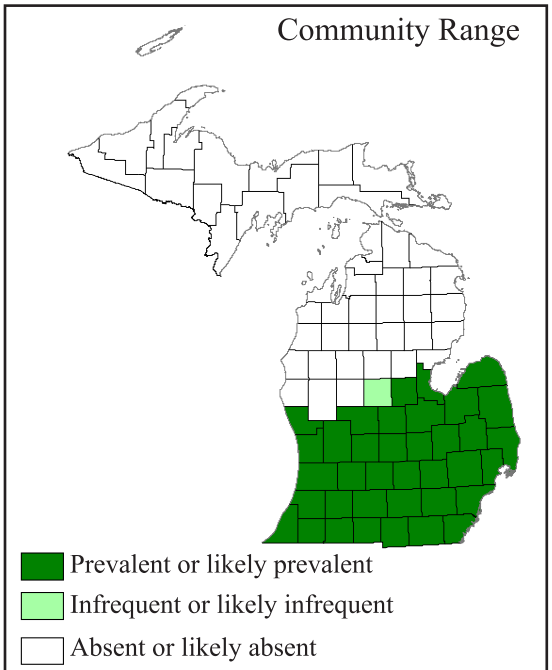
Southern Hardwood Swamp — Community Abstract

Photo by Michael A. Kost



Overview: Southern hardwood swamp is a minerotrophic forested wetland dominated by variety of lowland hardwoods that occurs on poorly drained mineral or organic soils throughout southern Lower Michigan. The community develops on a variety of landforms, including glacial lakeplains, outwash channels, and outwash plains, and in depressions on ground moraines, end moraines, and ice-contact features. Fluctuating water levels and windthrow are important natural processes that influence community structure, species composition, and succession.

Global and State Rank: G4?/S3

Range: Forested wetlands dominated by a mixture of lowland hardwoods occur throughout the eastern United States and adjacent Canadian provinces, including the Great Lakes states and provinces of Minnesota, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania, and Ontario (Faber-Langendoen 2001, NatureServe 2008). Canopy dominance and species composition vary regionally. In Michigan, southern hardwood swamp occurs primarily south of the climatic tension zone in the southern Lower Peninsula, where it is prevalent or was prevalent historically in all sub-subsections (Kost et al. 2007). Currently, high-quality southern hardwood swamps have been documented from Subsections VI.1 (Washtenaw), VI.2 (Kalamazoo Interlobate), VI.3 (Allegan), VI.4 (Ionia), and VI.6 (Saginaw Bay Lake Plain) (Albert 1995, Albert et al. 2008, MNFI 2009). The community also likely occurs in subsection VI.5 (Huron), but no occurrences have been documented. Historic, large-scale ditching and draining in this subsection have significantly altered natural hydrology that historically supported southern hardwood swamp and other wetland communities.

Rank Justification: Historical acreage of southern hardwood swamp in Michigan is difficult to determine. Analysis of General Land Office (GLO) survey notes in Michigan reveals that lowland forest dominated by hardwoods covered approximately 1,600,000 ac (650,000 ha) circa 1800 (Comer et al. 1995a). The majority of this acreage (1,400,000 ac or 570,000 ha) occurred in southern Lower Michigan, where the dominant lowland forest cover types were mixed hardwoods (1,200,000 ac or 490,000 ha), black ash (190,000 ac or 77,000 ha), elm (13,000 ac or 5,300 ha), and silver maple – red maple (10,000 ac or 4,000 ha). The majority of this acreage was associated with stream and river floodplains, and is classified as floodplain forest (Kost et al. 2007). Non-floodplain lowland hardwoods were concentrated on the southeastern Lower Michigan lakeplain, with extensive stands occurring in Wayne, Lenawee, Saginaw, St. Clair, Huron, Monroe, Sanilac, and Macomb Counties (Comer et al. 1995a). Elsewhere in southern Lower Michigan, southern hardwood swamp generally occurred in smaller stands in association with other wetland communities (e.g., rich tamarack swamp) or in isolated depressions

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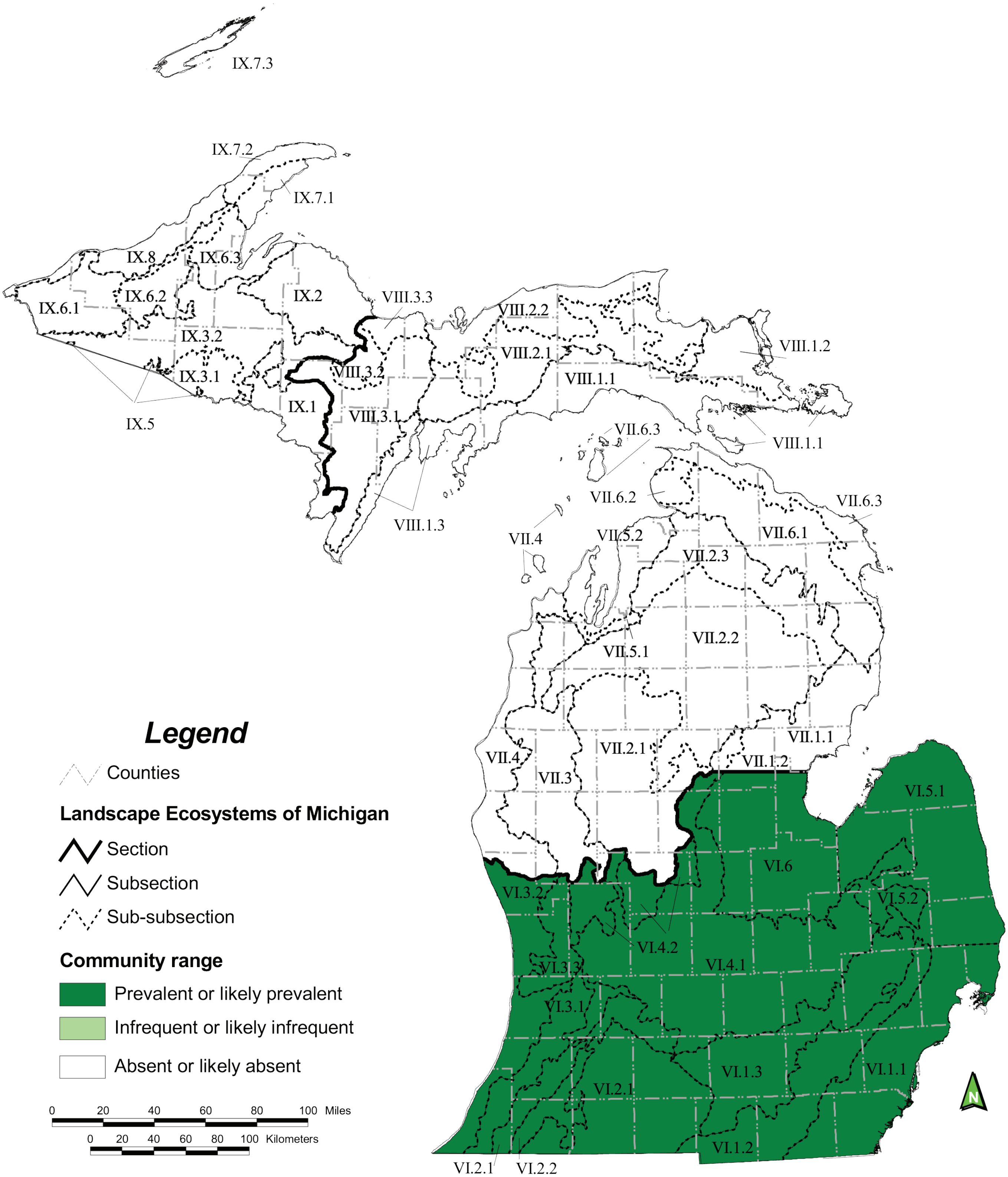

