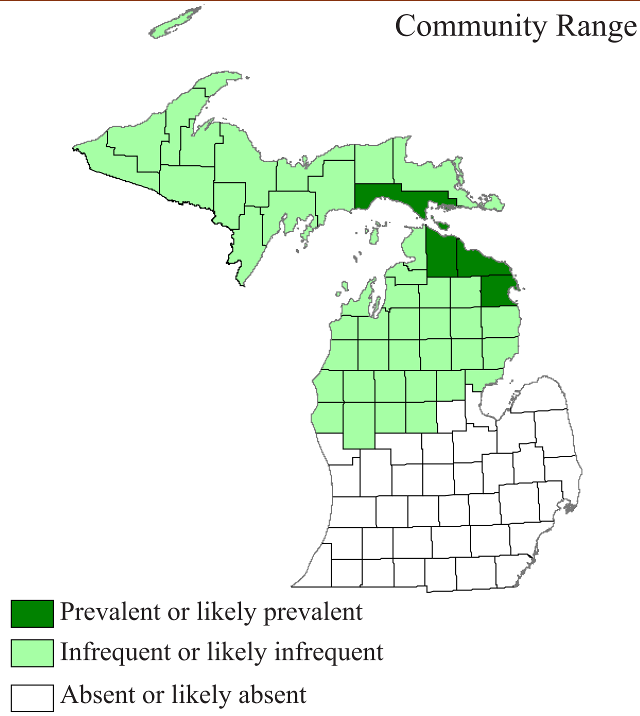
Northern Hardwood Swamp

Community Abstract

Photo by Joshua G. Cohen



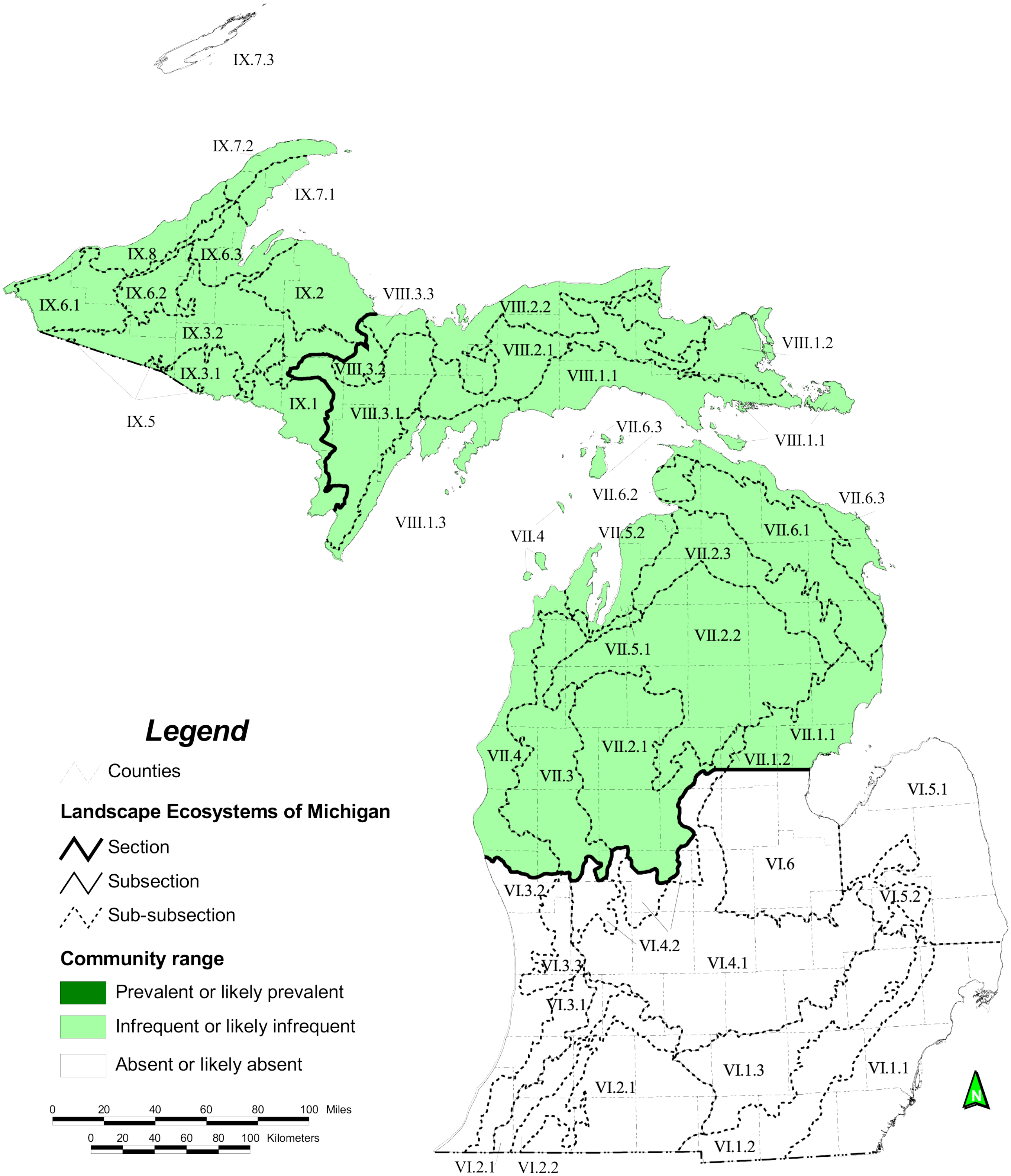
Overview: Northern hardwood swamp is a seasonally inundated, deciduous forest type dominated by black ash (*Fraxinus nigra*) that occurs on neutral to slightly acidic, hydric, mineral soils and shallow muck over mineral soils. Located north of the climatic tension zone, northern hardwood swamp is found primarily in depressions on glacial lakeplains, fine and medium textured glacial tills, and broad flat outwash plains. Fundamental disturbance factors driving northern hardwood swamp development include seasonal flooding and windthrow.

