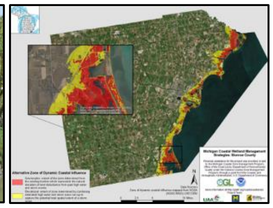
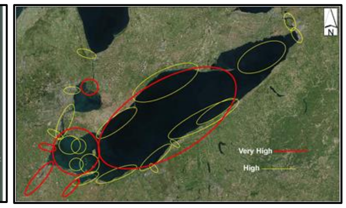
Report of the
Lake Erie Habitat Task Group
2018

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<u>Presented to:</u>

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Contents

Section 1. Charges to the Habitat Task Group 2017-2018

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.

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

4) Systematically develop and maintain a list of functional habitats and impediments for species specified by the LEC Fish Community Goal and Objectives (FCGOs) that can be used to identify and evaluate status of:
    a) Priority management areas that support LAMP, LEC Environmental Objectives (LEEOs and FCOs)
    b) Strategic research direction for the LEEOs

Section 2. Document Habitat Improvement Projects

S.Marklevitz, C. Harris

Charge 1 of the Habitat Task Group (HTG) is the documentation of habitat projects occurring throughout the Lake Erie and Lake St. Clair basins, including their associated watersheds.

Originally the documentation of habitat project was designed as a simple spreadsheet table but by 2007 had evolved into an online spatial inventory in efforts to effectively disseminate project information. In 2009, the LEC modified the charge to "Identify and prioritize relevant projects to take advantage of funding opportunities". In recent years HTG has questioned its ability to update and maintain a comprehensiveness database given we are not the only agencies undertaking or overseeing habitat projects in the Lake Erie Basin. HTG also questioned the usefulness of the inventory as it is not regularly used by any member agencies. With the overhaul of the GLFC website in 2018, links to the online spatial inventory have now been broken. As a result HTG will no longer maintain or update the list of habitat projects and the online spatial inventory will no longer be accessible. Alternatively, with the work towards the Priority Management Area exercise (Charge 4), the HTG will begin developing a way of documenting habitat projects relative to the PMA (Charge 4) and will continue to highlight key ongoing projects in the annual task group reports.

2a. *Evaluation of Fish Habitat Restoration in the St. Clair-Detroit River System*

E.Roseman, R.DeBruyne, J.Fischer, G.Kennedy, C.Mayer, T.Wills

The U.S. Geological Survey Great Lakes Science Center continued monitoring fish use and physical maturation of artificial fish spawning reefs in the St. Clair-Detroit River System (SCDRS) in 2017, including the Belle Isle Reef Complex constructed in December 2016 (Figure 1). Construction and monitoring of these projects has contributed to the achievement of LEEO #8 (fish habitat protection) and LEC fish community objectives d. (river and estuarine habitat), i. (fish habitat), k. (rare, threatened and endangered species). Biological monitoring of the artificial reefs consisted of egg mat sampling to quantify fish egg deposition on and adjacent to the artificial reefs and larval fish drift assessments using benthic D-frame sampled up- and downstream of the reefs. Lake Sturgeon (*Acipenser fulvescens*) eggs were collected on the Belle Isle Reefs for the first time, whereas they had not been detected in prior to construction. Lake Sturgeon eggs were also collected at all other artificial spawning reefs, indicating continued use as spawning habitat. A manuscript detailing egg depositional patterns over the reefs and throughout the system is in press with the Transactions of the American Fisheries Society**.** Lake sturgeon larvae were collected downstream of the Belle Isle Reef Complex, as well as in the Trenton Channel. Additionally, genetic analyses of collected lake sturgeon eggs and larval are underway to estimate the effective number of breeders and quantify genetic diversity at each reef location and throughout the system.

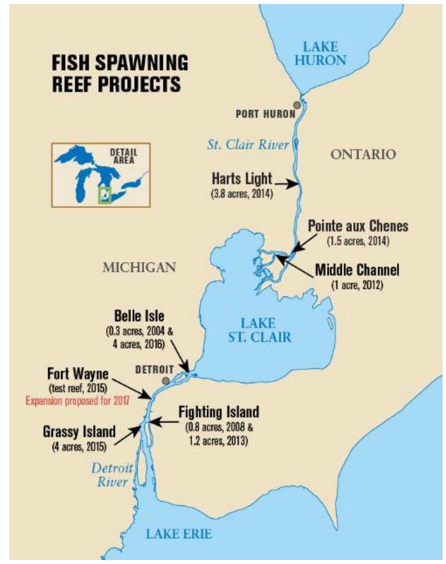

Figure 1*: Artificial spawning reef restoration projects in the St. Clair-Detroit River System. Map provided by Michigan Sea Grant.*

Monitoring artificial reef maturation was conducted in conjunction with the Michigan Department of Natural Resources and consisted of annual side-scan sonar and underwater video surveys used to quantify changes in surficial sediment composition and the degree of infilling by fine sediments on the reefs. Because reefs constructed after 2013 (Harts Light, Pointe Aux Chenes, Grassy Island, and Belle Isle) were developed using a revised protocol to minimize the likelihood of sediment deposition over the reefs, our assessment of reef maturation has focused on these reefs. Sonar surveys were used to quantify bottom hardness and showed a slight reduction in hardness at the Harts Light and Pointe Aux Chenes reefs within the first year of construction, but hardness appeared to stabilize thereafter, suggesting minimal infiltration of fine sediments over the reefs. This was corroborated with underwater video surveys which showed minimal accumulation of fine sediments over the reefs.

