

CHAPTER 6

ECOSYSTEM AND HABITAT

An **ecosystem** is a biological community of well-established living (biotic) organisms that occur because of favorable conditions provided by various non-living (abiotic) components. Biotic components help shape an ecosystem, and include plants, fish, animals and bacteria. Living organisms require energy to function and nutrients to grow. Abiotic components can be both chemical and physical, and include water, soil, temperature, humidity, sunlight, solar radiation, wind and the atmosphere. The interactions between biotic and abiotic components within an ecosystem are essential for nutrient cycling, energy flow, survival and reproduction.

The Lake Erie ecosystem is complex. Constant interaction occurs between plant and animal species. Many environmental changes and anthropogenic stressors continually affect and endanger the Lake Erie ecosystem. Such changes and stressors include the introduction of nonindigenous and invasive species, pollutants entering the lake and land use changes. These can impact water quality, native species populations, food webs, human health, recreation trends and visual aesthetics.

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LIMNOLOGY OF LAKE ERIE

Lake Erie is a **eutrophic** lake, meaning it is considered one of the most biologically-productive types of lakes. Characteristic of eutrophic bodies of water, Lake Erie yields high levels of nutrients and supports an abundance of aquatic plants, including algae. It is also conducive for high rates of photosynthesis to occur. Lake Erie is the only eutrophic Great Lake. Biological productivity and optimal aquatic habitat for plants, fish and other species is dependent on many physical, biological and chemical characteristics, including climate, air temperature, water temperature, sunlight penetration, lake levels, water movement, chemical conditions, food and oxygen availability, nutrient levels, lakebed substrates, basin geomorphology and local geology, among others. The study of these characteristics, their interactions and how they influence ecosystems and habitats in bodies of fresh water is called “limnology.”

Biological communities that are found in Lake Erie—and in many other freshwater lakes—typically occur within distinct ecological zones related to the lake’s various physical properties. These zones are delineated vertically by water depth and horizontally by distance from shore. The upper part of the water column, nearest to the lake surface, is called the **euphotic zone**. This is the zone that sunlight can penetrate and where photosynthesis can take place. The process of photosynthesis occurs when aquatic plants and algae use sunlight to convert dissolved carbon dioxide (in the water) into simple carbohydrate sugars and oxygen. Photosynthesis is a critical source of oxygen in the water and essential for maintaining the aquatic food web. In the Western and Central basins, the euphotic zone is usually less than ten feet deep.

The amount of subsurface light determines the maximum depth of algae and plant habitat in the euphotic zone. This depth is recognized as the point where available light is reduced to 0.5 to one percent the amount of light on the surface. Above this water column level, enough light is present for photosynthesis to occur. Between the lowest limit of the euphotic zone and the lake bottom is the **profundal zone**. This zone comprises the deeper and darker portions of the water column, where sunlight does not penetrate. The third vertical zone—the **benthic zone**—includes lakebed substrates, from the surface of the lake bottom to the deepest point of biologic activity. Organisms that are normally found in the benthic zone include invertebrates, such as insect larvae (e.g. larval mayflies), worms and crustaceans. Parallel to the lake plane, the **littoral zone** is the area nearest to the shore where sunlight can penetrate to bottom sediments—making it possible for rooted aquatic plants to grow. This zone typically intersects the euphotic zone. The **pelagic zone** includes open water areas where light penetrates the upper portion of the water column, but does not reach bottom sediments. Rooted plants are unable to establish a foothold in benthic areas of the pelagic zone; however, algae may occur in the upper waters. The pelagic zone includes both the euphotic and profundal zones.

In late winter and early spring, Lake Erie water temperatures are cold and nearly consistent throughout the entire water column. The lake's surface temperatures increase as sunlight is absorbed in late spring and summer. Sunlight and warmer air temperatures cause the upper layers of the water column to become warmer. The intensity that light can penetrate decreases with depth and as it passes through suspended particles in the water column. Subsequently, water temperature also decreases with depth during this time.

Fish and aquatic life depend on the oxygen that is dissolved into the water, called **dissolved oxygen**. In most lakes and streams, oxygen in the atmosphere continuously replenishes the oxygen in the water. Oxygen is also released into the water as a byproduct of photosynthesis. The amount of dissolved oxygen present in the water is both important for and affected primarily by biological activity. Higher levels of dissolved oxygen are present in the warmer, well-lit parts of Lake Erie during spring and summer. This is due to photosynthesis occurring at a very high rate in this part of the water column. In the deeper, poorly-lit areas of the lake, a higher biological oxygen demand combined with lower levels of photosynthesis may cause dissolved oxygen levels to drop.

Like terrestrial plants, algae and aquatic plants require nutrients to grow and photosynthesize, including nitrogen and phosphorous. When sufficient nutrient levels are present in the lake, large populations of algae and aquatic vegetation can grow. Conversely, when fewer nutrients are present in the lake, algae and plant growth is limited. Among the Great Lakes, Lake Erie maintains relatively high nutrient levels. The presence of algae in Lake Erie causes the water to look green and cloudy. In contrast, Lake Superior—which is significantly deeper and colder—has much fewer nutrients,



East Sandusky Bay, Erie County

supports lower populations of algae and aquatic vegetation, and therefore has greater water clarity. Higher nutrient levels in Lake Erie occur due to many factors. Since Lake Erie is shallow and well-mixed—especially in the Western Basin—nutrients are sufficiently circulated and increasingly available to aquatic vegetation. Fertilizer runoff from agricultural and residential lands near the lake is another source of high nutrient levels. When nutrient levels get too high, conditions become favorable for cyanobacteria blooms (also called “harmful algal blooms,” or “HABs,” for short) to develop. HABs can be visually unaesthetic and occasionally release toxins.

In late summer, warmer temperatures often cause the stratification of water in Lake Erie. **Stratification**, or “thermal stratification,” occurs when masses of water with different chemical and physical properties accumulate and separate to form distinct layers in the water column. Stratified water does not mix and is layered by density, where more dense, cooler water masses tend to flow below less dense, warmer water masses (see page 170). If the lake’s chemical and physical properties do not mix for a period, the colder and denser bottom waters will lack sufficient levels of oxygen.



Arcola Creek Park, Lake County

When this happens, nutrients become trapped in the sediments at the bottom of the lake. These nutrients are not available to new plant growth until lake waters mix again. Conversely, if there is sufficient oxygen at the bottom of the lake and the water column is well-mixed, decomposing algae and vegetation will release stored nutrients back into the water.

Conditions may occur in Lake Erie where dissolved oxygen is consumed by aquatic organisms faster than the rate at which oxygen in the air can replenish it—putting the lake bottom and benthic ecosystems at risk. Organic material settles at the lake bottom and is decomposed by bacteria. Dissolved oxygen is consumed by bacteria during this process. Thermal stratification in late summer prevents warmer, less dense water near the surface from mixing with cooler, denser water at the bottom of the water column. As a result, oxygen levels at the lake bottom are not replenished, creating a “dead zone.” The overgrowth of algae and cyanobacteria can be detrimental to aquatic life because when these organisms die, large deposits of organic material are distributed on the bottom of the lake. The larger the algal bloom, the greater the rate that dissolved oxygen is consumed and depleted, exacerbating anoxic (“dead zone”) conditions.

Expansive and dense populations of algae and cyanobacteria also inhibit sunlight from reaching underwater aquatic vegetation, impacting habitat. Large HABs in Lake Erie, especially in the Western Basin, can form during summer months. The overgrowth of cyanobacteria and other plankton is triggered by the excessive enrichment of nutrients entering the lake from agricultural and urban runoff. This process is called **eutrophication**. Common mechanisms that lead to the eutrophication of Lake Erie are due to human activity, including the clearing of land, which accelerates runoff, and fertilizer application, which adds phosphorous and nitrogen to runoff.

AQUATIC FOOD WEBS

Biological communities in Lake Erie are linked through food webs in the aquatic food chain. A **food chain** is a general hierachal model that shows how energy and nutrients flow from one organism to another in an ecosystem. A **food web**, or food cycle, is the natural interconnection between organisms and illustrates what different species eat in an ecosystem. The complexity of food webs may help to ensure survival in nature. If one organism in a chain becomes scarce, another may be a suitable substitute. Food webs begin with the introduction of energy from sunlight.

Aquatic plants and algae are “primary producer” organisms and at the bottom of the food web. Primary producers convert sunlight, nutrients and water into simple carbohydrate sugars (through photosynthesis), which can be used as food. In Lake Erie, most primary producers are microscopic phytoplankton, including green algae. The next level in the food web consists of “herbivorous consumers,” or organisms that eat food produced by plants. An example of a primary consumer is zooplankton. “Carnivorous consumers” make up the next level of the food web. Examples of carnivores include gizzard shad, juvenile fish and frogs. Top carnivorous predators at the end of the Lake Erie food web include adult fish (e.g. walleye and bass), birds and mammals, as well as humans. Bacteria and fungi are “decomposers” that live at the bottom of the lake. Decomposers convert dead and decaying organisms—from all food web levels—back into nutrients, which can be used again by primary producers. Aquatic food webs are extremely sensitive. A change at any level, such as the introduction of a nonindigenous species to the ecosystem, can lead to a chain reaction and affect other levels.

AQUATIC HABITAT

From coastal wetlands, estuaries and the shore to reefs, shoals and bottom substrates, Lake Erie provides a range of habitat types. **Habitat** is an ecological or environmental area that a living organism or biological population lives in or occurs. Wildlife species (fish, birds, mammals, amphibians, reptiles and invertebrates) depend on their natural setting for food, water, reproduction, nurturing young, protection and refuge. Habitat characteristics and conditions contrast between species, animal types and life stages. Productive aquatic habitat conditions occur in most of Lake Erie (see pages 154 and 156).

Wetlands are an integral part of the Great Lakes ecosystem. A wetland is an area of land that is seasonally or permanently saturated by shallow water, or an area where the water table is present at or near the surface (year-round or for varying periods of time during the year). Water saturation generally determines how soil develops and what types of plants and animals live in and on the soil.

Wetlands act as natural reservoirs of water and can reduce the risk of coastal flooding. The slow release of water minimizes erosion potential and enables groundwater recharge. A wetland's ability to collect floodwaters and reduce flow momentum can also lessen the risk of property damage and other hazards. Wetlands—especially coastal marshes—help improve water quality by filtering sediments, nutrients and contaminants (see below). These environments are biologically productive ecosystems and support many kinds of aquatic and terrestrial species. Some species are found exclusively in wetland habitats. The nutrient-rich water enables abundant vegetation growth. Aquatic vegetation and shallow water provides unique habitat conditions for fish and wildlife. Wetlands are important feeding and resting areas for migrating birds, shorebirds and waterfowl. They are also important spawning and nursery grounds for many species of fish. The four main wetland types include: marshes, swamps, bogs and fens. Marshes and swamps are common along Lake Erie and in the Lake Erie Watershed. Bogs and fens are rare (see page 139).

Coastal marshes are typically located along the periphery of the lake and along tributaries. These wetlands form a transitionary zone between aquatic and terrestrial habitats and are almost always flooded. Coastal marshes provide habitat to a variety of wildlife and vegetation types. Saturated and anaerobic (lacking oxygen) soil conditions are favorable for water-tolerant plants. Types of aquatic vegetation found in marsh wetland environments include grasses, rushes, sedges and herbaceous plant species, such as cattails and reeds. Many fish species, waterfowl types, insects, amphibians and terrestrial species that have adapted to living in flooded conditions are found in coastal marsh settings. Coastal marshes are among the most biologically-productive ecosystems in the world and help support diverse fisheries. Marsh wetlands also help water quality by filtering sediments, nutrients and contaminants. The slow-flowing nature of water allows sediments to settle to the bottom of the marsh. Nutrients

from agricultural fertilizers, manure, sewage and other contaminants are dissolved in the wetland before they can reach Lake Erie. Such pollutants are absorbed by plant roots and microorganisms in the soils. Significant Lake Erie marshes include: the Western Basin Marsh Complex in Lucas and Ottawa counties (which includes the protected marshes at Mallard Club Marsh Wildlife Area, Cedar Point National Wildlife Refuge, Metzger Marsh Wildlife Area, Ottawa National Wildlife Refuge and Magee Marsh Wildlife Area), the marshlands around Sandusky Bay in Ottawa and Sandusky counties, Sheldon Marsh in Erie County and Mentor Marsh in Lake County (see the Protected Lands map on page 144).

Swamps are forested wetlands and are dominated by hardwood trees and shrubs. Standing water and limited drainage are common swamp characteristics. Much of the Lake Erie Watershed in northwest Ohio was once covered by a vast swamp wetland known as the Great Black Swamp. It spanned a 900,000-acre area and ranged from the Lake Erie shore—between Toledo and Sandusky—to Fort Wayne, Indiana. The Great Black Swamp included coastal marshes, poorly-drained soils and lush elm-ash swamp forest (see the Original Vegetation map on page 68). Elm-ash canopy species common in the region included American elm, black ash, white ash, silver maple and red maple.



Metzger Marsh Wildlife Area, Lucas County



Great Egrets



Mentor Marsh State Nature Preserve, Mentor, Lake County

The Great Black Swamp provided diverse habitat for countless aquatic and terrestrial species including bald eagle, bear, beaver, bobcat, deer, mink, muskrat, raccoon, skunk and insects. In the 1850s, Ohio's General Assembly passed the first of many laws authorizing the drainage of the swamp. As a result, the massive effort to dig complex ditch networks, canals and feeders into Lake Erie tributaries commenced. The exposed land offered tremendously rich and productive soils (see Chapter 8: Soils, page 184) and the logging industry prospered. However, significant habitat was severely altered. Many native plant and animal species became extinct or were extirpated. Only the coastal marshes of the Western Basin Marsh Complex (approximately 15,000 acres) and wetland areas around the Sandusky Bay remain. Small remnants of the Great Black Swamp can be found at Goll Woods State Nature Preserve in Fulton County and Pearson Metropark in Oregon (Lucas County).

In north-central and northeast Ohio, swamps and swamp forests in the Lake Erie coastal plain and watershed once occupied much larger areas. Urban development, sprawl and other land uses have reduced these wetland communities to much smaller and fragmented areas. Today, notable swamps in the eastern part of the Lake Erie Watershed include: the Conneaut Swamp, Geneva Swamp, Kingsville Swamp and Morgan Swamp—all in Ashtabula County. In Ohio, rare hemlock hardwood swamp communities—found at Conneaut Swamp State Nature Preserve—only occur in the coastal plain of Ashtabula County or in the Grand River Lowlands (in Ashtabula County). The 2,000-acre Morgan Swamp is a remnant of a larger five-square mile swamp that existed at the time of settlement. Small swamp forests can be found at Bradley Woods Reservation in western Cuyahoga County, Carlisle Reservation in Lorain County, Eldon Russell Park in Geauga County and at New Lyme Wildlife Area in Ashtabula County.

Mentor Marsh occupies an ancestral section of the lower Grand River channel. The original river mouth at Mentor Lagoons in Mentor is located roughly 4.5 miles west of the current mouth at Fairport Harbor. Erosion from Lake Erie scoured away land near present-day Headlands Beach State Park and caused a breach in the river, creating a new outlet. The redirected Grand River watercourse gradually transformed the abandoned river channel into an extensive wetland area. Much of Mentor Marsh was originally swampland; however, in the 1960s, salt mine waste was dumped into the adjacent Blackbrook Creek, which slowly destroyed all swamp forest trees by the early 1970s. Eventually, non-native *Phragmites*, a tall and invasive reed grass, took over the marsh and smothered populations of native vegetation. In 2004, the Cleveland Museum of Natural History began the effort to restore Mentor Marsh, which involves various methods of *Phragmites* control and planting native vegetation.

