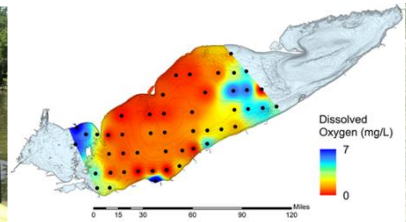
Report of the
Lake Erie Habitat Task Group
2021



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Presented to:

Standing Technical Committee, Lake Erie Committee

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Charges to the Habitat Task Group 2020-2021

1. Maintain a list of functional habitats and impediments for species specified by the LEC Fish Community Objectives (FCOs) that can be used to identify and evaluate status of:
    a. Priority management areas (PMA) that support LaMP, LEC Lake Erie Environmental Objectives (LEEOs) and FCOs
    b. Strategic research direction for the LEEOs
    c. Documentation of key habitat and research projects as related to priority management areas.
    d. Use GIS techniques to refine PMA mapping, coordination and scale.

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.

Charge 1: Maintain a list of functional habitats and impediments for species specified by the LEC Fish Community Objectives (FCO's)

Charge 1a: Priority management areas (PMA) that support LaMP, LEC Environmental Objectives (LEEO's and FCO's)

In 2021-22 the Habitat Task Group (HTG) defined a 4-phase process to better capture the progress to-date and communicate future work needs to finish developing a functional, systematic, adaptive, cumulative, and collaborative approach for identifying Priority Management Areas (PMAs). Phase 1 was the initial proof of concept including the initial PMA data collection, management prioritization and scoring. Work completed during Phase 1 was presented in the 2019 HTG report [1]. Phase 2 was defined as the proof of concept for moving the original flat file PMA dataset (Phase 1) into a GIS framework. This phase included the creation of functional GIS layers and a geospatial data viewer to help data visualization. Phase 2 formed the majority of the work done in 2021-22 and will be updated in more detail under Charge 1d. Phase 3 will be develop a user friendly backwards facing portal that will allow the underlying PMA data to be easily updated and refined as new information becomes available. This phase will also include development of a forward-facing viewer that will facilitate end-user analysis

[1] 2019 Habitat Task Group (http://www.glfc.org/pubs/lake_committees/erie/HTG_docs/annual_reports/HTG_AnnualReport2019.pdf)

of the data and broadly communicate Lake Erie's Environmental priorities. Finally, Phase 4 will be the ongoing updating and refining phase where the HTG will operationalize the PMA exercise and be able to update and refine PMA data, re-prioritize as required, and report out on progress within PMAs. The HTG is working to finish Phase 2 and beginning to develop process to execute phases 3 and 4.

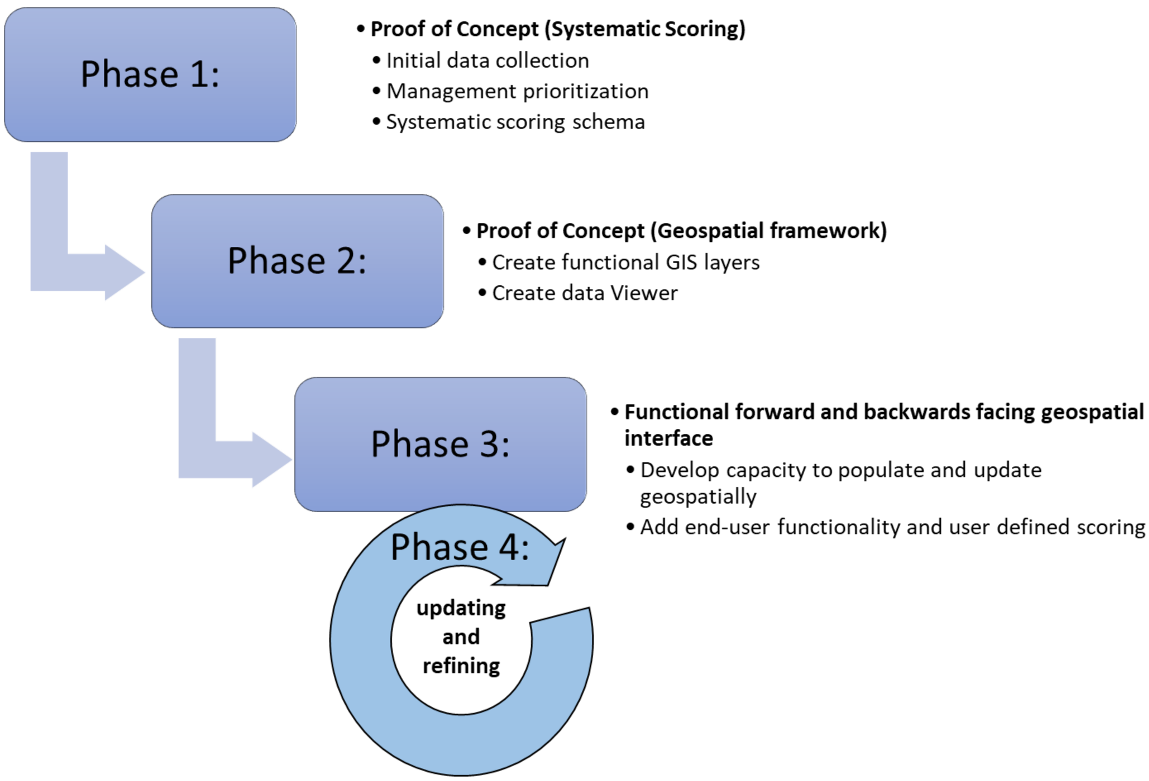

Figure 1: Four phases of PMA development identified by the Habitat Task group.

Charge 1b: Strategic research direction for the LEEO's

In 2017, the LEC linked the HTG strategic research direction for the LEEOs to the development of PMAs. Efforts to investigate use of the PMA dataset to identify knowledge gaps that could then be used to develop a list of strategic research questions began in 2019 and continued through 2020. In 2021, developments made while updating the PMA dataset into spatial a dataset made it evident that gaps and data needs coming from this process would drive research directions for the LEEOs. The HTG subsequently paused development of strategic research directions until this work is completed.

Charge 1c: Documentation of key habitat and research projects as related to priority management areas.

