Between Land and Lake: Michigan's Great Lakes Coastal Wetlands

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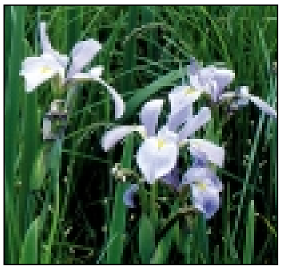
Between Land and Lake: Michigan's Great Lakes Coastal Wetlands

by

Dennis A. Albert



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Dedication and Acknowledgments

Many of us will remember Ted Cline for his tireless dedication to conserving Michigan's special places. Ted's aerial photography helped protect important biodiversity sites from Drummond Island to the tip of the Keweenaw Peninsula, as well as in New Mexico. In this book, his photos provide us an important landscape perspective.

Acknowledgments

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Table of Contents

Introduction

Introduction

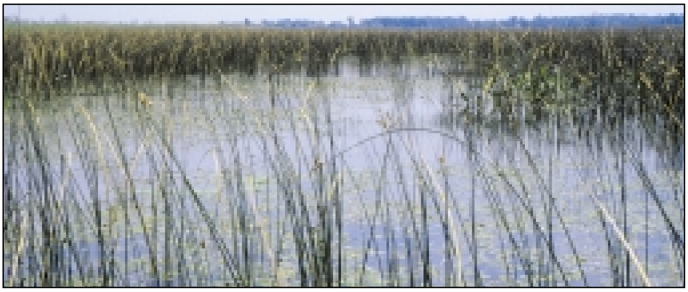
Imagine flying over the shoreline of western Lake Erie and seeing a mile-wide swath of grasses and bulrushes rippling in the winds. As the plane passes, thousands of waterfowl rise and take flight to a distant edge of the marsh. We could also be in a canoe, paddling through shallow, meandering channels at the mouth of the River Raisin, gliding through an open bed of wild rice, with broad meadows of blue-joint grass and bulrush surrounding us in all directions. The channel splits again and again before we reach the open waters of the lake.

J. Schafer

Aerial view of St. Clair River delta.

One hundred and fifty years ago, as the Michigan territory was being settled, broad coastal marshes lined western Lake Erie, Lake St. Clair and the magnificent bird's-foot delta of the St. Clair River, and many other river mouths and shallow bays of the Great Lakes. Such marshes could be found on all of the Great Lakes, from the western tip of Lake Superior to the upper reaches of the St. Lawrence River and its countless tributaries. Early surveyors and historians described

D. Albert



Canoeing in a slough of the St. Clair River delta.

and mapped many of the largest wetlands. These descriptions invariably include uncountable flocks of waterfowl or abundant spawning and feeding fish. For centuries, Native American villages had congregated on the shoreline, attracted by the abundant fish and wildlife. Annual spawning of lake sturgeon, whitefish and suckers and the presence of many other wildlife species provided a bountiful harvest to these original settlers of Michigan.

But as the number of European settlers to the Great Lakes region increased, these protected waters took on other values that conflicted with the ecological values so important to the Native American settlements and the fish and wildlife of the marsh. The river mouths and bays provided refuge to commercial boats and ships. The waters became important for industrial processes such as steam power or cooling. The shorelines were developed as factory or docking sites, requiring the wetlands to be filled. Ship access required dredging, straightening and stabilizing of the lower stream channels. Rapidly the seemingly limitless marshes along the Great Lakes and their connecting channels began to disappear.

In this book, we define and describe the diversity of coastal wetlands found along the Great Lakes shoreline and connecting waterways. Throughout the region, a series of environmental factors converge to create distinctive wetland environments and wetland types with characteristic assemblages of plant and animal species. We identify the natural processes that occur within the various types of coastal wetlands and make Great Lakes wetlands ecologically different from the smaller, inland wetlands familiar to many of us. Finally, we discuss the impacts of human development and land use on coastal wetlands and discuss ways in which we can protect and restore this important natural resource for future generations.

D. Albert

Rock-armored mouth of the Menominee River, previously a large wetland.

The Natural Setting: The Environmental Context of Coastal Wetlands

Great Lakes coastal wetlands occur along the Great Lakes shoreline proper and in portions of tributary rivers and streams that are directly affected by Great Lakes water regimes. These wetlands form a transition between the Great Lakes and adjacent terrestrial uplands and are influenced by both. Though multiple environmental factors are at work in structuring these systems, the most important factors appear to be:

- The aquatic environment.
- Shoreline configuration.
- Water level fluctuations.
- Bedrock geology.
- Climate.
- Human land use.

These factors — some regional, some local — create the context for Great Lakes coastal wetlands and provide a broad classification framework for understanding their diversity, distribution and species composition.

Aquatic Environments along the Great Lakes Shoreline

Water flow characteristics define distinctive aquatic environments within the Great Lakes. In ***lacustrine environments*** along the Great Lakes shoreline, water flow in the adjacent wetlands is controlled directly by waters of the Great Lakes; the wetlands are strongly affected by littoral (alongshore) currents and storm-driven wave action. Lacustrine habitats generally experience the greatest exposure to wind and wave action and to ice scour, the primary agents responsible for shore erosion and redeposition of sediments.

S. Kogge

Lacustrine environment: along western Saginaw Bay.

Along the most exposed shorelines, wetland habitat is rare, but wetlands frequently form in ***barrier-protected lacustrine environments***, where a sand dune or barrier beach separates the waters of the Great Lakes from the wetland. Barrier-protected wetlands are strongly influenced by the water levels of the neighboring Great Lake, but the dune or beach ridge protects the wetland from storm waves and reduces the chemical influence of the lake as well.

E. Epstein

Barrier-protected environment: Stockton Island, Apostle Islands.

In addition to the lakes themselves, multiple ***rivers and streams*** flow into or connect the Great Lakes, creating localized wetland habitats strongly influenced by the rivers. ***Connecting channels*** — the major rivers linking the Great Lakes — are the St. Marys, Detroit and St. Clair rivers in Michigan, as well as the Niagara and

C. McNabb

Connecting river: the St. Marys River joins Lake Superior and Lake Huron.

Among the smaller ***tributary rivers*** to the Great Lakes, water quality, flow rate and sediment load are controlled in large part by their individual drainages. Tributary rivers have a much lower volume and seasonally more variable flow than connecting channels, and they are influenced by the Great Lakes near their mouths. Where the tributaries

St. Lawrence rivers connecting the Great Lakes farther east in New York and Ontario. All connecting channels have been modified to accommodate large commercial vessels. Connecting channels are characterized by a large flow and seasonally stable hydrology. Their shallowness and strong current result in earlier spring warming and better oxygenation than in other aquatic environments. Because of their large size and modified hydrology, connecting channels are often treated as distinct from smaller rivers that flow into the lakes.

G. Reese

Potawatomi Bayou of the Grand River, a **tributary river** to Lake Michigan.

T. Cline

Protected embayment: Duck Bay.

enter the lakes, a transition zone from stream to lake occurs within which water level, sedimentation, erosion and biological processes are partially controlled by fluctuations in lake level. This transitional zone can extend several miles upstream and result in the formation of extensive wetlands. Examples include the Maumee River in western Lake Erie, whose water flow is affected by Lake Erie more than 10 miles upstream from the lake, and the Grand River, also with several miles of stream affected by Lake Michigan water levels. Potawatomi Bayou is a well-known tributary to the Grand River with an excellent marsh.

Shoreline Configuration

Today, glacial landforms, modified by lake currents and alongshore movement of sand, are the prevalent features along much of the Great Lakes shoreline. During the Wisconsin glaciation, the most recent glacial advance, much of the Great Lakes Basin was covered by ice. Advancing glaciers scoured the ancient landscape and transported rocks and soil on and in the glacial ice. As the glaciers retreated from Michigan approximately 10,000 years ago, these sediments were redeposited, forming diverse features including moraines, drumlins, eskers, kames and outwash plains.

The modern landscape closely reflects these glacial landforms, with surface sediments reworked by wind and water. Their characteristic differences in soils, slope and drainage conditions largely determine both natural shoreline configuration and sediment composition. These, in turn, generate distinctive contexts or site types for wetland development that vary in their exposure and resilience to lake stresses and in their soil chemistry and texture. The importance of these glacial features for understanding the diversity of Great Lakes coastal wetlands is clear. As Charles Herdendorf, a Great Lakes authority notes, “Perhaps in no other geographic environment is the relationship between landforms and vegetation so evident.”

Wetland Site Types of Lacustrine Systems

Lacustrine wetlands along the Great Lakes coastline generally occupy sites that offer some protection from the force of wind and waves. In contrast, where the shoreline is exposed to the full erosive forces of wind, wave and ice, high wave energies and the absence of stable substrates preclude wetland development. Protection from the lake may be created by upland topography and shoreline configuration, by a variety of nearshore barriers (including sand spits, shoals and islands), or by gently sloping and shallow bottom topography that attenuates wave height and reduces wave energy.

Several coastal features provide protection for wetland development along the Great Lakes proper. **Open embayments** — curving sections of shoreline open to the lake — offer some protection from the force of the lake in areas where shallow water depth and gently sloping bottom topography reduce wave height and energy, such as along the flat glacial lakeplains. On *clay lakeplains*, the fine-textured soils are ideal for the establishment and persistence of aquatic plants. They permit a continuous ring of emergent marsh vegetation such as that rimming large portions of Saginaw Bay. In contrast, on *sand lakeplains*, broad and shallow embayments are created through nearshore transport of sand. The shifting sands discourage aquatic plant roots and generally limit emergent wetlands to a narrow fringe along the shore.

Protected embayments, in contrast, are deeper shoreline indentations cut into resistant upland shoreline that provide significant protection from wind and wave energy. Tributary streams may flow into these embayments carrying organic and mineral sediments derived from adjacent uplands. The complex shoreline of the Les Cheneaux Islands consists of drumlinized ground moraine features that create numerous protected embayments. Protected embayments are sometimes common where glacial scouring has carved into bedrock, but examples

T. Cline

St. Martin Bay, an open embayment of northern Lake Huron.

D. Albert

Sand-spit embayment at Wigwam Bay, Saginaw Bay.

of such wetlands are more common outside of Michigan, such as along Georgian Bay on northeastern Lake Huron or the Thousand Islands of the upper St. Lawrence River. In Michigan, a few such bedrock embayments occur along the northern Drummond Island shoreline.

Shallow **sand-spit embayments** are created behind sand spits projecting along the coasts. These sand spits form along gently sloping and curving sections of shoreline where sand transport parallels the shore. The spits are exposed to both wave activity and overwash. On their landward side, however, the spits generally provide good protection from wind and waves that allows organic and fine mineral sediment accumulation and wetland development in the sheltered embayments. Large, recurved and compound sand spits may also enclose small swales or larger lagoons that offer a protected habitat for emergent vegetation. Major sand-spit features occur at Whitefish Point on Lake Superior. Smaller sand-spit embayments are common along Saginaw Bay.

Wetland Site Types of Barrier-protected Lacustrine Systems

Dune and swale complexes form along relatively flat shoreline, such as sand lakeplains. These complexes consist of a series of low, sandy dunes or beach ridges 2 to 15 feet high deposited by receding Great Lakes waters over the past 5,000 years. From the air, these ridges appear as a series of arcs extending inland up to 3 miles, generally parallel to the present shoreline. Wetlands form in the swales between the beach ridges. Close to the lake, water levels in these swales are directly tied to Great Lakes water level fluctuations, but swales more distant from the lake

E. Epstein

Dune and swale complex at Stockton Island, Apostle Islands, Wis.

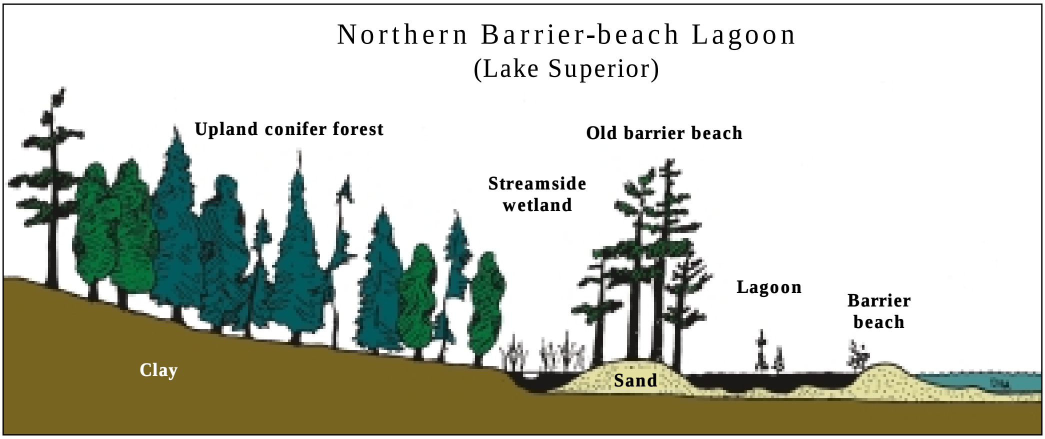
E. Epstein

Tombolo at Stockton Island, Apostle Islands, Wis.

are affected by groundwater flow from the uplands.

Tombolos form when bedrock islands are connected to the mainland by current-deposited sands. The embayment created on the leeward side of the tombolo offers sufficient protection from Great Lakes wave action that a fringe of marsh vegetation persists. The connecting bar or ridge may also enclose a swale or lagoon within which thick organic soils accumulate and support a dense growth of aquatic vegetation. Two Michigan examples, both on Lake Superior, are Murray Bay on eastern Grand Island near Munising and Pequaming on Keweenaw Bay.

Barrier-beach lagoons result when nearshore currents deposit a sand or gravel barrier bar across the mouth of an embayment. The resulting shallow pond or lagoon is



sheltered from the lake's wave energy; sediments accumulate in the lagoon basin and vegetation can become rooted. Although water levels in the lagoon may be augmented by tributary streams and groundwater seepage, coastal lagoon wetlands are also partially controlled by the Great Lakes through permanent or intermittent connecting channels, wave overwash or cross-bar seepage. Barrier-beach lagoons are a common wetland type in the Apostle Islands of Lake Superior and on Lake Ontario. Tobico Marsh on Saginaw Bay and Petobego Pond near Traverse City are two Michigan barrier-beach lagoons.

C. McNabb

Channelside wetland along the St. Marys River.

C. McNabb

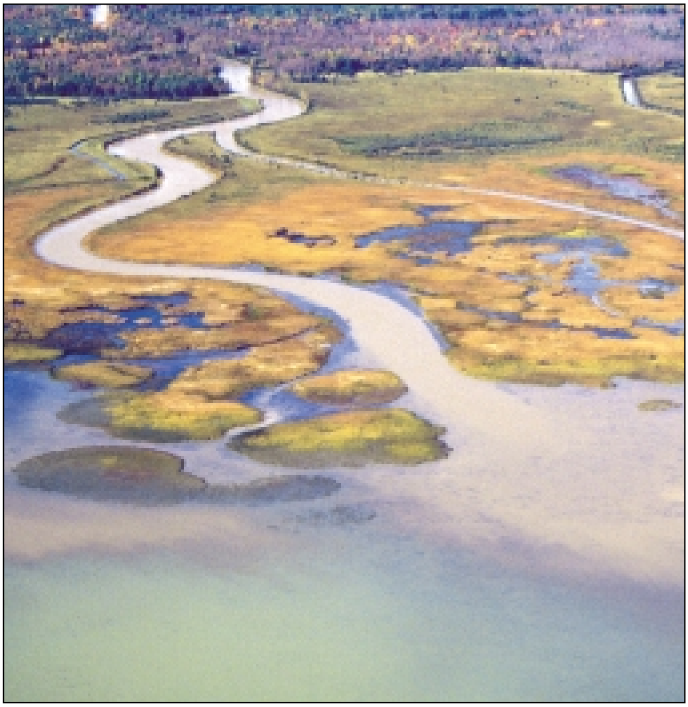
Streamside embayment, St. Marys River.

Wetland Site Types of Riverine Systems

Along the major **connecting rivers** that link the Great Lakes, streamside sites fronting the main channels are exposed to wave action from boat traffic, and vegetation is frequently limited to a thin fringe paralleling the shore. These **channelside wetland** sites experience strong currents, deep water, and little or no organic accumulation in the emergent marsh zone. Channelside wetlands are common along the St. Marys River and portions of both the St. Clair and Detroit rivers because of the flat, poorly drained glacial lacustrine topography. In contrast, shallow **streamside embayments** along the major connecting rivers provide additional protection from erosion. Effects of channel current and boat wash are reduced, organic sediments accumulate, and wetland vegetation is more extensive than in channel-side wetlands.

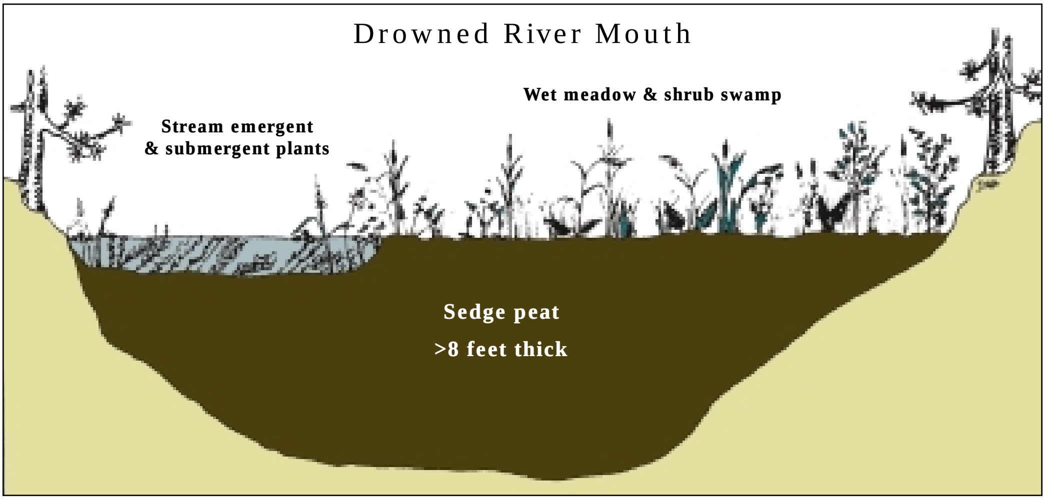
River deltas form as stream sediments deposited at the mouth of a river accumulate and create multiple shallow channels, low islands and abandoned meanders that allow for extensive wetland development. Wetland sites range from the generally sandy or gravel substrates and swift current of the main channel to the thick organic soils of the more protected secondary channels. Large deltas commonly form on flat glacial lakeplains. The St. Clair River, a connecting river, forms the largest freshwater delta in the world as it enters Lake St. Clair. More commonly, deltas are formed by large tributary rivers as they enter the Great Lakes. Prime examples include deltas formed by the Pine, Rifle and Saganing rivers on Saginaw Bay in Lake Huron, as well as the River Raisin on western Lake Erie.

G. Soulliere



Munuscong River delta.

Drowned river mouths form in the zone of riverine/lacustrine interface along the lower stretches of tributary rivers. During periods of extremely low lake levels, tributary rivers eroded broad ravines through bluffs bordering the Great Lakes shoreline. The subsequent rise in the Great Lakes to present-day levels drowned the mouths of these rivers, creating an embayed estuary whose water levels are controlled by the Great Lakes. Fairly steep upland slopes help shield the estuary, and reduced water velocities lead to deep accumulations of organic soils. The result is a protected, fertile (but topographically circumscribed) wetland.



Drowned river mouths that remain open to the lake experience continual water flows between river and lake and are subject to the direct impact of lake level fluctuations and storm events. Alternatively, a lacustrine estuary may be barred when nearshore currents deposit a partial berm or barrier dune across its mouth. Such barriers create a relatively sheltered inland "lake" or pond connected to Great Lakes water levels by an outlet channel but protected from the direct force of wind and wave action off the lake. Barred drowned river mouths are a dominant wetland feature along the Lake Michigan shoreline in southwestern lower Michigan where large dune features have partially blocked riverine flows. The protected, fertile wetland habitat extends inland for several miles along the Kalamazoo, White and Grand rivers.

