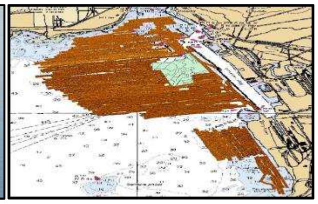
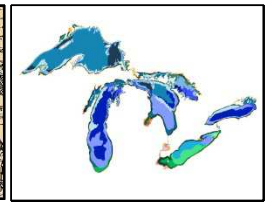
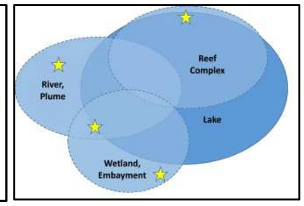
Report of the
Lake Erie Habitat Task Group
2017

<u>Prepared by members:</u>

Stephen Marklevitz (co-chair) Tom MacDougall, Yingming Zhao	*Ontario Ministry of Natural Resources and Forestry*
Cleyo Harris (co-chair)	*Michigan Department of Natural Resources*
Eric Weimer, Carey Knight, Ann Marie Gorman, Scudder Mackey Brandon Slone	*Ohio Department of Natural Resources*
Chris Castiglione, James Boase	*US Fish and Wildlife Service*
Jason Robinson	*New York Department of Environmental Conservation*
Richard Kraus	*USGS – Lake Erie Biological Station*
Ed Roseman	*USGS – Great Lakes Science Center*
Ed Rutherford	*NOAA Great Lakes Environmental Research Laboratory*
Mike Hosack	Pennsylvania Fish and Boat Commission

<u>And contributors:</u>

Kevin Wehrly	*Michigan Department of Natural Resources*
Catherine Riseng, Lacey Mason	*University of Michigan*
Tim DePriest	*New York Department of Environmental Conservation*
Christopher Vandergoot	*USGS – Lake Erie Biological Station*
Geoff Steinhart	*Ohio Department of Natural Resources*
Jessica Sherman, Christine Mayer, Todd Crail, Jon Bossengroek	*University of Toledo*

<u>Presented to:</u>

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Section 1. Charges to the Habitat Task Group 2016-2017

1. Document habitat improvement projects and research into fish use of habitat in Lake Erie. Identify and prioritize potential projects and research for future funding.

2. Assist member agencies with the use of technology (i.e., side-scan, GIS, remote sensing, etc.) to facilitate better understanding of habitat in Lake Erie, particularly in the Huron-Erie corridor, the nearshore, and other critical areas by participating in/supporting the following opportunities:

    a. Side-scan mapping techniques workshop.

    b. Lake Erie GIS/GLAHF development and deployment.

    c. Spawning habitat mapping.

    d. Nearshore substrate mapping.

3. Support other task groups by compiling metrics of habitat use by fish.

4. Develop a strategic research direction for the Environmental Objectives (Table 1-1).

5. Develop and maintain a list of key functional habitats and priority management areas that would support LaMP and LEC Environmental Objectives.

Table 1-1**.** Lake Erie Environmental Objectives (LEEOS) of the LEC (Lake Erie Committee 2005) with linkages to fish community objectives (*italicized*). See Table 1-2 for a description of each fish community objective.

1. Water levels and climate change—recognize and anticipate natural water level changes and long-term effects of global climate change and incorporate these into management decisions. *(Fish habitat, Nearshore habitat)*

2. Coastal and shoreline processes—restore natural coastal systems and nearshore hydrological processes. *(Nearshore habitat, Fish habitat)*

3. Rivers and estuaries—restore natural hydrological functions in Lake Erie rivers and estuaries. *(Riverine and estuarine habitat)*

4. Open water transparency—re-establish open water transparency consistent with mesotrophic conditions that are favorable to walleye in the central basin and areas of the eastern basin. (*Ecosystem conditions)*

5. Dissolved oxygen—maintain dissolved oxygen conditions necessary to complete all life history stages of fishes and aquatic invertebrates. (*Ecosystem conditions)*

6. Wetlands and submerged macrophytes—restore submerged aquatic macrophyte communities in estuaries, embayments, and protected nearshore areas. (*Fish habitat, Nearshore habitat)*

7. Contaminants—minimize the presence of contaminants in the aquatic environment such that the uptake of contaminants by fishes is significantly reduced. *(Contaminants)*

8. Fish habitat protection—halt cumulative incremental loss and degradation of fish habitat and reverse, where possible, loss and degradation of fish habitat. (*Fish habitat)*

9. Fish access—improve access to spawning and nursery habitat in rivers and coastal wetlands for native and naturalized fish species. (*Fish habitat)*

10. Habitat impacts of invasive species—prevent the unauthorized introduction and establishment of additional non-native biota into the Lake Erie basin, which have the capability to modify habitats in Lake Erie. (*Food web structure, Forage fish)*

Table 1-2. Fish community objectives (FCOS) of the LEC.

a. Ecosystem conditions—maintain mesotrophic conditions (10-20 µg·L-1 phosphorus) that favor a dominance of cool-water organisms in the western, central, and nearshore waters of the eastern basins; summer water transparencies should range from 3-5 m (9.75-16.25 ft) in mesotrophic areas

b. Productivity and yield—secure a potential annual sustainable harvest of 13.6-27.3 million kg (30-60 million lb) of highly valued fish

c. Nearshore habitat—maintain nearshore habitats that can support high quality fisheries for smallmouth bass, northern pike, muskellunge, yellow perch, and walleye

d. Riverine and estuarine habitat—protect and restore self-sustaining, stream-spawning stocks of walleye, white bass, lake sturgeon, and rainbow trout

e. Western basin—provide sustainable harvests of walleye, yellow perch, smallmouth bass, and other desired fishes

f. Central basin—provide sustainable harvests of walleye, yellow perch, smallmouth bass, rainbow smelt, rainbow trout, and other desired fishes

g. Eastern basin—provide sustainable harvests of walleye, smallmouth bass, yellow perch, whitefish, rainbow smelt, lake trout, rainbow trout, and other salmonids; restore a self-sustaining population of lake trout to historical levels of abundance

h. Contaminants—reduce contaminants in all fish species to levels that require no advisory for human consumption and that cause no detrimental effects on fish-eating wildlife, fish behavior, fish productivity, and fish reproduction

i. Fish habitat—protect, enhance, and restore fish habitat throughout the watershed to prevent degradation and foster restoration of the fish community

j. Genetic diversity—maintain and promote genetic diversity by identifying, rehabilitating, conserving, and/or protecting locally adapted stocks

k. Rare, threatened, and endangered species—prevent extinction by protecting rare, threatened, and endangered fish species (for example, lake sturgeon and lake herring) and their habitats

l. Forage fish—maintain a diversity of forage fishes to support terminal predators and to sustain human use

m. Food web structure—manage the food web structure of Lake Erie to optimize production of highly valued fish species; recognize the importance of Diporeia and Hexagenia as key species in the food web and as important indicators of habitat suitability

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Section 2. Document Habitat Improvement Projects

E. Weimer, C. Castiglione

The first charge to the Habitat Task Group (HTG) involves the documentation of habitat projects occurring throughout the Lake Erie and Lake St. Clair basins, including their associated watersheds. Although originally designed as a simple spreadsheet table, by 2007 it had evolved into an online, spatial inventory which, it was believed, would be an effective way of disseminating project information.

The habitat listing, presented as a spatial inventory presented with a map interface can be found online at:
http://glfc.org/lakecom/lec/spatial_inventory/inventory_index.html

In 2009, the LEC modified the charge to "Identify and prioritize relevant projects to take advantage of funding opportunities". Currently, we are re-evaluating the objectives of this charge and believe it is essential to provide a tool that promotes collaboration and prevents duplication of effort. We continue to address the initial charge by documenting current habitat improvement and research projects identified by task group members and need to expand the inventory beyond the task group member knowledge. The following tables identify the number of projects within each basin (Table 2-1), waterbody (Table 2-2), and watershed (Table 2-3).

Table 2-1. Summary of Habitat Projects by Basin.

Basin	# of Projects
Central	11
East-Central	7
East	15
Huron-Erie Corridor	19
Whole Lake	11
West-central	3
West	11

Table 2-2. Summary of Habitat Projects by Waterbody.

Waterbody	# of Projects
Crooked Creek	1
Detroit River	4
East Branch of Conneaut Creek, PA	2
Elk Creek	2
Four Mile Creek, PA	1
Lake Erie	13
Lake St. Clair	2
Middle Harbor	1
NA	39
Niagara River	2
North Maumee Bay	1
Sandusky River and Bay	1
Spooner Creek	1
St. Clair River	1
St. Clair River, Lake St. Clair	1
St. Clair River, Lake S. Clair, Detroit River	3
Walnut Creek, PA	1
Western and Central Basin of Lake Erie	1

Table 2-3. Summary of Habitat Projects by Watershed.

Watershed	# of Projects
Ashtabula-Chagrin	1
Big Creek	1
Big Creek, Lower Grand	1
Black-Rocky	1
Buffalo-Eighteenmile	1
Cattaraugus	2
Cedar-Portage	1
Cedar Creek	1

Cedar Creek, Rondeau, Big Creek	1
Chautauqua	1
Chautauqua-Conneaut	8
Clinton	1
Cuyahoga	2
Detroit	1
Halfway Creek, Ottawa River	1
Huron	1
Lake Erie	9
Lake St. Clair, Clinton, Syndenham, Lower Thames, Cedar Creek	1
Lower Grand	3
Lower Thames	1
Maumee	3
Maumee to Cuyahoga	1
Maumee, Ashtabula-Chagrin	1
NA	16
Niagara	2
Raisin	1
Rondeau	3
Sandusky	2
Sandusky River	1
St. Clair, Lake St. Clair, Clinton	1
St. Clair, Upper Thames, Syndenham, Lower Thames, Lake St. Clair, Clinton, Detroit, Cedar Creek	1
Syndenham, Lower Thames, Cedar Creek, Upper Thames	1
Toussaint River	1
Upper Grand, Lower Grand	1
Upper Grand, Lower Grand, Big Creek, Niagara	1
Upper Thames, Lower Thames	2

Building on the development of the Environmental Objectives (Table 1-1) and the identification of Priority Management Areas (PMAs) in Section 6, the second responsibility of this charge is focused on identifying potential projects and gaps in research/restoration for future funding opportunities. These recommendations would be developed from expert opinion among the task groups and prioritized within the framework of the Environmental Objectives.

Regardless of the state of our method of relaying the information, habitat related projects continue throughout the basin and we present a summary of notable ones below.