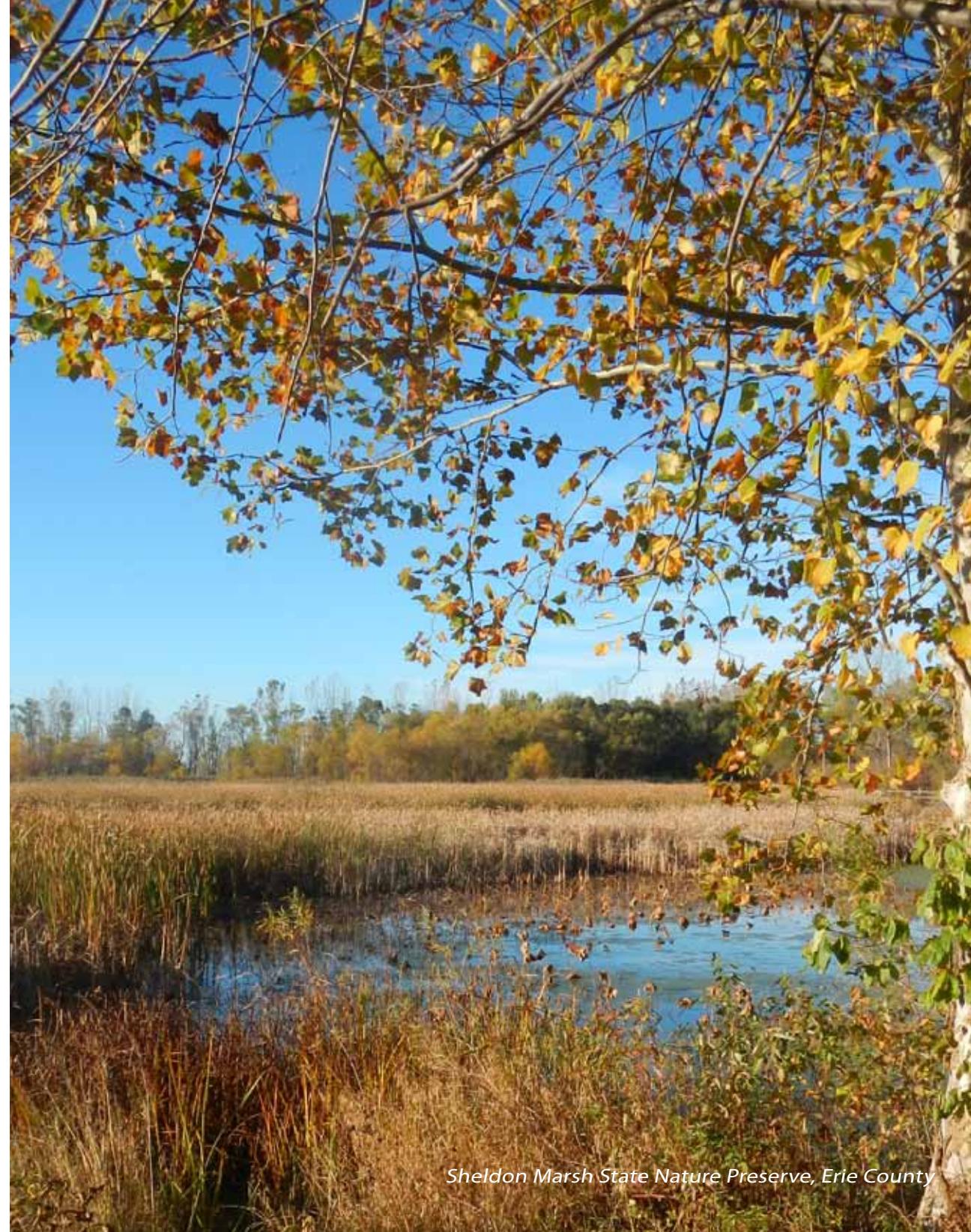
A **bog** is a peat-accumulating wetland that traps precipitation as its only source of water. Peat is a buildup of decayed and partially-decayed plant material and other organic matter. Bogs typically contain acidic, nutrient-poor water at the ground surface and anaerobic soils, which allows for minimal and slow vegetation growth. Bog habitats

are highly significant and biologically diverse. Plants found in these environments include Sphagnum moss (commonly known as “peat moss”), ericaceous (flowering) shrubs and trees and other mosses. The decomposition of organic matter occurs at such a slow rate—due to saturated soil conditions—that a bog will begin to function as a “carbon sink,” meaning it will absorb more carbon than it will release carbon dioxide into the atmosphere. Notable bogs in the Lake Erie Watershed include: Kent Bog and Triangle Lake Bog—both in Portage County—and Mud Lake Bog in Williams County. The 50-acre Kent Bog is a deep, glacially-carved kettle lake that is filled entirely with peat. It supports the largest, southernmost stand of tamarack trees in the country. Bogs are suitable habitat for a variety of insects and wildlife, including turtles, frogs, snowshoe hare, beaver and muskrat.

A **fen** is also a peat-accumulating wetland; however, fens are typically fed by mineral-rich surface water or groundwater. While bogs are acidic and nutrient-poor, fen wetlands are pH neutral or alkaline and rich with nutrients. Fens support a variety of specialized plant species, including orchids, sedges and grasses. In addition to specialized plant vegetation, fens also have a high diversity and distribution of other plant species. Fens support insect-eating birds, amphibians, shrews, voles, muskrats and insects, especially mosquitos. Fens are generally found near bogs. Gott Fen and Herrick Fen are two notable fens in Portage County. In Sandusky County, the fen area at Blue Heron Preserve is a remnant of the large fens that once flowed from the blue holes in the Castalia area (Erie County).

Vernal pools are temporary pools of water that form in natural depressions in the landscape for variable periods of time. They typically fill with water due to snow melt and spring precipitation. Vernal pools are usually dry for most of the summer and fall seasons, and may be forested or covered by herbaceous vegetation. Due to their ephemeral nature, vernal pools generally do not support fish populations. Instead, they provide essential breeding habitat for certain species of insects, frogs, salamanders and invertebrates that are otherwise vulnerable to fish predation. These include some threatened species and species of special concern. Areas with vernal pool habitat generally exhibit greater species biodiversity and richer ecological processes, such as nutrient cycling. However, these wetland areas are at risk for several reasons. Vernal pools are often overlooked due to their seasonality, location and small size (generally less than 99 feet in diameter). They are difficult to recognize during the dry season. Vernal pools can occur outside of known wetland habitat (e.g. in forests or throughout agricultural lands).

In the Great Lakes, an **estuary** is a partially-enclosed body of water where the water from a river or smaller tributary meets and mixes with lake water. Estuaries form at or near stream mouths. Freshwater estuarine conditions are significant aquatic and wetland environments because of their unique physical and water chemistry properties. These ecologically-productive environments provide habitat to an abundance of plant and animal species. Nutrient-rich estuarine waters support cattails, water lotus, sedges,



Sheldon Marsh State Nature Preserve, Erie County

reeds, grasses and other aquatic plants. Estuaries are important feeding and breeding areas for many fish species and provide critical spawning and nursery habitat. Algae, insects, reptiles and amphibians also flourish in estuarine habitat. Various aquatic organisms may travel back and forth between an estuary and the lake to maximize food and shelter needs. Estuarine environments also attract and protect terrestrial wildlife and birds, including waterfowl, shorebirds, raptors and migrating birds. Estuaries help filter sediments, nutrients and other pollutants before they enter the lake, which is critical to the lake's health, and reduces eutrophication. Estuaries also provide a buffer for upland areas from storms and coastal flooding. Nearly all estuaries along Ohio's shore have been impacted by human activity and development. The estuaries at Old Woman Creek in Erie County and Arcola Creek in Lake County are two of the few natural Lake Erie estuaries. The estuary at Old Woman Creek is relatively undisturbed, while the estuary at Arcola Creek has been restored back to its natural setting. It was heavily-impacted by shipbuilding and industrial activities in the 1800s. Today, the 573-acre Old Woman Creek State Nature Preserve and National Estuarine Research Reserve (NERR) and 62-acre Arcola Creek Park help protect and preserve these important environments. The NERR system is a network of 29 protected estuarine areas around the country dedicated to long-term research, education and coastal stewardship. Old Woman Creek NERR was designated in 1980 as the first freshwater estuary on the Great Lakes to join the reserve system.

A **reef** is a rocky outcrop that rises to or near the lake surface. Reefs are key reproductive sites for walleye, smallmouth bass, lake whitefish and other species. Cobble, pebbles and gravel substrates are ideal for nesting and broadcast-spawning fish. Compared to surrounding areas, the water above a reef warms earlier in the spring and cools earlier in the fall. This is due to the shallowness of the water column and the nature of the substrate. Spring temperatures promote spawning activity, especially for walleye. Reefs are subject to wave action and lake currents, which aids in the aeration of eggs and delivery of minerals necessary for larval development. Excessive currents and wave action caused by storms can remove incubating eggs from the substrate. Insufficient water movement may cause egg suffocation due to siltation or anoxia. Reefs also provide important feeding areas for Lake Erie fish, like smallmouth bass. Non-native species, such as round goby, are attracted to reefs for food and shelter, while zebra and quagga mussels reside on hard reef substrates to feed on suspended organic matter, like phytoplankton. Most Lake Erie reefs—especially in the Western Basin Reef Complex—are conical in shape and elongated in a northeast-southwest direction due to the influence and movement of the glaciers. Many of the same attributes that establish reefs as quality spawning habitat can also be detrimental.



Shoals are sandy areas in relatively shallow waters that are susceptible to turbulent conditions. Because of the turbulence, aquatic plants are typically not present in these shallower areas. Fish populations are lower around shoals as opposed to sheltered and more favorable habitat types in the nearshore. The soft, well-oxygenated sandy substrates provide optimal habitat to burrowing organisms, including insect larvae (e.g. larval mayflies) and worms. These organisms are readily-available food sources for fish species that do spawn in shoals, including smallmouth bass.

The shore area also provides optimal habitat for many aquatic species. For example, the rocky shores of the Lake Erie Islands are prime Lake Erie water snake habitat. The Lake Erie water snake has one of the smallest geographic ranges of any vertebrate species in the world. In 2011, it was delisted from the federal threatened and endangered species lists.

Additional information about the Lake Erie ecosystem, environment and habitat types are presented throughout this chapter. Topics include: (1) Ecological Regions (Ecoregions); (2) Protected Lands; (3) the National Wetlands Inventory; (4) Lake Erie Environmental Zones; (5) Walleye Habitat; (6) Aquatic Invasive Species, and; (7) Lake Erie's walleye and yellow perch fishery.

Learn more about the information presented in this chapter:

Ohio Department of Natural Resources, Division of Natural Areas and Preserves
naturepreserves.ohiodnr.gov

Ohio Department of Natural Resources, Division of Parks and Watercraft
parks.ohiodnr.gov

Ohio Department of Natural Resources, Division of Wildlife
wildlife.ohiodnr.gov

Ohio Environmental Protection Agency
epa.state.oh.us

Ohio State University, Ohio Sea Grant College Program
ohioseagrant.osu.edu

U.S. Environmental Protection Agency
epa.gov

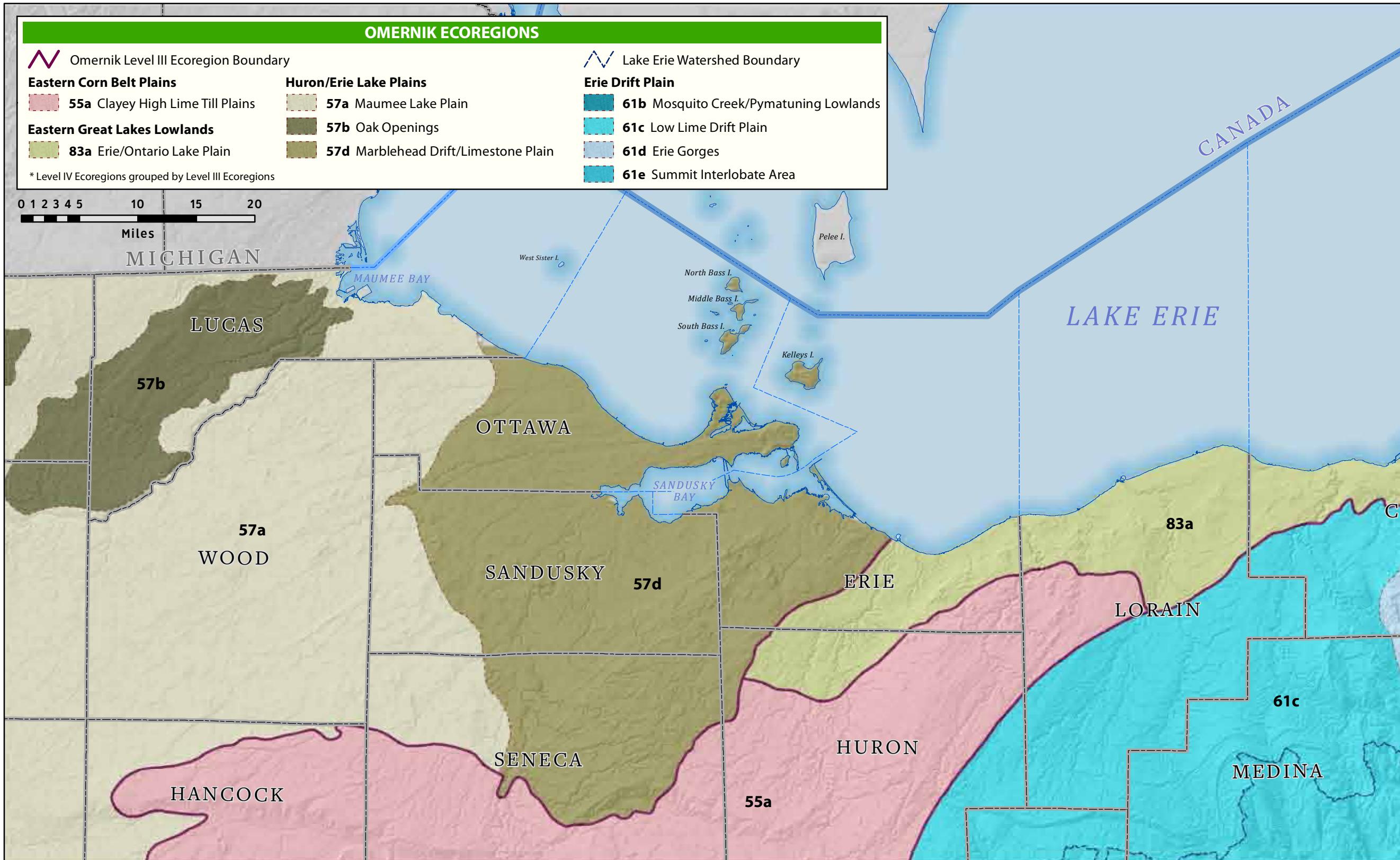
U.S. Fish and Wildlife Service
fws.gov

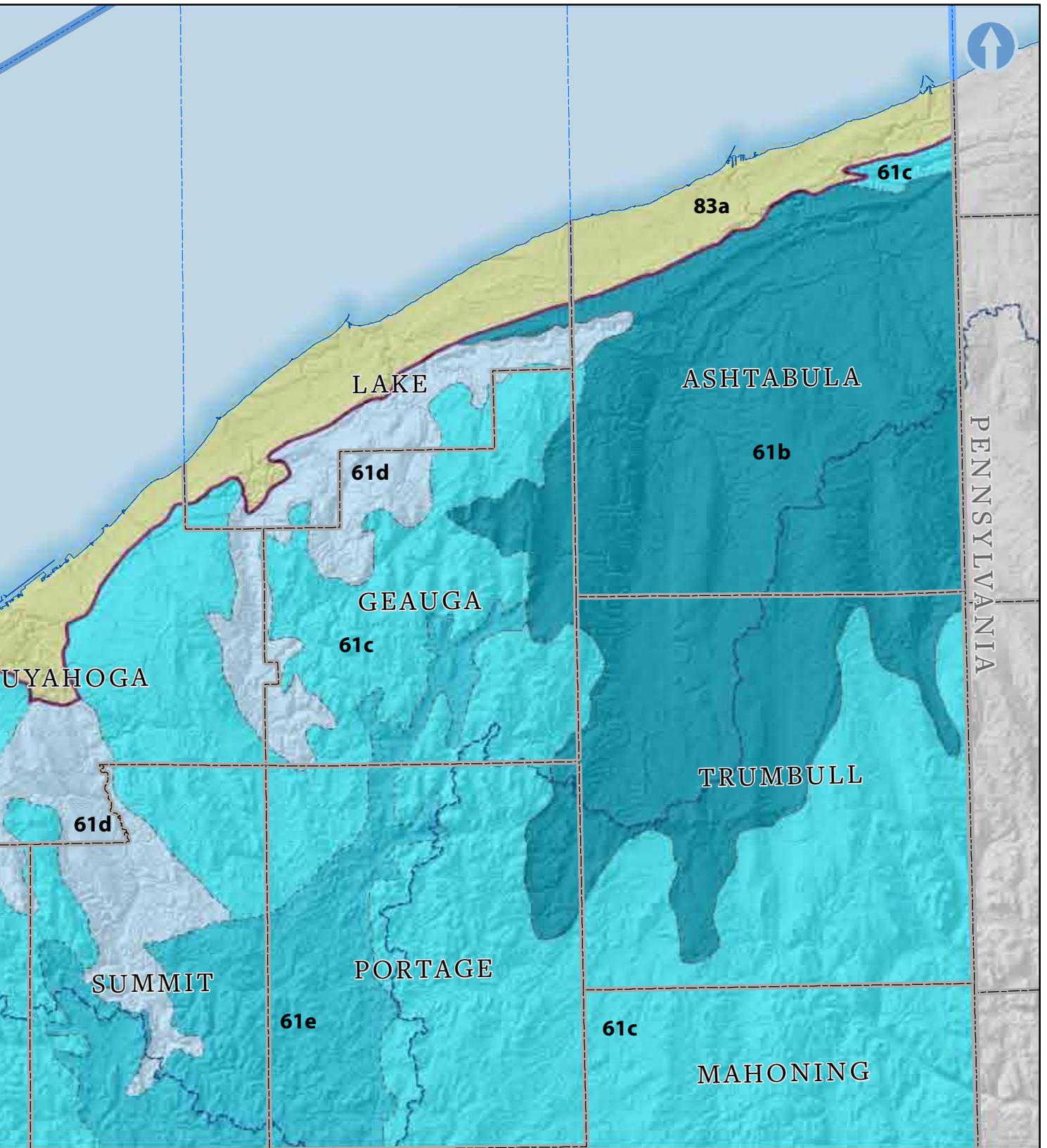
A complete list of chapter sources is found in the Appendix.