Moving into 2018 we will continue monitoring fish use and maturation of artificial reef projects in the SCDRS. We are also anticipating the construction of the Fort Wayne Reef, the final artificial reef restoration project slated for the Detroit River, in early 2018.

2b. Coastal Wetland restoration along the Canadian Shoreline of the Niagara River

Mike Rose and Joad Durst (MNRF), Corey Burant (Niagara Parks Commission)

The Canadian portion of the Upper Niagara River includes approximately 30km of shoreline from the Peace Bridge at Fort Erie to the south side of the mouth of the Chippawa Channel, and includes the 4.7km perimeter of Navy Island. Mapping analysis indicates the upper Niagara River which was once lined by coastal wetland now contains 77% of artificially hardened shoreline (Pearsall, et al., 2012). Emergent coastal wetlands currently cover approximately 8% (2.5km of 30km) of the Canadian shoreline [1]. Furthermore, the loss of a graduated shoreline attributed to infilling of former lowlands, shoreline armoring, and removal large woody debris, means that the minimal patches of existing coastal wetlands occur at the base of vertical banks or several meters out from shore. In their current state, coastal wetlands are significant degraded lacking important connectivity with upland vegetation and seasonal inundation of vegetated lands. Coastal wetlands form important habitats for aquatic insects, shellfish and small fish, provide nursery and spawning habitat for desired fish species including walleye and lake sturgeon, and are used by esocid ambush predators such as pike, grass pickerel and muskellunge. Recent MNRF and DFO boat electrofishing surveys (1999, 2004, 2008, 2013 and 2015) in the nearshore areas suggest these desired fish species are nearly absent.

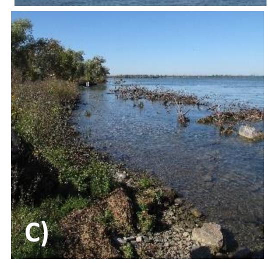

***Figure 2**: Niagara River Wetland site, A) Usshers Creek, B) and C) Bakers Creek, D) Gonder's Flats*

Over the past 10 years, US projects have been underway to increase coastal wetland habitat in the Upper Niagara River. Submerged rock berms and strategically anchored large woody debris haven been used to create physical structure to break wave action resulting in low energy areas. These areas have proven to be stable in the Niagara River conditions and have begun to fill with sediment and emergent wetland communities. Canadian projects are employing similar shoreline softening techniques to develop in-river areas. Over 3-5 years the Ministry of Natural Resources, Niagara Parks Commission and other community partners, aim to create at least four coastal wetland areas within the Upper Niagara River.

Work began in 2015 with feasibility studies, community outreach, and the development of conceptual designs. In 2017, two coastal wetlands were created at the mouths of Usshers and Bakers Creek (Figure 2). Using 110 dead Ash Trees (killed by the

[1] GIS analysis 2010 ortho imagery

Emerald Ash Borer) and 90 discarded conifers (Christmas trees) these projects restored 390m of shoreline with the creation of approximately 0.7Ha of aquatic habitat and 0.5 Ha of terrestrial habitat. In 2017, conceptual designs, public consultation, pre-construction fish community assessment and Stage 1 & 2 archaeological assessment were completed for a 375m wetland project at Gonder's Flats (Figure 2). This project was completed in March 2018. It is expected that post construction surveys of these sites will demonstrate improved productivity of many aquatic insects, shellfish and fish species, with the overall goal of an increase in top predators in the Upper Niagara River.

These projects will make direct progress towards the LEEOs: #2,, #3, #6, #8, and #9 and FCOs: C, G and I by protecting and restoring the nearshore areas

Reference: Pearsall, D., P. Carton de Grammont, C. Cavalieri , C. Chu, P. Doran, L. Elbing, D. Ewert, K. Hall, M. Herbert, M. Khoury, D. Kraus, S. Mysorekar, J. Paskus and A. Sasson 2012. Returning to a Healthy Lake: Lake Erie Biodiversity Conservation Strategy. Technical Report. A joint publication of The Nature Conservancy, Nature Conservancy of Canada, and Michigan Natural Features Inventory. 340 pp.

2c. Celeron and Stony Islands Habitat Restoration, Michigan

C.Harris

Celeron and Stony Islands (Figure 3) are uninhabited islands in public ownership as property of the Michigan Department of Natural Resources. Located in the lower Detroit River, both islands historically had substantial shoal areas that have been eroded over time. The loss of the protective shoreline has led to the loss of much of the complex wetland associations that lined both islands. In response to the habitat loss, habitat restoration projects around Celeron and Stony Islands were identified as priority projects to address the beneficial use impairments of fish and wildlife habitat and population loss for the Detroit River Area of Concern.

A portion of the habitat restoration has occurred around Stony Island and plans continue to move forward, finishing off the Stony Island project and to complete the Celeron Island project. Shoals will be created/restored around both islands; 3,000 linear feet around Stony Island and 2,800 linear feet of shoal around Celeron Island. The shoals will protect about 117 acres of backwater habitat around both islands. A 6-acre barrier beach will be created on the northeast side of Celeron island. Installation of stone and log habitat with the shoals will provide habitat structure for multiple aquatic organisms and shoal protection. These projects will make direct progress towards the Lake Erie environmental objectives #2, #6, #8, and #9 as well as the Lake Erie fish community objectives C and I by protecting the nearshore areas and restoring habitat around the islands.

