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Managing Black Ash in the Lake States

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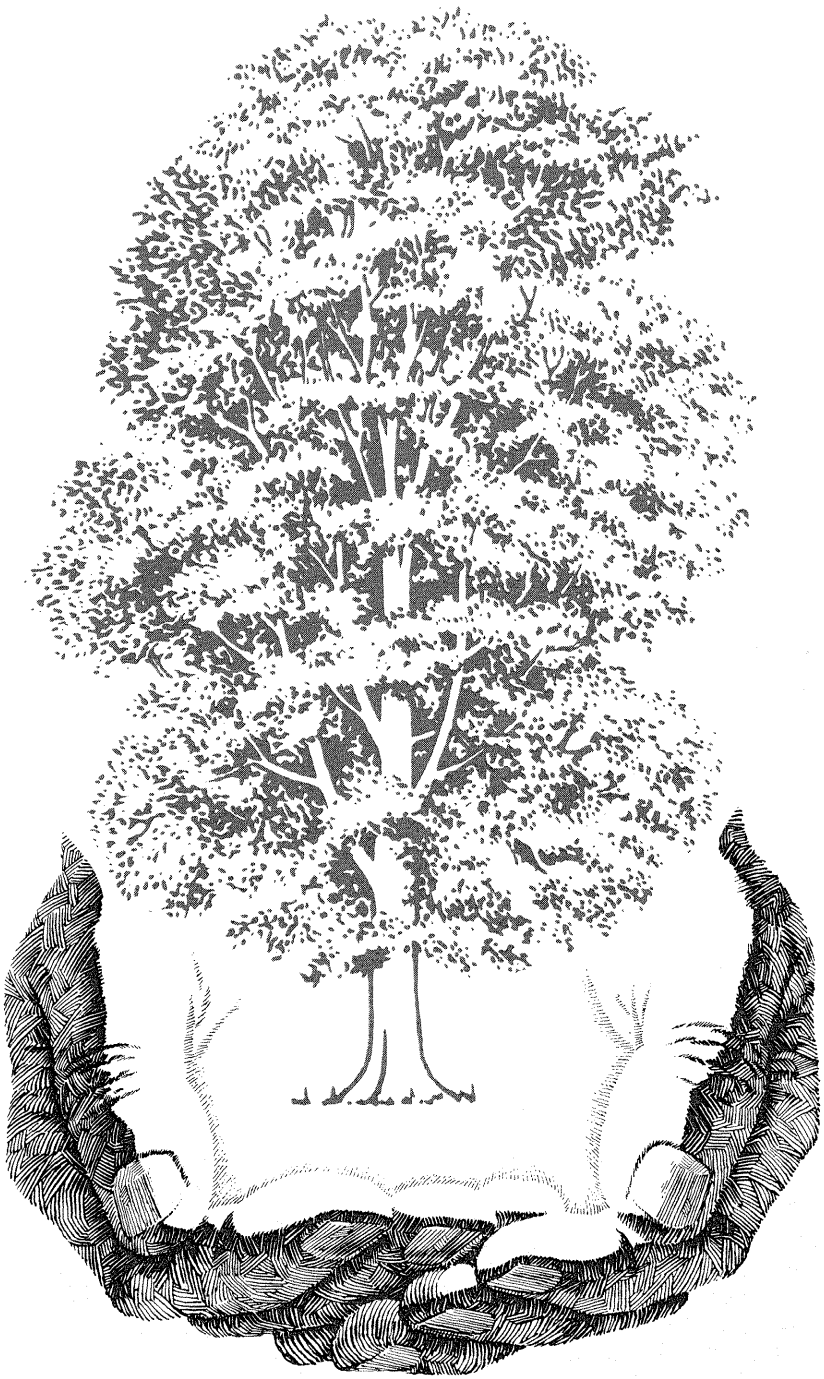

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Provides a guide for managing lowland hardwoods in the Lake States. Gives both even-age and uneven-age guides for black ash.

KEY WORDS: *Fraxinus nigra*, lowland hardwoods, swamp hardwoods, black ash-American elm-red maple type, management.