Global and State Rank: G4/S3?

Range: Northern hardwood swamps are found throughout most of the northern Midwestern region of the United States and into the boreal region of central Canada. The range includes Illinois, Indiana, Michigan, Wisconsin, Minnesota, North Dakota, Manitoba, and Ontario (Faber-Langendoen 2001, NatureServe 2006). In Michigan, northern hardwood swamps occur north of the climatic tension zone, in the northern Lower Peninsula and throughout the Upper Peninsula.

Rank Justification: Analysis of General Land Office survey notes in Michigan reveals that hardwood-dominated wetland forest covered over 500,000 acres (200,000 hectares) throughout the northern Lower Peninsula and Upper Peninsula. Of that total, black ash-dominated wetland forest covered approximately 190,000 ac (80,000 ha) (Comer et al. 1995). Today, lowland hardwood forests have increased, mostly due to extensive logging of former conifer-dominated swamps (Kost 2002). MIRIS data from 1978 estimated well over a million acres of lowland hardwood forest (1,300,000 ac, 500,000 ha) (MIRIS 1978). The proportion of current lowland hardwood forest dominated by black ash swamp is not known because this system has not been systematically surveyed in Michigan.

Physiographic Context: Northern hardwood swamps can be found in the following landscape settings: abandoned lake beds; level and pitted glacial lakeplains; shallow basins; groundwater seeps; low, level terrain near rivers, lakes, or wetlands; and small, forested depressions around edges of peatlands. The majority of circa 1800 black ash swamps were located on flat lacustrine plains, fine and medium textured glacial tills, or broad flat outwash plains (Ferrand and Bell 1982, Comer et al. 1995). Because they occupy depressions, these ecosystems are colder than the immediate surrounding landscape (Barnes and Wagner 2004). The soils are poorly to very poorly drained and often consist of a shallow layer of muck (i.e., sapric peat) overlaying mineral soil. As the peat layer increases, so does the conifer component of northern hardwood



Ecoregional map of Michigan (Albert 1995) depicting distribution of northern fen (Albert et al. 2008) swamps, which is usually comprised of northern white-cedar (*Thuja occidentalis*) and/or balsam fir (*Abies balsamifera*) (MNDNR 2003). The texture of mineral soils is most commonly fine sandy clay loam to fine loam and an underlying impermeable clay lens is often present. Because northern hardwood swamps occur on poorly drained soils and in areas that receive seasonal flooding or have high water tables, perched saturated pockets and pools of standing water are common (Faber-Langendoen 2001).

