Chapter 43

Aspen Cover Type

WISCONSIN
DEPT. OF NATURAL RESOURCES

Last Full Revision: 1/3/2019
Note- this chapter has not been fully revised since the restructuring of the Wisconsin Silviculture Guide, therefore some subject areas may be missing in the current version of this chapter.

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1 TYPE DESCRIPTION

1.1 Stand Composition and Associated Species

Stand Composition
Aspen comprises more than 50% of the basal area in sawtimber and poletimber stands or more than 50% of the stems in sapling and seedling stands. Principal species are bigtooth aspen (*Populus grandidentata*) and trembling aspen (*P. tremuloides*). Aspen will refer to both trembling and bigtooth in this chapter, unless otherwise noted. Balsam poplar (*P. balsamifera*) will also be discussed in this chapter.

Associated Species
Aspen grows with a variety of trees and shrubs over its extensive range, either as a dominant or an associate. Within the aspen cover type, the predominant associates in Wisconsin currently are (1996 FIA): red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), balsam fir (*Abies balsamea*), red oak (*Quercus rubra*), and white pine (*Pinus strobus*). Most other major tree species occurring in Wisconsin can be found as occasional associates in aspen stands.

In Wisconsin, balsam poplar is found mainly in mixed stands where other species dominate.

1.2 Silvical Characteristics[1]

Trembling aspen is a medium-sized, fast-growing, short-lived tree. Typically, mature trees are 66-82 feet tall and average 6-12 inches dbh. On mesic and dry-mesic sites, trembling aspen may attain 120 feet and 22 inches dbh. Stands often begin to deteriorate near age 55-60 years. Growth continues in older stands but loss from decay and rot increase rapidly. Single clones typically occupy one-tenth to one-fifth acre, occasionally up to four acres.

Bigtooth aspen is a medium-sized, fast-growing, short-lived tree. Typically, mature trees are 60-80 feet tall and average 8-16 inches dbh. On the best sites, bigtooth aspen can reach 120 feet and 30 inches dbh. Height growth is rapid for the first 20-30 years and slows markedly thereafter. Stands often begin to deteriorate at age 40-45 years on wet-mesic to wet and very dry to dry sites and at age 50-70 years on more productive sites. Individual trees more than 100 years old have been found. Bigtooth aspen appears to be more resistant to disease than trembling aspen.

Balsam poplar is a medium to large, fast-growing, short-lived tree. Typically, mature trees are 75-100 feet tall and average 14-28 inches dbh. In Wisconsin, on mesic to wet-mesic sites, balsam poplar can reach 80 feet and 20 inches dbh. Stands can persist for up to 100 years.

Aspen is a “pioneer” tree species generally growing in even-aged stands regenerated following a major disturbance. Aspen often outgrows other associated species and can form nearly pure stands. Two-aged stands are the result of suckering after partial cutting or partial loss from natural disturbance events like wind or fire. In undisturbed stands, more tolerant associates will replace aspen through natural succession.

[1] Information compiled mostly from Fowells (1965), Burns and Honkala (1990), Perala (1977,1984), and Peterson (1992)

All three species are intolerant of shade, suffer stem mortality after fire, and are sensitive to mechanical injury to the root system and soil compaction. This is important when implementing aspen thinning and harvesting. Aspen is a vulnerable species because of its thin bark and is susceptible to many biotic and abiotic agents causing mild to moderate damage. There are only a few diseases that seriously damage or kill aspen trees (Ostry, 1982).

Aspen is well adapted to regenerating after fire via suckering and seeding. Thin bark predisposes aspen to mortality from fire. Root sucker response to the top kill of stems can enable aspen to assert dominance following catastrophic fire, even when it was merely an associate previous to stand disturbance. Aspen is a prolific seed producer, and its wind-disseminated seed can travel many miles. Catastrophic fires can create an ideal mineral seedbed for the germination of seed and early growth of seedlings, facilitating the colonization of sites by aspen.

After an aspen stand is disturbed by harvest, windthrow, or fire, root suckers generally sprout. Typically 10,000 to 30,000 suckers per acre are regenerated after a simple coppice regeneration harvest. Most suckers develop the first growing season following harvest and stand density gradually declines in succeeding years. Suckering is controlled both by growth regulating compounds (auxins/hormones), and by soil conditions (temperature and aeration). Aspen will not sucker when root temperatures are maintained below 55° F or when soils are saturated (Bates et al. 1990).

The time of year cutting is conducted affects the number of suckers and their vigor. Harvesting aspen stands during the dormant season generally produces the most abundant and vigorous sucker crops, while summer harvests generally produce less abundant and vigorous crops. The number of suckers produced is also related to the degree of cutting, with the greatest number occurring after cutting of all trees. Young suckers cut or destroyed by browsing for three successive years usually will not resprout. As far as is known, the aspen type can be maintained indefinitely by simple coppice. The presence of viruses in some clones may gradually deteriorate some stands.

Aspen responds to intensive management. In one study, production of thinned stands for a 50-year rotation, including thinnings removed at ages 10, 20, and 30, was about 57 cords/acre (1.14 cords/acre/year). This was about 42% greater than for similar unthinned stands.

Aspen produces abundant viable seed, but the seed typically remains viable for less than one week. Germination and initial growth require moist bare mineral soil. The major deterrents for managing reproduction by seed are the short duration of seed viability and the ease of coppice regeneration.

Balsam poplar regenerates by seed, stump sprouts, root suckers, and buried branches. Balsam poplar seeds are well adapted to flood plain conditions as the seeds disperse easily by water and require moisture to germinate. Germination can occur under water, and even mild water deficits reduce germination. Most balsam poplar seeds die within several weeks of dispersal, but some remain viable for 4-5 weeks.

Table 43.1. Summary of selected silvical characteristics.

	TREMBLING OR BIGTOOTH ASPEN	BALSAM POPLAR
Flowers	Dioecious, but some trees bear perfect flowers. Flowers emerge early in the growing season before leaves (March-April depending on location).	Dioecious. Flowers emerge early in the growing season before leaves (April-June depending on location).
Fruit Ripens	May and June (4-6 weeks after flowering, and before the leaves are fully expanded). Capsule with many small brown seeds, each surrounded by tufts of long, white silky hair.	May and June. Each small seed is attached to a tuft of long, silky hair.
Seed Dispersal	Wind and water for both species. 2.5-3 million seeds per pound. Transported many miles.	Wind and water. Relatively warm, dry weather causes rapid dispersal.
Good Seed Years	Every 4 or 5 years with light crops in most intervening years.	Every year.
Seed Bearing Age	Trembling: Significant production begins between age 10 and 20. Bigtooth: 20 years for vigorous trees	8-10 years with large seed production every year.
Seed Viability	High viability but short duration (typically 3-4 days or as long as 2-4 weeks). When stored properly, 97% germination after one year may be attained.	Seeds can remain viable for 4-5 weeks. Viability is dependent on temperature and moisture; cooler, drier conditions prolong viability.
Germination	No dormancy. Germination occurs in 1-2 days if seed lands on moist soil and temperature ranges between 32–95° F. Germination can occur in water.	No dormancy. Germination occurs between 41-95° F. if moisture is adequate. Germination can occur under water. Even moderate moisture deficits reduce germination.
Seedling Development	Primary root develops slowly during first few days. Bare soil required; young seedlings roots are unable to penetrate deep or dry leaf litter. Initial root hairs are delicate and need a moist soil surface. After primary root develops, seedlings remain highly susceptible to heat, drought, and fungi. In the first year, seedlings will grow 12 inches in height and will develop 8-10 inch taproots. Lateral roots develop in the second-to-third year.	Moist mineral soil surfaces are optimal seedbeds. Seeds germinate on moist organic seedbeds, but seedling survival is poor. Development depends on photosynthesis soon after germination.

Vegetative Reproduction	Vigorous root suckers from lateral roots 3-4 inches below the soil, root collar sprouts less vigorous, and stump sprouts least vigorous. Warm temperature (opt. 74° F.) stimulates sucker formation, while light is necessary for continued vigorous development. Time of harvest influences number of suckers, summer often produces fewer stems. Suckering usually ceases if suckers are destroyed for 3 successive years.	Balsam poplar reproduces vegetatively via branches, root and stump sprouts. On wet sites reproduction is greatest from buried branches sprouting root systems. Summer harvests result in less reproduction. Stump sprouts are generally short lived.
	CHARACTERISTICS ACROSS COVER TYPE	
Growth	Growth is rapid for the first 20-30 years, then slows. Dominant suckers may grow 4-6 feet in height the first year; seedlings in contrast may grow only 6-24 inches. High mortality typical with rapid natural thinning. First accelerated mortality occurs at age 5.	
Shade Tolerance	Intolerant; aggressive pioneer species; pronounced ability to express dominance.	
Diseases	Hypoxylon canker (*Entoleuca mammata*) is one of the most serious diseases affecting aspen by girdling and killing the tree or causing stem breakage. Well-stocked stands are less susceptible than poorly stocked stands. Bigtooth aspen is attacked less frequently. Consider harvesting infected, poorly stocked stands early to improve stocking through root sucker formation. Site treatment under advisement of the forest pathologist is recommended to encourage good regeneration. White Trunk Rot (*Phellinus tremulae)* causes more volume loss in aspen than any other disease. Primarily a problem in stands approaching maturity. Harvest stands damaged by fire or weather early. Maintain well-stocked stands to minimize infection sites.	
Insects	Forest tent caterpillar (*Malacosoma disstria Hubner*) and large aspen tortrix (*Choristoneura conflictana*) are defoliators which reduce aspen diameter growth if defoliation occurs for several successive years. No actual mortality is attributed to these defoliations, but attacks weaken trees making them susceptible to secondary insect and disease problems. Spongy moth (*Lymantria dispar*) (formerly called Gypsy moth) a severe hardwood defoliator, is responsible for attacking over a million acres of forestland in the eastern US since 1980. Repeated defoliation increases susceptibility to secondary attacks.	
Herbivory	Beaver, snowshoe hare, and other bark-eating mammals can impact aspen stands on a local level. Deer browse new shoots and rub antlers on stems.	

2 MANAGEMENT GOALS, LANDOWNER OBJECTIVES

Management objectives should be identified in accordance with landowner goals within an ecosystem management framework, which gives consideration to a variety of goals and objectives within the local and regional landscape. The silvicultural system described below is designed to promote the optimum vigor of aspen stands. Pulpwood production is the objective for most sites; however sawlog production can be considered on productive sites (dry-mesic to wet-mesic). This silvicultural system may be modified to satisfy other management objectives, but aspen vigor and growth potential may be reduced. The habitat type is the preferred indicator of site potential.

3 LANDSCAPE, SITE, AND STAND MANAGEMENT CONSIDERATIONS

3.1 Landscape Considerations

The aspen forest type provides significant social and ecological benefits, but there are also concerns about effects at landscape and regional scales. Considerations are related to the total amount of aspen and its spatial distribution, which can benefit some species while negatively affecting others.