Ecoregional map of Michigan (Albert 1995) depicting distribution of southern hardwood swamp (Albert et al. 2008) embedded within upland matrix communities (e.g., mesic southern forest).

Following European settlement, southern hardwood swamp was significantly impacted by logging and conversion for agriculture and urban development. Extensive drainage networks, particularly on glacial lakeplain in southeastern Lower Michigan, lowered regional water tables and allowed extensive agricultural development, reducing southern hardwood swamp to small, isolated woodlots (Knopp 1999). Despite a significant loss of wetland acreage in Michigan since the early 1800s (Dahl 1990), recent estimates of landcover in the 1970s (MDNR 1978) and circa 2000 (MDNR 2001) indicate lowland hardwoods remain common, and appear to have increased from 1,600,000 ac circa 1800 to 2,300,000 ac (930,000 ha) in the 1970s and 1,800,000 ac (730,000 ha) circa 2000. This apparent expansion of lowland hardwoods may in part reflect the conversion of conifer-dominated lowland forests to hardwood stands following logging and hydrologic alteration (Comer 1996). The percentage of lowland hardwood acreage characterized by southern hardwood swamp at the present is unknown.

Currently, 15 occurrences of southern hardwood swamp are tracked in the MNFI statewide database, totaling approximately 1,350 ac (550 ha) (MNFI 2009). Only seven of these occurrences are estimated to be of excellent (A-rank) or good (B-rank) viability. Many sites show evidence of hydrologic disturbance, including ditching and the conversion of adjacent uplands for agricultural or residential uses. Additional disturbances that have reduced viability of southern hardwood swamp over the past century include the introduction of exotic pests and pathogens (e.g., elm blight and emerald ash borer) and excessive deer herbivory (Barnes 1976, Rooney and Waller 2003, McCullough and Katovich 2004, Roberts 2004).

Physiographic Context: The Michigan range of southern hardwood swamp is restricted to southern Lower Michigan, south of the climatic tension zone. This region has a warm, temperate, rainy to cool, snow-forest climate with hot summers and no dry season. The daily maximum temperature in July ranges from 29° to 32° C (85° to 90° F), the daily minimum temperature in January ranges from -9° to -4° C (15° to 25° F), and the annual average temperature ranges from 8.2° to 9.4° C (47° to 49° F) (Albert et al. 1986, Barnes 1991). The mean number of freeze-free days is between 146 and 163, and the average number of days per year with snow cover of 2.5 cm (1 in) or more is between 10 and 60. The mean annual total precipitation for southern Lower Michigan is 82 cm (32 in).

Southern hardwood swamp occurs on a variety of landforms, including poorly drained clay and sand lakeplains, poorly drained outwash channels and outwash plains, and depressions on ground moraines, end moraines, and ice-contact features (Kost et al. 2007). Historically, the most extensive occurrences were found on poorly drained clay and sand lakeplain in southeastern Lower Michigan, where the presence of impermeable subsurface layers impeded drainage and caused seasonal ponding (Albert et al. 1986, Comer et al. 1995b). Elsewhere in southern Lower Michigan, southern hardwood swamp occurred in smaller stands in a variety of hydrologic settings, including surface water depressions, groundwater depressions, groundwater slopes, and surface water slopes (Novitzki 1979).

Southern hardwood swamp occurs on both mineral and organic soils. Where the water table drops well below the ground surface, the organic matter that accumulates on the forest floor decomposes. Southern hardwood swamps on these seasonally desiccated mineral soils occur primarily on clay and sand lakeplain (Knopp 1999, Lee 2005). Where permanently saturated, anaerobic conditions occur, such as in groundwater-fed depressions, sapric peat (muck) accumulates over the mineral soil layers. Southern hardwood swamps in kettle depressions on moraines and ice-contact features are often characterized by these muck soils (Lee 2005). Both mineral and organic substrates are generally circumneutral (pH= 6.6-7.3), but can range from very strongly acid (pH= 4.5-5.0) in leached, sandy soils isolated from contact with lime-rich parent material to strongly alkaline (pH= 8.5-9.0) where marl occurs near the surface (Knopp 1999, Lee 2005, MNFI 2009). Vegetation, depth to the water table, and groundwater movement all influence substrate chemistry.

