Appendix B - Harvest Cutting Methods

There are 14 management prescriptions presented in the Huron-Manistee National Forests' Land and Resource Management Plan (Forest Plan). These management prescriptions, which will be applied to areas of land that are called management areas, provide for different future forest conditions. Timber harvest methods are specified in the Standards and Guidelines for each Management Prescription. This Appendix specifies timber harvest methods by forest type to meet the objectives of each management prescription. Rationale and references for each harvest method are presented.

Management Prescription Summaries

Roaded Natural Areas:

Prescription 2.1 - Roaded Natural Rolling Plains and Morainal Hills:

Management activities provide high volumes of quality hardwood timber products and firewood with special consideration for enhancing wildlife habitats. Emphasis is given to managing deer, grouse and wildlife emphasis areas and fish habitat. A broad variety of recreational opportunities is available and visual diversity is high.

Even-aged management practices of clearcutting, thinning or shelterwood will be the primary silvicultural system used. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

Prescription 4.2 - Roaded Natural Sandy Plains and Hills:

Management activities enhance and increase the variety of wildlife habitats with emphasis given to managing deer, grouse, wildlife and Kirtland's warbler essential habitat. High volumes of softwood and hardwood timber products are produced, except in Kirtland's warbler emphasis areas. Emphasis includes reducing life-threatening and property-damaging wildfire potential and providing a variety of recreational opportunities.

Even-aged management practices of clearcutting, thinning or shelterwood will be the primary silvicultural system used. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

A considerable portion of the dry sand outwash plains on the Huron National Forest in Management Prescription 4.2 will be managed as essential habitat for the Kirtland’s warbler. Management activities maintain and develop essential nesting habitat for the Kirtland's warbler in compliance with the provisions of Section 7 of the Endangered Species Act (P.L. 93-205) and as outlined in the Strategy for Kirtland's Warbler Habitat Management and the Kirtland's Warbler Recovery Plan.

In the Kirtland's warbler essential habitat, even-aged management practices of clearcutting and, when feasible, seed-tree or shelterwood cutting best achieve the desired conditions and normally will be used. Planned timber harvests follow the intent of the Kirtland's Warbler Recovery Plan.

The National Forest Management Act of 1976 [Section 6(g) (3), (E)(iv), and (P)(i)l and the resulting Secretary's Regulations (36 CFR 219.15)] requires that vegetation management practices be appropriate to meet the objectives and requirements of the Land and Resource Management Plan.

Prescription 4.3 - Roaded Natural Wetlands:

Management activities in these areas provide a variety of forest views and scenes and recreational experiences in a primarily motorized recreational environment. Fish and wildlife are abundant, and efforts are made to increase and enhance various habitats. Emphasis is given to managing deer, grouse, and wildlife emphasis areas.

Even-aged management practices of clearcutting, thinning or shelterwood will be the primary silvicultural system used. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

Rural Areas:

Prescription 4.4 - Rural:

Management activities provide recreational opportunities, sources of firewood close to users, and moderate to high volumes of softwood timber products. Emphasis includes reducing life-threatening and property-damaging wildfire potential. Wildlife management is coordinated with adjacent non-National Forest land management with emphasis on deer, grouse and wildlife management. Some small blocks will be managed to protect isolated, essential areas for endangered, threatened or sensitive species.

Even-aged management practices will be the primary silvicultural system used. Clearcutting and thinnings best achieve the desired conditions for these areas. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

Wilderness Areas:

Prescription 5.1 - Wilderness:

Management activities of Congressionally designated Wilderness provide for the protection and enhancement of wilderness characteristics and values. Primitive or semiprimitive, non-mechanized recreational opportunities occur in a natural environment emphasizing solitude. Recreational opportunities include backpacking, hiking, camping, canoeing, hunting, fishing, cross-country skiing, snowshoeing and other nonmotorized activities.

Semiprimitive Nonmotorized Areas:

Prescription 6.1 - Semiprimitive Nonmotorized Areas:

Management activities in these areas provide for semiprimitive, nonmotorized recreational experiences and will reduce life-threatening and property-damaging wildfire potential. Areas support a wide variety of fish and wildlife species. Management enhances and improves habitats for species which avoid human activity.

Low-intensity vegetative management and nonmotorized recreation in these forest areas will enhance conditions which favor wildlife species intolerant of human disturbance. Much of the areas will be maintained as old growth.

Even-aged management practices of clearcutting, thinning or shelterwood best achieve the desired conditions and normally will be used. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

Semiprimitive Motorized Areas:

Prescription 6.2 - Semiprimitive Motorized Areas:

Management activities provide for semiprimitive, motorized recreational experiences. These areas provide high visual diversity; enhance and increase wildlife habitats; will reduce damaging wildfire potential; and provide moderate amounts of quality hardwood timber products from appropriate areas.

Even-aged management practices of clearcutting, thinning or shelterwood best achieve the desired condition and normally will be used. The uneven-aged system can be used in the northern hardwood types. Other practices identified in the Standards and Guidelines may be used.

Concentrated Recreation Areas:

Prescription 7.1 - Concentrated Recreation Areas:

Management activities will provide for a variety of high-density nonmotorized recreational experiences in a roaded natural environment.