***Figure 3**: Aerial images of Celeron and Stony Islands with locations of habitat restoration work.*

2d. Ballville Dam removal

Z. Slagle, E. Weimer

Removal of the Ballville Dam, located near Fremont, Ohio, began in 2017. A former hydroelectric dam that impounds ~40 river km of the Sandusky River, the dam has stood since 1913, and has recently served as the water source for the city. Ohio EPA filed notice with Fremont in 2008, asserting that the dam required either extensive repairs or removal. City officials elected to construct an off-channel water supply and remove the dam, but removal was delayed over concerns by locals and environmental groups regarding potential contaminated sediment release from the impoundment. The US Fish and Wildlife Service completed a Supplemental Environmental Impact Statement in 2016 after additional sediment testing, and released a supplemental Record of Decision in February of 2017 identifying removal as the preferred alternative.

***Figure 4**: Notched Ballville Dam, Fremont Ohio*

The first phase of dam demolition began on September 13, 2017; a 3 m deep, 6 m wide notch was cut into the dam to facilitate draw-down of the water level and controlled sediment dispersal. The final phase of dam removal will begin in July 2018, with completion likely by late fall. Ohio DNR estimates that suitable spawning habitat for local and migratory fish, such as walleye and white bass, will increase from 8 ha to 120 ha with dam removal. Ohio DNR conducted pre-removal fish community assessments in 2009 and 2010 in support of this project, and plan post-removal assessment in the upcoming years. In addition, 100 spawning walleye were implanted with transmitters in 2016, and an additional 100 walleye are planned for the spring of 2018; these fish will enable managers to document walleye response to dam removal and monitor the use of this newly available habitat.

2e. Offshore Wind (Icebreaker Wind) Project in Lake Erie

A.M. Gorman

Wind turbine installation, measured by global cumulative wind capacity, saw a 2,300% increase between 2001 and 2017 (GWEC 2018). Although the first operational offshore wind farm was established in Denmark in 1991 (Vindeby Offshore Wind Farm), offshore wind only comprised 3% of the total global wind capacity in 2017 compared to 97% provided by land-based or onshore farms. Offshore wind was not established in the United States until 2016 (Block Island Wind Farm, RI), and presently the only freshwater wind farm worldwide exists in an inland lake in Sweden (Vindpark Vanern, 2010).

An initiative towards offshore wind power in Lake Erie began in 2009 with the creation of Lake Erie Energy Development Corporation (LEEDCo). Interest stemmed from the ability to harness more wind energy over the lake compared to over land, the potential to connect to an existing power grid, high energy demand in neighboring urban areas, increased demand due to impending closures of existing power plants, nearby manufacturing resources, and a lack of existing renewable energy. In 2016, Icebreaker Windpower, Inc. (LEEDCo in collaboration with Fred Olsen Renewables) was awarded up to $40M through the Department of Energy's Offshore Wind Advanced Technology Demonstration Projects program to begin work on a demonstration-scale project of the first freshwater wind farm in the United States. Icebreaker Windpower obtained a Submerged Lands Lease from the State of Ohio and submitted an application through the Ohio Power Siting Board. The current project plan includes installation of 6-3.45MW turbines with Mono Bucket foundations, located 8-10 miles offshore of Cleveland, OH on Lake Erie, with an emphasis on development of ice-breaking technology necessary to withstand the harsh ice conditions not seen in marine environments. According to LEEDCo's website, installation is currently planned for 2020.

***Table 1**: Icebreaker Wind environmental survey time frames*

Surveys		Time Frame
Fish Community		
	Hydroacoustic	Monthly MAY-OCT
	Larval Fish	MAY-JUL
	Juvenile	MAY, AUG, OCT
	Zooplankton	Monthly MAY-OCT
	Phytoplankton	Monthly MAY-OCT
	Benthos	MAY, OCT
Physical		
	Chemistry (discrete)	Monthly MAY-OCT
	Chemistry (continuous)	Monthly MAY-OCT
	Substrate Mapping	
	Hydrodynamic	Monthly MAY-OCT
Fish Behavior		
	Fixed acoustics	Monthly MAY-OCT
	Noise	Monthly MAY-OCT
	Acoustic Telemetry	Year-round
	Aerial Surveys	Monthly MAY-OCT

To address knowledge gaps related to the potential impacts of wind farms in aquatic environments, the Ohio Department of Natural Resources, Division of Wildlife developed "*Aquatic Sampling Protocols for Offshore Wind Development for the Purpose of Securing Submerged Land Leases*". This protocol was established based on research gaps identified by experts attending the "*Offshore Wind Energy: Understanding Impacts on Great Lakes Fishery and Other Aquatic Resources*" workshop hosted by the Great Lakes Commission and Great Lakes Wind Collaborative in 2012. Concerns included potential impacts to the fish community or lower trophic levels, fish behavior, and physical habitat. The intent of the protocol was 1) to identify areas within Lake Erie that may be more or less sensitive to offshore wind development using science- and fishery-based information, and 2) to request varying levels of pre-, during, and post-construction monitoring to further inform the siting process using Before-After-Control-Impact (BACI) survey design. To date, Limnotech, the environmental consulting firm with which Icebreaker Windpower, Inc. is working, has conducted pre-construction sampling in 2016 and 2017 along with a group of technical experts (OSU Stone Lab, BSA Environmental Services, Inc., Cornell Bioacoustics Research Program, Biosonics, and Aerodata). A summary of the pre-construction sampling requested by Ohio Division of Wildlife can be found in Table 1.