2a. ***St. Clair – Detroit River System***

(LEEO #2, #3, #6, #8, #9; Table 1-1)

R. DeBruyne, J. Chiotti, J. Boase, and E. Roseman

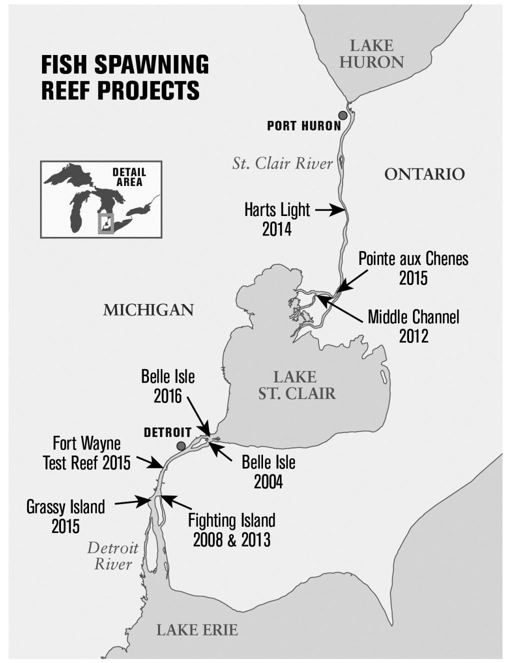

Figure 1: Map of completed spawning reef projects in the St. Clair and Detroit rivers
(Photo credit – Michigan Sea Grant).

Historically, the St. Clair and Detroit rivers have supported diverse and productive fisheries. Lake Sturgeon, Walleye, and Lake Whitefish traveled to these rivers to spawn, depositing and fertilizing eggs in rocky areas with fast-flowing currents. Beginning in 1874, both the St. Clair River and Detroit River were extensively modified through the dredging of river bottoms to create deep navigation channels for large commercial ships. Dredging and disposal of dredged materials damaged the natural limestone spawning reefs and changed the flow of the river. Destruction of spawning habitat, shoreline development, and historical overfishing combined to dramatically reduce native fish populations in these rivers. Consequently, the St. Clair and Detroit rivers, and two direct tributaries (Clinton and Rouge rivers), were classified as Great Lakes Areas of Concern (AOC) in 1987. After the AOC designations, plans were enacted to remove the Beneficial Use Impairments (BUIs; a sufficient degradation in the chemical, physical or biological integrity of the Great Lakes system) within these systems. A major component of the habitat restoration efforts in the St. Clair-Detroit River System (SCDRS) has been the construction of artificial reefs. Locations of the constructed reefs were selected based on a bio-physical model identifying the best potential locations for lake sturgeon spawning (Bennion and Manny 2014). The goals of this work were to 1) construct fish spawning reefs to enhance the productivity of native fish species, with special attention on lake sturgeon, 2) remove the Detroit River and St. Clair River BUIs resulting from the loss of fish and wildlife habitat and populations, and 3) improve understanding of fish communities and fish habitat restoration. The process and evaluation for reef site placement and evaluation has evolved, applying lessons learned from each reef-building process to future potential reefs (Manny et al. 2015; Vacarro et al. 2016).

Since 2004, seven artificial spawning reefs have been constructed in the St. Clair and Detroit rivers (Figure 1). These reefs were constructed to restore spawning habitat lost during channelization in the SCDRS with the most recent reefs being constructed at Belle Isle which added another three acres for a total of over 16 acres of new habitat. The construction of these reef complexes directly contributed to the achievement of LEEO #3, #8 (Table 1-1) and is helping to prevent extinction of rare, threatened, and endangered fish species (i.e., Lake Sturgeon, ciscos, and Northern Madtom) and their habitats a Lake Erie FCO.

Monitoring of the constructed reefs has been accomplished through collaborations among OMNRF, USGS, USFWS, and MI DNR pre- and post-construction to evaluate the fish response and fish life-stage use. These reefs have been used by Lake Sturgeon (Roseman et al. 2011; Bouckaert et al. 2014), Walleye (Manny et al. 2010), Catostomid species (Manny et al. 2010), and Lake Whitefish (Roseman et al. 2012) for spawning, which has been confirmed through the collection of ripe adults and eggs on and around these reefs. The larval fish community has been monitored since 2006, revealing successful production of key species for Lake Erie originating within the SCDRS (McDonald et al. 2014; Pritt et al. 2014, 2015). Juvenile fishes have been sampled and relationships between species and habitats explored, as well as work to determine the more efficient sampling strategy for long-term monitoring (Francis et al. 2014). Analysis of the effects of reef habitat construction on genetic diversity revealed that these habitat projects are likely maintaining the genetic diversity of the lake sturgeon SCDRS population (Marranca et al. 2015). These assessments are continuing with the goals of effectively assessing the impact of the habitat improvements and their effect on native and invasive species populations within the SCDRS. The success of these collaborative monitoring programs provide prime examples of the achievements of recommendations put forward in the 2009 State of Lake Erie Report, primarily *1) Continue and expand successful collaborative monitoring, assessment, planning, and research efforts in support of management activities; and 2) Achieve a better understanding of the relationship between suitable habitat and improved fish populations.*

Smaller shoreline habitat projects have also been completed through the SCDRS with the goals of removing BUIs, improving nearshore habitat and complexity, and providing nursery and refuge areas for aquatic organisms. Shoreline habitat enhancement projects have improved the condition and connectivity between the shoreline and main channel along the St. Clair River. Multiple projects along the St. Clair River improved > 1,900 meters of shoreline. Post-construction assessments indicate all life stages of fishes are using these newly created areas (E. Roseman, USGS, unpublished data). With the construction of these projects we have met the BUI benchmarks for the Management Actions, resulting in the Michigan Department of Environmental Quality and Bi-National Public Advisory Council approving the delisting the Loss of Fish and Wildlife Habitat impairment. Additionally, habitat projects within the Blue Heron Lagoon on Belle Isle in the Detroit River improved connectivity between the main channel and this wetland nursery area. These projects have made direct progress towards the LEEO #*2* and #*6* (Table 1-1) by improving coastal shoreline processes to promote naturally occurring vegetation and providing linkages to the terrestrial ecosystems.

2b. Strawberry Island Habitat Improvement Project

(LEEO #2, #6, #8, #9; Table 1-1 and FCO C; Table 1-2)
J. Robinson, T. DePriest

The final phases of the Strawberry Island Habitat Improvement Project were completed by the NY Power Authority in collaboration with NYS DEC, USFWS, Tribal Nations, and local organizations in partial fulfillment of their Re-licensing agreement for the Niagara Power Project. The scope of this project is to build on past work to restore emergent wetland habitat in the shallow water areas around the perimeter of the island as well as inside the "lagoon." By amending the substrate with coarse sediment and constructing rock berms and anchoring large wood the goal is to mitigate wave and ice scour in this high energy, mid-river environment. This will promote growing conditions in which emergent wetland vegetation can be established successfully as well as creating complexity and diversity in the plant community with variable water depth and physical structure. The newly established wetlands will support the native fish community by creating foraging, spawning, and nursery habitat in locations that have experienced habitat degradation due to past and current practices related to mining, commercial shipping and recreational boating. The earth work was completed in early 2016 with the wetland plantings installed later in the summer. These projects have restored approximately 18 acres of mid river and coastal habitat, and have made direct progress towards the LEEO #2, #6, #8, and #9 (Table 1-1), and FCO C (Table 1-2) by improving coastal shoreline processes to promote naturally occurring vegetation, halting and reversing habitat loss, and providing access to spawning and nursery habitat for native fish species.

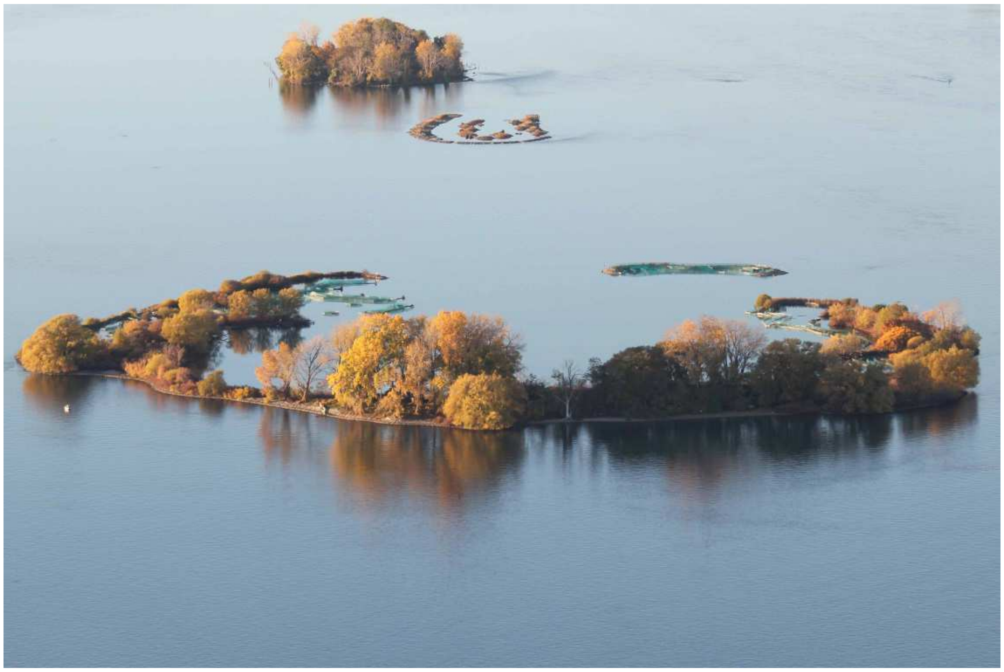

Figure 2 View of Strawberry Island looking downstream toward Frog and Motor Islands. Photo: Paul Leuchner

2c. Projects Identified to Address Loss of Habitat in Niagara River Area of Concern

(LEEO #2, #6, #8, #9; Table 1-1 and FCO C; Table 1-2)
J. Robinson and T. DePriest

In 2016 the US EPA committed funding to various agencies and organizations to initiate design and eventual implementation of a series of habitat restoration projects that will allow for the de-listing of Niagara River as a Great Lakes Area of Concern. The main focus of the projects are to restore the coastal wetland plant communities that were once abundant in the protected near shore areas of the river and which have gradually disappeared from the river system over the past century. Coastal wetlands in the upper Niagara River are critical to the reproduction and early life stage survival of important game species such as Muskellunge and their prey. The projects are located at Beaver Island and Buckhorn Island State Parks and at Spicer Creek Wildlife Management area and will utilized off-shore breakwater structures constructed of heavy stone and large wood anchored to the riverbed to reduce the effects of excessive boat wakes and ice floes combined with highly fluctuating water levels experienced in the river. Reducing the effects of these physical forces will allow for the establishment and maintenance of a sustainable, diverse wetland plant community. The designs are expected to be completed in 2017 with construction in 2018. These projects will make direct progress towards the LEEO #2, #6, #8, and #9 (Table 1-1), and FCO C (Table 1-2) by improving coastal shoreline processes to promote naturally occurring vegetation, halting and reversing habitat loss, and providing access to spawning and nursery habitat for native fish species.