The majority of the area is in old growth. A variety of practices may be used for these areas. Either even- or uneven-aged silvicultural systems may be used as long as the practice follows the individual area's management plan.

Special Management Areas:

Prescription 8.1 - Wild and Scenic Rivers:

Management of Wild and Scenic River corridors will protect unique areas that have outstandingly remarkable values such as scientific, biological, geological, historical or recreational characteristics of local, regional or national significance.

Other practices identified in the Standards and Guidelines may be used based on the management plan for the individual river.

Prescription 8.2 - Research Natural Areas:

Management of designated Research Natural Areas will protect unique areas that have scientific, biological, geological or historical characteristics of local, regional or national significance.

Management activities provide for non-destructive research, education and ecological representation.

Prescription 8.3 - Experimental Forests:

Management of designated Experimental Forests will provide a land base for research activities.

All harvest methods may be utilized in the Experimental Forests.

Prescription 8.4 - Special Areas:

Management of special areas will protect areas that have scientific, biological, geological, historical, social or recreational characteristics of local, regional or national significance.

Silvicultural systems may be either even- or uneven-aged, depending upon the management objectives and the silvicultural needs of the area. The Standards and Guidelines in the individual area management plan will be followed.

Prescription 9.1 - Candidate Research Natural Areas:

Management of candidate Research Natural Areas will protect unique areas that have scientific, biological, geological or historical characteristics of local, regional or national significance.

Management activities provide for Research Natural Area attributes and values.

Prescription 9.2 - Wild and Scenic Study Rivers:

Management of study Wild and Scenic River corridors will protect unique areas that have scientific, biological, geological, historical or recreational characteristics of local, regional or national significance.

Management activities provide for Wild and Scenic River attributes and values.

Description of Forest Types and Harvest Methods on the Huron-Manistee National Forests

The forest types on the Huron-Manistee National Forests fit the Society of American Foresters' definitions (Society of American Foresters 1980). For the purposes of this discussion, a single species will represent 51 percent or more of the total trees in a stand. In multiple species types, a group of species will represent 51 percent or more of the total tree stock. The descriptions of each forest type are brief. More detailed descriptions can be found in the United States Department of Agriculture, Handbook Number 445, *Silvicultural Systems for the Major Forest Types of the United States*, revised December 1983; and the various manager's handbooks and other technical publications and information sources for the specific forest types provided by the Forest Service. These references are cited in the tables shown later in this appendix and are listed in the References section at the end of this appendix.

Silvicultural Systems and Regeneration Harvest Methods:

The principal reasons for harvesting timber are to regenerate and to meet a number of resource management objectives. These objectives include achieving desired conditions for visual management, recreation, vegetative species composition, wildlife habitat, timber products, mineral, gas, and oil products and integrated pest management. Achieving the management objectives is foremost when land managers select a harvest method. Although many harvest methods are used in managing forest lands, there are only two silvicultural systems; even- and uneven-aged management.

Within the even-aged category, there are three silvicultural harvest methods recognized by the Society of American Foresters: clearcut, shelterwood and seed-tree. The uneven-aged system consists of single-tree and group selection harvests.

Uneven-aged System:

A stand is considered uneven-aged if three or more 20-year classes are represented within the stand. With an uneven-aged system, a portion of each age class in each stand must be harvested on a routine cutting cycle, such as 10 to 20 years.

Two harvest methods may be used in an uneven-aged silvicultural system, individual-tree selection and group selection. The individual-tree selection method will be the predominant

uneven-aged harvest method used on these Forests. However, in some cases, group selection may be used to more effectively meet the management objectives on a particular site.

The Forest Plan accents uneven-aged management of northern hardwoods. The uneven-aged system cannot be successfully used to regenerate trees, such as aspen, that require full sunlight.

Individual-Tree Selection Method:

Individual-tree selection entails the periodic removal of individual trees. The goal is to maintain a given number of trees per acre in several diameter classes. In order for the practice to work, some live trees must be removed within most, or all, diameter classes to maintain the desired distribution of diameter classes in the residual stand. This method favors shade-tolerant tree species. Shade-tolerance is a term that refers to the ability of a tree to survive and grow in shaded conditions. Sugar maple is the primary shade-tolerant species in this area. Shade-intolerant species, such as aspen, require full sunlight to regenerate while shade mid-tolerant species, such as red oak, require partial sunlight to regenerate.

The individual-tree selection method provides habitats for most high forest, cavity-dwelling, closed-canopy wildlife species. This method is least beneficial for wildlife species that require openings, edges or low browse.

Harvesting with the individual-tree selection method affects the visual resource minimally. This method retains a landscape with large-tree characteristics. To some individuals, the frequent and repeated harvest operations and the extensive timber skidding system may be objectionable. The Forests' vegetative type that has the highest potential to respond to individual-tree selection is northern hardwood. The northern hardwood type contains shade-tolerant species such as sugar maple. Often vegetative types, if managed by individual-tree selection, will eventually be replaced by shade-tolerant species, such as maples. For example, if high-site oak stands are managed by individual-tree selection, in time the stands may convert to northern hardwoods. This may be less desirable for wildlife because an important mast source may be lost.