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MANAGING BLACK ASH IN THE LAKE STATES

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In the Lake States black ash occurs most frequently in the black ash-American elm-red maple type (SAF type 39).[1] It is the major hardwood type on lowlands in the northern Lake States region with black ash (*Fraxinus nigra* Marsh.), American elm (*Ulmus americana* L.), and red maple (*Acer rubrum* L.) as the predominate species. The type is commonly called lowland hardwoods or swamp hardwoods. Black ash occurs on 2,567,000 acres of commercial forest land in the elm-ash-soft maple type in Michigan (Raile and Smith 1983) and Wisconsin (Smith 1986). More than three quarters of this acreage is suitable for saw log production (SI_{50} > 50). Black ash is the preferred species and dominates the type in northern Wisconsin and the Upper Peninsula of Michigan. Elsewhere in Michigan and Wisconsin, red maple dominates the type but black ash still accounts for a large share of the growing stock. In Minnesota black ash occurs on 683,000 acres of commercial forest land in the elm-ash-cottonwood type within the Aspen-Birch, Northern Pine, and Central Hardwood Survey Units (Jakes 1980). More than half of this acreage is suitable for saw log production. Here, black ash, American elm, and red maple comprise the majority of the stocking but black ash generally is more abundant than the other two species. Dutch elm disease has almost eliminated the elm, and red maple is usually defective on wet sites.

The black ash-American elm-red maple type is a long-lived subclimax on somewhat poorly drained mineral soils (Braun 1964). The type grades into an almost pure black ash type, which is prevalent where drainage is very poor on the wetter organic peat and muck sites. Black ash is probably the climax species here. In the northern Lake States the type frequently grades into northern white-cedar on the wetter sites and into the hemlock-yellow birch type on better-drained areas and into tamarack or tamarack-black spruce stands in northern Wisconsin (Rudolf 1980).

Black ash is most commonly found growing in moist to wet muck or shallow organic peat soils but also grows in swamps, along small streams in gullies, and in small poorly drained depressions (Rudolf 1980). It also grows on fine sands and loams underlain by clays where surface drainage is impeded and on poorly drained sites with high water tables (Wright 1965). In the uplands, black ash is restricted to impeded drainageways where it grows on wetter than normal mineral soils and mingles with white ash, red maple, yellow birch, American basswood, and sugar maple. Trees growing on better than normal mineral soils with high water tables or impeded drainage may reach heights of 65 to 75 feet at 50 years and diameters of 18 inches at d.b.h. in 130 years.

MAJOR PROBLEMS

Black ash grows slowly on organic peats and mucks, attaining heights of only 30 to 45 feet at 50 years and about 50 to 60 feet at 100 years. D.b.h. of the best trees averages only 10 inches at 110 years and 12 inches at 130 years. Black ash seedlings, saplings, and sprouts tend to dominate the regeneration where partial openings in the canopy have occurred. Clearcuttings on organic sites often result in inadequate natural regeneration or loss of advance regeneration to rising water tables or from competition with grass and brush. This is winter habitat for deer that browse heavily on black ash seedlings and stump sprouts. Most swamp hardwood stands contain many overmature, defective, and diseased trees. Some stands have been so severely high-graded for quality trees that they are now fully stocked with poor quality trees. Many unmanaged, fully stocked stands contain no desirable advance black

[1] *This type should not be confused with other more southerly bottomland cover types of the Society of American Foresters: silver maple-American elm (type 62); cottonwood (type 63).*

ash regeneration. Trees on wet sites are shallow-rooted and subject to windthrow. Black ash is the key high value species in the black ash-American elm-red maple type because it produces wood that is free from disease and insect damage.

IMPORTANT SILVICAL CHARACTERISTICS OF BLACK ASH

Flowering and Fruiting

Black ash is polygamous (Bonner 1974). Its flowers appear before the leaves in late May or early June. The fruit is a winged, flattened, single-seeded samara that is borne in terminal or lateral branch clusters. It ripens in late August or September and is dispersed from October until early spring. Ripe seed is yellow-brown, 1½ inches long, ⅜-inch wide and averages 8,100 cleaned seed per pound (Bonner 1974). It has a wing that extends almost to the base and often is notched at the apex of the pericarp. Black ash seed is indistinct within the pericarp and has a characteristic spicy odor (USDA 1948).