Reference: Global Wind Energy Council (GWEC), Global wind statistics 2017, Feb 14, 2018.

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. Mapping and Monitoring Aquatic Vegetation in Lake Erie for Potential Grass Carp Impacts

N. King – University of Toledo

University of Toledo & USGS with support from Ohio DNR are in the process of mapping aquatic vegetation in Lake Erie to monitor potential impacts of Grass Carp herbivory. Efforts consist of a 3-tier mapping system including object-based image analysis (OBIA) from pre-existing aerial imagery, hydroacoustics, and grab sampling. Work from 2016-2017 yielded a map of select sites within the U.S. side of the Western Basin Lake Erie. Future work includes continued mapping of the nearshore Central and Eastern Basins with emphasis on Dunkirk and Buffalo Harbors. Project leads are looking for assistance from local agencies (identifying areas of interest, boat usage, etc.) and any high-quality aerial or satellite images of Lake Erie. Contact Nicole King (Nicole.King2@UToledo.edu) or Patrick Kocovsky (PKocovsky@USGS.gov).

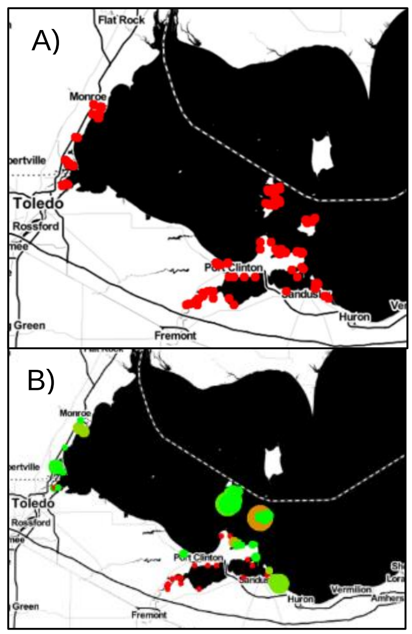

Figure 5: *Lake Erie aquatic vegetation project map. Panel A is Vegetation Survey sample locations from 2016-2017. Panel B is estimated Grass carp preferred areas based on feeding preferences and available biomass.*

3c. Updates to the GLAHF Explorer

K. Wehrly, C. Riseng, L. Mason and E. Rutherford

Coast Wetlands: Great Lakes coastal wetlands are highly productive and essential to the overall health of the surrounding ecosystems. The GLAHF team and others from University of Michigan and Michigan Tech University worked with two coastal communities (Luna Pier on Lake Erie, and Les Chenaux Islands on Lake Huron) to develop strategies to achieve coastal resiliency in the face of changing water levels, coastal storms and climate change (https://www.glahf.org/coastal-wetlands/). Urban planners worked with the communities to help evaluate community master plans, while the GLAHF team helped to identify hydrologically-connected coastal wetlands and designate dynamic zones of coastal resilience based on the extent of high and low water levels, storm surges and modeled hydrologic connectivity (Figure 6 A, B).

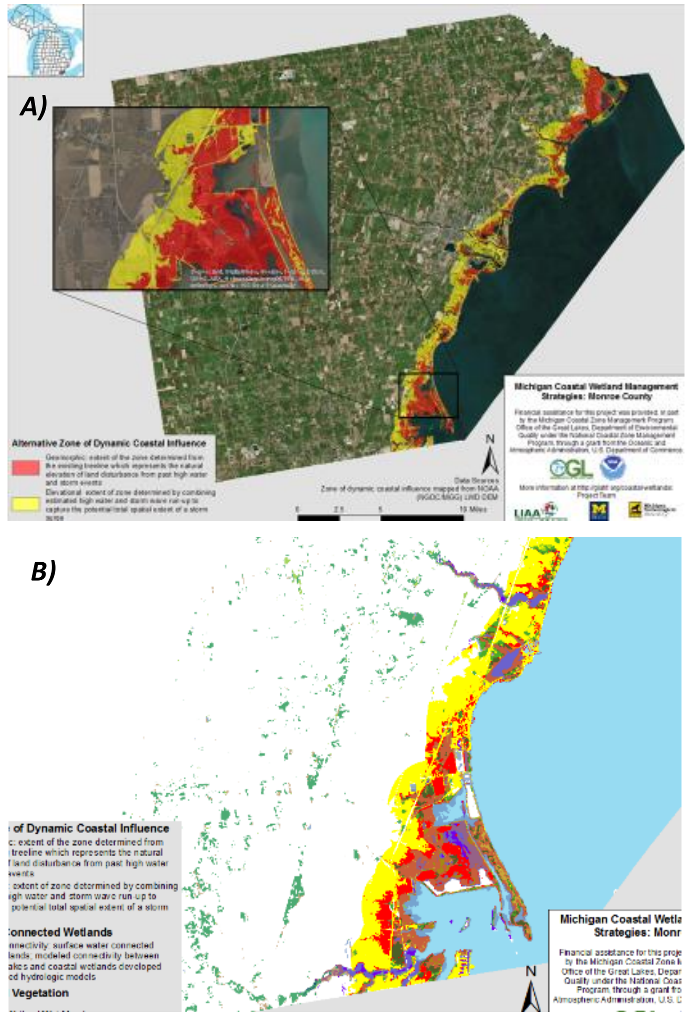

Figure 6:

Habitat Classification: The GLAHF team completed an ecosystem classification of Great Lakes aquatic habitats (Riseng et al. 2017). They identified and mapped 77 aquatic ecological units (AEUs) that depict unique 14 combinations of depth, thermal regime, hydraulic, and landscape classifiers (Figure 7, Figure 8). The AEU types were distributed across 1,997 polygons ranging from 1 km^2 to > 48,000 km^2 in area and were most diverse in the nearshore (35 types), followed by the coastal margin (26), and then the offshore (16). The classification and mapping of ecological units captures gradients that characterize types of aquatic systems in the Great Lakes and provides a geospatial accounting framework for resource inventory, status and trend assessment, research for ecosystem questions, and management and policy-making. The journal publication can be accessed at (https://doi.org/10.1139/cjfas-2017-0242).

Habitat Assessment: Kevin Wehrly (Michigan DNR) and Catherine Riseng (University of Michigan) completed an integrated assessment of coastal and nearshore habitats of the Great Lakes that was funded by the Great Lakes Basin Fish Habitat Partnership (Lake Erie example, Figure 9). The goal was to assess, model and map available fish habitat based on species-specific habitat conditions for all five Great Lakes in both the coastal margin and nearshore zones. Data for the habitat assessment and fish abundance models were provided by the Great Lakes Environmental Indicator Project and federal and state agency trawls, respectively. In GLAHF explorer, users can view maps of modeled fish species abundance, optimal habitat and risk. Fifteen fish species were modeled for the coastal margin zone and 53 species were modeled for the nearshore zone, although data for all species were not available for all lakes.

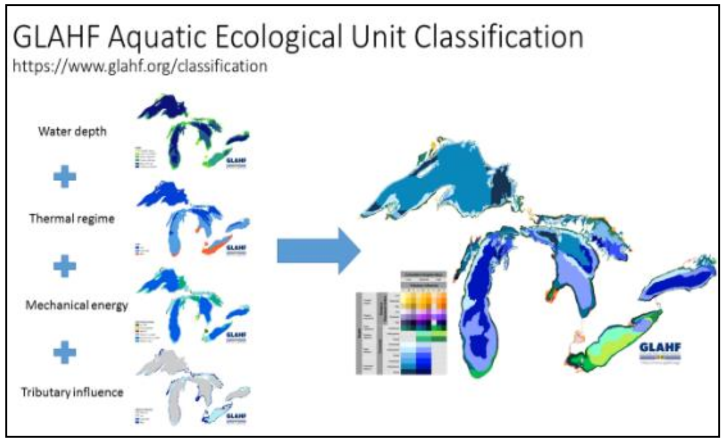

Figure 7:*Great Lakes Habitat classification and Aquatic Ecological Units (Riseng et al. 2017).*

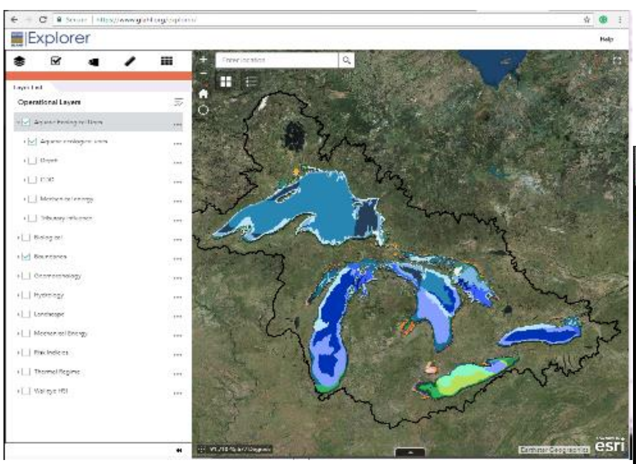

Figure 8: *Aquatic Ecological Units in the GLAHF classification scheme (Riseng et al. 2017), available through the GLAHF Explorer.*

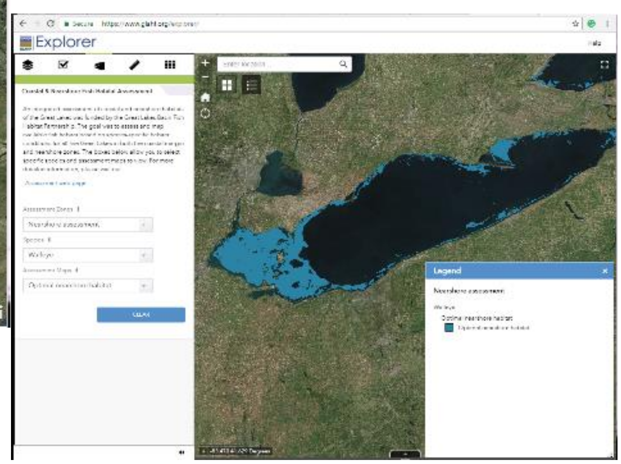

Figure 9: *Lake Erie coastal margin and nearshore fish habitat assessment, available through the GLAHF Explorer. The boxes below permit viewing of species and assessment maps.*