E. Epstein

Open drowned river mouth, Sand River in Bayfield County, Wis.

Fluctuations in Great Lakes Water Levels

All of the preceding wetland environments are influenced, to differing degrees, by fluctuations in Great Lakes water levels. These fluctuations occur over three temporal scales: short-term, seasonal, and interannual or multiyear. All of these scales contribute to the dynamic character of coastal wetlands, although interannual fluctuations impose the greatest stress.

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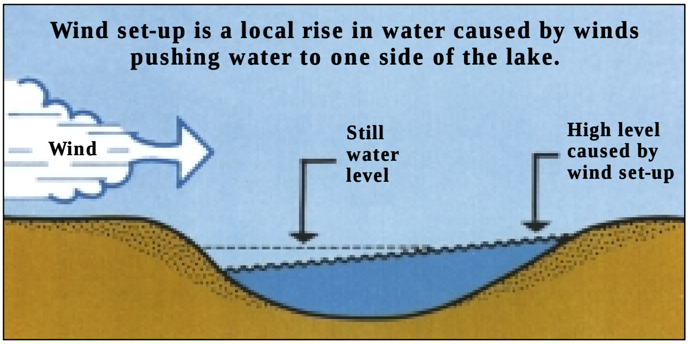
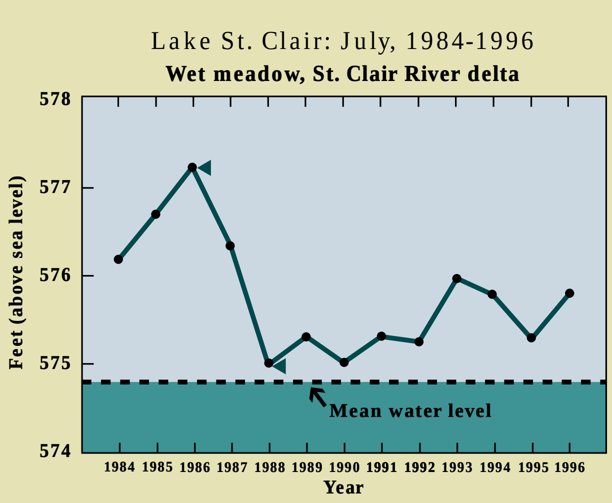


Diagram of wind set.

Short-term fluctuations in water level are caused by persistent winds and/or differences in barometric pressure. Short-term fluctuations are known as **seiche** or **wind-set** events. Though these fluctuations are of relatively short duration, their effects can be quite extreme, especially when associated with storms. Seiches as high as 5 feet have been recorded on Lake Michigan and as high as 9 feet on Lake Huron. Lake Erie, the shallowest of the Great



1986: Extreme high water level.

1988: Average water level.

Diagram of long-term water level changes, with accompanying photos of the wet meadow zone of the St. Clair River delta.

Lakes, experiences some of the most dramatic seiches, with lake level surges as high as 15 feet (5 meters). Such storm surges have tremendous impact on coastal wetlands and their inhabitants. Waves can destroy wetland vegetation, eliminating habitat for fish, waterfowl and aquatic mammals. A spring storm in 1998 destroyed hundreds of muskrat lodges along Saginaw Bay at a time when young muskrats were highly vulnerable.

Many plants and animals of the marsh, however, are adapted to survive either temporary flooding or exposure to air. On many occasions while sampling vegetation in Saginaw Bay marshes, we discovered that plants submerged near shore were completely exposed to the air an hour or two later following a wind change. Similarly, along the shores of Lake Erie, spawning northern pike are temporarily trapped in shallow isolated pools within the marsh when lake waters are pushed from the wetland by strong offshore winds.

Seasonal fluctuations in lake levels reflect the annual hydrologic cycle in the Great Lakes basin. Water levels in the Great Lakes are characterized by low water levels in the winter and spring and high water levels in summer and early fall. Highest water levels are typically seen in early August. The effects of these seasonal changes on marsh plants and animals have not been studied in detail but may be significant for germination of many plants. Many aquatic plants germinate best on moist soils or in very shallow water, even though they thrive as adults in completely flooded conditions.

Interannual or year-to-year fluctuations in lake levels are the result of variable precipitation and evaporation within Great

D. Albert

Interannual fluctuations: wave erosion of wet meadow in 1986 high water.

Lakes drainage basins. Interannual fluctuations can be as extreme as 3.5 to 6.5 feet (1.3 to 2.5 meters); they occur with no regular periodicity. In general, as water levels rise and fall, vegetation communities shift their location — landward during high-water years and lakeward during low-water years. However, fluctuating lake levels effect not only a change in water depth but a broad range of associated stresses to which plants must respond, including changes in water current, wave action, turbidity (clarity or light penetration), nutrient content or availability, alkalinity and temperature, as well as ice scour and sediment displacement. Individual species display different tolerance limits along one or more of these dimensions of stress, so species composition within a marsh or marsh zone can change dramatically in response to water level fluctuations. Wetland animal species, including

D. Albert

Wave erosion of bulrush (*Schoenoplectus acutus*) stems in 1986 high water.

muskrats, demonstrate an equally dramatic response. During high-water conditions in 1986 and 1987, muskrat lodges were very abundant in flooded sedge meadows and cat-tail beds. When water levels dropped in 1988, exposing most of the sedge meadow and cat-tail beds, muskrat lodges became much less numerous. Similar changes affect waterfowl breeding success and fish spawning, as well as distribution of invertebrates such as dragonflies and mayflies.

Conversely, the absence or dampening of natural lake level fluctuations alters plant species composition as well. Coastal wetland systems are adapted to and require periodic inundation. Where regulation of water levels has significantly reduced the occurrence of extreme high and low water levels, disruption of the natural cycle favors species intolerant of water depth change and associated stresses, and/or excludes species requiring periodic exposure of fertile substrates. The result may be a reduction of species diversity. A reduction in the amplitude of natural water level fluctuations has been suggested as the reason for reduced species diversity in many Lake Ontario marshes.

Wetland Plant Response to Water Level Fluctuations

Multiyear studies of Michigan's Great Lakes wetlands have shown us how vegetation responds to interannual water level fluctuations. When water levels rise, sedges, grasses and cattails along the shore are eroded by wave action. Some species of the emergent marsh zone shift inland, such as cattails and bulrushes. Small bladderworts, including *Utricularia intermedia*, appear as soon as shallow water covers the wet meadow.

But when the water level drops, changes on the newly exposed mud flats are often more dramatic. It is common to see a lawn of minute annual spike-rushes. Softstem bulrush may explode in coverage, often forming a dense band with hundreds of stems per square meter. Another conspicuous arrival is the sedge *Carex cryptolepis*, resembling small pincushions, locally carpeting a band several feet wide just above the water's edge. Each sedge plant bears dozens of seeds that will ripen and drop onto the soil, where they may rest dormant for years until conditions are again right for their germination. The ability of seeds to remain dormant in the seed bank is an adaptation that has proven successful for many plant species in the fluctuating environment of coastal marshes.

D. Albert

A dense band of sedge (*Carex cryptolepis*) occupies the dried-down strand zone following a drop in Great Lakes water level.

D. Albert

Seeds of Montevidens' arrowhead (*Sagittaria montevidensis*), an annual, germinate from the seed bank when water levels drop.

Wetland Plant Response (continued)

D. Albert

Nodding smartweed (*Polygonum lapathifolium*) growing on silt-rich mud following a drop in water level. Erie Marsh, Lake Erie.

Probably the most amazing response to the dry-downs is seen on Lake Erie marshes. Nodding smartweed, an annual, uses the surge of newly available nutrients to form dense stands of heavily fruiting plants 6 feet tall. A year later, with reduced nutrients and competition from other plant species, nodding smartweed is only a few inches high. Some submergent plants flower and fruit abundantly during low-water conditions as well. Water star-grass, typically growing in 1 to 3 feet of water, flowers profusely only when it is stranded along the shoreline. When water levels are high, water bulrush (*Schoenoplectus subterminalis*) forms slender, limp leaves that shift with each passing wave. But when water levels drop, it produces short stems, each with a single fruit, sometimes called "bug on a stick".

A. Reznicek

Both forms of water bulrush (*Schoenoplectus subterminalis*): low-water emergent form with fruit and high-water limp, submergent form.

D. Albert

Water star-grass (*Heteranthera dubia*) flowers abundantly when stranded during low-water periods.

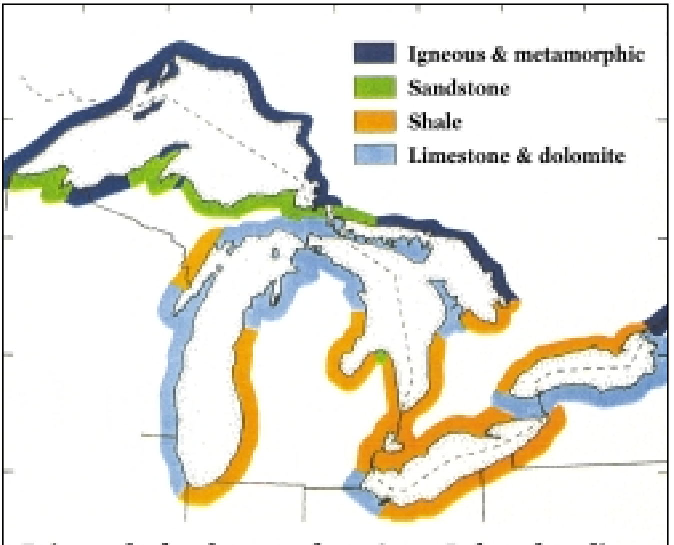
Most aquatic plants in the coastal marshes exhibit changes in structure, dominance or fruit production in response to water level fluctuations. This seems only natural in an ecosystem where water level change is so prevalent.

Bedrock Geology

The physical and chemical characteristics of various bedrock types can affect both wetland location and species composition. The major bedrock distinction in the Great Lakes Basin is between igneous and metamorphic bedrock (including granite, basalt and rhyolite) of the Precambrian period and younger (Paleozoic) sedimentary bedrock (including sandstone, shale, limestone and dolomite). Igneous and metamorphic bedrocks form the southern shore of western Lake Superior, where they co-occur with younger sedimentary rock, primarily sandstone. In contrast, only softer sedimentary bedrock types underlie lakes Michigan, Huron, St. Clair, Erie and Ontario.

As a major determinant of coastline configuration, the physical structure of bedrock type limits the distribution of coastal wetlands at a regional scale. The rugged Lake Superior shoreline of sandstone and igneous and metamorphic rock lacks the shallow protected waters and fine-textured substrates that support broad coastal wetlands. Here almost all coastal wetlands occur behind protective barrier beaches or are localized at stream mouths. In contrast, the horizontally deposited marine and near-shore sedimentary rock that underlies lakes Michigan, Huron, St. Clair, Erie and Ontario provides broad zones of shallow water and fine-textured substrates for marsh development.

Bedrock chemistry can affect wetland species composition as well. Soils derived from much of the Precambrian bedrock are generally acid and favor the development of poor fen or bog communities. In contrast, soils derived from marine deposits, including shale and



Primary bedrock types along Great Lakes shorelines.

D. Albert

Steep volcanic conglomerate bedrock along Lake Superior provides few sites for wetland development.

marine limestone, dolomite and evaporites, are typically more calcareous (less acid), nutrient- and moisture-rich loams and clays. Where these bedrock types are at or near the surface, their alkalinity creates the preferred habitat for many calcium-loving plant species.

P. Comer

Flat-lying limestone bedrock. The flat landscape and nutrient-rich sediments derived from the limestone produce ideal conditions for the formation of large coastal wetlands.

Climate

Variation in climate within the Great Lakes Basin is largely determined by latitude, with the modifying influence of the lakes (i.e., lake effect) operating at a more local level. The strong latitudinal gradient from southern Lake Erie to northern Lake Superior creates marked differences in length of growing season and annual input of solar energy across the region. These differences, in turn, are reflected in the regional distributions of a number of species common to Great Lakes wetlands.

Though most aquatic plants are widely distributed, species with known southern affinities make their appearance, as do those of the far-northern boreal forest. Lake Erie wetlands, for example, are rich in southern marsh species that rarely occur along the other Great Lakes; species representative of southern wet prairie are locally abundant there as well. Both of these southern floras differ significantly from the complex of boreal, subarctic and arctic species found in the northern portions of lakes Huron, Michigan and Superior.

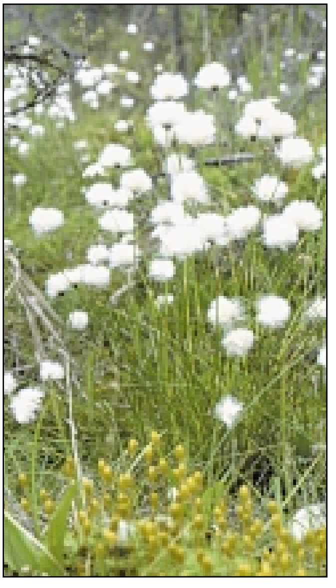
D. Albert

In Michigan, Sullivant's milkweed (*Asclepias sullivantii*) is found in lakeplain wet prairies along the southern lakes from Lake Erie to Saginaw Bay.

D. Albert

A southern species, Montevidens' arrowhead, grows only as far north as Lake Erie's shoreline.

D. Albert



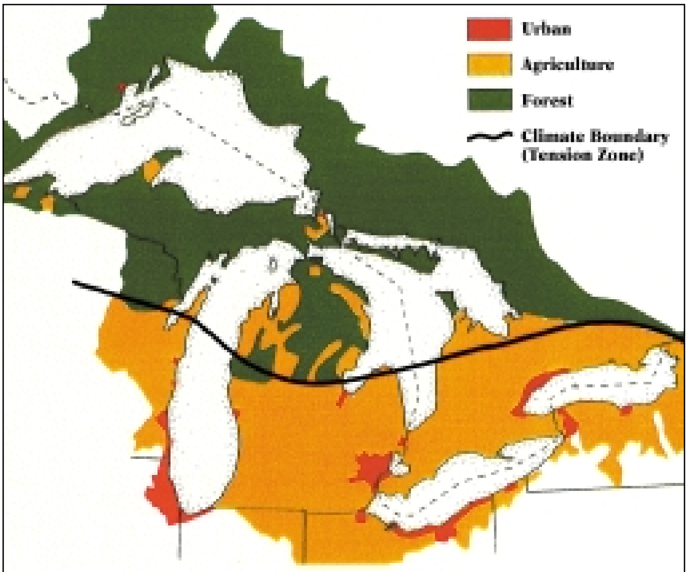
Cotton-grass (*Eriophorum* spp.), characteristic of northern bog wetlands, here is seen growing in a coastal dune and swale complex.

Human Land Use and Anthropogenic Stress

Differences in land use — whether urban, agricultural or forested — create regional differences in the extent and quality of coastal wetlands, as well as in their species composition. To a large extent, land use is a composite variable reflecting climate, physiography and soils. The tension zone, a rough climatic boundary separating the forested north from the more agricultural south, closely follows regional differences in summer mean daily air temperature. Urban development, in contrast, reflects the early location of good harbors and the distribution of natural resources such as timber and mineral ores. Both urban and agricultural development have resulted in severe degradation and loss of coastal marshes.

J. Schafer

No island within the delta is viewed as too small for development.



Major land use divisions in the Great Lakes Basin.

Impacts of Urban Development:

- Armoring of the shoreline and dredging of channels to create harbors eliminate marsh and wetland habitat.

Human Land Use and Anthropogenic Stress

R. Cole

On Lake Ontario, cat-tail-choked wetlands along stream margins are partially the result of water level control.

- Dumping of waste materials such as sawdust and sewage and a wide variety of chemicals increases turbidity, reduces oxygen concentrations and alters the pH of the shallow-water marsh environment.
- Shipping traffic and associated wave action erode shoreline vegetation.
- Water level control of the Great Lakes and connecting rivers reduces short-term and inter-annual water level fluctuations and alters natural wetland dynamics.
- Marina development and beach grooming by lakeside residents removes aquatic vegetation; without roots to stabilize bottom sediments, lake currents erode adjacent shoreline, resulting in wetland loss or degradation.

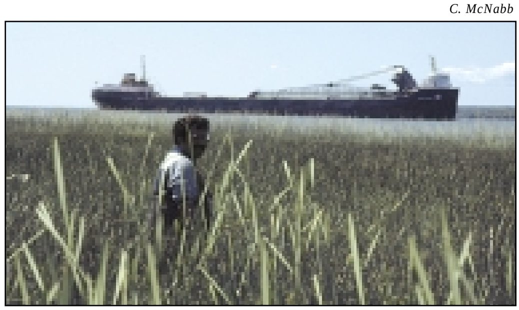
J. Haas

Beach plowing on Saginaw Bay reduces bulrush regeneration and rooting.

D. Albert

Grand River sewage spill results in dense growth of duckweed.

C. McNabb



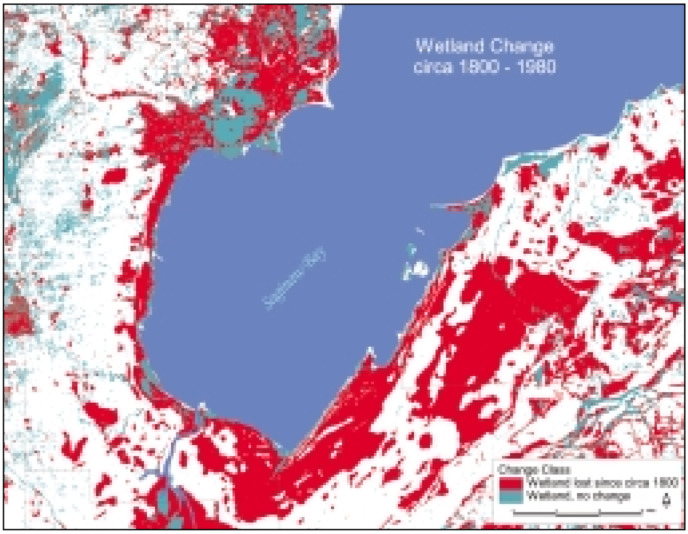
Commercial vessels can contribute to erosion of coastal wetlands.

Impacts of Agricultural Development:

- Field drainage has eliminated large areas of marsh and coastal wetlands.
- Erosion and sedimentation from plowed fields have greatly increased water turbidity and eliminated aquatic plants requiring clear water.
- Nutrient loading has locally reduced oxygen levels, prompted algal blooms, and led to the dominance of species such as cat-tails that

D. Albert

Drainage of lakeplain prairie along Saginaw Bay with drainage ditches and tiles.

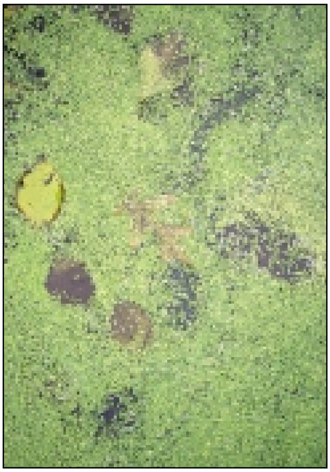


Historic wetland change on Saginaw Bay.

Lois Wolfson

Curly-leaved pondweed (*Potamogeton crispus*), an aggressive exotic plant, tolerates turbid waters by concentrating leaves near water surface.

D. Albert

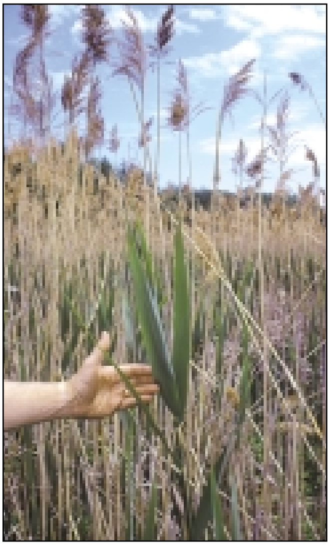


Duckweed in drainage ditch carrying water and sediments from agricultural lands along Saginaw Bay.

thrive on high nutrient levels.