Black ash bears good seed crops infrequently (Bonner 1974, Godman and Mattson 1976, 1985). Only 11 good or better black ash seed crops were produced during a 35-year observation period in northeastern Wisconsin. Good seed crops occurred at 1- to 8-year intervals with most intervening years having poor seed crops. The longest period of successive poor seed crops was 7 years (Godman and Mattson 1976, 1985).

Seed soundness can be determined by using either a cutting test or x-rays to see if a firm, white, fully-elongated seed fills the samara. Viability can be tested by using the excised embryo and tetrazolium staining methods (Association of Official Seed Analysts 1965).

Germination

Fresh black ash seed contains both an immature and dormant embryo that require warm moist and cold temperature after-ripening prior to good germination (Vanstone and LaCroix 1975). Eighty-seven percent germination was obtained by placing fresh, sound samaras in moist peat (75 percent moisture content) at 44° F for 126 days and then after-ripening them at 14° F for 168 days (Vanstone and LaCroix 1975). Before black ash embryos germinate, they must grow from about one-half to two-thirds the length of the seed (Steinbauer 1937). As a result of this, most black ash seed will not germinate until the second spring after seedfall. Some seed may lie dormant in the litter for up to 8 years (Wright 1965).

Seedling Development

Black ash seed is capable of germinating in hardwood leaf litter or under 1/4- to 3/4-inch of soil, but grass, brush, and advance hardwood reproduction must be controlled for successful black ash seedling establishment. New germinants are about 2 inches tall within 2 weeks and under the best conditions may average about 6 inches in height by the end of their first growing season. At this time, the first-year seedlings still retain their single pair of opposite cotyledons and may have up to four pairs of single, opposite, stalkless leaflets. Typical compound ash leaves are not normally produced until the seedlings' second year.

Black ash seedlings and sprouts frequently are the only advance hardwood reproduction that occurs in canopy gaps in uneven-aged stands growing on wet organic soils in the black ash-American elm-red maple type. However, on disturbed mineral soils with either a high water table or impeded drainage, the advance reproduction often is red maple, American elm, and green or white ash. On these sites black ash seedlings grow faster than red maple seedlings but grow slower than American elm seedlings (Rudolf 1980). Without disturbance, reproduction is almost entirely absent on better sites within the black ash-American elm-red maple type.

On slightly better drained sites, tree species are more abundant and diverse. Here, species more demanding in their site requirements such as white ash, green ash, basswood, yellow birch, red maple, and even sugar maple occur along with black ash.

Black ash seedlings, like white ash seedlings, initially are more shade tolerant than yellow birch and American elm. However, they become more intolerant with increasing age. White ash seedlings should receive from 55 to 75 percent shade the first year (Logan 1973). Best overall white and black ash seedling development *probably* occurs in about 45 to 50 percent of full sunlight.

Vegetative Reproduction

Black ash sprouts readily from low cut stumps up to 12 inches in diameter. Sprouts originate from adventitious buds on the sides of the stump and at the root collar. Stump sprouts can be extremely fast growers. Black ash will also produce root suckers from cut trees.

White-tailed Deer

Black ash seedlings and sprouts are heavily browsed by deer in the swamp and lowland black ash-American

elm-red maple types. Apparently they can withstand moderate to heavy winter browsing.

MANAGEMENT OBJECTIVES

Lowland hardwood stands should be managed to produce the maximum quality and quantity of high value sawtimber, pulpwood, fuelwood, and other products, consistent with the site potential. Not all lowland hardwood stands can or should be managed for timber production. Due to a raised water table and decreased transpiration, clearcutting or strip cutting on excessively wet organic peat or muck sites may result in loss of the site to brush, grass, or even cattails. On these excessively wet areas where site index is less than 45, natural succession should be allowed to continue with the objectives of maintaining wildlife habitat and watershed quality.

Silvicultural practices should be concentrated on the better drained sites where seedling and sprout regeneration can be expected. Lowland hardwoods frequently border streams and lakes where they may influence water quality, water temperature, and fish populations. Single-tree selection cutting should be considered along stream borders and lake shores to enhance or preserve these features.

On sites averaging 45 to 55 feet at 50 years, the primary objectives are to provide food and shelter for wildlife and to protect the watershed values. However, some small saw logs (10 to 12 inches in d.b.h.) and fiber can be harvested without sacrificing these objectives.

