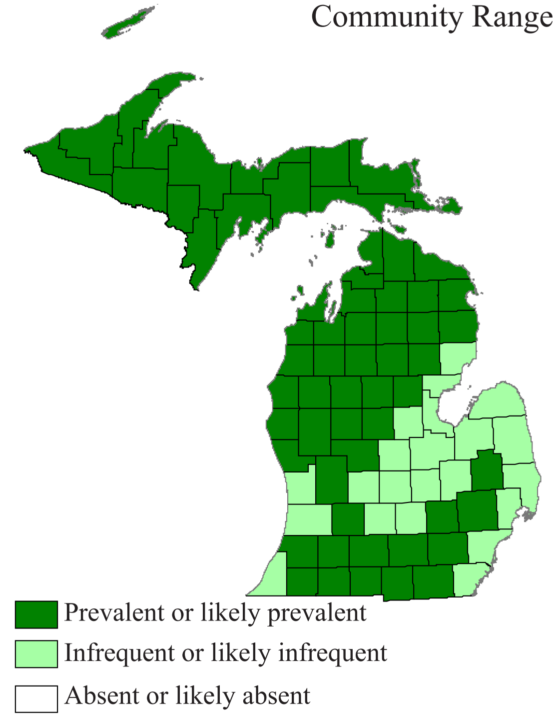
# Floodplain Forest — Community Abstract


Photo by Joshua G. Cohen




**Overview:** Floodplain forests occupy the low-lying areas adjacent to streams and rivers which are third order or greater and subject to periodic over-the-bank flooding and cycles of erosion and deposition. The floodplain forest is a broadly defined community type, where species composition and community structure vary regionally along with varying flooding frequency and duration. *Acer saccharinum* (silver maple) and *Fraxinus pennsylvanica* (red ash) are the major overstory dominants. These dynamic forested systems represent an interface between terrestrial and aquatic ecosystems.

**Global and state rank:** G3?/S3

**Range:** Floodplain forests dominated by silver maple and red ash occur throughout the midwestern states, in much of the eastern U.S., and in southern Canada (Manitoba and Ontario), ranging primarily from Minnesota east to New England, south to Virginia and west to Arkansas (Faber-Langendoen 2001, NatureServe 2003). In Michigan, floodplain forests are found along major rivers and streams throughout the state but are most extensive in the Lower Peninsula (Kost et al. 2007). Species richness is greatest in the southern Lower Peninsula where many floodplain species reach the northern extent of their range.

**Rank Justification:** Although there were an estimated 1.8 million hectares (4.4 million acres) of floodplain forest in the Lake States (MI, WI, and MN) circa 1800, just over 3,000 hectares (7,400 acres) of unlogged floodplain forest remain today. Only 29 hectares (72 acres) of unlogged floodplain forest are located in Michigan, which formerly supported approximately 1.1 million hectares (2.7 million acres) of floodplain forest circa 1800 (Frelich 1995). The damage caused to floodplain forests during logging operations of the late nineteenth and early twentieth centuries was not limited to the removal of overstory trees. Logs from floodplains as well as adjacent upland forests were transported along rollways to rivers and streams where splash dams were used to transport the logs, altering stream flow and channel characteristics. In addition, the clearing of floodplain forests was often followed by cultivation, homesteading, or livestock grazing (Malanson 1993, Verry and Dolloff 2000). Where agricultural practices were not conducted, forests regenerated following cutting. Such regeneration accounts for the current 21,500 hectares (53,100 acres) of floodplain forest greater than 120 years old in Michigan and 98,300 hectares (242,800 acres) in the 80-120–year age class (Frelich 1995). Currently there are 47 documented occurrences of floodplain forest in Michigan (approximately 7,160 hectares or 17,700 acres). Seventeen of these occurrences, constituting approximately 4,850 hectares (12,000 acres), are high-quality representations of the type.

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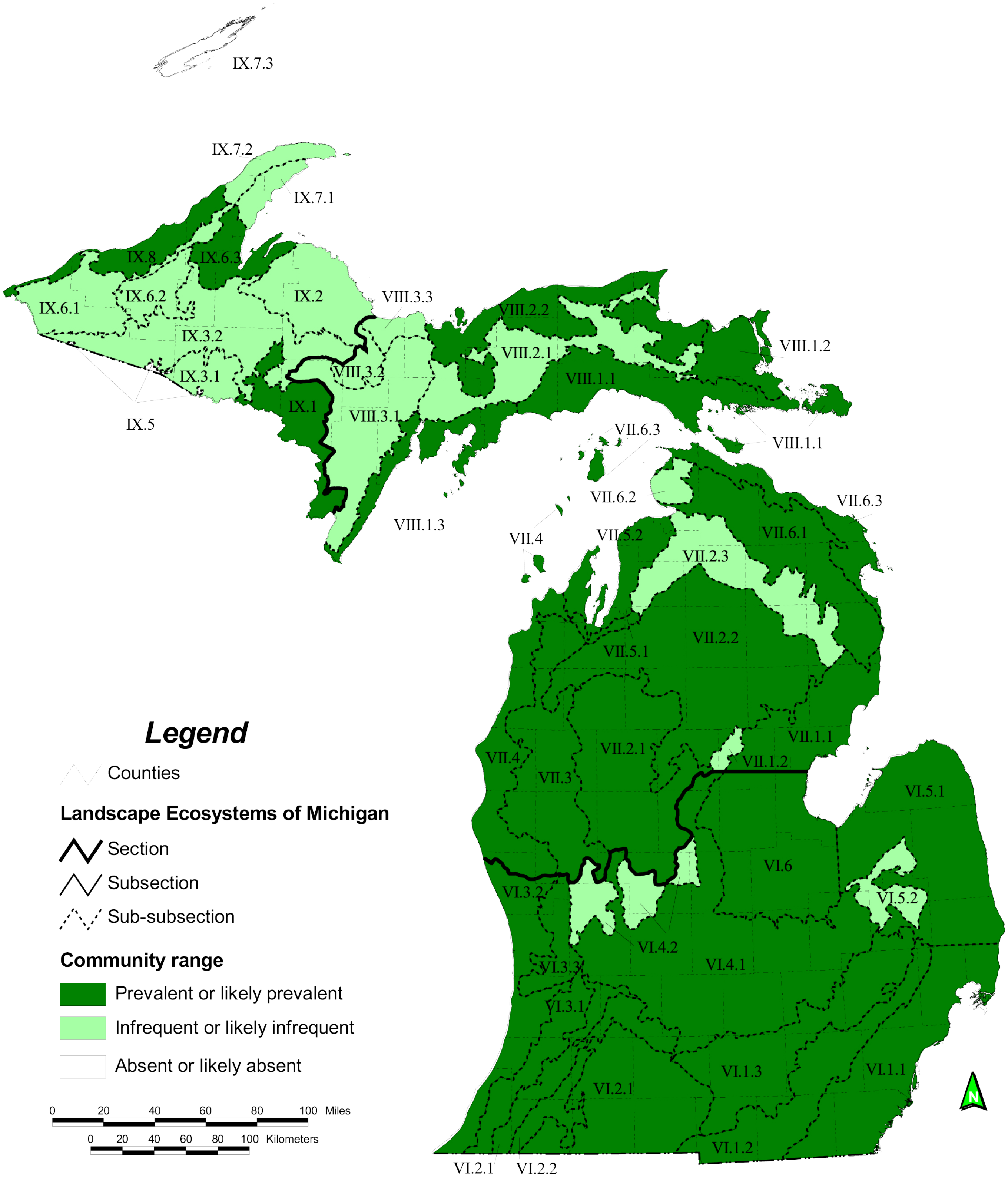


