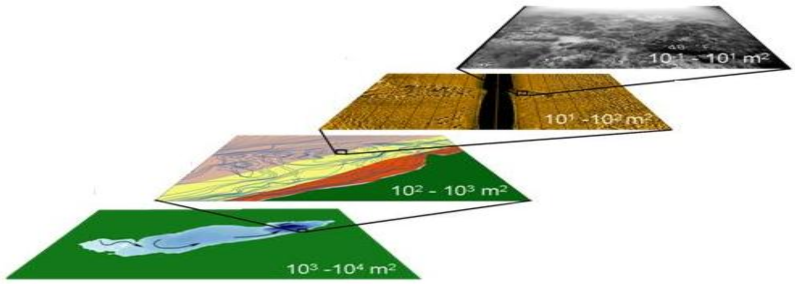
Report of the
Lake Erie Habitat Task Group
2013



Multiscalar habitat assessment of historical and potential lake trout spawning habitats in Lake Erie.

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Section 1. Charges to the Habitat Task Group 2012-2013

1. Document habitat related projects. Identify and prioritize relevant projects to take advantage of funding opportunities.

2. Support Lake Erie GIS development and deployment.

3. Assist the Coldwater Task Group with the lake trout habitat assessment initiative.

4. Develop compilation of fish habitat related metrics.
    a. With the assistance of the Walleye Task Group, identify metrics related to walleye habitat for the purpose of re-examining the extent of suitable adult walleye habitat in Lake Erie.

5. Develop a strategic research direction for the Lake Erie Environmental Objectives.

Section 2. Document Habitat Related Projects

C. Castiglione, E. Weimer

The first charge to the 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 with a map interface can be found online at:
http://www.glfc.org/lakecom/lec/spatial_inventory/inventory_index.htm

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) and waterbody (Table 2-2).

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

Basin	Number of Projects
Western basin	10
Western and Central basin	3
Central basin	11
Central and Eastern basin	7
Eastern basin	15
Entire Lake Erie basin	11
Huron-Erie corridor	19

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

Waterbody	Number 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	14
Lake St. Clair	2
Middle Harbor	1
Niagara River	2
North Maumee Bay	1
Sandusky River and Bay	1
Spooner Creek	1
St. Clair River and/or Lake St. Clair	2
St. Clair River, Lake St. Clair, Detroit River	3
Walnut Creek, PA	1
N/A	38

Building on the development of the Environmental Objectives detailed in Section 6 (below), the second responsibility of this charge is focused on recommending projects and identifying gaps in research/restoration needs for future funding opportunities. These recommendations would be developed from expert opinion within the task group 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. Fish Habitat Assessment and Rehabilitation in the St. Clair-Detroit River System

G. Kennedy, J. Craig, E. Roseman, J. Boase, J. Chiotti, S. Ireland

Field and laboratory investigations continue in the St. Clair-Detroit rivers system to assess and measure the location, phenology, and density of fish eggs and larvae. Detailed sampling methods are available in Roseman et al. (2011a, b) and Figure 2a-1 displays sample sites for fish eggs and larval fishes. Information and data gleaned from these studies is being used to develop habitat restoration strategies that address BUIs and assess the efficacy of recently established spawning areas.

Spawning Reef Construction

The Middle Channel reef in the lower St. Clair River (SCR) was constructed in summer, 2012. Lake sturgeon responded positively to the establishment of this reef by spawning on it while it was being constructed (http://gallery.usgs.gov/videos/543). Physical and biological assessment of the efficacy of this reef will continue in 2013-14. Three new fish spawning reefs are scheduled for establishment in the St. Clair River 2013. These include Hart's Light, Pt. Aux Chenes, and a third site yet to be determined.

In the Detroit River (DR), one new fish spawning reef is scheduled for establishment in 2013 at the Fort Wayne (FW) location. Also, efforts are underway to secure funding for enlargement of the Fighting Island (FI) reef in the Detroit River, a known lake sturgeon spawning site (Roseman et al. 2011a).

Egg Deposition Studies

2012 Progress

Our gear is designed to collect eggs from broadcast spawners. Species that we collect include walleye, sucker spp., *Morone* spp., lake sturgeon, trout-perch, and johnny darters.

Spring egg deposition in the DR was sampled with less intensity than in years past. The objective was to use the Fighting Island reef as a control for the Middle Channel reef; sites were limited to the Fighting Island area and sampling focused primarily on lake sturgeon spawning. We didn't set our gear until after the majority of walleye were done spawning, resulting in a 3-week sampling season.

The number of sampling sites in the SCR was also reduced, but still covered the entire length of the river and the full 10-week sampling season. Of notable mention is that 62 lake sturgeon eggs (222 eggs/m2) were collected on the Middle Channel site as the reef was being constructed.

In 3 weeks at Fighting Island we collected almost 12 times the number of eggs we got in 10 weeks in the entire SCR.

Fall sampling for fish eggs on the DR occurred over 4 weeks and was river-wide, including the Belle Isle reefs, Fighting Island reefs, and pre-assessment for the Fort Wayne reefs. 741 lake whitefish eggs were collected and eggs were found at all but one site over the 4-week sampling period. We ran into the unfortunate situation of massive gear loss at the Fort Wayne pre-assessment sites, but despite that, we did learn that lake whitefish are reproducing there on the natural substrate.

As with the DR, fall sampling on the SCR was also river-wide and ran for 6 weeks. This was the first fall sampling season in which we collected lake whitefish eggs from the SCR since our sampling program began there in 2010. Three lake whitefish eggs were collected from a site just downstream of the city of St. Clair, the only site to produce any eggs. This sampling season was the first full post-assessment of the Middle Channel reefs and they produced no lake whitefish eggs.

2013 Plans

Future plans for studying egg deposition include: SCR – post-assessment of the Middle Channel reef, and pre-assessment at Hart's Light near Marine City and in the North Channel at Pointe aux Chenes; DR – re-do the pre-assessment at Fort Wayne (modified location) and Grassy Island, post-assessment of the reef expansion at Fighting Island.

Larval Fish Studies

2012 Progress

While many of the same native and invasive species were found in both systems, the DR had about an order of magnitude more larval fish than the SCR and the timing of fish early life history events was delayed in the SCR compared to the DR, likely due to water warming rates being slower in the SCR.

In the DR, we found lake whitefish, walleye, yellow perch, *Morone* spp. (white bass/white perch), suckers, lake sturgeon, and several native forage fish species to be relatively abundant in the middle and lower river as well as at sites in Lake Erie near the river mouth.

In the SCR, walleye, yellow perch, and suckers were found in lower abundances than in the DR.

Transient coldwater fishes such as deepwater sculpin, rainbow smelt, cisco, and lake whitefish were found in both rivers in low abundances. Invasive species were found in both rivers and included rainbow smelt, round gobies, tubenose gobies, white perch, and common carp.

