OAKS:
A MANAGEMENT GUIDE FOR MICHIGAN'S STATE FORESTS

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

FOREST MANAGEMENT DIVISION
WILDLIFE DIVISION

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Note: While designed for use on Michigan's extensive state forest system, other landowners may find certain of these concepts and guidelines of value on other scales.

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OAKS IN MICHIGAN

Species

Most scientists agree there are thirteen species of oak native to Michigan. This discussion will deal with the six species of oaks native to the northern two-thirds of Michigan. They are:

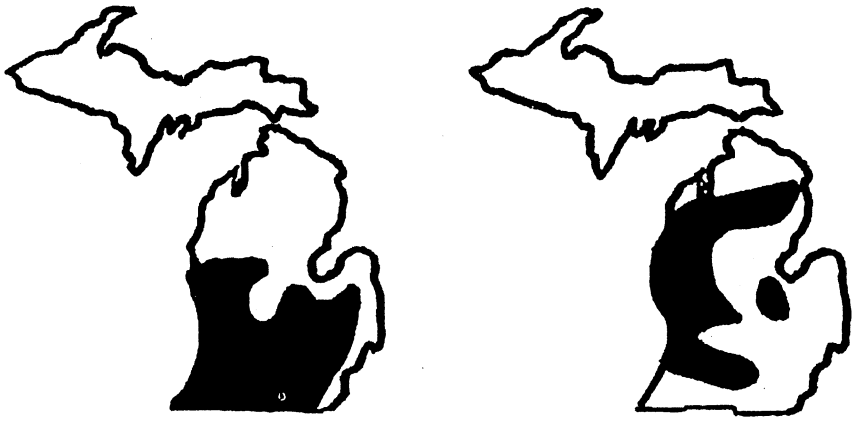
Northern red oak	*Quercus rubra*
Northern pin oak	*Q. ellipsoidalis*
Black oak	*Q. velutina*
White oak	*Q. alba*
Bur oak	*Q. macrocarpa*
Swamp white oak	*Q. bicolor*

In addition to the above, there are numerous hybrids found, particularly between northern red and northern pin oaks.

Each species reacts differently to management and to the variety of conditions found on different sites. When we consider that several of the species we are dealing with occur on a wide range of sites, we realize why oak management is a complex issue.

Oak in the "Olden Days" and Today

The occurrence of oak cover types today is in a much different geographic pattern from that of pre-settlement times (Figures 1 and 2). The range of oak types has made a dramatic shift northward.



Oak Forests in 1800 **Oak Forests Today**

Figures 1 and 2

This northward shift of oak types does not mean that the oaks have extended their range. It means they have gained control of sites in the north and have lost control of much of their former domain in the south.

Farming, housing development, and commercial land development displaced the oak cover types over very large portions of their former southern Michigan range. Oaks are still common across the entire area but they no longer dominate the landscape as they once did. In addition to the wholesale conversion due to changing land use, many landowners are gradually shifting oak cover types to sugar maple and other shade-tolerant species through use of the single-tree selection system of management.

While oak types were being converted to farmland in the south, oaks were gaining control of the former pine lands in the north. Oaks had existed in small stands and as scattered individuals throughout the pine forests. The pine stands provided ideal greenhouse-like conditions for the oak to become established (Figure 3). The pine canopy guarded against drying winds and provided a thermal blanket to protect against frost damage. The bed of needles on the forest floor discouraged competition from other vegetation. Very few browsing deer lived in the vast mature pine forests.

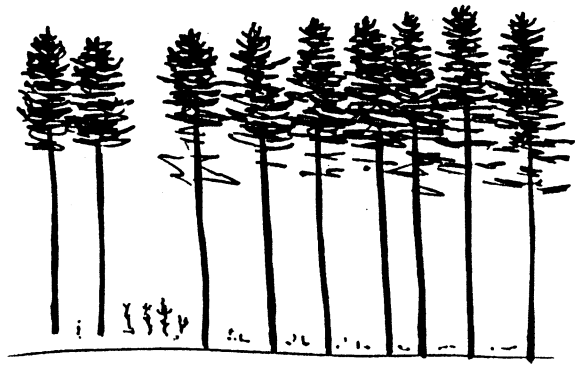


FIGURE 3

The elimination of the pine by early logging operations was often followed by fire fueled by residual brush and tops. Oak was able to sprout vigorously after the fires and quickly took control of the sites.

"Why," one might ask, "if oak so aggressively took control of these sites a hundred years ago, is it so difficult to re-establish oak today?" Good question.

Things have changed in several ways in Northern Lower Michigan in the last century. These changes have a great impact on oak since this group of species is very sensitive to frost during the spring growing season.

Air Drainage

The very open nature of the landscape 100 years ago provided no obstructions to flow of cold air. (Figure 4) Today, patches of forest growth block cold air flow forming "frost pockets" where formerly there was good air drainage.

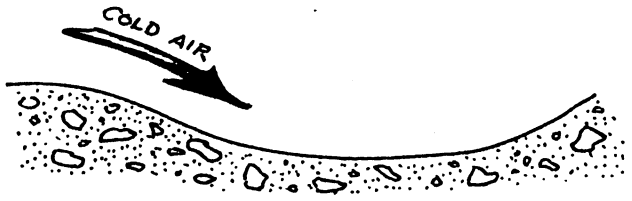


FIGURE 4

Air Mixing

The vast open plains that were produced by logging and the fires of the nineteenth century allowed free air movement across the surface of the ground. As winds swept across the landscape, they mixed and moved the air in various pockets and valleys, preventing the collection of cold air in frost pockets and loss of heat into the upper atmosphere (Figure 5).

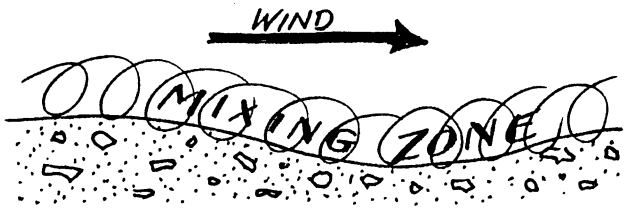


FIGURE 5

Today we are happy to have forest cover on the landscape once again, but it complicates the picture when we begin to talk of oak regeneration. Air drainage can be slowed and moderating breezes intercepted by the forest cover which has developed. This tends to increase the susceptibility of stands to frost damage.

Overstory trees provide a thermal blanket for young seedlings (Figure 6). Pine seems to be most effective at this, perhaps because it has full foliage during the critical late spring/early summer period. In order to realize the benefits of this blanket, we must retain a crown cover of at least 25% and preferably 40-50% in a hardwood forest.

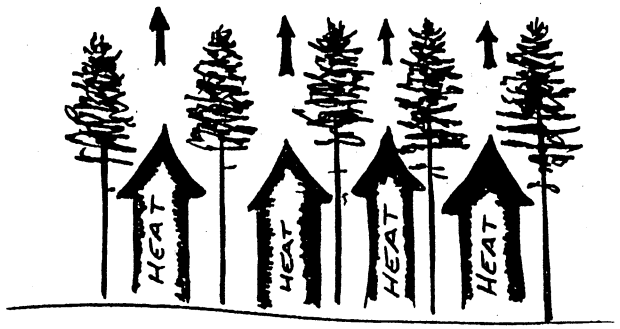


FIGURE 6

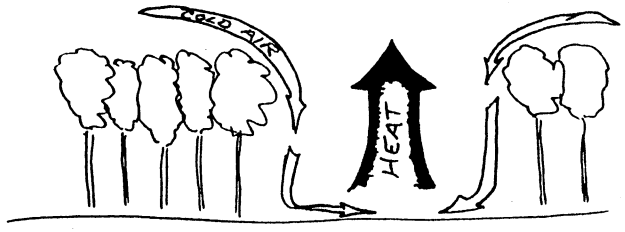


FIGURE 7

Frost pockets can occur on the flat, sandy plains of Northern Michigan when clearcuts exceed about two acres. Large cuttings allow heat to escape in a sort of chimney effect while the cold air flows down around the edges of the opening and settles on the ground (Figure 7).

Cuttings of two acres or less result in the mixing of cold air as it tries to settle into the opening with warm air trying to rise from the warm ground. The result is frost protection in the smaller openings (Figure 8).