Ecoregional map of Michigan (Albert 1995) depicting distribution of floodplain forest (Albert et al. 2008)

In addition to disturbances related to the turn-of-the-century logging, floodplain forests of Michigan are highly susceptible to more recent and ongoing disturbances that alter their hydrology (Ligon et al. 1995). Throughout North America, almost all large rivers and their floodplains are subject to multiple hydrologic alterations, such as human-made levees, impoundments, channelization, dams, and changes in land use (Gergel 2002, Gergel et al. 2002). By changing the flow of water, such hydrologic alterations interrupt flood pulses, which are critical in the dynamics of seed dispersal, plant establishment, nutrient cycling, channel scouring, sediment deposition, and the maintenance of species richness (Gergel et al. 2002). Changes in land cover surrounding the floodplain have also altered species composition and structure within floodplain forests. Agricultural land cover often leads to high nutrient inputs into the floodplain (Lowrance et al. 1984), and the abundance of non-pervious surface in urban landscapes often results in a flashy discharge into nearby rivers.

The introduction of non-native organisms to floodplain ecosystems in North America is so pervasive that few communities remain unaffected. The high frequency of natural disturbances and high nutrient availability, which characterize floodplain ecosystems, facilitate colonization of the floodplain by non-native plant species (Planty-Tabacchi et al. 1996). Once established, their dispersal is enhanced by the connectivity of the riparian corridor. In addition to exotic plant species, exotic pathogens and insects have profoundly affected floodplain forests. For example, the mortality of *Ulmus americana* (American elm) caused by Dutch elm disease has virtually eliminated elm as a dominant overstory tree even though it was historically one of the major dominants in many floodplain forests of Michigan (Barnes 1976). In 2002, a new exotic pest, the emerald ash borer (*Agrilus planipennis*), was identified in southeastern Michigan. This Asiatic beetle has already killed millions of ash trees and will likely alter the species composition and structure of floodplain forests (USDA Forest Service 2002, Roberts 2003).

**Landscape Context and Natural Processes:** River valleys are linear depressions that contain a river channel and its floodplain, often embedded within a series of higher terraces. River valleys, formed by the meltwater of glaciers, occur in glacial outwash channels. The river floodplain is the low-lying area adjacent to the river that was formed under the present drainage system and is subject to periodic flooding and cycles of erosion and deposition. In contrast, terraces are former floodplain surfaces at higher elevations than the floodplain that were abandoned when the river channel incised lower into the valley floor. Within the broader landscape, river valleys represent an unusually diverse mosaic of landforms, physical environmental factors, species, and biological communities because of their abrupt environmental gradients and complex ecological processes (Brinson 1990, Gregory et al. 1991, Naiman et al. 1993). Floodplain forests occur along streams or rivers that are third order or greater (Strahler 1952).

***Fluvial Landforms***

The dynamic process of channel migration creates a diversity of landscape features in floodplains. Due to the geomorphic processes of over-the-bank flooding, transport and deposition of sediment, and erosive and abrasive water movement, the floodplains of large rivers exhibit a typical pattern of fluvial landforms, each of which is associated with a particular kind of vegetation (Hupp and Osterkamp 1985, Baker and Barnes 1998) (see Figure 1). Such fluvial landforms are distinguished by their size, shape, elevation, soil characteristics, and location in relation to the stream channel. Due to the global distribution of river valley landscapes, a variety of names have been applied to their fluvial landforms. Several of the most characteristic fluvial landforms are described below and illustrated in Figure 1 (Hosner and Minckler 1960, Buccholz 1981, Baker and Barnes 1998):

- **natural levee** – relatively high feature located adjacent to the river channel where the coarsest sediment is deposited by the fastest moving floodwaters (Brinson 1990); in comparison to other parts of the floodplain, levees have soils of coarser texture and greater depth to water table, which result in better soil drainage and soil aeration (Buccholz 1981) (Figure 1)
- **point bar** – formed by deposition of relatively coarse sediment on the inner side of a curve in the river; often colonized by early successional vegetation that stabilizes the soil (not shown in figure)
- **front** – fine-textured new land deposits along stream margins (Hosner and Minckler 1960); typically support early successional vegetation (not shown in figure)
- **first bottom** – low, poorly drained bottomland located adjacent to the levee (Figure 1); formed by the present drainage system and subject to frequent over-the-bank flooding; soil texture is typically finer than that of the levee. Although the range of topographic relief on the first bottom is often less than two meters, the first bottom is typically composed of low levees and adjacent wetter