The Michigan range of northern hardwood swamp falls within the following regions classified by Albert et al. (1986) and Albert (1995): Region II, Northern Lower Michigan; Region III, Eastern Upper Michigan; and Region IV, Western Upper Michigan. This area has a cool snow-forest climate with short, warm summers, cold winters, and a large number of cloudy days. The mean number of freeze-free days is between 90 and 160, and the average number of days per year with snow cover of 2.5 cm (1 inch) or more is between 80 and 140 days. The normal annual total precipitation ranges from 740 to 900 mm (29 to 35 in) with a mean of 823 mm (32 in). The daily maximum temperature in July ranges from 24 to 29 °C (75 to 85 °F), the daily minimum temperature in January ranges from -21 to -9 °C (-5 to 15 °F) and the mean annual temperature is 7 °C (45 °F) (Albert et al. 1986, Barnes 1991).

Photos by Joshua G. Cohen

Enlarged lenticels on the bole and roots of black ash are an adaptation to soil saturation.

Natural Processes: Seasonal flooding is the primary disturbance in northern hardwood swamps. Standing water, usually a result of groundwater seepages, can reach over a foot in depth, and is usually present in the spring and drained by late summer. Water often pools due to an impermeable clay layer in the soil. Overstory species associated with flooding have several adaptations to soil saturation such as hypertrophied lenticels (oversized pores on woody stems that foster gas exchange between plants and the atmosphere), rapid stomatal closure, adventitious roots, and reproductive plasticity (Tardif et al. 1994, Kozlowski and Pallardy 2002). Flooding extent has even been found to dictate the mode of regeneration for black ash. For example, heavy flooding events usually results in vegetative reproduction by stump sprouting, whereas sexual reproduction is usually fostered with less prolonged flooding (Tardif et al. 1994).

Differences in species composition, in particular the distribution of different *Fraxinus* species, are dependent upon variation in timing, extent, and duration of high water. The relationship between variations in flooding and species composition is demonstrated by the differences between black ash-dominated swamps and river floodplains where green ash (*Fraxinus pennslyvanica*) is a more common dominant species. Green ash requires moving, oxygen-rich water characteristic of river floodplains, whereas black ash has adapted to the usually stagnant water with reduced oxygen content associated with swamp depressions. Green ash on river floodplains withstands routine flooding throughout the growing season. Black ash is very tolerant of low oxygen levels found in stagnant swamps, but is intolerant of flooding well into the growing season. Massive dieback of understory and sometimes overstory vegetation often results from extended periods of high water in northern hardwood swamps. An adaptation to this common occurrence is the long dormancy period (up to eight years) of black ash seeds (Wright and Rauscher 1990). In northern hardwood swamps, drier periods that allow for exposure of saturated organic soils are essential for regeneration of swamp vegetation. However, because of the high water retaining capacity of sapric peat, soil moisture within northern hardwood swamp is typically maintained throughout the growing season, unlike the mineral soils of many floodplains, which can experience summer droughts. While xeric stress is harmful to shallow rooting black ash seedlings (Tardif et al. 1994), green ash commonly withstands periods of low soil moisture on river floodplains. Northern hardwood swamp communities are therefore relegated to areas of depressions, or low level terrain near rivers, lakes, or wetlands, which experience seasonal flooding but not the more pronounced levels of soil desiccation found in floodplain systems (Kost et al. 2007).

Catastrophic disturbances other than flooding were most likely infrequent. Large scale windthrow and fire in northern hardwood swamps of Minnesota had a rotation of 370 and 1,000 years, respectively (MNDNR 2003). However, small windthrow events are common in these systems due to shallow rooting within muck soils. The uprooting of trees creates pit and mound microtopography that results in fine-scale gradients of soil moisture and soil chemistry.