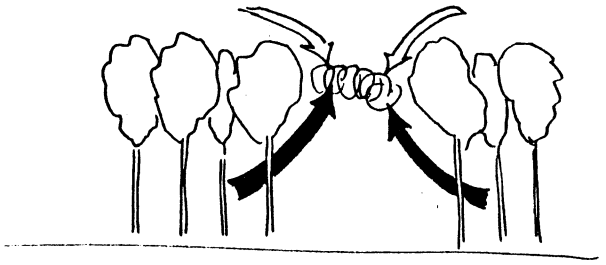


FIGURE 8

Management History

Little attention was given to oak management on state forest lands until the late 1970s. The "energy crisis" of those years led to increased interest in fuelwood and that led to interest in harvesting some of the "scrub" oak types on state land. Clearcutting was found to work well as a management technique. Sprouts quickly rose from the stumps and stands were adequately regenerated.

Little thought was given to thinning oaks on better sites, as these northern sites had never been considered to be oak country and markets did not exist for small diameter oak. In retrospect, we could have accomplished a great deal by thinning young oak stands on good or medium sites if we had started in the 60s or 70s.

Current Conditions

In the 1990s our northern pin oak stands are becoming too old to sprout vigorously, forcing us to look at other regeneration methods. They are also dying from the combined effects of age, spring frosts, insects, disease, and drought.

Through natural processes many oak stands are reverting to pine. This is not necessarily bad, but Michigan's citizens are fond of oak and wish to keep a fair portion of these stands as oak. Because our mature oaks are dying in some parts of the state, we cannot wait to manage for oak.

We cannot clearcut large areas, particularly on flat frost-prone land, because frost will kill the oak seedlings. We must develop a silvicultural system that will satisfy a complicated series of criteria. What follows is our answer to this need.

Oak markets and prices make it possible and practical to manage our oak stands. We have the opportunity to improve our system and we have some new knowledge to employ in the process. Now it is up to us to make constructive use of them.

Wildlife and Habitat Diversity in Oak Types

Diversity comes in several types when we look at wildlife habitat. Oaks, too, exhibit diversity in various ways. Three types of diversity will be considered relative to oak and wildlife habitat.

- Diversity of oak species
- Diversity among stands
- Diversity within stands

Diversity of Oak Species

There are six species of oak native to Northern Michigan – northern red, northern pin, black, bur, white, and swamp. All have some value for wildlife. How much value each species has will vary from year to year depending on mast (acorn) crops and other variables. Because most oaks do not bear good mast crops every year, it is desirable to have a mixture of species to increase the chances of a mast crop in one species or another. On state forest land northern red, northern pin, and white oaks are by far the most common and most important species.

Diversity Among Stands

Site quality exerts significant influence on wildlife habitat quality. Northern red oak stands, for example, comprise quite different habitats when grown on good sites as compared to those associated with red oak on poor sites.

Best Sites

On the best sites (Site Index 80 and better), associated tree species commonly include sugar maple, beech, yellow birch, and ironwood. Game species such as deer, grouse, and turkeys may come from long distances to feed at individual trees with good acorn crops.

When red oak occurs on such sites, it is usually as scattered individuals. These trees are often the largest diameter and tallest species in the stand. As such, they may offer opportunities for raptors to nest in a developing stand much earlier than would otherwise be the case.

Inclusion of some oak in these northern hardwood stands is desirable from a wildlife habitat standpoint. Guides for maintaining oak in these stands are found elsewhere in this document.

Medium Sites

On medium to good sites (Site Index 55 to 80), we often find red oak growing in combination with aspen, red maple, and white pine with understory growth of witch hazel, maple leaf viburnum, and other shrubs. The oak is a sustainable component of most stands on these sites. Its retention is of high value to wildlife populations.

Poor Sites

On poor sites (Site Index less than 55), oaks may dominate the stands or may be mixed with jack pine, red pine, white pine, and red maple.

Oak Barrens

Oak barrens or oak savannas are types typical of prairie edges and some dry, fire-prone areas of Northern Michigan. The rare Karner blue butterfly is often found in the oak savannas of Southern Michigan. However, its host species, wild lupine, is a wildflower seldom found in Northern Michigan.

Diversity Within Stands

Habitats differ from place to place within a given stand. These differences could be grouped into four separate strata:

Stratum 1	Ground level
Stratum 2	Shrub canopy level
Stratum 3	Intermediate crown level
Stratum 4	Treetop level

Ground Layer

At the ground level, grasses, forbs, and woody debris are important components of habitat. Management practices employed for oak regeneration will normally work to the advantage of the ground vegetation as well as oak, but the woody debris may need special attention. Land managers should take into account the need for some material to be left on the ground in designing cutting specifications.

Often, firewood operations follow timber harvest and lead to a very clean condition on the forest floor. This is good for hunters to walk through but deprives the stand of certain ground-level habitats. A means should be sought for providing for the retention of some of this material.

Shrub Layer

The shrub layer will not be present in all stands. This is dependent on the site quality and the amount of light available to the forest floor. In general, oak management practices will favor development of the shrub layer on sites prone to shrub growth. Thinning and shelterwood regeneration cutting will provide the necessary sunlight for shrub growth.

Intermediate Crown Layer

Management using the five-spot cutting system will favor the intermediate crown level. After about 45 years of treatment, the developing oaks create a canopy layer that could be described as intermediate.

Treetop Layer

Mature stands will automatically contain a treetop layer. Contiguous crowns provide the best habitat in this layer. Squirrels, martens, and others can move from treetop to treetop when crowns are contiguous. As the shelterwood system progresses, thinnings do not seriously reduce the value of the habitat but the regeneration cut does begin to change things.

At this point, the crown canopy is broken up and the stand takes on a more open character. Species such as red-tailed hawks may use the stand during this stage, nesting in the tops of the trees.

All stages of oak management will provide good habitat for some species of wildlife. A good mix of stands in various stages of development will provide for a good degree of wildlife and plant diversity.

Some Notes About Acorn Production Management

When acorn production is the primary objective of oak management, there are several factors to consider. Acorn production varies with soil conditions, microclimate, insect problems, tree characteristics, competition, and crown size. For example, stress caused by light insect defoliation and other moderate disturbances can trigger increased acorn production in subsequent years. Consider these factors when managing oak stands to improve mast production over a long period.

- Encourage large crowns to improve seed production. Trees growing on edges, in the open, or on southern or western aspects should be favored. Promote dominant crown position in the oak component.

- Look for evidence of past acorn production when selecting leave trees. These trees can be left indefinitely or harvested during the first thinning of the next crop.

- Manage to reduce the risk of frost damage. Air drainage and aspect are important considerations and are described elsewhere in this guide.

- Tree maturity and vigor are correlated with mast production. White oak and northern red oak may be left well beyond normal rotation age. Old dominant oak trees, even on poor sites, often produce acorns to a very old age. Hazard trees should be selectively harvested or allowed to decline, providing cavity sites and large diameter dead wood.

- When oak trees are left following a harvest, groups of trees are preferable to single trees. Groups are identifiable and provide a habitat that is distinct from the surrounding forest. This helps provide diversity in vegetation type and structure. Cultural applications to reduce competing vegetation are more easily applied to groups or stands of crop trees.

- The highest site index will provide the greatest mast production, other factors being equal.

- Oak species diversity will enhance mast production. White oak may produce acorns in years when red oak do not. Insect pests and weather factors will affect species differently and diversity improves the likelihood that acorns will be present in a given year.

Forest Health: Oak Decline Considerations

Oak and Susceptibility to Decline

The oak family in general, and northern pin oak in particular, are inherently susceptible to periodic bouts of decline and mortality. For one, oak is a colonizer. Adapted to establishing itself under conditions of little or no shade, it does not compete well with more shade-tolerant species. In nature, oak typically does not succeed itself. Forest managers interested in keeping oak in the forest are often fighting a natural progression toward other species, requiring them to silviculturally create conditions favorable for oak.

Northern pin oak is a relatively short-lived tree and is particularly prone to problems. It is found on glacial outwash areas characterized by shallow, droughty, nutrient-poor soils. While genetically adapted to these sites, they are also more prone to periodic stresses caused by water table fluctuations and erosion. Poor growing conditions also lengthen the time northern pin oak needs to recover from bouts with stress.

Northern pin oak commonly regenerates from stump sprouts. Only two or three sprouts typically survive to maturity and dead stems can provide an entry point for wood-decaying diseases like the butt rots. In addition, the ability of a tree to stump sprout is directly related to root starch reserves.

