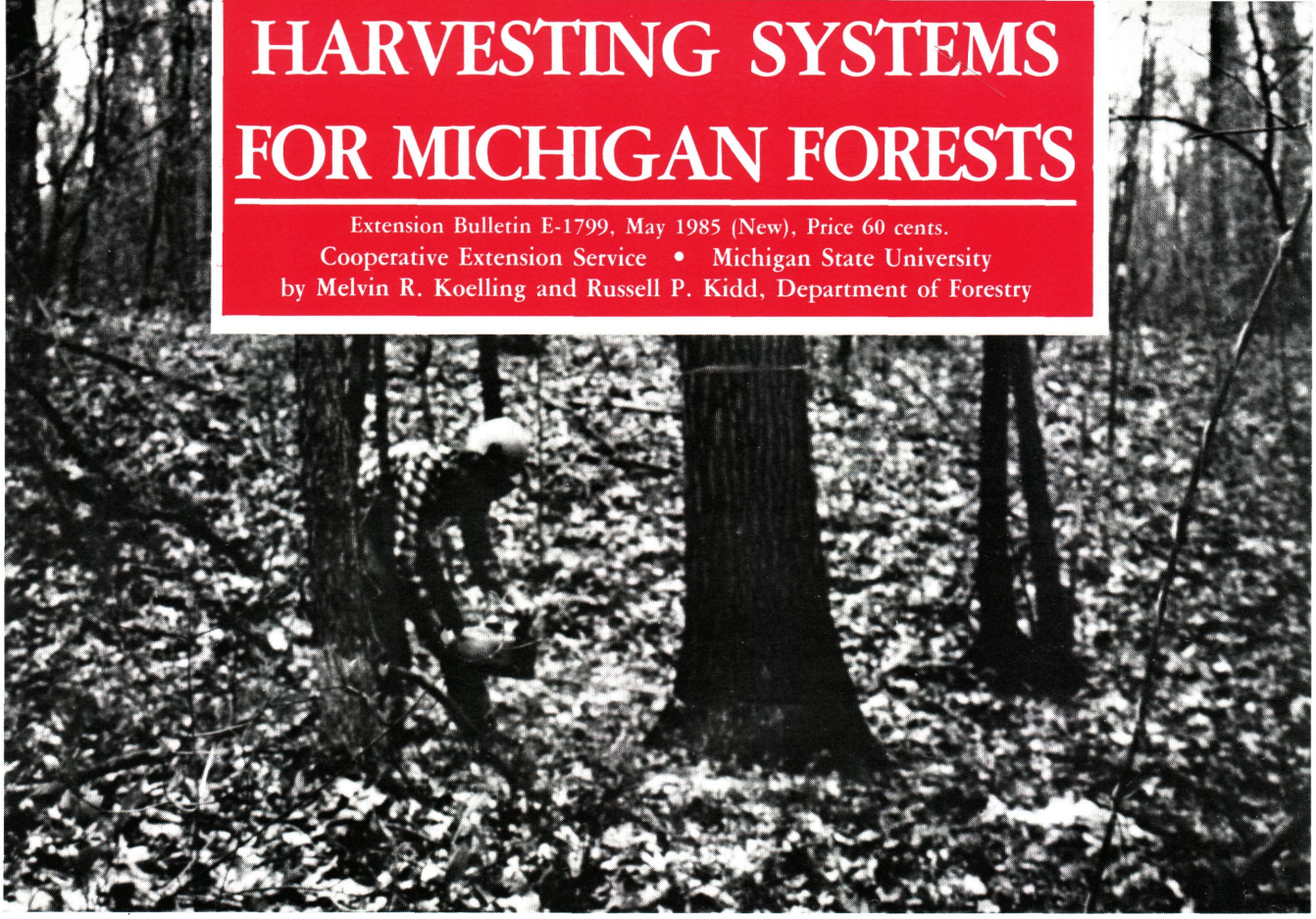

Figure 1. When completed as a part of a forest management plan, harvesting is designed to accomplish several objectives including facilitating regeneration of a new forest stand.

Forests occupy a significant portion of Michigan's land area. Nearly 50 percent, some 17.5 million acres, is covered by forest vegetation. These forests provide raw materials for a large forest based industry. High quality lumber, veneer, pulp and a variety of composite boards are produced in addition to many other products ranging from utility poles to roofing shingles.

The level and intensity of forest management is variable, depending upon landowner objectives and the product to be produced. But all management for the production of wood products involves harvesting of the forest crop (Figure 1).