Group Selection Method:

In order to establish regeneration, the group selection method removes all the trees in small areas or groups. These areas can vary from several trees to a few acres. Because the removal of groups will permit more light to reach the forest floor than individual-tree selection will, group selection can be used to encourage a higher proportion of shade-intolerant or shade mid-tolerant species.

When group selections, often up to two acres in size, are made, they resemble small clearcuts. The aesthetic and wildlife benefits of using group selection depend largely upon group size and spacing. Group selection harvest systems develop a vegetative condition with an interconnected canopy and many small openings, one-half to two acres, simulating a checkerboard pattern within a forested environment. Unbroken stands of timber greater than 20 acres would not exist.

Regeneration of shade mid-tolerant species, such as red oak, can be accomplished more efficiently with the shelterwood method. Also, the group selection method is more difficult to regulate over long periods of time. The very small size of regeneration groups and intensive skidding systems is inefficient for small tracts. Maximum growth occurs only in the opening not influenced by the tall trees.

Even-aged System:

The intent of an even-aged management system is to maintain stands of manageable size and of the same age or age class. A stand is considered even-aged if the difference in age between the oldest and youngest trees of the managed stand does not exceed 20 percent of the length of rotation. This is 16 years for an 80-year rotation and 24 years for a 120-year rotation. With any of these systems the size, shape, timing and dispersion of harvest units is done to achieve the multiple-use management objectives for the area.

The rotation age under an even-aged management system is the number of years between establishment of a stand of timber and when it is considered ready for harvesting and regeneration. Culmination of mean annual increment is generally used to determine a stand's rotation age. If a forested area is being managed on a 120-year average rotation, about 8 percent of the area would be regenerated each decade, or less than 1 percent per year. During a rotation, there may be one or more periodic thinnings prior to the next regeneration harvest. Thus, after the trees in the stand reach commercial size, the area may be impacted periodically by harvesting equipment.

Even-aged management offers many opportunities for a wide range of vegetative diversity. It provides a wide range of vegetative cover types and age classes, ranging from old, mature forest to open conditions.

Three harvest methods may be used in an even-aged silvicultural system: clearcut, shelterwood, and seed-tree. Under this Forest Plan, the clearcut and shelterwood methods will be featured. However, in some situations, the seed-tree method may best meet site-specific management objectives, with limited application.

Clearcut Method:

With the exception of trees left for wildlife or visual purposes, all merchantable trees on an area are harvested at one time by clearcutting. Non-merchantable live trees are also felled to eliminate competition with the regeneration. Regeneration of tree species develops from natural seeding and/or sprouting or artificial seeding or planting in clearcut areas. This regeneration method favors the establishment and development of shade-intolerant species, such as aspen and jack pine.

Clearcutting is used to create conditions necessary to regenerate early successional vegetation, such as aspen and jack pine. Without man-made or natural disturbances, the forest would move toward a condition dominated by late successional vegetation, such as sugar maple.

Clearcutting favors species of wildlife that utilize open and young-growth habitat conditions, such as the white-tailed deer, ruffed grouse, chestnut-sided warbler and Lincoln's sparrow.

Shelterwood Method:

In the shelterwood method, the mature stand is regenerated in a series of two or three cuts. The early cuts are designed to improve the vigor and seed production of the remaining trees while preparing the site for new seedlings. The removal harvest is made when a sufficient amount of desirable reproduction has become established and before the regeneration has reached 20 percent of its rotation age. This method provides a partial cover of either large or small trees. When the shelter or overstory becomes a hindrance to the growth of the seedlings, rather than a benefit, it is necessary to treat the remainder of the mature stand.

The shelterwood method is most appropriate for species or sites where the shelter of a partial overstory is needed for reproduction, or to give desirable regeneration an advantage over less desirable species.

The shelterwood method provides conditions favorable to regeneration of a wide variety of hardwood and conifer tree species; such as white pine, red pine, red oak, sugar maple and black oak. The individual species favored depends on several physical and biological factors; such as seed source, soil-site conditions, seedbed conditions, amount of shade and microclimatic conditions at the forest floor. Therefore, shelterwood cutting tends to favor wildlife species similar to those species listed under clearcutting.

The shelterwood method will be commonly used on these Forests in oaks and northern hardwoods and in long-lived conifers.

Seed-Tree Method:

This method involves harvesting all but a few well-distributed trees of the desired species to provide seed for natural regeneration. After adequate regeneration has been established, the seed trees are normally treated. This method is suited to situations where a seed source is needed along with full sunlight. This method will be utilized on a very limited basis under this Forest Plan.

Selection of Harvest Method:

Some forest types can be regenerated by more than one silvicultural system and/or harvest method, but other types cannot. Since a management area typically contains several forest types and forest type diversity is desirable within a management area, more than one silvicultural system or harvest method may be used within a management area.

Table B-1 shows the common harvest methods by forest type that may be used on the Huron-Manistee National Forests in management areas where timber harvest is utilized to meet the management area objectives. It illustrates harvest cutting methods that are considered

appropriate for regeneration of each of the major forest types on the Huron-Manistee National Forests. The amount of each harvest cutting method used will vary by management area.