Southern hardwood swamp is associated with a variety of natural community types. Adjacent uplands support either fire-dependent systems, such as oak barrens, oak openings, dry southern forest, and dry-mesic southern forest, or systems characterized by low fire frequency, such as mesic southern forest. A variety of open or forested wetland communities occur in adjacent lowlands, including rich tamarack swamp, hardwood-conifer swamp, southern wet meadow, wet prairie, wet-mesic prairie, prairie fen, bog, interdunal wetland, and southern shrub-carr. On glacial lakeplain, southern hardwood swamp was associated with extensive tracts of wet-mesic flatwoods, lakeplain oak openings, lakeplain wet prairie, lakeplain wet-mesic prairie, and emergent marsh circa 1800 (Comer et al. 1995a, 1995b, Kost et al. 2007).

Natural Processes: The primary natural processes influencing community structure, species composition, and succession of southern hardwood swamp are surface water and groundwater dynamics and small-scale windthrow. Southern hardwood swamp occurs in several hydrologic settings, including surface water depressions, surface water slopes, groundwater depressions, and groundwater slopes (Novitzki 1979, Brinson 1993). Surface water depressions and surface water slopes occur above the water table, and receive most of their water from overland flow and precipitation (rain and snow), as opposed to groundwater inputs. Surface water depressions are characteristic of southern hardwood swamps on glacial lakeplains, where impermeable subsurface clay layers impede internal drainage and allow water to pool seasonally. Species composition in these systems is regulated by inundation in spring and early summer followed by soil desiccation in late summer and fall, when the water levels drop well below the soil surface (Bryant 1963, Lee 2005). Surface water depressions are characterized by plant species that are adapted to flood-drought cycles, such as silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*). These species exhibit a number of adaptations to inundation, rapid changes in water level, and low oxygen availability during the growing season, including hypertrophied lenticels (gas-exchanging pores), shallow roots, adventitious roots, a lack of seed dormancy, rapid growth, and stomatal closure during periods of root submergence (Hosner 1960, Hosner and Boyce 1962, Kozlowski and Pallardy 2002, Barnes and Wagner 2004, Lee 2005, Weber et al. 2007). Species that are intolerant of flood-drought cycles are rare or absent in these wetlands (Lee 2005). Southern hardwood swamps associated with surface water depressions are often characterized by sparse shrub and ground layers, with most species occurring on hummocks above the zone of inundation (Lee 2005).

Surface water slope wetlands are similar to surface water depression wetlands, but occur on a slope that allows outflow of precipitation and runoff. These systems usually occur adjacent to lakes, streams, and other water bodies. Seasonal fluctuation of the water level in these water bodies causes periods of inundation in the adjacent wetland, which is otherwise perched above the water table (Novitzki 1979, Brinson 1993). Southern hardwood swamps that develop on surface water slopes (e.g., along a lakeshore) are characterized by species similar to those found in floodplain forests and in surface water depressions on glacial lakeplain (Knopp 1999, Barnes and Wagner 2004, Tepley et al. 2004, Lee 2005).


Photo by Michael A. Kost

Inundated soil conditions follow snow melt and rain in early spring (above). Water levels recede during summer, when remaining surface water is obscured by vegetation (below).


Photo by Michael A. Kost

In contrast to surface water depression wetlands, groundwater depression wetlands intercept the water table and receive groundwater inflow, in addition to surface runoff and precipitation (Novitzki 1979, Brinson 1993). Groundwater inflow creates saturated conditions throughout the year, fostering the accumulation of muck (sapric peat). Like surface water depressions, groundwater depressions may be seasonally inundated, but do not generally experience flood-drought cycles. Southern hardwood swamps on organic soils that are inundated during a portion of the growing season are characterized by flood-tolerant tree species such as silver maple and green ash. In contrast, sites on organic soils that remain wet at the surface due to groundwater percolation but do not experience growing season inundation are often dominated by flood-intolerant wetland trees, shrubs, and herbs, including red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and yellow birch (*Betula alleghaniensis*) (Hosner 1960, Tardif et al. 1994, Barnes and Wagner 2004, Lee 2005). The percentage of organic matter in the soil has a significant impact on the species composition of the ground layer (Dunn and Stearns 1987a, 1987b).

Groundwater slope wetlands are associated with hydrologic breaks, such as where outwash channels bisect moraines (Novitzki 1979, Brinson 1993, Amon et al. 2002). These hydrologic breaks are often associated with groundwater seepages that are rich in calcium and magnesium carbonates and have high pH values due to movement of groundwater through base-rich glacial deposits. Most seeps have relatively stable hydrology due to steady inputs of groundwater throughout the year and their occurrence at the bases of slopes that promote surface water drainage (Amon et al. 2002, Bedford and Godwin 2003). Seeps range from non-forested to thinly forested, and are characterized by skunk-cabbage (*Symplocarpus foetidus*) and shrubs such as spicebush (*Lindera benzoin*) and musclewood (*Carpinus caroliniana*) (NatureServe 2008).

Small-scale windthrow is a characteristic disturbance in southern hardwood swamp. Southern hardwood swamp often occurs on structurally weak organic soils where trees exhibit shallow rooting due to anaerobic conditions, making them particularly susceptible to windthrow. On mineral soils with seasonally low water tables, canopy trees are less susceptible to windthrow due to greater rooting depth (Lee 2005). Tipped and uprooted trees create pit-and-mound topography and small-scale gradients in soil moisture and chemistry, providing suitable microhabitats for a diversity of plant species (Christensen et al. 1959, Paratley and Fahey 1986, Vivian-Smith 1997, McGee 2001, Anderson and Leopold 2002). In addition, the canopy gaps created by small-scale windthrow allow light to penetrate to the forest floor, creating conditions suitable for light-dependent tree seedlings and saplings, shrubs, and herbs.

Photo by Michael A. Kost

Shallowly rooted trees growing on structurally weak organic soils are susceptible to windthrow, which creates canopy gaps and the characteristic pit-and-mound topography of the soil surface.