Mayflies

ECOLOGICAL REGIONS (OMERNIK ECOREGIONS, LEVELS III AND IV)





An ecological region, or “**ecoregion**,” for short, is a large geographic area that exhibits similar environmental traits and distinct groupings of natural communities and species. The ecoregions illustrated in this map were originally delineated by James Omernik (et al) of the U.S. Environmental Protection Agency in 1987. Boundaries are determined by examining patterns of vegetation, animal life, geology, physiography, soils, water quality, climate, land use and other components. The biological diversity (“**biodiversity**”) that characterizes one ecoregion tends to be different in adjacent ecoregions.

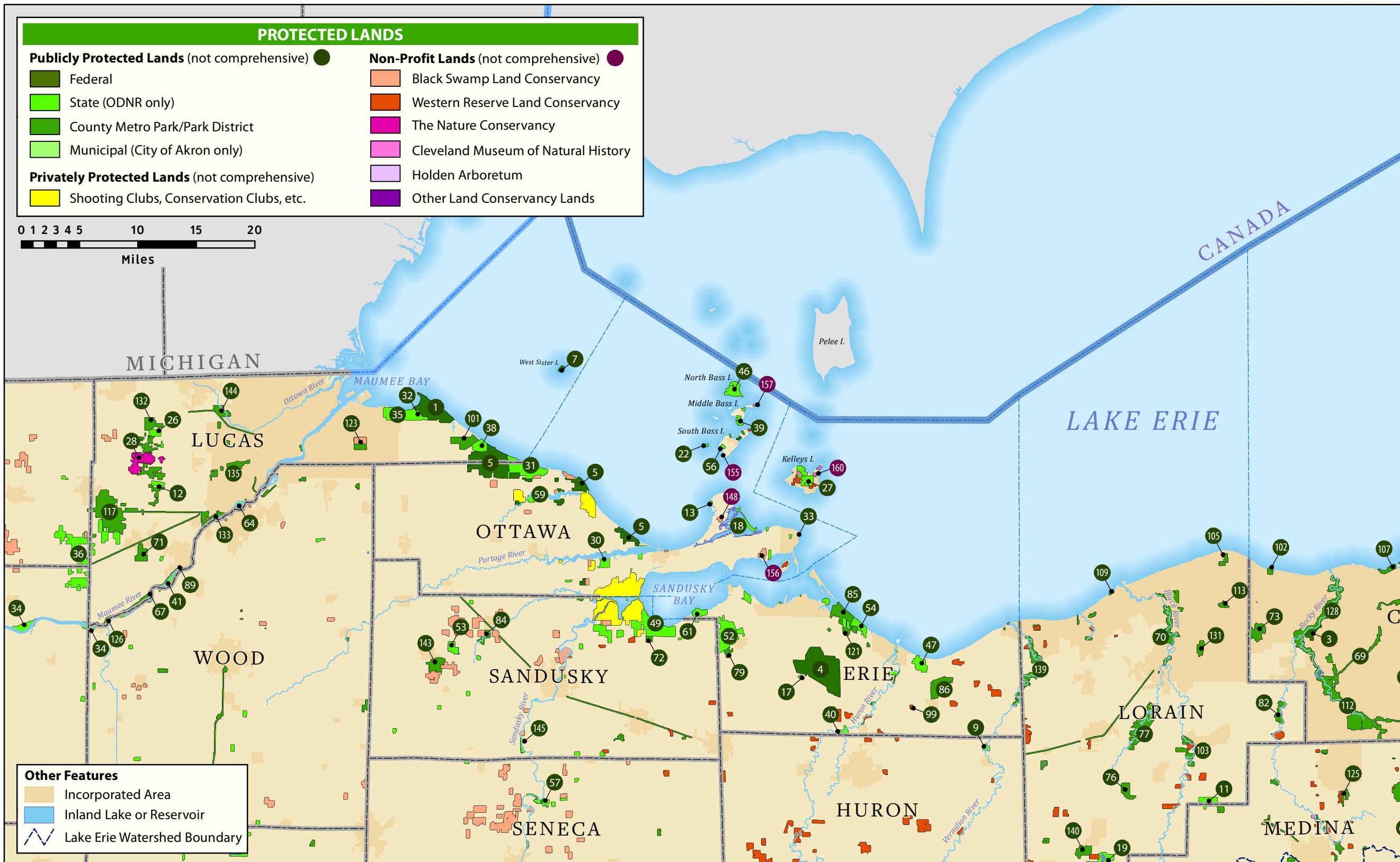
Classification consists of a four-level hierachal scheme. The levels, in order from broadest to more detailed, include: Level I (L1), Level II, Level III (L3) and Level IV (L4). There are 15 L1 ecoregions in North America. All of Ohio—and majority of the eastern U.S.—is in the “**Eastern Temperate Forests**” L1 ecoregion. This map shows L3 and L4 ecoregions. Greater ecoregion detail allows local characteristics to be identified specifically for strategic management practices. Level III ecoregions are outlined on the map with thick dark lines. Level IV subdivisions are nested within L3 ecoregions, and individually color-coded.

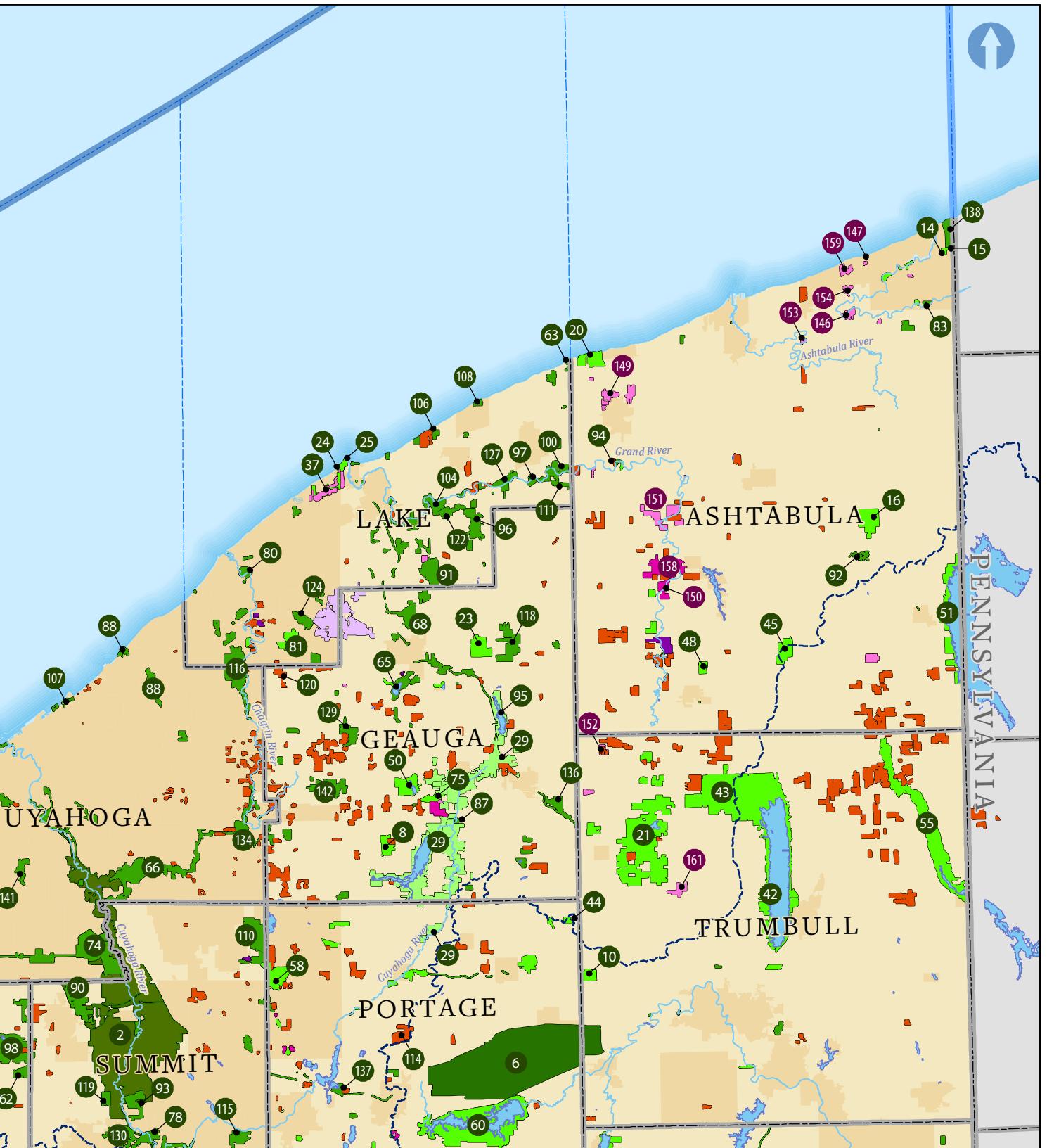
The Huron/Erie Lake Plains (L3) ecoregion is a highly-fertile and nearly flat plain containing ancient sand dunes, beach ridges and end moraines. The Maumee Lake Plains (57a) and much of the Marblehead Drift/Limestone Plain (57d) were once covered by the Great Black Swamp. Soils are poorly drained and contain clayey deposits and glacial till. Coastal marshes, beech and elm-ash swamp forests were widespread prior to gradual draining of the swamp. Low-gradient tributaries slowly flow through the region and contain high, suspended loads of clayey silts. Exposures of carbonate (limestone and dolomite) bedrock and sinkholes are common throughout the Marblehead Drift/Limestone Plain. Many isolated plant species occur in this ecoregion, e.g. the Lakeside Daisy. Oak woodland, oak savanna, wet prairie and dry dune communities are common in the Oak Openings (57b).

The Erie Lake Plain (83a) follows a narrow strip of low-lying land along Lake Erie. It is part of the Eastern Great Lakes Lowlands (L3) ecoregion. Beach ridges and high coastal bluffs are prominent features. The diverse physical landscapes of the Erie Drift Plain (L3) are located south of the lake plain. The Low Lime Drift Plain (61c) includes fairly level and rolling terrain, which differs from the unglaciated, wooded and hilly regions to the south. Soils are typically less fertile than in the till plains to the west. The Erie Gorges (61d) feature distinctively steep river valleys where relief can exceed 500 feet. Inland lakes, wetlands, bogs and hilly terrain are characteristic of the Summit Interlobate Area (61e), while the Mosquito Creek/Pymatuning Lowlands (61b) features fairly level-to-rolling, poorly-drained terrain with wetlands and moisture-tolerant woodlands. Lake Erie’s impact greatly increases snowfall totals and extends the growing season in both the lake and drift plains.

Much of the land in these ecoregions has been cleared and/or artificially drained for widespread urban development, residential growth and farming.

PROTECTED LANDS





Protected lands are legally set-aside areas of land that are owned and/or managed by various federal, state, county, local, non-profit or non-public agencies. Land is protected for many reasons, including, but not limited to: habitat conservation and wildlife protection, including the protection of rare, threatened and endangered species; protecting unique geologic features and landscapes; creating and protecting recreational spaces; preserving agricultural areas; forestry management, and; preserving historic and culturally-significant lands. The various designations and levels of protected land are wide-ranging and based on the managing authority, purpose for protection, laws and regulations.

This map shows lands protected and managed by public entities, private entities and non-profit organizations. Many protected lands are publicly accessible and available for active- and passive-use recreation, while other lands provide limited access or no access. ***This map does not specify lands that are publicly accessible or lands that are not.*** The map key is found on pages 148-149.

Of note, many local soil and water conservation districts hold conservation easements and manage lands for various protection purposes. These lands are not illustrated on the map.

FEDERAL AND STATE LANDS

Public lands that are protected and managed by federal, state and county agencies include parks, reservations, nature preserves, wildlife areas/refuges and forests, among other property types. Significant federal lands include Cuyahoga Valley National Park (nearly 33,000 acres), Ottawa National Wildlife Refuge* (approximately 10,000 acres) and Cedar Point National Wildlife Refuget (approximately 2,500 acres). The 77-acre West Sister Island National Wildlife Refuge is managed as a wilderness area, as provided under the Wilderness Act, and specifically designated to protect the largest wading bird nesting colony on the U.S. Great Lakes. Public access to West Sister Island is prohibited.

The state-protected lands illustrated on this map are all ODNR properties (not all have identification labels). These include state parks, state nature preserves, state wildlife areas, state forests and scenic river lands, among other property types. There are 11 state parks adjacent to Lake Erie, which comprise over 5,500 acres. East Harbor State Park in Ottawa County is the largest (over 1,800 acres), followed by Maumee Bay State Park in Lucas County (over 1,400 acres) and Geneva State Park in Ashtabula County (about 700 acres). There are five state parks in the Lake Erie Islands region. The island parks range in size from the 1.5-acre Oak Point State Park to the nearly 700-acre Kelleys Island State Park. Combined, over 1,400 acres of state park land is managed on Kelleys, South Bass, Middle Bass and North Bass islands.

Continued on next page

PROTECTED LANDS



Cuyahoga Valley National Park, Cuyahoga and Summit counties

Continued from previous page

Nearly 1,000 acres of land is protected along Lake Erie at five state nature preserves. Old Woman Creek State Nature Preserve (SNP) in Erie County is the largest (over 500 acres), followed by Sheldon Marsh SNP (nearly 400 acres)—also in Erie County. North Pond and North Shore Alvar state nature preserves are both located within Kelleys Island State Park (Erie County). The 25-acre Headlands Dunes SNP—adjacent to Headlands Beach State Park—is located in Lake County. ODNR also manages approximately 350 acres of Mentor Marsh SNP (located less than one mile from Lake Erie in Lake County). Mentor Marsh was established in 1971 as Ohio's first state nature preserve. The Cleveland Museum of Natural History and Lake Metroparks also help protect it.

There are ten state wildlife areas directly adjacent to Lake Erie. All ten are located between Toledo and Sandusky. Combined, they comprise over 7,000 acres. Pickerel Creek Wildlife Area in Sandusky County is located on Sandusky Bay and is the largest (over 3,300 acres). Magee Marsh Wildlife Area, which straddles Lucas and Ottawa counties, is the second largest (over 2,000 acres), followed by Willow Point Wildlife Area in Erie and Sandusky counties (over 600 acres) and Metzger Marsh Wildlife Area in Lucas County (over 550 acres). Other notable areas on the map include Grand River, LaDue and Resthaven wildlife areas. Resthaven comprises over 2,200 acres of land, mostly in Erie County. Grand River and LaDue wildlife areas combine for over 16,000 acres of protected land in Geauga, Portage and Trumbull counties. The nearly 8,800-acre LaDue Wildlife Area is managed by ODNR and owned by the city of Akron.

METROPOLITAN PARK DISTRICTS

Coastal counties with metropolitan park districts include Lucas County (Metroparks Toledo), Sandusky County (Sandusky County Park District), Erie County (Erie MetroParks), Lorain County (Lorain County Metro Parks), Cuyahoga County (Cleveland Metroparks), Lake County (Lake Metroparks) and Ashtabula County (Ashtabula County Metroparks). These park districts protect and preserve natural areas and important habitat, and offer many recreational activities.

There are 13 metropolitan parks (metroparks) adjacent to Lake Erie. Combined, these lands comprise over 4,200 acres. Erie County has the most protected metropark land on Lake Erie (over 2,300 acres at two sites), followed by Lake County (over 900 acres at six sites), Ashtabula County (approximately 600 acres at one site), Cuyahoga County (over 400 acres at three sites) and Lorain County (20 acres at one site). There are no Lake Erie-adjacent metroparks in Lucas or Sandusky counties. East Sandusky Bay MetroPark in Erie County is the largest coastal metropark (over 2,300 acres), followed by Ashtabula County's Turkey Creek Metropark (602 acres) and Lake County's Lake Erie Bluffs (592 acres). The multiple sites that make up the Cleveland Metroparks' Lakefront Reservation (Edgewater Park, Wendy Park, East 55th Street Marina, East 72nd Street Fishing Access and Gordon Park) combine for 230 acres.

In total, Cleveland Metroparks preserves over 23,000 acres of land—more than any other coastal county metropolitan park district—at 18 reservations (Cleveland Metroparks, 2017), including 8,700 acres on the Rocky River (includes Hinckley Reservation in Medina County), 4,350 acres on the Cuyahoga River and over 3,500 acres on the Chagrin River. The Cleveland Metroparks' first 3.8-acre parcel of land—purchased in 1919—is in the Rocky River Reservation.