- Heavy agricultural run-off has led to the deposition of rich organic mud in the wet meadows and along the shoreline, favoring the dominance of early successional and weedy species.
- Introduced aggressive exotic plants have crowded out native plant species and reduced dependent insects and birds.

D. Albert



An exotic variety of reed (*Phragmites australis*) is a large, aggressive emergent species that expands into disturbed habitat.

D. Albert

Mats of filamentous algae along Frenchman Creek, Lake Erie.

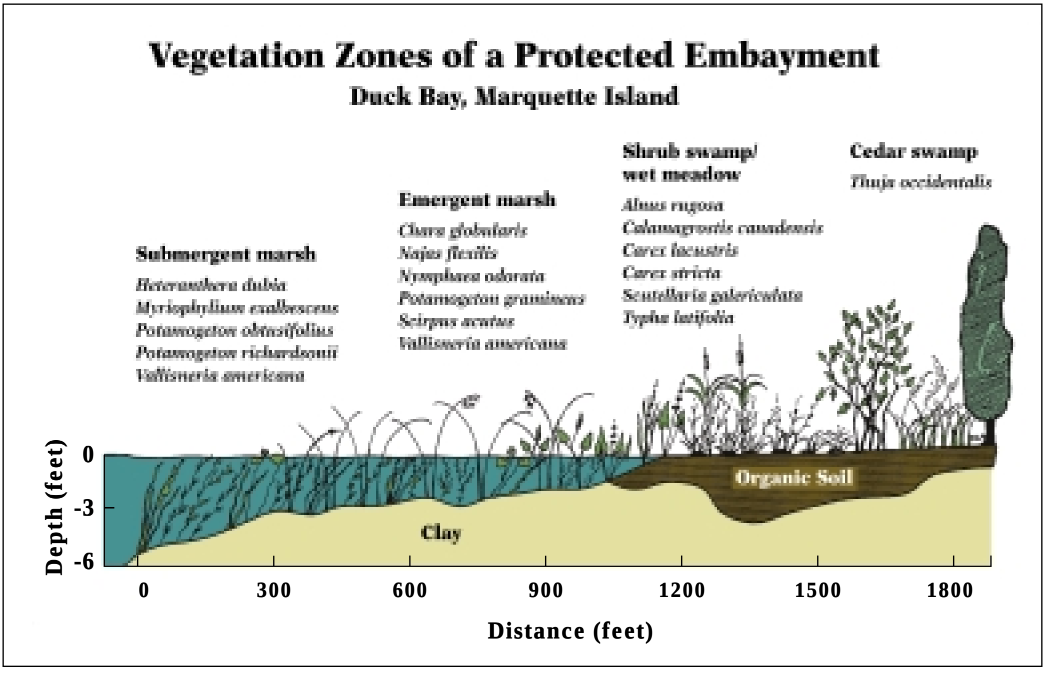
G. Soulliere

Stream carrying nutrient-rich sediments from agricultural fields.

The Diversity of Great Lakes Coastal Wetlands

Zonal Wetland Vegetation

Great Lakes coastal wetlands usually contain several distinct zones of aquatic and wetland vegetation. Moving from deeper water to the shore, typical zonation includes the **submergent marsh** containing submerged (underwater) and/or floating vegetation such as water-lilies; the **emergent marsh**, characterized by shallow water or saturated soils and typically dominated by bulrushes, cattails and other species emerging above the water, but also containing submergent and/or floating vegetation; and a narrow but diverse **shoreline** or **strand zone** at or just above the water line where seasonal water level fluctuations and waves cause erosion, usually dominated by annual herbs. Inland from the water's edge, additional zones can be identified: the **herbaceous** or **wet meadow** zone characterized by saturated or periodically flooded soils and dominated by sedges, grasses and other herbs; and the **shrub swamp** and s**wamp forest** zones, both characterized by periodic standing water and dominated by woody species adapted to a variety of flooding regimes. Not all zones are present or well developed in every wetland.



D. Albert

Submergent vegetation such as wild-celery (*Vallisneria americana*) can occupy clear waters much deeper than emergent plants.

D. Albert

The outer emergent bulrush beds are quite sparse as a result of strong wave activity.

The development of distinct vegetation zones, species composition and quality of Great Lakes coastal wetlands directly reflect the controlling influence of specific environmental factors discussed above. Through a combined analysis of the vegetation and the environmental context, we can identify several types of Great Lakes coastal wetlands in Michigan, each with distinctive floristic characteristics and a restricted geographic distribution.

D. Albert

Wet meadow dominated by broad blue-joint grass (*Calamagrostis canadensis*) and sedge (*Carex stricta*) with speckled alder (*Alnosa rugosa*) and willows (*Salix* spp.) closer to shore.

D. Albert

Submergent and floating types of vegetation often grow densely in the protected inner emergent marsh.

Northern Great Lakes Marsh

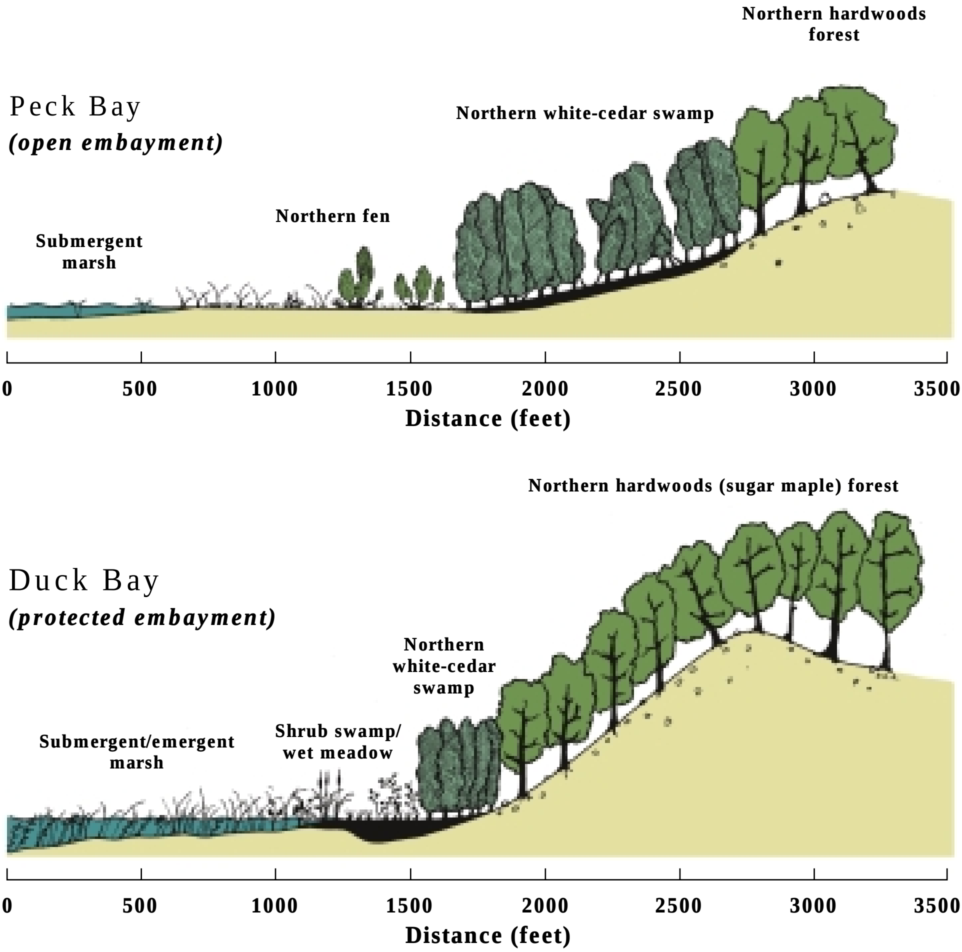
The clear, cool waters of northern Lake Michigan and Lake Huron are home to some of the least disturbed Great Lakes coastal wetlands in Michigan. Their intactness, resulting from relatively low levels of agricultural, industrial and residential development, allows us to better understand the natural wetland zonation and dynamics of Great Lakes wetlands.

The Les Cheneaux Islands on northern Lake Huron contain prime examples of northern Great Lakes marshes. Among these islands there are countless small bays, some protected between the island and the mainland and others open to the full wind of Lake Huron. Two nearby marshes on Marquette Island — Duck Bay and Peck Bay — illustrate the strong contrast in wetland vegetation resulting from the different degrees of exposure to the open lake.

T. Cline

Aerial photo of Duck, Peck and Voight bays on Marquette Island.

Bays protected from the full energy of storm waves support broad bands of emergent marsh and wet meadow along their shores, such as those encountered at Duck Bay. Submergent plants grow to depths of 6 feet in the clear waters of Duck Bay, Comparison of Plant Communities at Peck Bay and Duck Bay, Marquette Island



well beyond the outer margin of the emergent zone. Low densities of hardstem bulrush and spike-rush characterize the outer emergent beds. Vegetation becomes denser close to shore, where wave action becomes less severe. Diverse emergent beds of water bulrush, water horsetail, arrowhead, pickerel weed and bur-reed form near shore, providing additional protection for floating water-lilies and spatterdock, as well as submerged beds of pondweeds, naiad, water-weed, water-milfoil and wild-celery. The protected waters of the inner bay accumulate silt and fine decomposing organic material important to the ecology of the wetland.

Inland from the water's edge, a zone of grasses and sedges several hundred feet wide begins, continuing until conditions become dry enough to support swamp or upland forest. Among the most common wet meadow plants are blue-joint grass and tussock-forming sedges (*Carex stricta* and *C. aquatilis*). Marsh fern, marsh bellflower, marsh pea and marsh cinquefoil, along with many other forbs, are scattered throughout the meadow.

In the narrow band of northern shrubs that borders many of these wetlands, one regularly sees speckled alder, sweet gale, meadowsweet and shrubby willows, all surrounded by blue-joint grass and tussock sedges. As conditions become drier, the shrubs are replaced by

J. Schafer

Marsh pea (*Lathyrus palustris*) in wet meadow.

northern white-cedar or other swamp trees.

Conditions in the wet meadow and shrub swamp are wet enough that trees seldom survive to adulthood. During the wettest years, the entire wet meadow can be covered with shallow water, which kills any tree seedlings that might have established. Continuously wet conditions in the meadow result in accumulation of partially decomposed vegetation, often to the depth of 2 or 3 feet.

Michigan Sea Grant

Yellow perch (*Perca flavescens*).

In the nearby open embayments at Peck and Voight bays, intense wave action creates very different conditions. Here, the broad emergent marsh is absent and there are few submergent plants, with the exception of scattered pondweed and muskgrass. During high-water years, bulrushes in such open bays are subjected to large storm waves that often break stems at the plant base. If all of the stems of a bulrush plant are broken, adequate levels of oxygen may not reach the plant's rhizomes and the plant will die. It can then take several years for bulrushes to reestablish in the emergent zone of the wetland. Without their tenacious root structure to anchor sediments and reduce wave action, storms erode organic material, leaving a surface of cobbly clay. As a result, the zones of the open embayment at Peck and Voight bays are much narrower and less well developed than those of protected embayments. Where organic materials have been completely removed, a distinctive assemblage of plants known as **northern fen** grows directly on the clay or marl substrate. Northern fens will be discussed in more detail in the following section.

M. Blouin

Perch spawn deposited on bulrush stems.

Nutrient enrichment from agricultural fertilizers and sewage effluent have altered most marshes along the southern Great Lakes, but few of these northern wetlands have undergone significant alterations. This has allowed for some interesting comparisons at Cedarville, where a small flow of nutrient-rich wastewater enters a coastal wetland from Pearson Creek. While the emergent zone of most protected embayments contains only open beds of submergent plants, the nutrient input from Pearson Creek has resulted in dense submergent and floating plant beds. The effect is quite localized — a few hundred yards from the source, nutrient levels have been reduced by lake currents and the plant beds cannot be distinguished from those in other nearby protected embayments.

T. White

Midge (*Chironomus* spp.)

The extensive emergent marshes of the Les Cheneaux islands are considered by many to be critical for maintaining the famous perch fishery of the islands. This dependency begins as the fish spawn, commonly attaching their egg masses to bulrush stems; later the weed beds provide protective cover for newly hatched and juvenile perch. The young perch feed heavily on abundant plankton in May and June, but as plankton numbers begin to decline and fish grow into their larger juvenile stage, they begin feeding on larvae of midges and other macroinvertebrate fauna.

The importance of marsh invertebrates in maintaining a healthy fishery has long been recognized. Another surprising and important ecological relationship was only recently discovered: that between midges and migratory songbirds, especially the spring migration of warblers. Warblers migrate north during late April and early May when there are few insects or other high-calorie foods to reenergize these long-distance travelers. During these first warm spring days, swarms of midges emerge from the shallow waters along the shoreline, alighting by the millions on shoreline trees. Warblers feast on these minute insects and are fueled up to complete their long journey.

B. D. Cottrille

Black-throated blue warbler (*Dendroica caerulescens*).

Plankton: The Hidden World of the Marsh

Sheila McNair and Vanessa Lougheed

The broad northern marshes provide food and habitat for a diverse and complex group of animals, including insects, amphibians, fish, mammals and wetland birds. At the base of the food chain are the microscopic aquatic organisms, phytoplankton and zooplankton. Phytoplankton include a broad group of algae living in open waters of the lake, dependent on sunlight and nutrients in the water for their survival and reproduction. Most phytoplankton have no power of locomotion and are distributed by water movement. Other algae, commonly called periphyton, form thick layers on the submerged portions of plants growing within the marsh and provide an abundant and important food source for aquatic invertebrates such as caddisflies, mayflies, water boatmen, segmented worms, midges and snails.

Collect a bottle of water from a wetland and you could see well over 1,000 tiny animals per liter or hundreds of small plants living in a single drop. Although invisible to the naked eye, these microscopic organisms play a critical part in the ecology of Great Lakes coastal marshes. Both microscopic plants (algae) and animals (microinvertebrates) are found in large numbers throughout these diverse ecosystems. In the water column and attached to various surfaces, algae form the base of aquatic food webs. They are used as food by microinvertebrates, which may then be eaten by other invertebrates or fish.

Specialized microscopic communities become established in the various types of open-water and vegetated habitats found in wetlands. In the open-water areas, planktonic organisms, including both plant (phytoplankton) and animal (zooplankton) forms, float about or swim weakly in the water column. In shallower areas, plants and sediments provide a surface for a unique community of attached algae and substrate-associated microinvertebrates. Certain organisms may even be adapted to living on a specific type or species of aquatic plant.

V. Lougheed

Highly specialized microinvertebrate (Cladosceran, 0.3 mm) uses fine hairs (bottom of picture) to attach firmly to undersides of leaves.

Organisms have special adaptations that allow them to thrive in these shallow, plant-dominated habitats. Many algae are able to attach to the surfaces of plants (epiphyton) or to submerged woody debris, fenceposts

Plankton: The Hidden World (continued)

or other hard surfaces (periphyton) using specialized structures such as mucilage pads, mucous tubes or specialized attachment cells. Other forms live on and within the sediment or attached to hard pebble or stone surfaces. Some algae are perched on stalks that allow them to compete for space, light and nutrients by extending out into the water from the point of attachment.

S. McNair

Floating algae mat, made up of floating vascular plants and filamentous green algae.

The microinvertebrate community is generally dominated by poor swimmers that live attached to plants or close to them. Animals are adapted to cling firmly to the under-

S. McNair

Stalked diatoms magnified 400 times.

sides of leaves, burrow into soft sediment or survive in conditions of low oxygen. Specialized body parts are used to collect food by scraping algae from attached surfaces or by selecting particles that have sunk out of the water column.

Scientists are just starting to use invertebrates and algae as indicators of wetland quality. These organisms reproduce quickly and are relatively short-lived, so they often respond to chemical and physical stress before longer lived organisms such as fish and vascular plants. In addition, because they are at the bottom of the food web and their movements are usually restricted to a fairly small area, they quickly reflect changes in their immediate habitat and may thus be used as an early warning signal of environmental change. For example, microscopic algae are often inconspicuous unless elevated

S. McNair

The submergent vegetation in this coastal wetland is covered by clouds of attached algae (epiphyton).

nutrient inputs to the wetland produce a “nuisance bloom” that may be more visible. Similarly, with reduced wetland quality, plant-associated microscopic organisms may become replaced by more tolerant, smaller bodied open-water species.

Northern Rich Fen

Coastal wetlands of this type are concentrated near the Straits of Mackinac in open embayments where clay, limestone bedrock or limestone cobbles are at or near the surface. Some well-known fens in public ownership are Wilderness State Park, Thompsons Harbor State Park, El Cajon Bay near Alpena and Voight Bay on Marquette Island. Many of our northern fens are geologically interesting, containing sinkholes or springs sometimes fed by streams that disappeared belowground miles from the lakeshore. Both sinkholes and springs occur at El Cajon Bay.

Unlike most of the other Great Lakes coastal wetlands, the northern rich fen sites have calcareous soils with pH values higher than 8.0. The open, exposed conditions of the open embayments do not allow organic materials to accumulate, so the exposed lime-rich mineral soils are maintained. As a result, submergent and emergent types of vegetation are often sparse and diversity is low in the shallow waters of the open bays. Muskgrass sometimes forms an underwater "lawn" in shallow waters, and sparse stands of hardstem bulrush form an open emergent zone.

Along the shore, however, algal precipitation of calcium carbonate in the relatively warm, carbonate-saturated waters forms distinctive marly flats that host a diverse and colorful flora of calcium-loving plants. Within the meadow zone, an interesting indicator plant of the northern fen is walking sedge, a spike-rush that arches over and roots at the tip of its stem, producing a loop that can trip a careless visitor. One of the earliest plants of the shoreline, bird's-eye primula, brightens the shoreline in mid-May, to be rapidly joined by Indian

T. Cline

Open northern fens along the shoreline of Horseshoe Bay Wilderness Area.

D. Albert

Northern fen at El Cajon Bay, near Alpena.

D. Albert

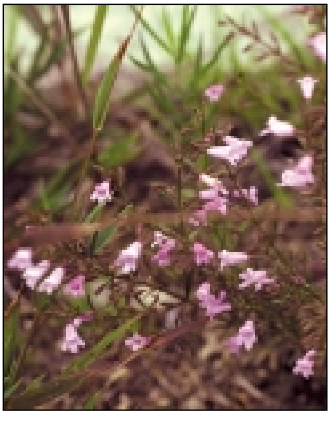
Walking sedge (*Eleocharis rostellata*) growing on marl flat. Notice stems rooting from their tip.

paintbrush. As the summer progresses, Kalm's lobelia, calamint and grass-of-Parnassus appear, followed by Ohio goldenrod, fringed gentian and several late-flowering asters.

D. Albert

One of the earliest flowers of the marsh, bird's-eye primula (*Primula mistassinica*).

D. Albert



Calamint (*Calamintha arkansana*) blooms in late summer.

D. Albert

Grass-of-Parnassus (*Parnassia glauca*), Ohio goldenrod (*Solidago ohioensis*) and fringed gentian (*Gentianopsis procera*) flowering in mid-September.

The carbonate-rich waters of the northern fens do not provide all of the nutrients needed by some plants. Bladderworts, which get some of their nutrients from insects that are captured in tiny bladders and then slowly digested, are one of several carnivorous plants found in the fen. When moisture conditions are right in the fen, thousands of bladderworts can be flowering. Other carnivorous plants of the fen that supplement their diet with insects are butterwort, pitcher-plant and sundews. Butterwort, a rare plant along the shoreline, tracks moisture conditions closely, always staying near the moist wetland edge.

Two other rare plants associated with the fens are Houghton's goldenrod, found at the edge of moist swales, and dwarf lake iris, found along the upland edge of the fen and sometimes within the fen itself. Two shrubs characteristic of the fen are sweet gale and shrubby cinquefoil.

D. Albert

Bladderwort (*Utricularia intermedia*) growing densely in shallow water.

S. Crispin

Houghton's goldenrod (*Solidago houghtonii*) grows along moist margins of swales.

Tamarack and northern white-cedar are the most common trees.