2d. Coastal Wetland Restoration and Fish Passage at Middle Harbor, Ohio

(LEEO #2, #6, #8, #9; Table 1-1 and FCO C, I; Table 1-2)
E. Weimer, G. Steinhart

Restoration of Great Lakes wetlands remain a high priority among natural resource agencies. The Middle Harbor Coastal Wetland restoration project, a collaborative effort between Ducks Unlimited, The Nature Conservancy, and the Ohio Department of Natural Resources, will result in benefits to the physical, chemical, and biological processes of Middle Harbor by restoring hydrological connection to Lake Erie, enhancing 350 acres of Lake Erie coastal wetland through the re-establishing of native submergent and emergent macrophytes, and providing nearshore Lake Erie fish species with access to vegetated spawning habitat. Achieving these results will directly address several of the LEEOs (Table 1-1) and FCOs (Table 1-2) established by the Lake Erie Committee.

Middle Harbor is 390 acres of wetland and upland area located immediately adjacent to Lake Erie in East Harbor State Park, Ottawa County, Ohio. Historically, Middle Harbor was known spawning habitat for northern pike *Esox lucius* and other wetland-spawning fish, and was used by migratory waterfowl and shorebirds. The 350 acre wetland was isolated in the 1940s through the construction of causeways on the east and west sides of Middle Harbor, separating it from East and West Harbors and Lake Erie, and leaving no water exchange. Large-bodied fish, such as common carp *Cyprinus carpio*, were trapped in the shallow wetland, where their activity quickly reduced water clarity and aquatic macrophytes. Since isolation, Middle Harbor has become significantly degraded, with low water clarity and little-to-no submergent vegetation, a fish community dominated by low-quality tolerant species, and providing little benefit to aquatic or terrestrial biota.

In an effort to restore some quality and functionality, the dike between Middle Harbor and West Harbor was breached in 2013, and a culvert and water control structure was installed to allow for water level control and fish exclusion. During the spring of 2014 and 2015, Middle Harbor was drawn down partially to expose sediments, although not fully de-watered. Japanese millet was aerially seeded on the exposed sediment in late-spring to benefit waterfowl and to limit the spread of exotic *Phragmites*. In addition, many native species of wetland vegetation regenerated in Middle Harbor without seeding. The water level was kept low for the remainder of this period.

Spring of 2016 marked the first time the water control gates were opened, allowing for the movement of fish between Middle Harbor and West Harbor/Lake Erie. The gates were opened in mid-February, and remained open until approximately April 24th, when rising water levels in the Lake forced the gate to be closed. Had the water levels remained low, the gates would have remained open until the water temperature in Middle Harbor reached 12^{o}C. According to literature reviews, this temperature represents a balance between allowing northern pike spawning and restricting common carp access to the wetland.

In addition, staff at the Sandusky office collaborated with researchers from Bowling Green State University to position a DIDSON sonar imaging system to collect preliminary data on the movement of fish through the water control structure. A DIDSON uses multiple sonar frequencies to produce video-like recordings of fish as they pass through the transducer's cone, allowing for both enumeration and identification of fish entering and leaving the wetland. The DIDSON was placed on March 3rd, and remained in near-constant operation until its removal on April 18th. Data were recorded to an external hard drive, and brought back to the Sandusky office for analysis.

The DIDSON recorded the movements of approximately 4,900 fish through the water control structure during the month of March (the DIDSON transducer was shifted slightly in April in an attempt to see more of the fish passage opening, but the resulting data collected was not clear, not comparable to the March data and was not used for analyses). A combination morphological measurements and swimming behavior were used to identify species. Frequently observed species included common carp, bullheads *Ameiurus spp*., and bowfin *Amia calva*; possible northern pike and longnose gar *Lepisosteus osseus* were identified but not confirmed (Figure 1). Many fish were unidentifiable, including small (< 200 mm) fish and schools of fish.

Patterns of fish movement varied. Fish activity (# fish recorded per day) increased in early March, and became variable by late March. Diel activity varied by species; carp were more active during daylight, as were small fish and fish schools. Bullheads and bowfin were mostly nocturnal.

Immigration and emigration from Middle Harbor was influenced by environmental and behavioral factors. During March, 2,046 fish entered Middle Harbor and 741 fish left, a net gain of 1,305 fish. Fish moved in response to the direction of water flow. The most common pattern was for fish to move into Middle Harbor when the water flow was out of the wetland; regardless of direction, the predominant pattern was moving against the flow (Figure 2). More fish immigrated to the wetland during daylight than at night; the highest level of activity was carp moving and immigrating to the wetland during daylight.

The results of this pilot work will provide further insight into managing water levels and fish passage to balance benefits to the fish community with efforts to reduce the risk of habitat degradation due to high water levels and carp overpopulation. Additional research into the fish community response to this project is being planned for Middle Harbor.

2e. Creating a habitat suitability index model to assess lake sturgeon (*Acipenser fulvescens*) reintroduction in the Maumee River, Ohio

(LEEO #3, #8, #9; Table 1-1 and FCO D, I, K; Table 1-2)

J. Sherman, J Bossenbroek, T. Crail, C. Mayer, J. Boase, J. Chiotti, C. Vandergoot

Lake sturgeon (*Acipenser fulvescens*) were once a common species throughout the Great Lakes with a historical abundance estimated between 671,000 – 2.3 million fish. Overfishing and habitat degradation have eliminated lake sturgeon from many areas and their populations have been reduced to less than 1% of historic abundance. Rehabilitation and restoration efforts are being implemented throughout their native range to increase population numbers and reintroduce extirpated populations. Lake sturgeon are a candidate for reintroduction in the Maumee River, Ohio, where they were historically abundant, but are now functionally extirpated. Therefore, the objective of this work is to determine if current habitat quantity and quality are sufficient to support reintroduction using a spatially explicit habitat suitability index model for spawning adult and age-0 lake sturgeon for the lower Maumee River. Substrate, water depth, and water velocity were assessed and integrated into a suitability index value to delineate good, moderate, and poor areas throughout the lower Maumee for each life stage. Substrate and water depth were surveyed simultaneously using side-scan sonar and ground-truthing techniques while water velocity was modeled with HEC-RAS software and discharge data from the USGS gage on the river. Each habitat characteristic was mapped as a spatially explicit layer in ArcGIS and then combined to provide an overall assessment of habitat suitability and connectivity. This works supports LEEO #3, #8, and #9 as well as FCO D, I and K by identifying areas of the Maumee River where habitat restoration or improvement efforts would be beneficial, providing a better understanding of habitat available in the Maumee River, including suitable spawning habitat.

Model results for spawning adults indicate 12.3 % of the total habitat (192.2 hectares) in the lower Maumee River is good spawning habitat, while 63.1% and 24.6% classified as moderate and poor, respectively. Good spawning habitat is found around the Bluegrass and Audubon Island complex and further upstream between Van Tassel Island and the Missionary Island complex. For age-0 lake sturgeon, model results classify 23.7% (429.3 hectares) of habitat in the lower Maumee River is good for this life stage, 61.3% is moderate, and 15% is poor. The majority of good habitat for age-0 lake sturgeon is between Bluegrass Island and the Delaware and Grassy Island complex with some good habitat upstream around the Missionary Island complex. While 12.3% may seem like a relatively low amount of total habitat to support spawning, the spawning habitat of other river systems with self-sustaining lake sturgeon population typically comprises only 1-10% of the total available habitat. Therefore, results the habitat suitability index models indicate habitat in the Maumee River is not limiting for lake sturgeon reintroduction and supports the goal of restoring their population to this system.

Section 3. Assist Member Agencies with Technology Use

Members of the HTG are involved in a variety of projects, often using specialized equipment and techniques to identify, survey, and modify aquatic habitat in Lake Erie and its surrounding watersheds. The HTG desires to assist interested agencies and researchers with the selection, use, and analysis of data collected with these technologies in a standardized fashion. What follows is a brief synopsis of how the HTG is working toward this charge.

3a. Sidescan Sonar Comparison

(LEEO #8; Table 1-1 and FCO C, I; Table 1-2)
C. Castiglione, S.D. Mackey

Sidescan sonar technology is an increasingly popular and important tool for evaluating habitat in aquatic systems. Sidescan has been used on Lake Erie to map substrate distributions, target potential Lake Trout spawning habitat, and evaluate habitat in the nearshore. Historically, this work has required the use of specialized, stand-alone sidescan systems that have been cost prohibitive for many agencies to purchase. In recent years, manufacturers have begun to integrate sidescan technology into sonar/chart plotter systems that mount on vessel hulls. These integrated sidescan systems are relatively inexpensive, and many agencies around Lake Erie have begun using these systems to collect data. The HTG encourages these activities, but understands that integrated sidescan systems may perform differently at various depths, ranges, and frequencies compared to traditional, stand-alone systems. Recognizing this, the HTG has begun a series of exercises that will establish recommendations for collecting, processing, and analyzing sidescan data in Lake Erie. Over the past two years, comparison surveys using different sidescan equipment and processing software were performed and the results shared with respective fish management agencies.

<u>Upper Niagara River Sidescan Sonar Comparison</u>

This year, the U.S. Fish & Wildlife Service performed a comparison between a standalone dual frequency (400/900kHz) Edgetech 4125 unit and an integrated Lowrance HDS-12 StructureScan Gen2 with the 455/800kHz transducer. The Edgetech system is a portable system using a towfish transducer, while the Lowrance system is a fixed mount system with a static transducer mounted on the transom of the vessel. Imagery was acquired during September 2016 in the Tonawanda Channel of the Upper Niagara River (east branch) near Tonawanda Island (Figure 3a-1). This section of the river contains a variety of nearshore depths (1-10m), substrate types, and vegetative cover that will be used in the comparisons of the two systems based on the quality of data, acquisition and processing time, and ease of use.