Oak is at a particular disadvantage during bouts with defoliation and drought when the amount of starch reserves available for storage in roots can be seriously reduced.

The History of Oak Decline in Michigan

Oak decline is nothing new to Michigan's forests. Since the 1950s, when forest health specialists first began keeping statewide records and probably for some time before that, large-scale oak decline has surfaced periodically in Michigan. The stresses responsible for triggering the declines are varied and include age, oak leafroller, post oak locust and gypsy moth outbreaks, spring frosts, and drought. Declines have varied in length from two to four years or more. Most have been isolated to the oak on poor sites, although good quality red oak has also been affected.

The Status of Oak Decline in Michigan

The current decline in northern pin oak first began to appear in the Northern Lower Peninsula in the late 1980s, when the oaks were 65 to 80 years old. At present these oaks are nearing 80 to 100 years of age and mortality can be found in stands across their range. Much of the area is marked by 20 to 25 percent mortality and several thousand acres are suffering 50 to 100 percent mortality. As these stands continue to age, periodic declines will persist.

The stresses currently plaguing northern pin oak are numerous and include:

- Old age
- The droughts of 1987 - 1988 and 1997 - 1998
- Two separate freezes during the spring of 1992
- Repeated insect defoliation in some areas

A Problem: Oak Growing on Pine Sites

Oak took over sites it was not well suited for following the logging of pine and subsequent fires. This set the stage for rather predictable cycles of decline.

The Role of Secondary Pests

While drought, age, and defoliation led to tree decline and mortality, they are not ultimately what cause death. Trees do not die until they are killed by secondary pests – insects and diseases that "sense" stress and take advantage of the tree's weakened condition to establish themselves.

Healthy trees have natural defense mechanisms that help them ward off attack by these pests. The high moisture and low oxygen content of sapwood tissue is not favorable for the spread of rot fungi like *Armillaria.* Sapwood disrupted by lack of moisture during a drought is less likely to fend off an attack by pathogens. Likewise, a tree's ability to physically isolate or compartmentalize fungi at the site of attack (*e.g.* a wound or hollow stem) is hampered by stress-induced changes in the tree.

Two-lined Chestnut Borer (TLCB) can also take advantage of a tree's inability to defend itself from attack when under stress. Adult beetles lay eggs on the bark surface of stressed trees in springtime. These eggs hatch and the young larvae move into the cambium tissue below the bark. Feeding by large larvae destroy the phloem (nutrient conducting) and xylem (water conducting) cells, cutting off movement of materials between roots and leaves. Depending on the speed and severity of the attack and the condition of the tree, death usually occurs within one to three growing seasons. Dieback occurs from the top down. Two-lined chestnut borer can be found in nearly all oak stands suffering mortality.

Two-lined chestnut borer is also a major factor in the edge-effect mortality seen in many stands. Mortality is often confined initially to stand edges, especially those adjacent to clearcuts, roads, or openings. More often than not, the effect is most noticeable along south-facing exposures. Among the reasons edges are more susceptible to decline are:

- An increase in the incidence of root rot fungi from stumps and roots of harvested trees.
- Higher soil temperatures in exposed areas can injure fine roots and mycorrhizae.
- Warm bark surfaces on exposed trunks that provide attractive sites for egg-laying by TLCB adults.

- TLCB is likely to be active in fresh-cut stumps and tops.
- Exposed trunks are more susceptible to sunscald damage than shaded ones.
- Felling and skidding wounds create stress in edge trees.
- An increased likelihood of radiation frost next to openings.

The Effect of Stress on Oak and Oak Regeneration

Trees differ in their ability to adapt to stress. Poplars, for example, will often shed leaves in response to drought, reducing the amount of leaf area available for transpiration. Oak, on the other hand, tends to "ignore" stressful conditions and will usually attempt to set bud following a stressful growing season. The result can be:

- Poor bud-set the following spring
- Increased epicormic branching

Stress also reduces the stump-sprouting capability of northern pin oak. Trees forced to re-foliate following defoliation from freeze or insect damage rely on root starch reserves for the energy needed. This depletes the amount of energy available for sprouting. How severe the effect will be depends on the severity and duration of the stressing agent and the age and health of the tree. Older trees growing on poor sites and subject to repeated defoliation are most likely to lose stump-sprouting capability.

Stump sprouts are also susceptible to problems including:

- Attack by rot fungi that enter through dead stems.
- Increased incidence of sunscald from exposure.
- Increased incidence of attack by insects (*e.g.* gouty oak gall) attracted to sun-warmed shoots.
- Browsing by deer.

Dealing with Decline and Two-lined Chestnut Borer

When TLCB attacks a stand, the immediate management objective should be to reduce mortality by promoting stand vigor. Unfortunately, only a few options are open to managers when TLCB outbreaks occur:

- Sanitation
- Salvage
- Sitting tight

Sanitation is the best option if the TLCB infestation is related to localized events that wound trees or reduce vigor. Examples of such events are:

- Wind shears
- Flooding
- Logging damage

The objective should be to remove dead trees and those with advanced crown dieback. Usually, northern pin oak trees with more than 50 percent of the crown dead will die within a few years and should be removed. Harvests are best done on frozen ground to reduce root damage to remaining trees. If possible, sanitation cuts should not be scheduled until the year following the disturbance to give the residual stand time to recover. Heavily stressed trees need at least a year to rebuild root reserves before attempting to fill crown gaps left by a cutting operation. For this reason, every effort should be made to minimize logging wounds during a sanitation cut.

Salvage may be the best option if a merchantable sale can be made from dead oak and oak with advanced crown dieback. Some general guidelines include:

- Marking trees when leaves are on to help assess crown condition.
- Salvage during the winter following a "normal" growing season.
- Avoid areas of the stand untouched or lightly damaged by TLCB.

Sitting tight, or doing nothing, may be the best option during outbreaks when further disturbances could prolong outbreak conditions. Following a drought, cuttings should not be scheduled until the winter following a growing season with adequate rainfall.

In the case of heavy gypsy moth defoliation, cuts should be postponed until the winter following a population collapse. Depending on the severity of the disturbance and the crown condition within the stand, trees may still be vulnerable to mortality 3 to 5 years after stress conditions subside.

In the case of red oak stands thinning should be avoided during a TLCB outbreak when:

- A reduction in stocking will increase the effects of wind on drought stress.
- Mechanical damage to roots and main stems is likely.
- Roots and crowns are too weak to occupy spaces created by thinning.

Things to Remember about TLCB Management

- Fresh stumps and roots created by thinning can favor root rot development,
- Trees usually die over a 2- to 4 - year period,
- Infested trees cut within one year of infestation will contain TLCB larvae (summer-cut) or adults (winter/early spring-cut).

Shelterwood is the name given to an even-aged management system designed to regenerate the mid-tolerant species. Often the name "shelterwood" is used to describe a certain type of partial cutting, but that is only a part of the shelterwood system.

Steps in the Shelterwood System

There are three steps commonly applied in using shelterwood – preparatory cut, regeneration cut, and final harvest. All three may not be needed in order to achieve the desired objectives. Moreover, thinnings may be needed before the actual shelterwood system is invoked. Such thinnings are not technically part of the shelterwood system, but will be included in this discussion.

Thinnings

As a stand develops into poles, thinnings are often needed, regardless of the species or management system used. These thinnings follow essentially the same pattern with a purpose of releasing designated "crop" trees (Figure 9) for increased growth and maintaining vigorous full crowns more capable of withstanding stress. Thinned stands will also produce more mast for wildlife.

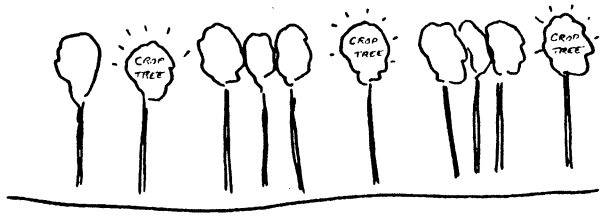


FIGURE 9

Figure 9. Periodic thinnings are needed in most stands to increase diameter growth on the better quality trees. These thinnings are the same in the shelterwood system as in the single-tree selection system. Stocking should be kept relatively high to protect quality.

As we manage our hardwood stands on state forest land, we often encounter even-aged, pole-sized stands in need of thinning. When marking thinnings in various hardwood species we should follow the normal marking rules and maintain the stocking levels that will protect the stem quality in the residual stand. Generally, this is a basal area of 85 square feet. Not until the stand reaches medium to large sawlog size do we begin to employ the actual shelterwood steps.