Photo by Joshua G. Cohen

Small windthrow events, which are prevalent due to the shallow rooting of canopy trees, generate microtopography that increases floristic diversity.

Microtopography is an important driver of vegetation patterns within swamp systems since it provides a diversity of microsites for plant establishment. As flood water drains, both the residual mucky pools and exposed mounds left by uprooted trees provide unique substrates for a variety of northern hardwood swamp plants (MNDNR 2003). Coarse woody debris, which typically lies above the zone of flooding, remains a continued source of saturated substrate for seed germination and seedling establishment through dryer periods.

Hydrological changes in deciduous lowland, black ash-dominated forest can be part of a natural succession from heavily inundated conifer swamps to more wet-mesic, mixed hardwood-conifer and hardwood forests (Curtis 1959). As the water-holding capacity of the organic soil of conifer-dominated wetlands or shrub-dominated swamps decreases, deciduous black ash can then invade. Black ash leaves have larger amounts of calcium, magnesium, and nitrogen than other hardwoods and can increase the nutrient supply in the system (Reiners and Reiners 1970). Increased levels of nutrients can facilitate colonization of other deciduous trees such as red maple (*Acer rubrum*) and yellow birch (*Betula alleghaniensis*) (Curtis 1959). However, if hydrologic conditions such as regular, seasonal flooding remain, black ash can maintain its dominant overstory position. Sexual and vegetative regeneration of black ash fostered by gap phase dynamics in old-growth settings are believed to be sufficient for black ash self-maintenance (Tardif and Bergeron 1999). Black ash can also invade northern shrub thickets, as soils under alder thickets develop enough to support canopy trees. Invading canopy trees, such as black ash, can subsequently lead to the shading out and decline of the alder (Curtis 1959).

A common agent in hydrologic change in swamp systems is beaver. Through dam-building activities, beaver can instigate substantial hydrologic change; either causing prolonged flooding or lowering of the water table depending on the location of the forest in relation to the dam (Gates 1942, Curtis 1959, Heinselman 1963, Jeglum 1975, Futyma and Miller 1986). Behind a beaver dam the water table is higher while below it, drier conditions are generated (Jeglum 1975). In addition to altering hydrology, beaver can generate canopy gaps within these systems by cutting down trees that range in stump diameter from 25 to 51 cm (10 to 20 in) (Wright and Rauscher 1990).

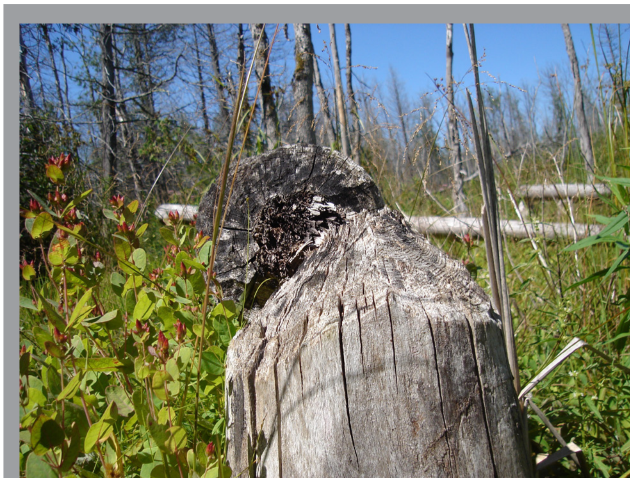


Photo by Joshua G. Cohen

Beaver can influence northern hardwood swamps by generating canopy gaps and by altering the hydrology.