On better ash sites with mineral soils that are either somewhat poorly drained or have impeded drainage, site index averages 55 feet or more at 50 years. On these sites producing high-value sawtimber and veneer is the primary management objective with pulpwood, fuelwood, and other products as secondary objectives.

Cutting in the black ash-American elm-red maple type should be done when the ground is frozen and preferably when it is covered with snow to minimize seedling loss, improve equipment access, limit damage to the site, and provide alternative winter deer browse from the tops of felled trees.

SILVICULTURAL SYSTEMS

An examination of the diameter and age class distributions in six natural unmanaged black ash stands on the Nicolet National Forest indicates that black ash can be managed by either uneven- or even-aged management systems. Stand data obtained from sampling two lowland stands (two one-half acre plots in each; stands 1 and 2) on organic material of the Carbondale series had at least 11 different age classes (from new seedlings up to trees 94 to 241 years old) present, the typical inverse J-shaped diameter distribution, and the irregular appearance of an uneven-aged stand (table 1). On wet, organic sites black ash seedlings, stump sprouts, and saplings tend to dominate the regeneration where harvest tree-size openings in the canopy have been created by either the cutting or the death of a saw log-sized tree. The presence of black ash seedlings in uneven-aged climax or subclimax stands where single trees or small groups of trees have died is evidence that the selection management system will work on wet organic sites where watershed protection and wildlife considerations are major concerns. If the ground is frozen, individual mature, defective, and diseased ash trees can be harvested in wet swamps and lowland areas when cutting adjacent uplands.

One (stand 3) of the four stands examined (one-half acre plot in each) growing on mineral soils of the Iron River or Monico series with impeded drainage looked like an even-aged stand, but it had upper canopy trees ranging from 56 to 109 years old and the typical diameter distribution of an uneven-aged stand. Each of the three remaining stands on mineral soils had diameter distributions that closely resembled the normal bell-shaped frequency distribution of an even-aged stand (stands 4, 5, and 6). Thus, even-aged silviculture also can be used to regenerate moderately tolerant black ash seedlings, especially on somewhat poorly drained mineral soils. Because of the infrequency of good seed crops and the risks of losing the sites to grass and brush, the shelterwood cutting method appears to be the only safe even-aged cutting method to use in regenerating new black ash stands on mineral soils either poorly drained or with impeded drainage. Past clearcuttings on wet sites with poor or impeded drainage frequently have resulted in inadequate natural regeneration or complete loss of advance regeneration to grass and brush. However, the final shelterwood removal cut in mature stands is a clearcut. Clearcutting is appropriate only after adequate, established, advance black ash regeneration is present (at least 5,000 well-distributed stems per acre 2 to 3 feet tall).

The best way to obtain conditions favorable for black ash regeneration is through single-tree selection cuttings on the organic sites and through shelterwood cuttings on wet mineral soils where black ash is less tolerant. The shelterwood cutting method also can be used to regenerate black ash stands of seed bearing age that are inadequately stocked with crop type trees. This could be the best treatment for stands that previously have been high-graded for quality trees on mineral soils.

Table 1.--Diameter distributions and stand characteristics of natural black ash stands on wet organic and somewhat poorly drained mineral soils

D.b.h. class (In.)	Organic 1/		Mineral 2/			
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6
			Trees/A			
5	96	79	86	26	22	12
6	58	47	96	50	16	36
7	41	34	46	26	20	34
8	30	45	56	26	40	34
9	20	40	30	48	34	36
10	15	24	12	46	30	40
11	14	18	6	20	20	26
12	5	13	2	32	20	36
13	8	10	4	12	14	30
14	5	3	6	12	6	8
15	-	2	-	6	2	-
16	3	5	-	8 3/	8 3/	2 3/
17	1	-	-	2	6	6
18	-	-	-	2	-	-
19	-	-	-	2	-	-
20	-	-	-	-	2	-
21	-	-	-	-	2	-
22	-	-	-	-	2	-
Stand Total	296	320	344	318	244	300
Diameter distribution	uneven-age	uneven-age	uneven-age	even-age	even-age	even-age
Age(yrs)	1-241	1-94	1-109	71-78	79-81	78-82
Site index (SI_{50})	30	41	65	66	65	63
Basal area (ft^2/A)	94	119	99	167	144	162

1/ Stand 1 and 2 are growing on organic material of the Carbondale series; stand 1 has more than 50 inches of organic material (Euic Hemic Borosaprists) and stand 2 has 16 to 50 inches of organic material over sandy or sandy-skeletal, mixed, Euic Hemic Terric Borosaprists).