Large-scale windthrow is an infrequent disturbance in southern hardwood swamp, although estimates of return interval are not available for Michigan. In Minnesota, wet ash swamps, dominated by black ash, basswood, sugar maple, and American elm, were impacted by catastrophic windthrow at an estimated 630-year return interval (MNDNR 2005). Selective windthrow events associated with partial canopy loss occurred at an estimated 140-year return interval. Periodically flooded riparian forests had an estimated catastrophic windthrow return interval of 310 years (MNDNR 2005). Variation in frequency of stand-replacing windthrow is likely mediated by landscape position, identity of adjacent plant communities, and other site-specific factors. Large-scale windthrow may have occurred with greatest frequency on the expansive glacial lakeplain in southeastern Lower Michigan, where GLO surveyors noted extensive areas of wind-thrown trees in St. Clair and Macomb counties (Comer et al. 1995b).

Beaver (*Castor canadensis*) activity can also shape southern hardwood swamp structure and direct successional pathways. Southern hardwood swamps occurring in the immediate vicinity of streams and lakes are particularly susceptible to flood-kill and conversion to open wetland types. Beaver flooding results in the death of canopy trees and the development of shrub-, graminoid-, and herb-dominated communities that may persist for several decades (Terwilliger and Pastor 1999). Graminoid-covered substrates favor the establishment of red maple, black ash, and other hardwood species, although conversion of beaver-impacted open wetlands and ponds back to forested wetlands may be a very slow process (Terwilliger and Pastor 1999, Cunningham et al. 2006). Beaver increase plant species richness at the landscape scale by creating novel habitat patches with variability in light availability, soil moisture, and nutrient availability (Wright et al. 2002).

The role of fire in southern hardwood swamp is unclear. Fire rotation estimates for northern Michigan forested wetlands range from 120 years for wetlands adjacent to fire-prone uplands (generally, oak- and conifer-dominated systems) to 684 years for wetlands adjacent to northern hardwood–dominated uplands (Cleland et al. 2004). These wetlands were dominated by lowland conifers, including tamarack (*Larix laricina*), hemlock (*Tsuga canadensis*), black spruce (*Picea mariana*), and balsam fir (*Abies balsamea*). Whitney (1986) estimated a return interval of 3,000 years for destructive crown fires in conifer-dominated swamps in north central Lower Michigan. No fires were noted in Public Land Survey records for southern wet ash swamps in Minnesota, but surface fires may have occurred in floodplain systems (MNDNR 2005). Southern hardwood swamps associated with fire-dependent systems (e.g., lakeplain oak openings) likely burned more frequently than occurrences adjacent to or surrounded by systems that experienced infrequent fires (e.g., mesic southern forest). Occurrences on the southeastern Lower Michigan lakeplain, where fire-dependent upland and wetland systems occurred in close association on seasonally droughty soils, may have been impacted by fire with greater frequency than isolated swamps on permanently saturated peat soils.

Vegetation Description: Southern hardwood swamp is characterized by a variety of lowland hardwoods. Conifers are rare to absent. Nearly 350 vascular plant species have been documented from southern hardwood swamps in Michigan. The species listed below are derived from southern hardwood swamps surveyed by MNFI, Kost (2001a), Lee (2005), Yocum (2006), and NatureServe (2008). Additional sources include Curtis (1959) and Bryant (1963).

Tree species composition and canopy closure are regulated by hydroperiod, soil characteristics, and other site-specific factors (e.g., natural disturbances). Relatively few canopy species may occur in a single stand (Lee 2005). Characteristic overstory species of southern hardwood swamp include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), black ash (*Fraxinus nigra*), green ash (*F. pennsylvanica*), and yellow birch (*Betula alleghaniensis*). American elm (*Ulmus americana*) was an important canopy tree prior to the introduction and spread of elm blight, but is now primarily an understory species, where it associates with saplings of the canopy species (Barnes 1976). Silver maple and green ash tend to dominate stands characterized by significant fluctuations in water level (i.e., flood-drought cycles), periods of inundation during the growing season, and mineral soils underlain by clay lenses. American elm and cottonwood (*Populus deltoides*) are additional species typical of sites that experience flood-drought cycles (Barnes and Wagner 2004). In sites that experience relatively little fluctuation in water level, infrequent periods of inundation, and saturated organic soils, red maple and black ash tend to dominate the canopy (Lee 2005). Canopy associates of the dominant maples and ashes include sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), hackberry (*Celtis occidentalis*), beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), tamarack (*Larix laricina*), tulip-tree (*Liriodendron tulipifera*), black gum (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), black cherry (*Prunus serotina*), swamp white oak (*Quercus bicolor*), bur oak (*Q. macrocarpa*), pin oak (*Q. palustris*), red oak (*Q. rubra*), sassafras (*Sassafras albidum*), and basswood (*Tilia americana*).

Shrub layer closure depends on several factors, including canopy closure and hydroperiod. Southern hardwood swamps associated with surface water depressions often contain a sparse shrub layer, with most species occurring on hummocks above the zone of inundation (Bryant 1963, Lee 2005). In contrast, the shrub layer in groundwater-influenced sites and sites that exhibit a patchy or open canopy may be dense and species-rich. Characteristic tall shrubs include black chokeberry (*Aronia prunifolia*), musclewood (*Carpinus caroliniana*), gray dogwood (*Cornus foemina*), hazelnut (*Corylus americana*), Michigan holly (*Ilex verticillata*), spicebush (*Lindera benzoin*), choke cherry (*Prunus virginiana*), swamp rose (*Rosa palustris*), elderberry (*Sambucus canadensis*), poison sumac (*Toxicodendron vernix*), highbush blueberry (*Vaccinium corymbosum*), nannyberry (*Viburnum lentago*), and prickly ash (*Zanthoxylum americanum*). Black chokeberry, swamp rose, poison sumac, and highbush blueberry are concentrated in groundwater-influenced sites. Buttonbush (*Cephalanthus occidentalis*) occurs in vernal pools, inundated shrub swamps, or wet openings within the forest. Frequently encountered low shrubs include running strawberry bush (*Euonymus obovata*), wild black currant (*Ribes americanum*), prickly gooseberry (*R. cynosbati*), common blackberry (*Rubus allegheniensis*), and wild red raspberry (*R. strigosus*).

Photo by Michael A. Kost

The shallow, buttressed roots of wetland trees and a dense ground layer of skunk-cabbage (*Symplocarpus foetidus*) are characteristic of southern hardwood swamp on organic soils.