Habitat Suitability Indexes

Habitat suitability index (HSI) models are used to identify and quantify suitable habitat for various fish species by comparing habitat characteristics (e.g., substrate, water depth, and flow) to species' optimal ranges at various life stages (e.g., spawning and juvenile). Based on literature reviews, a species optimal range is used to categorize each habitat characteristic into a range of values that represent rating of "good", "moderate", or "poor" which are assigned numerical values such as 1, 0.5, and 0, respectively. For example, juvenile Lake Sturgeon prefer habitats containing silt, sand, gravel, and/or cobble substrates. Therefore, areas with these substrates would be rated as "good". Ratings for each habitat characteristic can then be analysed together with spatial habitat data to map the overall suitability of an area for a particular species and life stage. This information can be used to protect and/or restore suitable habitats of native fish species, as well as identify risks of invasive species. In Lake Erie there are several initiatives working to develop HSIs: 1) Walleye Spawning Habitat in the Sandusky River, 2) Native species Habitat Suitability in Southern Ontario tributaries, 3) Lake Sturgeon Habitat Suitability in the Cuyahoga River

H.S.I. 1: Ballville Dam Removal Doubles Available Walleye Spawning Habitat in the Sandusky River (UToledo, ODNR)

T. Sasak[2], and M. Myers[3]

The Ballville Dam on the Sandusky River, Ohio, was removed in the fall of 2018 which re-opened ~35.4 rkm that may now be accessible to migratory sport fish, such as Walleye. University of Toledo researchers collected substrate, water depth, and velocity data between July and October 2019–2020 to develop a Habitat Suitability Index (HSI) model for spawning Walleye. The model enabled us to identify areas of suitable Walleye spawning habitat from the mouth of the Sandusky River to Tiffin, Ohio (Table 1). Our HSI model classified 1.2 ha as good, 39.5 ha as moderate, and 452.1 ha as poor Walleye spawning habitat (Myers 2021). Overall, there is a total of 40.7 ha of suitable Walleye spawning habitat in the Sandusky River downstream of Tiffin, Ohio. The removal of the Ballville Dam doubled the amount of spawning habitat available to Walleye.

To assess migratory fish passage above the dam, electrofishing surveys were conducted during typical spawning periods in 2020 and 2021. Walleye and White Bass have not been documented upstream of the dam for many years prior to the

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dam's demolition. Spawning electrofishing surveys took place weekly from April to June to determine if migratory fish, such as Walleye and White Bass, were

Table 1: Total areas of available, accessible spawning Walleye habitat (ha) in the Sandusky River by suitability. Suitable (good and moderate) Walleye spawning habitat was found near Fremont, the former Ballville Dam, Old Fort, and Fort Seneca, Ohio. The removal of the Ballville Dam increased the amount of suitable Walleye spawning habitat by 21.9 ha.

	Good	Moderate	Poor
Total Habitat Available			
Downstream of the former dam	0.8	18.0	298.9
Upstream of the former dam	0.4	21.5	153.2
Total	1.2	39.5	452.1
Substrate			
Downstream of the former dam	12.6	11.4	293.7
Upstream of the former dam	5.7	16.5	152.9
Total	18.3	27.9	446.6
Depth			
Downstream of the former dam	5.8	18.8	293.0
Upstream of the former dam	61.8	60.8	52.2
Total	67.6	79.6	345.2
Velocity			
Downstream of the former dam	139.3	136.2	42.2
Upstream of the former dam	19.7	41.8	113.3
Total	159.0	178.0	155.5

travelling upstream of the former dam from Lake Erie. No Walleye or White Bass were captured upstream of the dam during the 2020 spawning run. However, Walleye were captured upstream of the dam during the 2021 spawning run (Sasak 2021). To assess the resident fish community, electrofishing surveys were conducted monthly from June–September 2020. A total of 45 species were captured. Two species were captured upstream of the former dam that previously have not been documented: White Bass and Flathead Catfish. On average, Index of Biotic Integrity scores were 28.4% lower in 2020 compared to scores from a 2009 pre-assessment. This could indicate a decline in the health of the residential fish community since dam removal. On average, Qualitative Habitat Evaluation Index scores were 10.5% lower in 2020 compared to scores from a 2009 pre-assessment. Changes in the quality of fish habitat were not apparent between pre- and post-assessments.

A barrier assessment was conducted to determine if physical or velocity barriers for Walleye still exist in the Sandusky River. Potential migratory barriers include the upstream shelf, the ice control structures (with or without debris blockage), downstream rapids, or Tiffin Road Bridge. All possible obstructions are within the former dam area. Elevation and discharge data was used to create a model using the U.S. Army Corps Hydrologic Engineering Center's River Analysis System (HEC-RAS). Fifteen models for velocity were created using five blockage levels at the ice control structures (0%, 25%, 50%, 75%, and 100%) and three flow levels based on discharge during the Walleye spawning season (Low: 548 cfs, Middle: 1173 cfs, and High: 5292 cfs). Each model was then compared to the prolonged critical 10 minute and burst swim speeds for three categories of Walleye (Small:

0.18m, Medium: 0.35m, and Large: 0.51m). It was concluded that at low flow there are barriers to all sizes of Walleye based on water depth. All sizes of Walleye in the middle and high flow scenarios must maintain burst swim speeds to pass the area, with the exception of small Walleye not passing during high flow for 0-75%, and medium Walleye during high flow for 0% blockage scenarios.

H.S.I. 2: Native species Habitat Suitability in Southern Ontario tributaries (NDMNRF)

T.Gehrke[4] and R. Poisson[5]

The NDMNRF is continuing to develop Habitat Suitability Indexes (H.S.I.) for native species including Walleye, White suckers, and Lake Sturgeon in Southern Ontario Tributaries (e.g., the Grand, Thames and Sydenham Rivers and Big and Big Otter Creeks). In 2019, a pilot project was conducted in Southern Grand River, Ontario, Canada, to create H.S.I. for Lake Sturgeon, as reported in the previous HTG report (2019/2020). Building on the success of the Grand River pilot project, in 2021, incredible support and participation from local Conservation Authorities and the Department of Fisheries and Oceans (DFO) has enabled work to begin on all targeted tributaries. With this expansion, field crews side-scanned accessible habitat in Big and Big Otter Creeks, which are being analyzed using the SonarWiz (version 7.09.01.) Seabed Classification Tool to classify substrate (Figure 2). Additionally, two biologists were onboarded for technical support and have been working closely with partners to collect available data and develop field plans. Research has also been ongoing to add water temperature to the H.S.I. models, as suitable spawning and juvenile habitats may be threatened by warming temperatures. In 2022, plans are to continue data analysis and side-scanning of the targeted tributaries (Figure 3). A trial will also be conducted in Southern Grand River to add water temperature to the existing H.S.I. model.

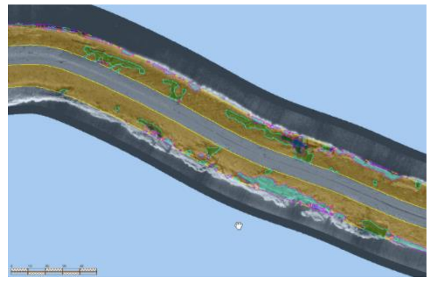

Figure 2: Example of the processed side-scan sonar imagery that has drawn polygons of different classes of substrate calculated using the SonarWiz Seabed Classification tool.

