Appendix A

Vegetation Management Practices

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INTRODUCTION

This appendix discusses various vegetation management practices focusing on silvicultural systems and treatments to be used on national forest lands that are suitable for timber production. The National Forest Management Act (NFMA) of 1976 and 36 CFR 219 (revised July 1, 1997) addresses the use of appropriate vegetation management practices to meet the goals, objectives, and requirements of the land and resource management plan.

The Monongahela National Forest (MNF) has 40 forest types. General information on these types is available in: *Silvicultural Systems for the Major Forest Types in the United States*, USDA Forest Service Agriculture Handbook 445 (1983); Silvics *of Forest Trees in the United States, Volume 1. Conifer and Volume 2. Hardwoods*, USDA Forest Service Agriculture Handbook 654 (1990); *The Scientific Basis for Silvicultural and Management Decisions in the National Forest System*, USDA Forest Service, General Technical Report WO-55 (1989); and *Forest Cover Types of the United States and Canada*, Society of American Foresters (1980). These publications describe geographical distribution of tree species and forest types, silvicultural characteristics, associated vegetation, and practices appropriate for various management objectives. They also have additional information on other resource considerations such as soils, water, recreation, wildlife, special uses, and insect and disease management.

Silviculture can be defined as the art and science of growing trees to meet management objectives. Although silviculture is usually thought of as growing trees for timber production, it is also used to manage vegetation for other resources of the forest including wildlife, water, recreation, and scenery. Growing pressures to provide a variety of resources and products, both commodity and non-commodity, to increasing populations presents challenging opportunities for multiple use management of national forest lands.

SILVICULTURAL SYSTEMS

A silvicultural system defines the management needed to regenerate (or prepare for a regeneration cut) a forested stand of trees using a particular harvest method. Each system is formulated and designed for a specific set of circumstances, objectives, or environmental conditions, yet is dynamic to allow flexibility as situations or scientific knowledge changes. Basic considerations when choosing a silvicultural system include:

1) Characteristics of the tree species and forest types.
2) Environmental features of the site(s) where the trees are growing.
3) Protection or enhancement of other resources such as wildlife, water, soils, etc.
4) Goals and objectives for the area.

The characteristic of the tree species or forest type (such as tolerance to shade, susceptibility to windthrow, adaptability to soil and moisture conditions, and vulnerability to insects, disease, and fire) determines the range of alternative treatments that can be prescribed. Some examples include: 1) a forest type consisting mostly of tree species needing full sunlight will not regenerate and grow under the shade of a forest canopy that occurs when applying the single tree selection harvest method; or 2) a tree species with a shallow root system should not be regenerated with the seed tree, shelterwood, or two-aged harvest method because the residual trees might blow over before a new stand can become established; or 3) a tree species that requires substantial moisture to thrive should not be planted in an area where soil conditions are very dry.

Generally, there are two silvicultural systems that have been used to regenerate forests: even-aged and uneven-aged.

Even-Aged Silvicultural System

This system is designed to create a forested stand where all the trees are about the same age or where the difference in age from the oldest tree to the youngest tree does not exceed 20% of the length of the rotation. The length of the rotation is the time when a stand of trees is mostly in the seedling stage (or immediately after a regeneration harvest) to the time when the stand is ready for a regeneration harvest. For example, in a recently regenerated stand with a 100-year rotation, most of the youngest trees would have an age between 0 and 1 while most of the oldest trees should be no older than 20. When most of these trees reach 100 years of age, the stand is again ready to be regenerated. This system is designed to create or maintain individual stands with trees that are similar in age. Collectively these stands should produce a diverse pattern of age classes across the landscape over time. The purpose of this system is to regenerate tree species generally intolerant or moderately tolerant of shade for a sustainable supply of forest products.

Harvest methods in the even-aged silvicultural system include:

1) Clearcutting with reserve trees,
2) Two-aged,
3) Shelterwood,
4) Seed tree, and
5) Thinning.

The even-aged system tends to mimic moderate to major disturbance events found in nature such as uncontrolled wild fires during periods of drought, hurricanes, tornadoes, ice storms, or insect/disease outbreaks, but in a more controlled manner. The intent is to open the forest floor to more sunlight so trees that need full or partial sunlight (shade intolerant) can grow. These methods require fewer harvest removal entries into a stand (at least 1 but usually no more than 4 within a 100 to 120 year rotation) to increase the growth or regenerate the desired species. The size of a single even-aged regeneration cutting unit has been limited to 25 acres in the existing Monongahela National Forest Land Management Plan, although the NFMA allows a 40-acre size limit for hardwood forest types. The 25-acre limit has been removed in the revised Plan. Exceptions to exceed the size limit need the approval of the Regional Forester.

The **clearcutting method** harvests most or all of the trees within a stand in one removal. Typically some reserve trees are left to meet wildlife habitat or other resource needs. This method requires fewer entries, is less costly to administer, and is considered to be the most economically efficient (over the long term) of all harvest methods. The **two-aged method** harvests most of the trees in the older age class to create a young age class. Harvest entries are usually scheduled 40 to 80 years apart to maintain two distinct age classes within the stand. The **shelterwood method** harvests the mature trees in two or more removal cuts within 3 to 20 years after the initial cut. Both the two-aged method and the shelterwood method are preferred where advanced regeneration is lacking or absent. The **seed tree method** is usually used in conifer stands, with the first cut removing all but 2 to 10 trees/acre of the best growing, seed-producing trees of the desired species to be regenerated. A second cut to remove the seed trees may be done once an adequate number of the desired seedlings have been established. The **thinning method** is an intermediate cut that prepares a stand for a regeneration harvest. This method removes high risk (trees that most likely will not survive until the regeneration harvest is initiated), low quality, diseased, and over mature trees to increase the health, development, and growth of the residual trees in a stand. One to several intermediate cuts may be applied in a stand prior to the regeneration harvest. Thinning is applicable to all of the forest types found on the Forest.