Metroparks Toledo protects over 12,000 acres of land (Metroparks Toledo, 2015), including the 5,000-acre Oak Openings Metropark and over 1,100 acres along the Maumee River at eight facilities (including Fort Miamis, Granger Island and Marengo Island). Howard Marsh Metropark preserves approximately 1,000 acres of coastal wetlands near Lake Erie. It is located adjacent to Metzger Marsh Wildlife Area and is part of over 8,400-acres of seamlessly-connected publicly-protected land that also includes the Ottawa National Wildlife Refuge-Ottawa Division and Magee Marsh Wildlife Area.

Lorain County Metro Parks protects over 9,000 acres of land at 25 parks and reservations, including over 3,600 acres on the Black River (including the East and West branches) and over 1,200 acres on the Vermilion River. The metropark system's first property was donated in 1958 and incorporated into its first park, the Vermilion River Reservation.

Lake Metroparks protects more than 8,200 acres of land at 38 parks and reservations, including over 2,400 acres on the Grand River. Lake Metroparks also protects over 300 acres on the Chagrin River. Girdled Road Reservation in southern Lake County is the park district's largest tract of protected land (over 900 acres). The park district also manages the nearly 400-acre Chapin Forest Reservation under a lease agreement with the ODNR Division of Forestry.

Erie MetroParks protects and manages over 4,200 acres at 13 parks and preserves, including East Sandusky Bay MetroPark, which protects 930 acres of open water and marsh areas in East Sandusky Bay. The park system's second largest park is Edison Woods MetroPark (1,300 acres). The Sandusky County Park District manages 13 facilities, covering over 2,300 acres, including the 93-acre Wolf Creek Park on the Sandusky River. Ashtabula County Metroparks manages over 1,600 acres of protected land, including the 602-acre Turkey Creek Metropark in Conneaut, located in the northeasternmost corner of Ohio.

This map also shows county park district and metropark facilities in Wood County (Wood County Park District), Seneca County (Seneca County Park District), Medina County (Medina County Park District), Summit County (Summit Metro Parks), Geauga County (Geauga Park District), Portage County (Portage Park District) and Trumbull County (Trumbull County MetroParks).

MUNICIPAL LANDS

All municipally-protected lands shown on this map are owned by the city of Akron, which manages 19,000 acres of land and three reservoirs (Lake Rockwell, LaDue Reservoir and East Branch Reservoir) in the upper Cuyahoga River Watershed.

The Lake Erie Public Access maps in Chapter 5: "Outdoor Recreation" (pages 106 and 108) show locally-managed parks and preserves adjacent to Lake Erie and major tributaries.

LAND TRUST PROTECTION

A land trust is a nonprofit, non-governmental organization that protects land through conservation easements and land acquisitions, or through the stewardship of such land or easements. Land trust conservation efforts include:

- Protecting natural areas and habitat;
- Protecting water quality, coastal areas, lakes and streams;
- Preserving agricultural lands and rural heritage, and;
- Ensuring that land uses, such as farming, forestry and recreation, are preserved.

Continued on next page



PROTECTED LANDS

Continued from previous page

The Protected Lands map shows areas and easements preserved by various land trusts, including the Black Swamp Conservancy, Cleveland Museum of Natural History, The Nature Conservancy (TNC) and the Western Reserve Land Conservancy, among others, such as the Chagrin River Land Conservancy, Grand River Partners, Tinkers Creek Land Conservancy, Waite Hill Land Conservancy and West Creek Land Conservancy. Land trusts in the Lake Erie Watershed protect coastal areas, woodlands, wetlands, prairies and important habitat; create public recreation lands for hunting, fishing, trails, wildlife viewing and active recreation; preserve farmland, and; oversee lands. Land trusts work cooperatively with landowners, donors, communities and other conservation organizations.

The Western Reserve Land Conservancy (WRLC) protects over 46,000 acres in north-central and northeast Ohio, including nearly 16,000 acres in Ottawa, Sandusky, Erie, Lorain, Cuyahoga, Lake and Ashtabula counties (WRLC, 2016). Of the coastal counties, the WRLC has the most protected land in Ashtabula County (over 7,000 acres), followed by Lorain County (about 3,500 acres) and Cuyahoga County (about 2,000 acres). The WRLC owns or works in partnership with local communities to protect many publicly accessible and limited-accessibility properties in the Lake Erie Watershed, including a 350-acre portion of Lake Erie Bluffs (a Lake Metropark-managed facility), Turkey Creek Metropark (an Ashtabula County Metroparks-managed facility) and the 1.5-acre Wakefield MetroPark (an Erie MetroParks-managed property).

The Black Swamp Conservancy (BSC) protects over 16,500 acres of land in northwest Ohio, including over 5,000 acres in Lucas, Ottawa, Sandusky and Erie counties (BSC, 2017). Nearly 3,500 acres, or 70 percent of the land preserved in coastal counties, is in Sandusky County. The BSC owns or works in partnership with local communities to protect many publicly accessible properties in the Lake Erie Watershed, including the 190-acre Meadowbrook Marsh Preserve in Ottawa County.

The Cleveland Museum of Natural History preserves 7,700 acres of land in northeast Ohio. Grand River Terraces and the Geneva Swamp—both in Ashtabula County—are the museum's largest properties, at nearly 1,000 acres and 800 acres, respectively. The museum also preserves nearly 700 acres of Mentor Marsh State Nature Preserve in Lake County. Of the museum's 46 properties, only Mentor Marsh, North Kingsville Sand Barrens in Ashtabula County (174 acres) and Scheele Preserve on Kelleys Island in Erie County (36 acres) are open to the public.

The Nature Conservancy (TNC) is a national nonprofit organization headquartered in Arlington, Virginia. It protects more than 60,000 acres of land in Ohio—nearly 4,000 acres in the Lake Erie Watershed—including Morgan Swamp Preserve in Ashtabula County (2,000 acres), Kitty Todd Preserve in Lucas County (1,000 acres) and Great Egret Marsh Preserve in Ottawa County (over 150 acres). All three properties are open to the public and allow various passive activities.

* The Darby and Navarre divisions are not publicly accessible. See the Lake Erie Public Access (west) map on page 106 to locate the accessible portion of Ottawa National Wildlife Refuge.

† Access to Lake Erie not permitted. Limited activities are seasonal.

PROTECTED LANDS MAP KEY

| Map ID | Protected Land | County |
|--------|--|----------------------|
| 1 | Cedar Point National Wildlife Refuge | Lucas |
| 2 | Cuyahoga Valley National Park | Summit, Cuyahoga |
| 3 | NASA Lewis Research Center | Cuyahoga |
| 4 | NASA Plum Brook Station | Erie |
| 5 | Ottawa National Wildlife Refuge | Ottawa, Lucas |
| 6 | Ravenna Arsenal | Portage |
| 7 | West Sister National Wildlife Refuge | Lucas |
| 8 | Auburn Marsh Wildlife Area | Geauga |
| 9 | Augusta-Anne Olsen State Nature Preserve | Huron |
| 10 | Brook Wildlife Area | Trumbull |
| 11 | Camp Belden Wildlife Area | Lorain, Medina |
| 12 | Campbell State Nature Preserve | Lucas |
| 13 | Catawba Island State Park | Ottawa |
| 14 | Conneaut Swamp State Nature Preserve | Ashtabula |
| 15 | Conneaut Wildlife Area | Ashtabula |
| 16 | Dorset Wildlife Area | Ashtabula |
| 17 | Erie Sand Barrens State Nature Preserve | Erie |
| 18 | East Harbor State Park | Ottawa |
| 19 | Findley State Park | Lorain |
| 20 | Geneva State Park | Ashtabula |
| 21 | Grand River Wildlife Area | Trumbull |
| 22 | Green Island Wildlife Area | Ottawa |
| 23 | Hambden Orchard Wildlife Area | Geauga |
| 24 | Headlands Beach State Park | Lake |
| 25 | Headlands Dunes State Nature Preserve | Lake |
| 26 | Irwin Prairie State Nature Preserve | Lucas |
| 27 | Kelleys Island State Park | Erie |
| 28 | Kitty Todd State Nature Preserve | Lucas |
| 29 | LaDue Wildlife Area | Geauga, Portage |
| 30 | Little Portage Wildlife Area | Ottawa |
| 31 | Magee Marsh Wildlife Area | Ottawa, Lucas |
| 32 | Mallard Club Marsh Wildlife Area | Lucas |
| 33 | Marblehead Lighthouse State Park | Ottawa |
| 34 | Mary Jane Thurston State Park | Wood, Henry |
| 35 | Maumee Bay State Park | Lucas |
| 36 | Maumee State Forest | Lucas, Fulton, Henry |
| 37 | Mentor Marsh State Nature Preserve | Lake |
| 38 | Metzger Marsh Wildlife Area | Ottawa |
| 39 | Middle Bass Island State Park | Ottawa |
| 40 | Milan Wildlife Area | Erie |
| 41 | Missionary Island Wildlife Area | Lucas |
| 42 | Mosquito Creek State Park | Trumbull |
| 43 | Mosquito Creek Wildlife Area | Trumbull |
| 44 | Nelson-Kennedy Ledges State Park | Portage |
| 45 | New Lyme Wildlife Area | Ashtabula |
| 46 | North Bass Island State Park | Ottawa |
| 47 | Old Woman Creek State Nature Preserve | Erie |
| 48 | Orwell Wildlife Area | Ashtabula |
| 49 | Pickerel Creek Wildlife Area | Sandusky |
| 50 | Punderson State Park | Geauga |
| 51 | Pymatuning State Park | Ashtabula |
| 52 | Resthaven Wildlife Area | Erie, Sandusky |
| 53 | Ringneck Ridge Wildlife Area | Sandusky |
| 54 | Sheldon Marsh State Nature Preserve | Erie |

| Map ID | Protected Land | County |
|--------|---------------------------------------|------------------|
| 55 | Shenango Wildlife Area | Trumbull |
| 56 | South Bass Island State Park | Ottawa |
| 57 | Sugar Creek Wildlife Area | Seneca |
| 58 | Tinkers Creek State Park | Portage |
| 59 | Toussaint Wildlife Area | Ottawa |
| 60 | West Branch State Park | Portage |
| 61 | Willow Point Wildlife Area | Erie, Sandusky |
| 62 | Allardale | Medina |
| 63 | Arcola Creek Park | Lake |
| 64 | Audubon Island State Nature Preserve | Lucas |
| 65 | Bass Lake Preserve | Geauga |
| 66 | Bedford Reservation | Cuyahoga |
| 67 | Bend View Metropark | Lucas |
| 68 | Big Creek Park | Geauga |
| 69 | Big Creek Reservation | Cuyahoga |
| 70 | Black River Reservation | Lorain |
| 71 | Blue Creek Conservation Area | Lucas |
| 72 | Blue Heron Preserve | Sandusky |
| 73 | Bradley Woods Reservation | Cuyahoga, Lorain |
| 74 | Brecksville Reservation | Cuyahoga |
| 75 | Burton Wetlands Nature Preserve | Geauga |
| 76 | Caley Reservation | Lorain |
| 77 | Carlisle Reservation | Lorain |
| 78 | Cascade Valley Metro Park | Summit |
| 79 | Castalia Quarry MetroPark | Erie |
| 80 | Chagrin River Park | Lake |
| 81 | Chapin Forest Reservation | Lake |
| 82 | Columbia Reservation | Lorain |
| 83 | Conneaut Creek MetroPark | Ashtabula |
| 84 | Creek Bend Farm | Sandusky |
| 85 | East Sandusky Bay MetroPark | Erie |
| 86 | Edison Woods MetroPark | Erie |
| 87 | Eldon Russell Park | Geauga |
| 88 | Euclid Creek Reservation | Cuyahoga |
| 89 | Farnsworth Metropark | Lucas |
| 90 | Furnace Run Metro Park | Summit |
| 91 | Girdled Road Reservation | Lake |
| 92 | The Grand Lakes | Ashtabula |
| 93 | Hampton Hills Metro Park | Summit |
| 94 | Harpersfield Covered Bridge MetroPark | Ashtabula |
| 95 | Headwaters Park | Geauga |
| 96 | Hell Hollow Wilderness Area | Lake |
| 97 | Hidden Valley Park | Lake |
| 98 | Hinckley Reservation | Medina, Summit |
| 99 | Hoffman Forest MetroPark | Erie |
| 100 | Hogback Ridge Park | Lake |
| 101 | Howard Marsh Metropark | Lucas |
| 102 | Huntington Reservation | Cuyahoga |
| 103 | Indian Hollow Reservation | Lorain |
| 104 | Indian Point Park | Lake |
| 105 | Kopf Family Reservation | Lorain |
| 106 | Lake Erie Bluffs | Lake |
| 107 | Lakefront Reservation | Cuyahoga |
| 108 | Lakeshore Reservation | Lake |

| Map ID | Protected Land | County |
|--------|--|------------------|
| 109 | Lakeview Park | Lorain |
| 110 | Liberty Park | Summit |
| 111 | Mill Creek Reservation | Lake |
| 112 | Mill Stream Run Reservation | Cuyahoga |
| 113 | Miller Nature Preserve | Lorain |
| 114 | Morgan Preserve | Portage |
| 115 | Munroe Falls Metro Park | Summit |
| 116 | North Chagrin Reservation | Cuyahoga, Lake |
| 117 | Oak Openings Metropark Preserve | Lucas, Fulton |
| 118 | Observatory Park | Geauga |
| 119 | O'Neill Woods Metro Park | Summit |
| 120 | Orchard Hills Park | Geauga |
| 121 | Osborn MetroPark | Erie |
| 122 | Paine Falls Park | Lake |
| 123 | Pearson Metropark | Lucas |
| 124 | Penitentiary Glen | Lake |
| 125 | Plum Creek Park | Medina |
| 126 | Providence Metropark | Lucas |
| 127 | River Road Park | Lake |
| 128 | Rocky River Reservation | Cuyahoga |
| 129 | The Rookery | Geauga |
| 130 | Sand Run Metro Park | Summit |
| 131 | Sandy Ridge Reservation | Lorain |
| 132 | Secor Metropark | Lucas |
| 133 | Side Cut Metropark | Lucas |
| 134 | South Chagrin Reservation | Cuyahoga, Geauga |
| 135 | Swan Creek Metropark | Lucas |
| 136 | Swine Creek Reservation | Geauga |
| 137 | Towner's Woods Park | Portage |
| 138 | Turkey Creek Metropark | Ashtabula |
| 139 | Vermilion River Reservation | Lorain |
| 140 | Wellington Reservation | Lorain |
| 141 | West Creek Reservation | Cuyahoga |
| 142 | The West Woods | Geauga |
| 143 | White Star Park | Sandusky |
| 144 | Wildwood Preserve Metropark | Lucas |
| 145 | Wolf Creek Park | Sandusky |
| 146 | Blakeslee/Barrows Preserve | Ashtabula |
| 147 | Cathedral Woods | Ashtabula |
| 148 | Cedar Meadow Preserve | Ottawa |
| 149 | Geneva Swamp Preserve | Ashtabula |
| 150 | Grand River Conservation Center | Ashtabula |
| 151 | Grand River Terraces | Ashtabula |
| 152 | Groves Woods Preserve | Trumbull |
| 153 | Hadlock Preserve | Ashtabula |
| 154 | Kingsville Swamp | Ashtabula |
| 155 | Ladd Carr Wildlife Woods | Ottawa |
| 156 | Meadowbrook Marsh | Ottawa |
| 157 | Middle Bass Island East Point Preserve | Ottawa |
| 158 | Morgan Swamp | Ashtabula |
| 159 | North Kingsville Sand Barrens | Ashtabula |
| 160 | Scheele Preserve | Erie |
| 161 | Sparks Preserve | Trumbull |