Some Notes About Stressors and Thinning

Research conducted in the forests of the northeastern United States suggest that thinning a stand just prior to, during, or right after a stressing event can lead to excessive mortality and dieback. While formal studies have not been done in Michigan, some general comments can be made based on our observations over the past several years:

- Past management history is important in determining the impact a stressing event will have on the stand. Stands that have been thinned regularly are better prepared to deal with periodic stress like defoliation.

- The process of thinning can stress a stand, particularly during the first few growing seasons. Trees in the residual stand expand their crowns to fill canopy gaps created by thinning. The tree is also dealing with stresses created by logging, including soil compaction, wounding, and fluctuations in the water table. These stresses can lead to dieback and mortality during the growing seasons immediately following treatment and for a period of years thereafter.

- As a rule of thumb, thinning should be avoided during and, when possible, at least one growing season following insect outbreaks or weather events that cause at least 30-50% defoliation throughout the stand. When early-season insect defoliation can be predicted in advance, thinning should also be avoided for at least a growing season prior to the outbreak. These precautions will give the stand time to build and replenish root reserves prior to dealing with the stress of thinning.

- When thinning cannot be avoided during an insect outbreak, it may be wise to schedule operations for the dormant season. Heavy defoliation can occur when caterpillars migrate from cut trees to residual trees during the summer months. White pine understories in Northern Lower Michigan have been seriously damaged by gypsy moth as a result of poorly-timed oak thinnings.

- Remember that healthy trees are resilient to periodic stress. It is best to begin improving a stand's health and vigor through good forest management as soon as practical.

Preparatory Cut

The preparatory cut is used to enhance the seed-producing capacity of the stand. It may be hard to differentiate between this and the thinnings described above, in fact, there is very little difference. All the previous thinnings have been working to enhance the best quality stems. Now that the stand is of sawlog size, we must decide which system to use to regenerate it. If it is a sugar maple stand of good quality with a few nice oaks scattered about, we will probably choose the selection system with some modifications here and there to encourage oak. If the stand is predominantly oak or if it is clear that oak is a good choice on this site, we will probably choose shelterwood.

Once the decision has been made to go with shelterwood, we need to plan for the regeneration cut. The preparatory cut, the last thinning before the regeneration cut, should remove any remaining seed sources that might offer serious competition to the desired species.

Regeneration Cut

When the stand is at or near the prescribed rotation diameter (generally around 20"), the regeneration cut should be applied. As a rule, this means reducing the stand to about 50% crown cover (Figure 10). How to determine the crown cover is a debatable point. The best tool is experience and a trained eye. A pocket instrument called a *crown densiometer* may be of help.

The regeneration cut must be accompanied by some manner of scarification in order to be effective in establishing regeneration. This can be accomplished in some circumstances by summer logging and in other cases must be supplemented by disking or other mechanical means.

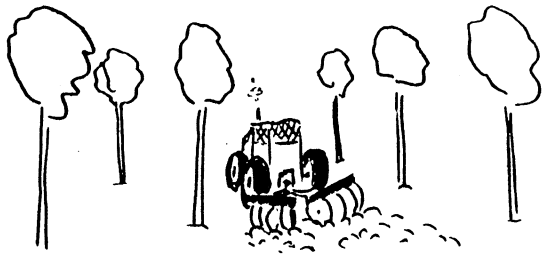


FIGURE 10

Figure 10. The regeneration cut should reduce the stand to approximately 50% (40% to 60%) crown cover. Usually some sort of soil scarification will be necessary.

Scarification is most effective when done during a good seed year prior to acorn fall. Effects last only one year in most cases due to the covering of the site by fallen leaves. Prescribed fire may be another option, but remember the residual stand is made up of the best trees you have grown and they can be easily damaged and degraded by fire.

Final Harvest

The final harvest is the removal of the residual trees left after the regeneration cut. This should be done only after the desired regeneration has reached a height of four to five feet and is considered well established.

It is not necessary to remove all residual trees in this operation. Trees can be retained for aesthetic or wildlife habitat purposes without causing extensive harm to the developing stand. It is important, however, to remove most of the overhead competition in order to favor development of the species with low shade tolerance (Figure 11).

Well established oak regeneration is very resilient and will re-sprout quickly if damaged during harvesting. However, full-tree skidding and other methods that can seriously damage the understory should be avoided.

FIGURE 11

Figure 11. The final harvest removes the remainder of the residual stand, providing growing space for the newly regenerated stand. Individual trees or a few small patches of trees may be left for aesthetics or other values. Generally no more than an average of one large tree per acre should be left.

Oak on High Quality Sites

This discussion is related to the sites normally occupied by northern hardwoods. Northern red oak is sometimes found on these sites, usually in mixture with sugar maple, yellow birch, basswood, ash, and hemlock. Oak normally forms a small component of such stands, either scattered individuals or "pockets". When it is present on northern hardwood sites, it is usually of excellent quality and vigor and of superior size.

Our management guides for the northern hardwood type call for favoring the best quality tree regardless of species. Therefore, our discussion here will be to outline what constitutes "favoring" oak when it is the best quality tree.

Regeneration Needs

Three things must come together to favor oak regeneration: viable seed, receptive seedbed, and good growing environment. Good seed crops occur in red oak every two to five years. Some trees are excellent producers on a more or less regular basis; others rarely produce seed. Squirrels and blue jays provide effective seed dispersal services. Blue jays can carry seeds 3/8 mile or more.

A seedbed of loose mineral soil is best for seed germination. The squirrels and blue jays mentioned above will bury the seeds in such places if they are available.

Scarification is short-lived since even one year of heavy leaf fall will cover most mineral soil.

Once seedlings appear, they need sunlight to develop properly. They will not do well under the canopy of a northern hardwood stand or under the parent tree but need open sun for about half the day for best growth and survival.

Harvesting Method

In order to provide the conditions described above as necessary for oak regeneration, some departure from the normal northern hardwood management regime is needed. Canopy gaps are used in the management of sugar maple stands and should be used also to encourage oak. For oak, however, the gaps should be larger, about two chains across, as measured from tree stem to stem (Figure 12). This will produce an opening of about 60 feet, compared to a prescribed opening of 30 feet for sugar maple. These large canopy gaps increase the likelihood that several acorns will germinate in the soil below.

Canopy gaps provide the prescribed sunny environment for optimum seedling development but do not address the seedbed needs.

Some form of scarification is needed to provide the bare mineral soil. Often summer logging will be sufficient to provide this, but disking may be necessary in some situations.

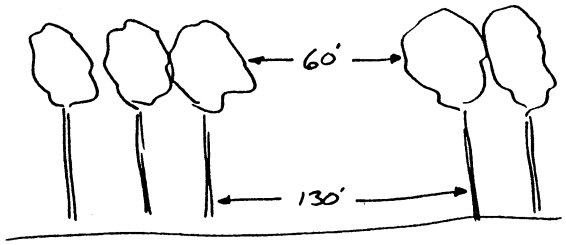


FIGURE 12
Figure 12. Regeneration openings for oak should be two chains across and have a 60-foot crown opening.

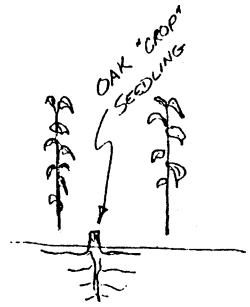
It is not absolutely necessary to put the gaps right next to the oak trees because the animal seed vectors are so effective in dispersing seed. A properly prepared seedbed nearby is attractive enough that the squirrels and jays will use it if acorns are available.

Seedling Development

After seedlings are established in the canopy gaps they must fight their way above the competition which is ever present in several forms. If vegetative competition is sufficient to impede the growth of the oak, a herbicide application can be used to set back the competition.

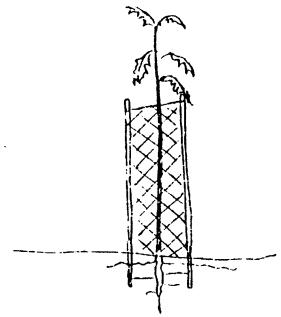
This method requires the cutting of oak seedlings at the ground line and subsequent spraying of the area with an appropriate herbicide (Figure 13). The foliage of the competition will take up the herbicide, not the snipped oaks. The oaks re-sprout and take advantage of the increased room for growth.