Lake sturgeon were collected in the DR immediately below the Fighting Island reef and in the North and Middle Channels of the SCR. Collections of larval and juvenile native lampreys (*Ichthyomyzon* and *Lampetra* species) occurred in the North Channel of the SCR concurrent with collections of lake sturgeon.

All larval fish samples from previous years have been sorted, identified and measured. Databases have been updated and QA/QC'd.

2013 Plans

Sampling will continue in both rivers this year with an emphasis on pre- and post-construction assessments of constructed habitats such as Middle Channel reef, Hart's Light, and Pt. Aux Chenes in the SCR, and at Fort Wayne, Belle Isle (reefs, connectivity and wetland restoration), and northeast Grassy Island in the DR, and assist with planning new restoration projects. In the lower DR and river mouth area, intensive collections will occur to satisfy data needs for collaborative bio-physical modeling efforts, genetics, and micro-elemental stock analyses. Sampling for larval lake sturgeon is scheduled to occur in the SCR at the Middle Channel reef.

Habitat Mapping

2012 Progress

Side-scan sonar (EdgeTech) and under-water TV for habitat mapping was conducted in the SCR in the spring/summer of 2012. Sites focused on areas that have been determined to be potential areas for future reef construction or restoration sites. Data collection is complete at Hart's Light and Algonac, which are priority sites that were picked for enhancement in 2013. Data processing is 70% complete for Hart's Light, and just beginning on Algonac N. Channel Split. Other sites where we are still collecting data are Marysville, Mid-Channel, Chenal A Bout Rond, and Marine City.

2013 Plans

Plans for habitat mapping include finishing data collection and processing for the SCR sites listed above, as well as begin data collection and processing at DR sites Fort Wayne, Belle Isle, and Grassy Island.

References

Roseman, E.F., B.A. Manny, J. Boase, G. Kennedy, M. Child, J. Craig, K. Soper, and R. Drouin. 2011a. Lake Sturgeon response to a spawning reef constructed in the Detroit River. Journal of Applied Ichthyology 27(Suppl 2):66-76.

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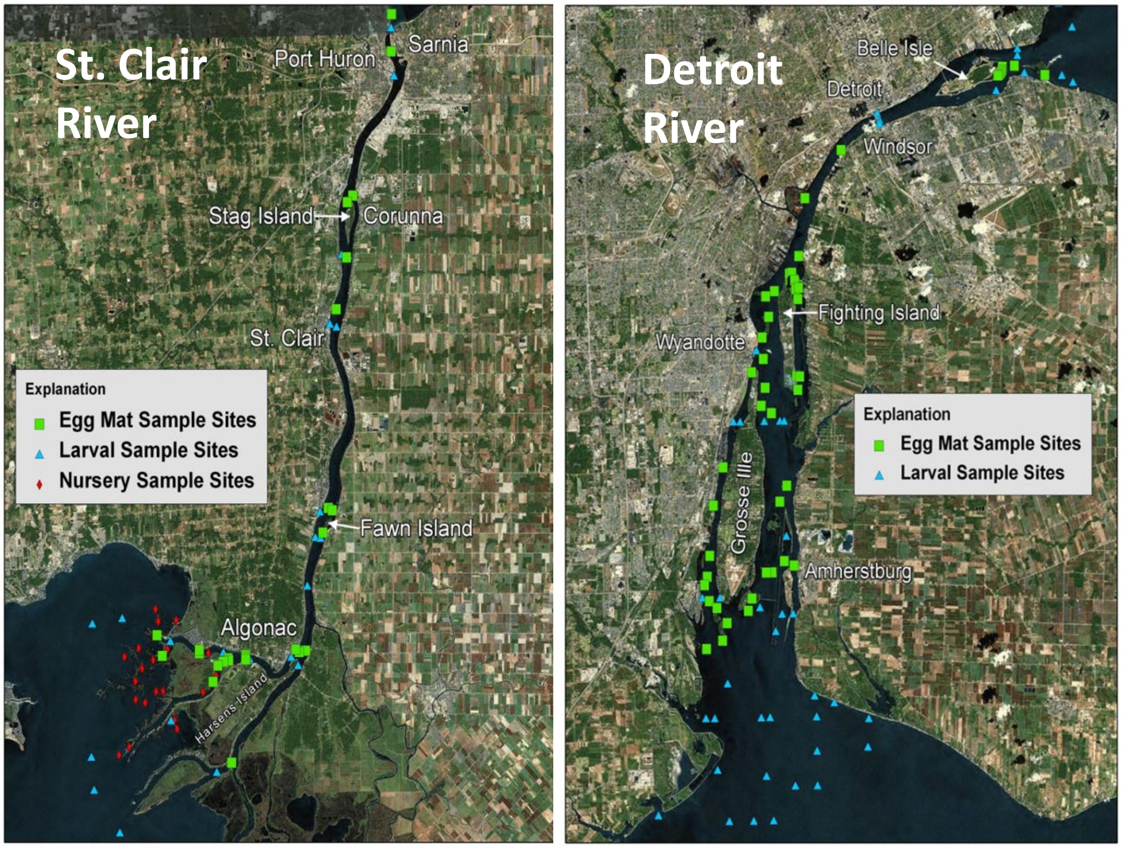

Figure 2a-1. Locations of egg, larval, and nursery sampling sites in the St. Clair-Detroit River System in 2012.

Adult Lake Sturgeon Setline Assessments

<u>2012 Progress</u>

Detroit River - The Fish and Wildlife Service has been conducting setline assessments in the Detroit River annually beginning in 2002 to obtain information on adult and subadult lake sturgeon. This data is used to obtain growth information, genetics, distribution, potential spawning sites, and population demographic information. To date, 234 sturgeon have been tagged. Using this mark-recapture data, the estimated population size of adult and subadult lake sturgeon in the Detroit River is near 4,000 individuals. In the spring of 2012, setline assessments began on April 4^{th} and continued until May 21^{st}. Water temperature during this time period ranged from 6.9 - 17.7 °C. A total of 22 lake sturgeon were captured. Eleven of these fish were implanted with transmitters to monitor movement throughout the St. Clair-Detroit River System as part of a "lake sturgeon migration" project funded by the Great Lakes Fishery Trust. Setlines were also deployed at the Fort Wayne reef location to monitor adult lake sturgeon use of this site prior to reef construction.

Southern Lake Huron - In 2012, setlines were deployed in the Upper St. Clair River and Southern Lake Huron near Port Huron to collect fish as part of the lake sturgeon migration project. Setline assessments began on May 29th and continued until June 6th. Water temperature during this time period ranged between 13.8 – 15.1 °C. A total of 36 lake sturgeon were collected. Twenty-six of these fish received transmitters.

Ultrasound - An ultrasound unit was purchased by the Service in 2012 in order to evaluate the utility of this gear to determine sex and maturity status of lake sturgeon in the field. The Great Lakes Fishery Trust Lake Sturgeon movement project provided us with the opportunity to test the ultrasound on fish of known sex since a small incision would be needed to insert transmitters. In 2012, ultrasound images were taken of 70 lake sturgeon.