Uneven-Aged Silvicultural System

This system is designed to maintain a high forest canopy cover of trees that have a range of diameter, size, and age classes while continuously regenerating desirable species. A stand is considered to be uneven-aged if three or more age classes are present. The purpose of this system is to regenerate desirable tree species that grow better under the shade of the forest canopy for a sustainable supply of forest products. It is often used to maintain or enhance the aesthetic values of a forested area.

Harvest methods in the uneven-aged silvicultural system include 1) single tree selection and 2) group selection. This system tends to mimic more of the minor disturbance events found in nature such as individual trees or small groups of trees dying from a weather, insect, disease, or age-related event. These events favor the regeneration of those trees that grow better underneath other trees (shade tolerant). Both harvest methods in this system require frequent entries into the stand (usually once every 10 to 20 years) to encourage continuous regeneration and growth of desired tree species. The **selection** or **single tree selection method** harvests individual trees, both large and small, favoring trees such as beech and sugar maple that are tolerant of the shade of the residual forest canopy. The **group selection method** removes all trees within a small area, generally at least ½ acre but typically no larger than 2 acres, within the larger forested stand. This method allows for the growth of some of the more shade intolerant trees species within the uneven-aged stand.

BASIS FOR THE ALLOCATION OF SILVICULTURAL SYSTEMS

The NFMA and its Code of Federal Regulations require identifying forested lands suitable for producing sustainable yields of wood products. The selection of which silvicultural system and harvest method to use on these lands is based on the existing condition of the forested stand, other resource considerations such as wildlife habitat, riparian, visual concerns, proximity to public or private facilities, water quality, etc., and the desired future condition and objectives of the management prescription.

The existing condition of MNF land has been greatly influenced by intensive logging and subsistence agriculture that occurred during the period from mid to late 1800s through the early 1930s. In addition, native inhabitants and early settlers used fire as a tool to manage or clear forest vegetation. More recently the multiple use management activities of the MNF have continued to shape the structure of the forest vegetation on national forest land. The result of centuries of human manipulation and use of the vegetation is the mostly even-aged forest we have today. The large majority of stands on the MNF (84 percent) are over 60 years old. Less than 2 percent of MNF land is in young forested stands less than 15 years old. As the forest continues to age it will become more susceptible to insect and disease outbreaks and other age-related effects.

Table A-1 presents the forest cover types on the MNF, and shows how 40 distinct cover types have been combined into 7 general types that have similar species and responses to silvicultural systems and treatments.

Table A-2 shows the recommended harvest methods by silvicultural systems for the seven forest cover types.

Table A-1. Forest Cover Types

Eastern Forest Cover Type	Forest Type (Combined Data System Code)
Eastern Spruce-Fir	Norway spruce (7) spruce (10) red spruce-balsam fir (13) tamarack (15) white spruce-balsam fir-Norway spruce (16)
Eastern White Pine Including Eastern Hemlock	red pine (02) white pine (03) white pine-hemlock (04) hemlock (05)
Oak-Pine	Virginia pine (33) pitch pine (38) oak-white pine (41,43) oak-yellow pine (45,49)
Oak-Hickory	chestnut oak (52) black oak-scarlet oak-hickory (53) white oak (54) northern red oak (55) scarlet oak (57) mixed oak (59)
Bottomland Hardwoods	river birch-sycamore (72) red maple, wet site (76)
Appalachian Mixed Hardwoods	yellow poplar-white oak-northern red oak (56) white ash (74) black walnut (78) black cherry-white ash-yellow poplar (83) black locust (88) mixed hardwoods (89) quaking aspen (91) bigtooth aspen (93)
Northern Hardwoods	sugar maple-beech-yellow birch (81) sugar maple-basswood (82) red maple, dry site (84) sugar maple (85) beech (86) sugar maple-beech-yellow birch-red spruce (87) birch (96)

Table A-2. Recommended Harvest Methods By Silvicultural System

Eastern Forest Cover Type	Even-Aged System				Uneven-Aged System	
	Clearcut	Two-Aged	Shelterwood	Seed Tree	Single Tree Selection	Group Selection
Eastern Spruce-Fir	P	NR	NR	NR	R	R
Eastern White Pine Including Eastern Hemlock	R	R	R	NR	NR	P
Oak-Pine	R	R	P	P	NR	P
Oak-Hickory	R	R	R	NR	NR	P
Bottomland Hardwoods	R	R	R	NR	P	R
Appalachian Mixed Hardwoods	R	R	R	NR	P	P
Northern Hardwoods	R	R	R	NR	R	R

Codes used in Table A-2:
R = recommended. The harvest method has proven reliable in creating conditions favorable for the regeneration and growth of the desirable tree species in this forest cover type. Additional silvicultural treatments such as site preparation for natural regeneration, vine control, crop tree release, timber stand improvement activities, etc. may be needed to maintain or enhance the presence and growth of desired tree species.

P = possible. The harvest method may need multiple or intensive silvicultural treatments or mitigating measures based on site specific analysis to create conditions favorable for the regeneration and growth of the desirable tree species in this forest cover type. If silvicultural treatments and/or mitigating measures are not successful, there is substantial risk of conversion to another forest cover type. For example, concern for other resources such as riparian may determine the harvest method and result in conversion of the forest cover type.