Wildlife habitat values of northern fens are not as well studied as those of many other Great Lakes wetland types. Minnows and crayfish are abundant when water levels are high, but during low-water conditions shoreline habitat is very restricted. Whitefish and suckers can be found in shallow waters during both the spring and fall.

St. Marys River Marshes

C. McNabb

Freighter traffic is restricted to the dredged shipping channel. Emergent vegetation is concentrated in shallow water along the shoreline.

The St. Marys River, which joins Lake Superior to Lake Huron, is one of three connecting channels in Michigan, along with the Detroit and St. Clair rivers. All of the connecting channels were originally characterized by clear and fast flowing water, and all have dredged channels to allow for commercial shipping. Wetlands remain relatively intact along the St. Marys River, but most of the wetlands along the Detroit and St. Clair rivers have been eliminated by extensive residential or industrial development.

The St. Marys River flows through flat clay lakeplain, a landscape supporting extensive inland wetlands. Along the St. Marys, a narrow fringe of wet meadow and emergent wetland continues almost unbroken for miles. Beds of submergent vegetation, including muskgrass, quillworts and pondweeds, continue into water as deep as 10 or 12 feet, especially in the upper reaches of the river, where water clarity is good. Much wider marshes occupy broad bays within the river, including Shingle Bay, Duck Bay and Munuscong Lake. Tributary rivers such as the Munuscong River carry high volumes of nutrient-rich silt and clay eroded from the extensive agricultural lands upriver. During the late 1800s and early 1900s, much of the mixed conifer swamp adjacent to the coast was cleared for agriculture, and drainage by surface ditching allowed these clay plain wetlands to be managed as productive hay and pasture lands.

Great Lakes water level changes cause dramatic changes in the wetland vegetation along the St. Marys River. During times of low water levels, dense beds of cat-tails expand rapidly. When the water level rises, however, wave action erodes the cat-tail root mats, creating large openings within the wetland. These newly created openings are quickly colonized, and the mucky substrate may become choked with naiad or aquatic mosses within a single growing season. Muskrats, especially abundant in the marsh during high-water conditions, use cat-tails as both food and nesting material and create small open ponds in the cat-tails. Submergent plants then establish in the muskrat ponds, increasing local plant diversity.

D. Albert

Openings created by feeding and lodge-building muskrats provide habitat for submergent plants such as bladderwort (*Utricularia* spp.) and pondweeds (*Potamogeton* spp.).

J. Schafer

Muskrats (*Ondatra zibethicus*) are quite abundant in the Munuscong River delta and other marshes along the St. Marys River.

The diversity of habitats in the marsh create ideal habitat for a wide range of invertebrates; a winter navigation study documented more than 170 taxa of insects in St. Marys marshes. This invertebrate diversity provides an important food source for both the fishery and for waterfowl during fall migration. In contrast, waterfowl nesting is concentrated in nearby inland wetlands. Inland wetlands warm up faster and begin producing abundant invertebrates earlier in the spring, allowing more successful brood production.

The importance of the St. Marys River wetlands for waterfowl has long been recognized. As early as 1905, wealthy sportsmen from the Dodge family established a private duck-hunting club at Munuscong Bay. Around 1920, heirs donated the land to the state of Michigan, creating the core of the Munuscong State Wildlife Area.

A major concern along the entire length of the St. Marys River has been the effect of winter navigation and resulting ice scour on the marsh beds along the river. Passing freighters cause the river's water level to rise, lifting the ice along with vegetation and attached roots and soil. A multiyear study documented that winter navigation resulted in the destruction of vegetation within the shoreline marshes.

C. McNabb

Ice floes can be broken loose by wakes of freighters, removing plants with their roots and soil.

G. Soulliere

Munuscong diked wetland.

Macroinvertebrates in Michigan's Coastal Wetlands

A great diversity of macroinvertebrates — spiders, insects, snails, mollusks and aquatic worms — thrive in Great Lakes coastal wetlands. Coastal marshes produce large quantities of vegetation during the growing season, but by late summer, plant growth stops and plants of the marsh begin to decompose. Invertebrates play a key role in nutrient cycling by breaking down coarse vegetation and making it available to other animals.

Aquatic macroinvertebrates have several feeding mechanisms. Some shred live vegetation or fragments of decomposing vegetation. One shredder is the scud (family *Gammaridae*), a shell-less crustacean that feeds by shredding coarse plant detritus. Larvae of case-making caddisflies (order *Trichoptera*), such as the Leptocerid and Limnephilid caddisflies, also shred coarse vegetation. These case-making caddisflies use bits of leaves, twigs or pebbles to build their cases.

Other invertebrates are collectors of fine organic material. Mayfly nymphs of the family *Caenidae* feed chiefly on algae and detritus. Midges of the family *Chironomidae* (order *Diptera*) are scavengers that live in decomposing organic material of the marsh.

Still other invertebrates scrape periphyton from vegetation or other substrates. These scrapers include the coiled-shell snails of the family *Hydrobiidae*. Small clams called fingernail clams (family *Sphaeriidae*) feed

T. White and R. Merritt

Asellidae: A shell-less crustacean (Isopoda).

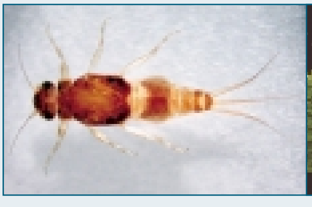
T. White and R. Merritt

Limnephilid caddisfly (*Trichoptera*) larva.

M. Higgins

Limnephilid caddisfly larva.

T. White and R. Merritt



Caenid: Mayfly nymph.

R. Merritt

Caenid: Mayfly adult.

T. White and R. Merritt

Midge (chironomid), a member of the fly family.

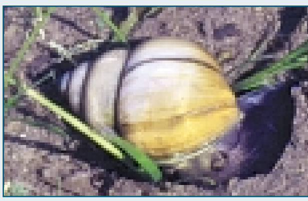
Macroinvertebrates (continued)

on much finer particles of organic material by filtering them through their gills.

But by far the greatest number are predators that prey on other macroinvertebrates. Nymphs of damselflies and dragonflies feed on other aquatic insects; as adults they feed on flying insects such as midges and mosquitoes. Phantom midge larvae also feed on mosquito larvae. The larvae of *Hydrachnid* water mites are parasitic on aquatic insects, including dragonfly nymphs; as nymphs and adults, water mites are predators. The larvae of another familiar insect, the whirligig beetle (*Gyrinidae*), prey on a variety of small aquatic insects; adults scavenge insects on the water surface. Larvae of the marsh fly (family *Sciomyzidae*) feed on snails and snail eggs.

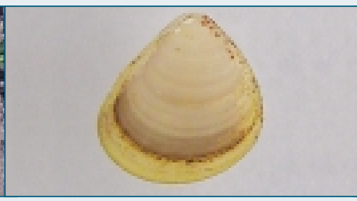
The high diversity of invertebrates in turn provides food for fish and wetland birds.

D. Albert



Coiled-shell snail.

T. White and R. Merritt



Clams (*Sphaeriid*).

M. Higgins

Narrow-winged damselfly (*Coenagrionid*) nymph.

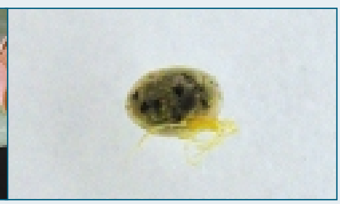
M. Higgins

Libellulid dragonfly nymph.

R. Merritt

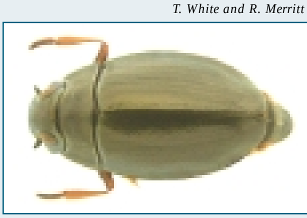
Adult *Libellulid* dragonfly.

T. White and R. Merritt



Water mite (*Hydrachnid*) larva.

T. White and R. Merritt

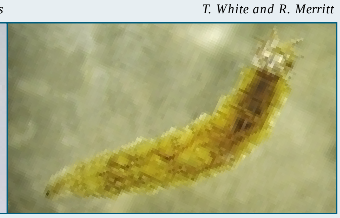


Whirligig beetle (*Gyrinidae*).

M. Higgins

Phantom midge (*Chaeoborus*) larva.

T. White and R. Merritt



Marsh fly (*Sciomyzidae*) larva.

Lake Superior Poor Fen

Wetlands seldom develop along unprotected stretches of Lake Superior's harsh shoreline. Instead, they occupy sheltered sites such as barrier-beach lagoons, drowned river mouths and river deltas. These coastal wetlands are characterized by acidic, sandy soils and an extreme northern climate, conditions that cause slow decomposition of wetland vegetation and result in development of deep organic soils.

Wetland vegetation mirrors this acidic condition, and the broad herbaceous zone that characterizes most Lake Superior wetlands could be classified as either poor fen or bog. The rhizomes of two sedges, *Carex oligosperma* and *C. lasiocarpa*, typically form a dense floating mat in which several species of sphagnum mosses grow, along with other bog herbs such as buckbean, bog aster, pitcher-plant, sundews and beak-rushes. The blossoms of two showy orchids, rose pogonia and grass-pink, are scattered throughout the wetland. Both shrubs and trees are dwarfed. Among the common bog shrubs are small and large cranberries (*Vaccinium oxycoccos* and *V. macrocarpon*), bog rosemary, leatherleaf and bog-laurel. Low mounds provide habitat for dwarfed tamarack and black spruce on the open mat, with a more dense treed zone sometimes forming along better drained wetland margins.

M. Penskar

Pequaming tombolo during 1987 high water levels.

J. Schafer

Tufted loosestrife (*Lysimachia thyrsiflora*) growing in the wet meadow zone.

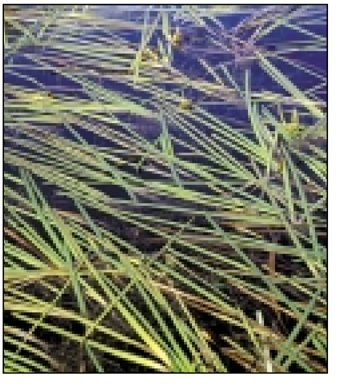
The nature of the bog changes with the water level. During low-water conditions, the wetland mat can be quite stable, possibly grounded on the underlying mineral substrate. In contrast, during high-water times, the mat can be treacherous, with open channels separating islands of vegetation. As in many of the coastal wetlands, changing moisture conditions result in major changes in the plants as well.

The emergent marsh zone often forms only a narrow, open fringe of plants associated with clear, well-aerated waters. These include spike-rush, bur-reed and water bulrush. Common floating-leaved species include yellow pond-lily, water-shield and water marigold; the pondweed *Potamogeton gramineus* is the most frequently encountered submergent species. Wild rice is a common plant along the margins of Wisconsin's riverine marshes, but none was encountered in our Michigan marsh surveys. This lack of rice may have been because of unusually high water levels during our Lake Superior surveys.

Most fish species are not well adapted to the weedy, boggy lagoons and slow flowing streams associated with many of these wetlands. A few species can tolerate these conditions — among them the native bullheads and mudminnows and introduced carp. All of these species are tolerant of oxygen-depleted waters. Mudminnows are secretive fish that flee into dense vegetation or soft, mucky substrates when pursued.

Several excellent Lake Superior coastal wetlands occur on public lands. Two of these are tombolos, Pequaming on Keweenaw Bay and Murray Bay on Grand Island, near Munising. Bald eagles nest in the pines of the extensive Murray Bay wetland. Two other coastal wetlands formed in riverine environments: Portage River marsh occupies a meander loop in the river near the Portage River harbor of refuge; Au Train marsh occupies a large dune and swale complex near the mouth of the Au Train River in Alger County.

D. Albert



Bur-reed (*Sparganium fluctuans*) is a narrow-leaved floating plant of clear Lake Superior deltas.

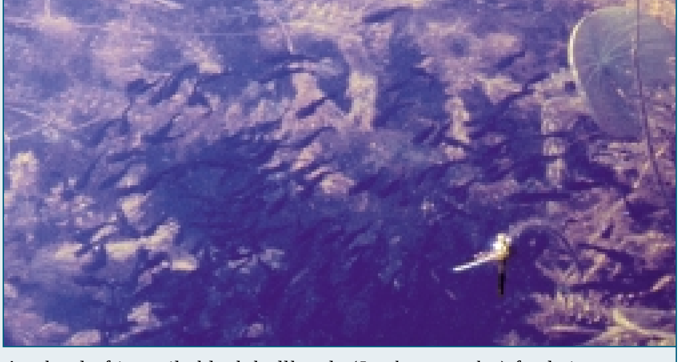
Fish in Great Lakes Coastal Wetlands

K. Schmidt

Adult northern pike (*Esox lucius*).

The Great Lakes support nearly 200 species of fish. Of these, more than 90 percent utilize coastal marshes during some part of their lives. Many fish spawn within coastal wetlands in early spring. These include familiar gamefish such as northern pike, muskellunge, yellow perch and largemouth bass, and also less familiar species, including bowfin and central mud-minnow. In the spring, one of Michigan's favorite sport fish, yellow perch, drapes its egg masses over aquatic vegetation, preferring bulrush stems of the open emergent zone. Northern pike similarly spawn in the shallow waters of the marsh; the female deposits thousands of adhesive eggs into decaying vegetation, where the eggs are immediately fertilized by nearby males. Central mud-minnows, another marsh spawner, also have adhesive eggs. Newly hatched pike and mud-minnows are adapted to the low-oxygen conditions resulting from

D. Albert



A school of juvenile black bullheads (*Ictalurus melas*) feeds in protected shallow water of the marsh; an adult male is probably nearby.

decomposition of large amounts of aquatic plants in the marsh. Decomposing vegetation provides both refuge and an abundant supply of prey in the form of minute crustaceans. When the eggs of northern pike hatch, the young fish immediately begin feeding on small aquatic crustaceans, progressing to a diet of small fish within a week.

Marshes serve as important nursery habitat, with diverse invertebrates providing an abundant diet for immature fish. This diet changes as fish develop and increase in size. Yellow perch, for exam-

Michigan Sea Grant

Common carp (*Cyprinus carpio*).

E. S. Damstra

Alewife (*Alosa pseudoharengus*), an exotic introduction to the Great Lakes.

Fish in Great Lakes Coastal Wetlands (continued)

ple, feed on small crustaceans until they are roughly 1/4 inch (60 mm) long. These immature fish then begin eating aquatic insects and crayfish. As adults, their diet consists largely of crayfish, along with burrowing mayflies and small fish.

Young fish of many marsh-spawning species remain in the marsh until they are quite mobile. These include northern pike, yellow perch, smallmouth bass, bowfin, longnose gar, black and brown bullhead, common carp and central mud-minnow. Others, including lake sturgeon and alewife, utilize the marsh during early stages but spend most of their adult lives in the open lakes and large rivers.

Both male bowfin and black bullheads remain in the marsh with their young fry, protecting them from predators. Dense swarms of young bowfins will feed in the dense vegetation under the protection of the male until they are nearly 4 inches long.

Adult fish may move into the marsh either to forage or to rest. Walleyes move into the emergent marsh to forage at night, while yellow perch are known to rest at night on the bottom within bulrush beds.

Historically, certain Great Lakes coastal wetlands provided exceptional recreational fishing. The marshes of western Lake Erie, especially Sandusky Bay, were known for their muskellunge and pike fishing. With the destruction of the marshes by industrial development, the famous Sandusky Bay fisheries collapsed. The St. Clair River delta remains recognized as one of the most productive muskellunge fisheries in North America.

Common carp have played an important role in the degradation of marsh habitat. Carp, an exotic species, was widely stocked in the late 19th century. Within the marsh, carp stir up fine sediment as they root along the bottom in search of food and as they breed in shallow water. The combination

K. Schmidt

Juvenile bowfin (*Amia calva*).

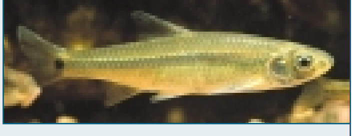
K. Schmidt

Gizzard shad (*Dorosoma cepedianum*).

K.. Schmidt

Central mud-minnow (*Umbra limi*).

K. Schmidt



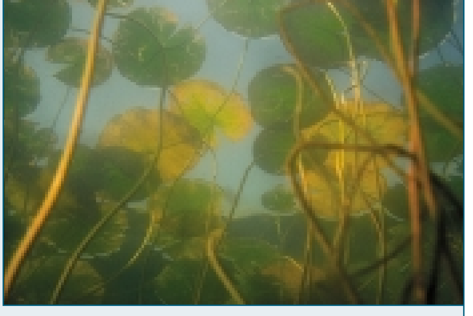
Spottail shiner (*Notropis hudsonius*).

E. S. Damstra

Juvenile northern pike (*Esox lucius*).

of loosening vegetation and increasing turbidity can contribute to the loss of submergent vegetation. Other inhabitants of degraded wetlands including spottail shiners and gizzard shad. Gizzard shad are prolific egg producers and can compete with other fish for habitat. A single female can lay up to 400,000 eggs, and large schools of shad can consume large quantities of plankton.

C. McNabb

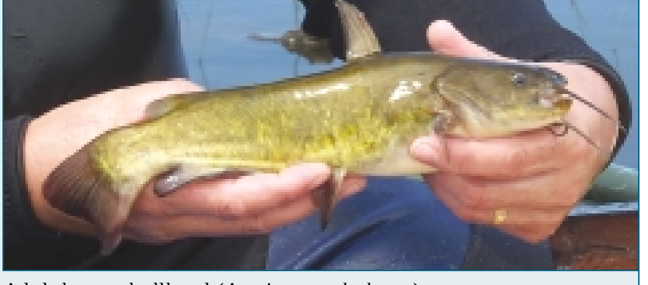


Water-lilies viewed from below. Water-lilies and other aquatic plants provide important cover for both juvenile and adult fish.

K. Schmidt

Newly hatched longnose gar (*Lepisosteus osseus*).

D. Wilcox



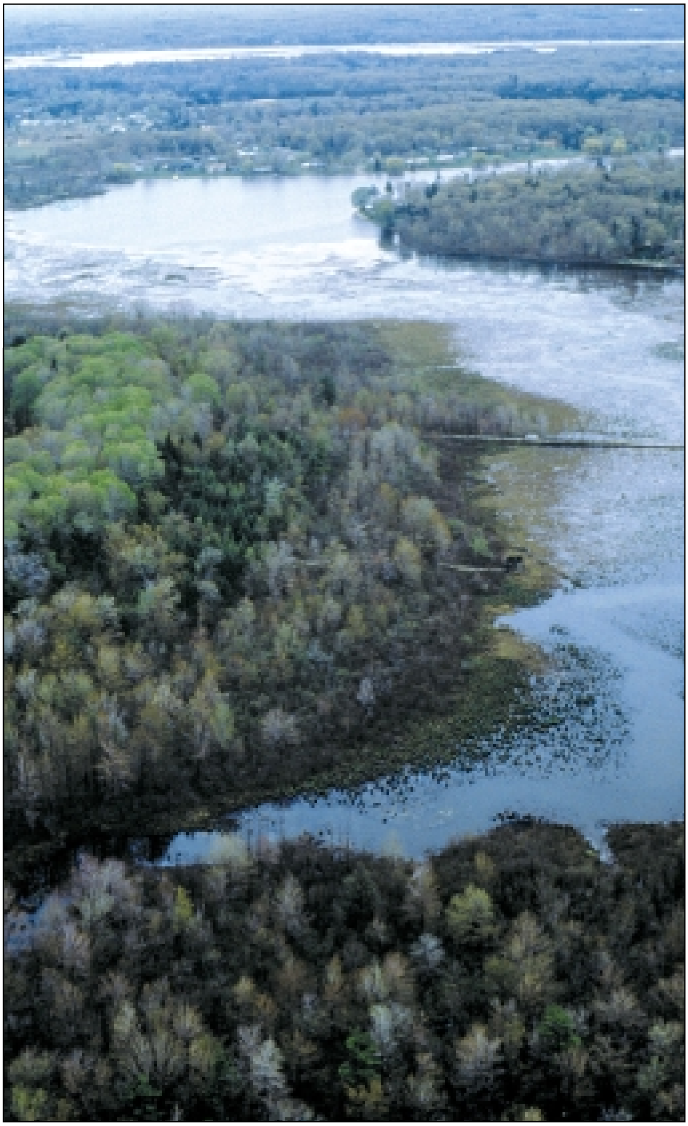
Adult brown bullhead (*Ameiurus nebulosus*).