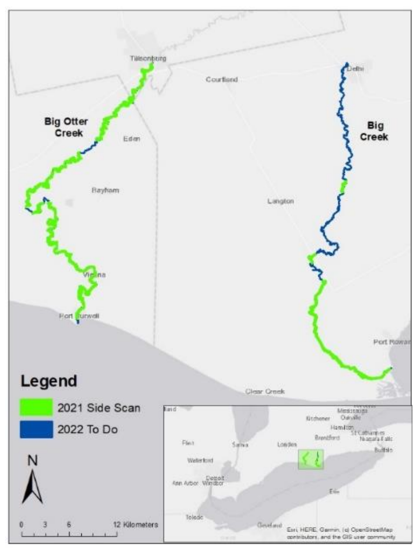

Figure 3:Map of side-scanned areas of Big Otter Creek and Big Creek in Ontario, Canada

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H.S.I. 3: Lake Sturgeon Habitat Suitability in the Cuyahoga River (USFWS)

J. Fischer

The Alpena U.S. Fish and Wildlife Service Conservation Office and partners began habitat assessments in the lower 72 km of the Cuyahoga River from Lake Erie to Ohio Edison Dam in partnership with the ODNR, Cuyahoga Valley NPS, and others. The 2021 surveys included a side-scan sonar survey that will be used to quantify the availability of suitable substrates for spawning Lake Sturgeon (*Acipenser fulvescens*) and age-0 individuals (Figure 4). Accompanying the side-scan sonar surveys, crews worked with the Cuyahoga Valley NPS to visually assess substrate composition at discrete points throughout the surveyed reach, which will be used to ground-truth the side-scan sonar data. Crews are currently classifying substrate types from the sonar imagery and anticipate a final map of substrate types within the study section of Cuyahoga will be completed in 2022. Additionally, in 2022, crews will survey bathymetry throughout the 72 km stretch of river. The bathymetry data will be used to develop a 1-D flow model to estimate the availability of suitable water depths and velocities for age-0 Lake Sturgeon and spawning adults, under multiple discharges. The products of this work will help determine if the Cuyahoga River can support Lake Sturgeon reintroduction.

Figure 4: Alpena FWCO and Cuyahoga Valley NPS employees conducting a side-scan sonar survey on the Cuyahoga River.

The H2Ohio Wetland Restoration and Monitoring Program: 2021 Update

J. Kerns

Globally, considerable investments are made to protect, restore, construct, and manage wetland ecosystems to improve water quality and mitigate excess nutrient loads that fuel eutrophication. In Ohio, wetland restoration is one of a set of Best Management Practices being implemented statewide as part of Governor Mike DeWine's H2Ohio Initiative to improve water quality throughout the state, with particular interest in diminishing harmful algal blooms in the western basin of Lake Erie. The Ohio Department of Natural Resources (ODNR) implemented H2Ohio Wetland Projects are diverse and numerous, representing over 80 planned projects including reconnection of diked coastal wetlands as well as wetland restoration and construction on agricultural land and floodplains (Table 2). To evaluate the effectiveness of this program at reducing nutrients within the associated watersheds, the H2Ohio Wetland Monitoring Program (HWMP) was developed and organized by the Lake Erie and Aquatic Research Network beginning in July of 2020.

Table 2: Summary of H2Ohio wetland restoration projects

H2Ohio Wetland Restoration Projects		
Regional Watershed	**Coastal**	**Inland**
Maumee River	1	27
Western Lake Erie Basin	10	10
Central Lake Erie Basin	1	11
Ohio River (Statewide)	-	23
Total	**12**	**71**

In the spring of 2021, this multi-disciplinary team began measurements of hydrologic features, groundwater exchange, bathymetric and elevation surveys, vegetation, soil characteristics and nutrient status, surface water nutrient concentrations, soil geophysical characteristics, and sediment-surface water nutrient exchange. In that time, over 100 research visits have been made to 28 project sites to collect drone imagery, soil geophysics, and over 400 soil, water, and plant samples collected. While the data generated by this long-term environmental monitoring are extremely valuable, its complexity poses a challenge to data and quality management. As the HWMP evaluates wetland projects under its umbrella, it has been developing a custom database design to accommodate the varied sources, formats, and workflows of data acquisition within the program. Some of the challenges the monitoring team are iteratively addressing include: 1) centralize data that is collected by and initially housed at six different institutions, 2) implement consistent collection and distribution workflows across water, soil, and vegetation samples, geophysical, hydrological, and drone measurements, and field-collected data from handheld probes and deployable sensors, 3) properly document and index sample metadata and corresponding analytical data, along with easily accessible sample chain-of-custody, 4) assure quality of raw and processed data analyzed and manipulated by different analytical instruments, software, and methodology, 5) store and backup data of all kinds and scales generated by the monitoring program in a searchable manner, and 6) make data that meet quality standards readily available to researchers and stakeholders. The HWMP has implemented the use of ArcGIS Field Maps mobile application to ensure proper metadata entry, completeness, unique sample identification, and accurate location in the field. Automated workflows have been developed with Python scripts to export ArcGIS Online data daily as a local backup and integrate the data into GitHub for version control. A continuous integration system established in GitHub Actions runs quality control checks on the newly imported data and, upon success, appends the data to our database. Database queries will allow program-wide users to retrieve the data for downstream analysis. Full access of verified data to researchers and stakeholders is still under development, along with beta testing of our current workflows.

With two years of implementation of the H2Ohio initiative complete and two more in progress, the HWMP will not only generate valuable knowledge of wetland function but will also enhance wetland research and management capacity through cultivating a network of wetland researchers and practitioners. Ultimately, the HWMP will provide an unprecedented opportunity to compare diverse wetland restoration, construction, and management approaches in terms of direct assessments of both nitrogen and phosphorus cycling mechanisms.