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

A. M. Gorman, C. Knight, and R. Kraus

Habitat Task Group members are actively working on three projects that support the compilation of fish habitat metrics for other task groups. The first project addresses the Walleye Task Group call for alternative walleye habitat models to help inform stock assessments and management decisions. The work is an evaluation of walleye depth telemetry from four years of data on 20 walleye within Lake Erie. Telemetry data were also compared with OMNRF partnership gill net survey data, and the results show that larger walleye infrequently occupy depths targeted in fall gill net assessments. A completed manuscript of this work is being revised for journal submission in April 2018. The second project is responsive to Coldwater Task Group efforts to assess and evaluate lake trout rehabilitation. Here, depth and temperature telemetry is providing novel information on summer refugia and fall spawning habitats. Fieldwork is currently in-progress and will help support improved decisions regarding stocking and habitat restoration. The third project addresses questions about the spatial distribution of summer refugia for coldwater species in Lake Erie. This project aims to determine how well existing water quality data (e.g., LTLA data from the Forage Task Group and EPA's Central Basin Hypoxia Survey data) delineates habitat for cold water species including: Lake Trout, Lake Whitefish, Burbot, Rainbow Smelt, and the extirpated Cisco. Models primarily developed by P. Jacobson for Minnesota Lakes will be applied to limnological depth profiles to predict coldwater species habitats within Lake Erie.

Section 5. Systematically develop and maintain a list of functional habitats and impediments for desired fish species

a) Priority management areas that support LAMP, LEC Environmental Objectives (LEEOs and FCOs)

S. Marklevitz, J. Tyson, C. Harris

In 2014, the Council of Lake Committees (CLC) adopted draft Environmental Principles (*EPs*). The premise of the CLC-EPs 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."*

The emphasis of this approach is protecting, restoring or enhancing functionality to habitats that support fish production (e.g., spawning and nursery areas). The CLC prioritizes "protection" over "restoration" over "enhancement", (i.e. Protection > Restoration > Enhancement) and defines each as follows:

- ***Protection***: guarding against threats to habitats already in functional condition,
- ***Restoration***: addressing threats/stresses thereby improving functionality to an unimpaired condition,

- ***Enhancement***: addressing threats/stresses thereby improving functionality to a less impaired condition.

Whether protecting, restoring or enhancing a habitat, the focus is on addressing manageable (vs. unmanageable) sources of threats/stresses on habitat functionality. Habitat restoration or enhancement actions do not need to lead to restoring a habitat to "pristine" conditions but can simply improve conditions to benefit the production of desirable fish species.

The CLC-EPs approach also addresses uncertainty for prioritizing habitat actions (*i.e.* Protection, Restoration, Enhancement), as it is recognized that we lack complete knowledge of specific habitat requirements or impediments of species and/or stocks. Therefore, priorities must be determined based on best available information and expert judgment while using a precautionary and adaptive approach for prioritizing potential habitat actions and their expected outcomes.

The intention of the CLC-EPs is to aid in the *prioritization* of habitat actions that would promote sustainable fisheries in the Great Lakes Basin. Subsequently when applied at appropriate spatial scales with fisheries management priorities (from regulations, policies, and practices), the EPs should help identify "*priority areas"* where focus habitat actions could have the greatest benefits to Great Lakes fisheries.

Identification of *priority areas* will help communicate and align complex fisheries management priorities at various levels of governance with other Great Lakes governance groups, such as land-use, water quality, and wildlife management committees/commissions, agencies, or community groups. The alignment of priorities across governance groups could have synergistic benefits through the development of cross-disciplinary/agency partnerships, efficient use of resources (e.g., cross-agency programs, and/or what to do now versus later), and collaborative evaluations. Opportunities to align lake-specific priorities among various governance groups 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, and within and among various federal, provincial, and state government agencies in each Great Lake.

To address the CLC-EPs, the LEC and HTG have set out to define priority areas within the LEC jurisdiction from the Bluewater Bridge (St.Clair River) to Niagara Falls (Niagara River). To accomplish this the HTG is identifying potential "*habitat actions*" within "*functional habitats*" by life stage and stock of desired fish species. Through a systematic and adaptable application of the CLC-EPs and LEC fisheries management priorities to these habitat actions, functional habitats are evaluated to define priority areas were management actions could have significant effects of the production of desired fish species, referred to as Priority Management Areas (PMAs).

To begin we must clearly define the key terminology for the determination of PMAs.

Key Terminology

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:

- ✓ Currently supports, or once supported, connected life stages of desired fish stocks and fisheries, as identified in the Fish community objectives (FCOs).
- ✓ 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.
- ✓ 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).
- ✓ 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.

Habitat Action (HA): An intentional action of protection, restoration, or enhancement as defined by the CLC-EPs on manageable threat/stress sources within a *FH*(s) for the purpose of promoting production of desired fish species. It should be noted that production in this case is defined as abundance of the desired fish species and does not explicitly consider growth.

Priority Management Area (PMA): A specific location within the Lake Erie watershed where *HA(s)* are needed to improve *FH*(s). PMAs can have more than one *HA*, address more than one source of stress, or encompass more than one FH.