NR = not recommended. The harvest method is not reliable in creating conditions favorable for the regeneration and growth of the desirable tree species, using standard or special treatments, in this forest cover type.

MANAGEMENT PRESCRIPTIONS

There are seven different Management Prescriptions (MPs) in the 2006 Forest Plan. These prescriptions include different practices with different costs and benefits that result in different future Forest conditions. Timber harvest methods are specified in the Standards and Guidelines for each Management Prescription. This section summarizes the timber harvest methods to meet the objectives of each Management Prescription. Methods may also be designed for smaller areas such as campgrounds. For a full description of the Management Prescriptions and harvest methods, see Chapter III of the 2006 Plan.

Management Prescription 3.0 emphasizes a variety of forest views, and large high quality hardwood trees for sawtimber and veneer, hard mast production, and scenic attributes. Forest areas are a mosaic of stands, predominantly hardwood, that vary in size, shape, and age depending on the silvicultural system applied. Even-aged management practices are used where intolerant species are desired, or where needed

for additional diversity. Uneven-aged management practices may be used where tolerant species are desired.

Management Prescription 4.1 emphasizes the active and passive restoration of spruce and spruce-hardwood communities and the recovery of species of concern found in these communities, a mix of forest products, and management of hardwood communities where spruce is not present or represents only a negligible component of a stand, and research or administrative studies on spruce restoration. On lands determined to be suitable habitat for the West Virginia northern flying squirrel, vegetation management initially would be limited to research or administrative studies to determine effective habitat enhancement techniques for the squirrel. After such studies have demonstrated effective techniques, vegetation management to enhance habitat for the squirrel or other TEP species could occur on a larger scale (see FW standard TE61).

Management Prescription 5.0 emphasizes management of congressionally designated wilderness. No timber management will be applied. Vegetation will follow natural succession.

Management Prescription 5.1 is intended to maintain wilderness attributes until a congressional designation occurs or assigned to the 6.2 management prescription. No commercial timber management will be applied. Vegetation will follow natural succession.

Management Prescription 6.1 emphasizes habitat for wildlife species intolerant of disturbance and a mix of forest timber products. In the revised Forest Plan active restoration of oak communities is also emphasized. Even-aged management practices of thinning and regeneration by the two-aged and clearcutting harvest methods best achieve the desired condition, and is normally used. Other practices may be used as specified in the Standards and Guidelines.

Management Prescription 6.2 emphasis is on maintaining a semi-primitive non-motorized recreation environment. Salvage of dead or dying trees is allowed. The revised Plan allows for the restoration of ecological communities predominantly through natural processes, although some vegetation management may occur. This management might consist of thinning, individual tree selection, or prescribed fire to a level that would not alter the undeveloped character of the area. Additional Forest Service roads would not be constructed.

Management Prescription 8.0 emphasizes the preservation of unique ecosystems for scientific or recreational purposes, areas to conduct research, and the protection of unique areas of national significance. Areas include the NRA (8.1), National Natural Landmarks (8.2), Scenic Areas (8.3), Ecological Areas (8.4), Research Areas (8.5), and Grouse Management Areas (8.6). Silvicultural systems may be either even-aged or uneven-aged, depending upon the management objectives and the silvics of the species involved. Relatively little mechanical vegetation management is expected in most areas. See Chapter III of the Plan for management variations within this prescription.

HARVEST SYSTEMS FOR THE FOREST TIMBER TYPES

Due to the geographic location, elevation differences, and varying weather conditions on the MNF, the forest timber seldom fits the normal Society of American Foresters definitions for specific types. In this area, plant species common to northern climates intermingle with plant species common to southern climates. This results in stands with a great number of species mixes not found in the north or south. Over 30 commercial species occur on the Forest, and it is not uncommon to find 10 to 15 commercial species growing in a 10-acre stand. Under natural conditions, a single species seldom exceeds 70 percent

of the stocking except in very small areas. Generally, a single-species type name will indicate that one species represents 51 percent or more of the total stocking, whereas in a multiple-species type, a group of species will represent 51 percent or more of the total stocking.

Selection of a silvicultural system and related regeneration harvest method depends on many factors, including implementation costs. Uneven-aged management is generally considered to involve higher management and harvesting costs than even-aged systems. The size of openings can also affect the costs and in some cases the value of the future crop. Reducing the size of the area harvested in a single clearcut increases the management and harvesting costs. An additional disadvantage of small clearcuts in hardwood stands is the increased number of border trees that are degraded from epicormic branching. This is due to the greater length of border resulting from the increased number of small area cuttings needed to harvest a given acreage.

The major forest types are described in detail in the Vegetation section of Chapter 3 of the EIS. The descriptions below focus on the appropriate silvicultural systems that may be used in those types.

Eastern Spruce-Fir Type

The eastern spruce-fir type represents about 4 percent of the forested area on the MNF and consists mostly of red spruce although there are some small scattered areas of balsam fir. Red spruce attains its maximum development in the Appalachians, and almost all the red spruce in the central Appalachians is in West Virginia. It has been estimated that red spruce originally occupied almost 470,000 acres in the mountains of northern and eastern West Virginia at elevations generally above 3,200 feet. The intense fires that followed the original c1earcutting around the turn of the 20th century drastically reduced the amount of red spruce. In the spruce areas, the climate is cool and humid with annual precipitation in the neighborhood of 60 inches.

Red spruce grows in association with hemlock, red and sugar maple, yellow birch, pin cherry, beech, and black cherry, but it may grow in almost pure stands. Part of the MNF formerly occupied by red spruce has been planted to Norway spruce due to the better post-planting survival rates and faster growth of this species.