E. S. Damstra

Juvenile longnose gar.

Lake Michigan Drowned River Mouths

G. Reese



Potawatomi Bayou, influenced by Great Lakes water levels several miles inland from Lake Michigan.

Along the eastern shoreline of Lake Michigan, strong winds from the southwest restrict wetlands to drowned river mouths protected from storm waves by sand bars or dunes. All major rivers along eastern Lake Michigan once had drowned river mouth wetlands along their lower reaches. These wetlands, under the influence of Great Lakes water levels, can extend for a considerable distance inland, up to 10 or 12 miles upriver from the lake. Potawatomi Bayou, a tributary of the Grand River that floods when lake levels are high, is more than 8 miles upriver from Lake Michigan.

Many drowned river mouths are barred by sand

G. Reese

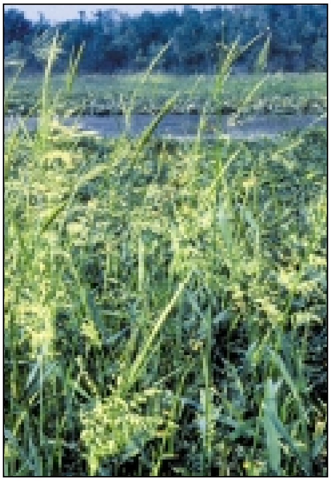
The stream flowing through Potawatomi Bayou occupies a shallow channel choked with submergent vegetation. Organic sediments are several feet thick.

dunes that create small inland lakes between the rivers and Lake Michigan, such as those found at the mouths of the White, Muskegon and Kalamazoo rivers. Where the inland lake meets the river, a broad, deltalike wetland forms. Because of their long, narrow configuration and partial separation from Lake Michigan, the wetlands are well protected from wind and wave action. This protection results in deep accumulations of muck or peat at the wetland margins. Many drowned river mouth wetlands now have artificially maintained channels to Lake Michigan for boat access, often resulting in major changes to the wetland dynamics.

The emergent and submergent vegetation zones of these riverine wetlands are quite variable in width. In some abandoned meander loops of the river, wide emergent beds can cover several acres. On fast flowing streams, emergents may be restricted to a thin fringe. On most of the larger streams, submergent vegetation is restricted to protected backwaters. Smaller streams, such as the Potawatomi Bayou, can be completely covered by submergent plants. In southern lower Michigan, yellow pond-lily and arrow-arum are characteristic on the muck soils of the emergent zone. Both species are uncommon north of Muskegon, where arrowhead, pickerel weed and bur-reed replace these southern species. Overly abundant submergent and floating species thrive in relatively protected waters with a high nutrient content. These include coontail, water-lily, and the duckweeds *Spirodela polyrhiza*, *Lemna trisulca* and *L. minor*.

The wet meadow grows as a floating mat on organic soils many feet thick. These meadows include blue-joint grass, jewelweed, yellow cress, nodding smartweed, cut grass and many more herbaceous plants. Scattered plants of a rare variety of wild rice often grow between the wet meadow and the emergent zone. Shrub swamp forms a narrow band along the upland margin, characterized by a mix of speckled alder, red-osier dogwood and red ash. They also contain many of the herbs of the wet meadow, as well as royal fern.

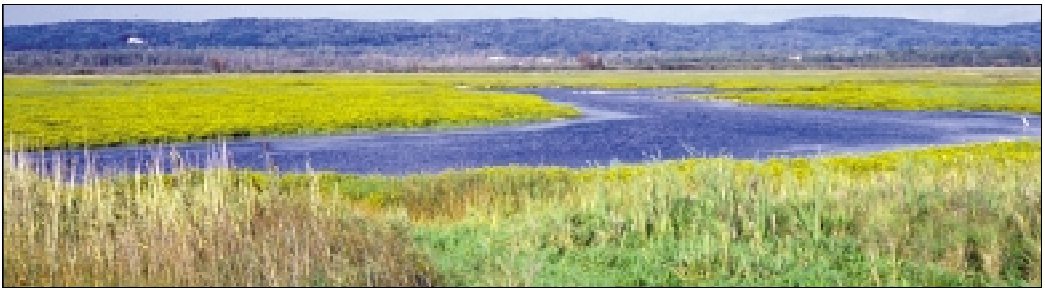
D. Albert



A rare variety of wild rice (*Zizania aquatica* var. *aquatica*) occurs in the open emergent zone of Potawatomi Bayou and other drowned river mouths.

Development of industrial and recreational marinas has severely altered the lower rivers. Beginning in the mid-1800s, lumber mills, paper mills and tanneries were built along the inland lake and drowned river mouth margins, which provided easy access for shipping to major markets such as Chicago. More recent alterations to the wetland include highway construction; dredging and filling for marinas, golf courses, shoreline homes and condos; and sewage treatment plants. These activities increase water turbidity, which in turn reduces submergent plant establishment and survival, especially in the larger stream channels.

D. Albert



Drowned river mouth along Bowens Creek at Arcadia during low-water conditions. Nodding beggar-ticks (*Bidens cernuus*), an annual, forms a broad band on the exposed mud.

Saginaw Bay Lakeplain Marsh

D. Albert

Emergent marsh dominated by threesquare (*Schoenoplectus pungens*) forms a 250- to 300-yard-wide zone along long stretches of Saginaw Bay. Stem density can be quite high in low-water years.

The shallow, gently sloping margins of Saginaw Bay provide excellent wetland habitat. The most extensive type of wetland on Saginaw Bay is a narrow band of open marsh 200 to 300 yards wide. Substrate for most of the bay's wetlands is a thin veneer of sand over clay.

Wider wetlands occur in small, protected bays behind sand spits and as deltaic deposits near the mouths of the larger rivers, including the Saginaw, Pine, Au Gres, Rifle and Quanicassee. Other broad prairie wetlands form parallel to the shoreline in dune and swale complexes.

The wetland types of Saginaw Bay are quite distinctive from one another. Wetlands of the open embayments, although forming an almost continuous band around Saginaw Bay, are generally low in diversity. Threesquare, a bulrush, is one of the few species tolerant of the storm waves that regularly buffet the shoreline. Its survival is linked to its root system — stout horizontal stems (rhizomes) sent into the underlying clay substrate allow it to resist erosion. At the same time, it produces a dense mat of fine roots near the surface. These bind the surface sands and further stabilize the sediments of the marsh. Nearer shore there may be more than 100 bulrush stems in a square meter of marsh. These provide a protective environment for other more weakly rooted emergent and submergent plants. Near the deeper, outer edge of the marsh, bulrush stems are more susceptible to wave action, and the marsh is quite open.

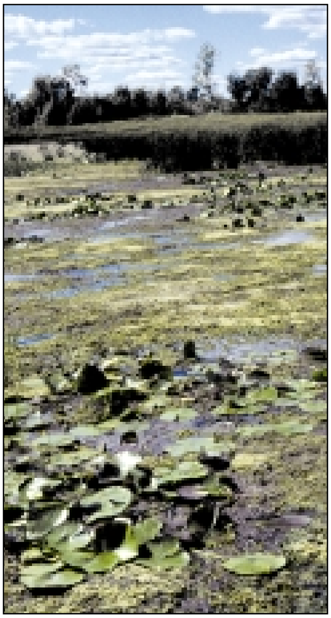
Sand-spit embayments, formed by sands carried into Saginaw Bay by small streams, provide a more protected environment than the open bay and support dense beds of submergent and emergent marsh plants. Well-developed sand-spit embayments include those at Pinconning and Nayanquing, both in public ownership. The Wildfowl Bay Islands near Sebewaing form a large complex of sand-spit embayments.

Typical zonation consists of a narrow band of emergent vegetation along the shoreline with a broad bay of submergent plants. Blue-joint grass and tussock sedges may once have dominated the emergent zone, but nutrient-rich agricultural runoff has resulted in the development of a dense band of cat-tails along the shore. Even this monoculture of cat-tails is subject to change. When water levels are high, cat-tails exclude most other species. However, when the water level drops, goldenrods, asters, willows, dogwoods, and seedlings of ash and cottonwood rapidly establish. The submergent zone is equally dynamic when water levels change. Coontail, pondweeds, common waterweed, slender naiad, yellow pond-lily and water-lily all share the 2- to 3-foot-deep waters of the bay. As water levels drop, a rapid succession of emergent plants moves across the newly exposed muck. Dense stands of stiff arrowhead along with muskgrass and yellow pond-lily fill the shallow (6 inches deep) water, with a 3- to 4-foot-tall band of softstem bulrush blanketing the exposed, moist muck. If water levels drop farther in following years, softstem bulrush plants continue their advance out into the bay, to be replaced nearer shore by another bulrush (*Schoenoplectus cespitosus*) and cat-tails.

D. Albert

The emergent zone is much less dense along its lakeward margin, as seen near the Pine River.

D. Albert



At Pinconning's sand-spit embayment, dense stands of softstem bulrush expand outward into the marsh, while spatterdock (*Nuphar advena*) and muskgrass (*Chara* spp.) carpet shallow water.

When water levels again rise, the emergent vegetation begins a slow retreat, driven back by reduced oxygen availability and the erosive force of storm waves.

The wetland plant communities of Saginaw Bay have been altered by surrounding intensive agricultural land use. Nutrient-rich runoff fosters dense stands of cat-tails along the shoreline. In addition, two aggressive exotic plant species — purple loosestrife and reed canary grass — rim almost the entire shoreline of the bay. Reed (*Phragmites australis*), another aggressive exotic, forms dense, almost impenetrable stands along the shoreline. Reed can grow out into deep water but is not tolerant of heavy wave action.

Intense development pressure has also adversely affected the fishery and waterfowl habitat of these coastal wetlands. Riverine and coastal marshes served as important spawning and nursery habitat for a large number of fish species, including lake perch and northern pike. Both fish and waterfowl were heavily harvested during early settlement of the state by European immigrants. Large fish and waterfowl harvests were aided by the local abundance of salt and ice for preservation. As coastal wetlands were

D. Albert

Softstem bulrush (*Schoenoplectus tabernaemontani*).

D. Albert

Asters, goldenrods and willows invade cat-tail stands when the marsh dries down.

degraded, ditched, drained and farmed, both fish and waterfowl harvests declined.

In addition to loss of spawning habitat, pollutants from agriculture, urban development and industry are often harmful to fish. Organic materials dumped into the bay — including sewage, sawdust and sugar beet pulp — produced anoxic conditions that resulted in major fish kills. In recent years, reductions in pollution levels have resulted in a recovery for parts of the Saginaw Bay fishery. The recent introductions of exotic species such as zebra mussels and round gobies, however, have brought new problems. Exotic species alter the wetland environment for native species by occupying their habitat and competing for food and, in some cases, by altering the chemical and physical nature of the environment. Many exotic species lack predators in their new environment, so their numbers can increase rapidly.

Michigan Sea Grant

Zebra mussel (*Dreissena polymorpha*).

Other animal species have suffered from alteration or reduction of coastal wetland habitat. King rail and American bittern numbers dropped as coastal marsh was eliminated. Turtles from the marsh lost access to important upland habitat for egg laying. Increased numbers of predators, such as raccoons and skunks, further reduce the number of turtle eggs that successfully hatch.

Recent legal settlements over industrial pollution have resulted in state acquisition of large areas of coastal agricultural lands. These once drained fields are being restored to marsh or lakeplain prairie by removing dikes and drainage tiles and, for the prairies, conducting prescribed burns.

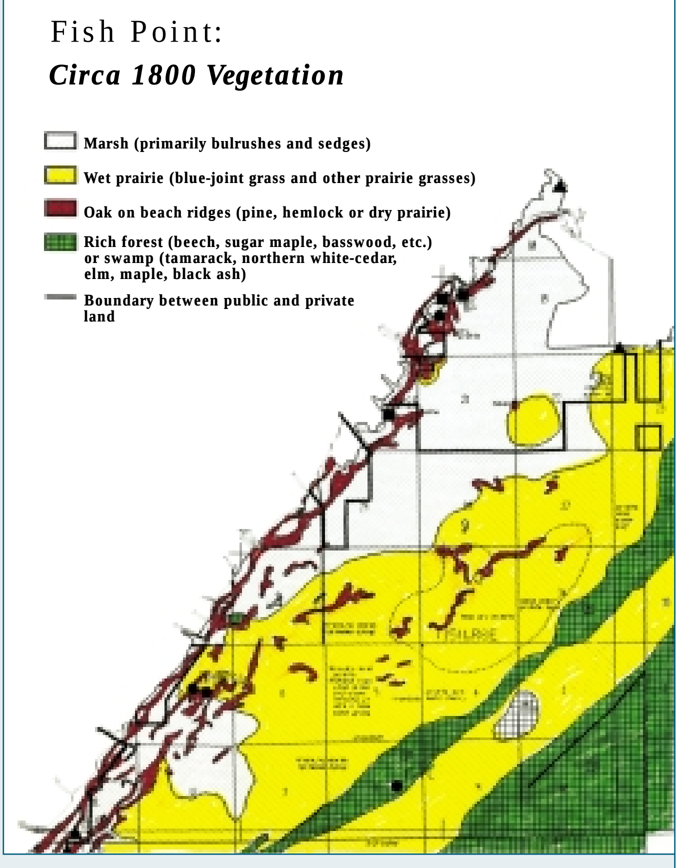
D. Albert

Nodding beggar-ticks (*Bidens cernuus*).

Lakeplain Prairie

A rare type of wetland, lakeplain prairie, occurs along the upland margins of coastal marshes on Lake Erie, Lake St. Clair and Saginaw Bay. One of the largest expanses formerly occurred on Saginaw Bay in a 3-mile-wide dune and swale complex that stretched for several miles from Sebewaing to Bay City. The original government land surveyors were the first to describe the changes within the marsh and prairie as the water levels of Saginaw Bay changed. They first surveyed the prairie during low-water conditions, mentioning prairie grasses and prairie dock. Ten years later, the shoreline was resurveyed during high-water conditions, and the surveyors noted rushes and bulrushes growing in shallow water and replacing the prairie. Such dynamics continue to play an important role in maintaining the diversity of the prairie-marsh landscape. The dominant prairie grasses are big bluestem, Indian grass, switch grass and prairie cordgrass. More than 200 plant species can occur in the lakeplain prairie, including mountain mint, purple milkweed, marsh blazing-star, ironweed, tall coreopsis, Riddell's and Ohio goldenrod, and many more showy forbs.

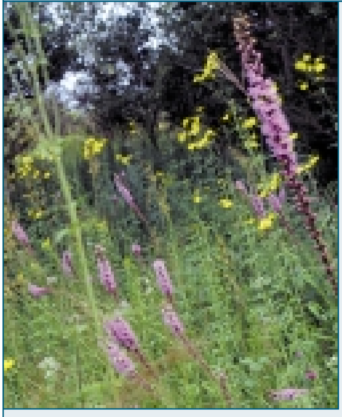
The prairies, because they flooded less often than the marsh, have been heavily converted to agriculture. A mile grid of large drainage ditches,



Original surveyor's map of lakeplain prairie along Saginaw Bay. Each square is a mile.

Lakeplain Prairie (continued)

D. Albert



Diverse lakeplain prairie following burn management.

combined with tiling, diking and pumping, has allowed most of the prairies to be farmed. The intensive conversion of prairie to agriculture has caused many prairie plants to become rare, including Sullivant's milkweed, tall green milkweed and tuberous Indian plantain.

G. Reese

Tall green milkweed (*Asclepias hirtella*), a rare prairie plant.

Lakeplain prairies also support a distinctive fauna. Prairie plants including prairie dock, Culver's-root and marsh blazing-star are host to rare borer moths. Two characteristic animals of lakeplain prairies are mound-producing ants, whose nests are common along the prairie margins, and burrowing crayfish, whose clay

K. Herman

Ant mound along the edge of the prairie.

chimneys occur throughout the prairie openings. Crayfish burrows are used by many snake species as hibernacula.

Active restoration of lakeplain prairies began in the late 1980s at St. John's Marsh and Algonac State Park, both within the St. Clair River

D. Albert

Chimney of burrowing crayfish (family *Cambaridae*).

delta, as well as at Thomas Road prairie within the Fish Point Wildlife Area on Saginaw Bay. Controlled burns, herbicide treatment of exotic herbs and shrubs, and mechanical removal of shrubs have resulted in increased native plant diversity and wildlife habitat.

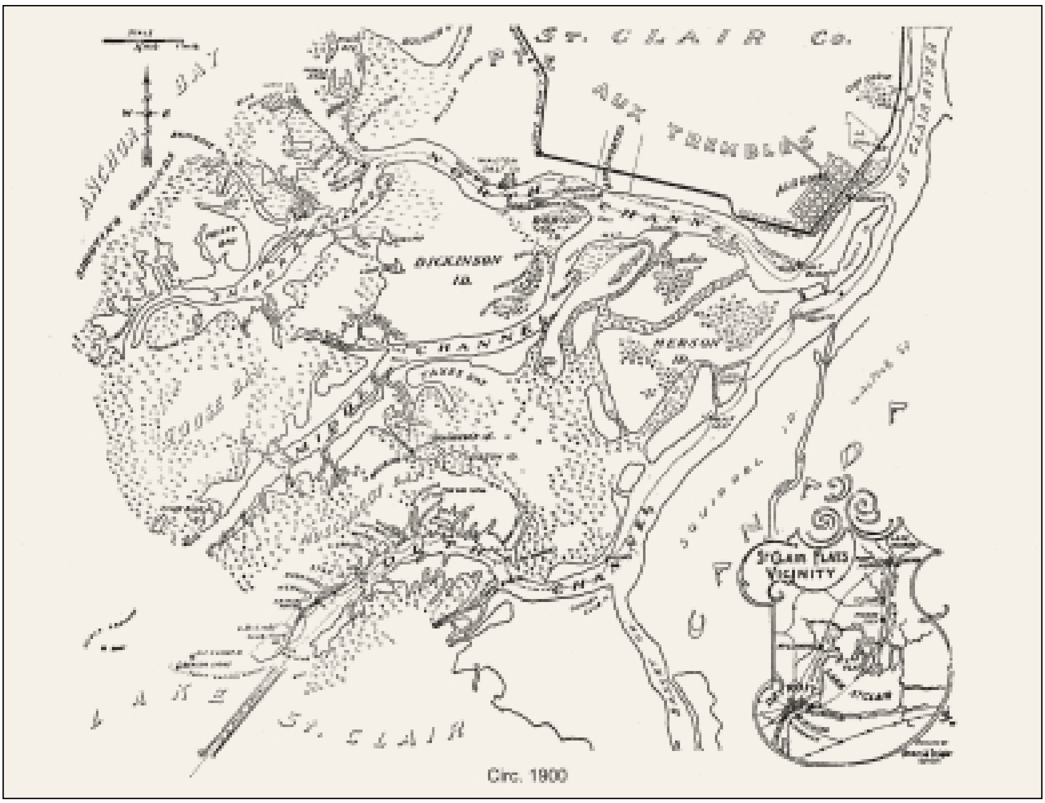
D. Albert

Densely flowering big bluestem (*Andropogon gerardii*) and sunflower (*Helianthus* spp.) following burn management.

St. Clair Lakeplain Marsh

The St. Clair River delta forms one of the largest wetlands in the Great Lakes. More than 10 miles long and almost 15 miles wide, the delta consists of several islands broken by channels of the St. Clair River. Elevation drops less than a foot over the 10-mile length of the delta, and the river meanders widely. Surface sediments of the delta are largely fine sand and silt over underlying lake clay. Finer, organic-rich sediments accumulate in alluvial channels within the wetland. Topographic relief on the island is low, with levees along the river generally less than 5 feet high. When Lake Huron water levels are high, large portions of the delta's islands are flooded with shallow water. Even when water levels are low, much of the delta still remains saturated.

Library of Michigan Archives



St. Clair River delta.