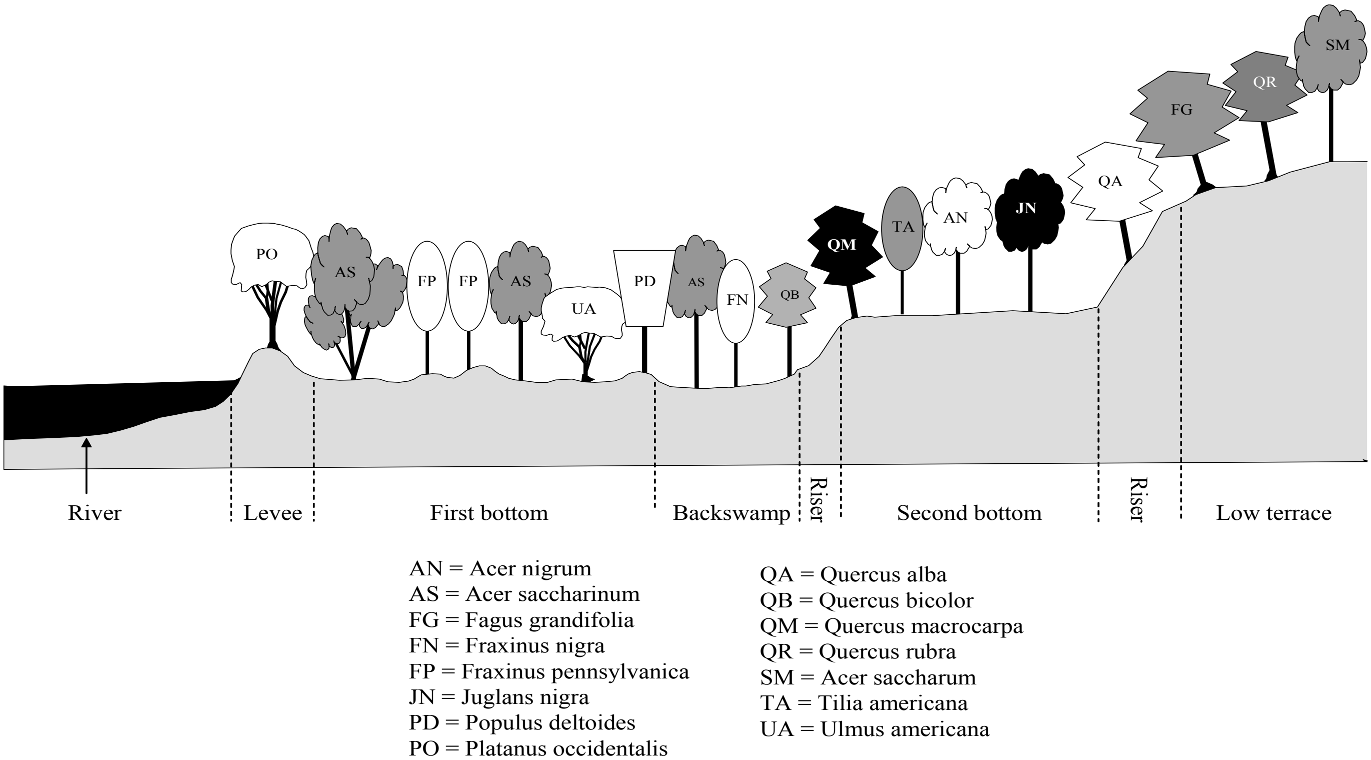


**Figure 1.** Idealized cross-section of river valley, southern Lower Michigan, illustrating the relation of canopy trees to fluvial landforms (Adapted from Baker and Barnes 1998; not drawn to scale).

- **first bottom** (continued) – swales, creating a landscape feature where small differences in elevation can lead to large differences in the frequency and duration of flooding, floodwater depth, and the distribution of vegetation.

**Major features of the first bottom are defined below:**

- **first bottom flat** – the general flat terrain of the first bottom; often located immediately adjacent to the levee; typically contains fine-textured mineral soil (Figure 1)
- **backswamp** – more poorly drained, at a lower elevation, and composed of finer-textured soil than the first bottom flat; located further from the levee than the first bottom flat; formed because surface elevation decreases and progressively finer sediment is deposited with increasing distance from the river; often experiences prolonged soil saturation due to the lower elevation, higher water table, and more moderate water level fluctuations than the first bottom flat; soil organic matter content is typically higher than that of the first bottom flat (Baker and Barnes 1998) (Figure 1)
- **meander-scar swamp** – located at the foot of a valley wall where the stream channel formerly cut into the bank along the outside of a meander; groundwater seeps typically saturate the soil; elevation is lower and soil organic matter content is higher than that of the first bottom flat; and muck or peat often accumulates.Similar features may occur on higher terraces where groundwater seeps saturate the soil at the foot of large terrace slopes (not shown in figure)
- **meander scrolls** – topography of low ridges and swales where former channels, point bars, levees, and backswamps were cut off and abandoned by the meandering stream (not shown in figure)
- **oxbow** – abandoned channel of permanently standing water that has been cut off by the meandering stream; often the most hydric part of the floodplain; hydroperiod may be too long and water depth may be too great for trees to become established. Instead, oxbows are typically shallow lakes or herb-dominated communities, often with deep deposits of fine mineral and organic sediments (not shown in figure)
- **slough** – area of dead water that forms in meander scrolls and along valley walls (not shown in figure)

- **second bottom** – situated adjacent to the first bottom and at a slightly higher elevation; flooded less frequently and for a shorter time than the first bottom; may contain any of the topographic features of the first bottom. Additional bottoms may occur adjacent to the second bottom and further from the river, where each additional bottom is flooded progressively less frequently and for a shorter time (Figure 1)
- **terrace** – abandoned floodplain surfaces that were formed by historical drainage systems and are not subject to cycles of erosion and deposition under present drainage conditions (Hosner and Minckler 1963). High terraces, formed early in the development of the river valley, are often characterized by deep sand soil and are typically dominated by dry-mesic or xeric plant communities. Lower terraces, formed later in the development of the river valley, typically have more silt and clay in their soil and are often dominated by mesic communities (Figure 1)
- **riser** – the steep slope between adjacent bottoms or terraces of a river valley; also referred to as a terrace slope (Figure 1)

***Soil***

The mineral soil texture and organic soil content of each fluvial landform is strongly associated with its position in relation to the river channel. The coarsest sediments are deposited immediately adjacent to the river channel, where flow velocity is greatest. Soils of levees are frequently sandy loams or loam. Progressively finer soil particles are deposited with increasing distance from the stream channel, where the friction of floodplain vegetation leads to lower floodwater velocity. Soil texture of the first bottom is often silt loam, with silty clay loam to clay-textured soil often occurring in swales and backswamps. Fine particle deposition away from the river often results in poor soil drainage. In general, cycles of over-the-bank flooding and regular soil aeration when floodwaters recede prevent the accumulation of organic matter close to the river (Brinson 1990). Farther from the river in backswamps and meander-scar swamps, where groundwater level is less strongly associated with the river level (Bell and Johnson 1974), an accumulation of deep organic matter can result from prolonged soil saturation with a high water table during the growing season. This isolation from the river also results in relatively low flood frequency and low flow velocity (Baker and Barnes 1998). Soils of floodplain forests are generally circumneutral to mildly alkaline, but acidic soils may be found on hummocks in the organic soils of backswamps and meander-scar swamps.

River floodplain forests are often noted for their high basal area and large-diameter trees relative to adjacent upland forests (Curtis 1959, Brinson 1990). Such high basal area results from the combined influences of high nutrient availability, an abundance of soil water throughout much of the growing season, and higher humidity levels than the upland landscape. Due to the input of nutrients from uplands, the fine texture of alluvial soils, and redeposition of sediments during flood events, nutrient availability in the floodplain is typically high. Because soil-water availability is typically much greater than that of the adjacent uplands, productivity is high for species tolerant of the low oxygen levels associated with inundation during floods.

***Microclimate***

Microclimatic conditions of river valleys may enhance the ability of southerly species to compete in floodplain forests, enabling them to extend their ranges farther northward than in the adjacent uplands. Due to their low topographic position, river floodplains warm up more slowly than the adjacent uplands, causing a given tree species to flush out later in the floodplain than it would in the adjacent upland. The later flushing in the floodplain reduces the risk of late spring frost. The lower risk of frost damage allows species not well-adapted to late spring frost to compete more successfully in floodplains than they could in the upland landscapes where frost damage is more likely. Woody species at the northern edge of their range that occur in floodplains of southern Michigan but are rarely found in upland landscapes include *Celtis occidentalis* (hackberry), *Cercis canadensis* (redbud), *Euonymus atropurpurea* (burning bush or wahoo, state special concern), *Gleditsia triacanthos* (honey locust), *Gymnocladus dioicus* (Kentucky coffee-tree, state special concern), *Fraxinus profunda* (pumpkin ash, state threatened), *Morus rubra* (red mulberry, state threatened), *Platanus occidentalis* (sycamore), *Populus deltoides* (eastern cottonwood), and *Salix nigra* (black willow).