Methods:

The HTG developed a three step process for determining PMAs (Figure 10). In Step 1, the HTG facilitated the collection of information on functional habitats by life stage and stock for all desired fish species. Desirable fish species were defined by species listed in the Lake Erie Fish community goals and objectives (FCOs). Limiting habitat components were identified within each function habitat, their status (impeded or not), sources of

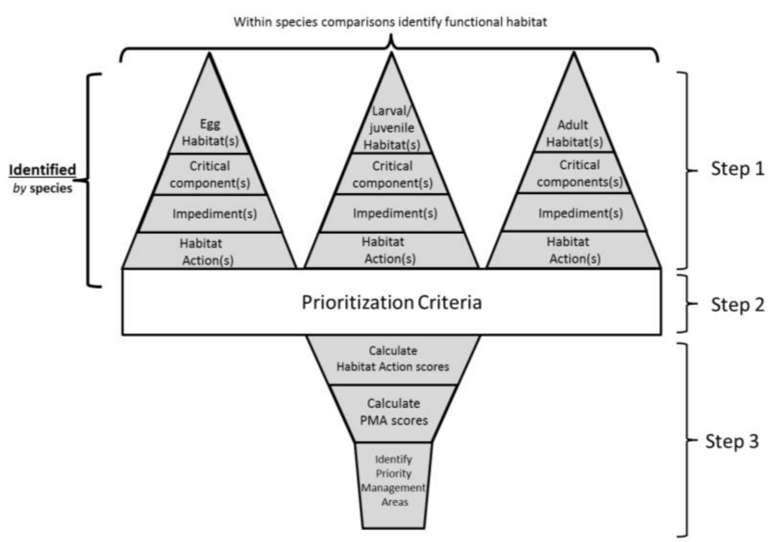

***Figure 10**: Schematic of the process for determining Priority Management Areas (PMAs)*

impediments and proposed habitat actions with estimates time to implement, if applicable. This information was collected based on the best available information or expert judgment and level of certainty associated with each piece of information was also captured.

In Step 2, the HTG surveyed the LEC to define management priority based on species, multi-species management and broad spatial areas. This information was combined with the CLC-EPs to derive prioritization scoring (Table 2). Step 3, was a three stage scoring process where first, individual scores for each proposed habitat action (HA) were calculated using the equation:

$$HA = Species \times Area \times \frac{Project\ type}{action\ certainty \times time\ to\ implement}$$

Where "species", "area", "project type", "action certainty" and "time to implement" variables are defined in Table 2

Table 2*: Priority scoring derived from LEC prioritization survey and Council of Lake Committee Environmental principles used to calculate habitat action (HA) scores*

Species		Area		Project type		Action Certainty		Time to implement	
Walleye	*26*	West Basin	*19*	Protection	*3*	Very high (supported by quantitative data)	*1*	0-5yrs	*1*
Yellow Perch	*26*	Central Basin	*16*	Restoration	*2*	High (supported by qualitative data)	*2*	5-10yrs	*2*
Lake Trout	*10*	East Basin	*19*	Enhancement	*1*	Moderate (supported by anecdotic evidence)	*3*	10-15yrs	*3*
Whitefish	*5*	Detroit River	*12*			Low (professional opinion)	*4*	15-20yrs	*4*
Burbot	*1*	Niagara River	*8*					20yrs+	*5*
Lake Sturgeon	*10*	St.Clair River	*10*					unknown	*5*
Smallmouth Bass	*5*	Lake St.Clair	*16*						
Rainbow Trout	*5*								
Rainbow Smelt	*1*								
Lake Herring (Ciscos)	*1*								
Northern Pike	*1*								
Muskellunge	*5*								
Emerald shiner	*4*								
Gizzard Shad	*1*								
Other forage species	*1*								

Individual HA scores where then aggregated to form average scores for each life stage, stock, species within a functional habitat and summed within functional habitats (FH) to form the PMA score for each using equation:

$$PMA\ score_{FH} = \sum (\overline{HA})_{area,\ species,\ stock,\ life\ stage}$$

The PMA scores for all identified functional habitats were then ranked and assigned priority based on the categories outline in Table 3:

***Table 3**: PMA score prioritization categories*

Prioritization categories	**PMA score percentile range**
Very High	$90^{th\%}$ <
High	$75^{th\%}$ - $90^{th\%}$
Med	$50^{th\%}$ - $75^{th\%}$
Low	$25^{th\%}$ - $50^{th\%}$
none	< $25^{th\%}$

Progress to-date and initial results:

In 2016, HTG members made a preliminary attempt to populate information on function habitats. In 2017, based on lessons learned from 2016 the HTG re-designed the data collection and engaged other LEC task groups, academic experts and individual members of agencies in a full data collection exercise. This first attempt to populate the current state of knowledge on functional habitats in Lake Erie was completed in January 2018. There is however significant work still required populating this information before a full list of PMAs can be made available. While the functional habitat information is incomplete, the information from this initial attempt was enough to help refine the prioritization methods and provide an initial attempt at PMA prioritization for proof of concept.

The initial attempt to populate functional habitat information defined 116 functional habitats the Lake Erie Basin. Through the initial PMA scoring, 12 functional habitats were identified as very high priority PMAs, 17 high priority PMAs and 40 had no PMA priority (Table 4, Table **5**, and Figure 11).

Through this initial PMA scoring the HTG was successfully able to assign priority to functional habitats to define PMAs at different spatial scales through the systematically application of fishery value (LEC priority and CLC-EPs) on manageable stresses. This collaborative approach should be cumulative and adaptable as new information on functional habitats and threats/stresses is populated or becomes available or as manageable threats/stresses are addressed.