Because the wildfires that reduced the acreage of spruce also reduced the depth of the largely organic soil in which most of the spruce formerly grew, site quality was also reduced. The relatively small acreage of spruce in pure or nearly pure stands generally occupies areas of shallow rocky soils where site quality is fair to poor. Most of the spruce found on better sites occurs as scattered groups or as individual trees in northern hardwood ecosystem. By definition, the eastern spruce-fir type includes stands composed 50 percent or more of spruce and/or fir, but because in most situations on the MNF this type includes stands composed of up to 50 percent hardwood stems, it is considered a spruce-hardwood complex.

Harvest Methods - Since red spruce is shade tolerant, the recommended regeneration harvest methods are in the uneven-aged silvicultural system. The two-aged, shelterwood, and seed-tree methods are not recommended because red spruce is so shallow-rooted that the residual trees tend to blow down before regeneration is established.

Where spruce is managed for improvement of deer and grouse habitat, even-aged management based on c1earcutting narrow patches of approximately 5 acres in size is recommended. Smaller and more numerous c1earcuts would be better for hares and the non-game species or the uneven-aged system may be used with the group selection harvest method. Both uneven-aged harvest methods may be used to secure regeneration, and they are particularly applicable where scenic

values, recreational use, and wildlife that are dependent on a healthy, continuous forest cover are of concern. However, care must be taken on exposed areas not to open up the stand heavily enough to risk wind throw.

Eastern White Pine Type (Including Eastern Hemlock)

White pine is a moderately tolerant, long-lived species that occurs throughout the MNF in pure stands and as a dominant species in association with hardwoods, hemlock, and other pines. It grows under a wide variety of site conditions, with the best development in moist stream bottoms, lower slopes, and protected coves along with eastern hemlock. White pine is able to compete on upper slopes and ridge tops, and holds its own on a dry southerly exposure. Although classified as intermediate in tolerance, in the seedling stage it can survive and grow slowly with as little as 20 percent of full sunlight. However, in order to develop past the seedling-sapling stage, it must eventually be released from overtopping trees. Once it is established, it grows best in full sunlight.

White pine was a major component in the stands that were harvested around 1900, but presently comprises less than 1 percent of the Forest. Wildfires followed the logging and destroyed much of the white pine regeneration; thus most of the white pine stands were replaced by poor quality oak. An effective fire control program has promoted the establishment of natural white pine regeneration in those stands where a seed source exists.

Eastern hemlock is a shallow-rooted, very shade tolerant species. It can grow under dense shade for up to 200 years and still respond well to a release by partial removal of the overstory. Unfortunately, a non-native insect, the hemlock wooly adelgid, is having a devastating effect on hemlock trees throughout the East. Eastern hemlock trees are showing no resistance to this pest. Unless a solution can be found to control this pest, most of the hemlocks on the MNF will die within the next 20 years.

Harvest Methods - There is no known harvest method that will slow the decline of eastern hemlock from the wooly adelgid. Therefore, this discussion will focus on white pine. Growth characteristics of white pine indicate that it can be managed best under even-aged stand conditions, though considerable leeway is allowed in choosing regeneration methods. White pine can be naturally regenerated by clearcutting in blocks and strips, by two-aged, shelterwood, and group selection methods. Single tree selection cutting has not proven to be as successful and the seed-tree method has a higher potential risk of blowdown. Prescribed fire should not be used where there is advance regeneration of white pine if the silvicultural objective is to maintain a white pine component on site.

Clearcutting during, or just after, a heavy seed crop often results in well-stocked stands. Clearcutting in small patches or strips with seed dispersed from adjacent stands is also possible, but the constraints imposed by periodicity of seed crops must be considered. Clearcutting or two-aged harvest methods are recommended when there is advanced regeneration.

The shelterwood method is the most versatile for regenerating white pine. Control of overstory density through a series of shelterwood harvests, or leaving a higher residual density in a two-age harvest with an earlier re-entry harvest, can be used to improve seedbed conditions; to allow accumulation of seedlings over a period of years; to protect seedlings on hot, dry aspects; and to help suppress competition from herbaceous vegetation and hardwood sprouts. Three or more cuts spread over a number of years may be used, but a minimum two-stage shelterwood harvest has provided successful results.

The seed tree method is not recommended because good seed crops occur only every 3 to 10 years. The lower residual basal area of this method would encourage the growth of hardwood seedlings intolerant of shade. Without intensive herbicide treatments the hardwood seedlings would outgrow the white pine.

White pine has been successfully regenerated by the group selection method, however, other methods are more economical to implement.

Oak-Pine Type

The oak-pine type is usually found on the eastern side of the MNF on dry ridges and generally on south- and west-facing slopes. Typically these are some of the least productive sites on the Forest due to lack of consistent moisture. The oak-pine type makes up about 5 percent of the vegetation types found on the MNF. This type is a transitional stage from a mostly pine type to the oak-hickory type. Without silvicultural treatments associated with timber harvests, such as planting with herbicide treatment or prescribed fire (if there are no pine seedlings in the understory), this type will continue to decrease.

Harvest Methods - All even-aged systems can be used to regenerate the oak-pine type. Clearcutting is the preferred harvest method to regenerate the pines since they are intolerant of shade. The two-aged or shelterwood method may be used when oaks are wanted in the next stand but advance regeneration is absent or too small. The first harvest cut will establish new oak seedlings and provide conditions that will allow them or existing small advance reproduction to develop into large sturdy stems. Care should be taken with the two-age harvest method not to leave too many residual trees. The growing crowns of too many residual trees would increase seedling mortality and prevent most seedlings from growing into the overstory. The seed tree method may be used if regenerating mostly pines is the main objective.