***Landscape Context and Hydrogeomorphic Processes***

River floodplains occur within the four major physiographic systems (landforms) of Michigan: moraine, outwash plain, ice-contact terrain, and lake plain. However, because the present drainage system is closely associated with drainage patterns that developed during the retreat of the Wisconsinan glaciers, river floodplains most frequently occur within former glacial meltwater (outwash) channels. River floodplains occur within broad outwash plains as well as narrow outwash plains situated between end moraines, and the river channels occasionally cut through moraines. In glacial lake plains, large stretches of rivers flow through sand channels that formed where glacial meltwater carried and deposited sand into the proglacial lakes, but some stretches cut through finer silty and clayey lacustrine sediments.

A key series of relationships link the physiography of the river valley with that of the upland landscape. Basin size, topographic relief, and geologic parent material of the upland landscape determine river discharge, river grade, sediment load, and sediment type. These in turn control the hydrogeomorphic processes that account for the formation of fluvial landforms: rates of erosion, deposition, and channel migration. The formation of fluvial landforms by such physical processes appears to be largely independent of floodplain vegetation (Hupp and Osterkamp 1985).

The size, shape, and diversity of fluvial landforms in a river floodplain and their spatial pattern are the result of the interaction between a river and the local landscape (Crow et al. 2000). Because physiographic systems are characterized by their topographic form and parent material, floodplains within different physiographic systems are characterized by differences in stream gradient, channel pattern, local hydrology, and fluvial landforms (Baker and Barnes 1998, Crow et al. 2000). When a river flows through a flat region, such as a broad outwash plain or a lake plain, a wide, continuous floodplain develops. Because the rate of channel migration tends to increase as bank sand content increases, river floodplains in outwash plains and sand lake plains are characterized by broad first bottoms. Within these wide floodplains, extensive lateral channel migration and the deposition of progressively finer-textured sediment with increasing distance from the river lead to the formation of a variety of fluvial landforms, including natural levees, first bottoms, meander scrolls, oxbow lakes, backswamps, and meander-scar swamps (Baker and Barnes 1998, Crow et al. 2000). With uniformly low topography and a relatively high water table, the broad first bottom of rivers within outwash plains and lake plains is periodically inundated during the growing season. The continuous floodplains of such rivers rarely contain higher terraces (Baker and Barnes 1998).

In contrast, both the higher topographic relief and finer-textured parent material of moraines encourage the development of narrow river valleys with more restricted floodplains and a reduced duration of flooding (Baker and Barnes 1998). The development of narrow valleys also occurs where rivers occupy narrow outwash channels situated between end moraines. The high topographic relief, relatively steep slope gradients, and fine-textured soil of morainal landscapes restrict lateral channel migration, resulting in narrow, sinuous floodplains that are frequently dissected by a series of higher terraces. Because channel migration is restricted, the micro-topography of low ridges and swales that characterizes the first bottom of many floodplains is often lacking. The frequency of over-the-bank flooding in morainal landscapes is generally less than that in outwash plains and lake plains. Instead, groundwater plays a stronger role, and constant soil saturation due to groundwater seepage often supports large accumulations of organic soil (Baker and Barnes 1998).

**Photo by Joshua G. Cohen**

Floodplain forests in broad outwash plains are characterized by wide, frequently inundated first bottoms.

The influence of broad physiographic features on floodplain characteristics including stream gradient, channel pattern, and fluvial landforms is illustrated in the distinct segments of the river valley that can be identified in landscapes where a river flows from one type of physiographic system into another. For example, the Big South Branch of the Pere Marquette River in northern Lower Michigan flows through a broad outwash plain, but it also occurs adjacent to moraines, where the valley encounters the underlying till (Crow et al. 2000). Within the outwash plain, the floodplain is broad and continuous with uniformly low topography, and it is rarely dissected by higher terraces. When the river flows adjacent to the moraine and it comes in contact with the underlying till, the river valley becomes narrow with numerous terraces (Baker and Barnes 1998). Many of the fluvial landforms that characterize the first bottom in the outwash plain landscape are absent from the first bottom in the morainal landscape. In addition, natural levees in the outwash plain are lower and wider than levees in the moraine (Crow et al. 2000). As the river leaves the moraine, a broad, continuous floodplain forms again (Baker and Barnes 1998).

***Interrelationship between Terrestrial and Aquatic Systems***

Direct interaction between terrestrial and aquatic ecosystems occurs in floodplain forests through the processes of over-the-bank flooding, bank cutting, and sedimentation (Gregory et al. 1991). Over-the-bank flooding can directly cause treefall or indirectly lead to windthrow through increased soil saturation. Seasonal inundation results in the absence of a substantial seedling and shrub layer in these systems. Spring floodwaters often carry ice floes and debris which can scour canopy trees, leading to the development of multiple-stemmed canopy trees (Curtis 1959). Through the input of organic matter, floodplain forests provide sources of energy for aquatic organisms. Shade from streamside vegetation moderates temperature regimes in aquatic systems, preventing excessive warming of the water during summer months. Woody debris from floodplain vegetation influences the development of channel morphology and provides necessary habitat for many aquatic organisms. Riparian vegetation affects overland flow of water and also influences sediment transport (Crow et al. 2000). Through the processes of nutrient uptake by floodplain vegetation and denitrification by soil bacteria, floodplain forests decrease the terrestrial inputs of nutrients into aquatic systems (Lowrance et al. 1981). Such processes are especially important in landscapes dominated by agricultural or urban land cover, where nutrient output from upland ecosystems is typically high.

**Vegetation description:** The floodplain forest is a broadly defined community type with numerous variations in species composition and vegetative structure. As a result of the dynamic, local nature of natural disturbance along stream channels, a typical floodplain forest consists of many small patches of vegetation of different species composition and successional ages. Within a given floodplain forest, vegetation changes along a gradient of flooding frequency and duration (Brinson 1990). Due to local variability in soil texture, internal drainage, and aeration, trends in species composition do not necessarily correspond with elevation. Fluvial landforms, which are defined by their size, shape, elevation, soil, and position in relation to the stream channel, provide the most meaningful framework for understanding species composition of the floodplain forest.

In addition to local variation in species composition and structure within a site, there are major differences in species composition between floodplain forests in the northern and southern parts of the state. Although *Acer saccharinum* (silver maple) and *Fraxinus pennsylvanica* (red ash) are the primary overstory dominants of floodplain forests throughout the state, overall species diversity is typically much greater in floodplain forests of southern Michigan than northern Michigan. While conifers are typically absent, or they account for only a minor component of southern Michigan floodplain forests, they are often abundant in the floodplain forests of northern Michigan. Such shifts in species composition occur along a gradient from south to north, and to a lesser extent from lake-moderated areas along the coast of the state to the interior of the state. Because species composition shifts along a gradient from south to north, southern and northern floodplains are summarized separately with the understanding that there is a continuum of conditions between the regional variants of floodplain forests. Fluvial landforms provide a useful framework for understanding forest composition and structure in the floodplain forest, and therefore trends in species composition are discussed along hypothetical transects from the river's edge to the upland.