Density and richness of ground layer species is affected by canopy and subcanopy closure, hydroperiod, and substrate type (Bryant 1963, NatureServe 2008). Sites that experience flood-drought cycles support lower ground cover and fewer species than sites with more stable hydrology (Bryant 1963, Kost 2001a, Lee 2005). Characteristic ground layer species of southern hardwood swamp include wild sarsaparilla (*Aralia nudicaulis*), jack-in-the-pulpit (*Arisaema triphyllum*), side-flowering aster (*Aster lateriflorus*), lady fern (*Athyrium filix-femina*), false nettle (*Boehmeria cylindrica*), marsh-marigold (*Caltha palustris*), sedge (*Carex blanda*), sedge (*C. bromoides*), sedge (*C. gracillima*), sedge (*C. lacustris*), sedge (*C. intumescens*), sedge (*C. leptalea*), sedge (*C. lupulina*), sedge (*C. stipata*), sedge (*C. stricta*), turtlehead (*Chelone glabra*), water hemlock (*Cicuta maculata*), enchanter's-nightshade (*Circaea lutetiana*), honewort (*Cryptotaenia canadensis*), spinulose woodfern (*Dryopteris carthusiana*), fragrant bedstraw (*Galium triflorum*), white avens (*Geum canadense*), fowl manna grass (*Glyceria striata*), spotted touch-me-not (*Impatiens capensis*), southern blue flag (*Iris virginica*), wood nettle (*Laportea canadensis*), northern bugle weed (*Lycopus uniflorus*), Canada mayflower (*Maianthemum canadense*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), clearweed (*Pilea pumila*), downy Solomon seal (*Polygonatum pubescens*), dwarf raspberry (*Rubus pubescens*), black snakeroot (*Sanicula gregaria*), mad-dog skullcap (*Scutellaria lateriflora*), rough goldenrod (*Solidago rugosa*), skunk-cabbage (*Symplocarpus foetidus*), and marsh fern (*Thelypteris palustris*). Twining herbs and woody vines may be abundant. Frequently occurring species include hog peanut (*Amphicarpaea bracteata*), Virginia creeper (*Parthenocissus quinquefolia*), poison-ivy (*Toxicodendron radicans*), and riverbank grape (*Vitis riparia*).

The bryophyte community of southern hardwood swamp is not well-documented. Sites on organic soils successionally related to rich tamarack swamp may contain some of the same species as that community or rich conifer swamp (see Kost 2002).

Noteworthy Animal Species: Southern hardwood swamp provides critical habitat for a variety of animal species. The community provides important breeding and foraging habitat for several amphibians, including striped chorus frog (*Pseudacris triseriata*), northern spring peeper (*P. c. crucifer*), eastern gray tree frog (*Hyla versicolor*), Cope's gray treefrog (*H. chrysoscelis*), green frog (*Rana clamitans melanota*), and wood frog (*R. sylvatica*). Several species of salamander may also occur in southern hardwood swamp. Amphibian diversity may be highest in sites that contain or occur in proximity to permanent bodies of water that serve as breeding habitat for several species. The community also provides important habitat for reptiles, including state-listed species, such as spotted turtle (*Clemmys guttata*), Kirtland's snake (*Clonophis kirtlandii*), Blanding's turtle (*Emydoidea blandingii*), and copperbelly watersnake (*Nerodia erythrogaster neglecta*).

Great blue heron (*Ardea herodias*) utilizes southern hardwood swamps and other forested wetlands as rookery sites. Red-shouldered hawk (*Buteo lineatus*), barred owl (*Strix varia*) and pileated woodpecker (*Dryocopus pileatus*) also nest in southern hardwood swamp, where they utilize large, mature trees and snags. Pileated woodpecker, red-bellied woodpecker (*Melanerpes carolinus*), and downy woodpecker (*Picoides pubescens*) forage on snags for wood-eating insects (Brewer et al. 1991). Other birds that may be encountered with high frequency in southern hardwood swamp include white-breasted nuthatch (*Sitta carolinensis*), wood thrush (*Hylocichla mustelina*), eastern wood-pewee (*Contopus virens*), rose-breasted grosbeak (*Pheucticus ludovicianus*), and black-capped chickadee (*Parus atricapillus*) (Brewer et al. 1991). Among mammals that utilize southern hardwood swamp, beaver likely have the greatest influence on community structure and succession. Beaver herbivory and flooding can convert southern hardwood swamp to open wetlands such as emergent marsh and southern wet meadow. Beaver floodings vary in depth and duration of inundation, and provide important breeding habitat for several amphibians (Cunningham et al. 2006). Beaver activity is also associated with increased herbaceous plant species richness in riparian zones (Wright et al. 2002), and may have a similar impact on southern hardwood swamp by creating a mosaic of open and forested wetland patches.

Perhaps the most noteworthy insect that inhabits southern hardwood swamp is a non-native beetle, the emerald ash borer (*Agrilus planipennis*). This beetle, native to Asia, was first noted in North America in 2002 in southeastern Lower Michigan, and has since been discovered elsewhere in Michigan and in Minnesota, Wisconsin, Missouri, Illinois, Indiana, Ohio, Pennsylvania, West Virginia, Maryland, Virginia, Ontario, and Quebec (Haack et al. 2002, USDA Forest Service et al. 2009). The larvae of this species feed on cambial tissue in the inner bark of ash trees, causing mortality of the host tree within three years (Haack et al. 2002). All species of ash in Michigan are considered hosts or potential hosts. Emerald ash borer has caused mortality of millions of ash trees since its introduction to southeastern Lower Michigan in the 1990s (McCullough and Katovich 2004, MacFarlane and Meyer 2005). This invasive beetle is likely to have a significant impact on southern hardwood swamps that contain large numbers of black and/or green ash. Structure and species composition of southern hardwood swamp has already been altered by elm blight, a fungal pathogen dispersed by native elm bark beetles that has caused widespread mortality of mature American elms that were once characteristic of the community (Barnes 1976). Emerald ash borer is likely to further alter community structure and composition of southern hardwood swamp by eliminating ash species.

Photo by Joshua G. Cohen

The death of ash trees (*Fraxinus* spp.) due to infestation by the emerald ash borer (*Agrilus planipennis*) creates large canopy gaps and an increase in the water table, leading to the conversion of southern hardwood swamp to herb- and shrub-dominated wetland communities.