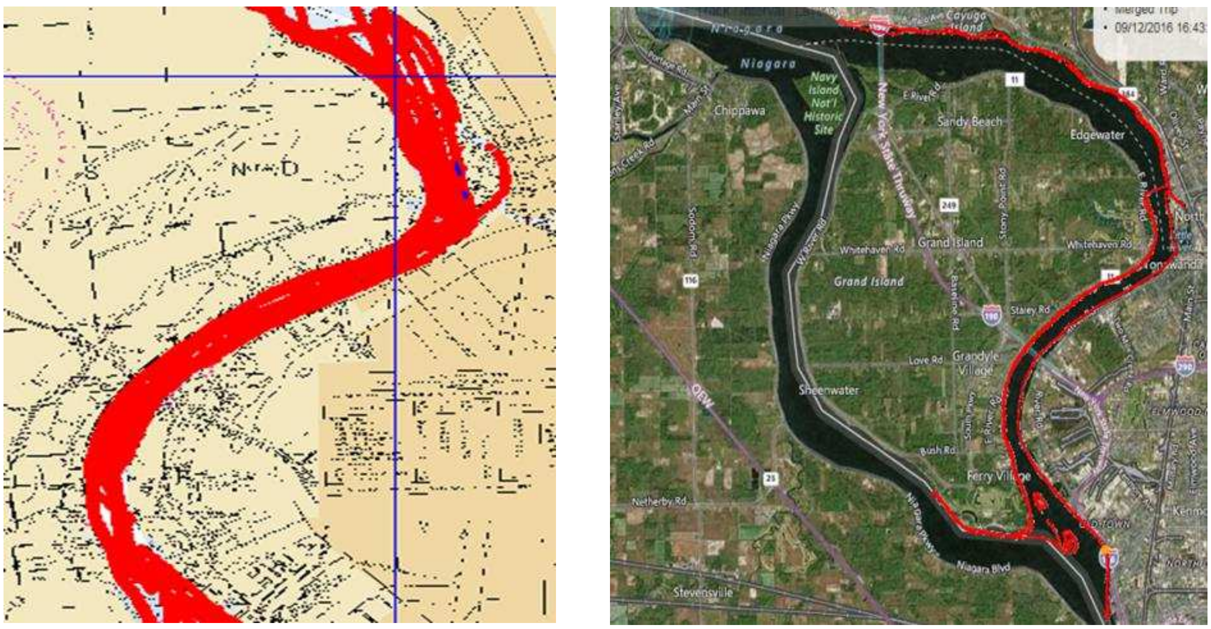

Figure 3a-1. Project area of the Upper Niagara River. Track and coverage areas (in red) of the Edgetech surveys (left) and the Lowrance surveys (right).

The initial settings for the Edgetech system were set to the highest frequency (900kHz), 75m range (150m swath), and boat speed around 3.5 mph. The settings for the Lowrance system were set to the highest frequency (800kHz), auto range, and a boat speed of 3.5 mph. Chesapeake Technologies SonarWiz sidescan processing software was used to process both sonar datasets. The variation in range settings was due to the protocols needed for alternative processing of the Lowrance sonar data using a cloud sourcing program, CI BioBase (http://www.cibiobase.com/Home/Index).

It was expected that the Edgetech data would show a slightly higher resolution based on its higher frequency, but the comparison showed negligible increase in the image quality (Figure 3a-2). This may be a result of the larger range settings that offset the increase in frequency. Since the Lowrance system is a fixed mount system, setup and deployment was quicker and more versatile for field acquisition but limited the depths that could be surveyed to keep a standard 10/1 range-to-depth ratio. This also reduces the range settings available and may result in more transects to cover the same surface area.

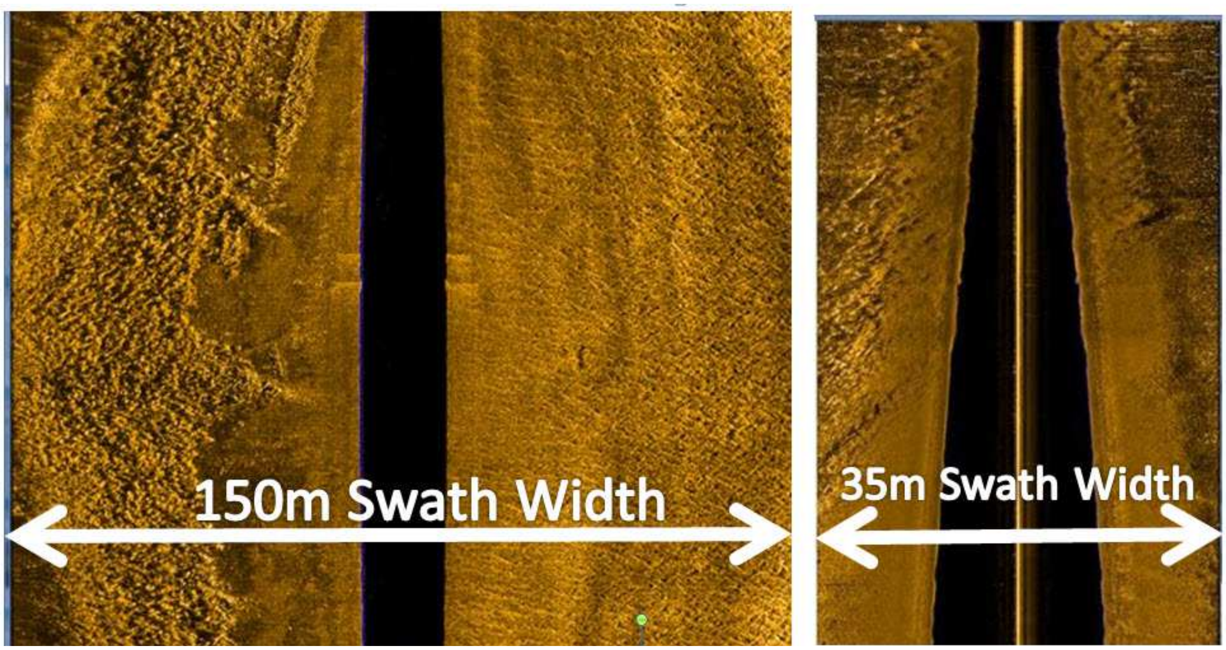

Figure 3a-2. Sections of sidescan sonar imagery (not to scale) showing the same area of the Upper Niagara River. Swath width of the Edgetch imagery (left) is 150 meters, while the Lowrance imagery (right) is 35 meters.

In the upcoming year, the HTG intends on continuing the system comparisons based on the increasing types and models of sidescan sonar systems available on the market today. Along with system comparisons, we are planning to complete processing and classification tests to identify the best practices for identifying habitat types and substrate composition. It is anticipated that a guidance document identifying recommended sidescan systems and settings for a particular data collection need can be developed, and that options for data processing can be evaluated.

These projects are designed to inventory and assess the nearshore and riverine habitat of the Great Lakes system. The outcomes of the sidescan acquisition and the comparison of systems, acquisition methods, and processing techniques will enhance the baseline habitat data needed to make sound resource management decisions. The classification will be used in conjunction with the lake sturgeon telemetry project to address the habitat use and distribution of this species. This collection of data is also important for the cataloguing of habitat and identifying changes in substrate composition and the cause and effect of anthropogenic uses, climate change scenarios, and geophysical processes.

3b. Sidescan Sonar Data Acquisition

(LEEO #2, #8, #9, #10; Table 1-1 and FCO C, I, K; Table 1-2)
C. Castiglione, S.D. Mackey

Buffalo Harbor Aquatic Habitat Mapping

Habitat reductions, changing environmental factors and invasive species introductions have affected available spawning and rearing habitat for native fish species within the Great Lakes system. Identifying current habitat types has been a high priority for the fishery managers of the lower Great Lakes. The USFWS in conjunction with the Army Corps of Engineers, Buffalo District has been collecting high-resolution substrate information in Buffalo Harbor section of Lake Erie. The goal of the project is identify the availability and quality of substrate available for a variety of fishery management objectives including lake sturgeon telemetry, aquatic invasive species survey locations, and benthic community models.

The USFWS is collecting sidescan sonar imagery using an Edgetech 4125 side scan sonar system (dual frequency 400/900 kHz). Edgetech's Discover and Chesapeake Technology Inc. SonarWiz software will be used for data acquisition and processing. The mosaic imagery is being classified using SonarWiz and ESRI ArcMap Software to identify distinct substrate type polygons within the study area. Field Verification and substrate composition will be determined using a SeaViewer underwater video drop camera along with ponar samples. The project area is over 23.5 square miles at the eastern end of Lake Erie.

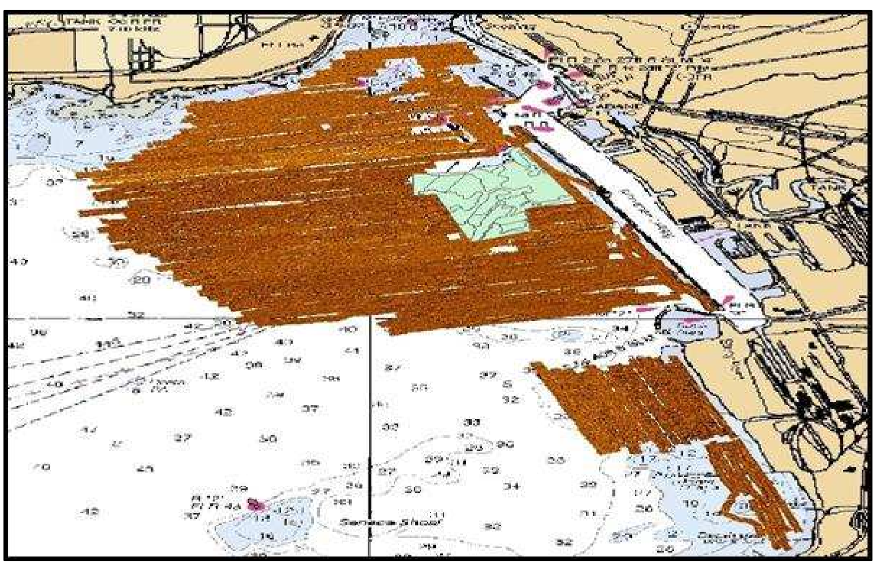

Figure 3b-1. Coverage area of sidescan sonar collection in the eastern basin of Lake Erie.

The output of this project was initially designed to identify critical habitat in coordination with the Lake Sturgeon Acoustic Telemetry project. This information will help identify the spawning areas and other habitat being utilized at different life stages. In addition to the lake sturgeon project, other application have found the habitat classification useful in their project planning and modeling effort. Identifying comparable habitat types used by invasive species will assist the biologists to focus their efforts and improve the efficiency of discovering early infestations. Early detection of Invasive Species allows the fisheries managers to respond quicker and more efficiently in the monitoring (and hopefully the eradication of) invasive species. This reduces the effects of habitat competition and species interaction between native and invasive species.