***1. Floodplain forests of southern Lower Michigan:*** Along the river's edge, shrub species such as *Cephalanthus occidentalis* (buttonbush), *Cornus amomum* (silky dogwood), *Cornus stolonifera* (red-osier dogwood), *Decodon verticillatus* (water-willow), and *Staphylea trifolia* (bladdernut) are common. These species, which are tolerant of the anaerobic soil conditions along the edge of the stream, thrive under the high light levels characteristic of the stream margin. Point bars and fronts are often colonized by pioneer tree species, including *Populus deltoides* (eastern cottonwood), *Salix exigua* (sandbar willow), and *Salix nigra* (black willow). The occurrence of bare mineral soil in these new land deposits, located adjacent to the stream channel where light levels are high, favors the establishment and growth of these trees, which are very intolerant of shade (Barnes and Wagner 1981), but moderately tolerant of inundation of the soil surface during the growing season (Hosner 1960). Herbaceous plants that are frequently found along river edges include *Lobelia cardinalis* (cardinal-flower), *Peltandra virginica* (arrow-arum), and *Pontederia cordata* (pickerel weed). A large number of tree species are likely to occur on the higher, more stable terrain of the levee, where the frequency and duration of flooding are relatively low and the sandy soil drains rapidly when floodwaters recede. Such species include *Carya ovata* (shagbark hickory), *Celtis occidentalis* (hackberry), *Juglans cinerea* (butternut), *Juglans nigra* (black walnut), *Platanus occidentalis* (sycamore), *Quercus bicolor* (swamp white oak), *Quercus macrocarpa* (bur oak), *Salix amygdaloides* (peachleaf willow), and *Tilia americana* (basswood). Numerous records for the rare trees *Gymnocladus dioicus* (Kentucky coffee-tree) and *Morus rubra* (red mulberry) are known from levees. Due to the lower frequency and duration of flooding on the levee than on other parts of the floodplain and the relatively high light levels due to its location adjacent to the stream channel, the understory is often dense. A variety of tall shrubs and small-tree species may be abundant, including *Carpinus caroliniana* (musclewood), *Cercis canadensis* (redbud), *Cornus* spp. (dogwoods), *Fraxinus quadrangulata* (blue ash), *Lindera benzoin* (spicebush), *Prunus virginiana* (choke cherry), *Sambucus canadensis* (common elder), *Viburnum lentago* (nannyberry), and *Zanthoxylum americanum* (prickly-ash). *Euonymus atropurpurea* (burning-bush or wahoo, state special concern) is a rare shrub that is found primarily on levees.

Adjacent to the levee, the first bottom flat is dominated by silver maple and red ash, with few other tree species present. Prior to the Dutch elm disease epidemic of the 1960s, *Ulmus americana* (American elm) was formerly a canopy dominant. However, the disease has relegated elm to a common species of the subcanopy and understory: in many stands, all elms greater than six inches in diameter have been killed (Beaman 1970, Frye 1976). Understory vegetation is typically sparse. While short shrubs, such as *Ribes americanum* (red courant) and *Rubus strigosus* (red raspberry) may be common, tall shrubs and small-tree-species are typically absent. However, vines including *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (poison ivy), and *Vitis riparia* (riverbank grape) are abundant, often achieving optimum growth (Curtis 1959). Other than in small sloughs and depressions where standing water occurs, the ground-cover layer is often continuous following floodwater recession, and an enormous diversity of species may be present. The following species are among the most characteristic ground-cover species of the first bottom in southern Lower Michigan: *Arisaema dracontium* (green dragon), *Asarum canadense* (wild ginger), *Aster lateriflorus* (calico aster), *Boehmeria cylindrica* (false nettle), *Calamagrostis canadensis* (blue-joint), *Carex grayi* (Gray's sedge), *Cinna arundinacea* (wood reedgrass), *Elymus virginicus* (Virginia wild rye), *Equisetum arvense* (field horsetail), *Geum canadense* (avens), *Impatiens capensis* (jewelweed), *Iris virginica* (southern blue flag), *Laportea canadensis* (wood nettle), *Lysimachia ciliata* (fringed loosestrife), *Matteuccia struthiopteris* (ostrich fern), *Onoclea sensibilis* (sensitive fern), *Pilea* spp. (clearweed), *Ranunculus hispidus* (swamp buttercup), *Saururus cernuus* (lizard's tail), *Senecio aureus* (golden ragwort), *Smilacina stellata* (starry false Solomon's seal), *Smilax ecirrhata* (carrion flower), *Solidago gigantea* (late goldenrod), *Symplocarpus foetidus* (skunk cabbage), *Thalictrum dasycarpum* (tall meadow rue), and *Urtica dioica* (stinging nettle) (Goforth et al. 2002).

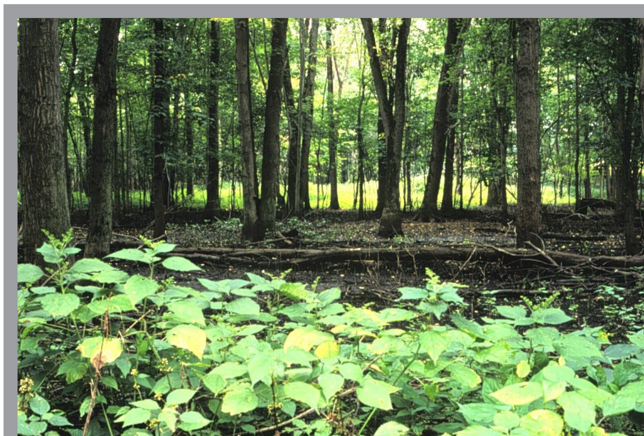
Photo by Joshua G. Cohen

Local variability of flooding frequency and duration generates high floristic diversity within floodplain forests.

Adjacent to the first bottom flat is the backswamp, where silver maple and red ash often share canopy dominance with *Fraxinus nigra* (black ash). Swamp white oak can also be an important component of the canopy. The coverage of ground-cover vegetation in the backswamp is typically low due to prolonged inundation of the soil surface during flooding and saturation of the soil surface when floodwaters recede. Although the overall coverage of ground-cover vegetation in the backswamp is considerably lower than that of the first bottom flat, species including *Caltha palustris* (marsh-marigold), *Carex lacustris* (sedge), and *Glyceria striata* (fowl manna grass) may be more abundant in the backswamp than in the first bottom flat.

The species composition of the second bottom is markedly different from that of the first bottom. In contrast to forests of the first bottom flat that are only dominated by two species (silver maple and red ash), many overstory species occur on the second bottom. These include *Acer nigrum* (black maple), basswood, black walnut, bur oak, *Carya cordiformis* (bitternut hickory), *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), hackberry, and occasionally *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), and *Quercus rubra* (red oak). Rare tree species including Kentucky coffee-tree and red mulberry may also be present on the second bottom.

Conifers are typically absent from floodplain forests of southern Lower Michigan: occasionally groundwater seepages associated with meander scars support *Larix laricina* (tamarack), and less often *Thuja occidentalis* (northern white-cedar). Such groundwater seepages are typically not directly influenced by over-the-bank flooding. Low terraces within the floodplain are often dominated by American beech and sugar maple, often with red oak and basswood. Higher terraces typically support drier, oak-dominated forests.