3.1.1 Historical Context

When the General Land Office surveys were conducted in Wisconsin (1832-1866), forests dominated by aspen or aspen-white pine occupied about 3.5 to 4.3 percent (approximately 680 to 835 thousand acres) of the area within Province 212 in northern Wisconsin according to data interpretations by Schulte et al. (2001). Fire disturbance was a historic factor in development of aspen forests, and native Americans were undoubtedly instrumental in setting some of the fires that led to aspen regeneration. Fire frequency was significantly greater in sandy outwash areas than in the loamy moraines (Mladenoff 2000). Aspen forests typically developed where fire regimes were moderate, such as in transitional areas between outwash and moraines, or where till materials are intermingled with outwash sands. Fire disturbance regenerated aspen clones and exposed mineral soils for seed germination. Aspen that developed after fire would have had a patchy distribution, often as a component of mixed stands. Some aspen clones would have been perpetuated in very young or sparsely forested conditions, leading to more variable aspen densities and age classes than are typically found in coppice-regenerated stands.

After the Cutover, very hot slash fires occurred extensively over northern Wisconsin. The repeated fires eliminated seedlings of many tree species, at the same time as harvesting reduced seed sources. Aspen, because of its abundant wind-dispersed seed, was able to invade large areas (Mladenoff 2000). FIA records show that aspen-birch reached a historic maximum of about 5.3 million acres in the 1930’s; net acreage has decreased since then through natural succession to other cover types. In 1996, the aspen-birch forest type group occupied about 16 percent (approximately 3 million acres) of land area in northern Wisconsin (Province 212) (Schmidt 1998). Although the proportion of aspen-birch forest has declined since the 1930’s, it still occupies a much larger area than it did 100-150 years ago.

3.1.2 Current Context

Age-Class Distribution

Maintaining a desirable aspen age-class distribution is a landscape-level consideration. A relatively stable age class structure in aspen maximizes its benefits to wildlife by providing a full range of age and structural conditions. Economic interests that depend on aspen products prefer to have an even flow in supply. Because aspen regenerated all over Wisconsin at about the same time after the Cutover, there were dramatic peaks and valleys in the supply of mature aspen for many years. These fluctuations appear to have diminished at a statewide level, based on comparisons of age-class distributions from 1983 and 1996 (Schmidt 1998, Spencer et al. 1988), but maintaining the distribution requires management attention. The following chart shows that aspen in the 0-20 age class decreased by 9.6% in 1996 as compared with 1983, but the greatest decrease was in the 41-60 age class. Age classes 61 years and older have the same distribution in both inventory cycles.

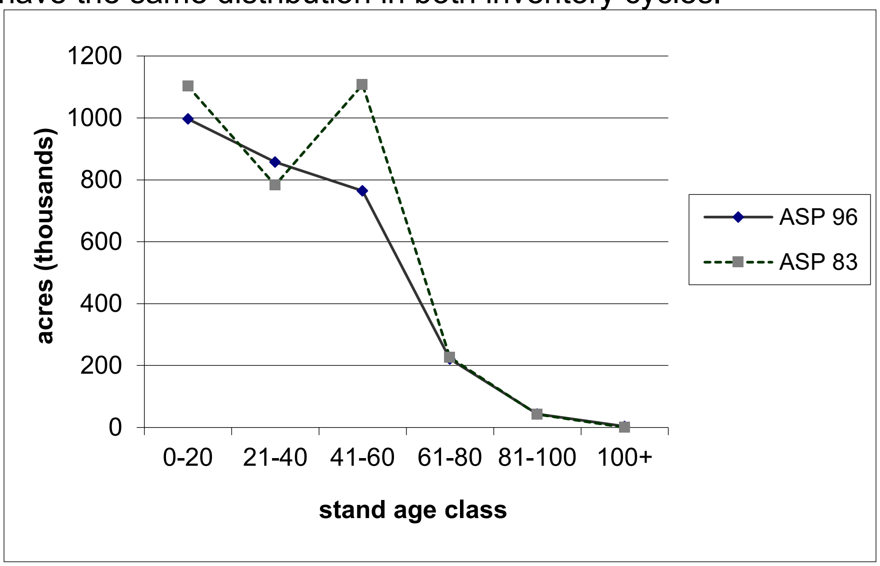


Figure 43.1. Aspen age-class distribution in 1983 and 1996.

3.1.4 Summary of Landscape Considerations

When deciding whether to regenerate an aspen stand or convert another forest type to aspen, assuming the habitat type is suitable, consider the following factors:

- What are the characteristics of the broader-scaled ecological unit (LTA or Subsection) around the stand?
- Is the ecological unit in northern or southern Wisconsin? In some parts of southern Wisconsin, permanent fragmentation from agricultural, residential, and urban land uses is so prevalent that habitat fragmentation due to aspen conversion is a minimal effect. However, if managing a relatively large forest patch in southern Wisconsin, fragmentation and edge considerations regarding NTMBs still apply.
- Is the ecological unit already fragmented by either habitat or permanent fragmentation or by “natural fragmentation” (a heterogeneous landscape that contains a wide variety of Habitat Types, wetlands, and/or water bodies)?

- Consider the dominant natural disturbance in the surrounding LTA. If fire, consider managing for a large patch of aspen. If wind, consider regenerating aspen as a component of a northern hardwood forest, emulating the small sized patches characteristic of gap disturbance.
- Aggregating individual cuts will reduce the amount of edge.
- Are there NTMBs of concern in the surrounding LTA, which ones are they, and how will the proposed management affect them?
- Is the area around the stand a large patch of northern hardwood forest? Large forest patches with older age-class structure are scarce, and managing for interior NTMBs may be an important consideration.
- What are the local and regional issues surrounding deer density (e.g. car-deer collisions, hunting opportunities, local economy)? Are there issues with herbivory in the surrounding LTA (e.g. lack of regeneration of hemlock, yellow birch, cedar, or Canada yew; excessive browsing of lilies and orchids)?
- What is the age class distribution of aspen in the broader-scaled ecological unit?
- Aspen can attract deer into a local area. If cedar, hemlock, yellow birch, or Canada yew is present, it may not be advisable to manage aspen in the same area because of the potential impact on these declining species. If the deer herd were predicted to be dramatically lower for at least a ten-year period, foresters may wish to consider cedar and hemlock regeneration.

3.2 Site and Stand Considerations

3.2.1 Soils

The aspen type occurs on a wide range of soil conditions, from sand to clay and from dry to wet. Best growth is demonstrated on dry-mesic and mesic sites with well-drained loamy soils, but growth potential is good for all sites, except dry, excessively drained sands, poorly drained wet sites, and heavy clays. Although both species can be found across the full range of site conditions, bigtooth aspen occurs predominantly on very dry to dry-mesic sites, whereas trembling aspen occurs predominantly on dry-mesic to wet sites. Balsam poplar generally occurs on wet sites, such as river floodplains, stream and lake shores, moist depressions, and swamps, but will also grow on drier sites.

Potential impacts on long-term productivity is a consideration when maintaining aspen through multiple regeneration and harvest cycles on the same site. Management activities that remove organic matter have been associated with declines in site productivity. Concern has been expressed regarding potential nutrient losses from repeated aspen coppice harvests. Effects of multiple long-term coppice harvests on site productivity are unknown. Nutrient replacement following a typical harvest at full rotation age is relatively quick (less than 20 years for N, P, K, Mg and Ca) (Gordon, 1981).

- In one study, whole tree harvesting had no significant effect on soil nutrition levels 5 years after logging (Alban and Perala 1990).
- In another study on aspen productivity (Stone et al. 1999, Stone and Elioff 2000, Stone 2001), total tree harvesting of aspen on clay and loam soils had no negative effects on 5

year growth and productivity. In contrast, total tree harvesting on sand soils was associated with reduced 5 year aspen growth and productivity. Results indicate potential declines in aspen productivity with repeated total tree harvesting on sands. Retention of organic matter appears to be an important consideration to sustain long-term productivity of aspen stands on sand soils. Limbing at the stump and retaining logging slash on site is recommended to decrease nutrient removal on sandy sites.

Management activities that compact soil have been associated with declines in site productivity.

- In studies on aspen productivity (Stone et al. 1999, Stone and Elioff 2000, Stone 2001), compaction treatments that increased soil bulk density by 15% and 30% had no consistent negative effects on 5-year aspen growth and productivity. In further operational studies, excessive compaction at landings and rutting by careless logging operations significantly reduced sucker density and growth on fine textured soils.
- The physical effects of soil compaction, increased bulk density and decreased soil porosity, are long-term.
- Snow cover does not protect soils from compaction and rutting; frozen soil conditions do. Recommendations to protect soils from excessive compaction and rutting when logging in deep snow include: 1) plow and pack snow on skid trails and allow to freeze before use, and/or 2) delay skidding for 1-4 weeks following felling.

On wet to wet-mesic soils (poorly drained and somewhat poorly drained), removing only commercial wood (retain some hardwoods and conifers) can result in less rutting and compaction. Harvesting on these sites on frozen or dry ground will minimize rutting. Rutting can impede water flow and alter existing drainage. Also, reserve trees can help avoid significant water table rises.

3.2.2 Site Quality

3.2.2.1 Range of Habitat Types

The aspen cover type has the potential to develop on all upland habitat type groups and most habitat types in Wisconsin, but actual distribution and potential productivity are variable. Although bigtooth and trembling aspen are similar, there are individual differences in distribution and productivity across site types.

Aspen Cover Type

Acreage Distribution: The aspen cover type occupies approximately 18% of Wisconsin forest land acreage as estimated by the 1996 Wisconsin Forest Inventory and Analysis (FIA).

a. Northern Habitat Type Groups: About 87% of the total statewide aspen acreage occurs associated with the northern habitat type groups. These groups are:

N. Very Dry to Dry (VD-D)	N. Dry to Dry-mesic (D-DM)	N. Dry-mesic (DM)
N. Mesic (M)	N. Mesic to Wet-mesic (M-WM)	N. Wet-mesic to Wet (WM-W)

The aspen cover type occurs on all northern groups, with its greatest acreage on M-WM, and the least acreage on WM-W (Figure 43.3).

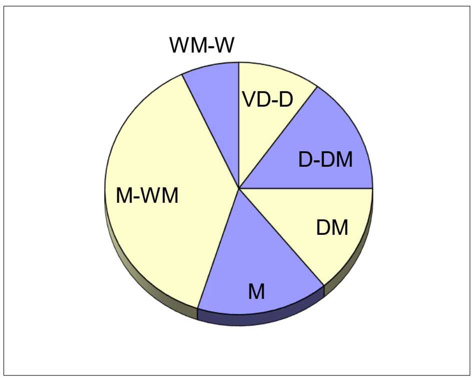


Figure 43.2. Aspen cover type acreage by habitat type group, as a percent of total aspen acreage in northern Wisconsin.