The silvicultural system and harvest cutting methods chosen are based on achieving a desired mixture of conditions within each management area and across the Forests. The method selected will best meet the Forest-wide management objectives and respond to the public issues, management concerns, and resource opportunities. The rationale for selection of a harvest method is based on a variety of factors, some of which are site-specific in nature, as well as the overall direction for the management area.

Table B-1. Common Harvest Methods by Vegetation Type.

Vegetation Type 1/	Harvest Cutting Method			
	Clearcutting 2/	Shelterwood 2/	Individual or Group Selection	Seed-Tree 2/
Aspen/Birch	X			
Low-site Oak	X	X		
High-site Oak	X	X		
Short-lived Conifer	X	X		X
Northern Hardwood		X	X	
Long-lived Conifer	X	X		X
Lowland Conifer	X	X		X
Lowland Hardwood		X		

1/ Type to be regenerated through maintenance of an existing type or converted from another forest type. For example: Conversion of hardwood to aspen would utilize harvest cutting methods for aspen.
2/ Clearcutting, shelterwood and seed-tree may include intermediate cuts during the rotation of the stand.

The harvest method is based upon the vegetative type that is to be regenerated and how that regeneration is to be accomplished either naturally or artificially. The determination of the desired vegetative type to be regenerated requires management considerations such as:

- Vegetative composition objectives for the management area.
- Existing vegetative conditions.
- Spatial distribution of types within the management area.
- Potential soil-site productivity for suitable vegetative types based on ecological classification system information.
- Relative cost and benefits of alternative regeneration options.
- Ability to manage and protect the regenerated stand.
- Need for intra-stand diversity.
- Desired recreation setting objectives.
- Desired mixture of timber products.
- Presence of riparian areas.
- Scenery Management System.
- Integrated Pest Management.

The optimum mixture of harvest methods proposed in this Forest Plan is based on the objective of maximizing net public benefits from the entire Forests as a unit, as opposed to site-by-site analysis. As part of the overall Forests' objectives, clearcutting was determined to be the optimum harvest cutting method to achieve some of those objectives. The appropriate silvicultural system and harvest method will be determined at the project level and will consider the site-specific conditions along with the objectives for the management area.

Table B-1 lists the common harvest methods by vegetation type. Tables B-2 through B-10 list the forest type harvest methods by management prescription area. Common harvest methods will be used when both the objectives of the management prescription can be met and the methods are compatible with the silvicultural characteristics of the primary species being regenerated. Other practices can be used when needed to achieve specific resource objectives. Any harvest method may be used if justified by an environmental analysis and approved by the Forest Supervisor.

Management Prescriptions 7.1, 8.1, 8.2, 8.3 and 8.4 are not included in the following tables because any timber harvest method may be used to achieve the management objective for the concentrated recreation and special management areas. Prescriptions 5.1, 9.1 and 9.2 are omitted because limited or no harvests are planned in the Wilderness and lands in holding areas.

Aspen/Birch Type:

Aspen occurs naturally across the entire range of soils on the Huron-Manistee National Forests, except for the poorest outwash sands and deep organic wetlands. Big tooth aspen is predominant in upland ecosystems, whereas quaking aspen occurs frequently on somewhat poorly drained soils and in calcareous and loamy uplands. The even-aged system of management is recommended for growing and reproducing aspen (Table B-2).

Table B-2. Aspen Harvest Cutting Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.3, 4.4, 6.1, 6.2	CC	9, 15	SEL, GS	9, 13, 14, 15	A, B, F

1/ Harvest methods: CC - clearcut; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; B - water temperature, and F - change in species composition desired.

Clearcutting was determined to be the optimum method for regeneration of aspen because:

- Aspen is a very shade-intolerant tree species.
- Early successional species, such as raspberries, blackberries, grasses and strawberries, or community types, including temporary openings, can be maintained within the management area as well as can aspen regeneration.
- Habitat conditions for wildlife species that use young-growth habitat are provided.

- Clearcutting stimulates root suckering and increases stocking and early growth of aspen. Partial cuts produce inadequate stocking and result in reduced growth.
- Visual variety can be increased in some specific locations through the design, timing, size and location of clearcuts.
- Other types, including hardwoods, balsam fir and jack pine can be naturally converted to aspen by clearcutting to meet management objectives.
- Motorized access needs are minimized. Most stands are accessed only once every 40 to 60 years, usually by temporary roads. This reduced access need results in conditions that reduce the conflicts with dispersed recreation activities and favor wildlife species requiring remoteness, such as the black bear.
- Costs are lower and revenues higher, when compared to other harvest methods. Costs are lower because there is only one final harvest sale entry, these stands regenerate naturally by suckering, they produce valued products, and the harvest operations are conducted in a more efficient manner.

Pest and disease problems may be reduced by harvesting aspen before the peak (culmination of mean annual increment) of growth occurs. *Phellinus tremulae*, a common heart rot disease, causes significant volume losses in aspen at advanced ages. Although no prevention methods are known, losses can be reduced by making regeneration harvests prior to culmination of mean annual increment. Rotation ages of 50 to 60 years are recommended to avoid unacceptable losses. Other common diseases include hypoxylon canker, cytospora canker, shepherd's crook and leaf and shoot blights. Insect pests, such as the forest tent caterpillar, aspen tortrix, gypsy moth and various wood borers, are common.