Vegetation Description: Black ash (*Fraxinus nigra*) is the overwhelming canopy dominant of northern hardwood swamp communities (Curtis 1959). Studies have reported black ash to be both a short-lived species, with a lifespan of around 75 years (Parker and Schneider 1974, Lees and West 1988, Sims et al. 1990), and a relatively long-lived species with trees frequently over 200 years old (Tardif and Bergeron 1999). Average diameter at breast height (DBH) of trees that are 110 to 130 years old ranged from 25 to 30 cm (10 to 12 in) (Tardif and Bergeron 1999). A sample of tree DBHs recorded by GLO surveyors in lowland hardwood swamps of Mason County in the early 1800s ranged from 15 to 66 cm (6 to 26 in) and averaged approximately 32 cm (13 in). Preliminary surveys of current northern hardwood swamp indicate that diameters typically range from 10 to 30 cm (4 to 12 in).

Photo by Joshua G. Cohen

Northern hardwood swamps are characterized by overstory dominance by black ash, patches of shrubs, such as alder and winterberry, and a diverse ground cover, with ferns and graminoids well represented.

Canopy associates of black ash include red maple (*Acer rubrum*), American elm (*Ulmus americana*), silver maple (*Acer saccharinum*), yellow birch (*Betula alleghaniensis*), paper birch (*B. papyrifera*), basswood (*Tilia americana*), balsam fir (*Abies balsamifera*), northern white-cedar (*Thuja occidentalis*), green ash (*Fraxinus pennsylvanica*), and hemlock (*Tsuga canadensis*), however these are all found in greater density in other communities. The shrub layer can consist of saplings of overstory species along with Michigan holly (*Ilex verticillata*) and speckled alder (*Alnus rugosa*). Northern hardwood swamps are characterized by a diverse groundcover that is patchy both seasonally and spatially depending on timing, location, and duration of flooding. Sites are often saturated to inundated in spring and following heavy rains, resulting in numerous sparsely vegetated to bare areas in the understory and ground layers. During the late growing season, when seasonal waters draw down, the herbaceous layer is typically dense.

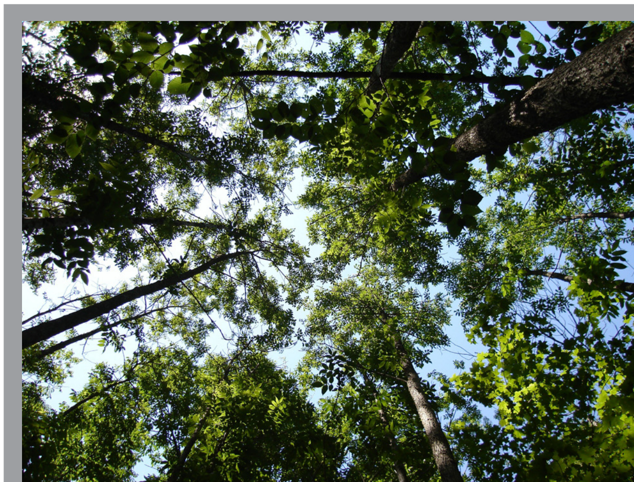


Photo by Joshua G. Cohen

Filtered light through the open black ash canopy allows for a dense and diverse ground cover layer to develop following the recession of seasonal flooding.

Photo by Joshua G. Cohen

Common herbaceous plants include northern bugleweed (*Lycopus uniflorus*), mad-dog skullcap (*Scutellaria lateriflora*), common skullcap (*S. lateriflora*), wood anemone (*Anemone quinquefolia*), jack-in-the-pulpit (*Arisaema triphyllum*), false nettle (*Boehmeria cylindrica*), marsh marigold (*Caltha palustris*), Pennsylvania bittercress (*Cardamine pensylvanica*), fringed sedge (*Carex crinita*), bladder sedge (*C. intumescens*), hairy sedge (*C. lacustris*), alpine enchanter nightshade (*Circaea alpina*), goldthread