Genetics - Blood samples and morphological pictures of the head region of lake sturgeon were taken of fish that received transmitters in Southern Lake Huron. The blood samples and pictures will be used to determine if a distinction can be made between St. Clair River and Lake Huron resident sturgeon by researchers from West Virginia University.

<u>2013 Plans</u>

Detroit River - Lake sturgeon tagging will continue in the Detroit River to obtain population demographic (ex. stock size, survival, and movement) information. This will mark the eighth year of subadult and adult lake sturgeon assessments. A subsample of fish captured will receive transmitters as part of the lake sturgeon migration project. Setlines will be deployed weekly at the Fort Wayne reef location to monitor the use of this area by adult lake sturgeon prior to reef construction.

Southern Lake Huron – Lake sturgeon setline assessments will continue in Southern Lake Huron and in the Upper St. Clair River to capture sturgeon as part of the lake sturgeon migration project.

St. Clair River – Setlines will be deployed weekly at the Hart's Light and Marine City proposed reef locations to monitor use of this area by adult lake sturgeon prior to reef construction.

Ultrasound images will be taken of all fish that receive a transmitter as part of the lake sturgeon migration project. Genetic and blood samples will continue to be collected.

This work is conducted in cooperation with the USGS Great Lakes Science Center, Michigan Department of Natural Resources, Great Lakes Fish Commission, Ontario Ministry of Natural Resources, and West Virginia University.

Juvenile Lake Sturgeon Assessments

2012 Progress

The Fish and Wildlife Service has been conducting juvenile lake sturgeon assessments in the St. Clair River, Detroit River, and Western Lake Erie, since 2010, evaluating habitat restoration efforts and to gain a better understanding of juvenile distribution and abundance in this system. Juvenile lake sturgeon (< 500 mm) have been targeted using otter trawls (4.9 and 6.1 m head rope; 3 mm and 32 mm cod end, respectively) and monofilament gill nets (25, 38 and 51 mm mesh). To date, efforts have included 88, 39, and 93 bottom trawls in the Detroit River, Lake Erie, and St. Clair Rivers, respectively, for a total sampling area of 375,000 meters^2. Monofilament gill net efforts include 119 hours in the Detroit River and 530 hours in the St. Clair River in 2012. From the combined trawl and gill net effort, six YOY (134-190 mm) and one juvenile lake sturgeon (476 mm) have been captured. Three YOY were captured in a bottom trawl along the east side of Fighting Island in the Detroit River in 2010, two were captured in a bottom trawl near the head of Dickinson Island in 2011, and one was captured in a gill net (38 mm mesh) near the head of Dickinson Island in 2012. There are an estimated 50,000 adult lake sturgeon utilizing the SCDRS, and while good numbers of juveniles over the age of 3 have been observed, different locations and techniques should be considered for the collection of younger age classes.

The most common fish species captured during 2012 trawls surveys in the Detroit River and Lake Erie included: spottail shiner (61%), white perch (9%), gizzard shad (5%), and smallmouth bass (4%). The most common fish species captured in the St. Clair River trawl surveys included: spottail shiner (49%), log perch (10%), rainbow smelt (8%) and round goby (7%). Catches in the gill nets primarily included rock bass (24%), white perch (21%), stonecats (8%), yellow perch (7%), northern madtom (7%), walleye (6%), and channel catfish (6%).

2013 Plans

St. Clair River/Southern Lake Huron - Trawl and gill net assessments targeting juvenile lake sturgeon will continue in 2013. More effort will be devoted towards gill netting (25, 38 and 51 mm mesh) because of the positive results obtained during the 2012 sampling season. Assessments will focus in areas below habitat enhancement projects (Middle Channel reef, Hart's Light reef, and Marine City reef), but will also be placed throughout the river. Gill netting in Southern Lake Huron/Upper St. Clair River will follow the protocol developed by the Lake Superior Lake Sturgeon Task Group. Monofilament gill nets consisting of 183 m of 124 mm mesh, 61 m of 203 mm mesh, and 61 m of 254 mm mesh (1000' total) will be used. Nets will be placed at random locations in three different zones (0-2, 2-5, and 5-10 km) originating from the headwaters of the St. Clair River (Figure 2a-2). Approximately 50% of effort will be allocated in the 0-2 km zone while 25% in the other two zones. This technique has proven to be successful in other areas of the Great Lakes to capture juvenile lake sturgeon. This same technique may be used using smaller gill nets (25, 38 and 51 mm mesh) in the fall of 2013 targeting younger age classes.

Detroit River/Western Lake Erie – Trawl and gill net assessments targeting juvenile lake sturgeon will continue in 2013. More effort will be devoted towards gill netting (25, 38 and 51 mm mesh) because of the positive results obtained during the 2012 sampling season. Gill netting and trawling in the river will focus in the areas downstream of the Fighting Island reef. Gill netting in Western Lake Erie will follow the protocol developed by the Lake Superior Lake Sturgeon Task Group, however different nets will be used (25, 38 and 51 mm mesh) targeting younger sturgeon. Nets will be placed at random locations within three different zones (0-2, 2-5, and 5-10 km) starting at the Detroit River mouth (see Figure 2a-2 for an example).

Assessments conducted in cooperation with: Michigan DNR, Ontario Ministry of Natural Resources, and U.S. Geological Survey

Adult Fish Community Assessments Associated with Habitat Enhancement Projects

<u>2012 Progress</u>
St. Clair River Middle Channel Reef - The Service has been deploying gill nets to monitor the adult fish community before and after the construction of the Middle Channel reef. Experimental gill nets are fished once per week in the spring and early summer (April through June) and fall (November and December) at the middle channel reef and at a control site near the head of Russel Island. Three gill nets are set at each location. Gill nets consist of mesh sizes ranging from 75 to 150 mm in 12.5 mm increments with each net having 14 panels (2 of each mesh size). Nets dimensions are 2 m tall x 7.6 m panels x 14 panels (with randomly placed mesh sizes) for a total length of 106 m. Common biological metrics are collected from each fish species including genetic samples and aging structures from select sport fish.

Table 2a-1. Overview of adult fish community assessment effort associated with the Middle Channel reef Project.

Year	Season	Middle Channel Reef Effort in Hours (# of Weeks)	Control Site Effort in Hours (# of Weeks)
2010	Spring	184 (6 weeks)	-
	Fall	-	-
2011	Spring	445 (7 weeks)	266 (5 weeks)
	Fall	135 (2 weeks)	111 2 (weeks)
2012	Spring	113 (2 weeks)	143 (2 weeks)
	Fall	219 (4 weeks)	194 (4 weeks)

Spring (Middle Channel Reef vs. Control) - We have captured a total of 205 fish during our spring assessments on the Middle Channel reef representing 19 different fish species, the most common being white bass (0.06/hr), white sucker (0.06/hr), walleye (0.04/hr), and silver redhorse (0.03/hr). Fish species captured at the reef site which have not been captured at the control site include: chinook salmon, freshwater drum, rainbow trout, round goby, and smallmouth bass. We have captured a total of 100 fish at the control site representing 16 different fish species. The most common fish species are white sucker (0.11/hr), walleye (0.03/hr), white bass (0.02/hr), and rock bass (0.02/hr). Fish species captured at the control site and not found at the Middle Channel reef include: common carp, golden redhorse, and largemouth bass. Due to minimal effort in the spring of 2012, comparisons between pre- and post-construction cannot be made.