Low-Site Oak and High-Site Oak Types:

The predominant oak species occurring naturally on the Huron-Manistee National Forests are red, white, black and northern pin oak. Oaks cover a broad range of soils on the Forests and are divided into two management classifications based on site index, a measure of soil productivity. Oak regeneration problems differ in the two management classifications as the soil productivity values differ. Low-site oaks occur in areas with a site index of 55 or less. High-site oaks occur in areas with a site index of more than 55.

Low-site Oak - Site Indices Less Than 55:

Low-site oak types, site indices less than 55, occur on poor outwash sands, presorted sand moraines, and sandy glaciated topography. The soils of these landforms have a limited capacity to provide water and nutrients. The black, white and northern pin oaks predominate on these sites and often are interspersed with pines, red oak and red maple.

The even-aged management system best perpetuates low-site oaks (Table B-3). Clearcutting is recommended when adequate regeneration is established prior to harvesting, while shelterwood harvests may be appropriate under some stand conditions.

Table B-3. Low-Site Oak (Site Index Less Than 55) Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.4, 6.1, 6.2	CC, SW	2, 3, 6, 15, 17	SEL, GS	2, 3, 15, 17	A, D, E
4.3	N/A Tree types not common or not found in these Prescription areas.				

1/ Harvest methods: CC - clearcut; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; D - wildlife cover; and E - regeneration inadequate.

High-Site Oak - Site Indices Greater Than or Equal to 55:

High-site oak types, composed of northern red, white and black oaks, primarily occur on loamy moraines and outwash. The soils of these landforms have higher moisture and nutrient levels than low-site soils due to the composition of the unconsolidated glacial drift and their manner of deposition. Many productive oak systems are on sandy materials underlain by loamy substrata and/or perched water tables.

Even-aged management by shelterwood harvest is the recommended method of management for high-site oaks (Table B-4). Clearcutting is appropriate when abundant natural oak reproduction is present. Shelterwood harvest methods are used when there is inadequate advance regeneration.

Table B-4. High-Site Oak (Site Index Greater Than 55) Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.4, 6.1, 6.2	CC, SW	2, 3, 6, 15	SEL, GS	2, 3, 6, 15, 18	A, D, E
4.3	N/A Tree types not common or not found in these Prescription areas.				

1/ Harvest methods: CC - clearcut; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; D - wildlife cover; and E - regeneration inadequate.

Silvicultural knowledge for managing the oak type is improving. Most oak reproduction originates from stump sprouts or seedling sprouts. Since nearly full sunlight is necessary for optimum development and growth, either a clearcut or shelterwood harvesting system is best suited for oaks. Uneven-aged management through selection harvest is not recommended because more shade enduring species, such as maples, will become dominant through natural succession over a period of years. This may be undesirable for the wildlife resource since desirable mast (acorn) production could be lost.

To determine which harvest system to use, a number of factors must be considered. Chief among them are: 1) the amount of oak regeneration; the number of seedlings and seedling sprouts per acre existing prior to harvest, 2) the adequacy of the oak advance regeneration; the number of seedlings and seedling sprouts exceeding 4.5 feet in height, and 3) the predicted capacity of oak stumps to sprout after harvesting to supplement the advance regeneration of seedlings and seedling sprouts (Sander, et al. 1976).

Clearcutting was determined to be the preferred harvest method when:

- The amount and adequacy of advanced oak regeneration equals or exceeds the minimum stocking requirements.
- The amount and adequacy of advanced oak regeneration combined with the predicted stump sprouting capacity equals or exceeds minimum stocking requirements.
- There is inadequate stocking and stand volume to support more than one operable cut.
- Stands are over-mature, classed as high risk, and will not survive through more than one cutting cycle.
- The stand must be salvaged due to fire; wind; or insect and disease outbreak.

When one of the above conditions is met, clearcutting is optimum because:

- The oaks are shade intolerant.
- Habitat conditions for wildlife species that use young-growth habitat are provided.
- Clearcutting stimulates stump sprouting and increases growth and development of advanced regeneration.
- Visual variety can be increased in specific locations through the design, timing, size and location of clearcuts.
- Motorized access needs are minimized. Stands are accessed once every 60 to 100 years, usually by temporary roads. The reduced access results in conditions that reduce conflicts with dispersed recreation activities.
- Costs are lower and revenues higher, when compared to other harvest methods. Costs are lower because there is only one final harvest entry; these stands regenerate naturally; they produce valued products; and the harvest operations are conducted in a more efficient manner.
- Mature and over-mature stands can be utilized.
- Low volume stands that would be inoperable under the shelterwood method can be sold commercially.

The shelterwood method will be applied on sites where clearcutting is determined not to be the optimum method. This would normally be the case where advanced regeneration and predicted stump sprouting will not provide adequate stocking after clearcutting.

Some insect and disease factors associated with high- and low-site oak types are the red-humped oakworm, oak leaf roller, saddled prominent oak leaftier, forest tent caterpillar, gypsy moth, oak wilt, anthracnose and an oak sprout canker caused by a fungus on sprouts in naturally regenerated stands. The oak canker problem may be reduced by ensuring that natural

reproduction has occurred prior to clearcut harvests and by planting oaks interspersed with pines when natural reproduction is supplemented.