2/ The four upland stands are growing on mineral soils mapped as the Iron River Series (coarse-loamy, mixed, frigid Alfic Fragiorthods) but some may be small inclusions of the Monico Series (coarse-loamy, mixed, frigid Aquic Dystrochrepts).

3/ Most trees larger than 16 inches d.b.h. are older residual trees.

THINNING BLACK ASH STANDS

Intermediate thinnings should be restricted to stands that are less than 110 years old, contain at least 100 square feet of basal area per acre, and will have time to respond to thinning before the harvest cut.

First, reduce the residual basal area to the prescribed stocking level (80 percent crown cover for the first entry) using the even-aged stocking guide for black ash (fig. 1, table 2). The stocking guide is based on the average residual d.b.h. of all trees 4.6 inches d.b.h. and larger after thinning. The cut should be primarily from below but an attempt should be made to free crop trees from poor quality main canopy competition. Black ash has a narrower crown than sugar maple, red maple, or yellow birch. This suggests freeing crop tree crowns for only 5 feet beyond their crown perimeters in pole-size stands and from two poor quality main canopy competitors in saw log-size stands. Leave adjacent tree crowns to correct small forks (less than 2 inches in diameter). Remove high risk and cull trees with little growth and grade improvement potential to reduce mortality and upgrade the stand. Favor black ash by discriminating against other species that are growing on mineral soils with poor or impeded drainage.

Later thinnings should be delayed until crowns close and lower branches die on the crop trees. Thinnings should be made to the 90 percent crown cover stocking level to maintain growth responses and bole quality development on the main canopy stand. Cuts should be primarily from below.

Small black ash stands (less than 10 acres in size) on impeded drainageways in the uplands should be managed the same as the surrounding stand (either even-aged or uneven-aged) because in wet situations black ash has a decided advantage over associated species regardless of the management systems employed. The Manager's Handbook for Northern Hardwoods is the appropriate guide to use for managing small, upland, black ash stands (Tubbs 1977).

REGENERATING BLACK ASH STANDS

In selection stands, canopy gaps are needed to encourage black ash reproduction. All poor-quality residual stems larger than 2 inches in d.b.h. must be cut in these small openings so that vigorous regeneration can develop. Satisfactory black ash sprouts also can be obtained from stumps that are cut close to the ground. Desirable residual stocking and structure for sustained growth of black ash on wet peat or muck soils were calculated (table 3). A stand containing 80

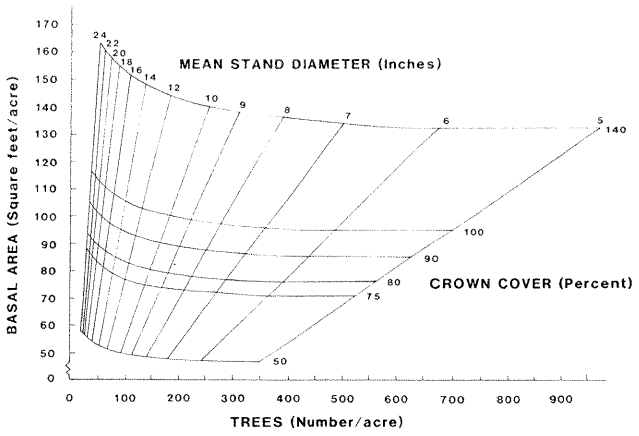

Figure 1.—*Stocking levels for black ash by crown cover, basal area, and trees per acre for specified average stand d.b.h. classes.*

square feet of basal area per acre in trees 5 inches d.b.h. and larger with a maximum tree size of 12 inches d.b.h. and a q factor of 1.3 was used to develop this uneven-aged size class distribution guide. Most second-growth stands require about three cyclic cuts aimed at achieving a desirable stocking and structure goal before they are fully regulated for sustained growth and yield.