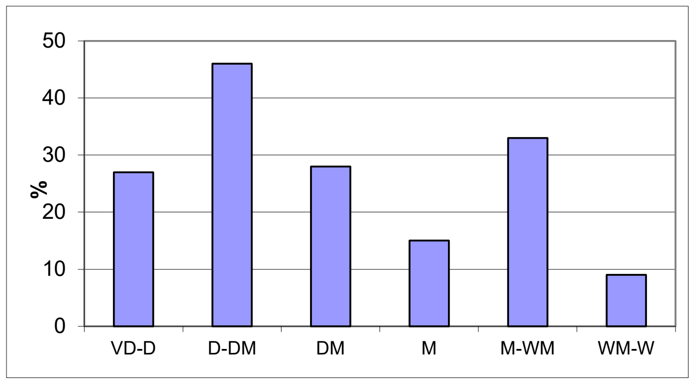


Figure 43.3. Aspen cover type acreage as a percent of total forest land acreage within each northern habitat type group.

Within habitat type groups, the aspen cover type is of common occurrence (>10% of total group acreage) on all the northern habitat type groups except WM-W. It is most common within the D-DM group where it occurs on approximately 46% of all D-DM habitat type acres (Figure 43.2). The aspen type is common on most northern habitat types, with the notable exception of the driest, most nutrient poor habitat types, and some mesic, nutrient rich types.

b. Southern Habitat Type Groups: The other 13% of statewide aspen cover type acres occur on southern habitat types, which are grouped as:

S. Dry (D)	S. Dry-mesic	S. Dry-mesic to Mesic	S. Dry-mesic to Mesic
S. Mesic (M)	S. Mesic Phase [M(P)]	S. Mesic to Wet-mesic (M-WM)	S. Wet-mesic to Wet (WM-W).

The aspen cover type occurs on most southern habitat type groups. However, over one-half of all the aspen acres associated with the southern groups occur on Dry sites (centered in the Central Sands region). Other southern habitat type groups with notable aspen type acreages are DM and M (X).

Within the individual southern habitat type groups, aspen stands are of common occurrence (>10% of total group acreage) only on the D group; elsewhere the cover type is of minor occurrence (Figure 43.5). The southern habitat types with major aspen acreage are PVRh, PVHa, PVGy, PVG, ArCi-Ph, and ATiSa-De.

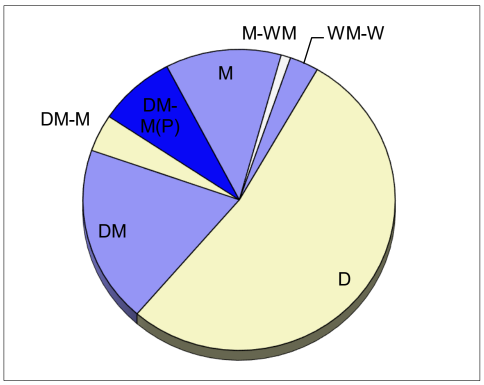


Figure 43.4. Aspen cover type acreage by habitat type group, as a percent of total aspen acreage in southern Wisconsin.

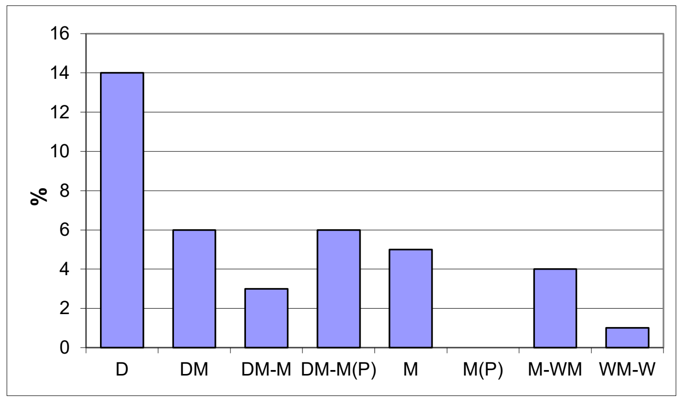


Figure 43.5. Aspen cover type acreage as a percent of total forest land acreage <u>within</u> each southern habitat type group.

Volume Per Acre: Potential stand growth and volumetric productivity of the aspen cover type vary across habitat type groups and habitat types. Figure 43.6 shows the aspen type's average standing volume per acre for selected habitat type groups (1996 FIA). Highest average standing volumes are associated with northern M, DM, D-DM, and southern DM habitat type groups. Although the northern WM-W group supports the greatest aspen type acreage, these stands are maintaining lower average volumes. The lowest volumes are associated with the driest and wettest sites.

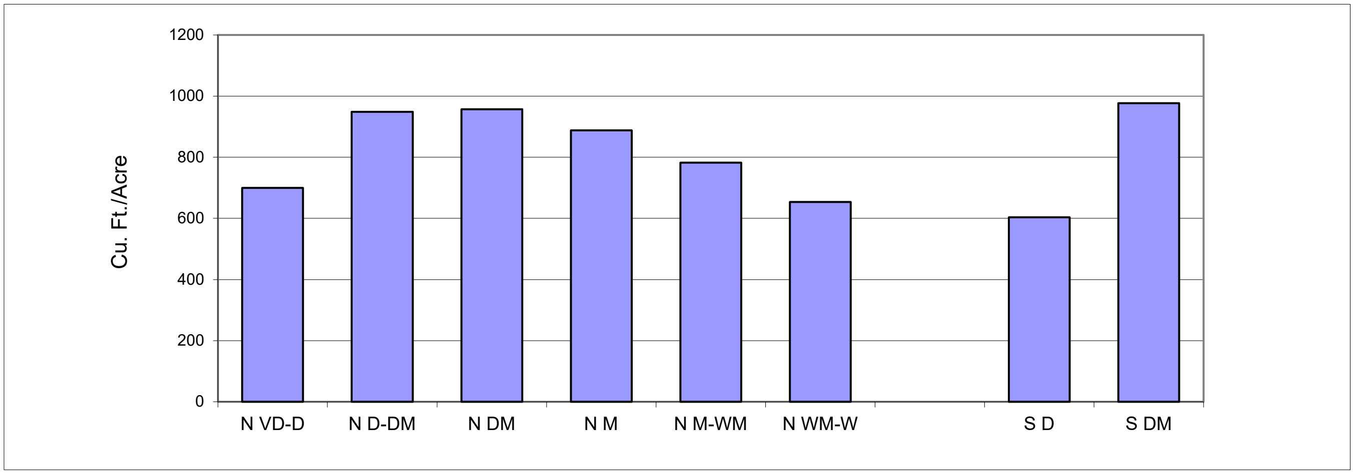


Figure 43.6. Aspen cover type average growing-stock volume per acre (cubic feet per acre) on forest land by each habitat type group

Associated Species: Within the aspen cover type in northern Wisconsin, red maple is the predominant associate (based on the percent of total number of trees greater than 5" dbh). It is an important associate within all habitat type groups, but is particularly abundant within the D-DM, DM, and M-WM habitat type groups. Balsam fir is a major associate on WM-W, M-WM, and to some extent on M sites. White birch is an abundant associate on D-DM, DM, and to some extent on M sites. Sugar maple is a somewhat abundant associate only on M sites. Within the VD-D habitat type group, red oak is the most abundant associate in aspen stands. In terms of regeneration and natural succession potentials, red maple and balsam fir are the most common and abundant saplings occurring in aspen stands. Sugar maple saplings are predominant only on mesic sites.

<u>Aspen Species</u>

Volume Distribution: The 1996 FIA estimates the two aspen species combined account for approximately 13% of the net growing-stock volume on forest land in Wisconsin. Trembling aspen accounts for 9% and bigtooth aspen for 4%.

a. Northern Habitat Type Groups: About 88% of trembling aspen volume occurs on northern habitat type groups. This species occurs on all northern groups, with the most volume on M-WM, and the least on VD-D (Figure 43.7).

About 61% of bigtooth aspen volume occurs on northern habitat type groups. This species occurs on all northern groups, with the most volume on DM, and the least on WM-W (Figure 43.8).

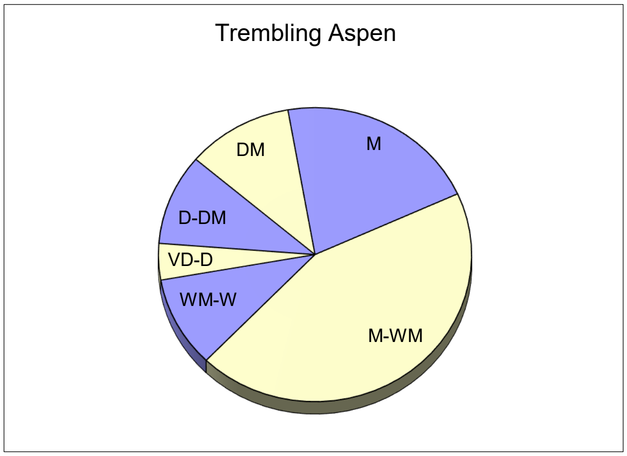


Figure 43.7. Representation of trembling aspen across the northern habitat type groups, as a percent of the total volume of trembling aspen in northern Wisconsin.

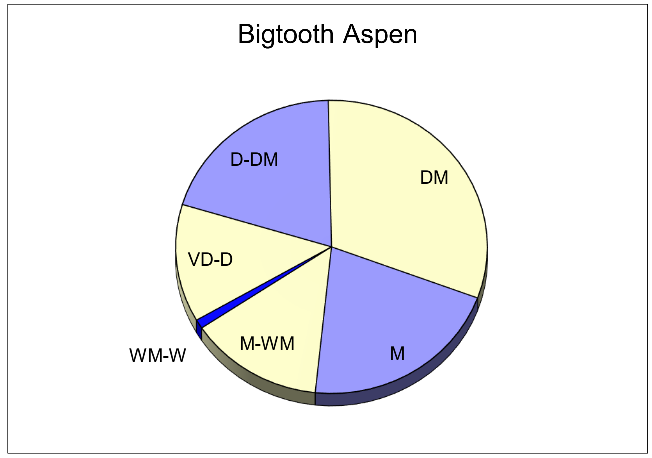


Figure 43.8. Representation of bigtooth aspen across the northern habitat type groups, as a percent of the total volume of bigtooth aspen in northern Wisconsin.

Within the northern habitat type groups, the aspen species combined are common (>10% of total group volume) on all groups except WM-W. Aspen accounts for nearly 25% of total group volume on D-DM and M-WM groups, but only 8% on the WM-W group. Trembling aspen represents significantly larger proportions of total group volume than does bigtooth aspen on the WM-W, M-WM, and M groups. Both species are fairly similar in volume representation on DM, D-DM, and VD-D northern habitat type groups (Figure 43.9).