Historically, almost the entire shoreline of Lake St. Clair supported coastal marshland. Today, coastal wetlands on Lake St. Clair are restricted largely to the delta — residential development has occurred along much of the lake's shoreline. The clear waters of Lake St. Clair allow submergent aquatic plants to grow on the bottom throughout much of the shallow lake. The channel of the St. Clair River upstream from the delta also supports a narrow zone of wet meadow and emergent marsh, with submergent vegetation continuing to depths of more than 10 feet in the clear waters of the river. Residential development along the river has resulted in the loss of most of the meadow and emergent vegetation.

The vegetation of the delta shares characteristics with both Saginaw Bay and Lake Erie, along with more northern wetlands.

The drier portions of the delta's wetlands support diverse wet and wet-mesic prairies, both southern wetland types. The vegetation of the emergent zone, however, is more typical of northern open marshes, perhaps owing to the flow of clear, cold river waters through the wetland.

Exotic species so characteristic of the wetlands of Lake Erie and Saginaw

J. Schafer

Wetlands were diked to provide increased habitat for waterfowl during migration, as well as increased hunting access. However, dikes also disrupt hydrologic processes and facilitate the spread of invasive species.

Bay are less prevalent in large portions of the St. Clair delta but are by no means absent. During low-water conditions in 2000-03, reed (*Phragmites australis*) has expanded its habitat greatly in St. John's Marsh and may have similarly expanded in other portions of the delta. But in some areas of the delta, the wet meadows still consist of a broad zone of blue-joint grass and tussock sedges.

In the emergent marsh, pickerel weed, arrowhead and bur-reed occur along with a diverse flora of submergent and floating plants, including several species of pondweed, naiad, water-lily and yellow pond-lily. Wild rice forms dense stands except when water level are at their highest, as in 1986 and 1987. Many of the southern emergent and submergent species, such as American lotus, Montevidens' arrowhead and arrow-arum, are absent from the delta.

J. Schafer

Personal watercraft can damage coastal wetland vegetation.

J. Schafer

Intensive residential and recreational use within the St. Clair delta.

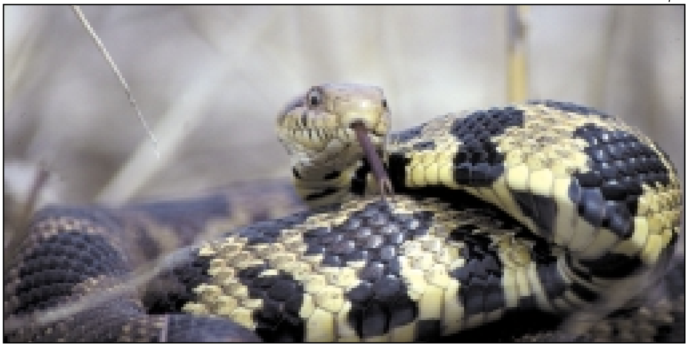
The St. Clair flats are recognized as a highly significant wetland area for waterfowl. In spite of intense residential development in portions of the delta, large areas continue to be managed as both natural and managed marsh, maintaining critical habitat for waterfowl and other wetland fauna, and providing adequate access to hunters from southern Michigan's large urban population.

Over the years, several management options have been explored to maintain conditions favorable to waterfowl. On Harsen's Island, large areas of marsh have been diked, so water levels can be manipulated both to meet waterfowl needs and to allow hunters increased access to the marsh. Elsewhere, in the past, openings were created with explosives.

J. Schafer

Common tern (*Sterna hirundo*).

J. Schafer



Eastern fox snake (*Elaphe gloydi*) is often seen on dikes or sand ridges within the marsh.

J. Schafer

Black tern (*Chlidonias niger*).

J. Schafer

Great egret (*Casmerodius albos*) feeding along a dike.

J. Schafer

Marina development on a small island within the delta.

More recently, prescribed burns have been conducted to maintain open conditions in the marsh. Most marsh burns are conducted when the marsh is frozen to increase the likelihood of a successful burn.

The marsh provides important habitat to many nongame animals as well. Several rare species are known from the marshes of the flats, including the eastern fox snake, spotted turtle, Blanding's turtle, black tern, common tern and king rail. The lakeplain prairies of Algonac State Park, also part of the delta wetland, are habitat for several rare plants, including Sullivant's milkweed. The Algonac prairies are currently managed with prescribed burns to improve species diversity, reduce shrub and tree encroachment, and eliminate exotic species.

J. Schafer

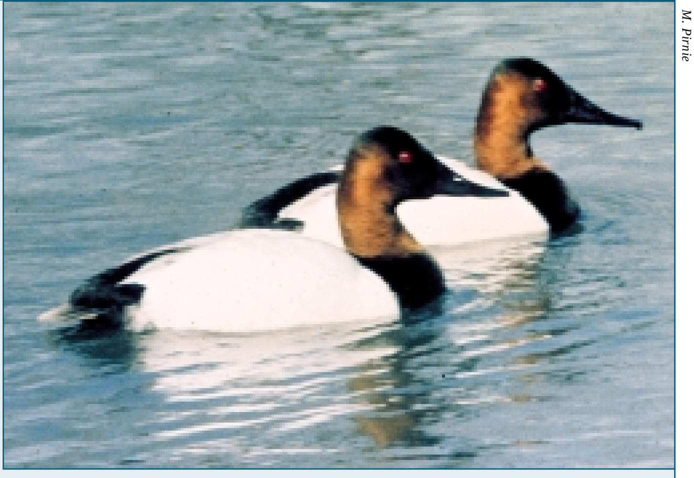
Spotted turtle (*Clemmys guttata*).

Waterfowl Use of Michigan's Coastal Wetlands

by Greg Soulliere

Impressive numbers of ducks, geese and swans move through Michigan's coastal marshes in the spring, often through the first half of May. Bird numbers again increase dramatically from late September through mid-November, with a peak in abundance the last week of October. The exceptions are Lake St. Clair and western Lake Erie, where some ducks can be numerous through early winter. Some years canvasbacks winter on Lake St. Clair and remain through spring.

M. Pirnie



Canvasbacks (*Aythya valisineria*).

The coastal wetlands of Michigan are less important than inland wetlands for waterfowl reproduction. They warm slowly in the spring, so they provide fewer invertebrates for food for early-breeding ducks. They stay warm longer in the fall, however, and provide invertebrates and seeds from aquatic plants for fall-migrating ducks. All of the plant seeds are not eaten in the fall, so some seeds along with submergent aquatic plants are available during spring migration.

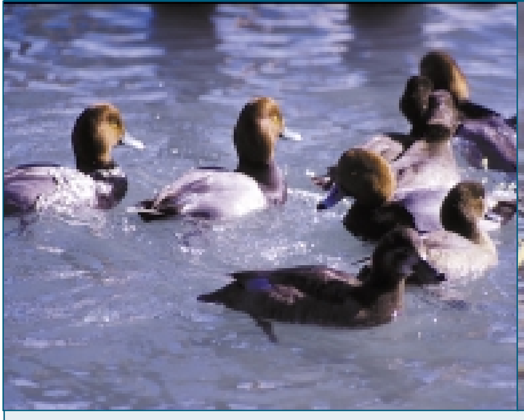
J. Schafer

Migrating waterfowl on St. Clair River delta.

Coastal wetlands along the east side of Michigan are especially important to staging waterfowl. Diving ducks, such as redheads and canvasbacks from the midcontinent prairies, arrive in

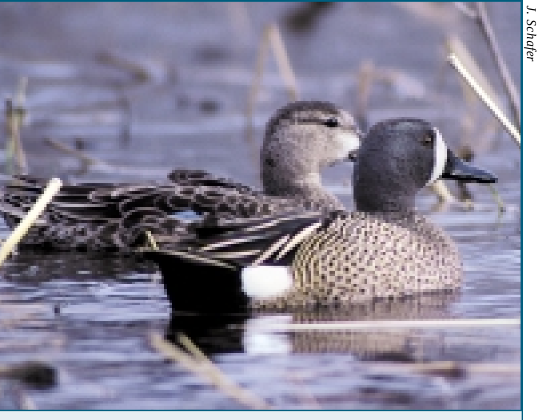
Waterfowl Use of Coastal Wetlands (continued)

J. Schafer



Migrating redheads (*Aythya americana*).

J. Schafer



Pair of blue-winged teal (*Anas discors*).

large numbers to wetlands along Saginaw Bay, Lake St. Clair, the lower Detroit River and western Lake Erie. Here they feed on aquatic plants, insects and mollusks of coastal deep-water wetlands. In some years, as much as 60 percent of the world's canvasback population can be found fall-staging on lakes St. Clair and Erie. High numbers of dabbling ducks — including mallards, black ducks, teal, wigeons and, in some years, pintails — also feed in the shallow marshes of Saginaw Bay and roost in the safety of the open bay.

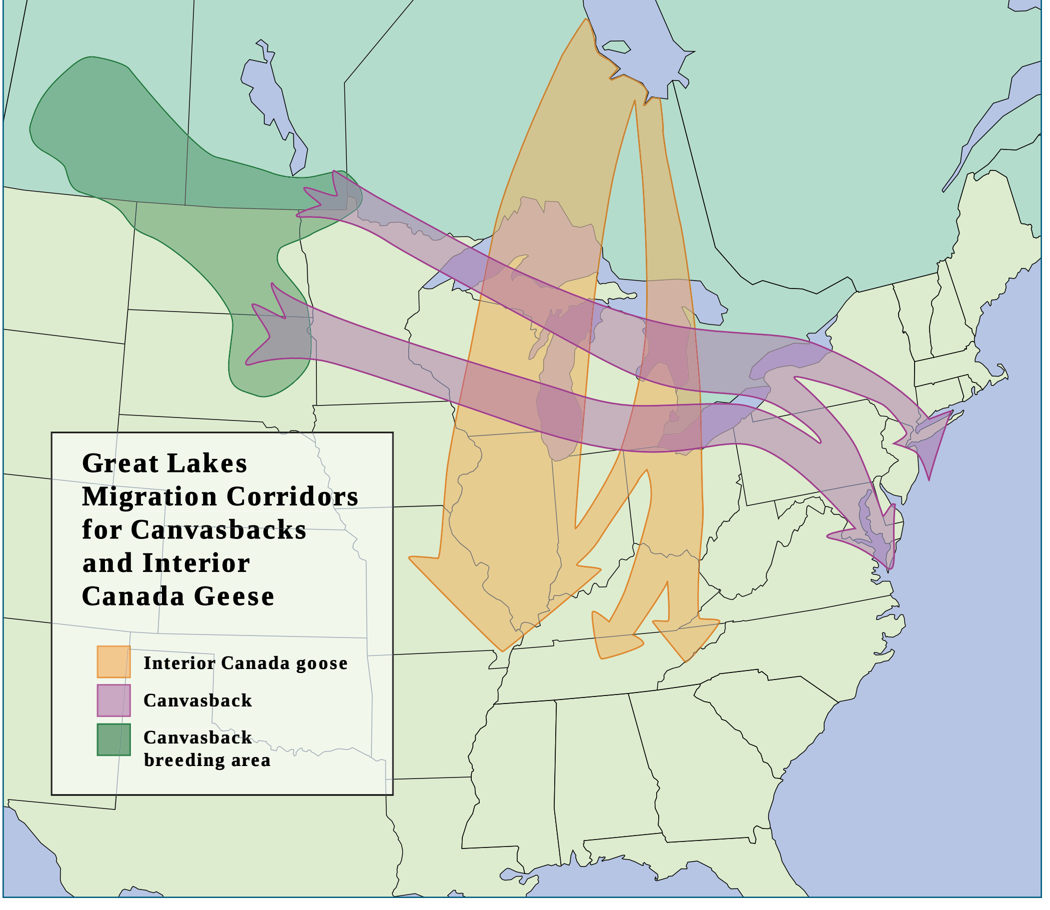
In western Michigan, the marshes of Lake Michigan's drowned river mouths, protected from the wave action of the Great Lakes, offer respite to migrating dabbling ducks, especially mallards and black ducks. Favored foods in this vegetation-rich habitat include the seeds from bur-reed, duck potato, and other emergent and submergent aquatic plants. Migrating birds often stop to refuel in these river mouth wetlands for days or even weeks.

Farther north, beaver ponds and forested wetlands in Michigan and eastern Canada provide nesting habitat for many species of ducks. This forested region provides dependable habitat from year to year, and as a result, the number of dabbling ducks moving through Michigan from Canada is relatively stable. St. Marys River wetlands — the largest is in Munuscong Lake — are the busiest in the Upper Peninsula for mallards, black ducks, teal and ring-necked ducks, and are recognized as quality wetlands for hunting. In the northern Lower Peninsula, these same species are common on Lake Huron's Misery and Squaw bays near Alpena. Wood ducks are common in many coastal wetlands during late summer as these birds group up after the breeding season. Large numbers of male wood ducks find protection and abundant food in coastal wetlands during the flightless period when they are replacing their wing feathers.

Wood ducks will often group with male mallards and black ducks in large coastal wetlands. Molting ducks rely on the marsh's protection and readily available food resources during the middle and later part of summer.

Canada geese are common in Michigan throughout the spring, summer and fall, and even through the winter in southern Michigan. Canada geese roost on sand bars and mud flats in coastal areas during low-water periods, where they feed on emergent

Modified from F. C. Bellrose.



Waterfowl Use of Coastal Wetlands (continued)

plants, the small shoots of strand plants and, occasionally, aquatic insects. During the spring, Canada geese readily nest in coastal wetlands, selecting any high point — including muskrat lodges and spoil islands from channel dredging — as the foundation for their nests. During the fall, these offshore shallow-water areas provide protection from disturbance and predators.

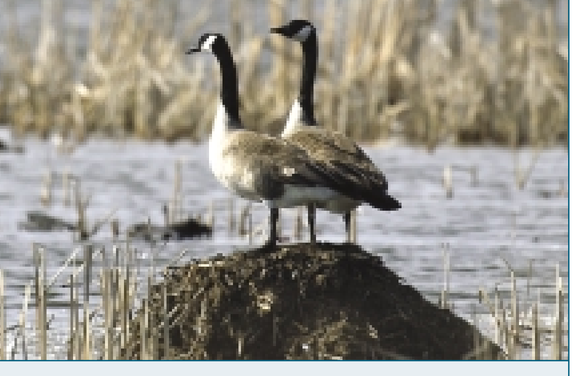
Swans also use coastal wetlands from early spring through the summer and fall, feeding mostly on submergent aquatic plants. Tundra swans are common during spring and fall migration, while mute and trumpeter swans nest in Michigan. Like Canada geese, swans will readily nest on muskrat or beaver lodges.

Michigan's long coastline hosts a variety of sea ducks, including black scoters, white-winged scoters, long-tailed ducks, buffleheads, goldeneyes, and red-breasted and American mergansers. Some of these birds are rarely seen in the interior of the United States; their diversity and abundance in Michigan reflect the high-quality habitat provided by the Great Lakes shoreline and associated coastal wetlands and shallow-water zones. Although these species are most commonly seen during the spring and fall in deeper open water, they will readily use coastal wetlands during migration, especially the long-tailed ducks, buffleheads and mergansers, finding food resources as well as shelter during storms. A few species, including the red-breasted and American mergansers, nest in Michigan as well. For these sea ducks, Michigan's coastal wetlands provide critical habitat during the brood-rearing period, offering a rich selection of small fish and mollusks.

J. Schafer

Pair of wood ducks (*Aix sponsa*).

D. Kenyon



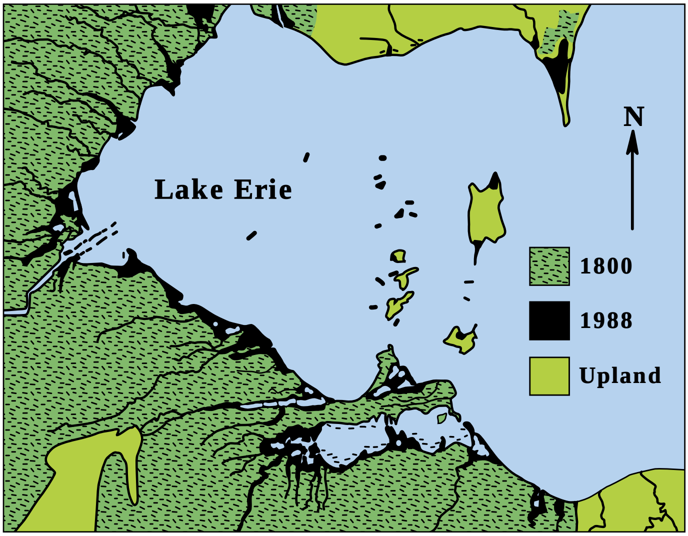
Canada geese (*Branta canadensis*) nesting on muskrat lodge.

Lake Erie Lakeplain Marsh

Much of the shoreline around the western basin of Lake Erie consists of flat glacial lakeplain. The shallow, sloping terrain and rich clay sediments historically supported extensive marshes and wet prairies along much of Lake Erie's southern shore. Because Lake Erie enjoys the most moderate climate of the Great Lakes region, these wetlands contained a suite of distinctly southern plant species not found elsewhere within the Great Lakes.

In the early 1800s, the Black Swamp, a band of swamp and marsh several miles wide, surrounded western Lake Erie from Sandusky, Ohio, to Detroit, Michigan. Large marshes formed at the mouths of major rivers such as the Raisin, Huron and lower Detroit rivers and the dozens of smaller creeks draining the flat lakeplain. By 1900, more than 90 percent of the Black Swamp had been drained for agriculture or modified for industrial and residential use.

C. E. Herdendorf



Black swamp along western Lake Erie. Most of the extensive swamp and marsh have been destroyed.

The Detroit, Maumee, Portage and Sandusky rivers also dump heavy sediment loads into the waters of western Lake Erie, where wind action continually stirs up silt and clay from the relatively shallow bottom. The resulting high turbidity, excessive suspended sediments and nutrient loading are significant stressors to remaining coastal wetlands of Lake Erie.

Today, the formerly extensive coastal marshes are limited to a few degraded sand-spit embayments, drowned river mouths or deltas. Here, relatively few rooted submergent species are found; instead, floating duckweeds (*Lemna minor* and *Spirodela polyrhiza*) and floating submergents such as hornwort, common waterweed and the exotic curly-leaved pondweed spread rapidly at or near

D. Albert

Duckweed: Lake Erie.

D. Albert

Marsh with arrowhead (*Sagittaria rigida*) and water-lily (*Nymphaea odorata*): Frenchman Creek, lower Detroit River.

D. Landis

Purple loosestrife (*Lythrum salicaria*), an aggressive exotic plant, readily colonizes mud flats.

the surface of muddy, nutrient-rich waters. The southern species of yellow pond-lily (*Nuphar advena*) is common, and American lotus attains very high densities at selected sites. Common arrowhead, soft-stem bulrush, narrow-leaved cat-tail and hybrid cat-tail are common edge species.

The herbaceous zone is southern wet meadow dominated by blue-joint grass along with reed canary grass, narrow-leaved cat-tail and nodding smartweed. The standard suite of early sucessional species (nodding beggar-ticks, spotted touch-me-not and yellow cress) and aggressive exotics (purple loosestrife and reed) are present as well. As in Saginaw Bay, the absence of a distinct shrub swamp zone often reflects the intensity of land use along Lake Erie, where fertile lacustrine soils are farmed as close to coastal wetlands as possible.

Case History of a Marsh: River Raisin Delta

Monroe Marsh, at the mouth of the River Raisin, typifies the historic changes seen in many of Michigan's large coastal marshes. From its earliest settlement until the 1890s, Monroe Marsh had an economy dependent on the harvest of the natural resources of the marsh and nearby Lake Erie.

Among the most valued resources in the shallow waters of Lake Erie was lake sturgeon, harvested annually at the river mouths by Wyandotte Indians. Early native fishermen took fish in shallow waters using seine nets or spears, while gill nets allowed fish to be taken in deeper waters. Muskrat, beaver and other furbearers were also trapped in the marshes by early native peoples for food, clothing and trade items.

Beginning in the mid-1800s, market hunters exploited the abundant aquatic resources of the marshes, harvesting waterfowl by the thousands to supply eastern and urban markets.