Harvesting is an essential part of forest management. When completed according to management objectives and plans, harvesting results in the production of usable economic products. It also provides for regeneration of the forest stand or facilitates reforestation by planting.

The concept of forests as a renewable source is only true if provision is made for reproducing the stand. Thus, proper harvesting and regeneration are the keys to a renewable and economically viable forest.

Objectives of Harvesting

The practice of harvesting is usually associated with producing logs, pulpwood or other raw wood materials. While the felling and removal of trees is required for the production of wood products, other implications of harvesting greatly affect the remaining forest stand. How and to what extent harvesting occurs will influence future forest quality and productivity.

When completed as a part of a forest management plan, harvesting is designed to accomplish certain objectives.

Removal of mature trees.

Individual trees in a forest stand eventually mature. This occurs when the year-to-year growth (i.e. volume of annual wood increment) begins to decrease or when present or potential damage from insects, disease or adverse environmental conditions assumes economic importance. Usually, but not always, maturity is associated with size. Mature trees are often quite large.

To obtain logs which can produce high quality products, trees should be harvested when mature. Overmature trees often contain defective wood. This reduces their dollar value for high quality products. Wood in immature trees is generally of high quality, but harvesting such trees reduces potential earnings. In essence, harvesting immature trees is like picking them before they are ripe.

Improving the quality of the residual stand.

When a harvesting system other than clearcutting is used there is an opportunity to improve the quality of the residual stand. Unless the woodlot has been managed previously for some length of time, it will probably contain several damaged and otherwise defective trees. Such trees usually do not contain high quality logs, although they

may be excellent fuelwood.

In many situations where harvesting occurs, defective trees are allowed to remain in the forest stand while only the best trees are removed. Over a period of successive harvests, leaving such trees allows a large percentage of the forest stand to be of low value. Thi common practice is referred to as "high grading" (Figure 2) and is responsible for the poor condition of many privately owned woodlots. When harvesting occurs, it is essential that low value, defective and/or damaged trees also be felled to permit the establishment of new desirable trees or to accelerate the growth of desirable trees left in the stand.

In addition to felling mature trees of low present or potential value during harvest, thinning of the residual stand should also be completed at the same time or immediately following their removal. Thinning should be done to favor individual trees of desirable species and form.

In addition, growing space among trees should be regulated. The objective is to channel all the growth potential on each acre of land to trees of the most desirable species and form. This will allow the maximum production of economically valuable wood per tree and per acre. The distance among trees or the amount of growing space required is related to tree size. A discussion of spacing guidelines is contained in Extension Bulletin E-1518, "Improving Hardwood Timber Stands."

Depending on the management system being followed, repeated thinnings will be necessary to maintain maximum growth rates throughout the life of the stand. In stands which have been under intensive management for several years, harvesting itself is a thinning operation.

Provide for regeneration of the forest crop.

Technically, harvesting is actually a method for regenerating the forest. While emphasis is placed on the removal of trees from the forest stand, openings created in the forest from harvesting provide for the establishment and development of new seedlings, or for additional growing space for established seedlings. *It is through planned and controlled harvesting that provision is made for the forest to renew itself.*

Figure 2. High grading or the removal of only the best trees in a forest stand results in low value and otherwise undesirable trees occupying growing space. This practice contributes to reducing the productivity of forest stands.

Characteristics of an individual forest stand will normally determine the method of harvesting to be used You should select a method based on its ability to promote regeneration of the forest and to provide for the removal of usable wood products. During any harvesting operation, take care to minimize damage to the residual stand and to the soil if you want to continue production at a high level.

Harvesting Methods

To fulfill the dual requirements of producing forest products and providing for forest regeneration, several methods of harvesting exist. When carefully followed these procedures prevent the forest resource from being depleted. If harvesting is simply defined as the removal of large trees from a forest stand, maximum productivity and renewability of the forest will not occur.

Four major methods of harvesting are recognized. Each has been developed by incorporating the regeneration requirements for a specific type of forest stand. These methods are identified as clearcutting, seed tree, shelterwood and selection.

Each method is distinguished by the degree of openness in the forest stand which results after harvest. Some species of trees reproduce themselves under relatively low light conditions, and in fact, some shading may be necessary for regeneration to occur. Such species are said to be shade tolerant and thrive under low light conditions.

Other trees require more light or exposure and regenerate only if shade is not present. Such species are referred to as being intolerant of shade. Consequently, successful regeneration of forests composed of intolerant species requires a harvesting system which removes all or nearly all of the forest stand at once.