For more information about the H2Ohio Initiative and up to date information about the wetland work the ODNR is doing, please see the following link: https://h2.ohio.gov/natural-resources/

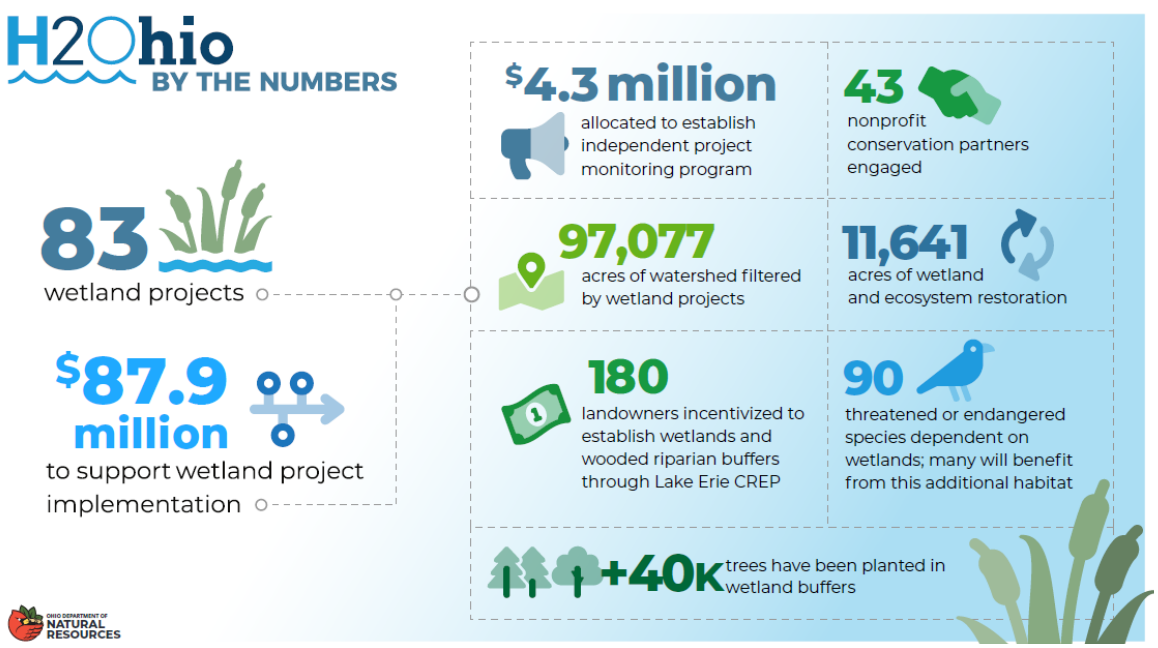

Figure 5: H2Ohio by the numbers

Identifying and characterizing Lake Whitefish spawning habitat in Lake Erie

J.Fischer, E. Roseman, D. Gorsky

In 2021 the USFWS, USGS, TNC, ODNR, NDMNRF, Univ. of Toledo, and NYSDEC began a joint project to assess Lake Whitefish (*Coregonus clupeaformis*) spawning activity and spawning habitat in Lake Erie. The project seeks to: 1) Describe the contemporary spawning habitat used by Lake Whitefish at known spawning locations in the western basin of Lake Erie; 2) Verify and describe suspected spawning sites used by Lake Whitefish in the central and eastern basins of Lake Erie; 3) Describe the factors (e.g., substrate composition, bottom slope, water temperature) influencing spawning of Lake Whitefish in the central and eastern basins; and 4) Evaluate restoration opportunities by describing habitat where future stocking could be successful. Fall of 2021 marked the first field season of the two-year project, with egg mats and egg pumping deployed by crews in nearshore areas of the central and eastern basins. Sampling was conducted following an occupancy modeling framework, with sampling sites revisited multiple times over the fall and winter, to determine the onset of spawning and account for imperfect detection of Lake Whitefish eggs. Crews collected Lake Whitefish eggs at multiple locations in the central basin, however, no Lake Whitefish eggs were collected in the eastern basin. The eggs were brought to the USGS Great Lakes Science Center where they are being reared to the larval stage to confirm species identification and undergo genetic analysis to hopefully identify the spawning stock. Lake Trout (*Salvelinus namaycush*) eggs were also observed at sites in both basins. Another round of egg surveys is slated for fall 2022 and this summer crews will be revisiting sampling sites to collect substrate and bathymetric data, which will be used to describe the bottom habitat where eggs were collected.

Figure 6: A crew conducting egg pump sampling for Lake Whitefish eggs in Lake Erie. Water is pumped through a sluice with a series of screens to filter out eggs.

Public Data on Temperature and Dissolved Oxygen

R.Kraus

USGS received support from the Great Lakes Restoration Initiative to leverage the Great Lakes Acoustic Telemetry Observation System in Lake Erie to measure hypolimnetic temperature and dissolved oxygen throughout the central basin. The objectives were to supplement fish detection data with measurements of water quality during stratification and to supply the NOAA hypoxia forecast model with ground-truth information for retrospective analyses. USGS deployed data loggers (PME, Inc., MiniDOT data loggers) in 2020 and 2021 during annual maintenance of GLATOS stations. Data loggers were programmed to measure dissolved oxygen via an optical sensor, as well as temperature and percent oxygen saturation at 10-minute intervals. Specified temperature range was 0 - 35 °C (accuracy ±0.1°) and the dissolved oxygen range was 0 - 150% (accuracy ±5%) saturation. The loggers were equipped with a separate mechanical anti-fouling wiper, along with copper plate surrounding the optical dissolved oxygen sensor to reduce the amount of bio-fouling during deployment. Factory calibration of dissolved oxygen was verified in the laboratory, and instrument drift was assessed in the field immediately after retrieval (i.e., zero-point calibration). The full sampling design was not achieved in 2020 due to restrictions on crossing the international border, but the full design was achieved in 2021 (Table 3; Figure 7;). At selected locations that were determined in collaboration with NOAA-GLERL researchers, a few stations had multiple loggers that were suspended into the water column. Additional details are described in the metadata that accompany the public data releases at the following URLs:

2020 data release: https://doi.org/10.5066/P9J9AV9V

2021 data release[6]: https://doi.org/10.5066/P953FO3I

Table 3: Data logger deployment information for Lake Erie 2020 - 2021

Year	Number of data loggers	Number of GLATOS stations*	Initial Deployment Date	Retrieval Date
2020	31	27	June 8, 2020	October 27, 2020
2021	56	48	May 10, 2021	October 27, 2021

*Less than the number of loggers due to mid-lake stations with additional suspended loggers.

[6] Note: the link to 2021 data will be made public soon, but it is not currently accessible at the time of writing this update.