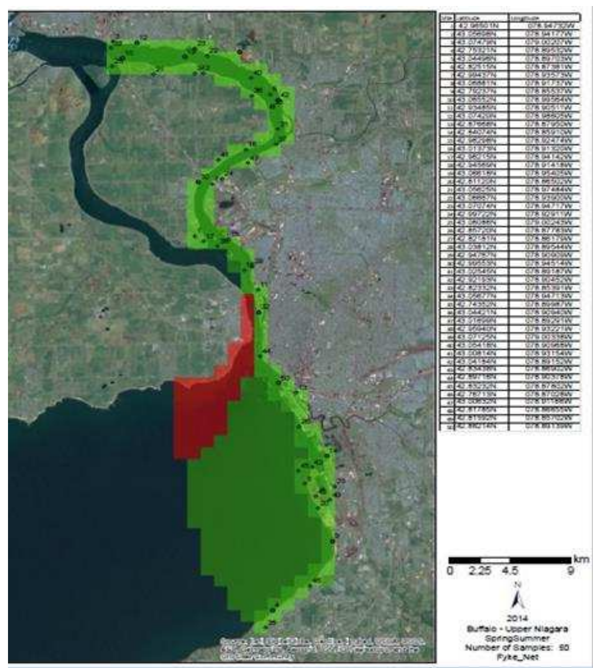

Figure 3b-2. Locations of lake sturgeon acoustic telemetry receivers within the Buffalo harbor (left). Random sampling sites for aquatic invasive species Early Detection and Monitoring program (right). The green area is the area of concern where the random points (black dots) are generated. Substrate maps will be used to stratify the random sampling locations.

ODNR and PA Coastal Management Conneaut Nearshore Survey

The Ohio DNR and PA Coastal Resources Management Programs acquired additional nearshore sidescan sonar data east of Conneaut Harbor (Figure 3b-3). The objective of the survey was to map the lakebed substrate distribution and assess the effectiveness of historic beach nourishment (sand bypassing) performed by the USACE and the Port of Conneaut at the request of the State of Pennsylvania. The intent of the sand bypassing operations was to create and maintain beaches in the nearshore to protect rapidly eroding Pennsylvania game lands further to the east.   The sidescan data revealed that bypassed sand is shunted offshore by bedrock ridges and accumulates in low-lying troughs oriented parallel to shore.

The sidescan sonar data also revealed several areas where boulder/cobble substrates are present could provide potential fish spawning habitat. Additional sidescan sonar and bathymetry data will be collected this upcoming field season to further assess the need for continued sand bypassing operations and to identify potential management actions to address the high rates of erosion along the Pennsylvania coastline.

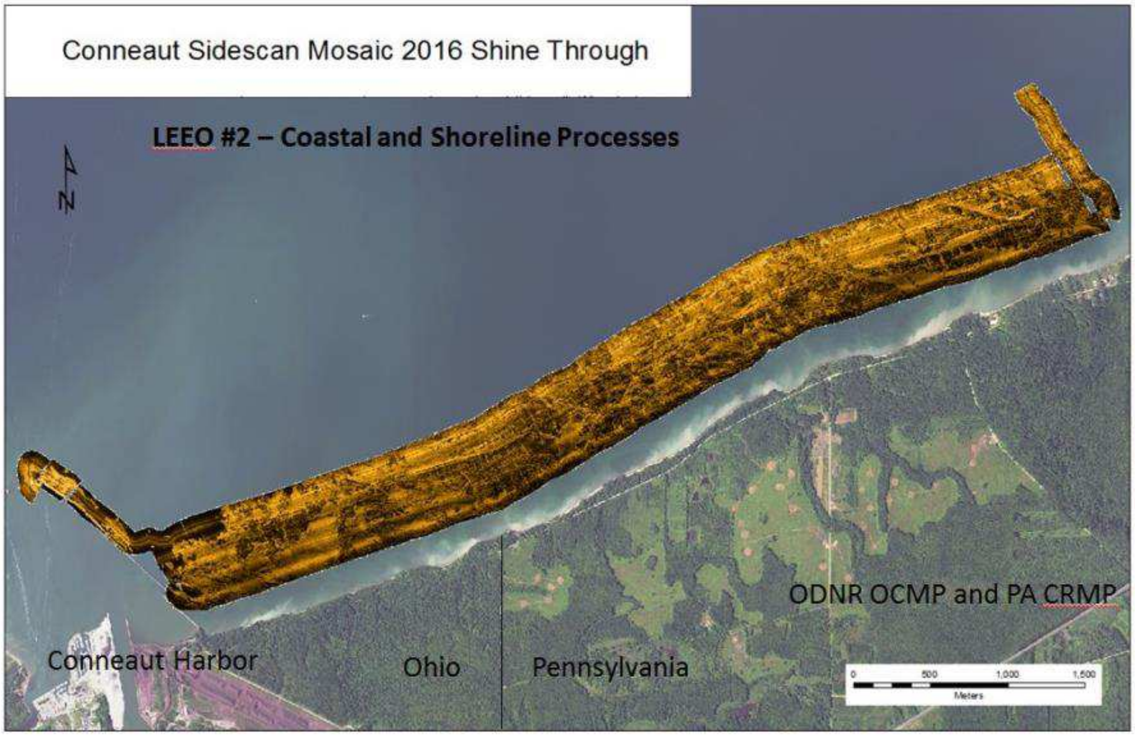

Figure 3b-3. Sidescan mosaic showing sidescan sonar data coverage east of Conneaut Harbor, OH. Light colored areas are mobile sandy sediments and dark areas are exposed flat-lying fractured bedrock.

3c. Continued support of Lake Erie GIS/GLAHF development and deployment

(LEEO #1, #2, #3, #4, #5, #6, #8, #9 ;Table 1-1)
C. Riseng, L. Mason and E. Rutherford

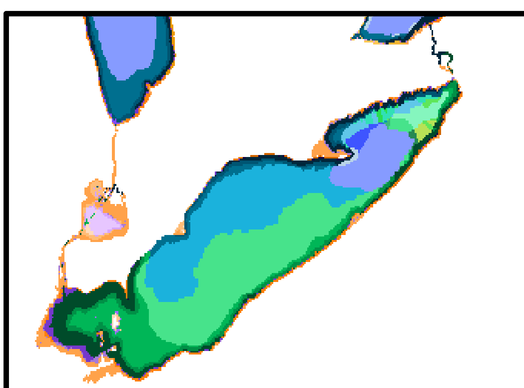

Figure 3c-1: Map of aquatic ecological units for Lake Erie

Access to spatially-explicit databases, maps and decision support tools are improving knowledge of interactions between fish populations and environmental variables on lake-wide and relevant spatio-temporal time scales. The Lake Erie Geographic Information system (GIS), a 2-dimensional database of open water habitats and fisheries data, has been incorporated into the Great Lakes Aquatic Habitat Framework

(GLAHF), which can be used to identify and examine aquatic ecological units (Figure 3c-1). The GLAHF is an online GIS framework and database of geo-referenced 3-dimensional data (including at depth) for Great Lakes coastal, large rivermouth, and open water habitats (www.glahf.org). GLAHF provides access to a consistent geographic classification framework to integrate and track data from habitat monitoring, assessment, indicator development, ecological forecasting, and restoration activities across the Great Lakes. GLAHF includes a web decision support tool for data download, data visualization, and habitat criteria for Lake Erie (glahf.org/explorer). The data contained in GLAHF include geo-processed biological data, especially fish community data, and data collected in recent surveys of nearshore areas (Environment Canada, U.S. Environmental Protection Agency, U.S.Geological Survey, state and provincial natural resource agencies,).

GLAHF project scientists have supported several Lake Erie habitat task group projects. The projects include: development of a Decision Support Tool that includes Great Lakes habitat data visualization and user defined habitat criteria mapping (with direct input from the LEHTG); Walleye habitat mapping; assessment of fish habitat for multiple species; development of lake-based IJC indicators; and nearshore habitat classification (discussed later in this section). Decision support for these projects provided a supportive role in progress towards LEEOs #*1*, #*2*, #*3*, #*4*, #*5*, #*6*, #*8*, #*9 (Table 1-1)*. The GLAHF team participated in the GLWQA 2012 pilot habitat and species assessment (Annexes 2 & 7) that focused on Lake Erie by sharing data and providing evaluation of assessment approaches. GLAHF has received and incorporated several Lake Erie habitat datasets, including total phosphorus and chlorophyll a (2001-2011), an updated substrate layer (Habitat Solutions, S. Mackey), and benthic invertebrate densities (1999-2011). The Pandit et al. (2013) model of walleye habitat suitability was combined with existing habitat data and ecological habitat classification to map walleye habitat suitability model (discussed later). By incorporating data on habitat including (substrate), with Walleye and Yellow Perch harvest data by grid, GLAFH provides a tool for displaying and interpreting data important for fisheries management and habitat restoration. GLAHF has also received fish monitoring data from the USGS, the Pennsylvania Fish and Boat Commission (PFBC), and the New York State Department of Environmental Conservation (NYSDEC). All reported trawl locations were examined for accuracy and corrected as necessary. If catch was reported by size class, the number of fish caught was summed for a total catch per fish species. Catch values were converted to CPUE in fish per 1,000m^2 using net wingspan, trawl time, and trawl lengths as available and in consultation with fisheries experts for each lake or data source. These data were used to conduct an assessment of fish habitat for the Great Lakes Basin Fish Habitat Partnership.

In addition, GLAHF’s comprehensive database and Framework supports EOs 1-6. 8-9, and 3 FCGOs for habitat. The database and framework allows storage, mapping and analysis at hierarchical scales (30m watershed, coastal and nearshore to 1.8 km open waters).

Decision support tools available on GLAHF EXPLORER allow online mapping and query of aquatic habitats and watersheds (EOs 1-6, 8-9). GLAHF EXPLORER algorithms allow the user to create one's own physical habitat suitability model, or use an existing model (e.g. Pandit et al. 2013 walleye habitat suitability model for Lake Erie).

Our Nearshore Condition Assessment supports EOs 1-6, 8, 9 to identify fish habitat potential, assess condition, and prioritize actions and funding. Our general approach was to develop neural network models predicting bottom trawl fish abundance class from habitat variables (e.g. depth, temperature, mechanical energy, shoreline, substrate, connectivity to other habitats, etc.). We modeled fish abundance by species and lake. Models were used to predict abundance by species within a lake, and lake maps combined for a basin-wide display. Habitat suitability was assumed to reflect species abundance. Below is an example for yellow perch (Figure 3).