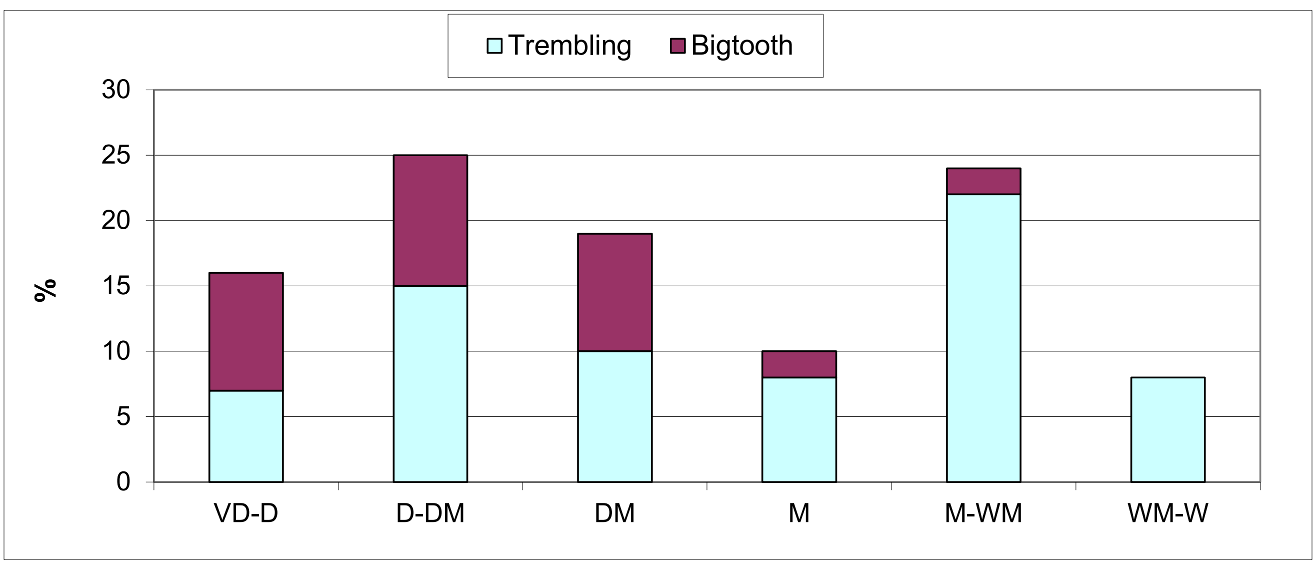


Figure 43.9. Trembling and bigtooth aspen individual and combined volumes as a percent of total net growing-stock volume on forest land within each northern habitat type group.

b. Southern Habitat Type Groups: About 12% of trembling aspen volume occurs on southern habitat type groups. This species occurs on all southern groups, with the most volume on D, and the least on M (P) (Figure 43.10).

About 39% of bigtooth aspen volume occurs on southern habitat type groups. This species occurs on all southern groups, with the most volume on DM, and only minuscule volumes on M (P), M-WM, and WM-W (Figure 43.11).

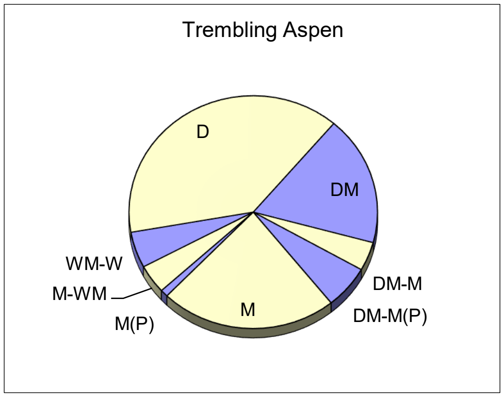


Figure 43.10. Representation of trembling aspen across the southern habitat type groups, as a percent of the total volume of trembling aspen in southern Wisconsin.

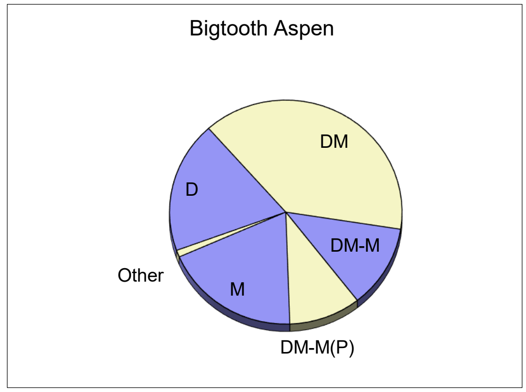


Figure 43.11. Representation of bigtooth aspen across the southern habitat type groups, as a percent of the total volume of bigtooth aspen in southern Wisconsin.

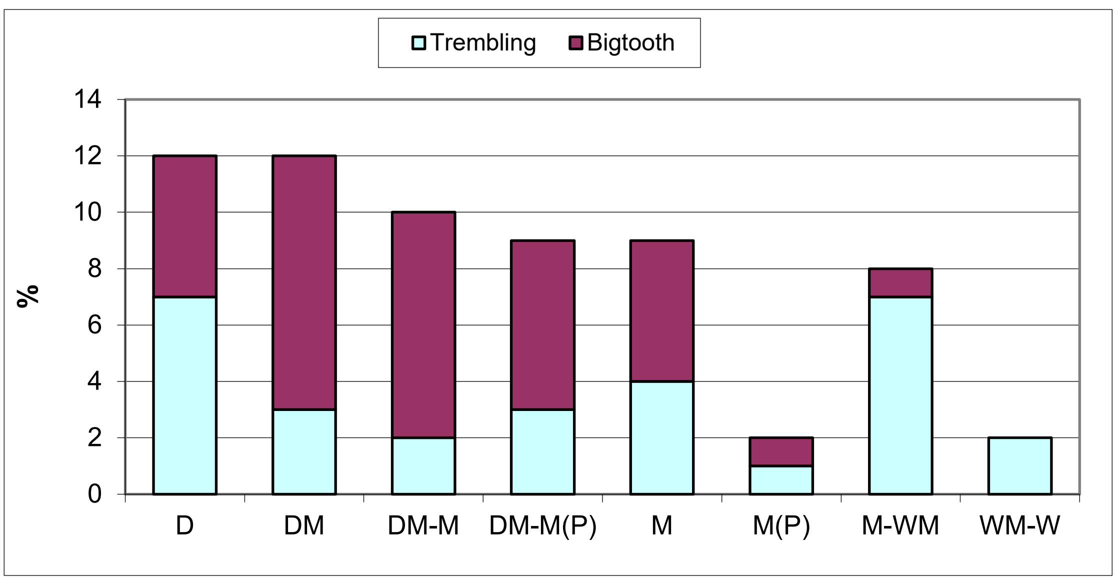
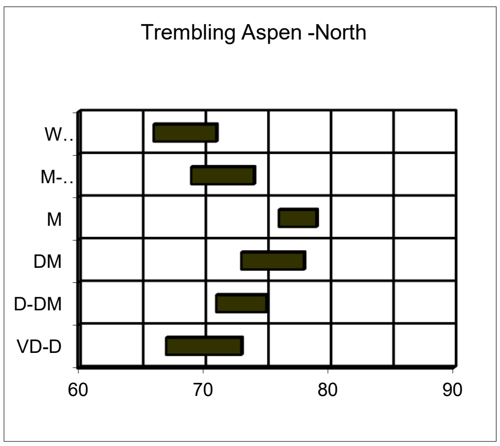


Figure 43.12. Trembling and bigtooth aspen individual and combined volumes as a percent of total net growing-stock volume on forest land within each southern habitat type group.

Within the southern habitat type groups, the aspen species combined are common (>10% of total group volume) only on the D and DM groups. Within each of these two groups, aspen accounts for about 12% of total group volume. In contrast, aspen accounts for only 2% of group volume on the M (P) and WM-W groups. Trembling aspen represents significantly larger proportions of total group volume than bigtooth aspen on the WM-W and M-WM groups. Both species are fairly similar in volume representation on M(P), M, and D groups. Bigtooth aspen represents significantly larger proportions of total group volume than trembling aspen on the DM, DM-M, and DM-M (P) southern habitat type groups (Figure 43.12).

Site Index: Average site index for trembling and bigtooth aspen varies across northern habitat type groups (Figure 43.13). Site index ranges within groups and patterns across groups are similar for both species. In general, average site index increases from very dry to mesic, then decreases from mesic to wet.



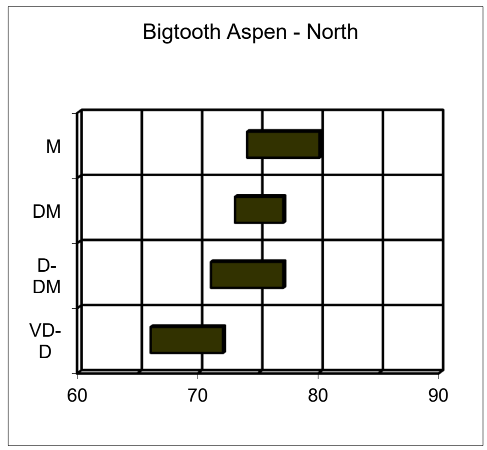


Figure 43.13. Site index for trembling and bigtooth aspen for northern habitat type groups. Bars indicate the 95% confidence limits for the mean. Non-overlapping bars indicate significant differences.

Data for southern habitat type groups are limited, but site index trends probably are similar to northern groups.

Potential Productivity: Using information on average aspen (cover type) volume per acre, with species average site indices and per tree volumes across northern habitat type groups, it is possible to estimate relative potential productivity.

In general, for northern habitat type groups and for both aspen species, relative growth potentials are:
very good: M
good to very good: DM
good: D-DM and M-WM
moderate to poor: VD-D and WM-W
Data for southern habitat type groups are limited, but growth potential trends probably are similar to northern groups.

Balsam Poplar Cover Type
The balsam poplar cover type occupies only approximately 0.2% of Wisconsin forest land acreage (1996 FIA). Most of this acreage is distributed among two northern habitat type groups: WM-W and M-WM (about one-half of this M-WM balsam poplar occurs on the Superior Clay Plain).

3.2.5 Wildlife

Aspen forests are critical to abundant populations of ruffed grouse, American woodcock, and beaver and important to many other species of Wisconsin wildlife. White-tailed deer and elk populations in northern Wisconsin use aspen for cover and forage. Wolves, fishers, goshawks, and other northern predators dependent on prey species, benefit from aspen forests. Black bear, snowshoe hares, and many songbirds use aspen. Some songbirds dependent on early-successional forests have experienced significant population declines both range-wide and in Wisconsin. Aspen forests in the Great Lakes region show evidence of being important for some species on a continental scale. For example, some early-successional breeding birds, such as golden-winged warbler, chestnut-sided warblers, and American woodcock, were identified by Howe et al. (1992) as being core/source species in northern Wisconsin. The group of species so identified has the core of their range centered on forests of the northern Lake States and/or provides a surplus of young, which may be important in maintaining populations elsewhere.

Aspen is used for cover and food from the seedling/sapling stage to the old-growth stage. Because of the short lifespan of aspen, examples of all life stages are present in Wisconsin and management for wildlife benefits from each stage is possible. Aspen bark, twigs, buds, and leaves are used by many herbivores in the northern forest. The decay characteristics of aspen make it particularly suitable for primary and secondary cavity nesting species of wildlife. The light-admitting canopy tends to allow development of understory plants and a diverse shrub layer. This expands the utility of an aspen stand to a large variety of wildlife.