(*Coptis trifolia*), sweet-scented bedstraw (*Galium triflorum*), fowl manna grass (*Glyceria striata*), spotted touch me not (*Impatiens capensis*), wild iris (*Iris versicolor*), wood nettle (*Laportea canadensis*), Canada mayflower (*Maianthemum canadense*), wild mint (*Mentha arvensis*), partridge berry (*Mitchella repens*), naked miterwort (*Mitella nuda*), Virginia creeper (*Parthenocissus quinquefolia*), clearweed (*Pilea pumila*), elliptic shinleaf (*Pyrola elliptica*), dwarf raspberry (*Rubus pubescens*), water parsnip (*Sium suave*), skunk cabbage (*Symplocarpus foetidus*), and wild violets (*Viola* spp.). Common ferns include sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), ostrich fern (*Matteuccia struthiopteris*), and woodland oak fern (*Gymnocarpium dryopteris*). In addition, horsetails (*Equisetum* spp.) are also prevalent in northern hardwood swamps. (Above species lists compiled from Michigan Natural Features Inventory Biotics Database 2007, Curtis 1959, Wells et al. 1975, Cleland et al. 1994, Eggers and Reed 1997, Faber-Langendoen 2001, MNDNR 2003, NatureServe 2006)

Rare Plants and Animals: Rare plants associated with northern hardwood swamps include narrow-leaved gentian (*Gentiana linearis*, state threatened), bog bluegrass (*Poa paludigena*, state threatened), and Assiniboia sedge (*Carex assiniboinensis*, state threatened). Rare animals include northern goshawk (*Accipiter gentilis*, state special concern), moose (*Alces americanus*, state special concern), spike-lip crater (*Appalachina sayanus,* state special concern land snail), gray wolf (*Canis lupus,* state threatened), Blanding's turtle (*Emydoidea blandingii*, state special concern), cougar (*Felis concolor*, state endangered), bald eagle (*Haliaeetus leucocephalus*, state special concern), three-horned moth (*Pachypolia atricornis*, state special concern), osprey (*Pandion haliaetus*, state special concern), eastern massasauga (*Sistrurus catenatus catenatus*, state special concern), and eastern box turtle (*Terrapene carolina carolina*, state special concern). Great blue heron rookeries are also found in northern hardwood swamps.

Conservation and Biodiversity Management: When the primary conservation objective is to maintain biodiversity in northern hardwood swamps, the best management is to leave large tracts unharvested and allow natural processes (e.g., flooding, windthrow, and senescence) to operate unhindered. Black ash seeds are an important food source to game birds, songbirds, and small mammals, and the leaves provide browse for deer and moose (Wright and Rauscher 1990).

Threats to northern hardwood swamps involve hydrological impacts such as drainage for agriculture, sedimentation due to logging or construction, or the deleterious impacts of stormwater or wastewater runoff either causing prolonged flooding outside the natural range of variation, or significantly increasing nutrient levels and facilitating invasion by non-native species such as reed canary grass (*Phalaris arundinacea*), giant reed (*Phragmites australis*), autumn olive (*Elaeagnus umbellate*), and glossy buckthorn (*Rhamnus frangula*). Black ash is a slow growing species and is usually found as small-sized trees under 25 cm DBH (10 in) (Wright and Rauscher 1990), and is therefore of minor commercial value. Black ash is, however, a component in northern Wisconsin and Upper Peninsula Michigan sawtimber production (Erdmann et al. 1987). Clear-cutting black ash swamps can cause the loss of the community type, due to a rise in water table as a result of decreased transpiration following tree removal (Erdmann et al. 1987).

In southeast Michigan, the introduction of the emerald ash borer (*Agrilus plannipenis*) has initiated new concern for ecosystems in which ash plays a significant role. The emerald ash borer (EAB), introduced to southeast Michigan around 1990, infests and kills all species of ash (Haack et al. 2002, McCullough and Roberts 2002). Similar to Dutch elm disease, which has virtually eliminated American elm (*Ulmus americana*) as a dominant overstory tree of swamp systems (Barnes 1976), EAB is having a comparable effect on southern swamps and floodplain forests dominated by black or green ash. Emerald ash borer has already killed millions of ash trees in southeastern Michigan and southeastern Ontario and threatens to drastically alter ash-dominated forests, including northern hardwood swamp (McCullough and Roberts 2002). Outside the EAB infested area in southeastern Michigan, the density and health of ash is relatively robust, and so will most likely foster EAB expansion throughout Michigan and beyond (MacFarlane and Meyer 2005, Weber et al. 2007). Ash plot monitoring has detected less of an impact to black ash than to green and white ash throughout the infected EAB zone, as well as fewer signs of decline in black ash throughout the rest of the state (Weber, unpublished data). The lower impact on black ash could be related to the isolated nature of the pockets of northern hardwood swamp and also low densities of black ash in many swamp communities. In time, if EAB is not contained, black ash communities could be severely impacted throughout the state with drastic changes to their structure and function.