Rare Plants Associated with Southern Hardwood Swamp (E, Endangered; T, Threatened; SC, species of special concern; X, presumed extirpated from Michigan).

Scientific Name	Common Name	State Status
Berula erecta	cut-leaved water-parsnip	T
Betula populifolia	gray birch	SC
Betula murrayana	Murray birch	SC
Carex lupuliformis	false hop sedge	T
Carex seorsa	sedge	T
Carex straminea	straw sedge	E
Cuscuta glomerata	rope dodder	SC

Scientific Name	Common Name	State Status
Cuscuta polygonorum	knotweed dodder	SC
Dichanthelium microcarpon	small-fruited panic-grass	SC
Dryopteris celsa	small log fern	T
Euonymus atropurpurea	wahoo	SC
Eupatorium fistulosum	hollow-stemmed joe-pye-weed	T
Fraxinus profunda	pumpkin ash	T
Galearis spectabilis	showy orchis	T
Hybanthus concolor	green violet	SC
Hydrastis canadensis	goldenseal	T
Isotria medeoloides	smaller whorled pogonia	X
Isotria verticillata	whorled pogonia	T
Lysimachia hybrida	swamp candles	X
Morus rubra	red mulberry	T
Panax quinquefolius	ginseng	T
Plantago cordata	heart-leaved plantain	E
Poa paludigena	bog bluegrass	T
Polymnia uvedalia	yellow-flowered leafcup	T
Populus heterophylla	swamp or black cottonwood	E
Rudbeckia subtomentosa	sweet coneflower	X
Trillium undulatum	painted trillium	E
Valerianella umbilicata	corn-salad	T
Viburnum prunifolium	black haw	SC
Woodwardia areolata	netted chain-fern	X

Rare Animals Associated with Southern Hardwood Swamp (E, Endangered; T, Threatened; SC, species of special concern; LE, Federally Endangered; LT, Federally Threatened).

Scientific Name	Common Name	State Status
Acronicta falcula	Corylus dagger moth	SC
Ambystoma opacum	marbled salamander	E
Ambystoma texanum	smallmouth salamander	E
Ardea herodias rookery	great blue heron rookery	*
Basilodes pepita	gold moth	SC
Buteo lineatus	red-shouldered hawk	T
Catocala illecta	Magdalen underwing	SC
Clemmys guttata	spotted turtle	T
Clonophis kirtlandii	Kirtland's snake	E
Emydoidea blandingii	Blanding's turtle	SC
Euphyes dukesi	Dukes' skipper	T
Haliaeetus leucocephalus	bald eagle	SC
Heterocampa subrotata	small heterocampa	SC
Heteropacha rileyana	Riley's lappet moth	SC
Myotis sodalis	Indiana bat	E; LE
Nerodia erythrogaster neglecta	copperbelly watersnake	E; LT**
Nycticorax nycticorax	black-crowned night-heron	SC
Pandion haliaetus	osprey	SC
Papaipema cerina	golden borer	SC
Papaipema speciosissima	regal fern borer	SC
Protonotaria citrea	prothonotary warbler	SC
Seiurus motacilla	Louisiana waterthrush	T
Sistrurus c. catenatus	eastern massasauga	SC
Terrapene c. carolina	eastern box turtle	SC

*Protected by the Migratory Bird Treaty Act of 1918.
**Populations of this species in the Great Lakes region (Michigan, northern Indiana, and northern Ohio) are federally listed; populations in Illinois, southern Indiana, Kentucky, and Tennessee are not listed (NatureServe 2008).

Conservation and Biodiversity Management: Conservation and management of southern hardwood swamp should focus on the following key areas: protection of groundwater and surface water hydrology, reduction of landscape fragmentation, retention of coarse woody debris, reduction of deer browse pressure, and the identification, removal, and monitoring of invasive plants, animals, and pathogens.

Protection of groundwater and surface water hydrology is critical to maintaining the integrity of southern hardwood swamp. Hydrologic disturbances, including road construction and ditching, cause peat subsidence and decomposition and alter water tables by draining water or blocking its flow (Bradof 1992, Hillman 1997, Amon et al. 2002). Urban development also disrupts hydrology and degrades water quality, but site-specific hydrologic effects of urbanization may be unpredictable (Ehrenfeld and Schneider 1993). Natural hydrologic disturbances, including flooding associated with beaver dams, also profoundly impact southern hardwood swamp. Several measures can be taken to protect the integrity of southern hardwood swamp hydrology. A relatively wide upland buffer zone can be established to prevent surface water run-off and protect groundwater seepage zones. Construction of new ditches should be avoided, as should new road construction and stream maintenance projects (e.g., dredging, straightening, and removal of fallen wood). Trapping and removal of beaver may be necessary in isolated nature preserves where the maintenance of southern hardwood swamp is a conservation priority, and where flooding is likely to eliminate species of conservation concern.

Landscape fragmentation has reduced many southern hardwood swamp occurrences to isolated stands surrounded by agriculture or urban development, particularly those remnants occurring in the heavily developed lakeplain region of southeastern Lower Michigan (Knopp 1999, Lee 2005). Fragmentation fosters the introduction of non-native competitors, predators, diseases, and parasites, reduces or eliminates dispersal corridors, disrupts ecosystem processes, and removes key resources (Marzluff and Ewing 2001). The impacts of fragmentation can be reduced by establishing habitat linkages among remnant stands and managing the surrounding landscape to more closely approximate conditions within the isolated stands (Marzluff and Ewing 2001). Research on wetland birds suggests that many species favor wetland tracts in a matrix of upland forest over isolated wetland tracts, regardless of size (Riffell et al. 2006). Though restoration of matrix forest with wetland inclusions may not be possible in particularly urbanized landscapes, conservation efforts for isolated southern hardwood swamp tracts in agricultural landscapes should focus on improving the suitability of adjacent land for native species.