Selection of the appropriate harvesting method depends primarily on the biological requirements of the species present. Factors to consider include the relative tolerance of desirable species of shading; the method of reproduction, whether it be by seed or sprouting; the amount of regeneration present in the stand at harvest time; and other unique aspects of the site such as competition from undesirable species, soil type, soil water level, slope, etc.

Forest types in Michigan have been classified and appropriate harvesting systems for each have been recommended. These are considered in a later section of this bulletin. A description of each of the four harvesting methods follows.

Clearcutting

As the name implies, clearcutting is the removal of all trees in a forest stand at the same time (Figure 3).

Figure 3. Clearcutting is the removal of all trees in the forest stand at the same time. This harvesting method is necessary to permit the regeneration of intolerant species.

Figure 4. One of the results of clearcutting in some forest types is the abundant production of browse which provides desirable wildlife habitat.

Felling is done without regard to individual tree condition, spacing or size. This method of harvest is applied where even-aged stands of intolerant species are present. Generally, most trees in such stands will be of the same relative size.

Clearcutting results in large volumes of wood being harvested and, more importantly, can prepare the site for rapid reestablishment of a new forest. The absence of shade is particularly favorable for those intolerant species which reproduce by seed or which produce stump sprouts or root suckers. If it is necessary to regenerate the forest by planting, the lack of standing trees makes this task easier.

Clearcutting is also an appropriate harvesting system to use when a change in species is desired. For example, red pine is sometimes planted on sites previously occupied by low quality hardwood stands. Moreover, clearcutting is a vital practice for improving wildlife habitat, particularly for ruffed grouse and white-tailed deer (Figure 4).

Clearcutting is often perceived as a drastic method for harvesting forest crops. Many people object to this practice because it is visually unattractive and dramatically alters the condition of the forest. However, these conditions exist for a relatively short period of time. Regrowth in many forest types harvested by clearcutting is rapid, particularly if the harvested species sprouts readily.

The adverse effects of clearcutting can be minimized if the size of the area harvested is small (generally 25 acres or less) and if the shape of the clearcut area is made to fit the natural landscape. Irregular, free-form shapes which follow natural landforms, contours and soil areas expose smaller portions of a clearcut area to view and result in a more natural landscape. Avoid rectangular shaped cuts with long straight edges. Through strict control of the logging operation, it is possible to achieve a clearcut harvest that minimizes adverse conditions or landowner concerns.

Seed Tree Method

This harvesting method is similar to clearcutting with the exception that a few large "seed" trees remain after cutting. The trees which remain are selected based on their potential to produce seed for regeneration of the new forest stand (Figure 5). The actual number required will depend on the species present, frequency of seed production, amount of seed produced, etc. Usually no fewer than 10 trees per acre are required. A few years following the initial harvest, when adequate reproduction has been established, these trees will also be harvested to permit maximum growth of the new stand.

The seed-tree harvest method is applicable to some of the same kinds of forest stands in which clearcutting is appropriate. It has been used with some success in oak types and with jack pine. It does not work for those types which reproduce by sprouting, such as aspen.

The seed-tree harvest method offers some advantages in forest areas where planting is not feasible. It should be applied only to windfirm species since success in regenerating the stand is dependent on the selected seed trees surviving after the initial harvest. As with clearcutting, this method is best suited to regenerating intolerant species and will lead to the development of an even-aged stand.

Shelterwood Method

The shelterwood method of harvesting a forest stand uses two or three partial cuts designed to pro-

Figure 5. The number of seed trees required to provide seed to reseed an area is usually no fewer than 10. Trees selected must be wind firm and capable of producing a good seed crop.

Figure 6. Harvesting using the shelterwood system removes the mature forest stand in 2 or 3 partial cuts. Partial removal of the overstory favors the establishment of many hardwood species.

mote the establishment and development of reproduction within the stand (Figure 6). The objective of the shelterwood method is to develop conditions favorable for regeneration to occur under the partial shade and protection of older trees. This method is best adapted to species which in their earlier years do not compete well with other vegetation when growing in full sunlight.

Implementing the shelterwood method requires two or three partial cuttings to remove the existing forest stand. In a three system cut, the first cut is designed to remove defective and/or competing trees to improve the vigor of the residual stand. This cutting will encourage growth of the remaining trees and should be helpful in promoting seed production. Some 25 to 35 percent of the total stand is removed in this first cutting.

A few years later (5 to 20), a second cut, or seed cut, is made. This is usually timed to occur following a good seed production year. Approximately 50 percent of the remaining stand is removed. This cut is designed to develop conditions favorable for the establishment and growth of new seedlings. Partial shade is provided, although abundant openings and light are present in the forest. These conditions should favor those species which have limited tolerance of shaded conditions.