Fall (Middle Channel Reef vs. Control) - We have captured a total of 45 fish during our fall assessments on the Middle Channel reef representing 10 different fish species. The most common collected were walleye (0.05/hr) and northern pike (0.03). Fish species captured at the reef site which have not been captured at the control site include: smallmouth bass. We have captured a total of 46 fish at the control site in the fall, representing 14 different fish species. The most common fish species include: shorthead redhorse (0.03/hr), walleye (0.03/hr), lake sturgeon (0.02/hr), silver redhorse (0.02/hr), and gizzard shad (0.02/hr). Fish species collected at the control site and not at the reef site include: lake sturgeon, rainbow trout, white perch, and golden redhorse.

The control site near the head of Russel Island and Pt. Aux Chene seems to be an important area for juvenile lake sturgeon. Between 2011 and 2012 a total of 10 juvenile lake sturgeon (0.01/hr) ranging in size from 335 – 870 mm have been captured at this location.

Detroit River Fort Wayne Reef - Pre-assessment of the Fort Wayne reef began in the fall of 2012. Two gill nets (same specifications as Middle Channel reef) were deployed at the Fort Wayne reef location beginning on November 7th continuing until December 6th. Water temperature during this time period ranged from 5.1 – 6.4 °C.

Table 2a-2. Overview of adult fish community assessment effort associated with the Fort Wayne reef Project.

Year	**Season**	**Fort Wayne Reef Effort in Hours (# of Weeks)**
2012	Spring	-
	Fall	244 (4 weeks)

Fall (Fort Wayne Reef) – A total of 50 fish were captured during fall gill net assessments at the Fort Wayne reef site representing 8 different species. Fish species captured at the reef site included: walleye (0.08/hr), gizzard shad

(0.06/hr), smallmouth bass (0.03/hr), shorthead redhorse (0.02/hr), lake whitefish, northern hogsucker, northern madtom, and white sucker (all < 0.01/hr).

2013 Plans The Service plans to deploy two gill nets weekly during the spring (April-late June) and fall (middle November – middle December) at the Middle Channel, Hart's Light, and Marine City reef locations in the St. Clair River and at the Fort Wayne reef in the Detroit River.

Using Fyke Nets to Assess the Near-Surface Fish Assemblage in the St. Clair-Detroit River System

2012 Progress
Invasive species assessments such as the USFWS Sea Lamprey Control – Adult Assessment Program can provide insight into important information regarding non-target fish populations. A juvenile sea lamprey monitoring study provided us with a unique opportunity to utilize by-catch data to describe the near-surface fish assemblage in the St. Clair-Detroit River System. Floating fyke nets were attached to navigational buoys in the lower St. Clair and upper and lower Detroit Rivers during November through December 2011 and 2012.

Over 7,000 fish were collected in 2011 and nearly 3,000 in 2012. Fish species composition was consistent between the lower St. Clair and upper and lower Detroit River with brook silversides, emerald shiners, and bluegill representing a large proportion of the catch. The contribution of rainbow smelt in the lower Detroit River was much higher in 2011 (33%) when compared to 2012 (2%). Shannon-Weiner diversity indices were similar between the lower Detroit and lower St. Clair regions (1.3 and 2.0, respectively). The upper Detroit River showed the lowest diversity value (0.70), likely driven by a high abundance of brook silversides. Similarly, species richness was greatest in the lower Detroit River, followed by the upper Detroit and the lower St. Clair. A total of ten unidentified Coregonines 51 to 75 mm total length were captured in the Livingstone Channel in the lower Detroit River. Seven of these fish have been identified as cisco (*Coregonus artedii*) using molecular techniques at the USGS Great Lake Science Center. The high number of littoral fishes and correlation between fish species captured in fyke nets with USGS bottom trawl data in Southern Lake Huron provides evidence that the connecting channel between Lakes Huron and Erie is an important vector for the downstream movement of fish. These findings highlight the utility of non-target data and demonstrate how cooperation between fisheries programs can prove instrumental in determining fish assemblages in large river systems.

2013 Plans
The Sea Lamprey Control Program has not yet determined if fyke netting will occur in the fall of 2013. Staff from the Alpena FWCO – Waterford Substation will likely continue this effort in the fall of 2013, focusing on the lower Detroit River where the juvenile cisco have been captured.