Retention of large-diameter rotting logs and dead standing wood in southern hardwood swamps is important for the preservation of structural diversity and to provide suitable substrates for the germination and establishment of several plant species, including yellow birch and numerous ground layer herbs (Paratley and Fahey 1986, McGee 2001, Anderson and Leopold 2002). Downed and standing dead wood also provides habitat for decomposers, invertebrates, and small mammals (Marzluff and Ewing 2001). In addition to retention of existing downed and dead wood, maintenance of mature and over-mature canopy trees ensures continued recruitment of coarse woody debris.

High white-tailed deer (*Odocoileus virginianus*) density has led to significant browse pressure on tree seedlings, shrubs, and herbs throughout much of the eastern United States and adjacent Canadian provinces, altering structure and composition of all forest strata and producing a cascade of effects, including detrimental impacts to pollinators of affected plant species (McShea and Rappole 1992, Balgooyen and Waller 1995, Waller and Alverson 1997, Augustine and Frelich 1998, Rooney and Waller 2003, Kraft et al. 2004). Reduction of regional deer densities will promote recovery of tree seedling, shrub, and herb populations. In areas where reducing the number of deer is not feasible, or in small, isolated stands of high-quality southern hardwood swamp, deer exclosures should be considered in order to promote tree regeneration and recruitment and recovery of impacted shrub and ground layer species.

Invasive plant species are a significant threat to southern hardwood swamp, especially in fragmented landscapes. Species of particular concern include garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculata*), autumn olive (*Elaeagnus umbellata*), honeysuckles (including *Lonicera maackii* and *L. tatarica*), reed canary grass (*Phalaris arundinacea*), reed (*Phragmites australis*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*R. frangula*), and multiflora rose (*Rosa multiflora*) (Kost et al. 2007). Fragmentation and isolation of southern hardwood swamp occurrences by residential, commercial, and industrial development threaten this natural community type by restricting dispersal of native species and increasing the likelihood of invasion by non-native trees, shrubs, and herbs. Hydrologic disturbances, including flooding and nutrient loading via surface water run-off, facilitate invasion of otherwise intact systems by non-native plants (Zedler and Kercher 2004). Monitoring and removal of invasive species should focus on those species which threaten to alter community composition, structure, and function (e.g., glossy buckthorn and multiflora rose). Management activities should avoid soil and hydrologic disturbances that assist the spread of invasive plant species. Land managers should consider the use of prescribed fire to control invasive plant species in fire-dependent uplands (e.g., dry-mesic southern forest, oak barrens) associated with southern hardwood swamp, and should allow these fires to spread into the wetland areas. However, prescribed fires should not be forced into southern hardwood swamps that are resistant to burning due to inundation and/or poor fuels.

Control of emerald ash borer is currently limited to prevention of human introduction of this species to new locations through transport of infected firewood or living trees. Research on parasitoids and fungal pathogens that may serve as potential biological controls of this species in North America is ongoing (Liu et al. 2003, Liu and Bauer 2006). All occurrences of southern hardwood swamp with a significant component of ash species are vulnerable to emerald ash borer, and the lack of a successful management strategy at this time emphasizes the importance of preventing its introduction to new sites. Evidence from previous die-off of American elm suggests shrub density may increase following mortality of canopy trees (Dunn 1986).

Research Needs: Relatively few studies have been conducted on southern hardwood swamp in Michigan and elsewhere in the northeastern United States and Canada. The majority of research on lowland forests in this region has been conducted on conifer-dominated peatlands (e.g., rich conifer swamp, poor conifer swamp) and hardwood-dominated floodplain forests. A systematic survey for southern hardwood swamp in Michigan, including the collection of plot data, is necessary to assess the statewide and ecoregional conservation status of this natural community type, and to determine if any variants warrant splitting as separate natural community types (e.g., forested and non-forested seeps).

Additional research on the edaphic characteristics and successional pathways associated with southern hardwood swamp is warranted. A more thorough understanding of the processes that lead to the conversion of open wetlands and rich tamarack swamp to southern hardwood swamp will assist land managers interested in maintaining heterogeneous wetland complexes. Tamarack is susceptible to a number of disturbances, including prolonged flooding, fires, insect outbreaks, and blowdown (Sytsma and Pippen 1982, Barnes and Wagner 2004). Southern hardwood swamp appears to develop from rich tamarack swamp in the absence of major disturbances that allow continued colonization by light-dependent tamarack seedlings and establishment of saplings (Sampson 1930, Sytsma and Pippen 1982, Kost 2001a). This conversion may be hastened or mimicked by anthropogenic disturbances. For example, logging, soil disturbance, fire suppression, and road and dam construction have been suggested as potential causes of shifts from tamarack dominance to hardwood dominance (Dunn 1987, Kost 2001a). Conversion of rich tamarack swamp to red maple–dominated southern hardwood swamp appears to be associated with a decrease in vascular plant species richness (Kost 2001a). Investigation of the natural processes that maintain successionally related wetland types in close association is warranted, as this knowledge will support development of effective management strategies for maintaining the diversity of wetland types and native plant species that characterize the landscape.

Many of the natural processes discussed in this abstract are not well-studied for southern hardwood swamp. For example, the natural fire regime of southern hardwood swamp, or landscape-dependent variation of this fire regime, is poorly understood. Deer browse is a significant disturbance, but its impacts on trees, shrubs, and ground layer species typical of southern hardwood swamp require further research. The interaction of natural and anthropogenic disturbances, and their impacts on southern hardwood swamp, should also be elucidated. For example, the impacts of beaver in forested wetlands associated with disturbed, developed landscapes may differ from impacts on wetlands associated with other natural communities, in part due to the relatively high ratio of non-native plant species that may serve as colonizers in disturbed landscapes.

Research on the short-term and long-term impacts of emerald ash borer on southern hardwood swamp canopy composition and community structure will aid the development of conservation and management plans for the community. This species has the potential to significantly alter the community by eliminating two of the dominant canopy tree species, green ash and black ash, from the system. Loss of trees may result in higher water tables and conversion of some stands to shrub-dominated wetlands, exacerbating a long-term trend of conversion of forested wetland to non-forested wetland (Comer 1996). Emerald ash borer has the potential to reduce acreage of high quality southern hardwood swamp and increase its rarity within the state and throughout the eastern United States and adjacent Canadian provinces.