Additional environmental factors associated with the establishment of oak regeneration include frost, drought and browse.

Short-Lived Conifer Type (Jack Pine):

Jack pine predominantly occurs naturally on very poor, infertile, outwash sand plains and sandy glacial lake beds. Continuous areas of natural jack pine generally occur in climatic zones where frosts are frequent in late spring and early summer and in more moderate climatic zones where fires have influenced vegetative diversity. A significant portion of the Forests' area is covered with jack pine. The Kirtland's Warbler Recovery Plan directs management on most of the jack pine areas on the Huron National Forest.

Even-aged management is the recommended silvicultural system (Table B-5). Clearcutting, seed-tree, and shelterwood methods are all acceptable. The forests have had very limited success with the shelterwood and seedtree methods. Various conditions, such as the quality of seed trees, the type of cones, slash disposal methods, wind exposure, and seedbeds, are considered when managing this type. Planting may be needed to establish or maintain jack pine on some sites. Cyclic epidemic outbreaks by the jack pine budworm or Sphaeropsis shoot blight have caused extensive damage to jack pine. To mitigate the budworm problem, stands should be managed to be fully stocked, even-aged, and harvested at 40 to 45 years of age. Opportunities to mitigate the budworm problem are limited because the Huron-Manistee National Forests currently have extensive acreage of mature jack pine.

Table B-5. Jack Pine Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.4, 6.1, 6.2	CC, ST, SW	4, 5, 15	SEL, GS	4, 5	A, F, H, HF
4.3	N/A Tree types not common or not found in these Prescription areas.				

1/ Harvest methods: CC - clearcut; ST - seed-tree; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; F - change in species composition desired; HF - fuels treatments, and H - low product values.

Clearcutting was determined to be the optimum method for regeneration of jack pine because:

- Jack pine is a very shade-intolerant tree species.
- Early successional species, such as blueberries and grasses, or community types, including temporary openings, can be maintained within the management area as well as jack pine regeneration.

- Habitat conditions for wildlife species that use young-growth conifer habitats are provided.
- Serotinous cones require high temperatures to open. These high temperatures can be achieved through the use of fire or mechanical means on cone-bearing slash lying on the ground in full sunlight.
- Site preparation for seeding, planting or natural regeneration, including prescribed burning, is accomplished more efficiently.
- Risk from windthrow and insects, such as jack pine budworm and Ips bark beetle, is reduced.
- Visual variety can be increased in some specific locations through the design, timing, size and location of clearcuts.
- Other types, including hardwoods, aspen, red pine, white pine, or balsam fir, can be converted to jack pine to meet management objectives.
- Genetically improved jack pine stock can be introduced through artificial reforestation.
- Costs are lower and revenues higher when compared to other harvest methods. Costs are lower because there is only one final harvest entry, these stands regenerate naturally, they produce valued products, and the harvest operations are conducted in a more efficient manner. Stands tend to be large, especially in Kirtland's warbler management areas.
- Motorized access needs are minimized. Most stands are accessed only once every 40 to 60 years, usually by temporary or short-term roads. This reduced access need results in conditions that reduce the conflicts with dispersed recreation activities and favor wildlife species requiring remoteness such as the black bear.

Some insects and diseases associated with jack pine include the jack pine budworm, white pine weevil, Ips beetles, heart rot and Sphaeropsis. Generally jack pine does not succumb to drought, but due to secondary vectors triggered by dissecation.

Northern Hardwood Type:

Northern hardwoods occur naturally on true moraines and ground moraines that have high moisture-holding capacities and nutrient levels. The soils supporting northern hardwoods typically have finer sands or heavier textures than those supporting oak. Both the overstory and understory of northern hardwoods have high species diversity. The most important species include sugar maple, beech, white ash, black cherry, northern red oak, red maple and basswood. Most of the present stands are even-aged and resulted from the original logging in the early 1900s.

This type can best be perpetuated by the even-aged management system using the shelterwood method. Clearcutting is usually not recommended as a harvest method because clearcutting often does not result in adequate regeneration. A shelterwood/seed-tree harvest made about 20 years prior to rotation age will help ensure that the natural regeneration is well established. Uneven-aged management, such as single-tree and group selection, can be used; it tends to favor the more shade-tolerant species, such as beech, sugar and red maples (Table B-6).

Table B-6. Northern Hardwood Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.4, 6.1, 6.2	SEL, SW	10, 11, 15, 18	GS, CC	10, 11, 13, 14, 15, 18	A, C, D, F
4.3	N/A Tree types not common or not found in these Prescription areas.				

1/ Harvest methods: SEL - selection; SW - shelterwood; GS - group selection; CC - clearcut.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; C - wildlife food; D - wildlife cover; and F - change in species composition desired.

Widespread pest problems are reduced in this type because of the diverse species mixture. However, basswood thrips, canker-worms, greenstriped mapleworm, maple anthracnose, gypsy moth and ash dieback may cause damage. If beech bark disease, Asian long-horned beetle, and emerald ash borer populations were to reach high levels, heavy mortality could occur in some species of this type.