Assessments conducted in cooperation with: U.S. Geological Survey

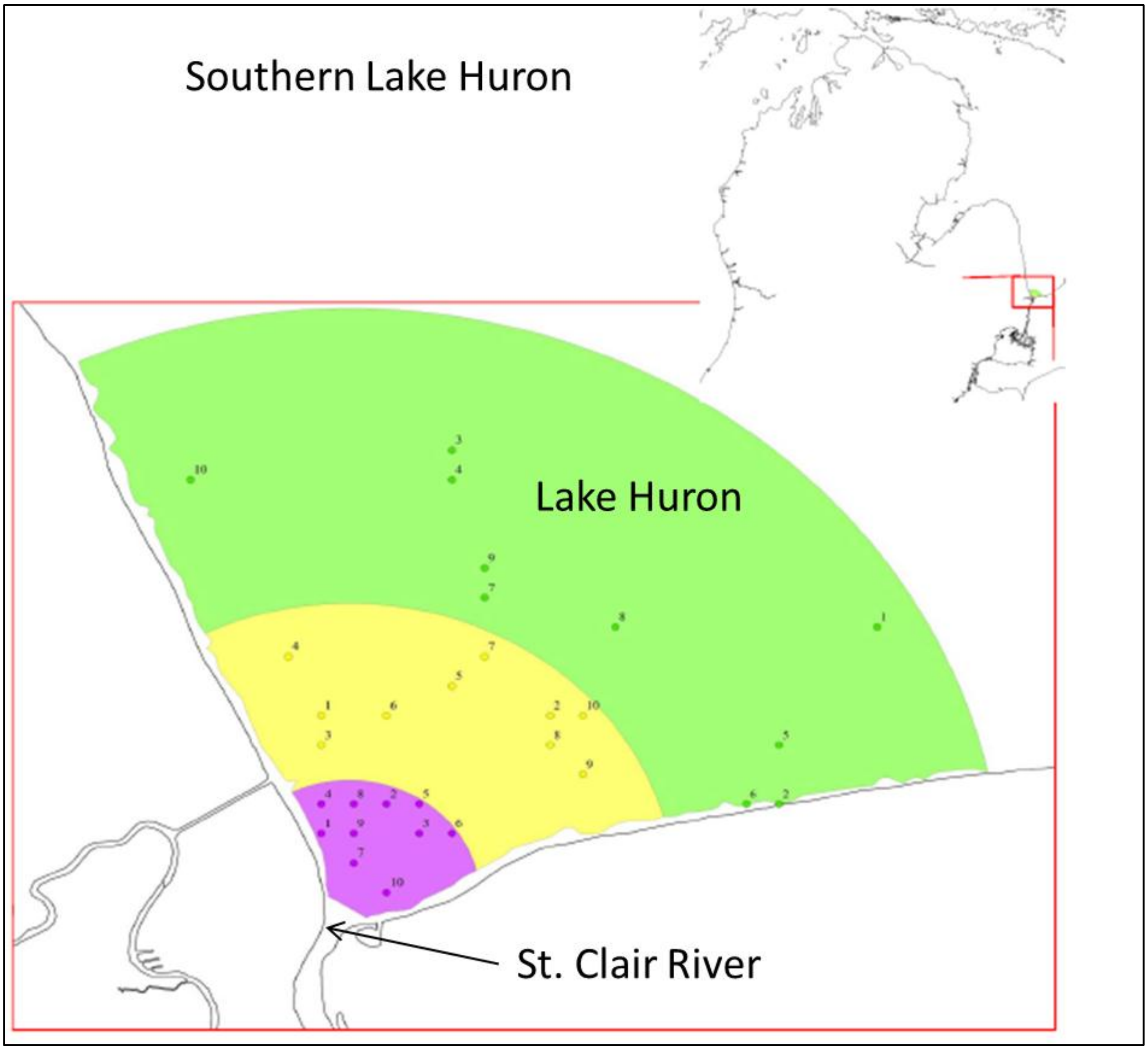

Figure 2a-2. Proposed Southern Lake Huron/Upper St. Clair River juvenile lake sturgeon sampling sites for 2013.

2b. Assessment of the Nearshore Fish Community

E. Weimer, J. Ross, C. Mayer

The fish community of the Lake Erie western basin nearshore historically contained many common phytophilic fish species (e.g., centrarchids, esocids), and even provided a valuable component to the commercial fishery (Baldwin et al. 1995). From the early 1900s until the 1970s, these species have suffered the impacts of increased anthropogenic activity (shoreline development, wetland loss and reduced water quality and clarity) in the Lake Erie watershed (Casselman and Lewis 1996), leading to a severe community decline in the lake. Following the 1972 signing of the Great Lakes Water Quality Agreement, water quality in Lake Erie generally improved, especially clarity as influenced by reductions in phosphorus and, later, the introduction of exotic Dreissenid mussels (Charlton et al. 1999). Improved water clarity and recent low water levels have stimulated an increase in the production of aquatic macrophytes along the shoreline of the western basin. This has led to increases in the occurrence of phytophilic fish species in ODNR trawling catches at some standardized sites (Division of Wildlife, unpublished data). However, the design of the current trawling program is not extensive enough in nearshore habitat to properly assess this community.

Since 2007, the Division of Wildlife has sampled sites in the nearshore using trawling and electrofishing. During 2011, the University of Toledo's Lake Erie Center undertook a cooperative project (FSGR02) with the Sandusky office of the Ohio Division of Wildlife to develop a sampling design for the nearshore fish community of western Lake Erie. Specific objectives include: 1) Determination of an optimal sampling method (night and day electrofishing and overnight trapnets) based on both fish abundance and species diversity, 2) Determine optimal sampling frequency, duration of sampling, and number of locations, and 3) Describe relationships between the nearshore fish community and limnological and physical parameters (TP, chl-a, zooplankton, benthic invertebrates, nearshore substrate, shoreline features).

Twenty-five sites between Toledo and Cleveland were selected for sampling (Figure 2b-1). Sites were selected based on geomorphic shoreline features and plume zones. The geomorphic shoreline features as categorized by the USACE include clay, bedrock, bluff bank, sand, and wetlands. Plume zones were generated based on the similarities of dominant summer flow, dissolved oxygen, temperature, and secchi depths. The four most easterly sites were sampled by Ohio EPA. During 2011, twenty sites were sampled by University of Toledo and Division of Wildlife personnel. Daytime electrofishing was conducted once at eleven sites and twice at nine sites. Nighttime electrofishing was conducted once at fifteen sites and twice at four sites. Six sites included overnight trapnet sets. During 2012, twenty-one sites were sampled by the University of Toledo and Ohio EPA personnel. Sites were sampled twice with both daytime and nighttime electrofishing; trapnets were not used in 2012. Sampling consisted of electrofishing a 500-m shoreline transect at each site using equipment and methods in accordance with Ohio EPA standards (Thoma 1999). Fish were processed and shoreline habitat types were recorded every 100-m in order to develop habitat associations for all fish species.

Optimal sampling method was examined based on fish abundance and species diversity. Because we were not able to sample the full 500 meters at some sites due to issues such as bad weather or boat malfunctions, we calculated the total fish species richness and total number of individuals for a given sampling event and set the values relative to 100-m. Total fish species richness was significantly greater with night electrofishing than daytime electrofishing during both years (Figure 2b-2). The number of individuals captured per 100-m transect was also significantly greater with nighttime electrofishing. Night electrofishing captured six species (creek chub, fathead minnow, northern hogsucker, northern pike, silver chub, and rainbow trout) that were not detected with daytime electrofishing. Overnight trapnet sets were ineffective in 2011, and not used in 2012. These results suggest that night electrofishing best describes the shoreline fish communities at the site level.

Incident-based species accumulation curves were used to examine survey timing. Early summer sampling accrued more species than late season sampling for both daytime and nighttime electrofishing, therefore requiring less sampling effort (Figure 2b-3). Based on a total of 52 fish species being captured across the two years of sampling, we calculated the number of sites required to capture 90%, 75%, and 65% of the total species richness. No sampling method captured 90% of total species richness (Figure 2b-3) with less than 25 sites. During 2011, early summer sampling at nighttime captured 65% and 75% of total species richness with fewer sites (7 and 12 sites, respectively) than daytime (12 and >20 sites, respectively). Early summer accumulation rates for night and day electrofishing were identical during 2012. In summary, nighttime electrofishing during early summer appears to be the most efficient method of sampling the Lake Erie nearshore fish community.