***2. Floodplain forests of northern Michigan (Northern Lower Michigan and Upper Michigan):*** Point bars and fronts in northern Michigan floodplains are often dominated by *Alnus rugosa* (speckled alder) and shrub willows, compared to black willow and eastern cottonwood, which are the dominant colonizers in southern Lower Michigan floodplains. Natural levees in northern Michigan floodplains are typically dominated by basswood, along with silver maple, red ash, and subcanopy American elm. Although a wide variety of tree and shrub species are likely to occur on the natural levee in the southern part of the state, many species characteristic of southern Lower Michigan levees, such as shagbark hickory, redbud, and hackberry, do not occur in the northern part of the state.

In broad outwash plain and lake plain landforms, where rivers form a wide, continuous first bottom, the overstory and understory vegetation of the first bottom flat is similar to that of the first bottom flat in southern Lower Michigan, but many of the characteristic ground-cover species are absent. In both northern and southern Michigan, the first bottom flat is dominated by silver maple and red ash with subcanopy elm and few other tree species present, and low understory stem density with few tall shrubs or small-tree species. Many characteristic ground-cover plants of southern Lower Michigan floodplains, such as wild ginger, green dragon, and lizard's tail, either are absent from northern Michigan floodplains or are a minor component of the ground cover. Grasses, including blue-joint, fowl manna grass, *Leersia oryzoides* (cut grass), *Leersia virginica* (white grass), Virginia wild rye, and a variety of sedges (*Carex lacustris, Carex intumescens*, *Carex lupulina*, and *Carex tuckermanii*) often account for a much larger proportion of the ground-layer coverage in northern Michigan than they do in southern Lower Michigan. In addition to grasses and sedges, species such as false nettle, jewelweed, sensitive fern, and skunk cabbage may be abundant in the first bottom of northern Michigan floodplains.

In landscapes where broad, continuous floodplains develop, the vegetation of backswamps and meander-scar swamps in northern Michigan is markedly different from that of southern Lower Michigan. In both northern and southern Michigan, backswamps are often dominated by silver maple, red ash, black ash, and subcanopy American elm. However, conifers such as northern white-cedar, *Pinus strobus* (eastern white pine), and *Tsuga canadensis* (eastern hemlock) are often present in backswamps of northern Michigan. Characteristic ground-cover species in northern Michigan backswamps include *Carex stricta* (tussock sedge), false nettle, sensitive fern, and skunk cabbage. Meander-scar swamps of northern Michigan floodplains are typically dominated by black ash and northern white-cedar, along with *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), eastern hemlock, and eastern white pine. Characteristic ground-cover species of northern Michigan meander-scar swamps include *Osmunda regalis* (royal fern), *Rubus pubescens* (dwarf raspberry), and *Thelypteris noveboracensis* (New York fern) (Baker and Barnes 1998), species typically absent from floodplain forests of southern Lower Michigan. Speckled alder is also common in meander-scar swamps. Similar forests dominated by northern white-cedar often occur along groundwater seepages and at the base of terrace slopes on second bottoms or higher terraces within the river valley.

In northern Michigan, the vegetation of the first bottom of narrow floodplains that develop in river valleys of narrow outwash plains that are constrained between end moraines or where rivers cut through moraines is markedly different from that of narrow floodplains in southern Lower Michigan. While narrow floodplains in southern Lower Michigan are often dominated by silver maple, red ash, and basswood, such floodplains in northern Michigan are often dominated by basswood, red ash, northern white cedar, and *Populus balsamifera* (balsam poplar) (Baker and Barnes 1998).

The second bottom of northern Michigan floodplain forests is often dominated by basswood, eastern white pine, or northern red oak. Swamps and groundwater seepages within the second bottom are typically dominated by northern white cedar, often with black ash, eastern hemlock, red maple, and yellow birch (Baker and Barnes 1998). Low terraces within the floodplain are typically dominated by northern hardwood forests, where species such as American beech, eastern hemlock, and sugar maple may be abundant. Higher terraces are typically dominated by drier, oak-pine forests. Terrace slopes are often dominated by eastern hemlock.

**Michigan Indicator Species:** *Acer nigrum* (black maple), *Acer saccharinum* (silver maple), *Arisaema dracontium* (green dragon), *Aster lateriflorus* (calico aster), *Boehmeria cylindrica* (false nettle), *Celtis occidentalis* (hackberry), *Euonymus atropurpurea* (burning bush or wahoo, state special concern), *Fraxinus pennsylvanica* (red ash), *Fraxinus profunda* (pumpkin ash, state threatened), *Gleditsia triacanthos* (honey locust), *Gymnocladus dioicus* (Kentucky coffee-tree), *Hybanthus concolor* (green violet, state special concern), *Hydrastis canadensis* (goldenseal, state threatened), *Jeffersonia diphylla* (twinleaf, state special concern), *Juglans cinerea* (butternut), *Laportea canadensis* (wood nettle), *Lindera benzoin* (spicebush), *Morus rubra* (red mulberry), *Platanus occidentalis* (sycamore), *Quercus bicolor* (swamp white oak), *Quercus macrocarpa* (bur oak), *Salix nigra* (black willow), *Staphylea trifolia* (bladdernut), *Toxicodendron radicans* (poison ivy), *Ulmus americana* (American elm), *Urtica dioica* (stinging nettle), and *Vitis riparia* (riverbank grape).

**Other Noteworthy Species:** Numerous rare plants are associated with floodplain forests: *Arabis perstellata* (rock cress, state threatened), *Aristolochia serpentaria* (Virginia snakeroot, state threatened), *Aster furcatus* (forked aster, state threatened), *Bromus nottowayanus* (satin brome, state special concern), *Camassia scilloides* (wild-hyacinth, state threatened), *Carex conjuncta* (sedge, state endangered), *Carex crus-corvi* (raven's-foot sedge, state threatened), *Carex davisii* (Davis' sedge, state special concern), *Carex decomposita* (log sedge, presumed extirpated from Michigan), *Carex lupuliformis* (false hop sedge, state threatened), *Carex squarrosa* (sedge, state special concern), *Carex trichocarpa* (hairy-fruited sedge, state special concern), *Carex typhina* (cat-tail sedge, state threatened), *Chasmanthium latifolium* (wild oats, state endangered), *Chelone obliqua* (purple turtlehead, state endangered), *Corydalis flavula* (yellow fumewort, state threatened), *Dasistoma macrophylla* (mullein-foxglove, state endangered), *Dentaria maxima* (large toothwort, state threatened), *Diarrhena obovata* (beak grass, state threatened), *Dryopteris celsa* (log fern, state threatened), *Euonymus atropurpurea* (burning bush or wahoo, state special concern), *Fraxinus profunda* (pumpkin ash, state threatened), *Galearis spectabilis* (showy orchis, state threatened), *Gentianella quinquefolia* (stiff gentian, state threatened), *Hybanthus concolor* (green violet, state special concern), *Hydrastis canadensis* (goldenseal, state threatened), *Jeffersonia diphylla* (twinleaf, state special concern), *Justicia americana* (water-willow, state threatened), *Lithospermum latifolium* (broad-leaved pucoon, state special concern), *Lycopus virginicus* (Virginia water-horehound, state threatened), *Mertensia virginica* (Virginia bluebells, state endangered), *Morus rubra* (red mulberry, state threatened), *Panax quinquefolius* (ginseng, state threatened), *Plantago cordata* (heart-leaved plantain, state endangered), *Poa paludigena* (bog bluegrass, state threatened), *Polemonium reptans* (Jacob's ladder or Greek-valerian, state threatened), *Pycnanthemum pilosum* (hairy mountain mint, state threatened), *Ruellia strepens* (smooth ruellia, state endangered), *Silphium perfoliatum* (cup-plant, state threatened), *Trillium nivale* (snow trillium, state threatened), *Trillium recurvatum* (prairie trillium, state threatened), *Trillium sessile* (toadshade, state threatened), *Valerianella chenopodiifolia* (goosefoot corn-salad, state threatened), *Valerianella umbilicata* (corn-salad, state threatened), *Viburnum prunifolium* (black haw, state special concern), and *Wisteria frutescens* (wisteria, state threatened).