Long-Lived Conifer Type (Red and White Pine and Hemlock):

Red and white pine types naturally occur on all soil types except the poorest sands and deep organic wetlands. Red pine was once more prevalent in the somewhat drier oak ecosystems. White pine occurs on knolls within wetlands and along wetland edges. In Pre-Euro-American times, white pine and hemlock were a major component in both northern hardwood and oak ecosystems. Their present distributions are more a function of seed source than soil potential; white pine and hemlock are considered together in the following text.

In today's Forests, red and white pines have been planted on upland soils. In many cases, they provided valuable conservation measures on the eroded soils of formerly mismanaged and abandoned lands. The amount of white pine is increasing as the species becomes established in the understory of stands where a seed source still occurs.

The even-aged management system is recommended for both the red and white pine species (Tables B-7 and B-8, respectively). Clearcutting, seed-tree and the shelterwood harvest systems usually are applied to red pine types. The shelterwood system is prone to insect and disease problems; such as *Sphaeropsis* shoot blight. Uneven-aged management may be appropriate in special areas, but it is not usually recommended. Clearcutting, seed-tree and shelterwood harvesting are acceptable methods of regenerating white pine. Although each method has advantages and disadvantages, the two-entry shelterwood system is the most successful for white pine.

Table B-7. Red Pine Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.4, 6.1, 6.2	CC, ST, SW	12, 15	SEL, GS,	12, 13, 14, 15	A, HF

1/ Harvest methods: CC - clearcut; ST - seed-tree; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics. HF – hazardous fuels

Table B-8. White Pine Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.2, 4.3, 4.4, 6.1, 6.2	CC, ST, SW	1, 15	SEL, GS,	1, 13, 14, 15	A

1/ Cutting methods: CC - clearcut; ST - seed-tree; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics.

Clearcutting, shelterwood, and seed-tree were determined to be the optimum methods for regeneration of red and white pine because:

- Red pine is a shade-intolerant species.
- White pine can be managed as if it were a shade-intolerant species
- Early successional species, such as raspberries, blackberries, blueberries and grasses, or community types, including temporary openings, can be maintained within the management area, as well as can red pine regeneration.
- Habitat conditions for wildlife species that use young-growth conifer habitats are provided.
- Artificial regeneration, planting, may be required. Seed production is irregular, occurring at intervals of 10 years or more.
- Site preparation, planting and release can be accomplished efficiently.
- Genetically improved stock or stock from known seed sources can be used.
- Risk from sirococcus and Sphaeropsis shoot blight is minimized in clearcuts and seedtree systems for red pine.
- Visual variety can be increased over time in some specific locations through the design, timing, size and location of clearcuts.
- Other types, including hardwoods, aspen, balsam fir, and jack pine, can be converted, planted, to red pine or white pine, following clearcutting, to meet management objectives.
- Revenue/cost ratios are high. Costs are lower because these stands regenerate naturally, they produce valued products, and the harvest operations are conducted in a more efficient manner.

White pine weevil and white pine blister rust are major insect and disease problems in the white pine type. Because of the severity of the weevil problem in open-grown plantations, white pine regeneration usually is limited to natural regeneration methods using the shelterwood system. Common insect and disease problems in the red pine type include the Saratoga-spittlebug, redheaded pine sawfly, white grubs, Ips bark beetles and Sphaeropsis. Although red and white pines are not a favored food of the gypsy moth, white pine grown under an oak shelterwood system could receive substantial growth loss and mortality from a gypsy moth outbreak. Introduction of the hemlock woolly adelgid would cause widespread mortality of hemlock.

Lowland Conifer Type:

Lowland conifers occur in deep neutral to alkaline swamps and in acid bogs. Productivity ranges from low in swamps to extremely low in bogs. Vegetative diversity is high in neutral to alkaline swamps but is very low in acid bogs, which are commonly covered with sphagnum moss and leatherleaf.

Even-aged management using clearcutting, shelterwood, and seed-tree cutting methods is the recommended silvicultural system (Table B-9). Most lowland conifer species are shallow rooted and are not windfirm; thus the seed-tree and shelterwood methods must be used with caution. Heavy concentrations of deer and rabbit can prevent success in regenerating northern white cedar. Regeneration of balsam fir is usually successful because balsam is seldom consumed by wildlife.

In situations where the desired condition is lowland conifer and advanced regeneration is not present in adequate numbers, shelterwood harvesting, strip clearcutting or patch clearcutting can be used where feasible. Stands that have a high windthrow hazard or have inadequate volume per acre to support two or more cuts are not shelterwood opportunities. These stands will be regenerated by clearcutting to regenerate lowland conifers.

Where the shelterwood method is not necessary to regenerate the type, or where shelterwood opportunities are not realistic, clearcutting is the optimum method because:

- Risk of windthrow in mature-overmature stands is reduced.
- Slash disposal such as whole tree logging, broadcast burning or piling and bunching to prepare, expose, a seedbed is accomplished more efficiently.
- Habitat conditions for wildlife species that utilize young-growth lowland conifers are provided.
- Costs are lower and revenues higher, when compared to other harvest methods. Costs are lower because there is only one final harvest entry; these stands regenerate naturally; they produce valued products; and the harvest operations are conducted in a more efficient manner.
- Visual variety can be increased in some specific locations through the design, timing, size and location of clearcuts.
- A variety of age/size classes of lowland conifer vegetation is provided.
- Planting and protection can be used to supplement natural regeneration.