For the uneven-aged system, only group selection harvest is suitable for regenerating this forest type since the pines need open areas with substantial sunlight to regenerate and grow. Group selection harvests in the oak-pine type provides a more aesthetically pleasing view to most Forest visitors. Prescribed fire should not be used if there are substantial numbers of existing pine seedlings in the opening or surrounding forested area.

Oak-Hickory Type

Although oak-hickory types occur over the entire Forest at elevations between 1200 and 3000 feet, the oak-dominated stands on good to excellent sites are classed with the Appalachian Mixed Hardwood type discussed elsewhere. This discussion will center on those stands of the oak-hickory complex with oak site indexes below 65.

The five widely distributed upland oaks in this type are white, northern red, black, scarlet, and chestnut. Although less abundant, the hickories are consistent stand components. This forest type comprises about 25 percent of the forested area on the MNF.

Most of the species found in this ecosystem are in the middle range in shade tolerance as exemplified by the oaks and hickories. However, considerable difference exists among species. For example, scarlet oak is relatively intolerant compared to white oak and red maple, while at the extremes, beech is very tolerant and black locust is very intolerant. Red oak is the most demanding oak in terms of site quality and is more abundant on the higher quality sites. Scarlet and chestnut oak are more commonly found at the lower end of the site range.

Harvest Methods - Any silvicultural system applied to the oak-hickory type will maintain a forest stand. However, species composition following cutting will differ by geographic location, site conditions, other species present, and the intensity of the cutting. The choice of silvicultural system and regeneration methods will depend greatly on the objectives of management and the requirements of the species desired. If the management objective is to perpetuate the oaks, even-aged systems will best satisfy the reproduction and growth requirements. Of the four even-aged reproduction methods, the seed-tree method is least useful for reproducing oaks and hickories. The heavy seed is poorly distributed and the slow growing seedlings are not able to compete with the other vegetation that will be present.

The decision whether to use clearcutting, two-aged, or the shelterwood method depends on the potential of existing advance reproduction and stump sprouting to replace the stand. Clearcutting will be successful if combinations of oak advance reproduction over 4.5 feet tall and potential stump sprouts are equivalent to 435 stems per acre well distributed over the area. When adequate advanced oak reproduction is present, the clearcutting method can reverse the naturally occurring conversion of the oak-hickory type to the more shade tolerant hardwood type.

The size of clearcuts is an important consideration but no size is optimum. The maximum size should be determined by stand and site uniformity, esthetic impacts, and wildlife needs. The minimum size is determined by silvicultural requirements, wildlife impacts, and logging economy. Although 0.5 acre openings will satisfy most silvical requirements, a large proportion of the opening will be affected by the surrounding stand. Openings must be at least 2 acres before a substantial area of the opening is not affected by the surrounding stand.

The two-aged or shelterwood method should be used when oaks and hickories are wanted in the next stand but advance regeneration is absent or too small. The first harvest cut will establish new oak seedlings and provide conditions that will allow them or existing small advance reproduction to develop into large sturdy stems.

Using the single tree selection method in the oak type will not perpetuate the quantity of oaks present now or other intolerant species. Harvesting single trees as they mature and cutting to maintain the specified size (age) class distribution results in an essentially complete crown cover at all times. Although oak seedlings will become established, they will be unable to survive in sufficient numbers and grow into the sapling and larger size classes. Furthermore, as the existing pole and small sawtimber-sized oaks pass through succeedingly larger size classes and are harvested, the sapling and small tree component will become dominated by whatever shade-tolerant species are present. Eventually the entire stand will be composed of these shade-tolerant species.

Group selection may be a successful regeneration method when certain conditions are met. Initial reproduction establishment and species composition will be the same as clearcutting in openings of 0.1 to 0.25 acres. Oaks will be present only to the extent they were present as large advance reproduction or as stump sprouts. However, reproduction growth will be retarded near the opening edges, with maximum growth occurring only in the central part of the opening not influenced by the surrounding stand. Although group selection is an effective method, controlling the amount of area regenerated and regulating the rate of cutting for sustained yield are difficult and expensive. The many small clumps of different age classes make cultural treatments and harvesting operations complicated and costly. The smaller openings allow heavier browsing by deer which may slow or prevent the oaks from growing into the overstory.

Bottomland Hardwoods Type

The bottomland hardwood forest types of river birch-sycamore and red maple (wet site) comprise less than 1 percent of the forest vegetation types on the MNF. However, numerous forest types within the Appalachian mixed hardwood forest cover type make up the rest of the floodplain and riparian forest. Most of the desirable species that grow in this type are intolerant or moderately tolerant of shade, with the exception of beech, maple, and hemlock. A higher percentage of seeds germinate on these sites because soil moisture remains relatively high throughout the year. However, animals, birds, and insects use large amounts of seeds.

Most hardwood tree species that grow near streams can survive minor flooding during the growing season and longer durations of flooding during the dormant season. The majority of flooding along streams in the MNF is usually of short duration (less than 1 week) since most of the national forest land is at the head of the watersheds of several major river systems.

Harvest Methods - The even-aged silvicultural system is recommended in this type with the exception of the seed tree harvest method. The seed tree harvest method is not necessary since there is an abundance of seeds in the soil with good germination and survival potential (if heavy deer browsing is not a problem). Seeds can also be transported downslope by water during flooding events. Stump sprouting from cut hardwood trees will contribute to the regeneration of desirable species.