To identify the impacts of shoreline alteration, we classified each 100-m transect within a site using three different categories: 1) shoreline type (i.e. hard, soft, or wetland), 2) aquatic vegetation (presence/absence), and 3) shoreline armoring (presence/absence). Categories for shoreline types were made by combining the geomorphic shoreline types; hard included bedrock and bluff/bank, soft included sand and clay, and wetland. To quantify differences of fish species richness in relation to shoreline alteration we ran a series of two-factor ANOVA's that were modified to fit Poisson distributions; year was nested within the factors. We selected two 100-m transects from each site that best represented the combination of categories to insure independence across sites. Mean fish species richness from all sampling was compared across shoreline classes. Armoring had differing impacts on species richness depending upon the shoreline types (Figure 2b-4). Richness was lower at wetland shoreline sites ($p=0.004$) that were armored, while soft shorelines that were armored showed increased species richness (p=0.0004). Species richness was higher in the presence of vegetation on all shoreline types (Figure 2b-5), although it was not significant on hard shorelines (p=0.85). Similarly, species richness was higher in the presence of vegetation regardless of presence of armoring (Figure 2b-6).

To examine the impacts of shoreline alteration on the nearshore fish community, we predicted the fish community response to shoreline changes. We developed a Habitat Use Index (HUI) using the probability of occurrence and distance of shoreline ($\sum(Distance_i * Pr(y_i=1))$). To calculate the probability of occurrence, we used a logistic regression with three predictor factors: shoreline type, vegetation, and armor. Fourteen fish species that are commonly found in the nearshore were selected; presence/absence of species from all sampling in 2011 and 2012 were pooled for this exercise. The resulting probabilities were joined to a layer in ArcGIS that comprised the shoreline factors to calculate the distance (meters) of shoreline associated with each of the predicted probabilities. The distances were then multiplied by the probabilities of occurrences and summed across the shoreline to calculate the HUI.

Since the shoreline is expected to be 100% armored in the future (OLEC 2004) we applied these results to five different scenarios that cover the extreme possibilities to be faced by future management. Each scenario simulates changes in the amount of armoring and vegetation while the shoreline types were left constant to emulate possible future shoreline conditions. Scenarios include: 1) current - 56% armor & 28% vegetation, 2) least impact - 0% armor & 100% vegetation, 3) armor with vegetation - 100% armor & 100% vegetation, 4) armor no vegetation - 100% armor & 0% vegetation, and 5) current armor with vegetation - 56% armor & 100% vegetation. The focal area for this exercise spanned the Lake Erie shoreline from the Portage River to Marblehead (Figure 2b-1). Mapping and quantifying the current amount of vegetation and armoring was done in ArcGIS and visually validated with Google Earth. When compared to the “current” scenario, “least impact” and “current with vegetation” scenarios both resulted in increases in the Habitat Use Index (HUI) for all but two species and had larger mean HUI’s than other scenarios (Table 2b-1). The scenarios with 100% armor resulted in large shifts in the fish communities. For example, “armored with vegetation” scenario depicted the reduction of habitat used by some Lake Erie offshore species (walleye, yellow perch, and white perch) while increasing habitat for other species. The “armored without vegetation” scenario resulted in a decrease in the HUI for most species. The Habitat Use Index and the species richness analysis portray the same negative impacts of armoring and benefits of vegetating shorelines. Future management actions should consider these results prior to undertaking large-scale changes to the nearshore.

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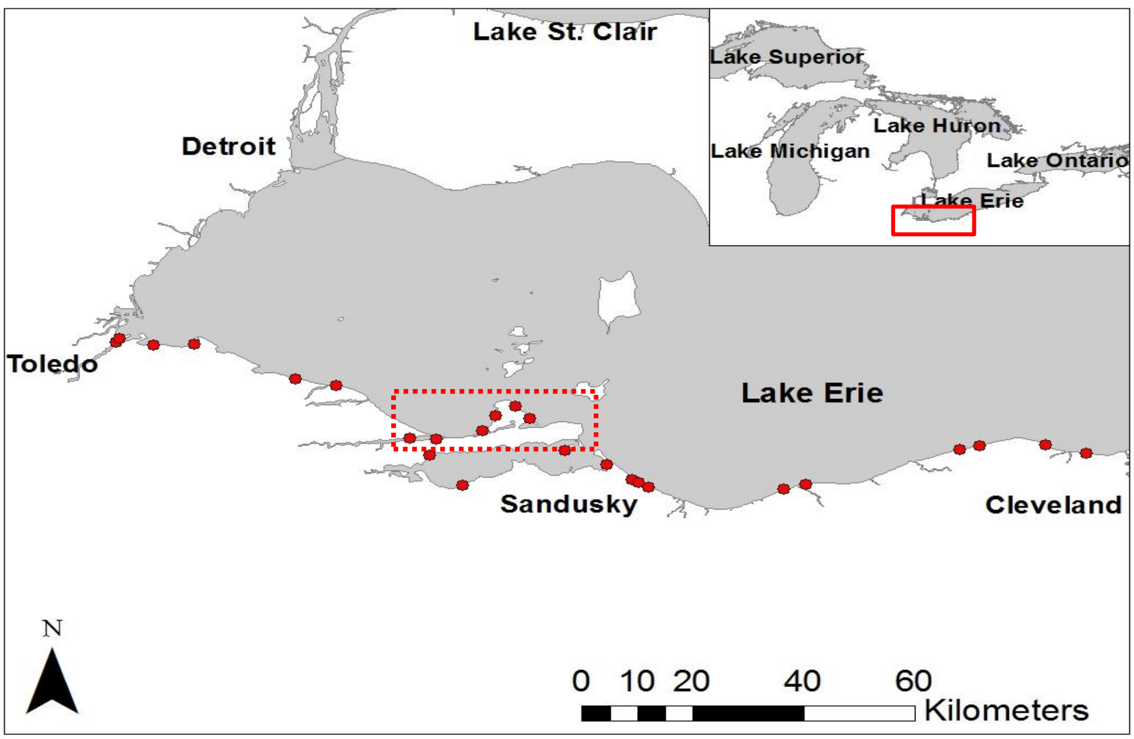

Figure 2b-1. Nearshore sampling locations in the western basin of Lake Erie during 2011 and 2012. Area inside red dotted line was used to forecast potential effects of shoreline changes on nearshore fish species.

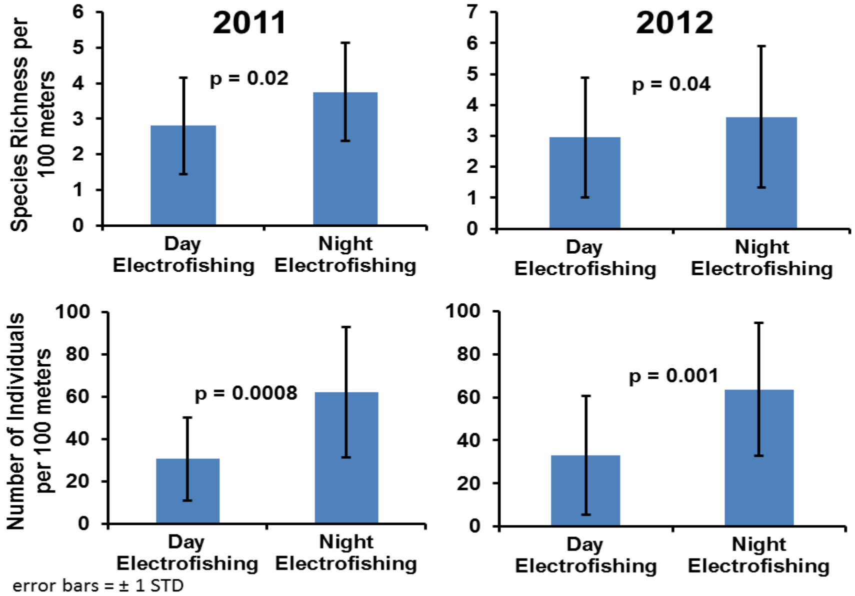

Figure 2b-2. Comparisons of night electrofishing and day electrofishing in 2011 and 2012. Night electrofishing captures significantly more species and individuals per 100 meters than day electrofishing.