***Table 4**: Summary of initial PMA scoring of functional habitat (FH).*

	Prioritization categories					**Total**
	Very High	**High**	**Med**	**Low**	**None**	
FHs (*n*)	12	17	29	18	40	116

Please note: results represent initial PMAs prioritization attempt and are intended to demonstrate proof of concept only. The HTG will continue to work over the next year to provide initial PMAs for the 2019 HTG report

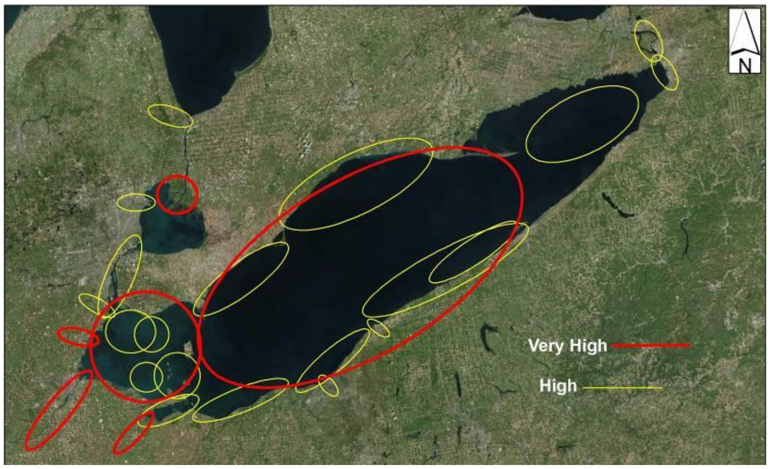

***Figure 11**: A map of specifically identified very high and high priority PMAs in the Lake Erie Basin based on the initial PMA evaluation.* ***Please note**: results represent initial PMAs prioritization attempt and are intended to demonstrate proof of concept only. The HTG will continue to work over the next year to provide initial PMAs for the 2019 HTG report.*

***Table 5**: List of specifically identified functional habitat with high and very high priority PMA scores*

Broad Area	PMA priority: Very High	PMA priority: High
St.Clair River		• Mill Creek, MI
Lake St.Clair	• St.Clair River Delta • Nearshore (generic)	• Clinton River, MI
Detroit River		• Detroit River (generic)
West Basin	• Open water Pelagic (generic) • Maumee River, OH • River Raisin, MI • Sandusky River, OH	• Nearshore from Port Clinton to Marblehead and Islands, OH • Sandusky Bay, OH • Detroit River Plume • Ohio reefs • Ontario reefs • Huron River, MI
Central basin	• Coastal wetlands (generic) • Nearshore (generic) • Openwater pelagic (generic) • Openwater benthic (generic) • Openwater- reef shoals (generic) • Rivers (generic)	• Central Basin River Plumes (generic) • Ohio Central Basin Reef complexes • Cuyahoga River, OH • Grand River, OH
East Basin		• Open water- pelagic (generic) • Buffalo Harbour, NY
Niagara River		• Strawberry/ Beaver Islands, NY

Please note: results represent initial PMAs prioritization attempt and are intended to demonstrate proof of concept only. The HTG will continue to work over the next year to provide initial PMAs for the 2019 HTG report

Future direction:

The HTG will continue to update and populate information about functional habitats over the next year. We should be in position to confidently provide the first list of prioritized PMAs for the 2019 HTG report. Through the PMA exercise the HTG has identified uses for this information beyond identifying PMAs. These include:

1) Agency specific priority areas through the application of agency specific priority within the prioritization criteria

2) State of knowledge statements which can be used to support other LEC activities or requests for LEC's support of external activates (e.g. academic researchers grants)

> **Example State of Knowledge statements**:
>
> - Detroit River (river/tributary) is identified as functional habitat for all muskellunge life stages (spawning, egg development, larval, juvenile, and adult). There is very high certainty that the river provides functional habitat for the adult and spawning life stages. The other life stages (egg development, larval, and juvenile) are considered to have high certainty.
> - Smallmouth bass in the nearshore areas of the Central Basin, from Fairport to Conneaut, were identified to have two limiting habitat components. There is high certainty that spawning and egg development are limited by sedimentation while there is low certainty that juvenile and adult smallmouth bass are limited by foraging (food resources quantity).
> - Spawning lake sturgeon in the Maumee River have a limiting habitat component of connectivity to spawning habitat and this component is highly impaired. The impediment is habitat discontinuity by direct human activities (construction of the Grand Rapids Dam).

3) Identification of knowledge gaps and priorities will drive re-development of the LEC strategic research direction for habitat projects.

b) Strategic research direction for the LEEOs

S.Marklevitz, C.Harris

In 2017, the LEC linked the HTG strategic research direction for the LEEOs to the development of PMAs. As outlined in the previous section of this report, the HTG is currently in development of PMA and accumulating the information of functional habitats. Once able to produce a list of PMAs the HTG will use the same information to identify and prioritize knowledge gaps to develop a list of strategic research questions.

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.

- All results provided from the PMA exercise in this report is a preliminary analysis of the data on functional habitats provided by agencies to-date. The dataset on functional habitat is incomplete and the presented results are to demonstrate *proof-of-concept only* and should not be used for any other purposes at this time.

- 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.

Appendix A: Lake Erie Environmental Objectives (LEEOs) of the LEC (Lake Erie Committee 2005) with linkages to fish community objectives (italicized).

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)*

Appendix B: 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