When adequate regeneration has been established, the remaining trees in the older overstory are removed. This final cut completes the harvest of the original stand and removes any competing influences remaining trees may have on growth of the new forest stand. However, care must be taken during the final cut to minimize damage to new seedlings.

In some applications the first preparatory cutting and the seed cutting are combined. This is done primarily for economic reasons. Entering the stand to remove relatively small volumes of material can be un-economical. However, from a regeneration perspective, as well as being visually more appealing, three partial cuts are preferred.

Selection Method

Harvesting individual trees with regard to their present position in the stand, or based on the lack of potential to produce high value products, is defined as a selection harvest. Mature individual trees are removed along with diseased, damaged or otherwise defective trees. Diseased and defective trees will not develop into high quality trees no matter how long they are left to grow.

Theoretically, harvests could be made every year. In practice, harvests are based on a cutting cycle. This interval varies from 5 to 15 years depending on growth rate and other site factors. The selection method is well adapted to species which are tolerant of shade and grow in uneven-aged conditions (Figure 7).

Implementation of the selection method requires careful planning and the exercise of some restraint. Selection does not mean cutting only large trees or cutting all trees above a certain diameter limit. A forest

Figure 7. The selection method of harvesting is well adapted to tolerant species such as those in northern hardwood stands. When properly carried out minimal disturbance occurs to the remaining forest stand.

which is managed under the selection method will have trees of all sizes present, although a greater number of small diameter trees will be present on each acre than will larger diameter trees.

Selection of trees to be harvested must be based on the present condition of an individual tree and the potential for that tree to increase in value during the next cutting cycle. Take into consideration the influence of each tree on the development and growth of other nearby trees.

The removal of individual mature trees and defective trees during each harvest leads to the development of a vigorous forest of high quality. If the total volume of timber removed during each cut does not exceed the total amount of annual volume increment for all years since the previous harvest, the basic appearance of the stand remains unchanged. For instance, if a hardwood stand contains a total volume of 5,000 board feet per acre, and is growing at the rate of 300 board feet per acre per year, 3,000 board feet could be harvested from each acre on a 10 year cutting cycle without altering the amount of growing stock. The openings which result from the cutting of individual trees are favorable to the development and growth of seedlings, saplings and pole-sized trees.

A variation of the selection method is the harvesting of trees in small groups, the so-called "small group" selection method. Cutting a few trees in the same area permits the establishment of larger openings in the stand and provides a larger amount of timber volume. Logging is easier since damage to the larger trees which remain in the stand is minimized compared to removing selected individual trees.

Aesthetically, the selection method has the least visual impact of any harvesting method. When carefully planned and carried out, its effects on the appearance of the forest stand are minimal. However, take extreme care when harvesting and removing individual trees. It is easy to damage remaining large trees and it can affect their future quality. Likewise excessive damage to reproduction and other small trees in the stand often occurs.

Harvesting Methods for Selected Forest Types

Several natural forest types are present in Michigan. Their presence reflects soil, climate, past land use and other factors. Variations in growth, tolerance, soil adaption, ease of regeneration and other characteristics occur among these forest types. Harvesting-regeneration requirements are, therefore, not the same for all types. Procedures which are most satisfactory for regenerating each of several Michigan forest types are described in the following paragraphs.

Aspen-Birch

Extensive stands of aspen (popple) and white birch are present in the northern Lower Peninsula and throughout the Upper Peninsula. In some areas, aspen and birch grow in the same stand. In others, either species may be present in essentially pure stands. These species grow on a variety of soil types, although best growth occurs on loamy, well-drained soils. Aspen-birch is usually not found on dry sandy soils or on soils that are excessively wet. If present on very wet sites, stand quality and growth will usually be poor.

Both aspen, whether it be trembling aspen, bigtooth aspen, or Balm-of-Gilead, and white birch are intolerant species. Accordingly, they are found in even-aged stands. Occasionally, these species may be minor components of other hardwood forest types but they will not reproduce in stands of mixed composition.

Aspen and white birch stands are defined as temporary forest types since they will not reproduce in their own shade. Normal life expectancy is relatively short, ranging from 40 to 60 years depending on the site. However, reproduction will occur through sprouting from the roots and stumps of cut trees. For this reason, clearcutting is recommended for harvesting and regenerating aspen-birch stands.

Removal of all trees in the stand will develop conditions favorable for

Figure 8. To create conditions favorable for the development of maximum sprout reproduction, it is necessary that all trees in the stand be felled. Failure to do this in aspen stands will result in the development of fewer root suckers than would otherwise be obtained.

prolific sprout development (Figure 8). For maximum sprouting, *all* stems in the older stand must be cut, including non-merchantable trees and trees of other species. Harvesting during the dormant period of the year encourages maximum sprout development.