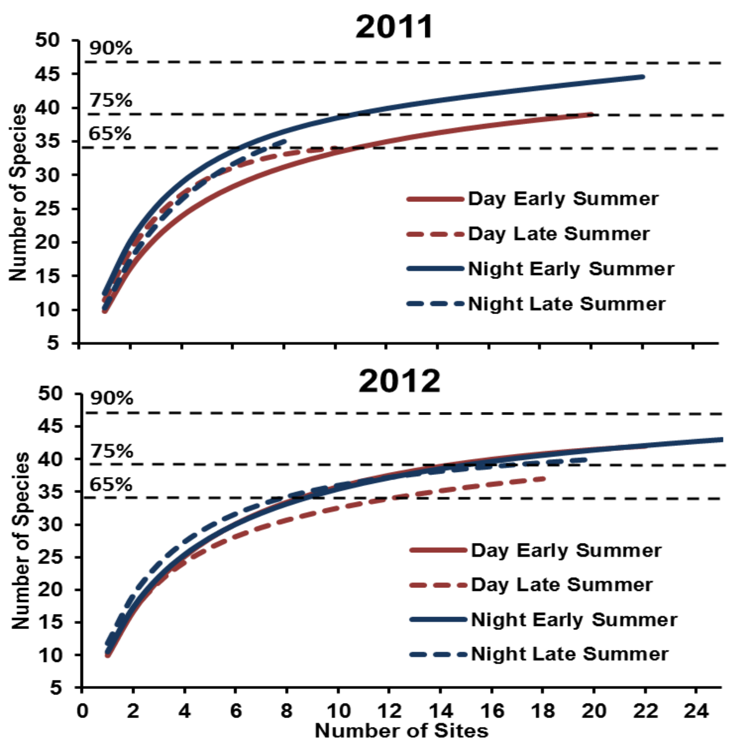

Figure 2b-3. Incident-bases species accumulation curves for day and night electrofishing throughout the summers of 2011 and 2012. Percentages are based on the total species richness across the two years (n=52).

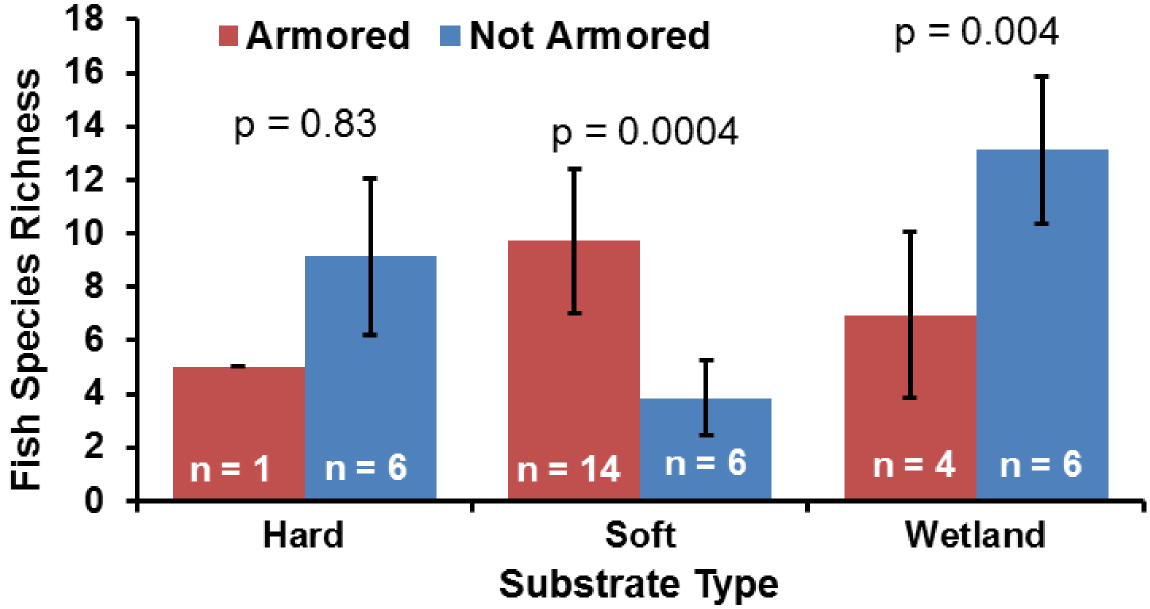

Figure 2b-4. Effect of armoring on fish species richness across shoreline types.

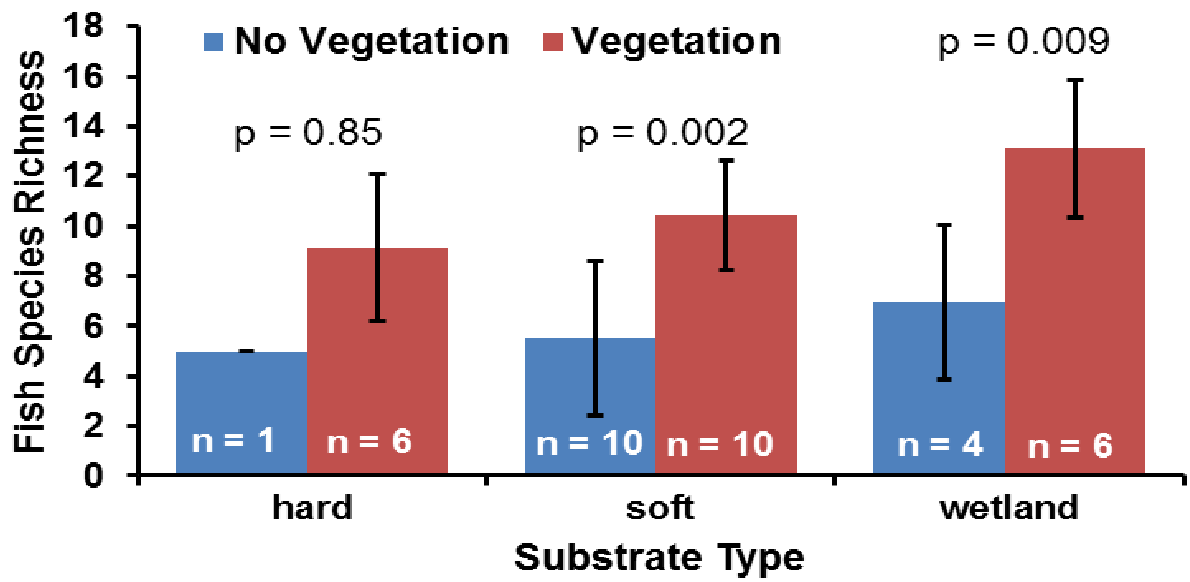

Figure 2b-5. Effect of vegetation presence/absence on fish species richness across shoreline types.