Deer present the next worst competition problem for oak seedlings. They can be discouraged with a variety of individual tree shelters available on the market (Figure 14). Tree shelters should be used with caution. Reduced light and heat buildup inside the shelters can cause spindly growth and scorching.



Vegetative competition can be controlled by snipping the oaks and spraying with an appropriate herbicide.

Figure 13



The use of tree shelters will protect trees from deer predation.

Figure 14

Red oak can be successfully planted or direct seeded into openings where no good seed source exists or in cases where created openings have failed to yield good regeneration.

Intermediate Treatments

Crown size is very important in red oak. Oaks are seldom found in intermediate or suppressed crown positions. Thus, they require early release from crown competition. This should be first considered in the 4" to 10" diameter range.

Large crowns encourage mast production, too, so when you are marking in hardwoods and find a pole-sized oak you would like to develop into a crop tree, make sure you give it a good crown release.

Pruning of oaks is worth considering, particularly if inexpensive labor is available. This operation can mean the difference between a sawlog and a veneer log at harvest time and that could mean a fourfold difference in value.

Oak on Medium Quality Sites

The previous discussion dealt with oaks on the very best northern hardwood sites. Here we will discuss the management of oaks on the medium quality sites. Often oaks are found in mixture with aspen, red maple, and/or pine on these sites. Site index for oak is typically from 55 to 80.

While oak occurs on a wide variety of sites in Northern Michigan, it does not produce quality trees on poor sites and it will never be a major component on the highest quality sites. Oak can, however, be a major, high quality component on medium quality sites. The best oak regeneration often occurs on these sites.

Oaks achieve high dollar values on medium sites. Wildlife values for mast production and nesting sites make oaks important for a variety of wildlife. Social and aesthetic values are also significant.

When to Manage for Oak

The medium quality sites discussed here offer opportunities for a variety of management objectives. Aspen and pine are common choices. Forest plans and compartment reviews should help in determining how much oak is appropriate. Armed with an idea of how much oak is desired, the stand examiner doing Operations Inventory must make recommendation for management objectives.

Oak is a reasonable objective when:

- There is quality oak in the stand.
- Oak seedlings appear with some frequency (oak seems to "want" to grow there).
- Site index for oak is over 55.
- Oak is desirable for diversity and wildlife.

Managing Oak is a Challenge

There is no way to write a "cookbook" for oak management. There are too many variables and unanswered questions for this to be possible. We have learned a lot in recent years, but there is much more to learn. Stand examiners must observe, think, and record their observations and thoughts. Not everything we try will work, but documented failures are valuable, too. Unrecorded or undocumented failures only invite us to repeat our mistakes.

Follow Shelterwood Principles

The following guides should be of help in writing stand prescriptions and in accomplishing the work. Most of the work can be accomplished through thoughtful crafting of timber sale cutting specifications.

Oak Guide for Medium Sites

Stands less than 16" DBH

- Thin to 80 - 90 square feet per acre.
- Thinning builds strong crowns (very important).
  - Helps trees resist environmental stress.
  - Helps prevent epicormic branching.
  - Increases acorn production.
- Discriminate against less desirable species and aggressive seeders like red maple.
- Save some trees for snags & dens.

Stands 16" DBH or larger with little or no regeneration

- Make initial regeneration cut.
  - Leave 40% to 60% crown cover.
    - Can be measured with pocket densiometer.
    - Leave shade from high crowns rather than from low crowns.
  - Provide for scarification.
    - May be done by logging operation.
    - May need extra operation.
  - Heavy slash will deter deer browsing.
  - Herbaceous competition may need to be treated.
    - Clip seedlings at ground line, then herbicide; or
    - Prescribe burn.

Stands over 16" DBH with established regeneration.

- Remove overstory.
  - DBH of 18" to 20" is considered economic maturity.
  - Regeneration should be at least 4 ½ feet tall.
- Save den trees and special aesthetic or mast production trees.

In most cases, following the above guide will not result in establishment of pure oak stands. It is not necessary to have pure stands in order to grow valuable oak. In many cases early commercial thinnings can shift stands toward higher proportions of oak. Oaks mixed with pines and other species have distinct aesthetic and biological advantages. Medium quality sites are capable of producing varied stands with multiple values.

Oak on Poor Quality Sites

Poor quality sites are considered to be those sites with a site index less than 55. This describes about half the oak sites on state forest land.

Northern pin and white oaks (with a mixture of black, red, and various hybrids) generally dominate these sites. Associated species include the pines, aspens, and red maple. These associates often play an important role in oak management.

Soils on poor quality sites are usually outwash sands.

Managing oak on these poor sites is a challenge. We have experienced many failures and some successes. Oak regeneration is fickle; what works in one place might not succeed in another place. We have learned a lot, but there is still much to learn.

Eleven Considerations for Poor-site Oak Regeneration

1. Data Collection All of our state forest prescriptions are based on Operations Inventory (OI) data, so it is very important that you collect good data when you are doing OI. Be observant and record what you see. Record remarks if you see something that does not fit neatly in one of the blanks on the form.

Site index is important enough to leave blank if you cannot get a good measurement. Sometimes it is very difficult when trees are frozen to get the increment borer into the tree. It is better in such cases to leave site index blank and collect the information later. The computer cannot differentiate between good and bad data, and poor decisions can result from poor data.

You will visit the stand again if there is a timber sale proposed. This will give you a better picture since it is a more thorough exam. If you feel the prescription from OI will not meet the management objective, stop and review it with local Forest Management Unit and Wildlife Division staff.

2. Age of the Stand Ideally, we should be harvesting oak stands on poor sites at or before age 70. This will result in vigorous stump sprouting.

3. Frost Situation Cold air is denser than warm air and will flow and settle in low areas. An overstory is beneficial in breaking up this airflow.

4. **Deer** Deer love oak regeneration. The slow growth rate of oak regeneration on poor sites renders it very vulnerable to deer browsing.

New seedlings will be vulnerable for 6 to 8 years; stump sprouts for about 3 years. High concentrations of deer can eliminate oak regeneration.

As a hedge against potential browsing, consider the following:

- Proximity to high deer populations. Oak harvested in these areas will need some special provisions.
- Larger cuttings will provide more forage.
- Clearcuts will provide more forage.
- Slash piles will restrict deer movements.
- We could defer cutting until deer population is lower.

5. Stress Many factors can cause stress. Poor site oak is very vulnerable to stress caused by age, insect attack, drought, cuttings, and other factors.

Cutting can stress residual trees. In stressful times, oak may not respond the way you expect it. Seed crops and stump sprouts may fail to appear as expected.

Stress can lead to crown mortality. This may not be all bad as it can provide some openings in the crown canopy for regeneration to get started.

6. Associated Species Associated species must be considered when you are making a prescription for an oak stand. A minor component of aspen, for instance, can dominate the stand after a clearcut. This is not bad, but if your management objective is oak, a clearcut in mixed oak and aspen may not accomplish your objective.

Red maple can occupy a site before oak regeneration starts. This must be anticipated before it becomes a problem.

White pine can be either friend or foe. A solid understory can shade out oak seedlings. But should the management objective be a mixture of white pine and oak instead? Keep in mind that partial shade can provide the needed thermal cover to protect young oaks from frost.

7. Average Stem Diameter Research has shown that sprouting declines with increasing stump diameter. If stump diameters average 14 to 16 inches or larger, you cannot expect much in the way of stump sprouts. In this situation, a clearcut is not a good idea unless you have plenty of waist-high, advanced regeneration.

8. Ground cover A heavy mat of grass or sedge will reduce the chances of new seedling establishment. Some form of scarification is advised in such cases. Disking, trenching, or scarification with anchor chains will provide the necessary mineral soil exposure.

9. Advanced Regeneration Seedlings with finger-sized diameter and heights of four feet or more are considered established, advanced regeneration. Six-inch seedlings are nice to have but they provide little assurance of a future stand. Once a tree reaches a height of 4 feet, it has broken out of the suppression stage and is ready to grow.

Advanced regeneration is common in some areas. Gladwin and Iosco counties are examples. Foresters often miss this in making stand exam and prescriptions. Advanced regeneration is not always obvious. A tree every 20 feet, combined with future stump sprouts, may be enough.

Watch for advanced regeneration. It provides an opportunity we should not pass up.

10. Adjacent Area Management Another very important consideration is what is happening on adjacent lands. We have done a lot of cutting that can serve as silvicultural trials. Cutting prescriptions and management objectives can be reviewed in compartment files. Did the treatment work? Can you determine why or why not? Use this information to help make a prescription.