- Protection devices, for example fencing, are easier to install in openings created by the clearcut.

Table B-9. Lowland Conifer Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.4, 6.1, 6.2	N/A Tree types not common or not found in these Prescription areas.				
4.1, 4.3, 6.3	CC, ST, SW	7, 8, 15	SEL, GS	7, 8, 13, 14, 15	A, C, D, F, G

1/ Harvest methods: CC - clearcut; ST - seed-tree; SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; C - wildlife food; D - wildlife cover; F - change in species composition desired; and G - species not windfirm.

The principal insect and disease problems for lowland conifers are the spruce budworm and heart rot. They are not significant on the Forests because of the minor acreages in balsam fir and spruce. The primary problem is extensive browsing that occurs during the winter season by deer and rabbit. The lowland conifer stands are of critical importance to wildlife during the bitter winter season because they provide thermal cover and food. Additional research on regeneration techniques, applicable to the Huron-Manistee National Forests, for the lowland conifers is needed. Some regeneration harvests and protection may occur during the first decade.

Lowland Hardwood Type:

Lowland hardwood types occur naturally in ancient glacial lake beds and drainways, which have evolved into today's organic wetlands. Productivity is generally low, because high water tables limit rooting zones. Areas with water tables 18 to 24 inches or more below the surface are often highly productive. Vegetative diversity is high with mixtures of red maple, black ash, yellow birch, balsam, balsam fir, hemlock, spruce and northern white cedar. Lowland hardwoods commonly intermix with swamp conifer types.

Even-aged management, using the shelterwood harvest system, is the recommended method (Table B-10). Uneven-aged management using the group selection and the single-tree selection methods can be used, but windthrow may occur. Uneven-aged harvests favor the more shade-tolerant types, such as red maple. Some regeneration cuts, protection and planting may occur during the first decade.

No significant insect or disease problems exist. The Dutch elm disease has reduced most of the elm in Lower Michigan to immature growth stages. If the emerald ash borer situation changes, it may significantly impact the ash species.

Table B-10. Lowland Hardwood Harvest Methods for Management Prescription Areas.

Management Prescription Area	Common Harvest Method(s) 1/	Reference 2/	Other Harvest Methods 1/	Reference 2/	Reason 3/
2.1, 4.4, 6.1, 6.2	N/A Tree types not common or not found in these Prescription areas.				
4.3	SW	15, 18	SEL, GS	15, 18	A, C, D, F, G, H, I

1/ Harvest methods: SW - shelterwood; SEL - selection; GS - group selection.
2/ Reference number in Footnotes for Tables B-2 through B-10 section.
3/ Reason for using other harvest methods: A - aesthetics; C - wildlife food; D - wildlife cover; F - change in species composition desired; G - species not windfirm; H - low product values; and I - species intolerant.

Footnotes for Tables B-2 through B-10:

The following references were cited in Tables B-2 through B-10:

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23. Williams, Anna T. 2003. *Oak Administrative Study Review: A Descriptive Summary of the Status of the Oak Administrative Study on the Huron-Manistee National Forests during the Summer of 2001*. Ann Arbor, MI: School of Natural Resources and Environment, University of Michigan.

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28. Michigan Cooperative Forest Pest Management Program. 1983. *Spruce-Fir Silviculture and Spruce Budworm in the Lake States*. Handbook 83-2. Cadillac, MI: Huron-Manistee National Forests.

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Intermediate Harvest Methods:

Intermediate harvests are modifications to the vegetation of a stand between its year of origin and the final harvest. Over the life of a stand there may be several reasons for entering the stand to modify the current vegetation; such as modify species composition, reduce competition, improve growth, remove volume, stimulate reproduction, reduce hazards for insect, disease, or fire, improve economic returns, and others.

Intermediate harvests remove various amounts of vegetation, but they leave enough good quality trees for the residual stand to meet at least C-level stocking guidelines, (more than 40 percent stocking, for the forest type. Generally thinnings remove less than 50 percent of the live tree biomass and residual stocking is kept above the B-level stocking guides, moderately stocked. The B-line stocking level varies by species, age, and size of trees. Stocking guides are typically found in the management guides for each forest type.

An intermediate harvest can be a valid prescription for all timber lands under all silvicultural management practices, especially to control growth and stocking in managed forests, and as a means to achieve balanced uneven-age classes when using the individual tree selection method.

Intermediate harvests are broken down into two major types: non-commercial thinnings and commercial thinnings.

Non-Commercial Thinnings:

As the name implies, this type of intermediate harvest does not generate commercially saleable volumes. Trees that are harvested are either too small or do not generate enough saleable volume to warrant offering it under a timber sale. Most of these types of treatments occur in very young stands or are used to cut non-merchantable trees or volumes; such as dead, a small number of trees, or species with no markets.

These thinnings are generally utilized to modify species composition, change size composition, alter age class structure, improve stand quality, and control competition.

Commercial Thinnings:

These are all intermediate harvests that generate commercially saleable volumes. This type of thinning generally occurs in older stands, where enough harvested trees have sufficient commercial value to warrant a timber sale. Commercial thinnings usually occur at intervals of 10 years or more, and may occur several times throughout the rotation of a timber stand.