E. S. Damstra

Lake sturgeon (*Acipenser fulvescens*).

Case History of a Marsh: River Raisin Delta (continued)

Working from punt boats only 16 to 18 feet long, they used large guns capable of killing dozens of birds with a single shot. It was not unusual to kill several hundred ducks in a night under cover of darkness, when it was easier to approach a large flock of ducks. The use of live decoys and hunting with bait and traps were other effective ways to harvest large hauls of waterfowl.

Fish were another valued resource for the expanding country. Early settlers fished with simple seines, brush weirs, spears, dip nets and lines with many fish hooks. By the 1840s and 1850s, large stationary nets called "pound nets" were set in shallow coastal waters, funneling fish to an offshore crib. Lighter, stronger machine-made nets allowed fishermen to harvest more fish in deeper water, and by the 1870s, steam tugs allowed fishing still farther from shore. At Monroe, the early fisheries harvested whitefish, trout, perch and walleye. Sturgeon were also netted, but only the roe (fish eggs) were sold; the fish were left to rot on shore.

Technological changes were rapidly altering the Great Lakes fishery, but most coastal habitats remained intact until the end of the century. Between the 1890s and 1930, however, industrialization of coastal wetlands greatly reduced the productivity of the marsh for waterfowl and fish and altered the habitat for the broad diversity of plants and wildlife native to the wetland.

Monroe Historical Museum

Punt boats were used by market hunters to harvest large numbers of waterfowl.

Case History of a Marsh: River Raisin Delta (continued)

State of Michigan Archives

Seining in coastal wetland (1890s).

As the town of Monroe grew, the mouth of the River Raisin was dredged and a port developed in 1843. By the 1880s, regular steamship service brought passengers into Monroe. One major attraction for wealthy East Coast businessmen was the hunt club established at the mouth of the river by a Monroe resident, John Sterling. When the hunt club burned, Sterling replaced it with a hotel and swimming beach, which drew hundreds of urban visitors by steamship from nearby Toledo and Detroit. Local trolley lines soon followed, and tourism boomed.

The marsh itself was still a favorite destination; fishing was popular and local boatmen rowed

Monroe Historical Museum

Successful duck hunters at Pt. Mouillee Hunt Club, 1910.

visitors to the famed lotus beds. Covering almost 1,000 acres, the lotus beds were a source of local pride; scenes of the lotus beds graced picture postcards, and lotus flowers graced the dining room of the hotel, which was named after the lovely flower.

With increased development, the ecology of the marsh declined rapidly. In the early 1900s, there were already accounts of pollution from the town and the accompanying turbidity in the marsh that resulted in the loss of aquatic plant beds and fish. Recreational fishing declined, and commercial fishing within the marsh collapsed. To maintain the local fishing industry, portions of the marsh were dredged into ponds for raising carp, which were shipped live as far as New York City.


Monroe Historical Museum

Youngsters fishing in Monroe Marsh with net (circa 1900).

Monroe Historical Museum


Picture postcard showing boatman with visitors to the Monroe lotus (*Nelumbo lutea*) bed, circa 1900.

Case History of a Marsh: River Raisin Delta (continued)

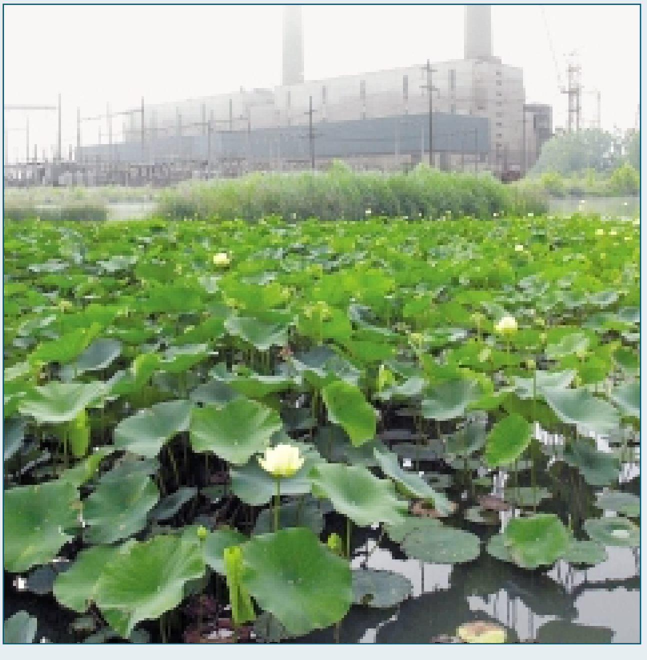
Other marsh values disappeared with changing technology. Before electrical refrigeration, blocks of ice were cut from the shallow waters of Lake Erie. Marsh hay was harvested with horse-drawn mowers and laid down in thick layers to insulate the ice blocks through the hot summer.

In 1920, Fisher Body purchased land in the marsh, followed by Newton Steel (now the site of Ford Motor Company) in 1927. The factories grew, filling additional lands and dredging ponds for waste materials. In 1931, a turning basin was dredged to allow passage of larger ships. In 1953, Detroit Edison bought 1,200 acres and built an electric plant on spoils within the marsh, which was being filled from all sides. Plans for a marina

Monroe Historical Museum

River Raisin with channel straightened and "turning basin" constructed in 1931 to allow for large ships.

Lotus Garden Club of Monroe



Lotus bed with Monroe power plant in background.

Case History of a Marsh: River Raisin Delta (continued)

with elite housing sites and a golf course were developed but abandoned during the Great Depression; the area is now in state ownership as Sterling State Park.

Today efforts are underway to protect and restore the remnants of the marsh. Detroit Edison has established a preserve dedicated to the protection of the American lotus. In 2002, Sterling State Park staff initiated a project aimed at restoring both coastal marsh and wet prairie. Diverse recreational use can be seen at remnants of numerous coastal wetlands along Lake Erie.

MI DNR

Intensive industrialization of Monroe Marsh can be seen on 1978 aerial photo.

D. Albert

Boardwalk in Lake Erie Metro Park.

Restoration and Recovery

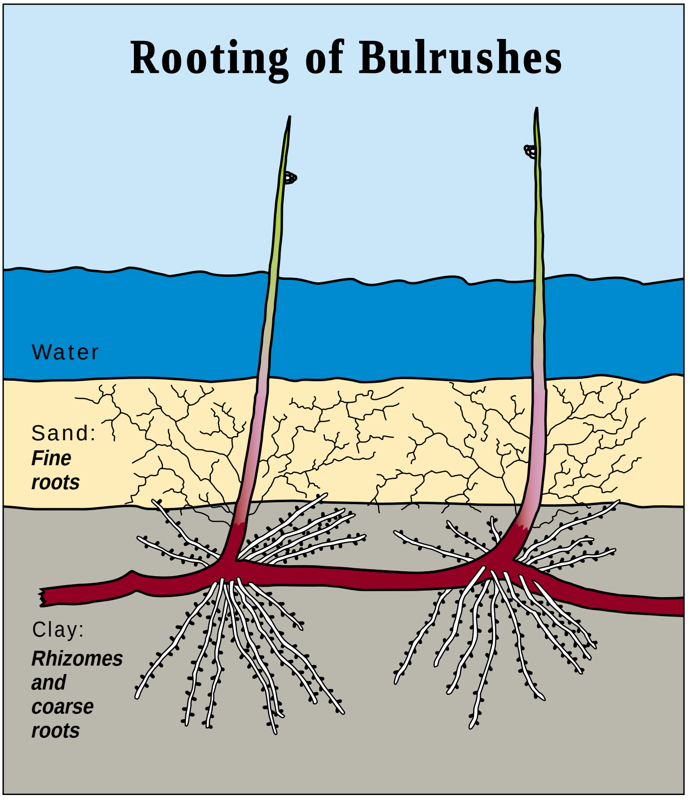
Restoration and Recovery

Estimates of overall wetland loss along the Great Lakes shoreline range from 30 to 50 percent. In Saginaw Bay, Lake St. Clair and western Lake Erie, comparison of historic maps to present aerial photos shows even greater levels of loss. These losses have resulted in significant ecological changes to the Great Lakes and its biota.

Historically, the earliest signs of significant wetland degradation were sharp declines in the coastal fishery and waterfowl populations. As large marshes disappeared or were severely degraded, fish and waterfowl populations responded to the habitat loss and their populations often plummeted, affecting both the economy and recreation of the local communities. Overall chemical and physical degradation of the lakes affected human health as well, and this was often the factor that triggered the cleanup of the Great Lakes, including their wetlands. Other values recognized as important to both residents and the general public were the importance of wetland vegetation for shoreline stabilization and the aesthetics and green space they provided.

The earliest coastal wetland restoration began with use of dikes to reduce erosion of coastal wetlands. On western Lake Erie, high turbidity resulting from agricultural

D. Albert

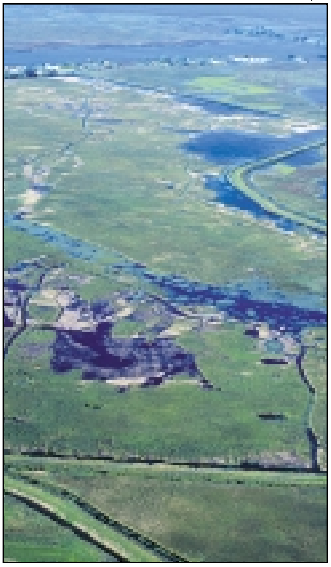


Rhizomes of bulrush reduce sediment erosion.

runoff and other forms of pollution, erosion by ship traffic and hardening of the shoreline had eliminated most of the original coastal marshes. Diking allowed manipulation of the water level throughout the year and improved access to marshes in heavily populated areas, increasing the number of hunters who could safely utilize a wetland.

Though dikes proved useful in restoring or maintaining degraded wetland systems, they can also result in degradation of otherwise intact wetlands, especially where wetlands meet diverse biological needs. In intact wetland systems, dike placements can fragment coastal wetlands and reduce function by altering water, nutrient and energy exchange. Impounded coastal marshes often exclude aquatic organisms and are no longer available for fish spawning and nurseries. Plant and wildlife populations are likely disrupted in other ways. Diking, which prevents dewatering or the influx of oxygenated lake water into coastal wetlands, causes buildup of dead plant material and the depletion of dissolved oxygen within impounded wetlands. Anaerobic conditions eventually result in the loss of additional species of aquatic life that depend on oxygenated water. Accumulation of nutrients and organic materials can lead to overly dense monocultures of cat-tails or other emergent vegetation.

J. Schafer



Dikes allow a variety of management opportunities, including water level control, planting, creating openings and more intensive use of marsh during hunting season.

J. Schafer

Dikes allow control of water levels in coastal marshes.

Other wetland restoration efforts have sought to create openings in dense emergent vegetation. One dramatic method — that of blowing openings in the marsh with explosives — is no longer a common practice. Instead, during low-water conditions, openings are created with heavy equipment.

G. Soulliere

Dikes are occasionally removed when they prove ineffective for management, as in the extensive marshes at the mouth of the Munuscong River. Dikes here were too large for effective water level control and subject to considerable damage by storm waves.

J. Schafer

Creating marsh openings with explosives is no longer a common practice.

Up through the early 1800s, Native Americans utilized fire to create more open-water habitat in coastal wetlands. Today, fire is once again recognized as an efficient management tool for restoring wetlands. The most effective time to burn is during the winter, when managers can work quickly and safely on ice. Controlled burns reduce cat-tail coverage and help to control exotic species such as reed and purple loosestrife.

Successful removal of some aggressive exotic plants, such as reed, may require herbicide treatments as well. Experimentation on exotic control is now being conducted at St. John's Marsh, along with controlled burning. *Galerucella*, a host-specific beetle that feeds only on purple loosestrife, has been introduced into wetlands and has reduced populations of this invasive plant by 90 percent in some areas.

Michigan wetland restoration projects include sites on lakes Michigan, Huron, St. Clair and Erie. On the St. Marys River, restoration efforts include removing ineffective waterfowl management dikes. On Saginaw Bay, a major mitigation project is restoring recently acquired agricultural lands to wet prairie and marsh; agricultural dikes are removed, selective drains are closed and tiles are broken in fields. At St. John's Marsh and Algonac State Park on Lake St. Clair, both marshes and wet prairies are now managed with prescribed burns, along with mechanical shrub removal and herbicide treatment of exotic plants. At Sterling State Park, on Lake Erie, the hydrology is being restored and coastal marsh is being replanted with seed from local wetland sources.

Recent restoration efforts, such as the project at Metzger Marsh near Sandusky, Ohio, are attempting to construct much more sophisticated diked wetlands, controlling not only water levels but the entry of fish into the wetland as well. The goal is to allow some fish to utilize the marsh while excluding common carp.

Metzger marsh originally had a barrier beach protecting the wetland from the waves of Lake Erie. The wetland had been

J. Schafer

Wetland restoration: burning cat-tails and reed on St. John's Marsh.

J. Schafer

Wetland restoration: using ORV to set marsh fires at St. John's Marsh.

heavily manipulated, with attempts to dike and farm it. Hardening of the adjacent shoreline eliminated the sediments that were needed to maintain the barrier beach. The barrier was eroded by high water conditions in 1973. Loss of the protective barrier combined with spawning and feeding of large numbers of carp resulted in almost complete loss of submergent and emergent wetland plants.

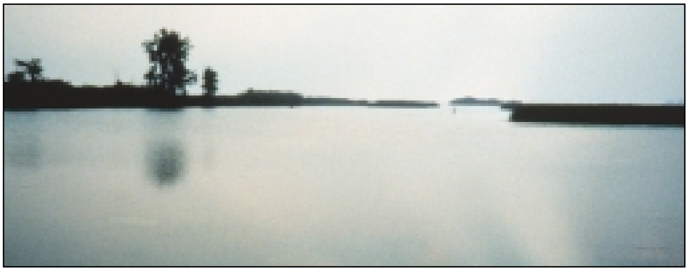
In 1995 the barrier beach was replaced by a dike, with five gates to allow drawdown to mimic low lake levels and allow the growth of emergent vegetation. Natural regeneration of the marsh from the seed bank was augmented with planting of wild-celery tubers. The dike gates were fitted with bars spaced five centimeters apart to allow small fish to enter the wetland but to exclude large carp. Lift baskets were also installed so that large fish other than carp could be introduced to the wetland. While some carp enter the wetland, reduced carp populations have allowed the vegetation in the marsh to persist.

The success of these recent experiments has not yet been fully evaluated.

In addition to these many management initiatives, conservation groups have been acquiring high-quality Great Lakes wetlands for preservation in perpetuity. Conservation organizations have purchased tracts along Duck, Voight, Dudley and El Cajon bays on northern Lake Huron as well as at Roach Point and adjacent wetlands along the St. Marys River. The Michigan Department of Natural Resources has acquired a large dune and swale complex west of Big Knob Campground on northern Lake Michigan. Michigan's government and numerous conservation organizations maintain their goal of protecting coastal wetlands.

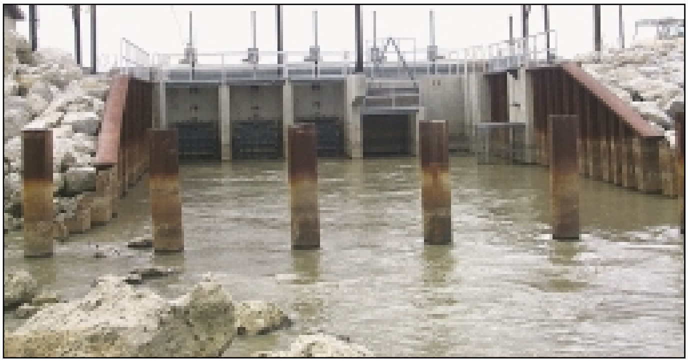
Though education, acquisition and more careful management of adjacent uplands have slowed the rate of wetland loss in recent years, coastal wetland loss has by no means been eliminated. Declining water levels in lakes Huron and Michigan since 1999 have exposed extensive beds of shoreline wetland vegetation, especially along Saginaw Bay. Some landowners have illegally plowed these coastal wetlands, altering hundreds of acres of open bulrush beds and wet meadow. It is too early to evaluate the full impact of these activities, but habitat value for many wetland animals has been reduced, and removal of stabilizing plant roots will likely increase shoreline erosion when water levels rise again.

D. Wilcox



Metzger Marsh. Prior to restoration, there was little aquatic vegetation in the carp-filled, turbid waters of the marsh.

D. Wilcox



Metzger Marsh. Five large gates provide effective control of the water levels in the marsh, while grates control entry of large fish.

D. Wilcox

Metzger Marsh. After dike construction and water drawdown, aquatic vegetation established from the seed bank.

Appendix A

Appendix B

Appendix C

G. Soulliere

Marshes in Michigan - Lake Erie

No.	Name	Lake	Type	Ownership
1	Erie Marsh	Erie	Sand-spit embayment	TNC, MI DNR, private
2	Otter Creek	Erie	Drowned river mouth	Private, MI DNR
3	River Raisin (Monroe)	Erie	Delta	Private, MI DNR (SP)
4	Swan Creek	Erie	Drowned river mouth	Private
5	**Pte. Mouillee**	**Erie**	**Delta**	**MI DNR**

** Public overlook
LTC = Little Traverse Conservancy
MI DNR = Michigan Department of Natural Resources
MNA = Michigan Nature Association
NF = National forest
SP = State park
TNC = The Nature Conservancy
USFS = U. S. Forest Service

Bolded sites are good examples of marsh types with public access.