11. "Pie in the Sky" Prescriptions Sometimes we are tempted to write a prescription that is quite detailed. Conditions vary from one part of a stand to another and one general prescription does not seem appropriate. It is good to use our imagination for creating innovative approaches, but we need to use some restraint. For instance, if we restrict cutting to years when acorns are a certain size and soil moisture is favorable for germination, we may defeat ourselves by making it impractical to accomplish.

Always try exploring new things, but make sure there is a practical possibility to your prescriptions. If you have an idea for a research project, submit it to your timber management specialist. He or she will pass it along through channels for consideration.

Silvicultural Summary for Poor-site Oak

I. Thinning: Maintain 80 - 90 square feet, but thinning is not often done on poor sites.

II. Intermediate Cuts: May be done to increase crown diameter prior to regeneration cut.

A. Remove undesirable species.

B. Try to find a way to do it without the expense of marking.

III. Regeneration Cuts: Several methods available.

A. *Clearcut.* Most practical if the following conditions are met:

1. Stand is age 70 or less and still vigorous.
2. Sufficient small stems to provide sprouts.
3. Sufficient advanced regeneration.
4. A combination of 1, 2, and 3 above.
5. Size of proposed clearcut must be acceptable.

B. *Spot Cut.* Cuts of ¼ acre to 1 acre.

1. Works well for regeneration.
2. Takes time to set it up.
3. Can be accomplished in some stands by cutting largest trees.

C. *Patch Cut.* Cuts of 2 to 5 acres. Have been done in east-central Michigan with good results.

D. *Shelterwood Cut.* Cut to 40% to 60% crown closure.

1. Encourages seed-origin oaks.
2. Can be done by marking, diameter limit, or species selection; depending on stand characteristics.

THE PLANTING AND SEEDING EXPERIENCE

There has been a good deal of research in recent years on the topic of oak planting. The following incorporates the findings of some of this research with our own experiences.

Planting Seedlings

Seedlings planted in open field conditions have not done very well. Sod competition, frost problems, and generally dry conditions are the suspected culprits. Under-plantings in openings created by shelterwood and group selection cuttings have been more successful in both survival and growth. This applies to both hardwood and pine types.

Large seedlings survive and grow best. Some research shows the best oak seedlings should be ½" diameter at the root collar and have three or more large lateral roots (Figure 15). Such trees are expensive to grow and very difficult to plant.

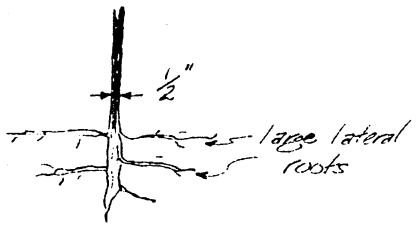


FIGURE 15

One approach to protecting the considerable investment in planted oak is the use of tree shelters. The most common shelters are the translucent plastic tubes available from several manufacturers. These seem to enhance height growth (although possibly at the expense of diameter and root growth). They work best in partial shade situations where oak seedlings may protrude from the top of a 4-foot tube in one year. In open field situations this same accelerated growth may be seen but trees seem to have a tendency to die back and may even die in the tubes. Hot, dry weather seems to exacerbate problems in tubes in open field plantings.

Caution must be taken in the use of the plastic tube shelters. They attract curious bluebirds and trap them. Dead birds, particularly bluebirds, have reportedly been found in the tubes. A "stocking cap" made of mosquito netting can be purchased from most suppliers of the tubes to prevent bird mortality.

Other types of shelters can be used for protection from deer. Polypropylene mesh tubes are available for this use. Two stakes must support them. Bamboo stakes are available with the mesh at low cost. A similar shelter can be made from poultry netting and staked in like fashion. These mesh shelters do not enhance growth but do provide physical protection from browsing. They can be raised, if desired, as the seedlings grow.

The cost of installing shelters prohibits their use on a large scale in most cases.

Direct Seeding

As is the case with planted seedlings, direct-seeded acorns seem to grow best in partial shade. Benefits of partial shade may be modification of temperature and moisture as well as reduction of competition. There is some evidence that direct seeding may be as effective as planting in establishing oak seedlings. It is certainly faster and more economical.

Seed should be planted 3 inches deep to protect against desiccation and rodent predation. Seeding must be done in competition-free spots, furrows, etc.

Oak can be direct-seeded mechanically by using a Killifer planting machine with a slightly modified shoe. (This has been done in the Northern Lower Peninsula and works well. The modified machine is available for use on state forests.)

A hand-seeder has also been developed for seeding oaks. One person can sow several hundred seeds per hour with this device.

Research

Recent and ongoing research on oak silviculture has contributed much to the content of this guide. Some local studies have made particularly important contributions.

Lynch, Ann and John Bassett, *Relation of Stump Diameter and DBH in Clearcut Oak Stands on Dry Sites in Michigan's Lower Peninsula,* University of Michigan School of Natural Resources, 1985.

The Five-Spot Cutting Pattern

The five-spot pattern staggers small, adjacent blocks over five consecutive 10- to 20-year cutting periods (Figure 16). When used to manage oak on poor and medium quality sites, the pattern can:

- Reduce visual impact
- Improve oak reproduction
- Maintain and improve mast production

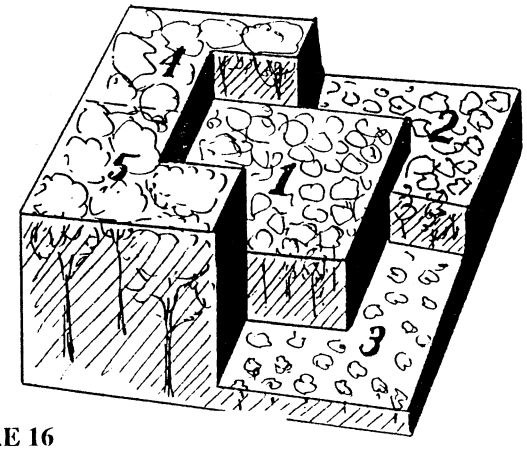


FIGURE 16
Five-Spot Cutting Pattern

The five-spot pattern can be used with various size cuts. When visual impact is a high priority, smaller cuts should be used. The smallest cut used with this method is one acre. Where visual impact is not as critical, cuts as large as eight acres can be used. Cuts larger than two acres may increase the risk of frost damage to regenerating oak on flat terrain or in depressions.

When used with a clearcut, the five-spot pattern should use cuts of 1 to 1¼ acres. This will create light and temperature conditions that will encourage seedling establishment in the cut area and in the surrounding edges.

When used with the shelterwood system, cutting cycles can be adjusted to accommodate the intermediate and final harvests that make up this method. For example, when the objective is a 100-year sawlog rotation, a five-spot shelterwood cut could be accomplished as follows:

Spot Number	Age Now (Years)	Prescription Now	Prescription in 10 Years	Prescription in 20 Years
1	100	Final harvest	--	--
2	80	Seed cut	Seedling release	Final harvest
3	60	Thin	Thin	Seed cut
4	40	Thin if needed	Thin	Thin
5	20	--	--	Thin if needed

Designing a five-spot is accomplished by compassing and pacing (Figure 17). Cruising should be done at the same time the five-spot is laid out. One or two people can design the five-spot. Typically, one person orients and paces between spots, then maps and cruises. The other person orients, paces and paints the spot boundaries.

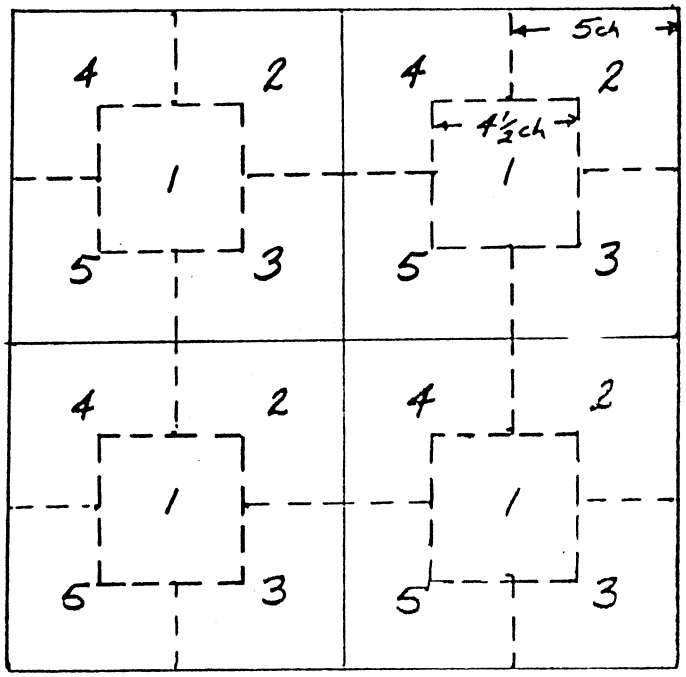


FIGURE 17
Compassing and Pacing

APPENDIX A
POINTS TO PONDER
ABOUT OAK MANAGEMENT

The following points are important for the oak manager in Northern Michigan to keep in mind. Experience has shown that attention or lack thereof may well make the difference between success and failure.