Either group selection or single tree selection may be acceptable harvest methods depending on the objective. Single tree selection would favor shade tolerant species such as beech and maple but these trees are not the well suited for large woody debris in streams since they decay fairly rapidly. Hemlock trees (also shade tolerant) are excellent for large woody debris. The wooly adelgid may prevent small hemlocks from growing large enough to provide this resource in most areas, although abundant debris may occur in the short term from adelgid-related mortality in larger trees. The group selection harvest method would favor some of the more intolerant and moderately tolerant tree species that would also provide more durable large woody debris (with the exception of species like buckeye, aspen, yellow poplar, and cucumber tree, which decay rapidly).

Concerns about stream sedimentation and the lack of large woody debris will limit the amount of harvesting near stream channels on MNF land. Many streams are still recovering from human disturbances such as agriculture (both pre- and post-settlement), grazing, and the railroad construction and subsequent logging that occurred around the turn of the 20th century.

Appalachian Mixed Hardwoods Type

Appalachian mixed hardwoods, commonly called cove hardwoods, is a forest complex found in rich, moist locations and is characterized by great diversity in composition. This type represents about 40 percent of the Forest and is found in topographic coves, on lower slopes with a northern or eastern aspect, and on gentle terrain. Stands are characterized by a large number and variety of plant species. Overstory composition may range from nearly pure stands of northern red oak or yellow poplar to typical mixtures of 20 or more commercial species. Among the more important trees are: yellow-poplar, sugar maple, northern red oak, hickories, black cherry, white oak, basswood, aspen, cucumbertree, white ash, red maple, sweet birch, beech, elm, and black locust. The mixtures vary with site quality, past treatment, elevation, and latitude. Conifer species can include white pine, red spruce, and hemlock.

Sources of reproduction in these stands include buried seed, stump sprouts, root suckers, and advance regeneration. Seed of several species--such as yellow poplar, basswood, white ash, black locust, and

black cherry--remain viable in the forest floor for at least three winters. Acorns and seed from maples, birches, and beech commonly remain viable over one winter. Nearly all hardwood species sprout vigorously especially when young, but as stems mature, sprouting decreases. Advance regeneration of tolerant species such as maples and beech occurs under dense canopies. Advance oak regeneration composed of seedlings an inch or more in base diameter, with a well-developed root system, is generally necessary for satisfactory growth after release. Logging usually does not kill advance regeneration because the damaged stems sprout vigorously. During their early years, sprouts grow rapidly; often dominating other forms of reproduction, and can produce high-quality trees for a number of species. Prolific sprouters include oaks, yellow poplar, basswood, black cherry, red maple, black locust, and beech.

Reproduction of intermediate tolerant species usually follows a moderate opening of the canopy and can persist for several years. Seeds of white ash, yellow poplar, black cherry, and basswood germinate when favorable conditions of light, temperature, and moisture are created by canopy removal. Because of the abundance of different species in these stands, it is rare that seed crops do not occur for several of these species.

Among major Appalachian mixed hardwood species, shade tolerance ranges from very tolerant beech, hemlock, sugar maple, and basswood to the intermediately tolerant oaks, hickories, birches, and white ash to intolerant black cherry, black locust, and yellow-poplar. Most intolerants and some intermediates will not survive long under a dense canopy. Sugar maple, beech, and, to a lesser degree, oak saplings and pole-size trees can persist for a long time under a dense canopy and then respond to release. Many intermediate and intolerant species in these mixed hardwood stands developed in large openings due to windthrow, fire, snow, ice, logging, etc.

Harvest Methods - In Appalachian hardwood stands there are a number of species that reproduce successfully following any regeneration cutting, thus reproduction usually is not difficult. However, species differences in shade tolerance and other silvical characteristics, combined with site variation, lead to changes in species composition. Species composition is affected by the silviculture and harvest systems used.

Even-aged and uneven-aged silvicultural practices have been used to manage Appalachian hardwood stands. Even-aged practices such as clearcutting result in a greater variety of species and a higher ratio of intolerant to tolerant species than uneven-aged practices. The intolerant to intermediate species usually are fast-growing, high-value trees such as black cherry, red oak, white ash, yellow-poplar, and basswood. Clearcutting generally is recommended as the optimum method to regenerate these stands. Both intolerant and tolerant species are reproduced by this method, though the month in which a clearcut is applied can influence the amount of regeneration due to late seed germination. Planned clearcuts provide stands of differing ages in the forest, with each stand contributing wildlife food and habitat that allows a variety of wildlife to prosper.

Two-aged and shelterwood harvests include removing trees in the stand in two or more cuts, usually over a period of 3 to 20 years for shelterwood and 40 to 80 years for two-aged. The higher the residual basal area that is left after the first harvest removal, the sooner the next harvest should occur. For example, if the residual basal area is 50 square feet per acre after the first harvest, then the next harvest entry should be no more than 5 years later. The reason for this is with a high residual basal area the crowns of the trees will close faster and shade out the intolerant tree species that are the objective of using the shelterwood or two-age harvest method. These methods may be used for reproducing species of intermediate tolerance such as oaks and are often recommended where there is no desirable advance regeneration. The effect of these methods on the regeneration depends on the density and duration of the residual overstory. Loss of residual stem quality from epicormic branching may occur.

Regeneration by the seed-tree method is seldom used or needed in Appalachian mixed hardwood stands. Under most circumstances, regeneration comprising the new stand is already established or will become established the first growing season after cutting, regardless of the presence or absence of seed trees. Where seed trees are left in the stand, windthrow and loss of stem quality from epicormic branching are major concerns.