Rare herptiles that utilize floodplain forests include *Clonophis kirtlandii* (Kirtland's snake, state endangered), *Pantherophis spiloides* (gray ratsnake, state special concern), *Emydoidea blandingii* (Blanding's turtle, state special concern), *Glyptemys insculpta* (wood turtle, state special concern), *Sistrus catenatus catenatus* (eastern massasauga, state special concern), and *Terrapene carolina carolina* (eastern box turtle, state special concern). Seasonally inundated portions of floodplains provide crucial habitat for reptiles and amphibians. Amphibian species most dependent on ephemeral pools in Michigan are *Ambystoma maculatum* (spotted salamander), *Ambytoma laterale* (blue-spotted salamander), *Bufo americanus* (American toad), *Hyla versicolor* (gray tree frog), *Psuedacris triseriata* (chorus frog), and *Rana sylvatica* (wood frog). Rare herptiles associated with these pools include *Ambystoma opacum* (marbled salamander, state endangered), *Ambystoma texanum* (smallmouth salamander, state endangered), Blanding's turtle, and *Nerodia erythrogaster neglecta* (copperbelly water snake, state endangered).

*Myosotis sodalis* (Indiana bat, state endangered) establish roosts and nurseries in standing snags within floodplain forests. Floodplain forests in Michigan support disproportionately large numbers of breeding bird species as compared to upland landscapes (Inman et al. 2002). Floodplain forests are especially important for obligate riparian bird species, including *Dendroica dominica* (yellow-throated warbler, state threatened), *Protonotaria citrea* (prothonotary warbler, state special concern), and *Seiurus motacilla* (Lousiana waterthrush, state threatened) and several breeding species of concern that are regionally rare or declining, including *Dendroica cerulea* (cerulean warbler, state threatened), *Empidonax virescens* (Acadian flycatcher), *Melanerpes erythrocephalus* (redheaded woodpecker), and *Wilsonia citrina* (hooded warbler, state special concern) (Inman et al. 2002). Nesting raptors that occur in floodplains include *Accipiter cooperii* (Cooper's hawk) and *Buteo lineatus* (red-shouldered hawk, state threatened). *Ardea herodias* (great blue heron) often construct rookeries within floodplain forests and hardwood swamps.

Numerous rare aquatic animals are associated with Michigan rivers that support floodplain forest. Rare mussels include *Alasmidonta marginata* (elktoe, state special concern), *Cyclonaias tuberculata* (purple wartyback, state threatened), *Epioblasma torulosa rangiana* (northern riffleshell, state endangered), *Epioblasma triquetra* (snuffbox, state endangered), *Lampsilis fasciola* (wavy-rayed lampmussel, state threatened), *Obovaria olivaria* (round hickorynut, state endangered), *Obovaria subrotunda* (round hickorynut, state endangered), *Pleurobema clava* (northern clubshell, state endangered), *Pleurobema sintozia* (round pigtoe, state special concern), *Simpsonaias ambigua* (salamander mussel, state endangered), *Toxolasma lividus* (purple lilliput, state endangered), *Venustaconcha ellipsiformis* (ellipse, state special concern), *Villosa fabalis* (rayed bean, state endangered), and *Villosa iris* (rainbow, state special concern). Rare fish and snails include *Accipenser fulvescens* (lake sturgeon, state threatened), *Anguispira kochi* (banded globe, state special concern snail), *Discus patulus* (domed disc, state special concern snail), *Lepisosteus oculatus* (spotted gar, state special concern), *Moxostoma carinatum* (river redhorse, state threatened), *Noturus stigmosus* (northern madtorn, state endangered), *Opsopoeodus emiliae* (pugnose minnow, state endangered), *Percina copelandi* (channel darter, state endangered ), *Percina shumardi* (river darter, state endangered), and *Pomatiopsis cincinnatiensis* (brown walker, state special concern snail).

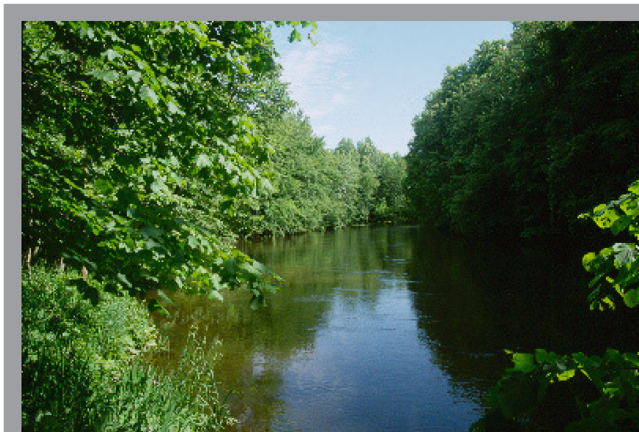

Photo by Joshua G. Cohen

Floodplain forests, interfaces between aquatic and terrestrial ecosystems, support high levels of biodiversity.

**Conservation and biodiversity management:** Successful conservation management of floodplain forests can contribute significantly to regional biodiversity because these systems possess an unusually high diversity of plant and animal species, vegetation types, and ecological processes (Nilsson 1992, Naiman et al. 1993). By providing necessary hibernacula, breeding sites, foraging areas, and travel corridors, floodplain forests often support a high diversity of birds, herptiles, and mammals. Wider and more contiguous riparian systems were found to support higher levels of native plant species diversity compared to narrow, fragmented riparian systems (Goforth et al. 2002). Riparian corridors may harbor twice the number of species occurring in adjacent upland areas (Gregory et al. 1991).