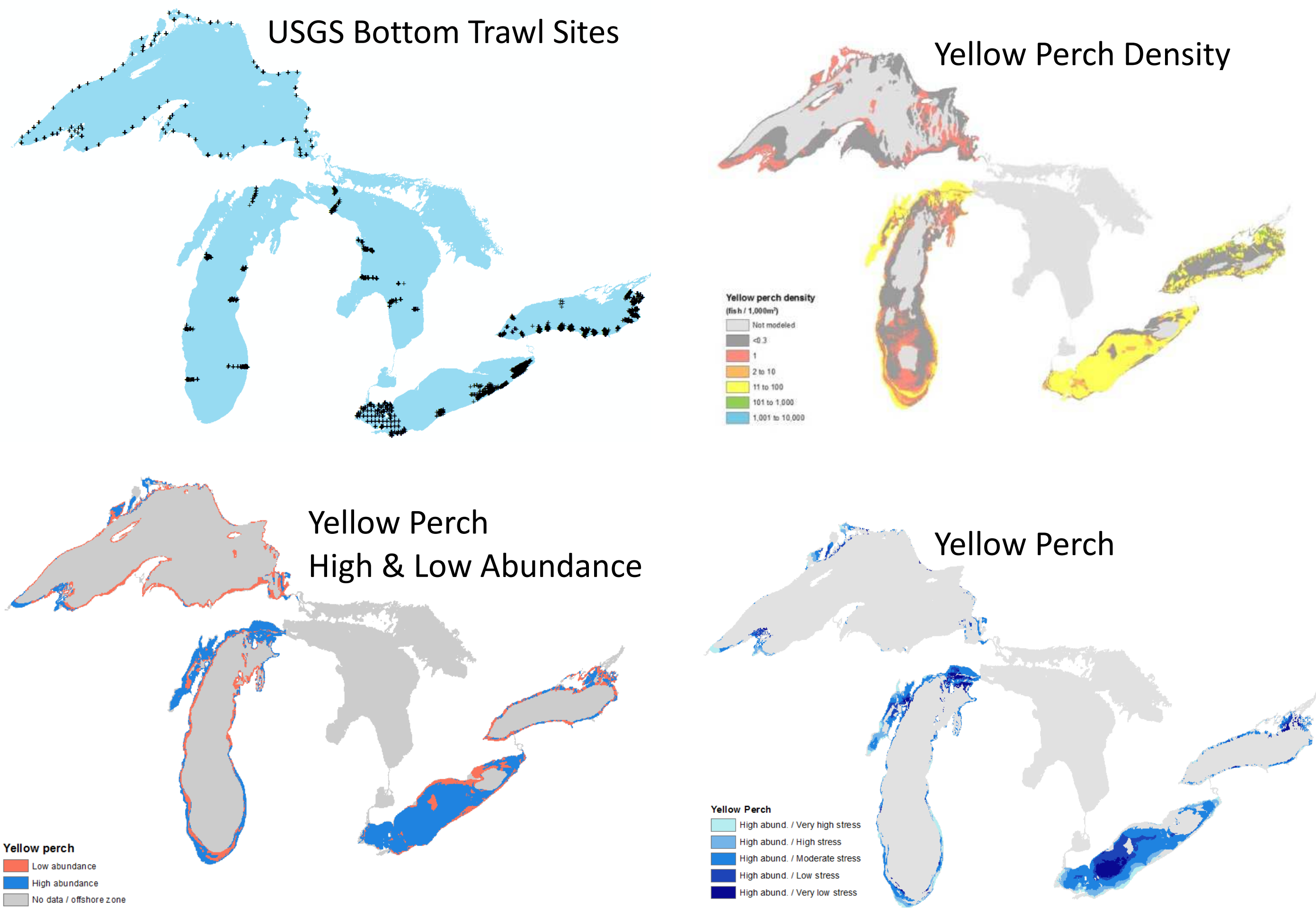

Figure 3. USGS-GLSC trawl ample sites (upper left), neural net model predictions of relative abundance of yellow perch (upper right), modeled habitat suitability for yellow perch (lower left), and suitability + risk assessment for yellow perch (lower right). Areas with very high suitability and low risk may be priorities for restoration.

The Great Lakes ecological habitat classification supports EOs 1-4. A classification simplifies the universe of habitats. It provides framework for fish habitat monitoring and assessment, and context for research and management. Our classification is broad scale, using dominant physical drivers (bathymetry, thermal regime, mechanical energy, and tributary influence) (Figure 4a).

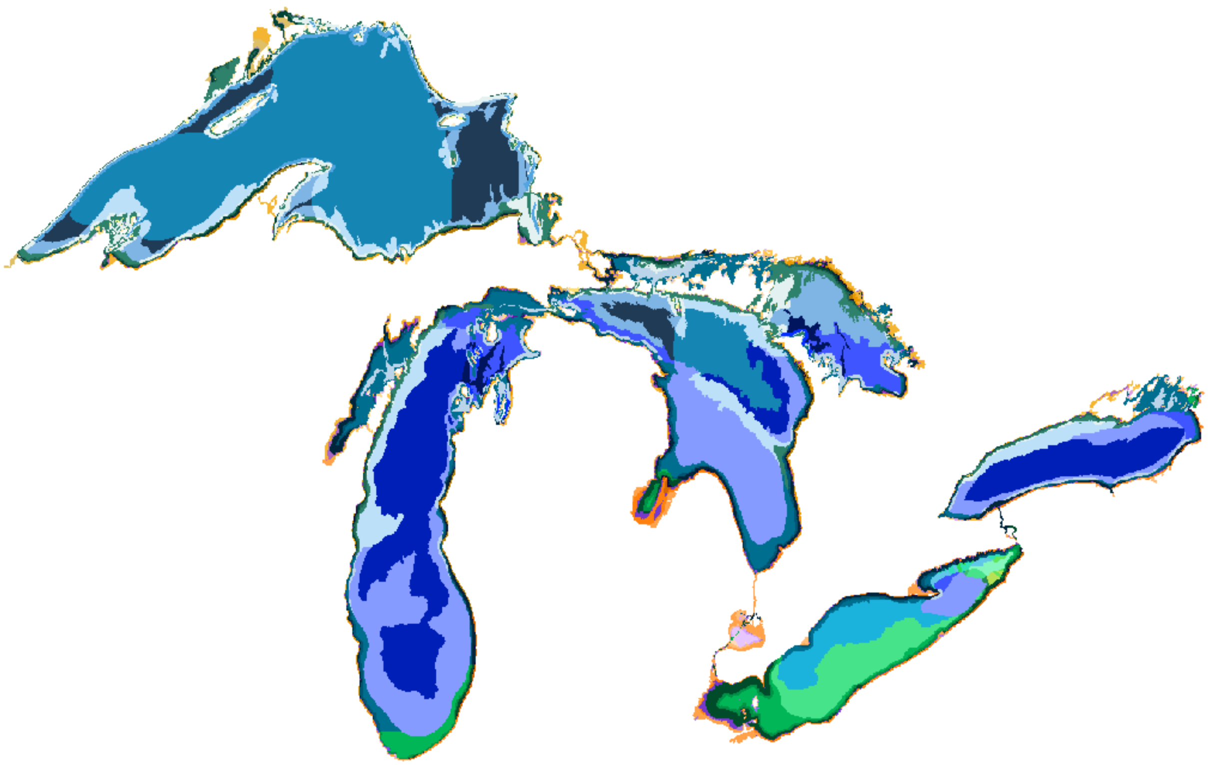

Figure 4a. The first ecological classification of the Great Lakes.

Section 4. Support other task groups by compiling metrics of habitat

Habitat influences the distribution of fish species. Evaluating how fish relate to habitat can play an important role in assessing and modeling key fish species in Lake Erie, particularly walleye and yellow perch. The HTG has been tasked with assisting other task groups in understanding the role of habitat in assessing these key species where appropriate. There currently are no official projects for the HTG but the following outlines previous and ongoing support of task groups.

4a. Central Basin Hypoxia and Yellow Perch

(LEEO #5, #8; Table 1-1 and FCO A, B, F, I, M; Table 1-2)
A. M. Gorman, C. Knight, and R. Kraus

Seasonal hypoxia (dissolved oxygen < 2.0 mg/L) in the hypolimnion of the central basin of Lake Erie has been increasing in extent and severity over the past decade. Limnological assessments in the Ohio waters of the central basin (ODNR unpublished data) indicate that hypoxic conditions (i.e. spatial extent and vertical thickness of the hypoxic zone) in 2016 were greater than other years in the 26 year time series. This situation represents a problem not only for the bi-national water quality agreement, but also for fishery independent population assessments. In particular, avoidance of low oxygen appears to concentrate Yellow Perch and other demersal fishes at the edge of hypoxia, and may bias recruitment predictions from bottom trawl assessments. Further, evidence suggests that catchability of Yellow Perch in the trap net fishery may be increased through strategic gear placement at the edge of the hypoxic zone (Kraus et al. 2015).

The YPTG interim decision rule to omit assessment trawl catches where bottom dissolved oxygen was < 2 mg/L when calculating indices of recruitment is conceptually supported by field investigations, which indicated that aggregation of fish at hypoxic zone edges may increase trawl catch rates (Kraus et al. 2015). Additional work is needed to quantify potential bias (if any) in indices from years with hypoxia-censored data. HTG would encourage rigorous evaluation of the interim decision rule via either simulation analyses or comparative field study.

Efforts to develop more data on dissolved oxygen effects on commercial trap nets continued in 2016 by placing data loggers near fishing gear. Preliminary analysis of these data is revealing the same pattern observed in previous years of higher catches during episodes with intermittent hypoxia. To test the broader applicability of this hypothesis, an interpolation model of hypoxia developed by Purdue University and Illinois-Indiana SeaGrant is being applied to compare predicted hypoxic episodes with recent (2014-2016) Ohio trap net catches across the entire central basin. Additionally, data logger results from multiple years are supporting efforts, led by NOAA-GLERL, to develop a forecast model of hypoxia for the central basin.

This work directly addresses LEEO #4 (Table 1-1) and, by defining ecologically-important thresholds for dissolved oxygen, provides baseline values for establishing suitable habitat that requires protection (LEEO #8; Table 1-1).

References

Kraus, R. T., C. T. Knight, T. M. Farmer, A. M. Gorman, P. D. Collingsworth, G. J. Warren, P. M. Kocovsky, and J. D. Conroy. 2015. Dynamic hypoxic zones in Lake Erie compress fish habitat, altering vulnerability to fishing gears. Canadian Journal of Fisheries and Aquatic Sciences 72:797-806.