Failure to harvest aspen-birch stands by clearcutting eventually results in conversion of the stand to other species. Depending on the soil type and location within the state, sugar maple, red maple, white pine, white spruce and balsam fir may develop as the replacement forest.

Jack Pine

Jack pine is present on sandy and otherwise droughty soils throughout much of northern Lower Michigan and the Upper Peninsula. On the driest sites, jack pine usually occurs in pure stands. On other sites, various oaks, red and white pine or occasional aspen may be present. Because it is an intolerant species most stands are relatively even-aged. Where the overstory is sparse, jack pine reproduction can occasionally be found in openings present in the understory.

Jack pine is considered a fire-adapted species. Dense, young stands often develop following an intense fire in older stands. The characteristic closed cones of this species are very persistent and will remain attached to the tree for several years. Heat produced by a fire often causes these persistent cones to open and disperse seed over the burned area (Figure 9). Many of the older jack pine stands in the state originated following extensive logging and fire in the early 1900's.

Without fire, natural regeneration of jack pine is difficult. Clearcutting of pure jack pine stands followed by planting is the most common management practice. The intentional scattering and burning of slash from the older stand may be helpful in obtaining some natural regeneration, although development of a fully stocked stand will not usually occur. On better sites, red pine is usually planted following harvest. On the driest sites, jack pine is replanted, especially where the establishment of wildlife habitat is important. This type provides both cover and food for several wildlife species. Harvesting is usually recommended when the stand is between 45 and 55 years old.

Harvesting methods vary for jack pine stands which contain mixtures of other species. In stands containing red and white pine a selection method management program which favors the best quality trees of these species over jack pine could be followed. Jack pine is principally used for pulpwood, whereas red and white pines have higher value for poles and sawlogs. Where hardwoods such as oak, cherry and aspen are present, they should be discriminated against since most are of low quality and value on sites where jack pine occurs.

Much jack pine in northern lower Michigan is infested with jack pine budworm. Repeated attacks by this insect are causing increased mortality and growth loss. Clearcutting of severely infected stands is recommended even in situations where full maturity has not occured. Replanting with red pine is recommended on appropriate sites.

Lowland Hardwoods

On poorly drained soils throughout much of the state, mixtures of hardwood species, including silver and red maple, white and black ash, swamp white oak, cottonwood, basswood and boxelder are present. American elm was formerly an important component of this forest type, but it has been largely eliminated by Dutch elm disease. However, scattered, small elm trees are present in the understory of many stands.

Considerable variation in species exists between lowland hardwoods in the southern and northern portions of the state. This forest type is not known for the production of high value products, although occasional high quality trees are present. In addition, this type only occurs in scattered locations throughout the state. Consequently, many stands have been neglected and are generally poorly managed, although some

Figure 9. Fire can be an important tool in managing jack pine stands. Burning of logging slash and cut over stands often results in establishing conditions favorable for the development of jack pine regeneration.

areas have the potential to produce high quality trees.

Most lowland hardwood stands contain large numbers of cull and otherwise low value material. These stands typically have been high-graded with only the best trees harvested, leaving all low quality material to occupy an ever-increasing component of the stand. Since many of the species in the stand sprout readily, multiple stems and clumps are common.

It is difficult to generalize a single harvesting method which is applicable to all lowland hardwood stands. The corrrect method will depend primarily on the condition of the stand. In some situations, clearcut all standing material to permit the establishment of a new stand from seedling and sprout regeneration. However, on some sites this may permit the water table to rise, thereby limiting conditions favorable for tree growth. In other stands, single tree selection or small group selection to remove mature individuals is appropriate.

To permit development of a higher value stand, all damaged and defective trees must be cut during or following a harvest operation. This will allow the development of new growing stock to eventually form a higher quality stand. Much of the low value wood removed is appropriate for fuelwood.

In young stands which develop following harvest, thinning and the removal of poorly formed trees should be done to favor trees of desirable species and form. Thinning and/or removal of multiple stemmed clumps is especially desirable. The practice of cutting vines which can affect tree form and growth also should be done.

Northern Hardwoods

Extensive stands of northern hardwoods are present throughout Michigan on soils ranging from loamy sands to those which are heavier textured but well drained. Composition of species within this type will vary depending on location within the state. In southern Michigan, sugar maple, northern red oak, American beech, American basswood, white ash and black cherry are common.

Figure 10. Northern hardwoods respond well to selection management. In harvesting individual trees care must be exercised to minimize damage to the residual stand.