Marshes in Michigan - Lake Huron

Marshes in Michigan - Lake Huron

No.	Name	Lake	Type	Ownership
6	Frenchman Creek	Detroit River	Drowned river mouth	Private
7	Clinton River	St. Clair	Delta	Metropark, private
8	**St. Clair River**	**St. Clair**	**Delta**	**MI DNR, private**
9	Hardwood Point	Huron	Open embayment	Private
10	Whiskey Harbor	Huron	Open embayment	Private
11	**Sleeper/Port Crescent**	**Huron**	**Dune & swale complex**	**MI DNR (SP)**
12	**Wildfowl Bay Islands**	**Huron**	**Sand-spit embayment**	**MI DNR**
13	Wildfowl Bay	Huron	Open embayment	Private, MI DNR
14	**Fish Point**	**Huron**	**Sand-spit embayment & open embayment**	**MI DNR, private**
15	Vanderbilt Park	Huron	Delta & open embayment	County park
16	Coryeon Point	Huron	Open embayment	Private, MI DNR
17	**Tobico State Park**	**Huron**	**Barrier beach lagoon**	**MI DNR**
18	**Nayanquing**	**Huron**	**Sand-spit embayment**	**MI DNR ****
19	**Pinconning**	**Huron**	**Sand-spit embayment**	**County park**
20	**Wigwam Bay/Pine R.**	**Huron**	**Delta & open embayment**	**MI DNR**
21	Rifle River	Huron	Delta	Private
22	Black River	Huron	Dune & swale complex	MI DNR
23	Squaw Bay	Huron	Open embayment	Private
24	Misery Bay	Huron	Open embayment	Private
25	**El Cajon Bay**	**Huron**	**Protected embayment**	**MI DNR**
26	False Presque Isle	Huron	Drowned river mouth	Private
27	Hammond Bay	Huron	Dune & swale complex	Private
28	Grass Bay	Huron	Dune & swale complex	TNC
29	**Cheboygan State Park**	**Huron**	**Dune & swale complex**	**MI DNR**
30	**Carp/Pine Rivers**	**Huron**	**Dune & swale complex**	**Hiawatha NF (USFS)**
31	**St. Martins Bay**	**Huron**	**Open embayment**	**Private, USFS**
32	Mismer Bay	Huron	Protected embayment	Private, LTC
33	**Mackinac Bay**	**Huron**	**Protected embayment**	**Private ****
34	**Duck Bay**	**Huron**	**Protected embayment**	**TNC, MI DNR, private**
35	Peck Bay	Huron	Open bay (n. fen)	Private
36	Voight Bay	Huron	Open bay (n. fen)	TNC, private
37	Big Shoal Cove	Huron	Open bay (n. fen)	Private
38	**Scott Bay/Paw Point**	**Huron**	**Protected embayment**	**MI DNR, private**
39	Burnt Island	Huron	Protected embayment	Private
40	Harbor Island	Huron	Protected embayment	Private

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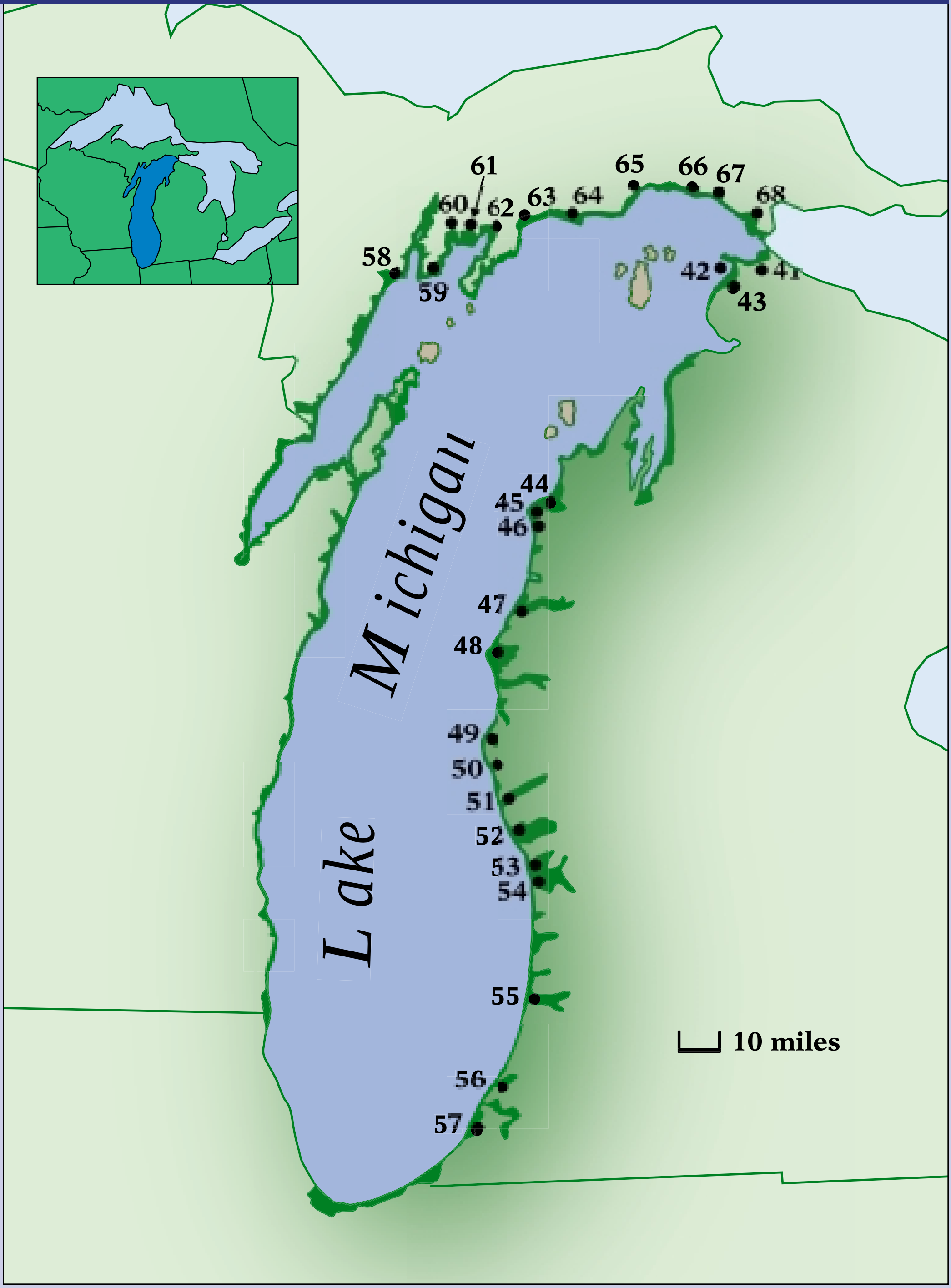
Bolded sites are good examples of marsh types with public access.

Marshes in Michigan - Lake Michigan



Marshes in Michigan - Lake Michigan

No.	Name	Lake	Type	Ownership
41	Trails End/Cecil Bays	Michigan	Open bays	Private, MI DNR
42	**Waugoshance Point**	**Michigan**	**Open bay (n. fen)**	**MI DNR (SP)**
43	**Sturgeon Bay**	**Michigan**	**Dune & swale complex**	**MI DNR (SP)**
44	**Platte Bay**	**Michigan**	**Dune & swale complex**	**Sleeping Bear NLS**
45	**Platte River Point**	**Michigan**	**Dune & swale complex**	**Sleeping Bear NLS**
46	Betsie River	Michigan	Drowned river mouth	MI DNR
47	Manistee River	Michigan	Drowned river mouth	MI DNR
48	Big Sable River	Michigan	Drowned river mouth	Private
49	Pentwater River	Michigan	Drowned river mouth	MI DNR
50	Stoney Creek	Michigan	Drowned river mouth	Private
51	White River	Michigan	Drowned river mouth	Private
52	Muskegon River	Michigan	Drowned river mouth	MI DNR, private
53	South Lloyd Island	Michigan	Drowned river mouth	Private
54	**Potawatomi Bayou**	**Michigan**	**Drowned river mouth**	**Ottawa Co. park**
55	**Kalamazoo River**	**Michigan**	**Drowned river mouth**	**Saugatuck Twp. park, private**
56	Paw Paw River	Michigan	Drowned river mouth	Private
57	Galien River	Michigan	Drowned river mouth	Private
58	Portage Creek	Michigan	Sand-spit embayment	MI DNR
59	Chippewa Point	Michigan	Open bay/delta	Private
60	**Ogontz Bay**	**Michigan**	**Dune & swale complex**	**Hiawatha NF (USFS)**
61	Indian Point/Nahma	Michigan	Open bay	Hiawatha NF (USFS)
62	**Fishdam Rivers**	**Michigan**	**Dune & swale complex**	**Hiawatha NF (USFS)**
63	Thompson	Michigan	Dune & swale complex/delta	Private, MI DNR
64	Gulliver Lake Dunes	Michigan	Dune & swale complex	Private
65	**Big Knob/Crow River**	**Michigan**	**Dune & swale complex**	**MI DNR**
66	Kenyon Bay	Michigan	Open bay	Private
67	Epoufette Bay	Michigan	Open bay	MI DNR, private
68	Pointe Aux Chenes	Michigan	Dune & swale complex	Hiawatha NF (USFS)

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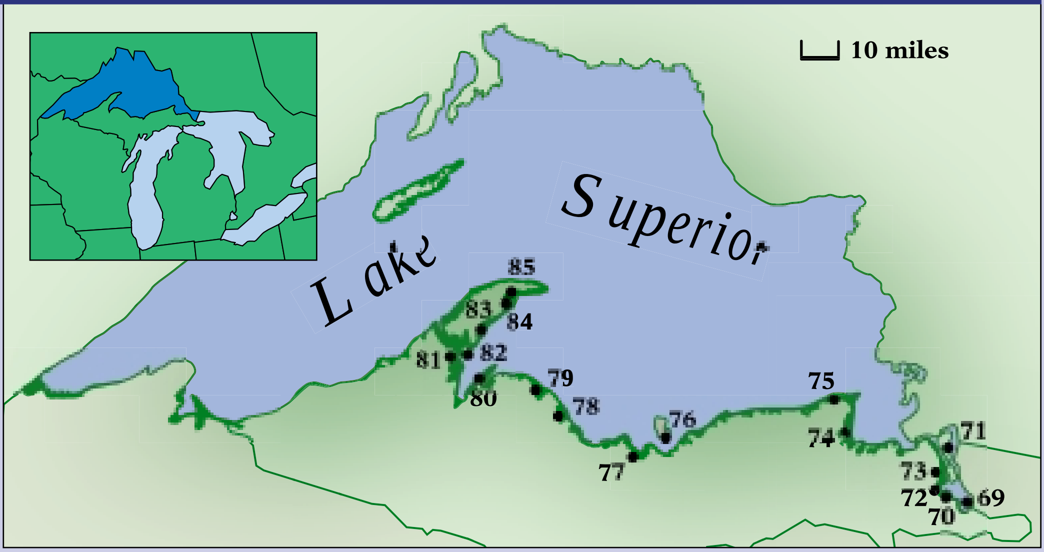
TNC = The Nature Conservancy
USFS = U. S. Forest Service
NLS = National Lakeshore

Bolded sites are good examples of marsh types with public access.

Marshes in Michigan - Lake Superior



No.	Name	Lake	Type	Ownership
69	Gogomain River	St. Marys R.	Connecting river - delta	Private
70	Roach Point	St. Marys R.	Connecting river – protected embayment	Michigan Nature Association
71	Sugar Island	St. Marys R.	Connecting river – protected embayment	University of Michigan, private
72	**Munuscong**	**St. Marys R.**	**Connecting river – delta**	**MI DNR**
73	Shingle Bay	St. Marys R.	Connecting river – protected embayment	Private
74	**Tahquamenon Bay**	**Superior**	**Dune & swale complex**	**MI DNR, USFS**
75	**Whitefish Point**	**Superior**	**Dune & swale complex**	**MI DNR**
76	**Grand I. – Murray Bay**	**Superior**	**Dune & swale complex**	**Hiawatha NF (USFS)**
77	**Au Train River**	**Superior**	**Dune & swale complex**	**Hiawatha NF, USFS, private**
78	Little Presque Isle	Superior	Dune & swale complex	MI DNR
79	Independence Lake	Superior	Dune & swale complex	Private
80	**Pequaming**	**Superior**	**Tombolo**	**County park**
81	**Sturgeon River**	**Superior**	**Delta**	**MI DNR ****
82	Portage Lake	Superior	Drowned river mouth	MI DNR, private
83	**Big Traverse Bay**	**Superior**	**Dune & swale complex**	**MI DNR, private**
84	Oliver Bay	Superior	Dune & swale complex	Private
85	Lac la Belle	Superior	Dune & swale complex	Private

** Public overlook
LTC = Little Traverse Conservancy
MI DNR = Michigan Department of Natural Resources
MNA = Michigan Nature Association
NF = National forest
SP = State park
TNC = The Nature Conservancy
USFS = U. S. Forest Service

Bolded sites are good examples of marsh types with public access.

Referenced Species: Common and Latin Names

Common Names	Latin Names
Plants	
Alder	*Alnosa rugosa*
American lotus	*Nelumbo lutea*
Arrow-arum	*Peltandra virginica*
Arrowhead	*Sagittaria* spp.
Aster	*Aster* spp.
Beak-rush	*Rhynchospora* spp.
Big bluestem	*Andropogon gerardii*
Bird's-eye primula	*Primula mistassinica*
Black spruce	*Picea mariana*
Bladderwort	*Utricularia* spp.
Blue-joint grass	*Calamagrostis canadensis*
Bog aster	*Aster nemoralis*
Bog-laurel	*Kalmia polifolia*
Bog rosemary	*Andromeda glaucophylla*
Buckbean	*Menyanthes trifoliata*
Bulrush	*Schoenoplectus* spp.
Bur-reed	*Sparganium chlorocarpum, S. fluctuans*
Butterwort	*Pinguicula vulgaris*
Calamint	*Calamintha arkansana*
Cat-tail	*Typha* spp.
Common waterweed	*Elodea canadensis*
Coontail	*Ceratophyllum demersum*
Cotton-grass	*Eriophorum* spp.
Cottonwood	*Populus deltoides*
Culver's-root	*Veronicastrum virginicum*
Curly-leaved pondweed	***Potamogeton crispus***
Cut grass	*Leersia oryzoides*
Dogwood	*Cornus* spp.
Duck potato	*Sagittaria* spp.
Duckweed	*Lemna minor, Lemna trisulca, Spirodela polyrhiza*
Dwarf lake iris	*Iris lacustris*
Fringed gentian	*Gentianopsis procera*
Frogbit	***Hydrocharis morsus-ranae***
Goldenrod	*Solidago* spp.
Grass-of-Parnassus	*Parnassia glauca*
Grass-pink	*Calopogon tuberosus*
Greater duckweed	*Spirodela polyrhiza*
Hardstem bulrush	*Schoenoplectus acutus*
Hornwort	*Ceratophyllum demersum*

Comon Names	Latin Names
Plants	
Houghton's goldenrod	*Solidago houghtonii*
Hybrid cat-tail	***Typha X glauca***
Indian grass	*Sorghastrum nutans*
Indian paintbrush	*Castilleja coccinea*
Ironweed	*Vernonia* spp.
Jewelweed	*Impatiens* spp.
Kalm's lobelia	*Lobelia kalmii*
Larch	*Larix laricina*
Large cranberry	*Vaccinium macrocarpon*
Leatherleaf	*Chamaedaphne calyculata*
Marsh bellflower	*Campanula aparinoides*
Marsh blazing-star	*Liatris spicata*
Marsh cinquefoil	*Potentilla palustris*
Marsh fern	*Thelypteris palustris*
Marsh pea	*Lathyrus palustris*
Meadowsweet	*Spiraea alba*
Montevidens' arrowhead	*Sagittaria montevidensis*
Mountain mint	*Pycnanthemum virginicum*
Muskgrass	*Chara* spp.
Naiad	*Najas* spp.
Narrow-leaved cat-tail	*Typha angustifolia*
Nodding beggar-ticks	*Bidens cernuus*
Nodding smartweed	*Polygonum lapathifolium*
Northern white-cedar	*Thuja occidentalis*
Ohio goldenrod	*Solidago ohioensis*
Pickerel weed	*Pontedaria cordata*
Pitcher-plant	*Sarracenia purpurea*
Pondweed	*Potamogeton* spp.
Prairie cordgrass	*Spartina pectinata*
Prairie dock	*Silphium terebinthinaceum*
Purple loosestrife	***Lythrum salicaria***
Purple milkweed	*Asclepias purpurascens*
Quillwort	*Isoetes* spp.
Red ash	*Fraxinus pennsylvanica*
Red-osier dogwood	*Cornus stolonifera*
Reed	***Phragmites australis****
Reed canary grass	***Phalaris arundinacea****
Riddell's goldenrod	*Solidago riddellii*
Rose pogonia	*Pogonia ophioglossoides*
Royal fern	*Osmunda regalis*

Referenced Species: Common and Latin Names

Plants

Comon Names	Latin Names
Sedge	*Carex* spp.
Shrubby cinquefoil	*Potentilla fruticosa*
Slender naiad	*Najas flexilis*
Small cranberry	*Vaccinium oxycoccos*
Softstem bulrush	*Schoenoplectus tabernaemontani*
Spatterdock	*Nuphar* spp.
Speckled alder	*Alnus rugosa*
Spike-rush	*Eleocharis* spp.
Spotted touch-me-not	*Impatiens capensis*
Sullivant's milkweed	*Asclepias sullivantii*
Sundew	*Drosera* spp.
Sunflower	*Helianthus* spp.
Sweet gale	*Myrica gale*
Switch grass	*Panicum virgatum*
Tall coreopsis	*Coreopsis tripteris*
Tall green milkweed	*Asclepias hirtella*
Tamarack	*Larix laricina*
Threesquare	*Schoenoplectus pungens*
Tuberous Indian plantain	*Cacalia plantaginea*
Tufted loosestrife	*Lysimachia thyrsiflora*
Tussock-forming sedges	*Carex stricta*, *C. aquatilis*, and others
Walking sedge	*Eleocharis rostellata*
Water bulrush	*Schoenoplectus subterminalis*
Water-celery	*Vallisneria americana*
Water horsetail	*Equisetum fluviatile*
Water-lily	*Nymphaea odorata*
Water-shield	*Brassenia schreberi*
Water star-grass	*Heteranthera dubia*
Water-marigold	*Megalodonta beckii*
Water-milfoil	*Myriophyllum* spp.
Waterweed	*Elodea canadensis*
Wild rice	*Zizania aquatica*
Wild-celery	*Vallisneria americana*
Willow	*Salix* spp.
Yellow cress	*Rorippa palustris*
Yellow pond-lily	*Nuphar advena*

Animals

Aquatic Worms

Common Names	Latin Names
Segmented worm	Order *Oligochaeta*

Arthropods – Spiders

Common Names	Latin Names
Water mite	Family *Hydrachnidae*

Birds

Common Names	Latin Names
American bittern	*Botaurus lentiginosus*
American black duck	*Anas rubripes*
Black scoter	*Melanitta nigra*
Black tern	*Chlidonias niger*
Black-throated blue warbler	*Dendroica caerulescens*
Blue-winged teal	*Anas discors*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Common goldeneye	*Bucephala clangula*
Common merganser	*Mergus merganser*
Common tern	*Sterna hirundo*
Great egret	*Casmerodius albos*
King rail	*Rallus elegans*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Red-breasted merganser	*Mergus serrator*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Swan, mute	***Cygnus olor***
Swan, trumpeter	*C. buccinator*
Swan, tundra	*C. columbianus*
White-winged scoter	*Melanitta fusca*
Wigeon, American	*Anas americana*
Wood duck	*Aix sponsa*

Crustaceans

Common Names	Latin Names
Burrowing crayfish	Family *Cambaridae*
Scud (shell-less crustacean)	Family *Gammaridae*
Water flea	*Daphnia* spp.

Referenced Species: Common and Latin Names

Common Names	Latin Names
Animals	
Fish	
Alewife	***Alosa pseudoharengus***
Black bullhead	*Ictalurus melas*
Bowfin	*Amia calva*
Brown bullhead	*Ameiurus nebulosus*
Central mud-minnow	*Umbra limi*
Common carp	***Cyprinus carpio***
Gizzard shad	*Dorosoma cepedianum*
Goldfish	***Carassius auratus***
Lake sturgeon	*Acipenser fulvescens*
Largemouth bass	*Micropterus salmoides*
Longnose gar	*Lepisosteus osseus*
Muskellunge	*Esox masquinongy*
Northern pike	*Esox lucius*
Round goby	***Neogobius melanostomus***
Smallmouth bass	*Micropterus dolomieu*
Spottail shiner	*Notropis hudsonius*
Sucker	Family *Catostomidae*
Trout	Family *Salmonidae*
Walleye	*Stizostedion vitreum*
Whitefish	*Coregonus* spp.
Yellow perch	*Perca flavescens*
Insects – Beetles	
Leaf-eating beetle (host – purple loosestrife)	***Galerucella* spp.****
Whirligig beetle	Family *Gyrinidae*
Insects – Dragonflies	
Dragonfly	Family *Libellulidae*
Narrow-winged damselfly	Family *Coenagrionidae*
Insects – Flies (Order *Diptera*)	
Marsh fly	Family *Sciomyzidae*
Midge	Family *Chironomidae*

Common Names	Latin Names
Animals	
Insects – Moths	
Borer moth	*Papaipema* spp.
Insects – Other	
Case-making caddisflies	Families *Leptoceridae* and *Limnephilidae*
Mayfly	Family *Caenidae*
Mound ant (wood ant)	Subfamily *Formicinae*
Water boatmen	Family *Corixidae*
Mammals	
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Raccoon	*Procyon lotor*
Skunk	*Mephitis mephitis*
Mollusks	
Coiled-shell snail	Family *Hydrobiidae*
Fingernail clam	Family *Sphaeriidae*
Zebra mussel	***Dreissena polymorpha***
Reptiles	
Eastern fox snake	*Elaphe gloydi*
Spotted turtle	*Clemmys guttata*
Blanding's turtle	*Emys blandingii*

Bolded species are exotics (introduced from outside Great Lakes region).

* ***Both native and aggressive exotic varieties of these species occur within coastal wetlands.***

** ***Introduced to control purple loosestrife.***

Suggested Readings

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For More Information Contact:

Michigan Natural Features Inventory
Michigan State University Extension
Mason Building, Box 30444
Lansing, MI 48909-7944
Phone: 517-373-1552
Web site: **www.msue.msu.edu/mnfi**

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