- **FROST**: Late spring and early summer frost is the oak manager's worst enemy. This is particularly so on the flat sandy sites where most northern pin oak grow. One must pay attention to frost management techniques such as five-spot cutting with spots less than two acres in area. Larger spots will become frost pockets. Shelterwood cuts that retain about 50% crown cover have been shown to provide some protection from frost as well.

- **ADVANCED REGENERATION:** Research has indicated that advanced regeneration must be five feet or better in height to have a good chance of recruiting into the future stand. There is a temptation to accept much shorter trees as adequately advanced. BEWARE! This is flirting with failure!

- **CROWNS:** When selecting trees to cut or retain, the emphasis should be on developing full crowns in the residual stand. Healthy, full crowns resist stress and help to accomplish the values we desire.

- **THINNING:** Thin for faster growth and crown development but beware of excessive thinning, especially in pole and small saw stands. Excessive thinning invites epicormic branching, shorter trees, and lower quality. Ideal basal area for thinnings is 80 to 90.

- **SHELTERWOOD:** Reduce crown closure ONLY when the stand is within about 20 years of final harvest. Ideal crown closure for regeneration is about 50%. Ideal final harvest diameter will vary by site but 18" to 20" on medium sites and 20" to 24" on good sites is "ball park".

- **RESERVE TREES:** Reserve trees may be left after final harvest for aesthetics, continued mast production, other wildlife values, or supplemental seeding. Improper selection of reserve trees can result in broad, low-crowned "wolf trees" that occupy and heavily shade too much of the stand area. One should select tall sawlog trees with a long, limbless bole and full crown. Such trees allow light to reach the ground right up to their bole and do not prevent regeneration from becoming established and growing.

- **EPICORMIC BRANCHING:** Epicormic branching is encouraged by over thinning of stands that have been overstocked for a considerable time. Oak trees or the upper portions of them that have smooth bark and trees with weak crowns are most likely to develop epicormic branches. Generally this smooth bark condition is located on portions of the trees that are under 12 inches in diameter.

- **SPECIES DIVERSITY:** Keeping some species diversity in stands is desirable. The amount of species such as pine and ash that grow in an oak stand can easily be controlled during cutting operations. Red maple is an aggressive regenerator and it may be necessary to aggressively control it to prevent the stand from converting.

- **DEER:** In most cases, deer impact oak regeneration and may even prevent it. Deer tend to do more damage in small clearcuts and in cuts that leave little brush and tops on site. Deer yard edges are extremely difficult areas to regenerate.

- **THINGS THAT WORK:** Past projects that worked in a particular area and conditions will likely work again. Change one critical condition and all bets are off!

- **FIRE:** Since mature oak are easily fire scarred and defect spreads rapidly in the wood, fire is a very risky tool to use to prepare a seed bed. However, using fire to release advanced regeneration from red maple and other competition after a final harvest is completed is well worth trying. Historically, many oak stands developed in a similar but unplanned manner.

- **NEW IDEAS:** Don't get into a rut. Be ready to combine or modify techniques as site and stand conditions allow or dictate. Try new things but keep in mind the basic requirements and limits that control oak regeneration and growth. One new method that may work in some Michigan stands is the German method (*groupenshermschlagen*) of cutting a group of about one half acre in size. Subsequent cutting then enlarges the group by cutting a donut around it of about one tree height in width. After three or four cutting cycles, the groups merge and the stand has been completely cut over. At that time the central portion of the group is already 30 years old. This method could work well in place of the five-spot technique. With early thinning, this method might even be applied to some better sites.

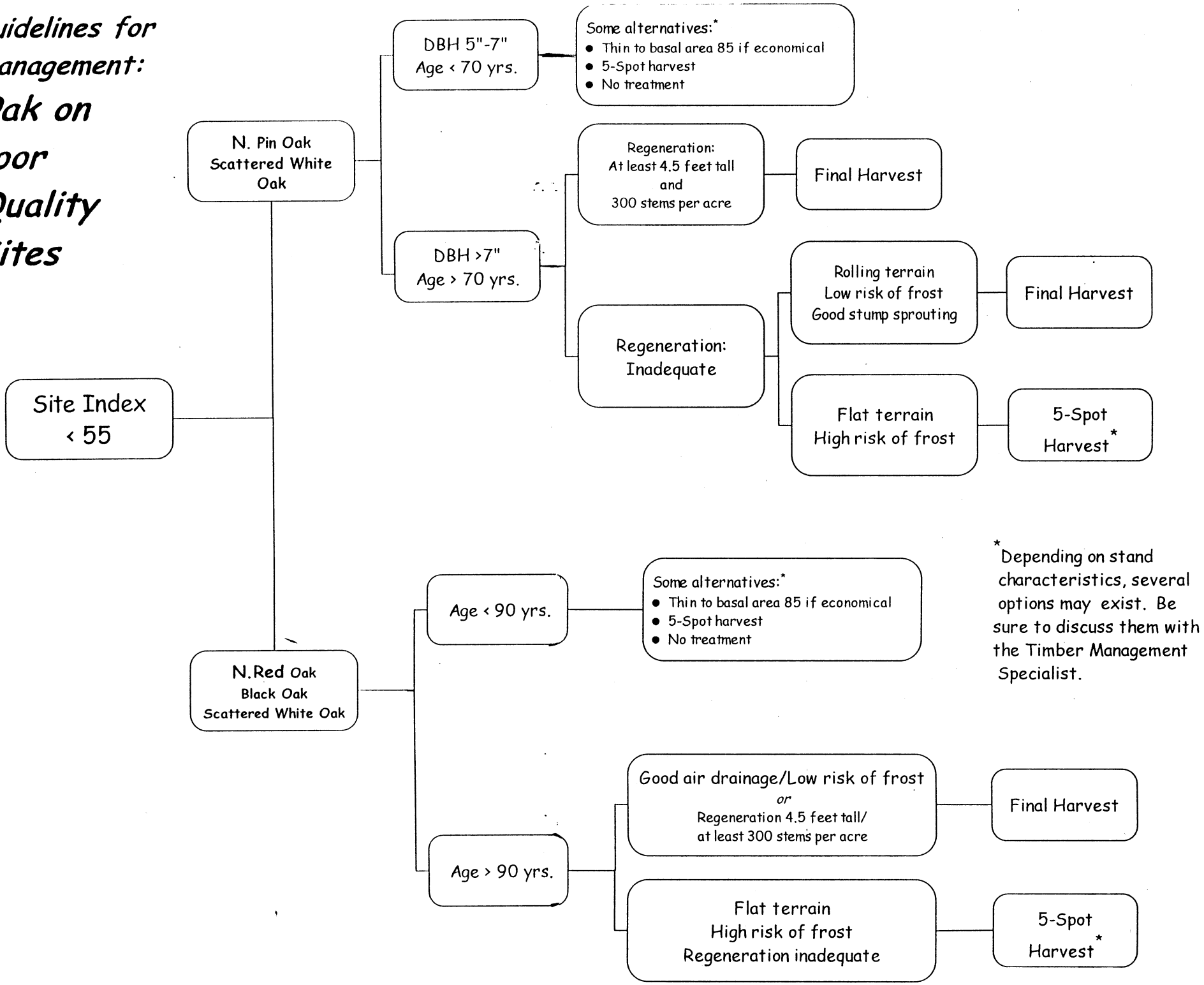
Bill Mahalak
August 1999

Appendix B

Mahalak's Handy Dandy Guide to Northern Michigan Oak Management

The following decision tree guide is no substitute for thorough knowledge of oak silviculture; nor does it consider wildlife, aesthetics, or other important issues. It is intended to be a helpful tool for making management decisions that will lead to a high probability of success. While it is designed for use with oak forest types, it should be helpful for deciding when and how to convert other forest types that contain an oak component into oak stands (e.g. an aspen stand with 50 or more square feet of oak).