Where uneven-aged practices are used, the tolerant, slow growing, less valuable commercial species such as beech and maple, eventually dominate. Frequently, noncommercial and shade tolerant species such as dogwood or striped maple are found in the understory.

Single tree selection results in the least disturbance to the forest canopy and is used where a nearly continuous forest canopy is preferred, or when stand and site disturbance must be minimized. However, the single tree selection method should not be used if intolerant species are desired because this practice encourages shade tolerant trees and shrubs. Eventually, the mixed character of the Appalachian hardwood stand will be reduced by the single tree selection method to a few commercial and shade tolerant species, such as sugar maple, beech, and red maple.

Group selection provides a mixture of desirable tolerant and intolerant species in mixed hardwood stands, if the openings are at least 0.5 acre, but this system is difficult to apply at periodically short intervals. If the openings are small and well-scattered, aesthetic qualities remain high and excellent wildlife habitat, forage, browse, edge, and mast-producing trees are produced. However, epicormic branching may reduce the quality of the border trees. Epicormic branching may be reduced by leaving smaller trees around the perimeter of the opening to shade the boles of the larger trees. High deer populations may prohibit regeneration success due to heavy browsing pressure in these small openings.

Northern Hardwoods Type

This type, comprising about 22 percent of forested area on the MNF, is normally found at higher elevations. At its highest limits, the type may merge with red spruce or may occupy areas where red spruce was formerly abundant but has been depleted by cutting and fire. When found at lower elevations on good and excellent sites, this type often merges with Appalachian mixed hardwoods and, depending on the cutting practices, may replace the Appalachian mixed hardwood type or be replaced by it. Repeated cuttings, wildfire, and past land use have created numerous combinations of stand conditions, age classes, and species.

Sugar maple and yellow birch are the most desirable hardwoods for timber production and also contribute to pleasing fall colors. Sugar maple, beech, and yellow birch are the major species and together comprise most of the stocking. Associated in varying mixtures are red maple, hemlock, black cherry, basswood, white ash, and red spruce. Noncommercial understory species include striped maple, hobblebush, eastern hophornbeam, witch hazel, pin cherry, viburnums and serviceberry.

All important, commercial species characteristically reproduce from seed, and some also reproduce by vegetative means. The yellow birch seeds prolifically, producing reasonably good crops every other fall. White ash, sugar maple, and beech produce good crops at intervals of as long as 5 to 8 years. Red maple produces abundant seed nearly every spring and sprouts prolifically from stumps of poletimber and small sawtimber size trees. Sugar maple, beech, and yellow birch sprout reasonably well from stumps of small trees. Beech sprouts on larger stumps generally are short lived but it root-suckers prolifically, especially following cutting. Striped maple also sprouts prolifically while brambles and pin cherry reproduce from seed buried in the upper soil horizon for as long as 100 years, though numbers decline sharply after 40 years.

Species in this type differ in shade tolerance, longevity, and growth rate. Yellow birch, white ash, and red maple are all intermediate in shade tolerance, but while the latter two have moderately fast growth rates, yellow birch has only a moderate growth rate. Sugar maple, beech, and red spruce are shade tolerant, long-lived species with moderately slow growth rates. Hemlock is also shade tolerant and long-lived and while it grows rapidly in diameter, it grows slowly in height. Tolerant small trees and shrubs such as striped maple, eastern hophornbeam, and hobblebush affect silvicultural procedures. Pin cherry, a very shade-intolerant small tree, can be a serious competitor in clearcuts.

The highly shade tolerant beech and sugar maple are the most common tree species in the understory of northern hardwood stands on well-drained sites. Red spruce and hemlock are more commonly found on wet or excessively well-drained sites. These species and the other long-lived tolerant species, when established, can respond to release after long periods of suppression. Yellow birch needs overhead light and a seedbed of moist humus or mineral soil for optimum early establishment and development. Yellow birch must become dominant early in life to survive to maturity. The capacity of birch and other less than tolerant species to respond to release after suppression is moderate to poor.

Harvest Methods - The choice of silvicultural systems and intensity of management in the northern hardwood type is influenced by species composition, habitat, site productivity, local markets, and objectives for the area. If the objective is to maintain or increase the stocking of intolerant and intermediate species, clearcutting is the optimum method to use because it allows these species to outgrow their competition.

In northern hardwoods, many seedlings and saplings grow under the shade of mature trees. They often include a variety of species and provide a primary source of regeneration for the new stand following clearcutting. Additional seedlings usually become established after clearcutting so that regeneration includes both trees that developed in advance of the cutting and ones from seeds that germinated later. This combination provides for a mix of species, including ones that will not survive under the shade of older trees. Yellow birch and red maple can develop quickly from seeds dispersed into newly created forest openings, especially if seeds fall onto mineral soil or decayed organic material. Clearcutting normally will increase the abundance of yellow birch, black cherry, white ash, and yellow-poplar. All of these need light and grow poorly under shaded conditions.

Stump sprouts grow rapidly in clearcuts and if the stumps are low, the sprouts develop into satisfactory trees. Because sprouting capacity decreases as trees age, sprouts seldom dominate regeneration following clearcutting of stands more than 75 years old.