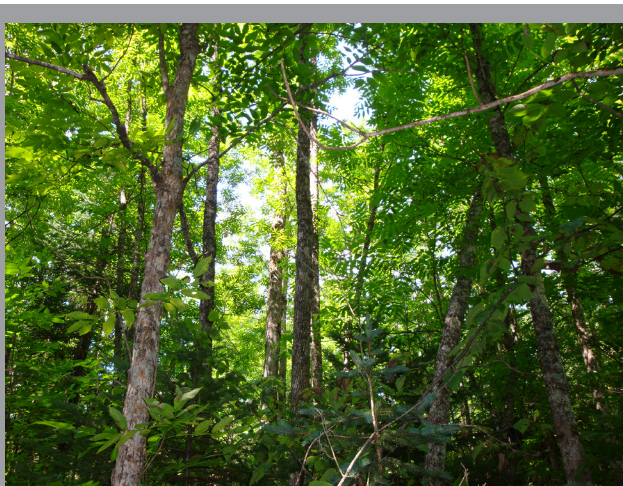


Photo by Joshua G. Cohen

A critical research need is to ascertain the possibility of preventing emerald ash borer from impacting northern hardwood swamps.

Research Needs: Further research is needed on the remaining, undisturbed black ash-dominated northern hardwood swamp ecosystems. Before emerald ash borer spreads to these systems, surveys and sampling are needed to better quantify community composition and dynamics. In addition, age structure of these ecosystems in Michigan is not well known. Improved understanding is needed of the ecological context of naturally occurring northern hardwood swamps in relation to the influence and impact of invasive species. A crucial research need is to determine if it is possible to prevent EAB from radically altering black ash-dominated forests. Using hindsight gained from assessing past epidemics, researchers can formulate strategies for prevention and hypothesize about the impacts that future outbreaks may have on forest structure and composition. Research is also needed to further characterize northern hardwood swamp and other lowland, hardwood community types. Intensive sampling of northern hardwood swamp, southern hardwood swamp, and hardwood-conifer swamp communities is needed to refine the ecological classification of these deciduous swamp types and better separate these communities in terms of their structure, species composition, and landscape context. Additional research questions include the examination how wetland ecosystems of the Great Lakes region have been and continue to be affected by fluctuations in populations of beaver and fragmentation of the surrounding uplands.

Similar Communities: southern hardwood swamp, hardwood-conifer swamp, northern shrub thicket, floodplain forest

Other Classifications:

Michigan Natural Features Inventory Circa 1800 Vegetation (MNFI): Black Ash Swamp (4121), Deciduous Lowland (412)

Michigan Department of Natural Resources (MDNR): E – Swamp Hardwoods

The Nature Conservancy U.S. National Vegetation Classification and International Classification of Ecological Communities (Faber-Langendoen 2001, NatureServe 2006): CODE; ALLIANCE; ASSOCIATION; COMMON NAME

I.B.2.N.g; *Fraxinus nigra – Acer rubrum* Saturated Forest Alliance; *Fraxinus nigra* - Mixed Hardwoods -Conifers / *Cornus sericea / Carex spp.* Forest; Black Ash - Mixed Hardwood Swamp

Related Abstracts: Cooper's hawk, northern goshawk, Blanding's turtle, eastern massasauga, eastern box turtle, great blue heron rookery, hardwood-conifer swamp, floodplain forest, northern shrub thicket

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Photo by Joshua G. Cohen

Intermittent stream bed meandering through a northern hardwood swamp with mucky soils.

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