In northern Michigan, eastern hemlock, yellow birch and sugar and red maple become major components of the stand. Many of the species present in the northern hardwood forest type have high commercial value for sawlog and veneer materials.

Most northern hardwood forest stands are uneven-aged, although some relatively even-aged young stands are present. The tolerant nature of the species that make up this type encourages the development of trees of all sizes within the stand. Accordingly, the selection method is ideally suited for harvesting and regenerating uneven-aged northern hardwood stands (Figure 10). It may be applied to individual trees or to small groups of trees.

Small-group selection is a preferred harvest method in stands where red oak, black cherry, white ash or other less tolerant species predominate. If the group selection method is used openings should not exceed 100 feet in width.

In applying the selection method, exercise care in marking trees for harvest. Select mature trees and those defective or otherwise undesirable for harvest. In actual felling and removal, take precautions to minimize damage to residual trees in the stand since injury to the boles of remaining trees will greatly reduce their quality and commercial value.

The temptation to harvest all large diameter trees in the stand must be resisted. The selection method implies that some large trees will remain to further increase in value and quality. Although practiced in some locations, diameter-limit cuts should not be interpreted as a responsible selection management practice.

Northern hardwoods respond well to a cutting cycle of 8 to 15 years. A stand with ideal structure will contain trees of several sizes and age classes. The stocking table (Table I) illustrates an ideal desirable stocking level which should remain following harvest.

Very few, if any, unmanaged stands will contain trees of this distribution. Management practices including thinning and regulated harvesting will be necessary to develop ideal stocking. Careful application of selection harvesting is an excellent means of obtaining a regulated forest stand.

Where stands of northern hardwoods have developed into a nearly even-aged condition, harvesting using shelterwood or group selection is recommended. If carefully completed, these two methods will create the relatively shaded conditions necessary to regenerate this type. In some even-aged northern hardwood stands, the removal of damaged or undesirable trees and thinning of the stand should be completed before application of shelterwood or small group selection harvesting methods.

Mixed Oak

Large areas of oak-hickory stands are best developed in southern lower Michigan. In other areas of the state this forest type is better described as mixed hardwoods since some components of the northern hardwood type, such as white ash, black cherry and American beech, are present. Hickory rarely occurs or is totally

absent from most mixed oak stands in the northern portion of the state.

In the southern half of the Lower Peninsula, black oak, white oak, and northern red oak are present with various hickories, sassafras, black cherry and white ash. These stands are typically even aged and occur on a variety of sites. Consequently, differences in site quality result in considerable variation in timber production and opportunities for profitable timber management.

In northern lower Michigan, oak stands are present on many areas formerly occupied by red and white pine. Principal species include northern pin oak, northern red oak, and white oak. Because of their overall poor quality on such sites, oak stands are often referred to as "scrub oak" (Figure 11). Trees in such stands are usually small and of very low quality. Their principal use is for pulpwood, pallet stock and fuelwood.

The method of harvesting selected for mixed oak stands will depend upon the amount of advance reproduction present. In relatively open stands where considerable advance oak reproduction is present, clearcutting of the overstory is recommended. Clearcutting should occur in small areas throughout the stand since oak reproduction is generally not established uniformly over large areas.

In mature stands with no advance oak reproduction, gradual removal of the stand by the shelterwood method is recommended. This will favor the reproduction of oak seedlings. If possible, the first shelterwood cutting should remove 40 to 50 percent of the volume of wood in the stand. To maximize conditions favorable for the development of oak regeneration, the first harvest cutting should be made following a good seed year. Remove the remaining trees when oak reproduction is adequately established, probably some 10 to 15 years after the initial shelterwood cutting.

Clearcutting is recommended for scrub oak stands in northern Michigan. Regeneration will occur principally from stump sprouts. Such stands will contain trees of acceptable quality for pulpwood and fuelwood. In areas where red and/or white pine are present, these species should not be cut. Permit them to increase as a major stand component.

Figure 11. Mixed stands of oak and jack pine are present on sandy soils in portions of northern lower Michigan. Management suggestions generally favor clearcutting with the expectation that sprouting from the oak stumps will regenerate the stand. In many areas replanting with red pine will maximize timber production.

Mixed Oak-Pine

Mixed stands of jack pine and scrub oak are present on sandy soils in much of northern lower Michigan and in scattered areas of the western Upper Peninsula. Other species such as red and white pine, red maple, aspen or birch may also be present. These stands are generally on droughty sites, although moisture relationships are somewhat better than for those sites occupied by pure stands of jack pine. Stand quality is low. Pulpwood and fuelwood are the primary products.