The two-aged and shelterwood methods regenerate stands of trees all having about the same age. They establish a crop of new seedlings and allow them to get a good start before all the older trees are removed. These methods require at least two harvest removals on the same area in a rotation length. The initial harvest of some of the older trees allows sunlight to reach the ground. This added light stimulates growth of seedlings after germination, then a second cutting removes the remaining older trees. In the two-aged method the harvest re-entry is usually 40 to 80 years after the initial harvest. The residual basal area in a two-age harvest should be from 15-25 square feet of basal area per acre. The lower residual basal area is necessary due to the length of time to the next entry to allow the intolerant and moderately tolerant species to grow into the canopy before the residual crowns close and suppress the growth of the regeneration. The shelterwood method requires a re-entry harvest usually within 3 to 20 years after the first entry, allowing a higher residual basal area of 30 to 50 square feet per acre. The longer the time between the initial entry and the second entry, the lower the residual basal area should be.

The seed-tree method has no value in the northern hardwood type because the new stand generally originates from seedlings and saplings that were established prior to harvest. In addition, most species in this type produce abundant seed that will store in the leaf litter for 3 to 10 years, thus seed trees are unnecessary.

If the objective is to move the stand towards climax species, then the uneven-aged system will accomplish this in the northern hardwood type. Stands managed by the single tree selection method are harvested at regular intervals (usually every 10 to 15 years) to remove some of the trees. At each harvest, mature trees are removed to make space for new seedlings to develop and also, younger trees are thinned. These cuttings remove single trees from across the stand, leaving behind well-distributed immature ones. The combination of new, young, and older trees makes the stand uneven-aged.

Single tree selection works in the northern hardwood type because sugar maple, beech, hemlock, and red spruce can grow under partial shade and develop in the small openings created by harvesting of a single mature tree. Seedlings of black cherry, yellow poplar, white ash, yellow birch, basswood, and red oak will not normally survive in such shade. Their numbers will decrease with each subsequent harvest, unless the stands are cut heavily.

The group selection method will create larger openings in the forest canopy than the single tree selection method so more sunlight can reach the ground. Species that cannot survive and grow well under partial shading can develop in these openings, so the regeneration will often include more yellow birch, black cherry, white ash, and yellow-poplar seedlings than are found under single-tree selection. By combining group removals and thinning of immature trees, the cuttings maintain a proper mix of tree sizes and ages to provide for regular harvests.

SILVICULTURAL TREATMENTS

Silvicultural treatments may include single or multiple actions of site preparation, reforestation, and timber stand improvement activities within a stand. Some of the more common silvicultural treatments on the MNF are described below.

Prescribed Fire

Prescribed burning can be used to achieve one or more objectives including reducing the risk of hazardous wildfires, controlling understory vegetation, restoring fire dependent species or ecosystems, and improving forage for wildlife. An example would be to use prescribed fire to enhance or restore oak regeneration by killing tops of competing vegetation. Oak seedlings put most of their early growth as seedlings and saplings in their roots and are able to re-sprout after fires by out-competing other seedlings and saplings that put most of their early growth in their tops.

Site Preparation with Hand Tools for Natural Regeneration

The objective of site preparation is to enhance germination, sprouting, and survival of natural regeneration. Site preparation includes cutting down residual trees between 1 and 5 inches in diameter during or immediately after a regeneration harvest. Normally red spruce, hemlock, white pine, dogwood, serviceberry, and shrub species that produce mast for wildlife are not cut. This treatment opens up the forest floor to increased sunlight to improve seed germination potential, promotes sprouting of cut trees, and reduces shading that could inhibit the growth of shade intolerant and moderately tolerant species.

Herbicide

Similar to prescribed fire, herbicides can be used to control competing vegetation, allowing limited nutrients and moisture to be more readily available to improve growth of the remaining vegetation. Herbicides registered for forest use are usually applied to individual stems by cut stump treatments, stem injection, or basal spray. Foliar spraying or soil application methods may also be used. All treatments would follow label guidelines and would be supervised by a State-certified applicator. In some cases, especially where interfering understories of fern, grass, beech root sprouts, or striped maple have become established on gentle slopes, mechanized equipment or broadcast spraying may be used. Herbicides may also be used along roads and utility corridors.

Planting

Although hardwood forests normally regenerate naturally after a timber harvest occurs, planting is sometimes used in stands to improve species diversity. Competition for sunlight, moisture, and soil nutrients is intense when a stand is regenerated. To improve the potential for planted seedlings to grow into and be retained as a viable component within a stand, protective tree shelters may be used to improve survival. A tree shelter acts like a mini greenhouse, providing increased temperatures over longer time periods than in open conditions, resulting in increased survival rates and overall growth of the planted seedlings. Tree shelters are also put in place to protect the seedlings from deer browsing.

Vine Control

Vines interfere with the growth of trees, causing decreased growth, deformity, and broken tops. Broken tops allow entrance for insect and diseases, decreasing the vigor of a stand. Vines are severed with cutting tools near the ground and about 4 feet above the ground leaving a gap to deter any sprouting vines from utilizing the dead vine to grow again into the crowns of the surrounding trees.

Crop Tree Release

This treatment may be used to achieve a variety of objectives including: to restore diversity of species within a stand; to develop mast producing trees for wildlife; increase commercial value; and/or to improve scenic quality. Criteria should be developed to meet specific objectives in selecting 30 to 50 trees per acre of good health and form to retain in the stand. These selected crop trees are released from competing vegetation by cutting or girdling nearby trees that touch the crowns of the selected trees. Cut or girdled trees that are of little commercial value or provide valuable wildlife habitat may be left on site.

Precommercial Thinning

This treatment is similar to the thinning harvest method except the cut stems do not have enough value to support a commercial timber sale. Trees that are of low vigor, are poorly formed, or diseased, and species with little commercial value such as fire cherry and striped maple, are cut and left on site to reduce competition for sunlight, water, and nutrients for the residual trees.