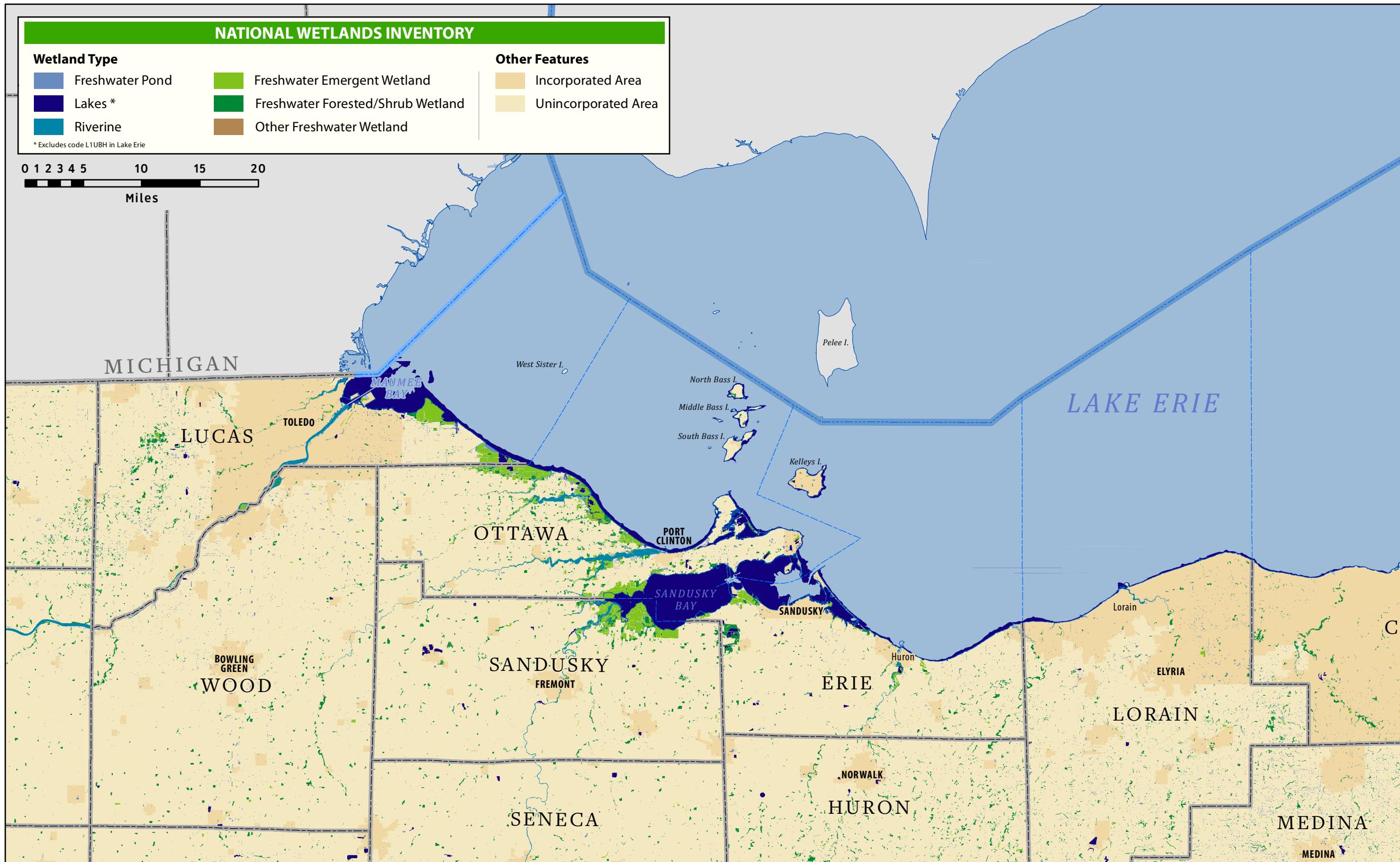


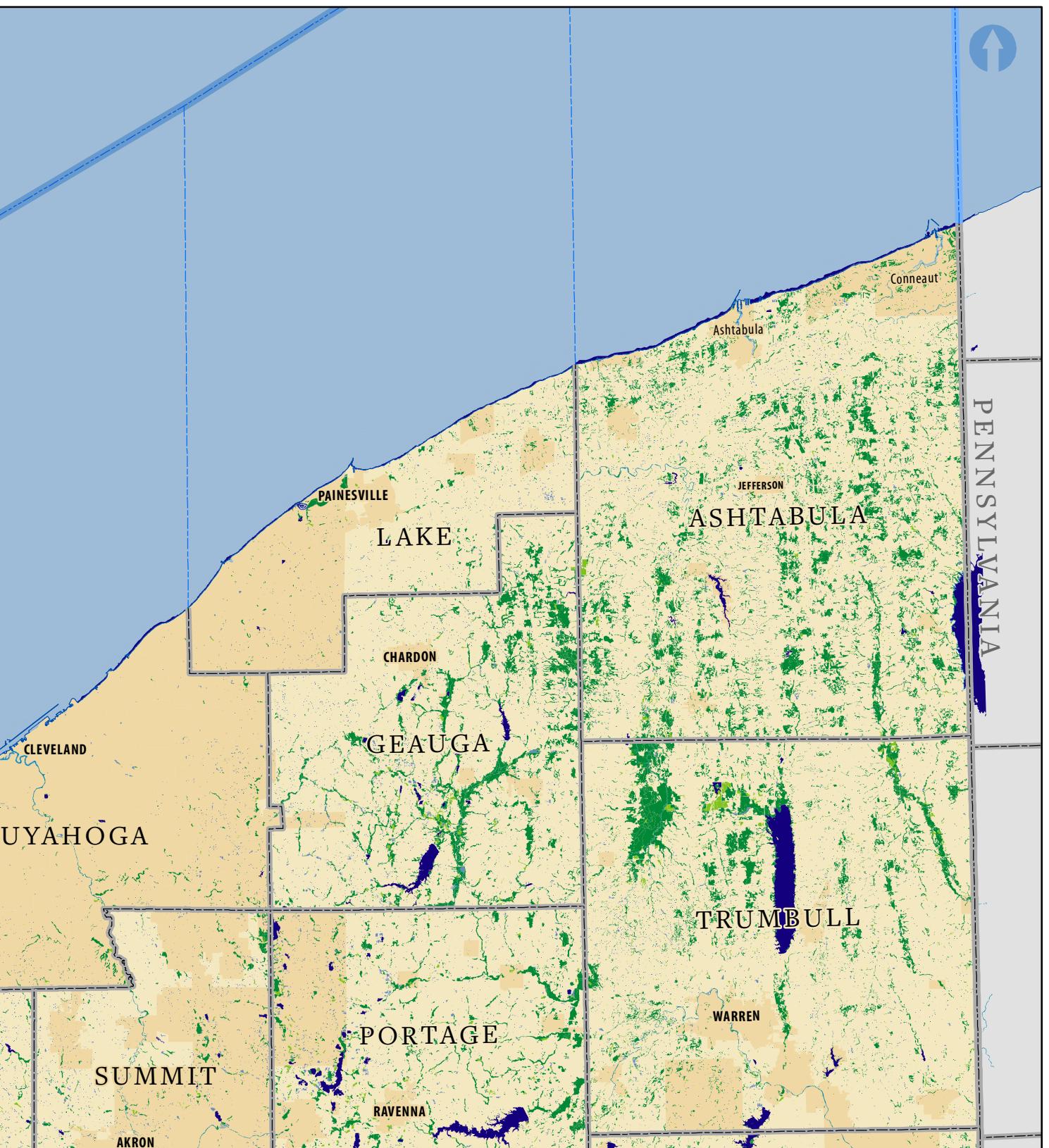
Harpersfield Covered Bridge MetroPark, Ashtabula County



Pickerel Creek Wildlife Area, Sandusky County

NATIONAL WETLANDS INVENTORY





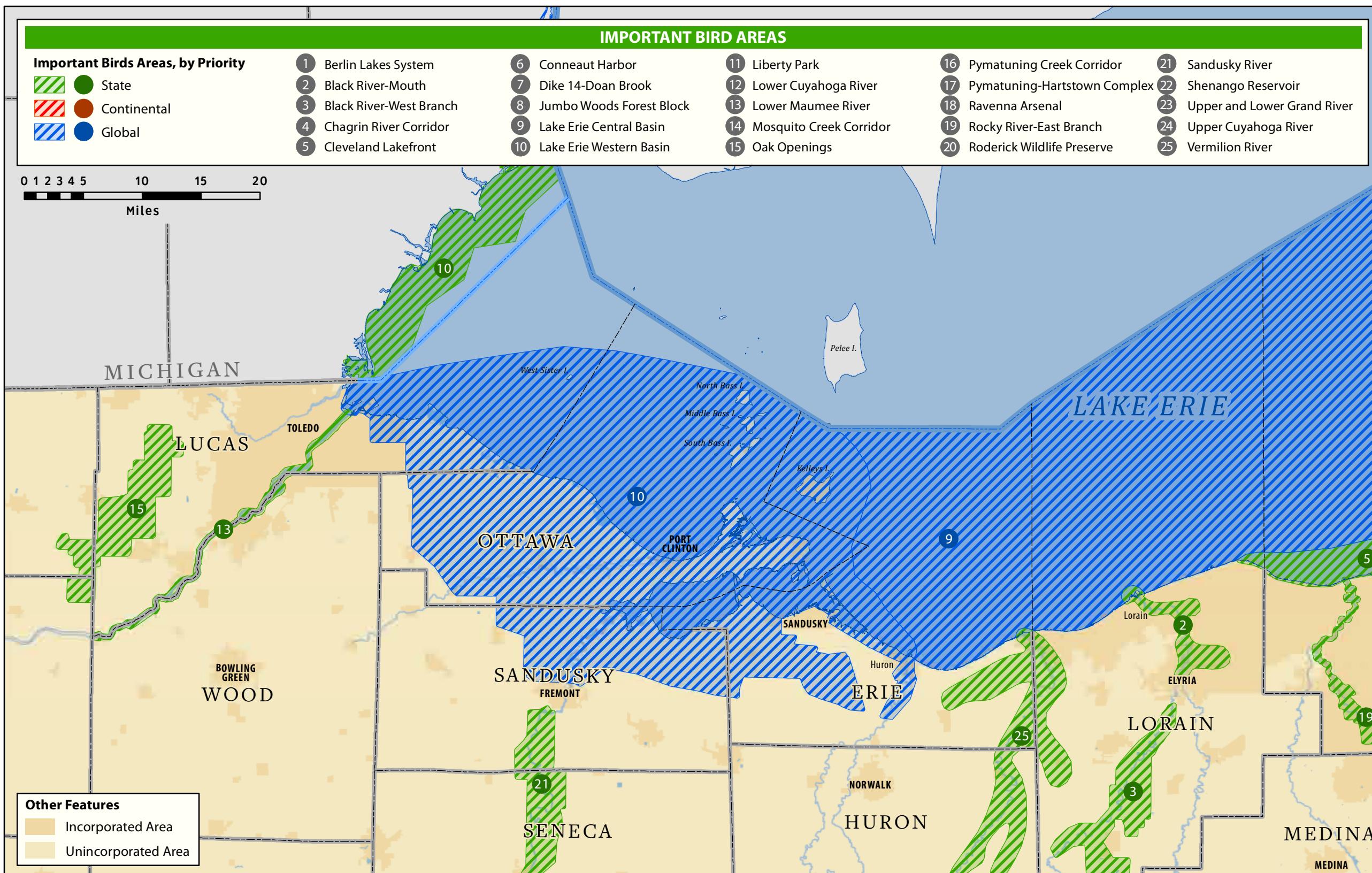
A **wetland** is an area of land that is seasonally or permanently saturated by shallow water, or an area where the water table is present at or near the surface (year-round or for varying periods of time during the year). Water saturation generally determines how soil develops and what types of plants and animals live in and on the soil. The prolonged presence of water causes the formation of hydric soils. Fully-saturated pores in the soil lack air and do not have the ability to consume oxygen. Hydric soils provide favorable growing conditions for water-tolerant vegetation. Plants with the ability to adapt to saturated, oxygen-lacking (anaerobic) soils are called "hydrophytes."

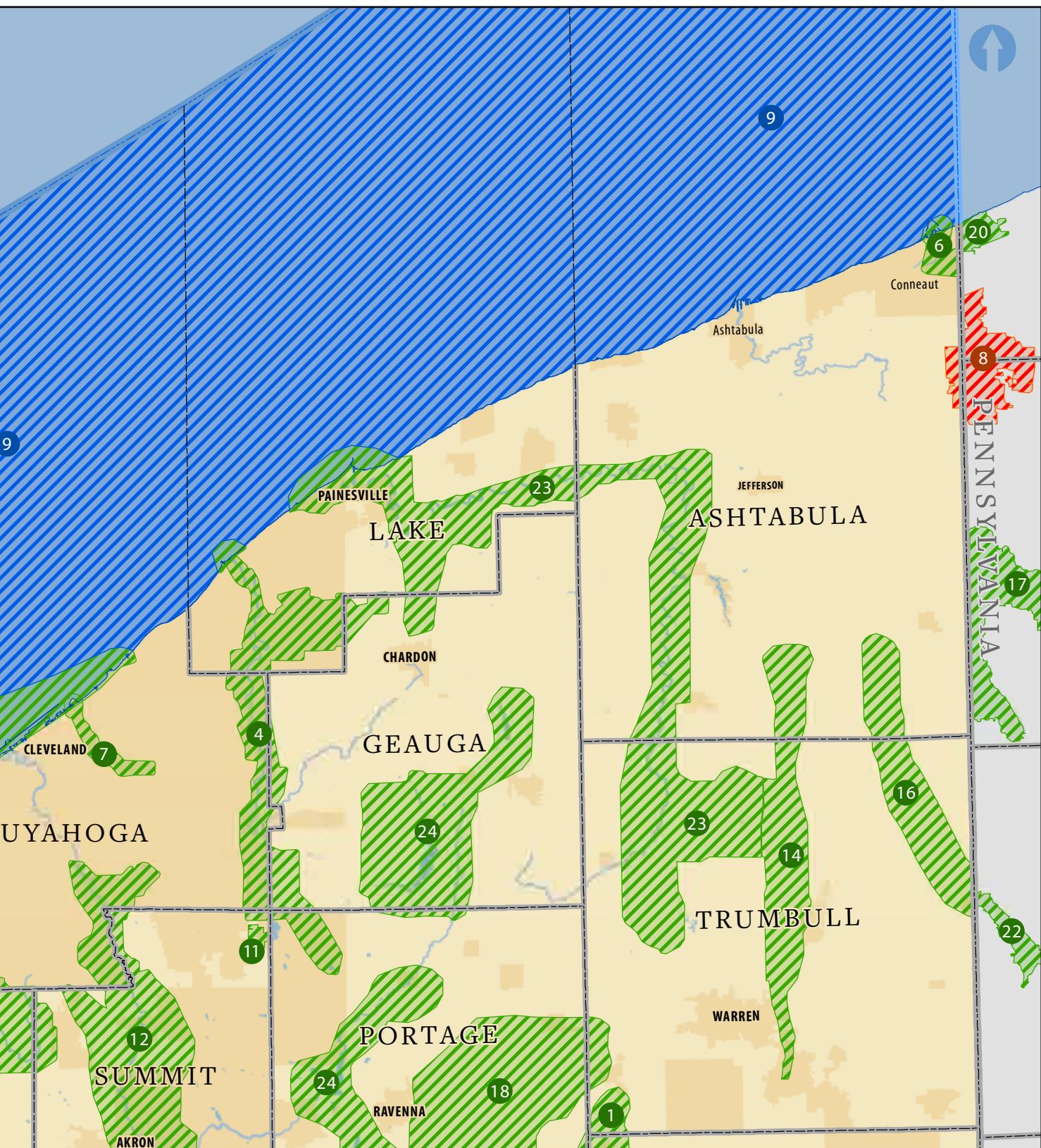
Wetlands are an integral part of the Great Lakes ecosystem. Wetlands cover roughly 1.8 percent of Ohio's total land area. Over the last 200 years, wetland areas in the state have declined by 90 percent (from about 5,000,000 acres to about 483,000 acres). The drainage of wetlands for agricultural use has been the main reason for wetland loss. Hydric soils are highly fertile and very favorable for agricultural practices when drained. Urban development, mining and logging operations, recreational use and fluctuating water levels have also contributed to wetland loss. Swamps, wet prairies, coastal marshes, embayment marshes and wetlands along stream margins and backwaters are the most common types of wetlands that occur in Ohio.

Wetlands act as natural reservoirs of water and can reduce the risk of coastal flooding. The slow release of water minimizes erosion potential and enables groundwater recharge. A wetland's ability to collect floodwaters and reduce flow momentum can also lessen the risk of potential property damage and other hazards. Wetlands also help to improve water quality by filtering sediments, nutrients and contaminants. The slow-flowing nature of water allows sediments to settle to the bottom of the wetland. Nutrients from fertilizers, manure, sewage and other contaminants are dissolved in the wetland before they can reach Lake Erie. Such pollutants are absorbed by plant roots and microorganisms in the soils. Wetland environments are biologically productive ecosystems and support many kinds of aquatic and terrestrial species. Some species are found exclusively in wetland habitats. The nutrient-rich water enables abundant vegetation growth. Aquatic vegetation and shallow water provides unique habitat conditions for fish and wildlife. Wetlands are important feeding and resting areas for migrating birds, shorebirds and waterfowl. They are also important spawning and nursery grounds for many species of fish.

The National Wetlands Inventory (NWI) was established by the U.S. Fish and Wildlife Service in 1974 to create a nationwide inventory of wetlands. The NWI catalogs the location, distribution, extent and types of wetlands and is intended to assist with conservation efforts. NWI mapping in the Great Lakes region was completed in the early 1980s. In 2011, an update for Ohio was completed by Ducks Unlimited. This map shows six wetland types: (1) freshwater pond; (2) lakes; (3) riverine; (4) freshwater emergent wetland (herbaceous marshes, fens, swales and/or wet meadows); (5) freshwater forested/shrub wetland (woody wetlands, forested swamps and shrub bogs), and; (6) "other" freshwater wetland (farmed and miscellaneous wetlands).