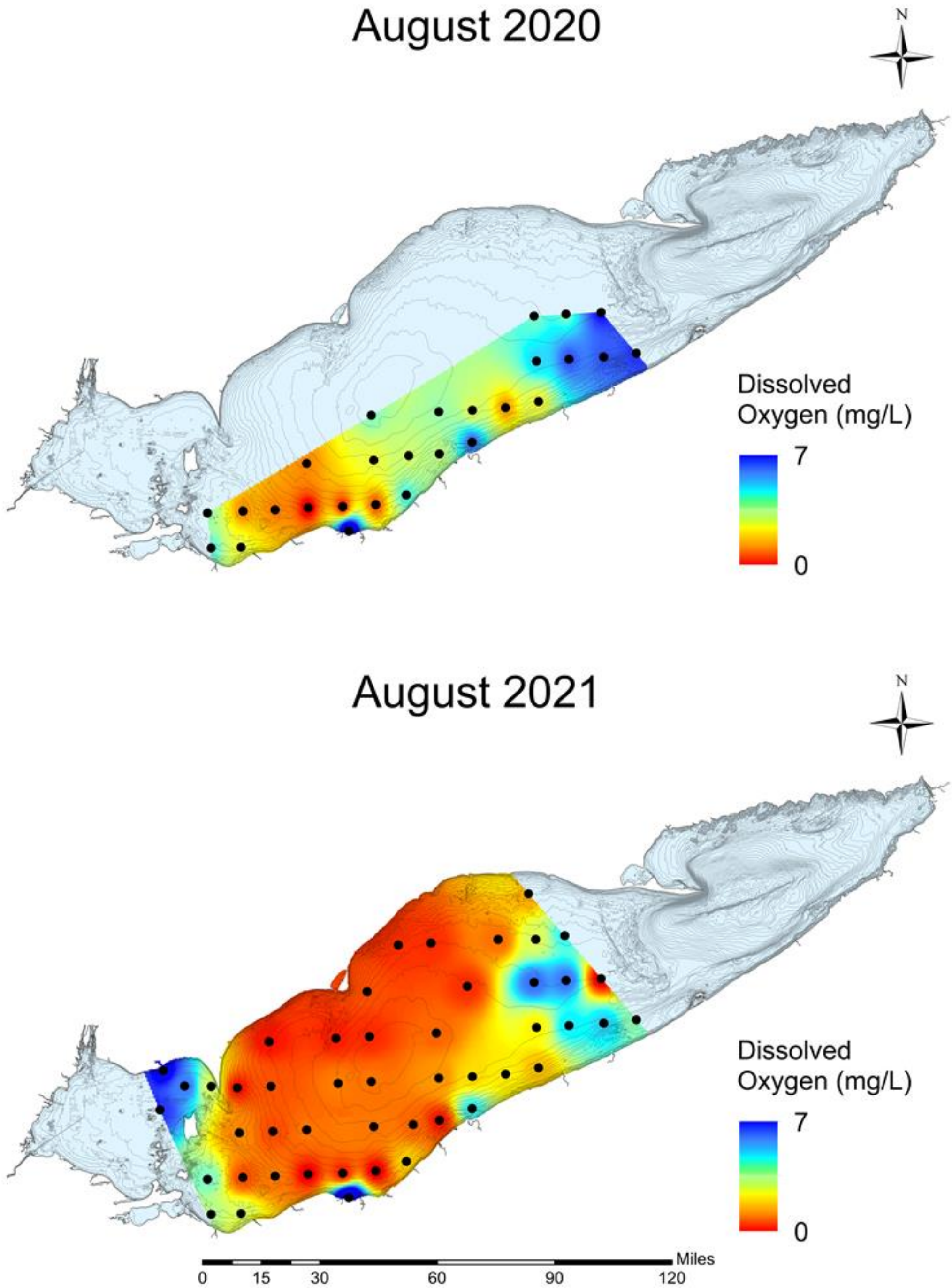

Figure 7: GLATOS stations equipped with data loggers during 2020 and 2021 (black dots). As an example, average dissolved oxygen distribution in the hypolimnion was interpolated (with IDW) and is plotted as a heat map.

Lake Erie MetroPark coastal wetland work

E. Ellis[7], T. Heatlie[8], T. Mitchell[9], S. Thomas[10] and C. Harris

Lake Erie Metropark is located along the shoreline of Lake Erie's western basin. The Metropark property spans 1,607 acres and has 3 miles of Lake Erie shoreline. At one time coastal wetlands covered much of this site that is now impacted by shoreline armoring, erosion, and invasive species.

Figure 8: Lake Erie Metropark project map

A project has been developed through the regional partnership with National Oceanic and Atmospheric Administration (NOAA) and the Great Lakes Commission (GLC), in collaboration with the Huron-Clinton Metropark Authority. The project is intended to restore the hardened shoreline (1,183 linear feet) and create low-velocity areas that are protected from direct wave action adjacent to the restored shoreline (Figure 8). Habitat improvements will also be made in the coastal marsh (1.7 acres) to improve fish access and nursery habitat, similar to historic access that had existed in the marsh. This project will benefit a wide variety of fish species (e.g. northern pike and yellow perch) among other herpetofauna and wildlife.

Project design, engineering and initial monitoring have been completed, now the project is moving towards implementation in 2022. The focus of this project will help achieve coastal wetland restoration and shoreline softening priority objectives set by the St. Clair-Detroit River System Initiative (www.scdrs.org). The nearshore component of this project improves habitat in a very high priority management area while the coastal wetland component improves habitat in a high priority management area.

A project team including representatives from GLC, NOAA, Huron-Clinton Metroparks, GEI Consultants, Michigan Department of Environment Great Lakes and Energy, and Michigan Department of Natural Resources are working to move this project forward.

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Niagara River Coastal Wetland Restoration Projects

C. Burant[11] and S. Marklevitz

Over the past century the shorelines of the Upper Niagara River have been hardened, reducing the complexity and functioning of nearshore habitats throughout the river. In recent years, extensive efforts on both side of the boarder have restored these habitats and protected shorelines from further erosion.

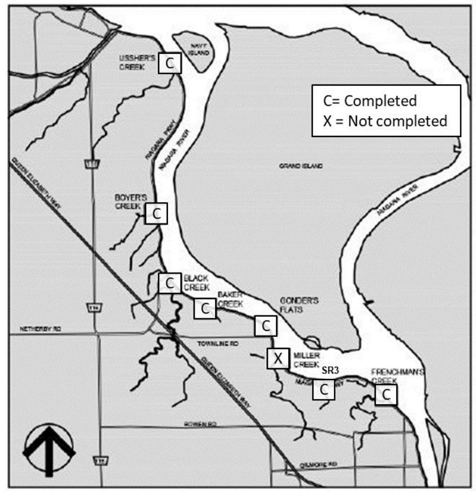

Figure 9: Coastal wetland projects in the upper Niagara River, identified in a 2016 MNRF survey. Projects proceed as planned except for the Miller's Creek location (X). The Miller's Creek project could not proceed due to archeological considerations so an alternative site at Service Road 3 (SR3) was completed.