4b. Identify Metrics Related to Walleye Habitat

(*LEEO #1, #4, #5; Table 1-1*)

A.M. Gorman, R. Kraus, Y. Zhao, and C. Knight, E. Rutherford, C. Riseng, L. Mason

The HTG was charged with assisting the Walleye Task Group (WTG) with identifying metrics related to walleye habitat for the purpose of re-examining the extent of suitable adult walleye habitat in Lake Erie. Presently, quotas are allocated proportionally based on surface area of waters less than or equal to 13 m deep by jurisdiction (Figure 4b-1; STC 2007), yet the accuracy of this model has not been evaluated in comparison with alternative habitat models for Walleye. The LEC assigned the HTG this charge in an attempt to further improve estimates of suitable walleye habitat through an expanded definition of habitat based on recent literature, geospatial analyses, and historic datasets. To date, a habitat suitability model developed from gill net catch data has been published (Pandit et al. 2013).

Using fishery-independent index gill net databases, OMNRF (i.e. 1989-2008 Partnership program) and ODNR (1990-2009), habitat suitability was evaluated based on absences or presences of Walleye (Pandit et al. 2013). Walleye were caught in waters ranging from 2.7 - 25.0 °C with 0.2 – 15 mg/l of dissolved oxygen (DO) and turbidity ranging from (secchi depth reading) 0.25 - 11.0 m (Pandit et al 2013). Using a stepwise logistic regression procedure, a species-habitat model of these abiotic parameters (temp, DO and water) (Christie and Regier 1988, Lester et al. 2004) was developed. Results demonstrated that sites with Walleye were warmer, shallower, and more turbid that sites where Walleye were absent. Juvenile Walleye tended to be caught at sites that were warmer, more turbid and had higher DO concentrations than adults; which may provide juveniles with greater predator avoidance or reduced competition with other piscivorous species. The abiotic parameters also demonstrated significant interactions indicating the importance of multiple environmental variables in defining habitat suitability. For example, Walleye habitat increased with increasing water temperatures but only if the water was turbid. Results from the species-habitat model were expanded to evaluate the amount of suitable Walleye habitat in West and East Basins and compared to the previous ≤ 13 m model (Table 2: Figure 3). For West Basin the models produced similar habitat quantity; 100% of the surface area for ≤ 13 m model or 95% for the species-habitat model. For East Basin the species-habitat model demonstrated significantly more suitable habitat (63% of the surface area) than the ≤ 13 m model (20% of the surface area). Currently, the resultant habitat suitability models for Walleye are being incorporated into the GLAHF to map total suitable area by life stage in Lake Erie. One objective of GLAHF is to present the spatial (i.e. basin-specific) and temporal (i.e. seasonal variation) distribution of suitable walleye habitat for the entire lake. A major challenge to achieve this objective is to obtain environmental data that can represent the data used to produce the model estimates. The GLAHF research team is working on the collection and analyses of existing environmental data from different sources and will provide a summary of representative dataset for the next modeling exercise. The results are expected to be presented in next year's report. These projects provide advancements towards LEEO's #1, #4, and #5 (Table 1) by establishing suitable ranges of water clarity, dissolved oxygen, and temperature for juvenile and adult Walleye and producing lakewide habitat suitability maps based on these attributes.

Since 2011, the use of acoustic telemetry has expanded across Lake Erie supported by the Great Lakes Acoustic Telemetry Observatory System (GLATOS). Acoustic telemetry studies continue to provide insight into habitat-related behaviors, such as lakewide movement, spawning behavior, and thermal and vertical preferences, in addition to bioenergetics, mortality estimates, and spatial exploitation patterns. Preliminary results from Walleye demonstrate greater use of deep offshore habitats (i.e. > 13m) than previously assumed as suggested by Pandit et al. (2013). The combination of these findings may actually result in the reconsideration of the Lake Erie FCO's related to Walleye habitat that ignores the importance of offshore environments in the East Basin.

Section 5. Strategic Research Direction for the Environmental Objectives

S.D. Mackey

The Lake Erie Environmental Objectives provide guidance to fishery and environmental management agencies in the form of descriptions of the various environmental conditions affecting Lake Erie fisheries resources and conditions needed to ensure that Lake Erie's FCOs (Table 1-2) will be achieved. For Lake Erie, the Environmental Objectives sub-committee (now the HTG) identified ten Environmental Objectives (Table 1-1) in support of the thirteen Fish Community Goals and Objectives (Table 1-2). The rationale behind each of the Environmental Objectives was described in a white paper released in July 2005.

The HTG continues to employ a process designed to systematically identify and address data gaps, knowledge gaps, and lack of understanding by evaluating past, current, and potential future threats and trends for the Environmental Objectives, and how those threats and trends may impact the ability of Lake Erie Committee to achieve stated Lake Erie FCGOs.

Review of ongoing Great Lakes habitat restoration projects and literature reveals a paucity of techniques for in-water restoration or enhancement of rivermouth, nearshore, and coastal habitats. Thus, even if fishery management agencies had the authority to manipulate nearshore and coastal habitats, limited information is available to provide guidance as to how best to enhance or restore those habitats. Science-based information and guidance is a key outreach strategy of the HTG to promote sound restoration projects and practices in riverine, coastal, and nearshore environments.

The HTG is implementing the following research strategies to address these needs:

1. There is a continuing need to identify habitat knowledge gaps and research needs.
    a. Development of techniques and methods to restore fish habitat in riverine, coastal, and nearshore environments through implementation of small pilot projects and associated monitoring work to validate project results.
    b. Encourage continued regional mapping and assessment of nearshore and coastal habitat areas (promote the use of new technologies such as sidescan sonar, multibeam, and underwater video technologies).
    c. Encourage continued sampling of fish communities in shallow-water coastal and nearshore habitats.
    d. Build linkages between coastal processes, hydrology, and habitat structure to promote sustainable habitat enhancement/restoration projects.
2. There is a need to identify opportunities and develop guidance materials to promote and implement nearshore habitat enhancement and restoration projects:
    a. Identify potential opportunities to influence the design and function of proposed shoreline projects through early collaboration with the USACE, U.S. EPA, Port Authorities, County Planning agencies, Municipalities, Townships, Engineering firms, Contractors, NGOs, and Coastal Property Owners.
    b. Develop guidance materials to support and implement nearshore and coastal habitat restoration through *existing State and Local regulatory processes* in collaboration with Federal, State, and Local agencies.
    c. Develop an outreach and education program to *actively distribute* guidance materials and information about the Lake Erie Environmental Objectives to other agencies/programs for inclusion in ongoing and proposed projects
    d. Support increased monitoring of nearshore areas adjacent to restoration/enhancement sites to document how improvements in nearshore habitats have benefited nearshore fish communities, including the development of performance indicators that can be used to quantify fisheries benefits.

The Ohio Department of Natural Resources Office of Coastal Management, working collaboratively with the Ohio Division of Wildlife, the University of Toledo, Bowling Green State University, and Ohio EPA is currently funding initiatives designed to address several of the research and implementation needs described above. Specifically, the *Building Resilient Shorelines Initiative* is designed to collect data at 51 sites located along the Ohio Lake Erie coastline that can be used to build correlative relationships between nearshore fish communities, nearshore habitat structure, and shoreline characteristics.

The objective is to identify what *actions* need to be taken to restore functional fishery habitats along the Ohio Lake Erie coastline. Based on this work, guidance materials can be developed that promote implementation nearshore habitat enhancement and restoration projects that directly address the Lake Erie EOs and FCGOs for Ohio waters. This information will also be used to develop data and criteria that can be used to identify and manage *Priority Management Areas* along the Ohio Lake Erie coastline. These areas will be incorporated into the Coastal Management regulatory review process when evaluating proposed shoreline modification and enhancement projects.

Section 6. Develop Key Functional Habitats and Priority Management Areas in support of the Environmental Objectives.

S. Marklevitz, J. Tyson, C. Harris

In October 2014, the CLC adopted a draft set of principles to assist a variety of users ("applicators") in their decisions involving actions on identified *priorities* that will protect or improve habitats for sustainable fisheries in the Great Lakes Basin. Potential applicators should know and understand the priorities of fisheries managers for implementation through regulations, policies, practices, and projects at appropriate spatial scales (e.g., specific locations to lakewide application). Implementation will also be affected by the interests/priorities of other groups, such as land-use, water quality, and wildlife managers. Where possible, alignment of priorities across potential applicators could benefit all through the efficient use of resources, collaborative evaluation of potential trade-offs, partnership establishment, and inform the ranking of actions (e.g., what to do now versus later). Opportunities to align lake-specific priorities among various applicators exist through binational initiatives, such as the Lake Erie Lake Partnership of the Great Lakes Water Quality Agreement and the new Great Lakes Regional Aquatic Habitat Connectivity Collaborative, as well as within and among the various federal, provincial, and state government agencies in each Great Lake.

The LEC wants to determine specific priorities for protecting and improving fish habitats in the Lake Erie basin and to communicate them to relevant applicators in our jurisdictions. The HTG is reaching out to all task groups for assistance in the first step of this process; determining functional habitats for species of bi-national importance as specified is the Lake Erie Fish Community Objectives (FCOs). Once this information is compile HTG will set out to identify PMAs following the guidance provided within the CLC's "Environmental Principles for Sustainable Fisheries".

The premise of the CLC approach is that sustainable fisheries can occur across the basin if

- *functional habitats are protected or improved in each lake*
- *through a systematic, adaptive, cumulative, and collaborative approach that*
- *accommodates fishery value in decisions to*
- *act on manageable anthropogenic stresses.*

Implicit in this approach is an emphasis on protecting or improving (restoring or enhancing) functionality to habitats that support fish production (e.g., spawning and nursery areas). The CLC prioritizes three types of management actions as Protection > Restoration > Enhancement, where Protection means guarding against threats to habitats that are already in functional condition, Restoration means addressing threats/stresses thereby improving functionality to an unimpaired condition, while Enhancement means addressing threats/stresses thereby improving functionality to a less impaired condition. Whether protecting or improving (restoring or enhancing), the focus is always on addressing manageable (as opposed to unmanageable) sources of threats or existing stresses on habitat functionality. Accordingly, the goal for a habitat improvement action, e.g., attaining "unimpaired" or "less impaired" functionality, is not to attain a "pristine" condition but to a state that supports an attainable level of fish production.