IMPORTANT BIRD AREAS





Lake Erie is located at the intersection of the Mississippi and Atlantic migratory flyways. Shore and open water areas, wetlands, marshes, estuaries, grasslands and forests provide perfect habitat for a variety of bird species during breeding, nesting and migration seasons. Bird enthusiasts from across the world flock to the Lake Erie area to observe nearly 400 bird species (almost 95 percent of all birds observed in Ohio). Many birds that naturally occur in Ohio were first recorded in the Lake Erie region.

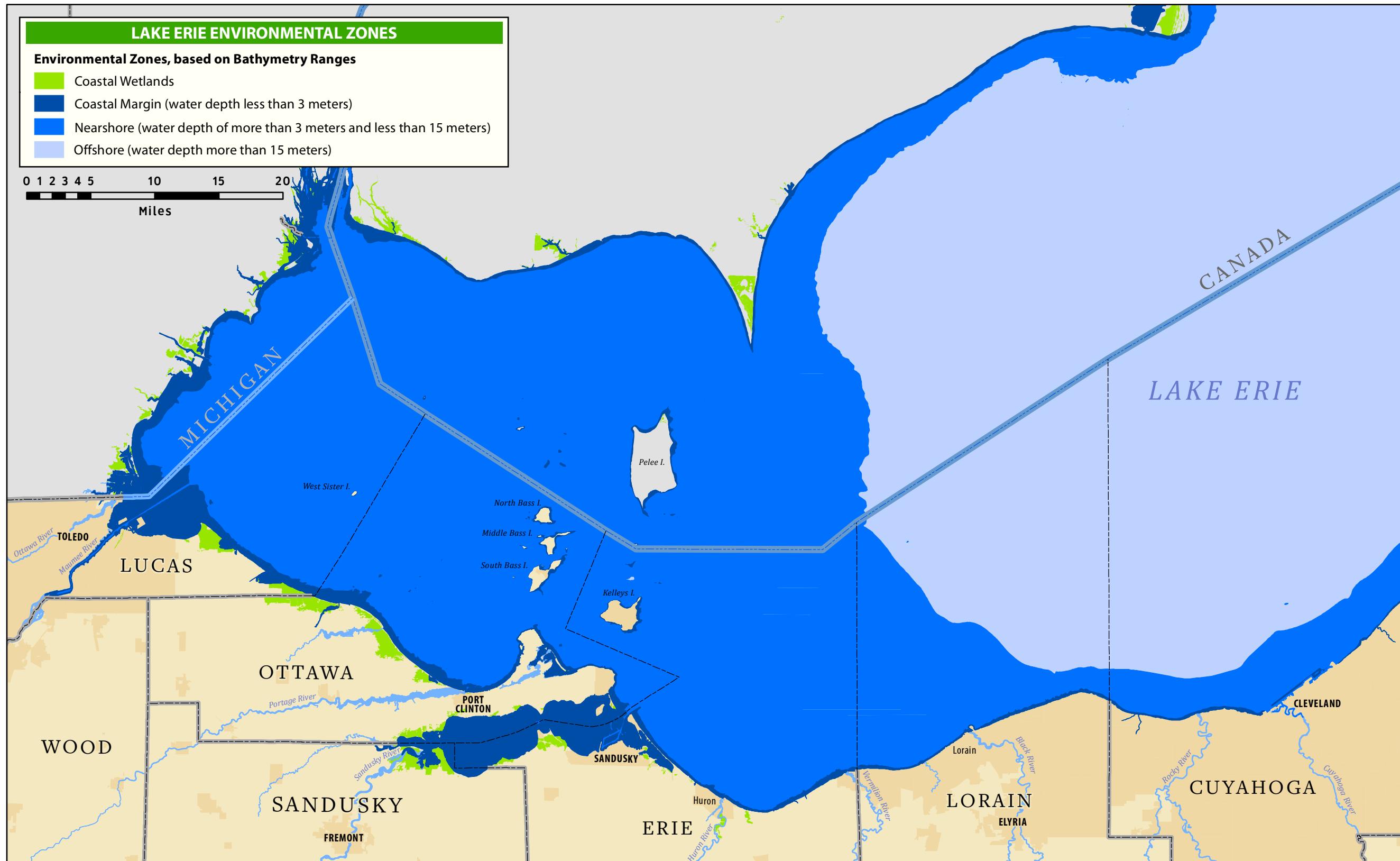
An Important Bird Area (IBA) is a location or area that provides essential habitat to one or more bird species during some portion of the year, including the breeding season, spring migration, fall migration and/or winter. IBAs are part of a global network of Key Biodiversity Areas and Important Bird and Biodiversity Areas identified by BirdLife International and its partners, including the National Audubon Society in the United States. Ohio's IBA Program was launched in 1999.

Important Bird Areas encompass private and public lands, protected and unprotected lands, open water areas and/or riverine areas. Sites are initially identified through a state-level process. According to the National Audubon Society, IBAs are sites or regions that support: (1) threatened and endangered species; (2) range-restricted species, or species that are vulnerable because they are not widely distributed; (3) species that are vulnerable because their populations are concentrated in one general habitat type, and; (4) species—or groups of species—that are vulnerable because they occur at high densities due to congregative behavior. In addition to meeting state-level criteria, some IBAs in the U.S. are further recognized as “continentally” significant or “globally” significant.

Important Birds Areas in the U.S. range in size from less than one acre to several million acres. The Northwestern Hawaiian Islands IBA in Hawai'i is the largest in the country (over 110-million acres), while 12 of the 16 smallest IBAs—all less than two acres in size—are located on Lake Huron or Lake Michigan in northern Michigan. There are 70 IBAs in Ohio. Many are associated with Lake Erie and the water resources within the watershed. This map shows 25 IBAs covering areas in Ohio, Michigan and Pennsylvania. The 20 IBAs located in Ohio (not including the Jumbo Woods Forest Block IBA) total over 5.9 million acres of land and water. These areas include open water, beaches, coastal wetlands, estuaries, grasslands, woodlands, riparian corridors, river mouths, harbor areas and islands. The Lake Erie Central Basin IBA (over 3.2 million acres) and the Lake Erie Western Basin IBA (over 1.1 million acres) are Ohio's largest IBAs. Both are recognized as globally significant.

Important Birds Areas were identified by a committee of ornithological experts, researchers, conservation experts and authorities on bird distribution. Changes in land use, land cover and pollution levels can significantly change the conservation value of a location. Accordingly, each IBA is reviewed periodically to determine if its qualifications still apply. IBAs help establish science-based priorities for conservation activities, land management plans and protecting bird habitat.

LAKE ERIE ENVIRONMENTAL ZONES





This map shows Lake Erie and adjacent upland areas delineated into four environmental habitat zones: (1) coastal wetlands; (2) the coastal margin; (3) the nearshore, and; (4) offshore. This classification scheme is based on the integration of physical, chemical and biological information and was developed by the Lake Erie Millennium Network.

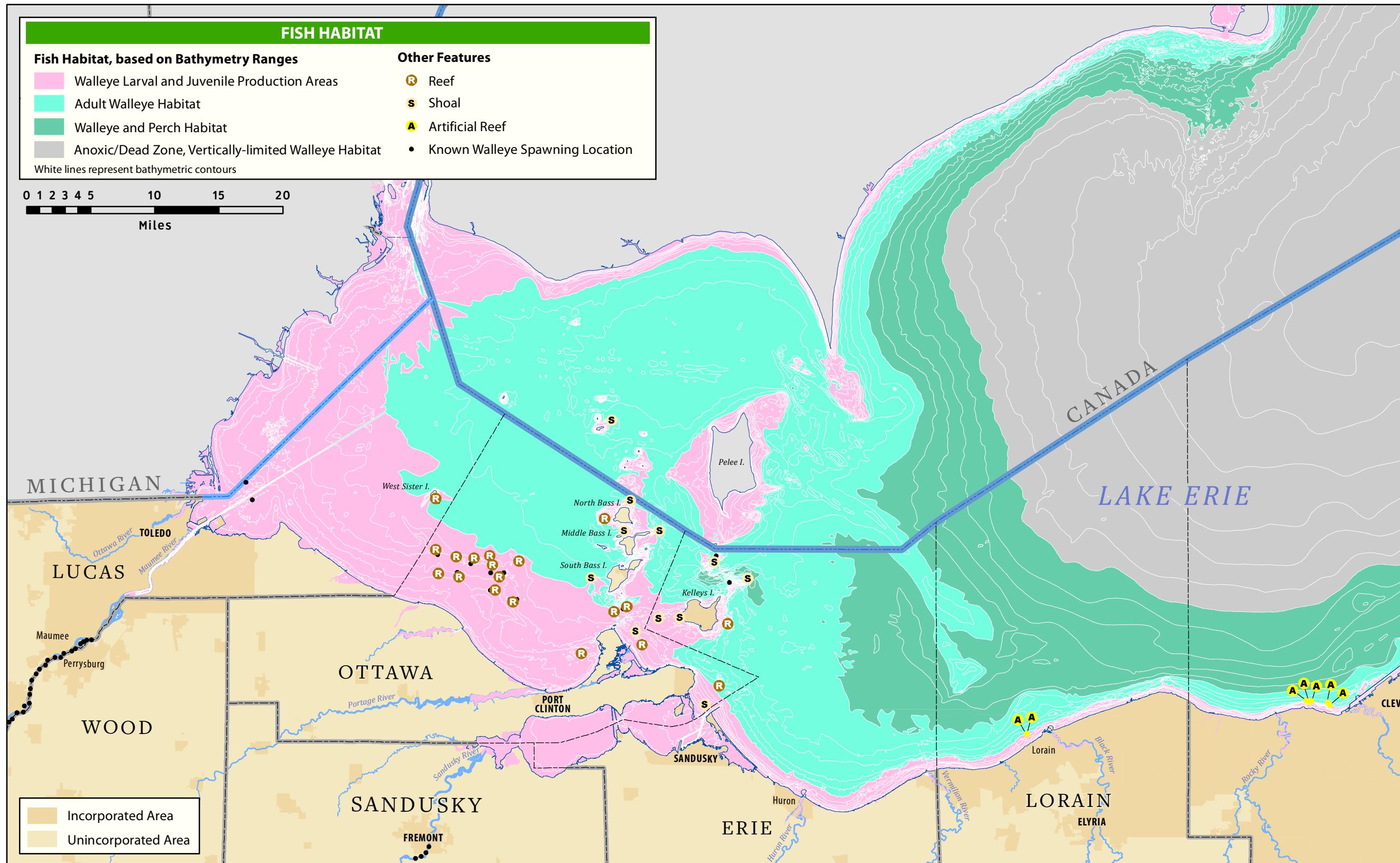
Coastal wetlands are generally found along the shoreline periphery, within an estuary or embayment, landward of a barrier beach or in a natural river mouth. Lake Erie's coastal wetlands provide critical habitat for many fish, especially species that rely exclusively on wetland environments during their lifespan. Other fish species utilize wetlands for only a portion of their lifespan, for spawning, feeding or refuge from predators. Avian species, such as waterfowl and nesting birds, and terrestrial species also depend on coastal wetland habitats.

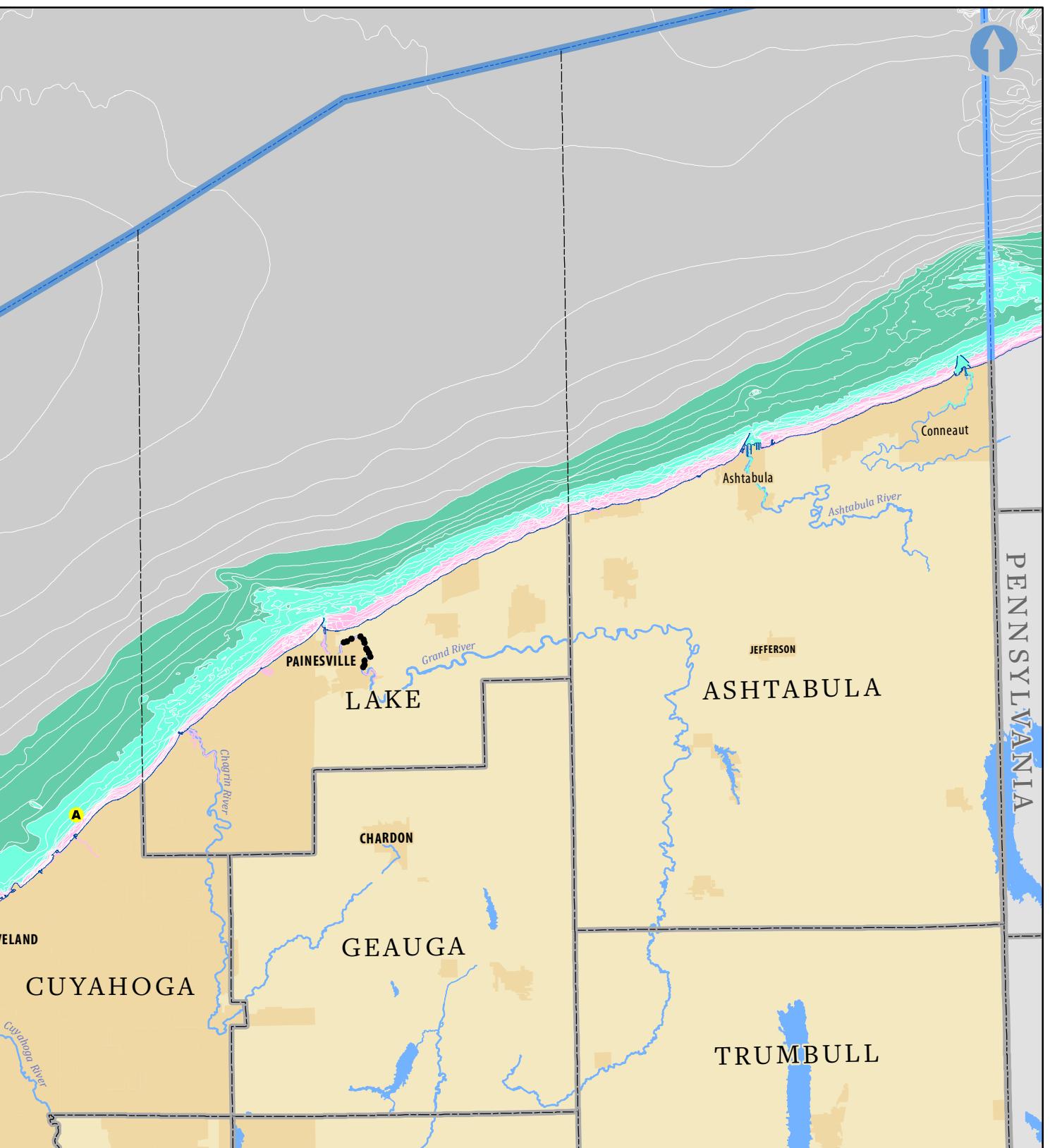
The **coastal margin** zone is a transitionary area between the lake and upland. It is a unique zone that connects aquatic and terrestrial habitats. The coastal margin is defined by an area ranging from a water depth of three meters or less to the shoreline, and includes embayments, portions of the nearshore, beaches, wetland areas, dunes and bluffs. Shallow-water areas are suitable for "submergent" (submerged) and "emergent" (above the water surface) aquatic vegetation to grow. Aquatic vegetation is often used as nursery habitat and foraging grounds for fish. The coastal margin is subject to various defining physical processes that affect the shoreline, including shore and bluff erosion, sediment transport, waves and lake level fluctuations. Hydrogeomorphic characteristics, such as geomorphic position, dominant hydrologic source and hydrologic connectivity to the lake, also help define this zone. Water (from tributaries and groundwater seepage) flowing into and mixing with Lake Erie can influence the coastal margin and add sediment to the littoral system. Coastal development, engineering projects and other artificial shore alterations can disturb or destroy this zone.

Lake Erie's **nearshore** environmental zone is defined by water depths between ten and 49 feet (about three to 15 meters). This definition is exclusive to Lake Erie; the nearshore zone for the other Great Lakes ranges between ten and 98 feet (about three to 30 meters). Lake Erie's nearshore zone encompasses vast expanses of open water, particularly in the Western Basin. This zone is subject to many physical processes, including lake circulation patterns, alongshore currents, sediment transport, waves and lakebed downcutting. The nearshore provides essential spawning habitat, nursery habitat and feeding grounds for many fish species.

The **offshore** zone is defined by a water depth of 49 feet or deeper. Much of the open-water areas of the Central Basin are categorized as "offshore." This zone is subject to anoxic, "dead zone" conditions (see Chapter Introduction). Fish avoid anoxic water by inhabiting areas above or shoreward of the dead zone, which may not provide suitable or preferred prey. Hypoxic zones hinder fish growth, survival and reproductive capacity. Many sessile organisms (e.g. mussels) die in oxygen-depleted areas.