On the Canadian side, the Niagara Parks Commission (NPC) has worked extensively to naturalize the shorelines including implementing a no-mow buffer, and restoring the natural riparian transition zones. In 2016, a NDMNRF lead survey identified and developed plans for 7 potential coastal wetland projects (Figure 9). These projects involved shoreline softening thru removal of hardened concrete walls, anchoring large woody debris and placement of large rocks to increase aquatic habitat complexity and promote retention of natural sediments and native vegetation.

In early 2022 after 6 years of work, the partnership between NPC, NDMNRF and Environment and Climate Change Canada (ECCC), completed six of the seven original coastal wetland projects and one alternative:

1) Ussher's Creek (2016/17)
2) Baker's Creek (2016/17),
3) Gonder's Flats (2017/18),
4) Boyer's Creek (2018/19),
5) Frenchman's Creek (2020/21),
6) Black Creek (2021)
7) Service Road 3 (2021/22)

While a site at Miller's Creek was originally identified, results of a Stage 1 & 2 Archaeological Assessment determined that the development of habitat at this site would not be feasible. Alternatively, a site at Service Road 3 (SR3) was selected based on its bathymetry and proximity to established aquatic vegetation upstream, which provided a suitable seed source.

In total these projects restored 1710m of naturalized shoreline habitat, which is expected to provide crucial habitat for various populations of plants, reptile, bird and fish species, enhancing recreational fishing opportunities in the upper Niagara River.

[11] Corey Burant, Niagara Parks Commission cburant@niagaraparks.com>

Spicer Creek Wildlife Management Area Habitat Restoration

P. Wilkins & T. DePriest[12]

The Upper Niagara River has been identified as place-specific functional habitat that is a medium PMA and the entire Niagara River is listed as a Great Lakes Area of Concern. Most of the coastal wetland plant communities that once fringed these shorelines have been degraded by industrialization, development, and pollution. Habitat restoration projects, like the one at Spicer Creek Wildlife Management Area, help reverse the historic pattern of habitat loss and degradation.

The Spicer Creek Wildlife Management Area is a 34-acre property located on Grand Island, New York, and managed by New York State Department of Environmental Conservation. The parcel includes rights to a portion of the Niagara Riverbed along 1,600 feet of its shoreline. The area consists of nearly 26 acres of wetland and eight acres of brushland and woodland.

The $2.2 million project placed low-profile berms along the shoreline to deflect wave energy and promote growth of shallow-water vegetation near the wildlife management area's shoreline. Eighteen segmented rock structures, each about 71 feet long, were placed to crest above the river (Figure 10). Log structures and single boulders were installed to further deflect wave energy. The structures being added create a protected 'backwater area' that is designed to keep the new habitat safe from boat wakes, ice scour, sediment, and other factors that can affect vegetation propagation. The enclosure allowed a flow of river water through an additional 16 acres of protected work area. Approximately 3,760 linear feet of shoreline was protected as a result of these habitat improvements. Native root vegetation and seed mixes were also planted to promote long-term naturalized growth.

Figure 10. Drone Images of Spicer Creek Wildlife Management Area habitat restoration work.

[12] Timothy DePriest, Niagara River Habitat Specialist, New York State Department of Environmental Conservation, timothy.depriest@dec.ny.gov

Buckhorn Island State Park Habitat Restoration

P. Wilkins & M. Filipski[13]

Buckhorn State Park is an 895 acre nature preserve located on Grand Island, New York, and managed by New York State Parks. The Buckhorn State Park is home to extensive marshland and wetlands that provides valuable fish and wildlife habitat. However, natural (ice, waves) and human (boat wake, disturbance) actions has resulted in losses of vegetation, habitat, and riverbank erosion in recent years. Two habitat restoration projects, Grass Island and Buckhorn Island State Park Shoreline, were completed in 2021 within Buckhorn Island State Park.

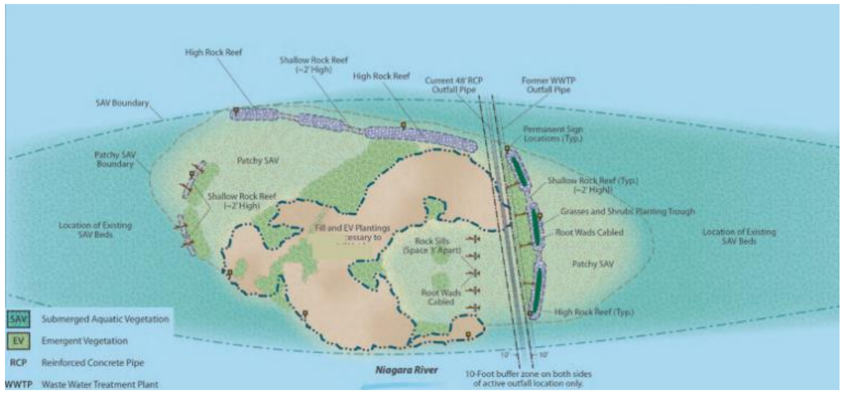

Figure 11: Grass Island Habitat Restoration Project Design

Grass Island is a 20 acre ecosystem designated as a protected wetland by New York State Department of Environmental Conservation. Grass Island provides important spawning and nursery habitat for fish and feeding and nesting habitat for waterfowl and other birds. The project helped to maintain and expand wetland and aquatic habitat through the installation of rock reefs to protect vegetation from ice, waves, boat wakes and human disturbance (Figure 11). Additionally, root wads were installed to provide underwater habitat structure, and native emergent and submerged vegetation was planted to promote long-term naturalized growth.

The Buckhorn Island State Park Shoreline project protected 8,900 feet of coastal wetlands through the installation of rock reefs and anchored log bundles to deflect wave energy (Figure 12). Small rock sills and logs were also installed at targeted locations to provide new, protected riparian wetland habitat for native vegetation and fish. Native emergent vegetation was also planted to promote long-term naturalized growth.

Figure 12: Buckhorn Island State Park Shoreline Habitat Restoration Project Design

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Charge 1d: Use GIS techniques to refine PMA mapping, coordination, and scale

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In 2019, the HTG began collaborating with the Great Lakes Aquatic Habitat Framework (GLAHF) project team to transition the Phase 1 "flat file" spreadsheet PMA dataset to the Phase 2 spatial dataset with accompanying GIS shape files (see Figure 1). In 2021 these efforts were enhanced with funding from GLFC to the University of Michigan (Dr. Catherine Riseng) that supported several part-time student positions. With these students collaborators there was dedicated support, time and expertise to the move PMA exercise forward.