Clearcutting is recommended for those stands predominated by jack pine and oak. Oak will regenerate by sprouting, whereas some jack pine reproduction from seed can be expected. Scattering of jack pine branches will help provide seed for reproduction. Planting harvested sites with red pine is often done to improve the composition and quality of the next stand.

In stands where red and/or white pine is present, a selection harvest which favors these species should be conducted. The growth, yield and value of red and white pine will be considerably better than for jack pine. If stocking allows, all hardwoods present in these stands should also be cut to favor the red and/or white pine.

Pine plantations

Many pine plantations have been

TABLE I. Stocking table showing ideal stocking levels which should remain after harvest (northern hardwoods).

diameter breast high (inches)	number of trees per acre
2 to 4	202
5 to 9	65
10 to 14	28
15 to 19	17
20 to 24	8

established throughout the state on a variety of soils and sites. Most consist of red pine although some white, jack and mixed species are also present. For the most part, these plantations have been established on abandoned agricultural lands. A few have been planted following harvest of forest stands which were generally composed of lower-valued hardwoods.

Management recommendations for pine plantations are somewhat variable depending on species composition and present condition. Most plantations will be harvested using clearcutting when they reach maturity between 70-100 years of age. White pine plantations may be an exception due to the rather high tolerance of this species to shade. Shelterwood or group selection can be used to harvest and regenerate white pine stands.

Since most pine plantations are less than 45 years old, harvesting for sawlogs has not occured. Emphasis in management is placed on thinning and timber stand improvement operations within the stand (Figure 12). In plantations of mixed species, such as red and jack pine, red pine should be favored.

Additional recommendations for pre-harvest management include initial thinning of every other or every third row depending upon tree spacing. This thinning is done when the average tree diameter equals or exceeds 4 inches when the tree reaches a height of 17 feet. In most plantations this will occur when the stand is 25 to 30 years old. On many sites this will produce two standard size pulpwood sticks per tree. A second thinning some 10 to 15 years later should favor those trees of good form and potential high quality. At that time, individual crop trees should be selected and marked.

Following marking, those trees which are competing for growing space with the crop trees are removed. Trees removed have value for pulpwood, poles and small sawlogs. A third thinning several years before the final harvest may also be necessary, particularly if large diameter sawlog and veneer log materials are to be produced. More specific guidelines for plantation management are contained in some of the references listed at the end of this bulletin.

Where red and white pine are growing in mixed natural stands, their presence should be favored in thinning and harvest operations. Expect regeneration of these species if adequate openings are present in natural stands. Very few mature natural stands of red and white pine remain since most were harvested several years ago. Harvest operations in immature all-aged stands should follow selection or shelterwood guidelines.

Swamp conifers

Coniferous swamps are present throughout the state, although the most extensive areas are located in the northern Lower and Upper Peninsulas. Species composition is quite diverse, depending on soil type, soil moisture levels, and past management history. Black spruce, balsam fir, northern white cedar and tamarack are major species, although white spruce, white pine and eastern hemlock can be found on drier edges. Tamarack is the principal species present in southern lower Michigan. Several hardwood species may also occur but are usually of low quality. Size, distribution and age classes are usually varied, reflecting past history and use of the area.

Harvesting in coniferous swamps is usually accomplished using a strip or patch clearcutting system. Uniformly stocked stands are well-adapted to clearcutting in regularly spaced strips of uniform width. Generally, width of the strip to be cut should not exceed 75 feet. Harvesting of larger stands is completed by cutting a 75 foot strip, leaving an uncut area of 150 feet, then harvesting an additional strip. This pattern is repeated throughout the area.

Natural reproduction in the clearcut area should become established within 5 to 10 years. When the new trees are approximately 5 feet high, which should occur within 10 years, clearcut a second strip. Cut the remaining 75 foot strip ten years later.

Complete clearcutting in small patches where irregularly shaped areas of trees are present. The size of the clearcut areas should range from ¼ to 1 acre in size, although they do not need to be regular in shape or follow any particular pattern. Scattering the harvested areas throughout the stand is desirable. No one harvest cutting should

Figure 12. Pine plantations must be thinned to maintain rapid rates of growth. Initial thinning recommendations in 25 to 35 year old stands suggest removal of every other row.

Figure 13. Coniferous swamps are of high value to many wildlife species. Scheduling harvesting operations for the winter months will provide food for deer and other wildlife species.

remove more than one-third of the total stand. Additional patches of mature timber may be clearcut after reproduction has become established.