Photo by Joshua G. Cohen

Reduction of the water table and a lack of fire can facilitate the conversion of open, graminoid-dominated wetlands to southern hardwood swamp.

Similar Communities: *Northern hardwood swamp* is a black ash–dominated forested wetland occurring north of the climatic tension zone in northern Lower and Upper Michigan (Weber et al. 2007). *Wet-mesic flatwoods* is a wet to mesic forest dominated by a mixture of upland and lowland hardwoods on the southeastern Lower Michigan glacial lakeplain (Slaughter and Cohen 2010). *Floodplain forest* is a lowland forest impacted by over-the-bank flooding and cycles of erosion and deposition associated with streams of third order or greater (Tepley et al. 2004). *Hardwood-conifer swamp* is a lowland forest dominated by a mixture of hardwoods and conifers, occurring throughout the state (Slaughter et al. 2007). *Rich tamarack swamp* is a tamarack-dominated peatland occurring south of the climatic tension zone in southern Lower Michigan, where it commonly occurs in association with, and sometimes converts to, southern hardwood swamp (Kost 2001b).

Other Classifications:

Michigan Natural Features Inventory Land Cover Mapping Code: 4141 (Black Ash, Red Maple, Yellow Birch, American Elm [Southern Swamp]), 4142 (Black Ash), 4143 (American Elm), 4144 (Red Maple), 4145 (Cottonwood), 4148 (Oak [Pin Oak, Swamp White Oak])

MNFI circa 1800 Vegetation: Mixed Hardwood Swamp, Black Ash Swamp

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

Michigan Resource Information Systems (MIRIS) (MDNR 1978)**:** 414 (Hardwood Swamp [Lowland Hardwoods])

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

MDNR IFMAP (MDNR 2001): Lowland Deciduous Forest

NatureServe U.S. National Vegetation Classification and International Classification of Ecological Communities (Faber-Langendoen 2001, NatureServe 2008): CODE; ALLIANCE; ASSOCIATION; COMMON NAME

I.B.2.N.e; *Acer rubrum – Fraxinus pennsylvanica* Seasonally Flooded Forest Alliance; *Acer (rubrum, saccharinum) – Fraxinus* spp. – *Ulmus americana* Forest; Maple – Ash – Elm Swamp Forest

I.B.2.N.e; *Quercus palustris – (Quercus bicolor)* Seasonally Flooded Forest Alliance; *Quercus palustris – Quercus bicolor – Acer rubrum* Flatwoods Forest; Northern (Great Lakes) Flatwoods

I.B.2.N.e; *Quercus palustris – (Quercus bicolor)* Seasonally Flooded Forest Alliance; *Quercus palustris – Quercus bicolor – Nyssa sylvatica – Acer rubrum* Sand Flatwoods Forest; Pin Oak – Swamp White Oak Sand Flatwoods

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

I.B.2.N.g; *Fraxinus nigra – Acer rubrum* Saturated Forest Alliance; *Acer rubrum – Fraxinus* spp. – *Betula papyrifera* / *Cornus canadensis* Forest; Red Maple – Ash – Birch Swamp Forest

V.B.2.N.f; *Symplocarpus foetidus – Caltha palustris* Saturated Herbaceous Alliance; *Symplocarpus foetidus* Herbaceous Vegetation; Skunk-cabbage Seepage Meadow

Other states and Canadian provinces (natural community types with significant overlap with Michigan southern hardwood swamp indicated in *italics*):

MN: Central wet-mesic hardwood forest; Southern wet-mesic hardwood forest; Northern wet ash swamp; Northern very wet ash swamp; *Southern wet ash swamp* (MNDNR 2005)
WI: *Southern hardwood swamp* (Epstein et al. 2002)
IL: Northern flatwoods; seep (White and Madany 1978)
IN: Boreal flatwoods; Circumneutral seep (Jacquart et al. 2002)
ON: *Fresh – moist lowland deciduous forest ecosite; Oak mineral deciduous swamp ecosite; Ash mineral deciduous swamp ecosite; Maple mineral deciduous swamp ecosite; Mineral deciduous swamp ecosite; Ash organic deciduous swamp ecosite; Maple organic deciduous swamp ecosite; Birch – poplar organic deciduous swamp ecosite* (Lee et al. 1998)
OH: *Maple – ash – oak swamp* (Schneider and Cochrane 1998) PA:*Bottomland oak – hardwood palustrine forest; Red maple – black-gum palustrine forest; Red maple – black ash palustrine forest; Great Lakes region lakeplain palustrine forest* (Fike 1999)
NY: *Red maple – hardwood swamp*; Red maple – black gum swamp; *Silver maple – ash swamp*; Red maple – tamarack peat swamp (Edinger et al. 2002)
MA: *Red maple swamp; black ash swamp*; Black ash – red maple – tamarack calcareous seepage swamp; Black gum – pin oak – swamp white oak "perched" swamp; Black gum swamp (Swain and Kearsley 2001)
VT: *Red maple – black ash swamp; Red or silver maple – green ash swamp*; Calcareous red maple – tamarack swamp; Red maple – black gum swamp (Thompson and Sorenson 2000)

NH: Black gum – red maple basin swamp; Swamp white oak basin swamp; *Red maple – black ash swamp saxifrage swamp; Red maple – lake sedge swamp; Red maple – sensitive fern swamp; Circumneutral seepage swamp; Seasonally flooded red maple swamp*; Red maple – elm – ladyfern silt forest; Red maple – red oak – cinnamon fern forest; *Circumneutral hardwood forest seep* (Sperduto and Nichols 2004)

ME: Red maple wooded fen; Red maple – sensitive fern swamp; Hardwood seepage forest (Gawler and Cutko 2004)

Related Abstracts: floodplain forest, hardwood-conifer swamp, lakeplain oak openings, northern hardwood swamp, rich tamarack swamp, wet-mesic flatwoods, Cooper's hawk, red-shouldered hawk, spotted turtle, Blanding's turtle, rapids clubtail, black-crowned night-heron, osprey, regal fern borer, prothonotary warbler, Louisiana waterthrush, eastern massasauga, eastern box turtle, wahoo, pumpkin ash, showy orchis, goldenseal, ginseng, painted trillium.

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