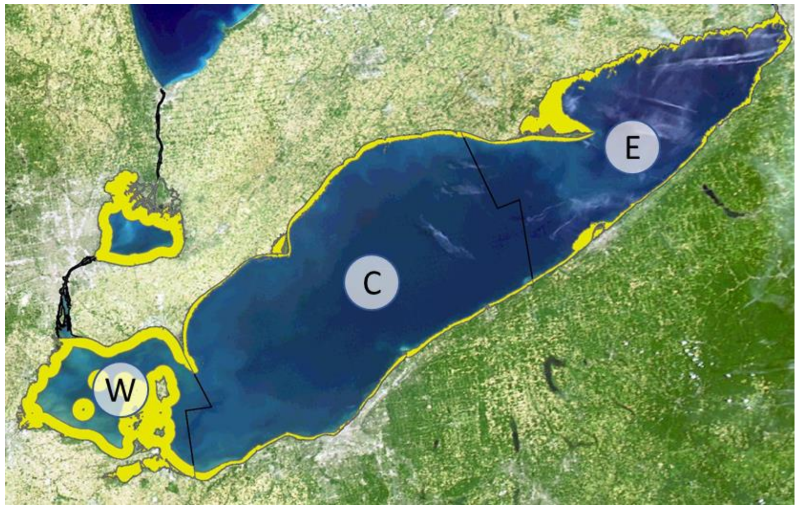

Figure 13: Lake Region and Nearshore PMA Layers. Lake regions layer delineates West(W), central (C) and East (E) basins, Nearshore defined using a 5km buffer in West Basin and the 10m depth contour in central and east basins

The majority of effort in 2021 was spent generating and editing functional habitat spatial layers specified during phase 1 of PMA development. Work initially focused on refinement of the existing GLAHF and agency geospatial habitat layers accounting for specific PMA considerations. An example of a specific Lake Erie PMA consideration was the definition of "nearshore", which was intended to capture the zone of the lake inhabited by nearshore fish communities prior to the transition to offshore fish communities. Following research and communication with partners this was defined by a 5 km buffer along the shoreline in the west basin, but in the central and eastern basins, was defined by the 10m depth contour (Figure 13).

The overall layers development work included:

- Lake Regions (Figure 13)
- Nearshore (Figure 13)
- Rivers and Tributaries (Figure 14A)
- Coastal Wetlands (Figure 14B)
- Natural Reef (Figure 14B)
- Constructed Reefs
- Open-water Benthic
- River Plumes (Figure 15)

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During the development and updating of functional habitat spatial layers the group explored and incorporated several new or improved methods using biologically/ecologically relevant criteria. This included mapping river plumes of watersheds of >450 km^2 using orthoimagery instead of the standardized application of 5km buffers to river mouths (Figure 15) or the GLAHF depth-decay algorithm. This produced layers much more inline with results in the published scientific literature, existing data and local knowledge. The group also started to explore new methods for defining "reefs" across the lake using topographic position index and rugosity, as an alternative to only using documented locations in the Goodyear Atlas[18], published document identifying reef systems and agency expert opinions. Although these were used to help validate the developing process.

Work in 2021 also included development of a data viewer that will facilitate visualization of the data and the spatial layers. Viewer development initially started in ESRI Dashboards, and later shifted to adopt the RShiny/Leaflet framework. This included development of filters, sort functions and a basic/advanced views in TableView panel, that can be displayed on a basemap, and reference maps in MapView (Figure 16).

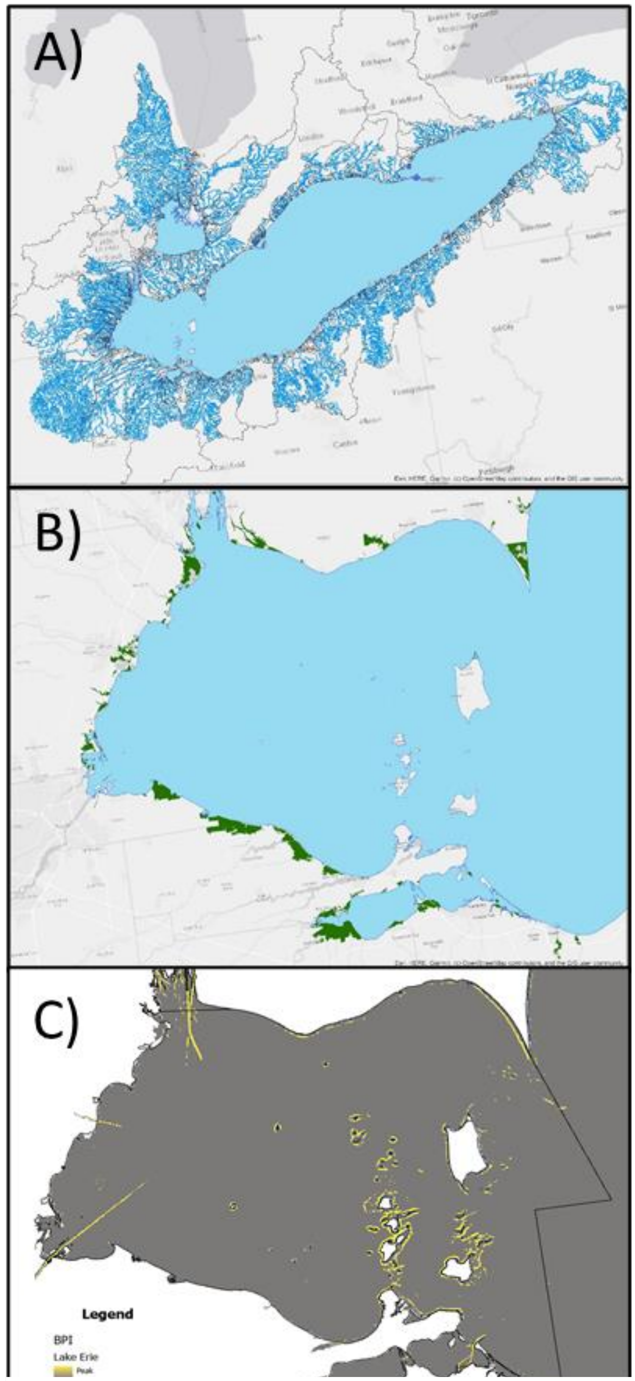

Figure 14:Example of some of the PMA layers updated or developed in 2021 including A) rivers and tributaries, B) Coastal wetlands, C) Natural reefs using topographic position index and rugosity (current in a development stage)

[18] Goodyear, C.S., T.A. Edsall, D.M. Ormsby Dempsey, G.D. Moss, and P.E. Polanski. 1982. Atlas of the spawning and nursery areas of Great Lakes fishes. Volume nine: Lake Erie. U.S. Fish and Wildlife Service, Washington, DC FWS/OBS-82/52.