Forty-seven species of Wisconsin birds use pioneer deciduous forests for breeding habitat (Robbins, 1990). Additionally, many species, which Robbins lists as preferring shrub/savanna habitats (e.g. American woodcock), use young aspen extensively. Breeding birds found in aspen forests include several warblers, all of the northern woodpeckers except the black-backed, woodland hawks and owls, and a variety of representatives of other groups. Bird species richness and total population size peaks at 2 age classes in aspen forests. One occurs shortly after regeneration and includes ground foragers such as robins, flickers, and rufous-sided towhees. Sparrows and some warblers are also present early in the life of the stand. The other peak is at stand maturity when the understory has fully developed. Species groups found during this second peak include thrushes, warblers, and cavity-nesting birds (Probst et al, 1992).

American woodcock begin using regenerating aspen in the first spring following harvest for display grounds and night roosting areas. Nesting and brood-rearing takes place in regenerating aspen and in older aspen with well-developed shrub understories. Aspen was important as diurnal resting cover in a study conducted in northern Wisconsin (Gregg, 1984). Many of the aspen stands identified during this study were either very young or poorly stocked due to site characteristics. Alder, either alone or in association with aspen, was nearly as important to woodcock. Over 80% of the diurnal resting sites identified in this study occurred in one of these two cover types. Structure of the cover was important but soil characteristics which affected food availability also played a role in selection of the habitat. Management for woodcock must emphasize early-successional habitats. Openings are important for breeding and night roosting. Dense vertical stem density provides cover for broods and for birds in daytime resting covers. Leaf mulch from aspen and alder contributes to the desirability of these covers for woodcock because it is a preferred food for earthworms.

Ruffed grouse selected aspen over all other habitat types in a study conducted in central Wisconsin (Kubisiak, 1985). Grouse use in regenerating aspen was highest in stands between 6 and 25 years of age. As with woodcock, the presence of alder as a component of the understory of the stand was associated with an increase in grouse use. Grouse use of aspen stands 26 years of age and older declined but was still high if a shrub understory was present. Older aspen is important to grouse as a food source in the winter months. Ruffed grouse drumming sites are also associated with mature aspen. Management direction in aspen for ruffed grouse should emphasize retention of the aspen type. Complete clearcuts, which result in a residual basal area of less than 15 $ft.^2$ per acre will provide the necessary vegetative structure for optimum ruffed grouse habitat. Small cuts of less that 5 acres may not provide adequate aspen regeneration due to suppression of aspen suckers. Large cuts of 40 acres or more may be acceptable but careful planning of the cut may be necessary. If large cuts are necessary, they should be rectangular so as to minimize the distance to older aspen. Alternatively, large cuts can be improved for ruffed grouse by retaining older aspen either in clumps of 30-50 trees within each 10-acre block or widely scattered mature aspen (2-9 per acre) throughout the cut. Optimum production of grouse will be attained where 30% - 35% of the aspen is in the sapling stage.

Habitat suitability for beaver is enhanced by aspen associated with water. Aspen is a favored food of beaver and an abundance of aspen contributes to high beaver populations. Beaver dams create habitat beneficial to many other species and mitigate peak flows that cause flooding. Beaver populations rose in the early 1990’s and then declined. Lowest populations in the mostly forested northern part of the state are in the northeast in beaver management zone B where population control measures are most prevalent (Kohn et al, 1999).

Some small mammal populations reach high numbers in early-successional forests in Wisconsin and the eastern United States. Representatives of these are cottontail rabbits and snowshoe hares. Because these two species are extremely important to predators, their abundance can affect a range of species. Productivity and survival of snowshoe hares in central Wisconsin is higher in habitats with high stem density deciduous cover and young aspen stands provide the best hare cover in the area. Snowshoe hares and cottontail rabbits are vulnerable to predation when dispersing through areas without heavy cover. Good interspersion of young, high-density aspen stands provides the best opportunity for high populations of these species.

Carrying capacity of deer within management units in Wisconsin is closely tied to the percentage of early successional habitats within the unit. Aspen, oak, jack pine, and openings are all desirable habitats for deer. Deer trails used as an index to deer use in central and northern Wisconsin indicate that aspen and jack pine are consistently preferred habitats, and the presence of tall shrubs or deciduous saplings increase the value of almost all habitats (Kubisiak and Rolley, 1997). Deer are valued by hunters and non-hunters as an emblematic resident of the forest. Deer also play a role in supporting other valued wildlife species in the state. Wolves, bear, coyotes, bobcat, and a host of scavengers feed on deer or deer remains in Wisconsin. Habitat management for deer should include early-successional types such as aspen.

Habitat management for wildlife in the aspen forest should include a diversity of age classes reflective of the wildlife values derived from each stage of aspen. Young and old aspen stands produce conditions that are favorable to high populations of some species and to a diverse array of wildlife. Wildlife species assemblages change with growth stage in all northern forest types. In aspen, these changes occur relatively rapidly due to the short lifespan of the tree. Maintaining aspen in a variety of age classes in conjunction with other northern forest types will ensure a diverse wildlife community.

Effects of Aspen Management on Neotropical Forest Migrants

During the past 20 years, there have been a number of studies conducted to generate explanations for the decline of many neotropical migrant bird species (NTMB) associated with forested landscapes. One segment of this research investigates the impact of edges and fragmentation, generated by forest management, on these species.

Landscapes like those of southern Wisconsin were the focus of many NTMB studies conducted during the 1980's. These areas have relatively high levels of permanent fragmentation brought about by agricultural and urban land uses. Most of this fragmentation creates "hard" edges, or abrupt changes between habitat types, such as woodlands adjoining farm fields. Bird populations within these fragmented woodlots are heavily impacted by nest predation and by high levels of nest parasitism by brown-headed cowbirds. These populations are generally "sink" populations because they are maintained by recruitment of individuals from other "source" populations.

Northern Wisconsin forests are more important for aspen management, and have different levels and types of fragmentation. The amount of edge within this landscape is determined primarily by timber management, and secondarily by permanent fragmentation associated with development. The hard edges generated by even-aged management are slowly transformed to "soft" edges, or areas of more gradual change between habitats, as forest regenerates.

Forests and associated wetlands of the northern Lake States support some of North America's highest densities and most diverse assemblages of breeding birds (Howe et al. 1996). This region is also thought to contain source populations of many NTMBs. Edge and fragmentation studies in the 1990's have focused more on these forested landscapes. Most researchers tested whether hard edges would affect avian productivity as they did in agricultural landscapes. Predictably, edge effects in forested landscapes are much more complex and local than those found in agricultural landscapes. Interspecific competition and predation rates are much more important than parasitism in forested landscapes. Cowbird abundance is much lower in northern Wisconsin because most areas lack agricultural or large open areas.

Studies focusing on the northern forest have found that principles applicable to agricultural landscapes cannot be extrapolated. Nest predation, not nest parasitism, is the most important demographic factor limiting nesting success in the northern Lake States forests. These predators include fisher, skunks, raccoons, foxes, crows, blue jays, a variety of other birds, and assorted small mammals. Predator species, abundance, and behaviors are different than those of southern Wisconsin. Fenske and Neimi (1996) found that predation rates extending into a mature aspen forest from hard edges (defined as vegetation less than 2 meters high next to medium age or older forest) were lower than predation rates at soft edges (vegetation 2-8 meters high) in Minnesota. This phenomenon warrants further study but may indicate that edge effects are more prolonged than believed. Flaspohler et al. (2001a) studied edge effects generated by clearcuts (6 years or less) adjacent to large stands of older deciduous forests in Wisconsin. Hermit Thrush and Ovenbird, forest interior species that nest on the ground, had lower nest success within 300m of hard edges generated by clearcuts. Forest interior birds that nest in the canopy nested at lower densities within 50 meters of clearcuts, but at higher densities between 50 and 300 meters. American Robin and Rose-breasted Grosbeak, species known to be less sensitive to edge, had higher nest densities near recent clearcuts. Predation was the leading cause of nest failure for both ground and canopy nesting birds. A related study of Ovenbirds determined that while nest density was similar between edges and interior, predation and mean clutch size were both highest near edges. Therefore, net productivity was similar. We do not know whether this result applies to other species. More research is needed in this region to better understand local predator populations and how they affect nest success of NTMB's.

Aspen management can also have direct and indirect effects on competition among bird species. Creation of edge and fragmentation in a landscape often benefits generalist bird species, which are adapted to a variety of habitats. Many of these species (e.g. House wren, Gray catbird, American crow, Blue jay) are egg predators, but their effects on local bird populations are not well known. Hamady (2000) found that Black-throated blue warblers, a forest gap-dependent species associated with shrub layers, declined in Upper Michigan landscapes with increasing habitat fragmentation, because of competition with forest generalist species.

Current research also suggests that vegetation patterns in forest-dominated landscapes can affect the composition of avian communities within individual forest stands. In northeast Wisconsin, forested stands in landscapes with greater amounts of upland open land, as well as higher levels of fragmentation as indicated by measures of landscape pattern, had a lower abundance of edge-sensitive NTMBs (McRae 1995). Amounts of open land were correlated with landscape pattern measures, making it difficult to study these effects separately. Pearson and Niemi (2000) sampled mature aspen stands in Minnesota to determine whether both within-stand habitat characteristics and landscape patterns influenced breeding bird abundance in a forested landscape. They found that habitat specialists (Blackburnian warbler and Magnolia warbler) were found in aspen if there was a conifer component retained in the stand and also a large conifer component in the surrounding landscape (up to 1/3 mile radius). Forest generalists (veery and ovenbird) were least influenced by landscapes. Retaining appropriate habitat in the landscape for certain habitat specialists as well as maintaining more diverse aspen stands may prove beneficial to regional populations of some NTMB's.

The overall effect of habitat fragmentation and edge on NTMBs in northern Wisconsin is not clear. Population estimates suggest that this region is a source population for many NTMBs and other bird species. Generation of excessive amounts of edge and habitat fragmentation within a landscape will be beneficial to some generalist NTMBs but may prove detrimental to source populations of forest interior NTMBs, many of which are of higher conservation concern. Local research results are difficult to extrapolate, appearing to vary by ecosystem type. Additional local research is needed to determine how aspen management affects patterns of interspecific competition and nest predation in the northern forests.

<u>Fragmentation and Edge Effects</u>
Fragmentation is a term used to describe certain kinds of landscape structure. Inherent fragmentation describes landscapes that are naturally heterogenous due to characteristics of the physical environment, such as an area with numerous small lakes and wetlands dispersed throughout a pitted outwash plain. Permanent fragmentation refers to long-term conversion of forest to urban, residential, or agricultural uses. Habitat fragmentation is defined as a disruption of habitat continuity, caused by forest harvesting or natural disturbance, which creates a mosaic of successional stages within a forested tract. This kind of fragmentation is shorter-term, affecting species while the forest regrows, and is a consideration in aspen management in northern Wisconsin. Aspen regeneration is generally accomplished through the use of evenaged management, and dispersion of clearcuts throughout the forest creates differences in forest structure that are a type of habitat fragmentation.