On sites where $SI_{50} > 55$, the shelterwood system can be used to regenerate even-aged stands that are larger than 10 acres in size. Follow these guidelines for establishing regeneration with a shelterwood:

1. Select stands 15 to 18 inches d.b.h. or 110 to 130 years of age or older.

2. If advance black ash regeneration is present, mark from below to leave 50 percent crown cover of the best growing stock. Favor black ash regeneration by discriminating against other species in the overstory.

3. If advance black ash regeneration is absent, mark from below (preferably during a good seed year) to leave 75 percent crown cover. When black ash regeneration appears, open the overstory canopy to leave a 50 percent crown cover.

4. Remove the shelterwood overstory when the ground is frozen (preferably with more than 12 inches of snow cover) after the seedling reproduction attains a height of 2 to 3 feet (after 3 to 5 years). A minimum of 5,000 well-spaced seedlings and low sprouts should be left per acre.

Table 2.--Even-age stocking level table for black ash by percent crown cover, basal area, and number of trees per acre for specified d.b.h. classes 1/

Stand d.b.h. (In.)	Crown cover (percent of 43,560 ft^2/A)									
	50 Percent		75 Percent		80 Percent		90 Percent		100 Percent	
	Trees	BA	Trees	BA	Trees	BA	Trees	BA	Trees	BA
	No./A	Ft^2/A	No./A	Ft^2/A	No./A	Ft^2/A	No./A	Ft^2/A	No./A	Ft^2/A
5	348	47.4	522	71.2	556	75.9	626	85.3	696	94.9
6	242	47.6	363	71.3	388	76.1	436	85.6	485	95.1
7	180	48.1	270	72.2	288	77.0	324	86.6	360	96.2
8	140	48.8	210	73.1	223	78.0	251	87.8	279	97.5
9	112	49.5	168	74.2	179	79.2	202	89.0	224	98.9
10	92	50.2	138	75.3	147	80.3	166	90.4	184	100.4
11	77	50.9	116	76.4	123	81.5	139	91.7	154	101.8
12	66	51.6	99	77.4	105	82.6	118	92.9	131	103.2
13	57	52.3	85	78.5	91	83.7	102	94.1	113	104.6
14	50	53.0	74	79.4	79	84.7	89	95.3	99	105.9
15	44	53.6	66	80.4	70	85.8	79	96.5	87	107.2
16	39	54.2	58	81.3	62	86.7	70	97.6	78	108.4
17	35	54.8	52	82.2	56	87.7	63	98.7	70	109.6
18	31	55.4	47	83.1	50	88.6	56	99.7	63	110.8
19	28	55.9	43	83.9	45	89.5	51	100.7	57	111.9
20	26	56.5	39	84.7	41	90.3	47	101.6	52	112.9
21	24	57.0	36	85.5	38	91.2	43	102.6	47	114.0
22	22	57.5	33	86.2	35	92.0	39	103.5	44	115.0
23	20	58.0	30	87.0	32	92.7	36	104.3	40	115.9
24	19	58.4	28	87.7	30	93.5	33	105.2	37	116.9

1/ Expected black ash crown area = $-7.6483 + 3.8952$ d.b.h. $^{1.7974}$ Where d.b.h. is in inches; basis n = 37 forest grown trees that have a d.b.h. at least as large as the average stand d.b.h.; $R^2 = 0.89$. Values for the 20-inch and larger d.b.h. classes have been projected beyond our data base.

Table 3.--Desired stocking after cutting for sustained growth of black ash on organic peat or muck soil

	D.b.h. classes	Trees/acre	Basal area/acre
	Inches	Number	Square feet
Poles	5	69	9.3
	6	53	10.3
	7	41	10.8
	8	31	10.9
	9	24	10.6
Subtotal		218	51.9
Small saw logs	10	18	10.1
	11	14	9.4
	12	11	8.6
Subtotal		43	28.1
Total		261	80.0

Note: Stocking recommendations are based on a maximum tree size of 12 inches d.b.h., a q factor of 1.3, and a basal area of 80 square feet per acre for trees 4.6 inches d.b.h. and larger.