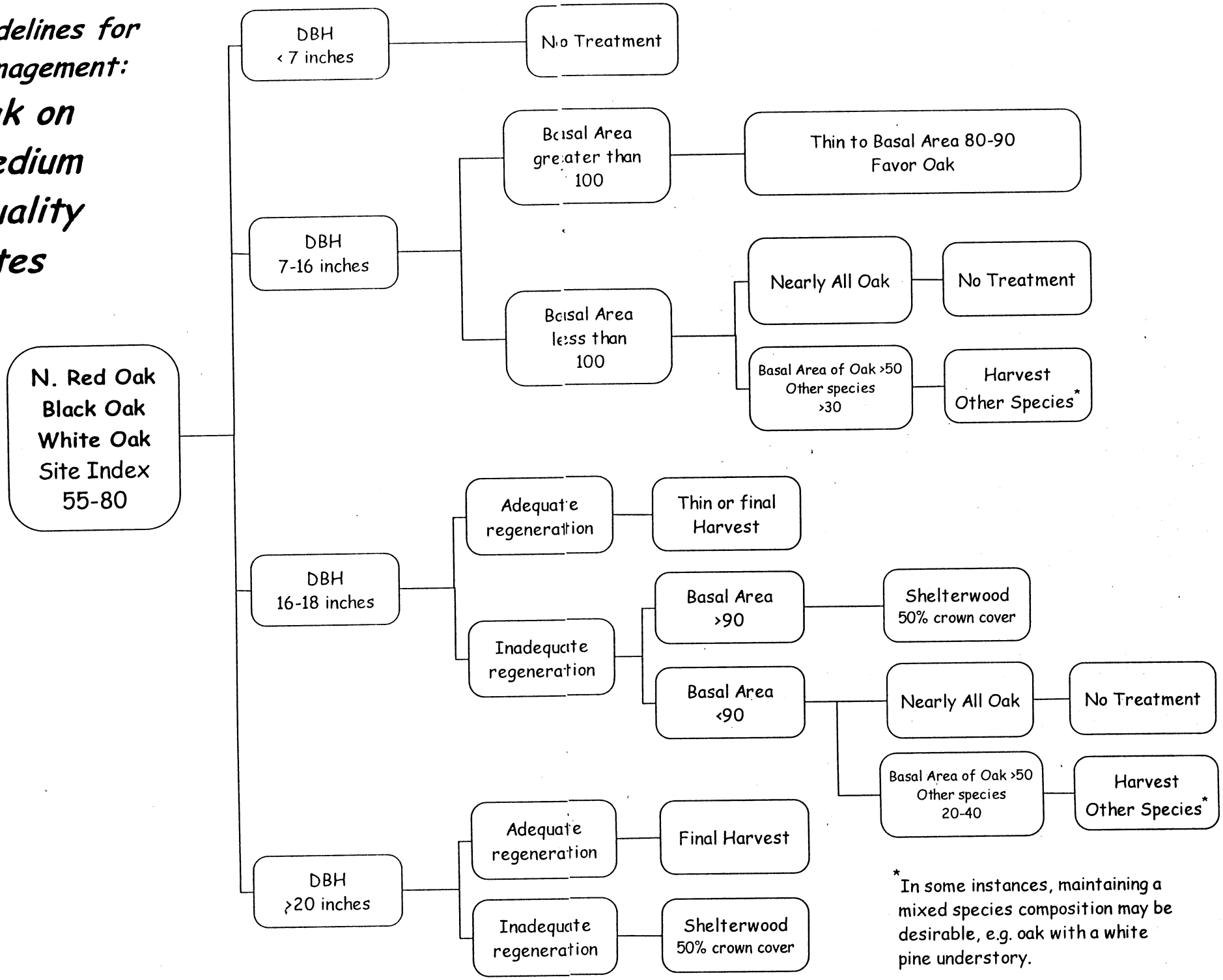
Guidelines for Management: Oak on Poor Quality Sites



*Depending on stand characteristics, several options may exist. Be sure to discuss them with the Timber Management Specialist.

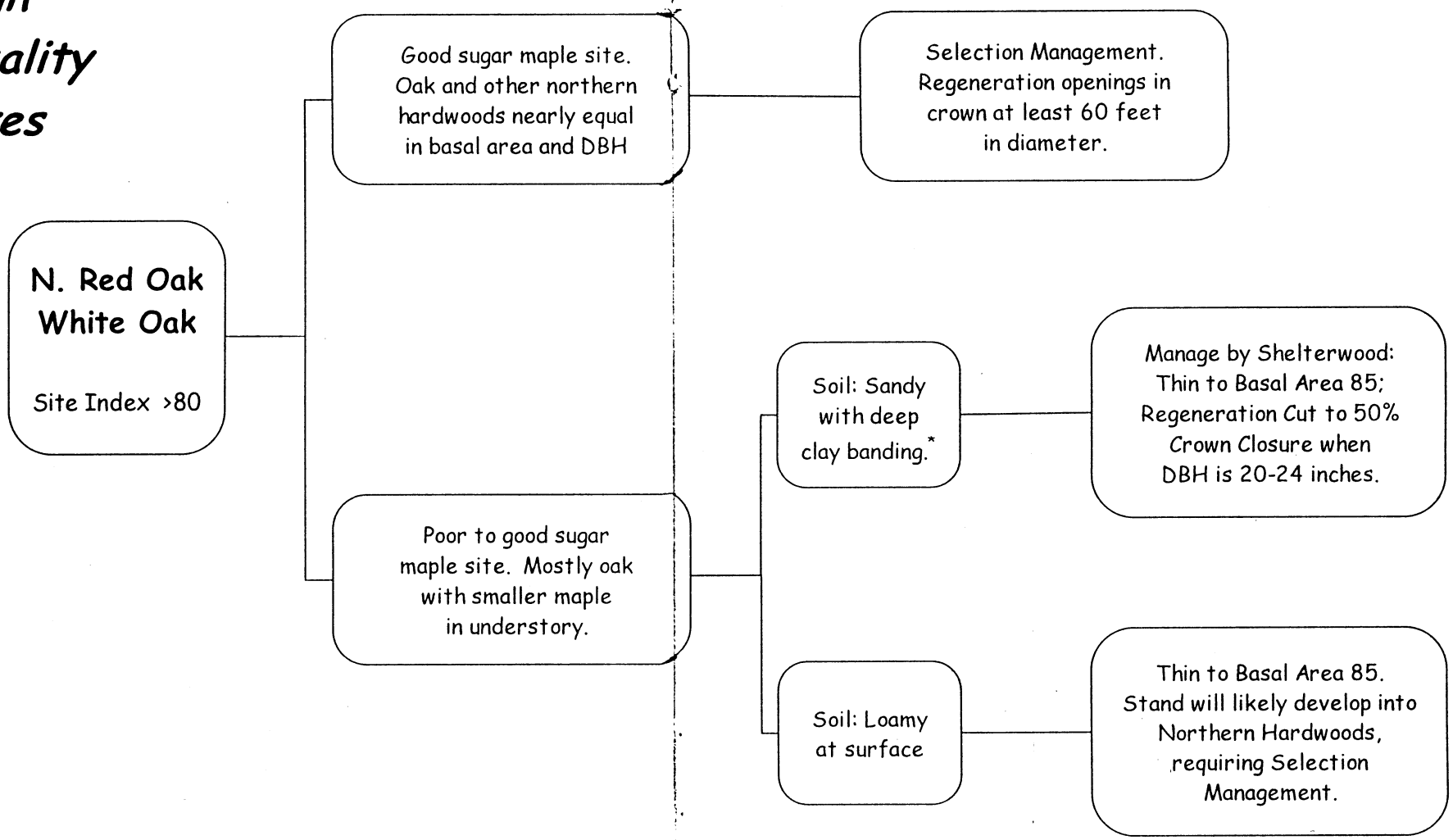
Guidelines for Management:

Oak on Medium Quality Sites



*In some instances, maintaining a mixed species composition may be desirable, e.g. oak with a white pine understory.

Guidelines for Management: Oak on High Quality Sites



*In this situation, the site may support sugar maple only if there is enough deep-rooted oak present to move nutrients to the surface.

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