In Wisconsin and elsewhere, the loss of forest habitat has a larger impact on species than shorter-term habitat fragmentation. However, area of habitat loss is often correlated with measures of fragmentation (e.g. patch size, distance between patches, cumulative length of patch edges, etc), making it difficult to quantify their separate effects. Habitat loss may result from second homes, or urban and industrial expansion. A drastic change in land cover, such as that which occurs after a clearcut harvest, represents a short-term loss of habitat for some species and a gain for others. Dispersal can be affected if species or their propagules cannot cross or get around the open land and cannot find suitable habitat within it. Other concerns about habitat fragmentation are related to edge and area effects.

3.2.5.1 Deer and Herbivory Effects

<u>Contribution to Deer Carrying Capacity</u>
In the northern forest the abundance of aspen, oak, upland brush, grass, and other early successional habitats contribute significantly to carrying capacity for white-tailed deer. Poorer habitat units are made up of pole and larger-sized maples, dense conifers, and swamps (McCaffery 1984). Deer are a keystone species because they directly or indirectly affect many other plants and animals in the ecosystem. These effects are apparent at stand, landscape, and regional scales.

There are positive impacts from the large deer herd, including:

- social and economic benefits

- recreational opportunities for hunting and viewing deer
- food source for wolves, eagle, crows, bear, chickadees, and other predators

There are also negative impacts from the large deer herd. The Deer 2000 report (Wisconsin Conservation Congress 2000) has noted:

- damage to natural, agricultural, and urban vegetation
- reduced regeneration and growth of some tree species, and changes in species composition (possible economic impact in areas of high deer abundance)
- local extirpation of some plant species
- reduction of habitat diversity
- effects on other wildlife that depend on understory plants and shrubs
- economic and social impacts of car-deer collisions
- food source for predators, which can lead to increased predation on other desirable species

3.2.6 Endangered, Threatened and Special Concern (ETS) Species

Most aspen management would have no effect on Endangered Resources (species listed in the Wisconsin Natural Heritage Inventory [NHI] Working List). Twenty-six species on the NHI working list occur regularly in aspen stands. Most of these twenty-six species are found in a variety of habitats and use aspen primarily for foraging. Several other species use aspen as breeding habitat, but also use many other habitats. None of these twenty-six species are obligates to the aspen habitat.

Wide-ranging species that utilize aspen areas for foraging are:

> Timber wolf (*Canis lupis*), northern myotis (*Myotis septentrionalis*), eastern pipistrelle (*Pipistrellus subflavus*), woodland vole (*Microtus pinetorum*), Arctic shrew (*Sorex arcticus*), pygmy shrew (*Sorex hoyi*), water shrew (*Sorex palustris*), bobcat (*Lynx rufus*), great gray owl (*Strix nebulosa*), sharp-tailed grouse (Tympanuchus phasianellus), Cooper's hawk (Accipiter cooperii), Swainson's thrush (*Catharus ustalatus*), veery (*Catharus fuscescens*), wood thrush (*Hylocichla mustelina*), and eastern kingbird (*Tyrannus verticalis*).

The remaining species use aspen as breeding sites and can be more directly influenced by stand management decisions. Only one species (DeGraaf et al. 1996) is considered to have aspen as preferred habitat, Nashville warbler (*Vermivora ruficapilla*). The Special Concern Nashville warbler prefers young (1-20 year-old) aspen stands, but also prefers young upland conifers, swamp conifers and old jack pine. Aspen stand management can add some benefit to this species.

Twelve species utilize aspen but have other preferred habitat. These species can be affected by harvest. When present, stand harvest may have benefits (from one to twenty years afterwards) for 4 species that utilize young aspen stands. A shifting mosaic of young stands can accommodate these species:

- The Special Concern black-throated blue warbler (*Dendroica caerulescens)* prefers dense understory in hardwood stands, but uses aspen coppice.

- The Special Concern golden-winged warbler (*Vermivora chrysoptera)* prefers dense shrubs along alder-lined streams or bog edges, and also uses young aspen (1 – 20 years after harvest). Additional discussion concerning this species is provided below.
- The Special Concern large-flowered ground-cherry (*Leucophysalis grandiflora)* can occasionally be found in aspen stands that regenerate following fire.
- The Special Concern Canada mountain-ricegrass (*Oryzopsis canadensis)* can be found in aspen clones in barrens areas.

When present, stand harvest could have negative impacts on eight species, because they utilize mature stands. Consideration of extended rotation ages for aspen may lessen the impacts of harvest on these species:

- Three Special Concern species occasionally use old aspen trees as nest sites: northern goshawk (*Accipiter gentilis),* common goldeneye (*Bucephala clangula),* and common merganser (*Mergus merganser).* When present, consideration for maintaining aspen to the top end of the extended rotation could benefit these species.
- The Special Concern woodland jumping mouse (*Napaeozapus insignis)* prefers northern hardwoods,but will utilize older aspen.
- The Special Concern yellow-billed cuckoo (*Coccyzus americanus)* forages for caterpillars in oak and northern hardwoods but will use older aspen for nesting and foraging.
- The Special Concern Hooker's orchid (*Platanthera hookeri)* is most often found in old red and white pine forests,but will grow in old aspen stands with the same habitat types as the pines.
- The Special Concern large roundleaf orchid (*Planthera orbiculata)* has similar habitat requirements, as Hooker's orchid.
- The Special Concern Indian cucumber-root (*Medeola virginiana)* can be found in aspen stands adjacent to its preferred beech forest habitat.

Golden-winged warbler is listed as special concern by the Wisconsin DNR, and a priority species for management concern by Partners in Flight. This warbler regularly occupies regenerating aspen stands and occasionally pole-sized aspen stands. A bird preferring early succession habitats, the golden-winged warbler is found most frequently in alder/tamarack swamps, alder-lined stream corridors, regenerating spruce/fir forest and shrubby sedge meadows. This warbler is also found in lower frequencies in many other forest cover types (and most age and size classes) as well as old fields.

The diversity of forest types used by golden-winged warbler requires management planning efforts focused on landscape attributes and wintering grounds in Central America and northern South America. Commonly cited factors limiting populations are: (1) loss of breeding habitat, especially conversion of early successional habitats in northeast U.S. to more mature forest and suburban development; (2) brown-headed cowbird parasitism; (3) competition from and hybridization with blue-winged warbler; and (4) loss of winter habitat (Confer 1992).

Aspen management can supply habitat for golden-winged warbler, although a decline of 9.6% in the acres of young aspen (0 – 20 years) between 1983 – 1996 (FIA data) is not correlated to a decline in golden-winged warbler population (0.0 trend in WI) during the same period. Some researchers have speculated that golden-winged warblers have higher productivity in young aspen near wetlands, than in upland situations. Additional research is needed to clarify habitat (stands and landscapes) preferences, threats, and management needs.

Other rare species may occur in aspen stands considered for harvest. Many of these species will be found in specialized habitats such as rock outcrops, cliffs, ephemeral ponds, and seeps. If an NHI occurrence or species verification is identified, contact the appropriate person according to the Department protocol. Information on species and habitat can be found at the Forestry web site: https://dnr.wisconsin.gov/topic/forestry.

4 STAND MANAGEMENT DECISION SUPPORT

4.2 Key/ Checklist for Evaluating Cover Type Stand Management Options

Note: The following recommendations assume the management objective is to regenerate aspen, maximizing growth and yield.

1. Aspen maintenance	**2**
1. Conversion to aspen	**5**
2. Primary timber management objective is produce pulpwood	**3**
2. Primary timber management objective is produce sawtimber on dry-mesic to wet-mesic sites with site index > 70	**4**
3. Wet, poorly drained soils	Aspen management NOT recommended.
3. Wet-mesic, somewhat poorly drained soils	Harvest at rotation age, using simple coppice or coppice with standards regeneration methods. To avoid rutting and compaction, operate on dry or frozen ground only. Consider maintaining reserve and immature hardwoods and conifers if water tables can potentially rise and kill regeneration.
3. Very Dry to Mesic sites	Harvest at rotation age, using simple coppice or coppice with standards regeneration methods.
4. Stand older than 30 years	Harvest at recommended or extended rotation age, using simple coppice or coppice with standards regeneration methods. Consider two-age aspen management at age 30-40 years based on management objectives.

4. Stand 16-30 years old	Thin at age 30. Commercially thin from below. If possible, cut narrow strips into stand for machine access, alternating with wide leave strips, and operate equipment only in cut strip on slash mat to minimize rutting and compaction. Reduce basal area to approximately 65 square feet per acre in leave strips. Leave DOMINANT TREES, spaced about 10-11 feet apart (400 trees/acre). (NOTE: Thinning could result in increased defect and mortality to residual trees if care is not taken to minimize mechanical damage).
4. Stand 15 years or younger **and** mesic site	Pre-commercially thin at age 15 only if residual stems will not be damaged. Leave 550-600 trees per acre (9 X 9 foot spacing). Felling by hand is desirable to prevent mechanical damage to residual stems. **OR** Mechanically flatten or chip 6-8 ft wide strips at a spacing of 6-10 ft.
5. At least 50 well-spaced aspen per acre present	Harvest at aspen rotation age, using simple coppice or coppice with standards regeneration methods.
REGENERATION BY SEED **5.** Not as in “5” above, but with a suitable aspen seed source adjacent to the stand.	Cut all trees on area to be regenerated to aspen (reserve trees can be retained). Create a suitable seedbed by prescribed burning or by mechanical scarification. Results will depend on seed crop, prevailing winds, and available moisture.
ARTIFICIAL REGENERATION **5.** Not as in “5” above, but suitable aspen site.	Plant with aspen seedlings (see Artificial Regeneration chapter).

5 SILVICULTURAL SYSTEMS

Management of aspen is usually on an even-age basis. Rotation ages are based on site productivity as defined by the habitat type classification system. Recommended regeneration methods include:

- Simple coppice (total tree harvest).
- Coppice with standards. Retain standards (reserve trees) at 5-15% crown cover or stand area; these trees are not harvested during the coppice rotation (see Chapter 24).

5.2 Intermediate Treatments

5.2.3 Thinning

5.2.3.1 Non-Commercial Thinning and Improvement

A **pre-commercial thinning** at age 15 can dramatically improve sawtimber yields on exceptional sites (mesic sites, site index ≥80) with a rotation age of 60 years. Growth of young aspen is particularly rapid for the first 20 years. Pre-commercial thinning has been conducted on a relatively large-scale basis. Blandin Paper Company in Grand Rapids, Minnesota has mechanically thinned about 16,250 acres in the past decade. Their prescription for 8- to 10-year-old aspen sapling stands calls for flattening 6-8 feet wide strips at a spacing of 6-10 feet (David et al. 2001). More recently chipping has been tried to reduce the tangle created by just pushing stems over and to improve access for hunters. Significant growth responses in the residual trees have been observed. **NOTE:** TAKE EXTREME CARE TO PREVENT DAMAGE TO RESIDUAL STAND. Pre-commercial thinning has been found to increase internal defect in residuals by up to 10 times versus control stands. Partial harvest of aspen was observed to increase mortality in residuals due to canker diseases associated with logging wounds, as well as damage from sunscald and woodboring insects (Ostry 1982).