This approach also addresses uncertainty in establishing habitat protection and improvement priorities. While the LEC agrees on the key fish species of interest (e.g., Fish Community Objectives), the LEC recognizes that we don't have perfect knowledge about the specific habitat requirements (and/or impediments) of species and stocks to determine priorities. The approach calls for a precautionary and adaptive application of working hypotheses to establish actions and expected outcomes, based on best available information and expert judgment. In short, we want to articulate what is needed, identify what is expected to result, establish short-term priorities, and learn as we implement. Identification of gaps in understanding that result from exercising the approach can be used to guide research priorities of the agencies.

<u>Terminology/Definitions/Criteria /Examples</u>

Functional Habitat (FH): A dynamic system of hydraulically-connected areas that support requirements of desired fish species for sustained production. Considerations for identifying a FH include:

- ✓ It currently supports, or once supported, connected life stages of desired fish stocks and fisheries, as identified in the FCOs.
- ✓ It consists of, or once consisted of, features that vary naturally with inherent dynamic processes (erosion, deposition, water circulation, lake level fluctuations, etc.) to provide repeated habitats that could support eventual stock formation.
- ✓ It can be protected or improved in a manner that is expected to result in stable or increased production to a stock over an accepted time period (e.g., degradation has not completely eliminated all reasonable opportunities to increase production).
- ✓ It can be effectively defined and recognized spatially for application. Note: there can be overlap among functional habitats of different species or stocks, especially for migratory fishes.

An example of Lake Erie FHs is shown conceptually in Figure 6-1. FHs should include healthy systems that need protection, as well as those that need improvement.

Priority Management Area (PMA): A specific location within the Lake Erie watershed where actions are needed on a manageable source (or threat) of stress to protect or improve designated functional habitat(s). PMAs can have more than one type of action, address more than one source of stress, or encompass more than one FH (shown conceptually in Figure 6-1). The LEC's Lake Erie Environmental Objectives document lists PMAs for each identified objective and should serve as a starting point for identifying areas where actions are needed to address identified sources of stress (or threats).

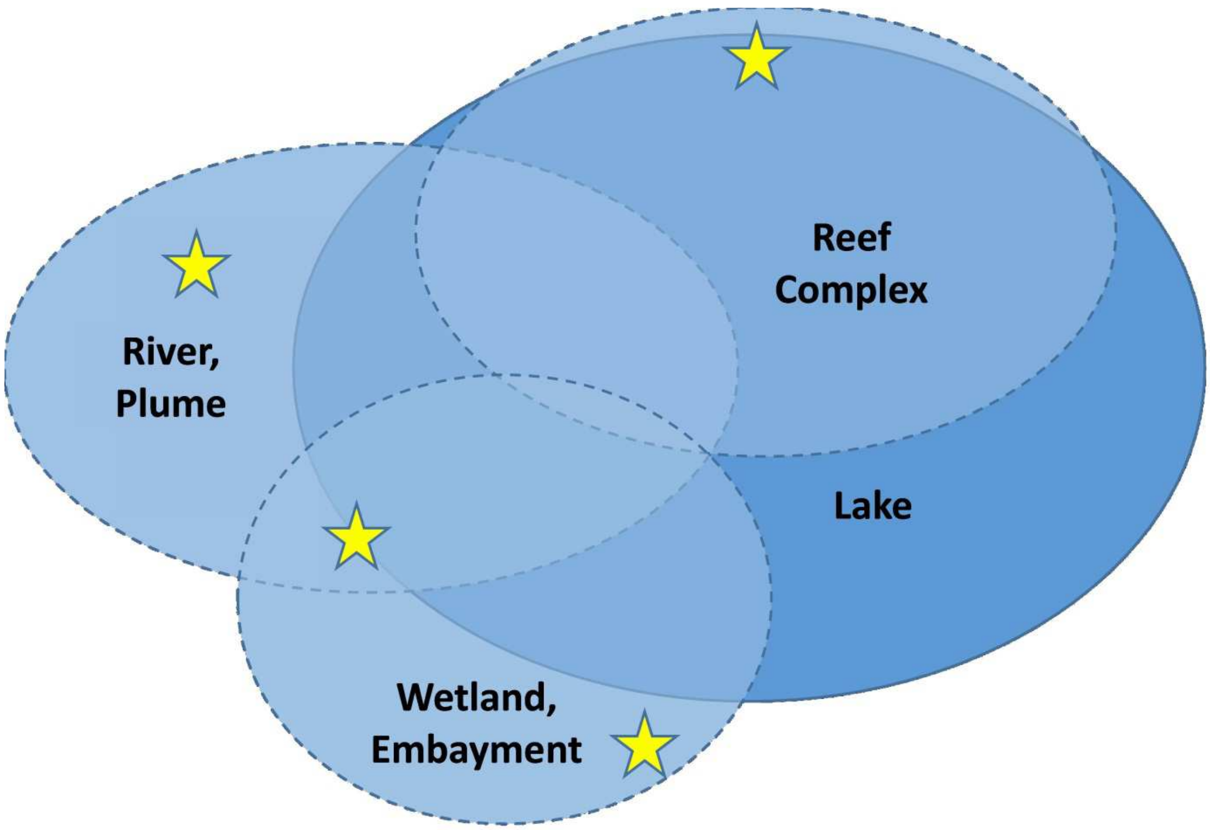

Figure 6-1. Conceptual examples of Functional Habitats (dashed ovals) and Priority Management Areas (stars).

In 2016 the HTG members initiated an exercise to populate a worksheet that captured information based on life history/function, the impairment status of the population with certainty measurements, the impediments acting upon the habitat component, and actions needed to improve the function. The intent of the exercise was to test out the worksheet and provide the LEC with initial information to verify that the process of information compilation was an efficient means to help compile information that would result in PMAs. Identifying some critical gaps in the test data collection in 2016, the HTG has re-designed the worksheet for a full data collection exercise in 2017. The 2017 exercise will see HTG members facilitate identification of functional habitats with other LEC task groups for each species identified in the FCOs (Figure 6-2). This information will include factors limiting productivity within each functional habitat, whether these factors are impeded and potential remediation action. Working with LEC, HTG will then create a prioritisation criterion so that all functional habitat and potential remediation actions can be systematically scored. Trend analysis will then be used to produce a list of 10-20 priority management area were habitat actions can have the greatest impacts on fish productivity. The HTG is working towards completing data collection and preliminary analysis by summer 2017 with an aim to complete the initial PMA exercise by 2018. The populated worksheet should provide a framework for future re-evaluation of PMAs and for systematically developing and maintaining our strategic research direction.

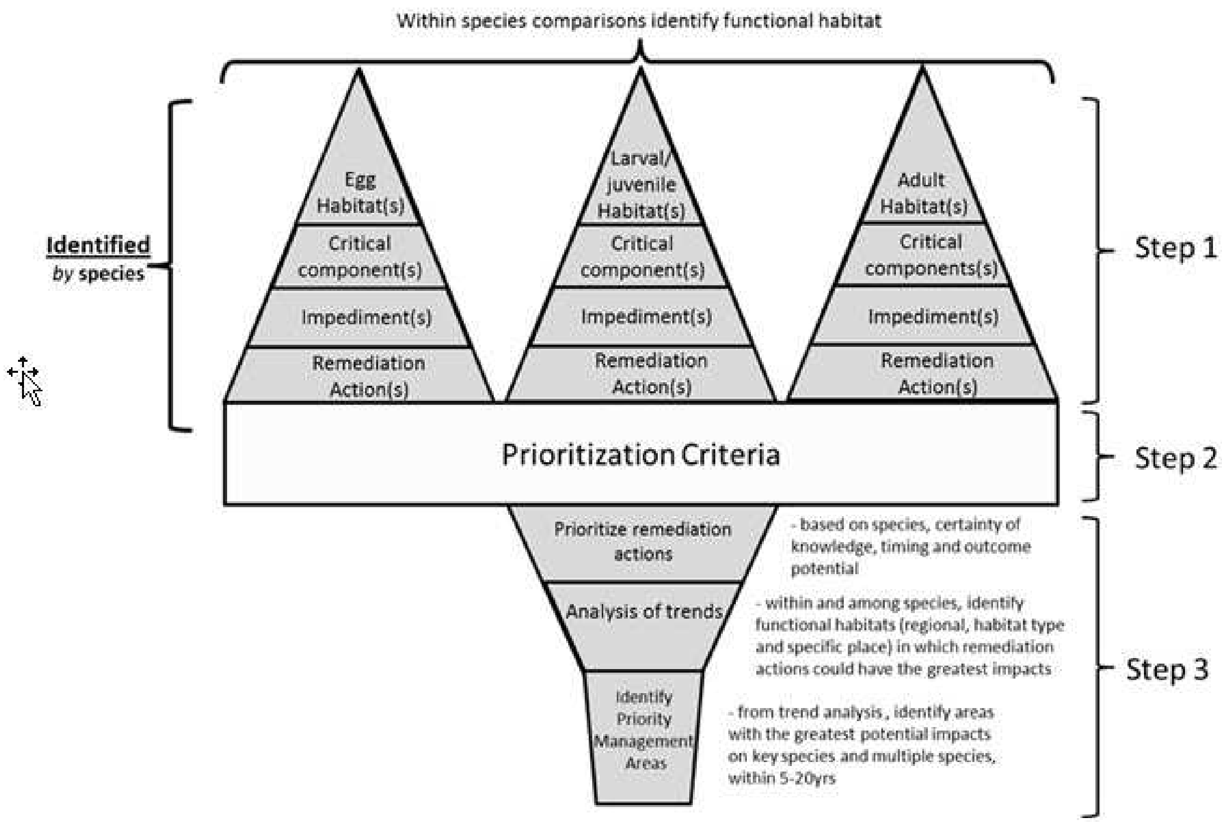

Figure 6-2. Schematic of the Priority Management Area exercise.

Section 7. Protocol for Use of Habitat Task Group Data and Reports

- The HTG has used standardized methods, equipment, and protocol in generating and analyzing data; however, the data are based on surveys that have limitations due to gear, depth, time and weather constraints that vary from year to year. Any results or conclusions must be treated with respect to these limitations. Caution should be exercised by outside researchers not familiar with each agency's collection and analysis methods to avoid misinterpretation.

- The HTG strongly encourages outside researchers to contact and involve the HTG in the use of any specific data contained in this report. Coordination with the HTG can only enhance the final output or publication and benefit all parties involved.

- Any data intended for publication should be reviewed by the HTG and written permission received from the agency responsible for the data collection.

Section 8. Acknowledgements

The HTG would like to acknowledge and thank the many contributors to the work presented in this report. As this report is mostly an overview of projects underway in the Lake Erie basin, it is impossible to identify every project and every individual involved. If you are involved in a habitat-related project in the Lake Erie basin and would like your work to be represented in the project table, please contact a member of the Habitat Task Group.