WALLEYE HABITAT





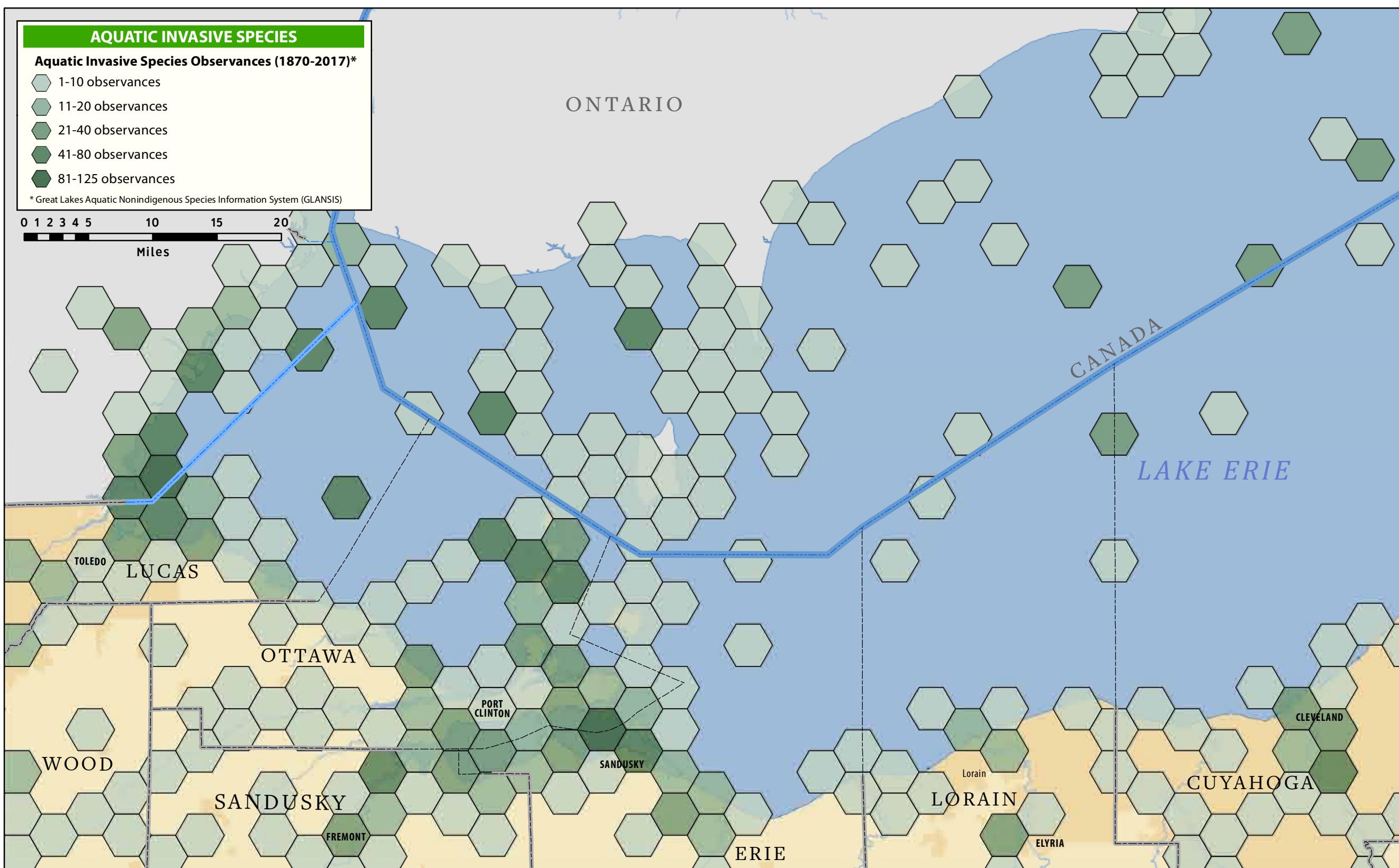
Native migratory fish species, e.g. walleye, lake whitefish and lake sturgeon, utilize different environmental zones of Lake Erie during various life stages. This map shows four classes of fish habitat: (1) Walleye Larval and Juvenile Production Areas; (2) Adult Walleye Habitat; (3) Walleye and Perch Habitat, and; (4) Anoxic/Dead Zone. These classes are based on bathymetry and existing fish community (biomass) data collected by the Ohio Department of Natural Resources, Division of Wildlife. Reefs, shoals, artificial reefs and walleye spawning locations are also included on this map.

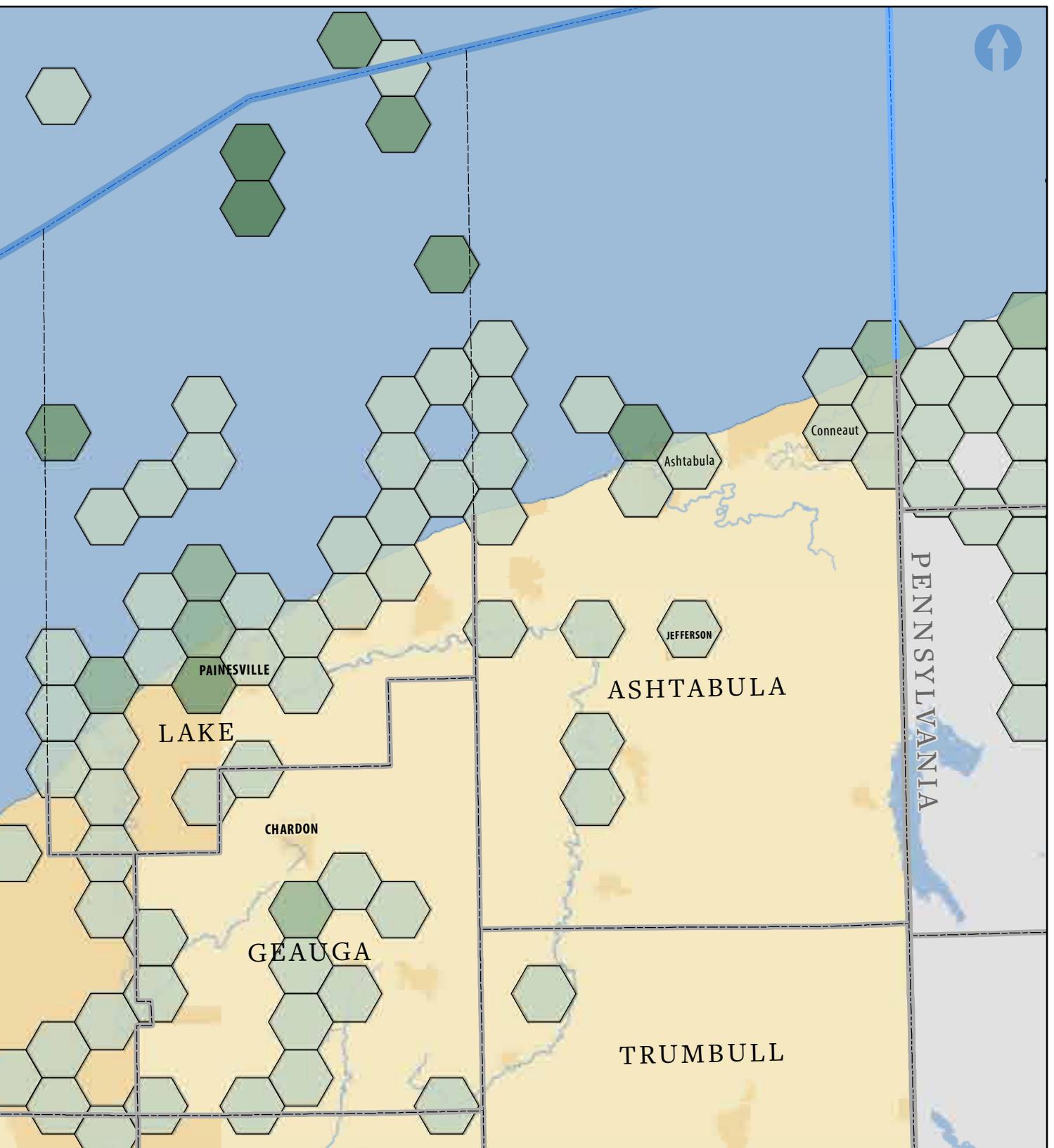
Significant walleye spawning areas include Western Basin reefs and in upriver sections of tributaries, such as the Maumee, Sandusky and Grand rivers. Walleye begin spawning shortly after winter ice breaks up in the lake and rivers (called "ice-out"). Peak spawning occurs between mid-March and late April. Females broadcast many hundreds of eggs in shallow waters over hard substrates and on top of reefs. The two-week incubation period is dependent on water temperature. Water that warms quickly and consistently typically leads to a higher survival rate. The incubation period is prolonged if water warms at a slower rate (or if temperature reversals occur). This can increase vulnerability to predation, siltation, low oxygen levels or removal by currents and waves. Many additional factors can disrupt walleye spawning, including severe storms, dredging, agricultural runoff and deposition from erosion. In rivers, high flow rates during the incubation period can remove eggs from favorable locations. Conversely, low flow rates can prohibit adult walleye from reaching spawning grounds. Drops in water levels can leave desirable substrates exposed and dehydrate eggs.

Walleye nursery and juvenile production areas are generally found in the shallower (less than ten feet) and moderately-turbid (low clarity) waters of the coastal margin and nearshore zones. This includes the mouths of spawning rivers, wetlands, embayments and reefs where rocky substrates are present. River flow and lake currents transport larval walleye from spawning grounds to nursery areas. The water from tributaries emptying into Lake Erie—especially in the Western Basin—tends to support larval and juvenile walleye. Nearshore water warms at a faster rate and offers greater feeding opportunities for young walleye. Dredging, deposition from erosion, changes in tributary flow and water level fluctuations can reduce the extent of nursery/production areas or disrupt the linkage between spawning and nursery habitats.

Adult walleye habitat is often defined by the area located between the shore and the seven-fathom bank (42-foot depth contour), including juvenile production areas (categorized separately). In mid to late summer, however, adult walleye leave the shallower Western Basin and move to the deeper waters of the Central and Eastern basins in search of cooler water. Anoxic conditions generally occur in depths greater than 55 feet. Walleye may inhabit water just above the dead zone. Adult walleye habitat encompasses the entire Western Basin, but only includes nearshore areas and the upper part of the water column in the Central Basin during summer months. Walleye typically return west in the fall to overwinter in areas near spring spawning locations.

AQUATIC INVASIVE SPECIES





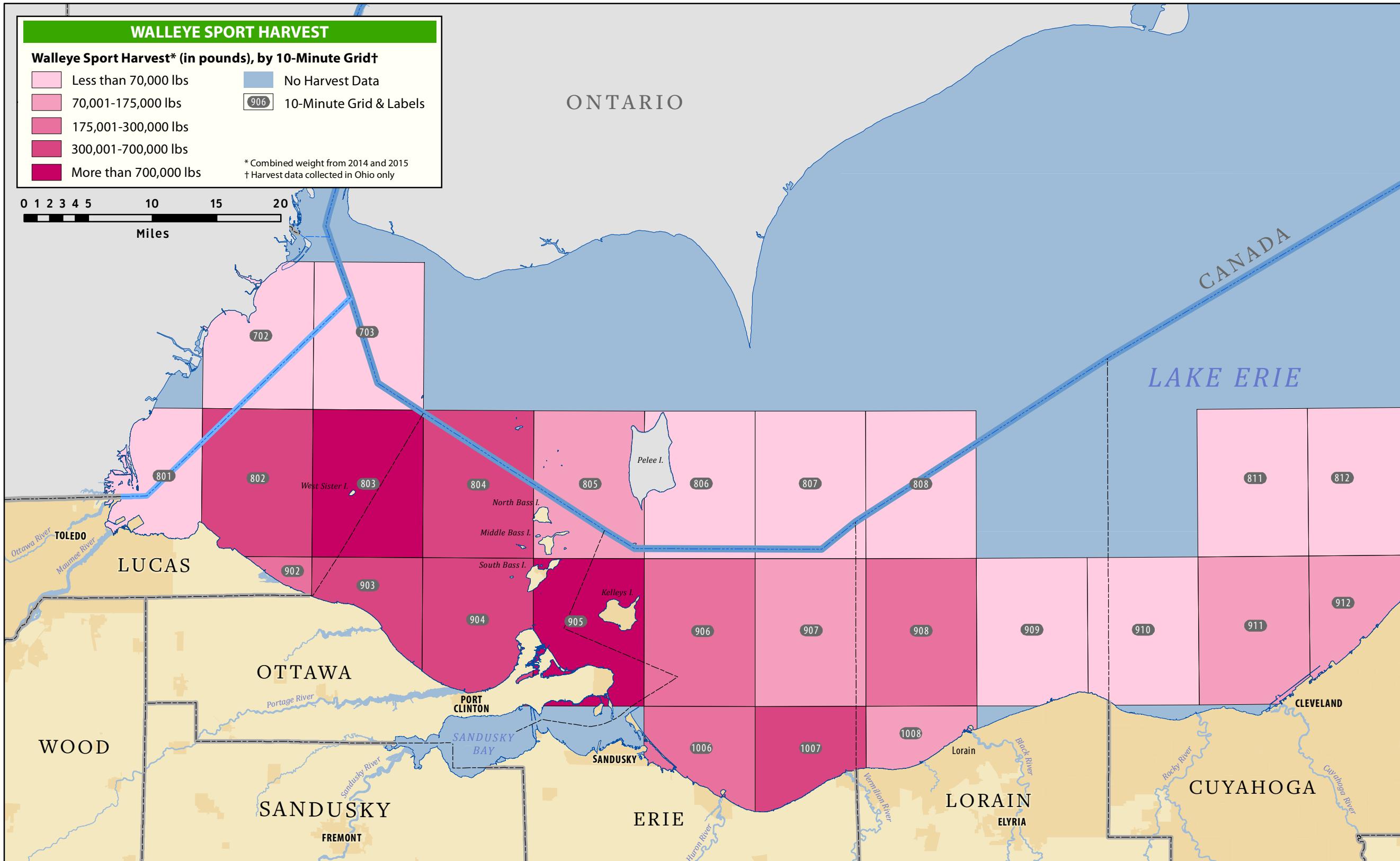
Invasive species are non-native plants and animals that enter an ecosystem outside of their original habitat and cause harm to the environment, regional economies and/or human health. Aquatic invasive species (AIS) are often aggressive colonizers and are not threatened by natural predators in their new environment. Such favorable dynamics allow invasive species to reproduce at rapid rates and spread to large geographic extents. The nature of these organisms often pushes out or kills off native species. Once an AIS becomes established in its new environment, eradication is nearly impossible and population control can be costly. Preventing the spread of invasive species is critical to protecting the natural habitats of native plant and animal populations.