5.2.3.2 Commercial Thinning and Improvement

Thinning has been demonstrated to reduce the length of pulpwood rotations (Jones et al. 1990), increase volume increment (Weingartner and Doucet 1990), and increase sawtimber output up to 40% and veneer output up to 140% (Perala 1977). Thinning also can be an effective means of eliminating poor clones from a stand, provided residual densities are heavy enough to retard suckering. To maximize aspen sawtimber production on dry-mesic to wet-mesic sites, commercially thin at age 30 (Perala 1977). This thinning will capture some of the natural mortality that occurs as the stand matures as well as release crop trees. NOTE: thinning at age 30 can result in increased defect and mortality to residual trees if care is not taken to minimize mechanical damage during the harvest.

5.3 Natural Regeneration Methods

5.3.1 Even-Age Regeneration Methods

<u>Management Recommendations</u>

- To maximize stand growth and vigor, aspen should be grown in full sunlight in a fully stocked condition. Optimum stocking is 12,000 well-spaced suckers per acre the first year, 6,000 suckers per acre is a minimum. Regeneration by simple coppice produces 10,000 to 30,000 suckers per acre (Graham et al. 1963).
- Retain some hardwoods and conifers on wet to wet-mesic soils when regenerating aspen. This maintains a portion of the normal evapotranspiration and nutrient cycling processes (Navratil et al. 1994), allowing for partial aspen regeneration in areas that may become non-forested due to a rise in the water table if all trees are cut.
- **Balsam poplar** can be regenerated from seeds, stump sprouts, root suckers, and buried branches.

Management Alternatives[2]

- The **aspen reserve management** method may reduce aspen sucker density and increase early aspen sucker growth, while maintaining species diversity (Stone et al. 2000). This method leaves 7-15 dominant or co-dominant aspen per acre at a uniform spacing of 50-66 feet in the regeneration area (10-12 square feet reserve basal area). In a study of the first full growing season following an aspen reserve harvest, sucker density was reduced 41% compared to the control. Moreover, suckers on these sites had a greater mean diameter (28% greater) and greater height growth (33% taller) than the simple coppice control site. This suggests carbohydrate and/or nutrient reserves in the parent root systems are channeled to fewer suckers, thereby increasing their early growth as postulated by Ruark (1990).
- **Two-age aspen management** was proposed by Ruark (1990). This method allows for sawtimber production while maximizing aspen pulpwood production. It is recommended only for dry-mesic and mesic sites. Although this method has not been validated, the proposed two-age management of aspen is: (1) Conduct a harvest at age 32 (maximum mean annual increment (MAI) for aspen pulpwood) leaving 10-20 scattered dominant aspen per acre in the initial cut. (2) Grow the regenerated stand for another 32 years. At that time, all 64-year old stems and most 32-year old aspen stems (all but 10-20 dominants per acre) are harvested. Care must be taken to not damage residual stems. No more than 20-30 mature trees per acre should remain standing following harvest. This amount of residual will not exceed the 30 square feet maximum reserved basal area per acre recommended in a coppice and standards regeneration method. This residual still allows enough light for aspen sucker development.

5.5 Rotation Lengths and Cutting Cycles

Rotation Definition

In even-aged silvicultural systems a rotation is defined as the period between regeneration establishment and final cutting. The length of rotation may be based on many criteria, including culmination of mean annual increment (CMAI), target size, attainment of a physical or value growth rate, and biological condition.

Choosing an Appropriate Rotation Age

Selecting when to rotate a stand is based on multiple considerations, including landowner goals, stand condition, and expected future growth. The rotation ages provided are guidelines based on literature, empirical data, and professional experience. In application, foresters will need to regularly review stands in the field and exercise professional judgment concerning tree vigor and mortality and stand growth and productivity. Different rotation lengths can result in increased production of some benefits and reduced production of others, and landowner goals will help inform the evaluation of the benefits and costs (ecological, economic, and social) associated with different forest management strategies. Below are aspen rotation length

[2] Management practice that may have potential for application in managing aspen but has not been widely utilized and tested.

guidelines based on three different management emphases to accommodate a variety of landowner goals.

Flexibility in Rotation Length Guidelines
The recommended rotation ages presented here are appropriate for most stand conditions and landowner goals encountered in aspen stands. Foresters may modify these guidelines to accommodate specific stand conditions and management objectives. Modifications to these guidelines should always be scientifically sound. Some of the more common modifications include early rotations due to significant stand health concerns, modifications to regulate a species' age class distribution at the property/landscape level, and accommodations due to operability issues. In addition, aspen rotations are sometimes modified to create age class diversity for ruffed grouse management.

0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
							Aspen Rotation Age (years)													
							Economic													
								Biological												
												Extended								

Figure 43.14. Economic, biological, and extended rotation length recommendations for aspen.

5.5.1 Economic Rotation

The economic rotation age seeks to maximize the net present value of the stand. It may only include financial (monetary) aspects but could also include non-timber benefits. The inclusion of non-timber benefits may shorten or lengthen the rotation age depending on the non-timber benefits included. For more details on the factors that affect economic rotation age, please refer to the Economics Chapter (Chapter 62). Landowners who choose economic rotation ages generally want to maximize the financial performance of the stand. Economic rotations will vary depending on the target discount rate and factors such as estimated costs and revenues (Minnesota DNR 2013; Steigerwaldt 2016). In practice, there can be significant overlap between economic and biological rotations, especially on higher quality sites. Current aspen markets in Wisconsin favor pulpwood and composite products. The density of aspen wood is low, making it less valuable for biofuel production. The majority of aspen sawtimber in Wisconsin is classified as lower grade. Bigtooth aspen is more likely to be of higher grade than quaking aspen. There are regional variations in aspen with the highest quality aspen generally found in northeast and northwest Wisconsin.

5.5.2 Biological Rotation

The biological rotation seeks to maximize long-term sustained yield, or volume production. In this guideline, the range in rotation ages is defined at the lower end by the age at which maximization or culmination of mean annual increment (CMAI) growth occurs and at the upper end by the average stand life expectancy. The recommended rotation to maximize average annual volume growth (CMAI) is 40-60 years, with CMAI generally occurring sooner on very dry or wet habitat types and later on rich habitat types. The better the site, the higher the potential to maintain high growth rates for a longer period; however, disease may cause significant declines in timber value in older stands. Bigtooth aspen has the potential to maintain vigor and growth longer than quaking aspen and is typically found on higher quality sites. Ecological benefits of biological (and economic) rotations can include more abundant coppice regeneration and maintenance of early successional wildlife habitat.

5.5.3 Extended Rotation

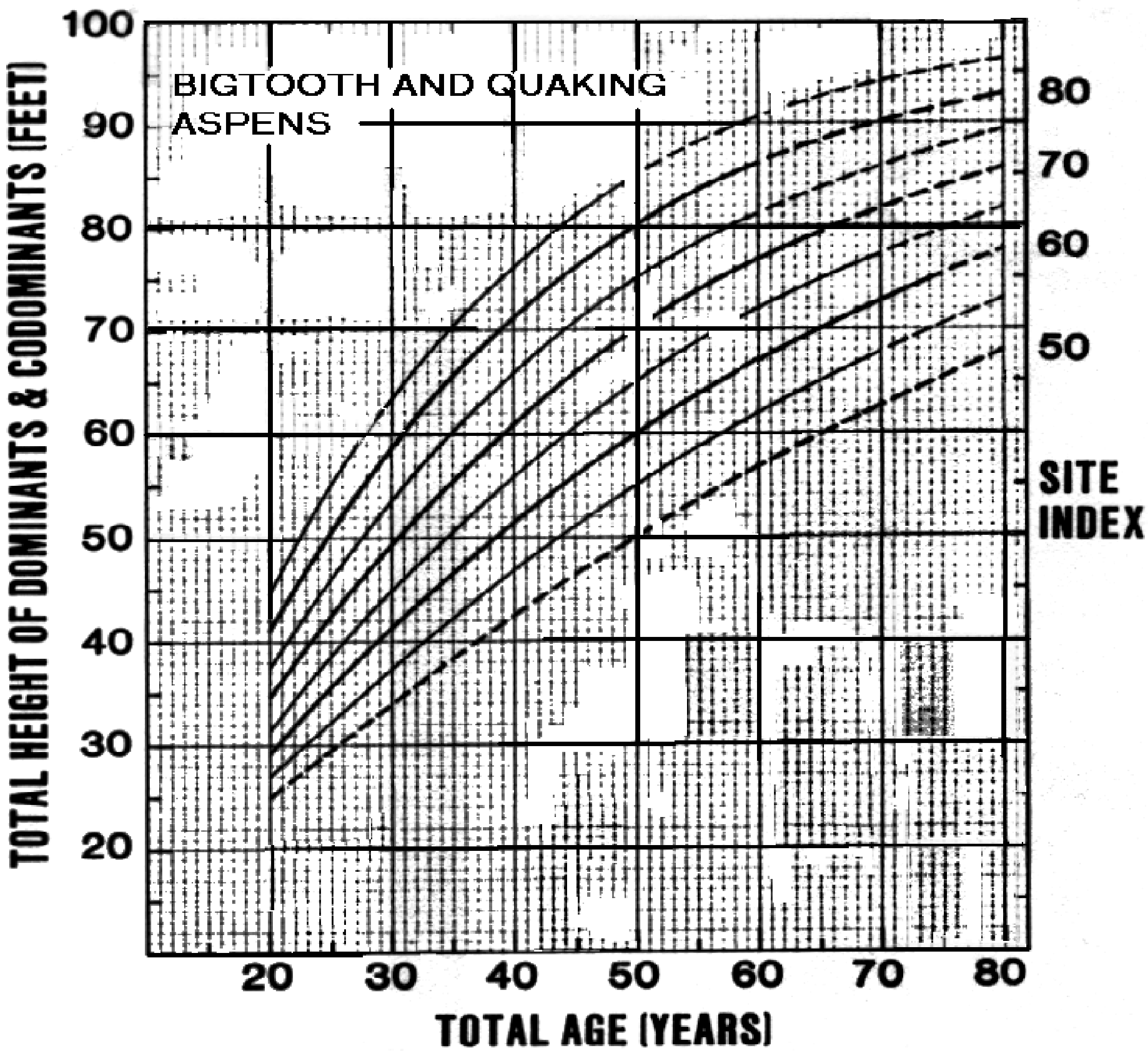
Extended rotation involves growing stands beyond typical biological rotation ages yet younger than average tree life expectancy, with the objective of managing for both commodity production and the development of some ecological and social benefits associated with older forests. Ecological benefits of extended rotations can include an abundance of large trees, more diverse vertical structure, and greater levels of standing snags and coarse woody debris that support organisms associated with these structures.