Swamp conifer stands have high value for wildlife (Figure 13). Grouse and woodcock are common around the edges and deer use these areas extensively during the winter. Scheduling harvest operations so that cutting occurs in different areas every few years will favor wildlife populations. Similarly, harvesting species like white cedar during the winter will provide browse for deer. However, high deer populations can adversely affect the regeneration of species such as white cedar due to excessive browsing.

Upland spruce-balsam fir

The upland spruce-balsam fir type occurs on mineral soils on upland sites. The principal species are white spruce and balsam fir. Occasionally, jack pine, white pine, red pine, hemlock and some black spruce may also be present. Upland spruce-balsam fir stands vary considerably as a result of past logging, fire and other disturbances. Stocking ranges from good to poor and both even-aged and uneven-aged stands occur. This type is found on a fairly wide range of soils, but it grows best on well-drained loamy soil. Growth rates may approach or exceed 1 cord per acre per year on good sites.

The selection method may be used to harvest mature trees from uneven-aged spruce-balsam fir stands. Balsam fir is highly susceptible to butt rot. To avoid serious losses from rot, balsam fir probably should not be grown beyond 45 to 50 years of age on average sites, and 55 to 60 years on good sites.

White spruce will stay sound longer than balsam fir and may be grown to 70 or even 80 years of age. In the cutting operation, remove the oldest and largest trees, singly or in small groups, and leave a good stocking of thrifty trees to grow favoring the white spruce when possible. Also, thin where trees are too dense and remove undesirable hardwoods of all sizes as well as culls of all species. This will improve the quality of the stand and favor the growth of spruce and balsam fir reproduction.

Clearcutting is also used to harvest mature spruce-balsam fir stands. This method is best applied to over-mature stands where advanced reproduction exists. The use of clearcutting, as well as the selection method, frequently results in considerable invasion of hardwood brush. Elimination of this brush when conifer reproduction is about 5 feet in height will help establish a new stand of spruce and balsam fir.

Harvest cutting in the upland spruce-balsam fir type does not always result in satisfactory reproduction of white spruce and balsam fir. Stocking is sometimes poor and the proportion of white spruce to balsam fir decreases. Planting of white spruce in openings will improve stocking and maintain this valuable species in the stand.

References

Benzie, J.W. 1977. Manager's Handbook for Jack Pine in the North Central States. Report No. NC-32. North Central Forest Experiment Station, St. Paul, MN. 18 p.

Benzie, J.S. 1977. Manager's Handbook for Red Pine in the North Central States. Report No. NC-33. North Central Forest Experiment Station, St. Paul, MN. 22 p.

Heiligmann, R.B. and M.R. Koelling. 1982. Marketing Timber from the Private Woodland. Extension Bulletin E-1265, Michigan State University, 12 p.

Johnston, William F. 1977. Manager's Handbook for Northern White-Cedar in the North Central States. Report No. NC-35. North Central Forest Experiment Station, St. Paul, MN, 18 p.

Kidd, R.P. and M.R. Koelling. 1981. Aspen Management in Michigan. Extension Bulletin E-1552, Michigan State University, 4 p.

Kidd, R.P. and M.R. Koelling. 1982. Improving Hardwood Timber Stands. Extension Bulletin E-1578, Michigan State University, 8 p.

Koelling, M.R. and R.P. Kidd. 1982. Why Manage Your Woodlot? Extension Bulletin E-1492, Michigan State University, 2 p.

Koelling, M.R. and R.B. Heiligmann. 1982. Forestry Terms for the Landowner. Extension Bulletin E-1238, Michigan State University, 8 p.

Koelling, M.D. and D.I. Dickmann. 1983. Some Guidelines for Improving Northern Hardwood Timber Stands. Extension Bulletin E-722, Michigan State University, 4 p.

Koelling, M.R. and D.I. Dickmann. 1983. Woodlot Management for Fuelwood. Extension Bulletin E-1483, Michigan State University, 6 p.

Perala, D.A. 1977. Manager's Handbook for Aspen in the North Central States. Report No. NC-56. North Central Forest Experiment Station, St. Paul, MN, 30 p.

Sander, I.L. 1977. Manager's Handbook for Oaks in the North Central States. Report No. NC-37. North Central Forest Experiment Station, St. Paul, MN, 35 p.

Szydik, A. and J.E. Gunter. 1982. Timber Sales Contracts. Extension Bulletin E-1656, Michigan State University, 6 p.

Tubbs, C.H. 1977. Manager's Handbook for Northern Hardwoods in the North Central States. Report No. NC-39. North Central Forest Experiment Station, St. Paul, MN, 29 p.

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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824.

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