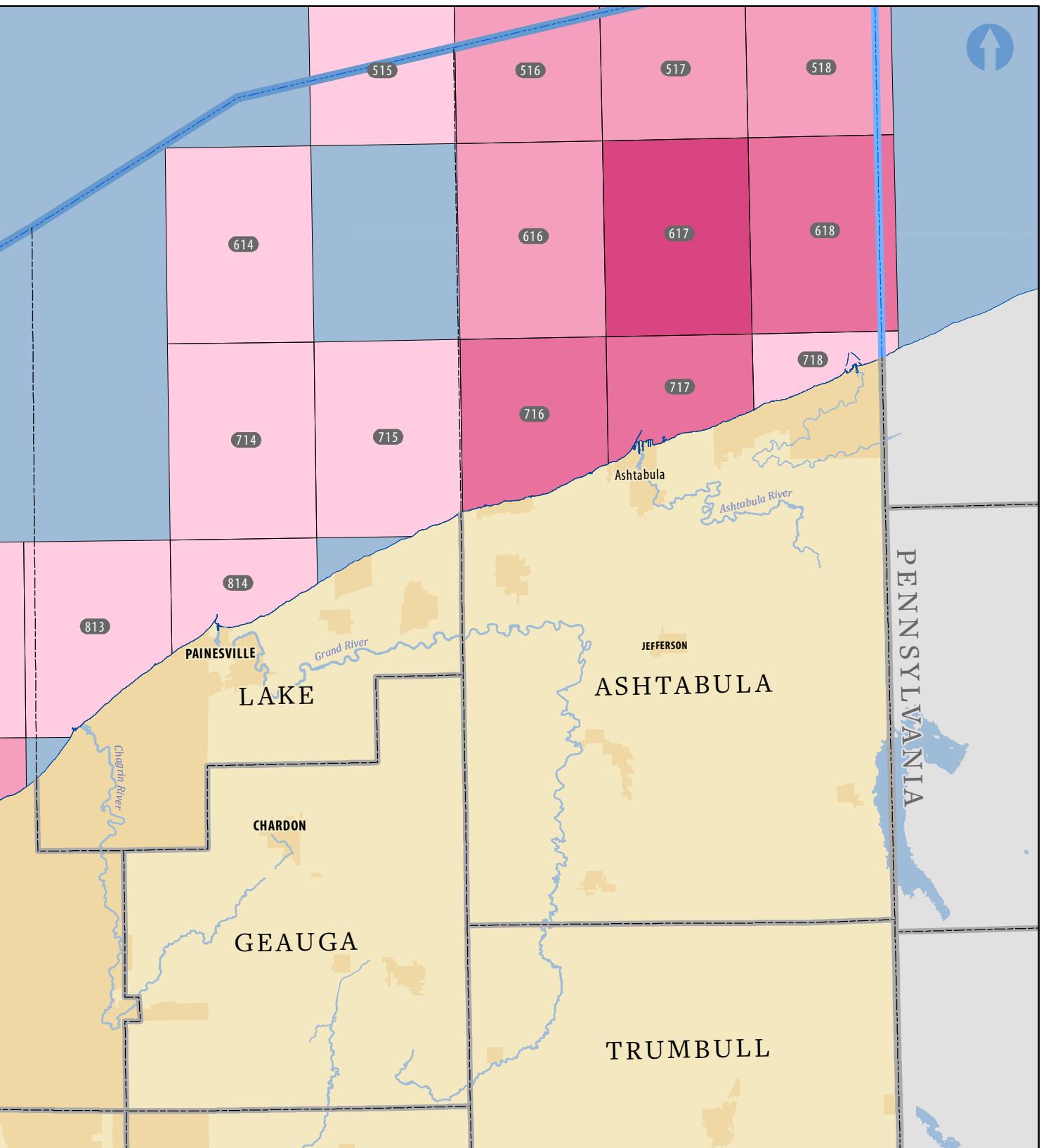
Invasive species affecting Lake Erie's ecosystem and biodiversity include fishes, invertebrates, plants, microscopic plankton, bacteria and viruses. The impacts of different species are unique and wide-ranging. Notable invasive animals include the zebra and quagga mussels, round goby, common carp, grass carp, white perch, sea lamprey, spiny water flea and fishhook water flea. Many AIS were introduced unintentionally from the ballast water discharges of cargo ships and through shipping canals, while others were deliberately or accidentally introduced via stocking or the pet and aquarium trades. These invaders can outcompete native species for essential resources, such as food, shelter and habitat, which threatens the integrity of the natural habitat. Invasive animals feed on native fish eggs and on fish species, utilize the same areas for spawning and disturb the natural food web. Notable invasive plant species include Eurasian watermilfoil, purple loosestrife and hydrilla. Nonindigenous plants can spread rapidly, choking out native plants, reducing habitat for native fishes (and other animals) and blocking sunlight. AIS can negatively impact recreational activities and tourism, and cause property damage. Natural resource managers are working on a range of prevention, management and eradication efforts to control AIS in the Great Lakes.

According to the National Oceanic and Atmospheric Administration's Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS), between 1870 and 2017 nearly 200 AIS have been documented in the Lake Erie Watershed. This total includes some species that are native to Lake Erie, but not indigenous to the other Great Lakes. It is equally important to document these species due to the ecologic threats they pose to the entire Great Lakes system. *Recorded observations documented in GLANSIS should be interpreted as a minimum total and not representative of entire AIS populations.*

This map uses shaded hexagonal bins, or hexbins, to show aggregated AIS observations (from GLANSIS) and the general distribution of invasive species. The darker the hexbin, the greater the number of observation points. One hexbin may contain a combination of multiple species observations and/or multiple observations of the same species. Areas with no bins represent areas where no observations have been recorded. In Ohio, the highest concentration of mapped AIS observations is in the Western Basin, particularly near Maumee Bay, Sandusky Bay and the Lake Erie Islands.

WALLEYE SPORT FISHERY HARVEST (2014-2015)





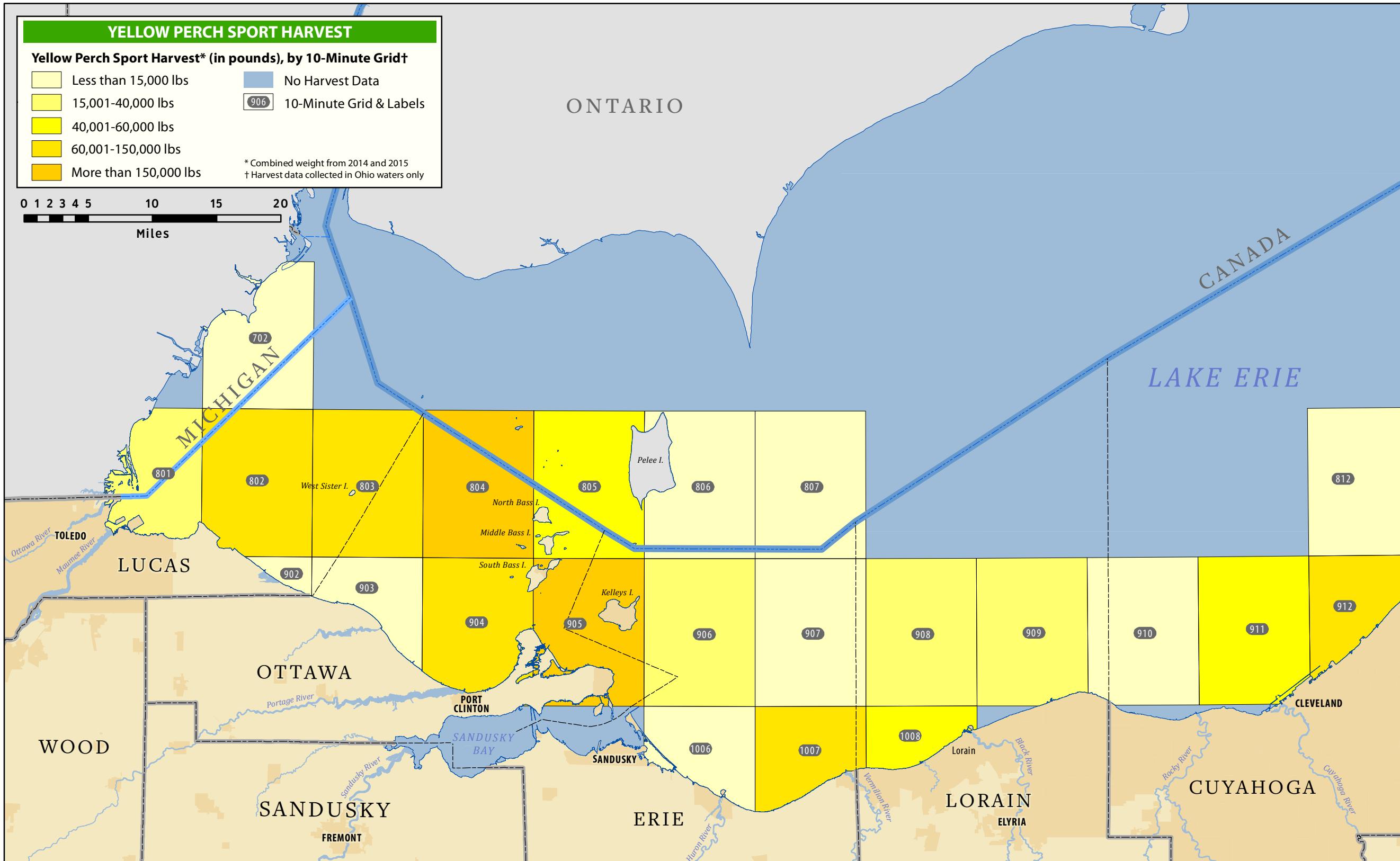
Lake Erie is Ohio's greatest fishing resource. It ranks as one of the best freshwater fishery centers in the country. Sport fishing is a major tourism draw and a vitally profitable industry for local and state economies. A range of habitat types contribute to the abundance and diversity of Lake Erie's sport fishery. The Western Basin is one of the most productive natural spawning and juvenile production areas on the Great Lakes. According to Ohio Sea Grant, Lake Erie produces 50 percent of all fish caught in the Great Lakes—more than lakes Superior, Michigan, Huron and Ontario combined. Walleye and yellow perch are Lake Erie's most popular fish, with 49 percent and 31 percent, respectively, of anglers targeting those species. Smallmouth bass and steelhead trout are also popular sport fish species that are commonly targeted by anglers.

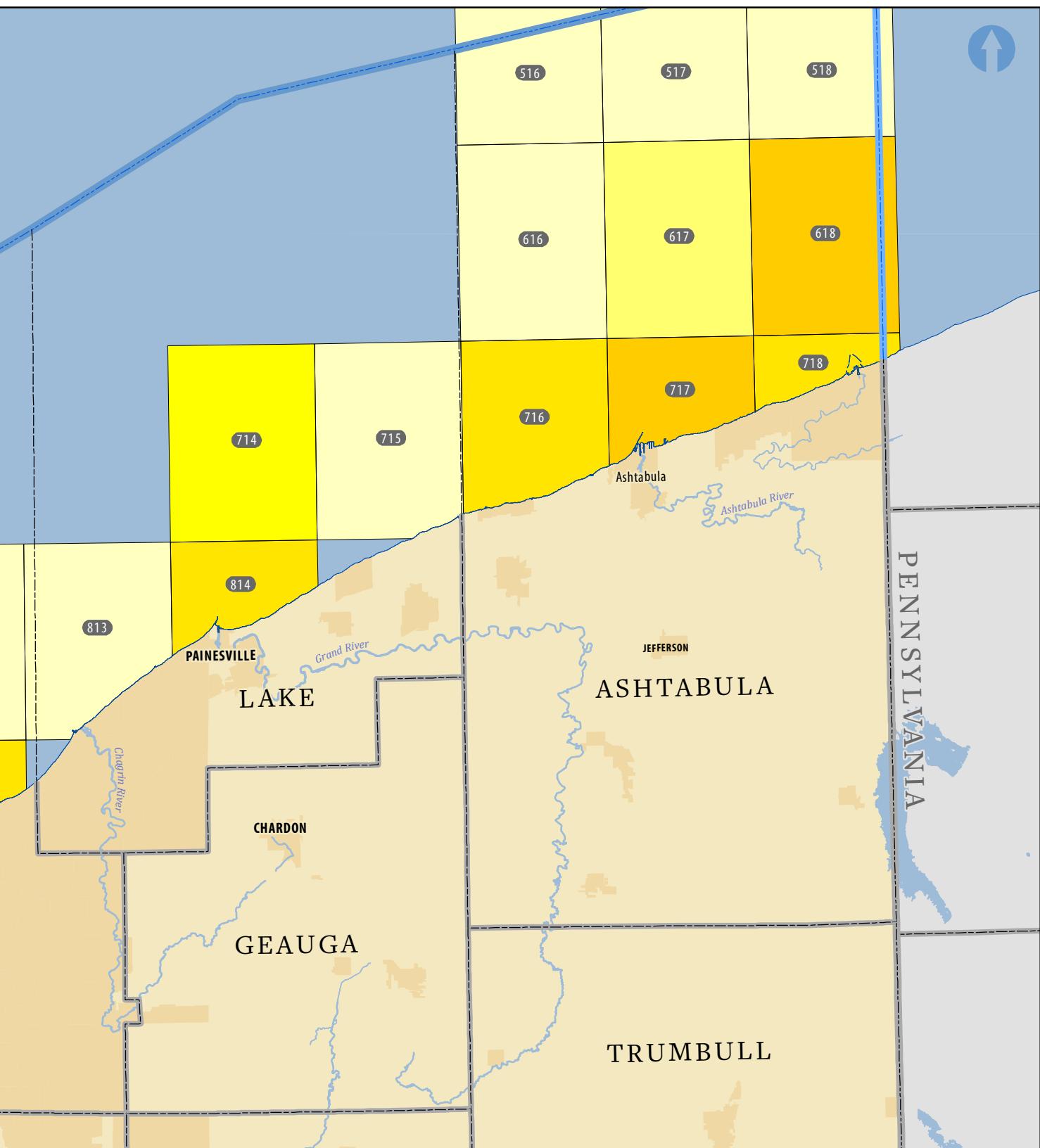
The Ohio Department of Natural Resources, Division of Wildlife (DOW) manages sport and commercial fisheries in Ohio's portion of Lake Erie. Walleye populations in Ohio's portion of Lake Erie—juvenile and adult—have been assessed annually by the DOW since 1978 using multifilament gill nets. This map shows sport walleye harvest (2014-2015), in pounds, by ten-minute grid. The darker the grid cell, the greater the combined weight of walleye harvested. Sport harvest statistics are obtained by interviewing anglers who have returned from fishing outings—including trips via private watercraft and charter boat. Completed-trip interviews are conducted at marinas, docks and ramps within harbor areas. Interview questions include: type of fishery (private or charter); number of anglers per boat; number of hours fished; number of each species harvested and released; the primary targeted species, and; the general location of where most fishing took place.

Sport walleye harvest is greatest in the Western Basin. Notable year-round hotspots include the Bass Islands, West Sister Island, Catawba Island, Kelleys Island, Marblehead and the Western Basin Reef Complex. In the Central Basin, spring walleye populations are active near breakwater structures and in the nearshore between Huron and Conneaut. In mid to late summer, walleye are commonly found in offshore areas of the Central Basin. Sport harvest numbers are greatest in Ashtabula County. During winter months, ice fishing is popular in the Western Basin. The area just west of South Bass Island typically offers some of the safest ice on the lake. Recreational walleye harvest numbers are also high in the Maumee and Sandusky rivers during spawning season (not mapped).

In general, walleye prefer cooler water (less than 72 degrees Fahrenheit) and moderately-turbid conditions (three- to six-foot visibility). Walleye will migrate significant distances to seek optimal habitat conditions. Changes in the weather can affect walleye activity. For instance, walleye are generally inactive and easily startled when temperatures are warmer and the water is clearer and calmer. They are more active during dawn and dusk. Walleye are also more active during overcast days with moderate (two-to-three foot) wave action. When foraging for food, walleye are often suspended in the water column and are relatively easy to catch. Inactive walleye can typically be found at or near the bottom of Lake Erie where rocky substrates are present.

YELLOW PERCH SPORT FISHERY HARVEST (2014-2015)





Lake Erie offers countless world-class fishing opportunities. Sport fishing in Ohio is a \$2.9 billion industry. It is important to local, state, national and international economies. Coastal communities actively market available fishing resources and profit from angler visits. Anglers to the Lake Erie region spend around \$2 billion annually. Local businesses, hotels, campgrounds, marinas, restaurants, bait and tackle stores, the charter boat industry and other businesses greatly benefit from the fishing opportunities Lake Erie provides. The lake's charter boat industry is the largest in North America and accounts for 40 percent of all Great Lakes charter boats.

The Ohio Department of Natural Resources, Division of Wildlife (DOW) manages sport and commercial fisheries in Ohio's portion of Lake Erie. Yellow perch populations in Ohio's portion of Lake Erie have been assessed annually by the DOW since 1969 using bottom-trawling equipment. This map shows sport yellow perch harvest (2014-2015), in pounds, by ten-minute grid. The darker the grid cell, the greater the combined weight of yellow perch harvested. Sport harvest statistics are obtained by interviewing anglers who have returned from fishing outings—including trips via private watercraft and charter boat. Completed-trip interviews are conducted at marinas, docks and ramps within harbor areas. Interview questions include: type of fishery (private or charter); number of anglers per boat; number of hours fished; number of each species harvested and released; the primary targeted species, and; the general location of where most fishing took place.

Yellow perch are often found in Ohio's slow-moving tributaries, lakes and reservoirs but are particularly common in Lake Erie. Like walleye, yellow perch are abundant in the Western and Central basins. Sport fishing harvest for yellow perch is distributed evenly in Lake Erie. In the Western Basin, year-round hotspots include areas around the Bass Islands, Catawba Island, Kelleys Island and Marblehead. In the summer, yellow perch catches increase near Metzger Marsh Wildlife Area and offshore of Cedar Point (Lucas County). Later in the year, yellow perch harvest upsurges around West Sister Island, the Toledo Shipping Channel and in Sandusky Bay. In the Central Basin, spring perch populations are active near breakwater structures and in the nearshore in Huron, Lorain, Cleveland, Mentor, Fairport Harbor and Ashtabula. In the summer and fall, yellow perch range between the nearshore and open offshore waters between Huron and Conneaut, although they tend to avoid bottom waters with low oxygen levels in the summer. Winter harvests are copious near breakwater structures in Huron, Bay Village, Cleveland and Fairport Harbor.

Yellow perch are typically more active during daylight hours and prefer water temperatures between 45 and 75 degrees Fahrenheit. Their diet is extensive, and includes insects (especially midges), plankton, mussels and smaller fish. The distribution of yellow perch is widespread. Habitat types range from rocky reefs in the Western Basin and nearshore to softer substrates in deeper waters. Yellow perch naturally stay near the bottom of the lake. Perch are generally easy to catch.