5.6 Other Silviculture Considerations

5.6.2 Cover Type Conversion

Conversion to aspen requires either an adequate aspen component in the overstory OR a suitable seedbed with an adjacent seed source. On well drained sites, coppice regeneration with as few as 50 trembling aspen per acre will normally create a fully stocked stand of suckers (Perala 1977). To establish aspen regeneration from seed, a continuously moist mineral soil seedbed is essential. Successful seeding has occurred on a seedbed scorched with a hot fire or scraped bare with a dozer blade so the seedbed has mineral soil fully exposed to the sun and soil conditions are firm. Firm soil (not compacted) increases the moisture retention needed for seed germination (Gullion 1984).

8 APPENDICES



Bigtooth and quaking aspens (Carmean 1978)
Northern Wisconsin and Upper Michigan
13 plots having 42 dominant and codominant trees
Stem analysis, nonlinear regression, polymorphic
Add 4 years to d.b.h. age to obtain total age (BH = 0.0)

	b_1	b_2	b_3	b_4	b_5	R^2	SE	Maximum difference
H	5.2188	0.6855	-0.0301	50.0071	-0.8695	0.99	1.58	4.5
SI	0.0612	1.4390	-0.0050	-3.9080	-0.4350	0.99	1.90	10.4

Figure 43.15. Site index curves for bigtooth and trembling aspens in northern Wisconsin and upper Michigan (Carmean et al., 1989).

8.1 Forest Health Guidelines - Forest Health Protection (FHP)

PEST MANAGEMENT GUIDELINES FOR ASPEN AND HYBRID POPLAR

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
ROOT DISEASE		
Armillaria Root Disease - *Armillaria* sp. Armillaria root disease is more of a threat if aspen is managed under frequent, short (less than 13 years) rotations. This disease is also more prevalent when aspen is stressed from defoliation or drought. 1. Sucker stands: mortality usually scattered, acting as a thinning agent. 2. 45-55 year-old stands: mortality can occur in pockets and develop rapidly following defoliation or drought. 3. In stands with frequent (2 or more) short (<13 years old) rotations, stem and root decay degrade root systems to a point where they are unable to support sprout growth.	1. No prevention necessary 2. Monitor stands > 40, every 5 years; more often when stands are over 55. If > 15% of the stems are infected, consider harvest. 3. Avoid repeated short rotations.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. Armillaria root rot in aspen stands after repeated short rotations. G.R. Stanosz and Patton, R.F. 1987. Can. J. of For. Research. 17:1001 - 1005.
STEM DISEASES		
Hypoxylon Canker - *Entoleuca mammata* Hypoxylon canker causes stem and branch cankers, top breakage, girdling and mortality. Mortality more common on	1. No action necessary 2. Harvest the stand early; treat to encourage good regeneration.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
young (10 years) trees. Stain and decay enter trees through cankers. Trembling aspen is most susceptible native aspen. 1. Sucker stands with 30,000-40,000 stems/acre: Hypoxylon kills an average of 1-2% of the stems/ year, acting as a thinning agent. Stand can suffer up to 7.5% mortality/ year and still yield 1,500 stems at 40 years. 2. If 15-25% of the stems are infected: 3. If more than 25% of the stems are infected.	3. Harvest the stand as soon as possible and convert to other species or convert to a less susceptible clone.	Hypoxylon Canker of Aspen. R.L. Anderson, G.W. Anderson and A.L Shipper. 1979. USDA FS FIDL #6.
Other Cankers *Cryptosphaeria populina* *Nectria galligena* *Ceratocystis fimbriata* *Encoelia pruinosa* Typically infecting through a wound, these canker-causing fungi can cause a reduction in tree quality through stem deformity, stain and stem breakage. Mortality can occur but is rare.	Avoid wounding and sunscald. Harvest trees before cankers reduce quality or yield potential.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. Identification of Aspen Cankers. M. Albers and J. Campbell. 1988. MN DNR leaflet.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
Cankers more serious in plantations and nurseries *Cytospora, chrysosperma Phomopsis macrospora,* *Cryptodiaporthe populea* These canker diseases are more prevalent in plantations and nurseries and on trees that are declining from some other cause. Cankers cause dieback, branch mortality, bark necrosis and cankers on branches and main stems of native/introduced poplars. Susceptibility to these fungi varies	In plantations and nurseries: Plant cuttings and seedlings during periods of favorable moisture and temperature to minimize stress. Plant on the best poplar sites. Control weeds, irrigate and fertilize. Plant trees far enough apart to minimize competition for light, moisture and nutrients. Plant clones resistant to *Melampsora, Septoria* or *Marssonina* leaf diseases. Plant cuttings from only disease-free	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. How To Identify and Prevent Injury to Poplars Caused by Cytospora, Phomopsis and Dothichiza. M.E. Ostry. 1982. USDA FS HOW TO.
FOLIAGE DISEASES		
Septoria Leaf Spot and Canker - *Septoria musiva* Can be a serious pathogen of aspen as the disease causes premature defoliation and cankers on the twigs and main stem. Other canker fungi often infect Septoria canker and cause further injury, twig and stem girdling and decay.	Plant only uninfected nursery stock. Harvest highly susceptible trees and replant using disease resistant clones.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. Biology of *Septoria musiva* and *Marssonina brunnea* in hybrid Populus plantations and control of Septoria canker in nurseries. M.E. Ostry. 1987. European J. of For. Pathology. 17:158-165.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
Leaf Rust - *Melampsora medusae, M. abietis-canadensis* Trees defoliated early in the growing season can experience growth loss. Repeated years of defoliation can cause a higher susceptibility to other diseases and environmental stress. M. medusae alternate host is eastern larch; alt. host for M. abietis-canadensis is eastern hemlock.	Plant disease resistant clones. Do not plant poplars adjacent to hemlock, red or jack pine or eastern larch. Some hybrid larches also act as alternate hosts. Space trees far apart (1.5m) to reduce rust severity on moderately susceptible clones. Wide spacing will not protect highly susceptible clones.	Diseases of trees and shrubs. W. Sinclair, Lyon and Johnson. 1987. Cornell University Press. How To Identify Leaf Rust of Poplar and Larch. A.Shipper, K Widin and B. Anderson. 1978. USDA FS. HOW TO.
Leaf Spots - *Phyllosticta, Ciborina, Marssonina, Septotinia* Heavily infection can cause premature defoliation and a reduction in growth rate.	Remove, bury or otherwise destroy infected leaf debris in fall or early spring to minimize new infections in the spring. Plant resistant clones.	How to Identify and Control Marssonina Leaf Spot of Poplars. M. Palmer. 1980. USDA FS HOW TO. How to Identify Septotinia and Phyllosticta leaf Spots of Poplars. M. Ostry. 1980. USDA Forest Ser. HOW TO.
Leaf Bronzing - Viruses, Phytoplasmas, Rickettsia, Spiroplasmas These pathogens can initiate decline and dieback, and cause a reduction in growth. These pathogens have not been extensively studied in aspen and are difficult to diagnose.	Plant only vigorous, disease-free stock.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
SHOOT BLIGHT CANKER ROT/DECAY		
Venturia macularis, V. populina, V. tremulae Venturia shoot blight is most severe in young aspen stands and hybrid poplars. Infected shoots and leaves become black and curled. Death of the terminal can deform small trees and cause a shrubby tree form. Saplings, after repeated attack may die.	Disease susceptibility varies among hybrids. Plant resistant clones.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. How To Identify Shoot Blight of Poplars. M.E. Ostry. 1980. USDA FS HOW TO.
SHOOT BLIGHT CANKER ROT/DECAY		
White Trunk Rot - *Phellinus tremulae* Known as "white trunk rot", this canker rot causes significant volume loss in aspen in the Lake States. Advanced decay and discoloration reduce the value of trees as fiber sources. This pathogen becomes more serious with stand age.	Monitor stands over 40 years, every 5 years; more often over 55. Look for signs (fruiting bodies) of decay. Harvest aspen before decay becomes extensive. Harvest stands damaged by fire or weather early as these stands are more susceptible to infection. Make regeneration cuts in overmature stands. Manage aspen to achieve uniform, well-stocked stands so natural pruning will minimize infection sites.	A Guide To Insects, Diseases, and Animal pests of Poplars. M.E. Ostry. 1989. USDA FS Agr. Handbook 677. How To Identify and Minimize White Trunk Rot of Aspen. A. Shipper, R. Anderson. 1978. USDA FS. HOW TO.
TWIG PESTS		
Poplar-Gall Saperda - *Saperda inornata* Tunneling and gall formation in twigs may result in heavy loss of twigs, stem deformity, and entry of canker diseases.	Avoid establishing new aspen stands in heavily damaged areas. Maintain well-stocked sucker stand.	How to Identify and Prevent Injury by the Poplar-Gall Saperda. L.F. Wilson. 1980. USDA FS, NCFES.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
FOLIAGE PESTS		
Spongy Moth – *Lymantria dispar* Periodic heavy defoliation can be expected at intervals of 5-15 years. Impacts should be similar to those of forest tent caterpillar, but outbreaks should be of shorter duration.	No prevention necessary. Manage by maximizing tree vigor in order to minimize mortality. OR Convert to alternate species (less susceptible species).	Gypsy Moth. M. McManus et al. 1980. USDA Forest Insect and Disease Leaflet 162. Gypsy Moth Silvicultural Guidelines for Wisconsin. C. Brooks and D. Hall. 1997. DNR PUB-FR-123
Forest Tent Caterpillar - *Malacosoma disstria* Periodic widespread outbreaks of defoliation in spring in northern 1/3 of Wisconsin lasting up to 3 years. Three years of defoliation can reduce growth by 90%. 1. On most sites, mortality is limited to a few suppressed trees. 2. On wet or excessively dry sites mortality may be heavy.	No prevention necessary. Convert to alternate species.	A Guide to Insect, Disease, and Animal Pests of Poplars. M. Ostry, . 1989. USDA FS Handbook 677.
Large Aspen Tortrix - *Choristoneura conflictana* Occasional outbreaks of spring defoliation seldom lasting more than one or two years. Little or no mortality, some growth loss.	Prevention or control unnecessary.	A Guide to Insect, Disease, and Animal Pests of Poplars. M. Ostry, . 1989. USDA FS Handbook 677.
Aspen Blotch Miner- *Phyllonorycter tremuloidiella (*Braun*).*	Prevention or control unnecessary.	A Guide to Insect, Disease, and Animal Pests of Poplars.

Disturbance Agent and Expected Mortality or Damage	Options for Minimizing Mortality or Preventing Disease	References
Occasional outbreaks of late summer defoliation. No growth loss or mortality has been observed.		M. Ostry, . 1989. USDA FS Handbook 677.

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