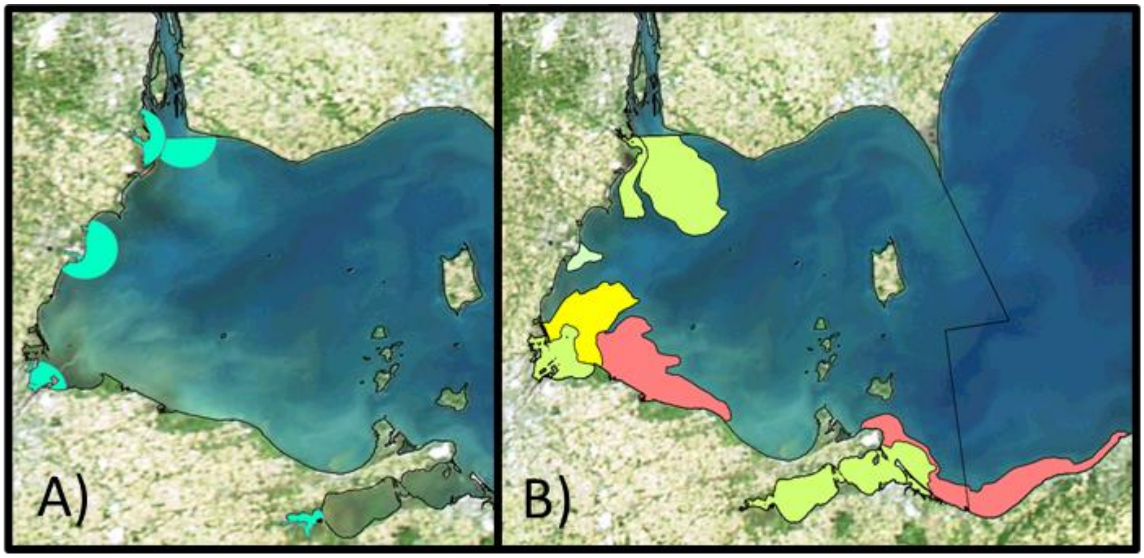

Figure 15: River plume layer development A) initial concept based on a 5km buffers around river mouths, transitioned into B) plumes delineation based on orthoimagery that define plume area and relative intensity gradient with highest plume intensity (green), moderate intensity (yellow), and minimal intensity (red).

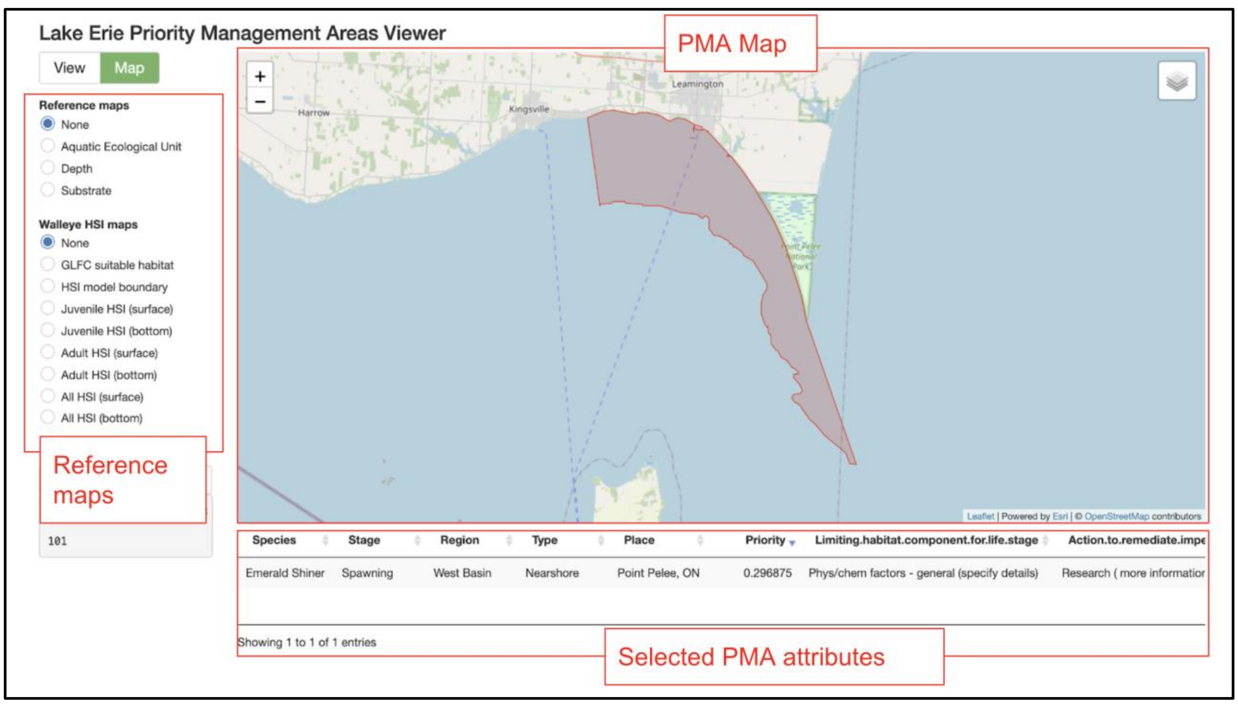

Figure 16: Screenshot of the PMA viewer

Charge 2. Assist Member Agencies with Technology Use

There was no new work towards this charge in 2021. There are ongoing efforts targeted at this charge which have been captured in prior reports. One such effort is the Real-time Aquatic Ecosystem Observation Network (RAEON; raeon.org). This program provides instruments, technical expertise, and data management for research on the Great Lakes. Through 2022 the HTG will continue to look for opportunities to assist agencies with the use of technologies.

Charge 3: Support other task groups by compiling metrics of habitat

There was no new work towards this charge in 2021. Like Charge 2, there are ongoing efforts reported in prior HTG reports. One ongoing effort is the Experimental Lake Erie Hypoxia Forecast led by NOAA (https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/hypoxiaWarningSystem.html). This system provides a forecast of bottom temperature and dissolved oxygen with the intent to alert users of hypoxic events (including upwelling events) in Lake Erie. The information collected and forecasted through this effort assists fisheries managers as well as a many other stakeholders around Lake Erie. Over the next year, the HTG will continue looking for opportunities to compile habitat metrics which are beneficial for the goals and objectives of the LEC.

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 data provided from the PMA exercise is reported with the caveat that it is a working dataset based on the best available information. The intention, as designed, is for the HTG to continuously refine the data as new information becomes available and prioritizations are subject to change. Use of the PMA information should be done with this understanding and consultation with HTG co-chairs to ensure proper interpretation of the most recent dataset is highly advised.

- 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.

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.