Conservation and management of floodplain forests require an ecosystem management perspective because of the complex longitudinal, lateral, and vertical dimensions of river systems (Sparks 1995, Ward 1998). The implementation of management approaches may be complicated and specific to individual river systems (Sparks 1995, Verry et al. 2000). However, some general conservation management guidelines have emerged from the study of the basic ecology of floodplain ecosystems (Brinson 1990, Nilsson 1992, Naiman et al. 1993, Ward 1998, Verry et al. 2000). It is crucial to maintain the connectivity and longitudinal environmental gradients from headwater streams to the broad floodplains downstream. The recognition of floodplain forests as important ecotones between aquatic and terrestrial ecosystems demands the maintenance or re-establishment of lateral connectivity and environmental gradients along riparian and upland areas. Because hydrologic regime is a primary driving force structuring floodplain forests, the natural spatial and temporal patterns of stream flow rates, water levels, and run-off patterns must be maintained or re-established. Restoration of channel morphology may be important in areas where stream channelization, channel constriction, and dams have altered water delivery and geomorphology. Floodplain forests are located in riparian areas that integrate the effects of human activities on the larger landscape. Thus, conservation management must also take into account the importance of chemical inputs, timber harvest, agriculture, grazing, and exotic species invasion (Brinson 1990, Nilsson 1992, Naiman et al. 1993, Ward 1998, Verry et al. 2000).

Floodplain forests are unusually susceptible to invasions by exotic species (Planty-Tabbachi et al. 1996). Because of their linear shape and location between aquatic and terrestrial environments, floodplain forests have a high ratio of edge to interior that may facilitate the movement of opportunistic species. Rivers and streams provide a route of transport that may encourage the spread of species across the landscape. Floodplain forests are highly and frequently disturbed systems that contain extensive areas of exposed mineral soil and have high nutrient availability; these are characteristics that also facilitate invasion by exotics. Preemptive measures to minimize impacts of invasive species include maintaining mature floodplain forest, minimizing and eliminating trails and roads through floodplains, and buffering riparian areas with mature, continuous uplands. Invasive exotics that can dominate the groundlayer include *Alliaria petiolata* (garlic mustard), *Glechoma hederacea* (gil-over-the ground), *Hesperis matronalis* (dame's rocket), *Lysimachia nummularia* (moneywort), *Lythrum salicaria* (purple loosestrife), and *Phalaris arundinacea* (reed canary grass). Prevalent exotic shrubs include *Berberis vulgaris* (Japanese barberry), *Elaeagnus umbellata* (autumn olive), *Ligustrum vulgare* (common privet), *Lonicera tatarica* (tartarian honeysuckle), *Lonicera morrowii* (morrow honeysuckle), *Morus alba* (white mulberry), *Rhamnus cathartica* (common buckthorn), *Rhamnus frangula* (glossy buckthorn), and *Rosa multiflora* (multiflora rose) (Goforth et al. 2002). In general, there are fewer non-native species in northern Michigan floodplains, and they are usually not as abundant as in the southern part of the state. Common non-native species in northern floodplains include Japanese barberry, moneywort, *Myosotis scorpoides* (forget-me-not), and *Solanum dulcamara* (bittersweet). Once these species become established, control (often through manual removal) becomes costly and intensive.


Photo by Joshua G. Cohen

Within fragmented landscapes, floodplain forests function as critical reservoirs of biodiversity and travel corridors.

**Research Needs:** An important research question to be addressed is how the ecological processes, structure, and species composition of this community will change as the Great Lakes region becomes increasingly fragmented. At what level of fragmentation will these systems stop functioning as suitable habitat or travel corridors for different species? Given the prevalence of invasive species in these highly disturbed systems, it is imperative to determine how non-native species alter species composition and structure. Resource managers need to know how best to manage against exotics not only locally but also at the landscape scale. As noted by Curtis (1959), many of the overstory dominants of floodplain forests are resistant to ground fires. Little is known about the role of fire in the disturbance regime of floodplains. Prescribed fire may prove a useful tool in controlling invasive exotics. Historically, introduced tree diseases and insects have had a profound impact on Michigan forests. A recently discovered Asiatic beetle, the emerald ash borer (*Agrilus planipennis*), has already killed millions of ash trees in southeastern Michigan and southeastern Ontario and threatens to drastically alter floodplain forests (USDA Forest Service 2002, Roberts 2003). A crucial research need is to determine if it is possible to prevent this pest from radically altering ash-dominated forests. Using hindsight gained from assessing past epidemics, researchers can formulate strategies for prevention and hypothesize about impacts future outbreaks may have on forest structure and composition.

**Similar Communities**: Hardwood-conifer swamp, mesic southern forest, mesic northern forest, northern hardwood swamp, southern hardwood swamp.

**Other Classifications:**

**Michigan Natural Features Inventory Circa 1800 Vegetation (Comer et al. 1995):** Mixed Hardwood Swamp and Floodplain

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

**Michigan Resource Information Systems (MIRIS)**: 4146 (Lowland Hardwood), 6110 (Wooded Wetland), 4148 (Undifferentiated Lowland Hardwood), 4144 (Cottonwood), 4145 (Elm)

**The Nature Conservancy National Classification:**

CODE; ALLIANCE; ASSOCIATION; COMMON NAME

I.B.2.N.d.4; *Acer saccharinum* Temporarily Flooded Forest Alliance; *Acer saccharinum* – *Ulmus americana* – (*Populus deltoides*) Forest; Silver Maple – Elm – (Cottonwood) Forest.

I.B.2.N.d.4; *Acer saccharinum* Temporarily Flooded Forest Alliance; *Acer saccharinum* – (*Populus deltoides*) / *Matteuccia struthiopteris* Forest; Silver Maple Floodplain Forest, Ostrich Fern Variant.

I.B.2.N.d.11; *Fraxinus pennsylvanica* – *Ulmus americana* – *Celtis* (*occidentalis, laevigata*) Temporarily Flooded Forest Alliance; *Fraxinus pennsylvanica* – *Ulmus americana* – (*Acer negundo*, *Tilia americana*) Northern Forest; Northern Ash – Elm Floodplain Forest.

I.B.2.N.d.24; *Acer* (*rubrum*, *saccharinum*) – *Ulmus americana* Temporarily Flooded Forest Alliance; *Acer saccharinum* – *Ulmus Americana* / *Onoclea sensibilis* Forest; Silver Maple – Elm / Sensitive Fern Forest.

I.B.2.N.e.1; *Acer rubrum* – *Fraxinus pennsylvanica* Seasonally Flooded Forest Alliance; *Acer (rubrum, saccharinum*) – *Fraxinus* spp. – *Ulmus americana* Forest; Maple – Ash – Elm Swamp Forest.

**Related Abstracts:** beaked grass, Blanding's turtle, channel darter, cerulean warbler, Cooper's hawk, eastern box turtle, eastern massasauga, elktoe, ginseng, goldenseal, hardwood-conifer swamp, lake sturgeon, large toothwort, mesic northern forest, mesic southern forest, northern clubshell, northern goshawk, northern hardwood swamp, northern madtom, northern riffleshell, pugnose minnow, purple lilliput, rayed bean, red-shouldered hawk, river redhorse, round hickorynut, salamander mussel, showy orchis, snuffbox, spotted gar, Virginia snakeroot, wavy-rayed lampmussel, and wood turtle.

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Floodplain forest along the Muskegon River, Clare County, Michigan. Photo by Joshua G. Cohen.