KEY TO RECOMMENDATIONS

Stand site index is less than 45	Manage to maintain wildlife habitat and water quality.
1. Stand site index is between 45 and 55	2
1. Stand site index is greater than 55	5
2. Soil is wet organic or muck	3
2. Soil is mineral with poor or impeded drainage	4
3. Stand basal area is less than 100 sq ft per acre	Review when stand reaches 100 ft^2/acre or is operable.
3. Stand basal area is more than 100 sq ft per acre	Make a partial cut (if operable) to recommended uneven-aged stocking level using upper d.b.h. of 12 inches (table 3).
4. Stand basal area is less than 100 sq ft per acre	Review when stand reaches 100 ft^2/acre.
4. Stand basal area is more than 100 sq ft per acre	Thin (if operable) to recommended even-aged stocking level (fig. 1 or table 2). First cut is to 80 percent crown cover. Subsequent cuts to 90 percent crown cover. Thin again after crown closure and lower branch mortality occurs on the crop trees.
5. Average d.b.h. (of trees 4.6 inches or more) is more than 18 inches	6
5. Average d.b.h. (of trees 4.6 inches or more) is less than 18 inches	7
6. Black ash reproduction is adequate (more than 5,000 stems per acre)	Make a shelterwood cut leaving 50 percent crown cover. Make a removal cut when regeneration is 2 to 3 ft tall (after 3 to 5 years).
6. Black ash reproduction less than 5,000 stems per acre	Make a shelterwood cut leaving 75 percent crown cover. Reduce overstory crown cover to 50 percent when stocking is adequate. Then make final removal cut as above in 6.
7. Stand basal area is less than 100 sq ft per acre	Review when stand reaches 100 ft^2/acre or is operable.
7. Stand basal area is more than 100 sq ft per acre	Thin (if operable) to recommended even-aged stocking level (fig. 1 or table 2). First cut to 80 percent crown cover; subsequent cuts to 90 percent crown cover.

EVALUATING SITE PRODUCTIVITY

Three site productivity classes are recognized in this key. Poor quality sites (SI_{50} less than 45) should be managed to maintain wildlife habitat and water quality. Medium quality sites (SI_{50} between 45 and 55) can be expected to produce some small saw logs (10 to 12 inches in d.b.h.). High quality sites (SI_{50} greater than 55) can be managed primarily for large saw logs (equal to or greater than 18 inches in d.b.h.). Site index, described as the average height of five dominant and codominant black ash trees in a stand at reference age 50, can be used to estimate the productivity of a given site for black ash. To determine site index select trees you would like to leave as crop trees. Suitable trees must be above average stand diameter; straight; single-stemmed; and without forks, serious diseases, or injuries. Fell each sample tree and measure the total tree height to the nearest foot. Then cut a 1- to 2-inch cross-section (disk) from just above (1 or 2 inches) ground line and count the rings on the disk. Use Carmean's (1978) polymorphic site index curves to determine the site index for each tree at reference age 50 and then calculate an average site index estimate for the stand (fig. 2).

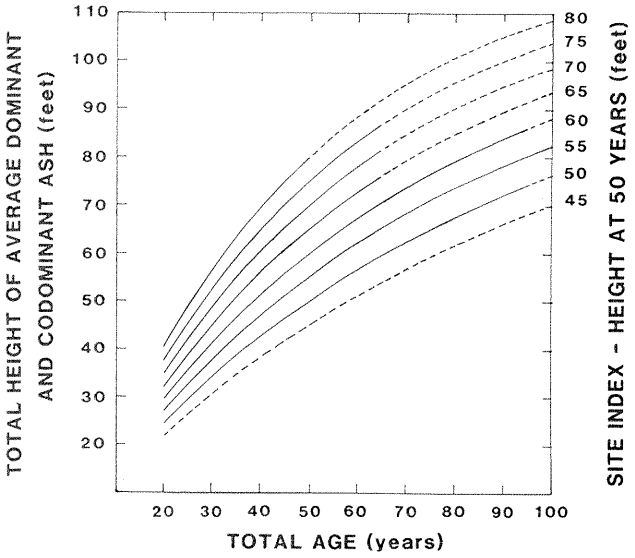

Figure 2.—*Site index curves for black ash in northern Wisconsin and Upper Michigan (Carmean 1978). Dashed lines indicate extrapolated data.*

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