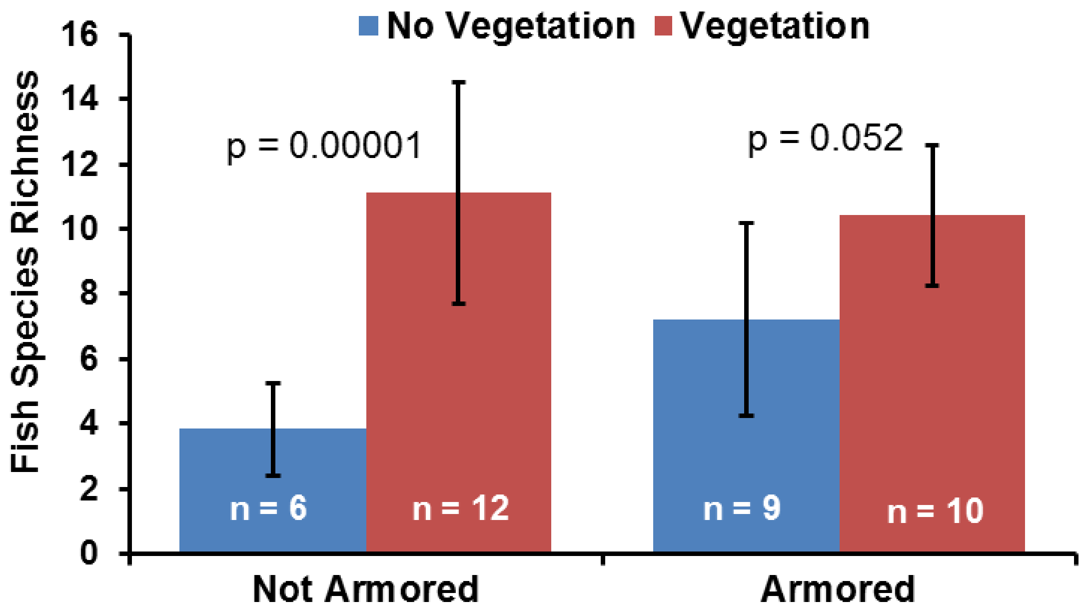

Figure 2b-6. Effect of vegetation presence/absence on fish species richness on armored and unarmored shorelines.

Table 2b-1. Comparison of the Habitat Use Index for 14 species across five forecasted management scenarios. Index values are set relative to the 'Current' scenario.

Species name	Current 56% armor 28% veg	Least impact 0% armor 100% veg	Armored w/veg 100% armor 100% veg	Armored no veg 100% armor 0% veg	Current w/veg 56% armor 100% veg
Bluegill	0	7773	12196	-442	12156
Bowfin	0	236	-466	-713	219
Golden redhorse	0	516	1725	1042	1020
Green sunfish	0	1555	1294	142	1860
Largemouth bass	0	6016	11068	-860	10009
Logperch	0	-1380	3695	3820	854
Pumpkinseed sunfish	0	9379	2530	-2064	7040
Round goby	0	-1380	3695	3820	854
Shorthead redhorse	0	1620	1042	-734	1257
Smallmouth bass	0	3639	5305	-1408	4342
Walleye	0	1172	-2243	-183	-796
White perch	0	3511	-3416	-1193	-193
Yellow bullhead	0	1692	-352	-1947	1349
Yellow perch	0	1624	-1094	-1107	594
Mean	**0**	**2570**	**2498**	**-130**	**2897**

2c. Central Basin Hypoxia and Yellow Perch

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

In systems that are seasonally affected by hypoxic bottom waters, such as Lake Erie, population assessments may be influenced by anomalous high catch rates of particular species. There is evidence that large catches are caused by an aggregation of fish in marginal habitats due to avoidance of low dissolved oxygen (D.O.). In 2008, for example, we collected 10,739 age-0 yellow perch in one 10 minute tow in normoxic waters adjacent to the hypoxic zone. All other catches at that site averaged 42 fish/tow (range 1-141), and this value of 10,000 was more than 200% greater than the next largest catch in the 22 years of this survey. We tracked the 2008 cohort in subsequent surveys from age-0 to age-2 and found that including this observation had a disproportionate influence on the District-2 (D2) index for that cohort. Including this datum, the 2008 cohort in D2 ranked among the top 15% of hatches in 22 years (i.e. rank of 3). Subsequent sampling of this cohort (as age-0 in the fall of 2008, as age-1 in fall of 2009, or as age-2 from the ADMB estimate in 2010) indicated that it was average (in the top 40-60% of all years). Similarly, low D.O. habitats frequently have zero catches, which may contribute to relative underestimation of year-class strength. Currently, there is no consensus on the best way to handle this sort of variability in the estimation of year-class strength for percids in Lake Erie. In part, this situation is hampered by a lack of understanding of how fish distribution changes in response to low dissolved oxygen.

To better understand how fish distribution changes in response to seasonal hypoxia, we conducted an intensive survey at one site (Chagrin, near the Grand River) in the Ohio waters of the Central Basin in 2011 and 2012. We quantified the epi- and hypo-limnetic spatial distribution of fishes across a depth gradient and associated ecotone of hypoxia in the central basin of Lake Erie. We used a combination of hydroacoustic surveys, bottom trawls, and mid-water trawls to characterize spatial patterns for individual species, fish assemblage structure, and total fish biomass. We examined diel migration effects with paired daytime-nighttime surveys in both August (during hypoxic bottom conditions) and September (during normoxic bottom conditions) in 2011. In 2012, we sampled in June, August, and September, during normoxic conditions (hypoxic conditions were not present during our 2012 sampling).

Although the biotic data are still being analyzed, we found high variability in dissolved oxygen at small spatial and short temporal scales. For example, D.O. may be normoxic (i.e. >7 mg/l) at the beginning of a trawl and hypoxic (i.e. <2 mg/l) at the end (Figure 2c-1), or the opening of the trawl net (2m high) may span a similar gradient of D.O. We installed a temperature and dissolved oxygen logger 1m from the bottom at Chagrin in 2012 (Green star in Figure 2c-1). Over short time scales (< 7 hrs) we found that bottom D.O. changed from normoxic to hypoxic at a single location (Figure 2c-2). A week prior to our August 15th survey in 2012, wind-driven events pushed hypoxic waters out of the Chagrin area (likely to the North shore), so conditions were normoxic for this survey; hypoxic waters returned shortly after the survey.

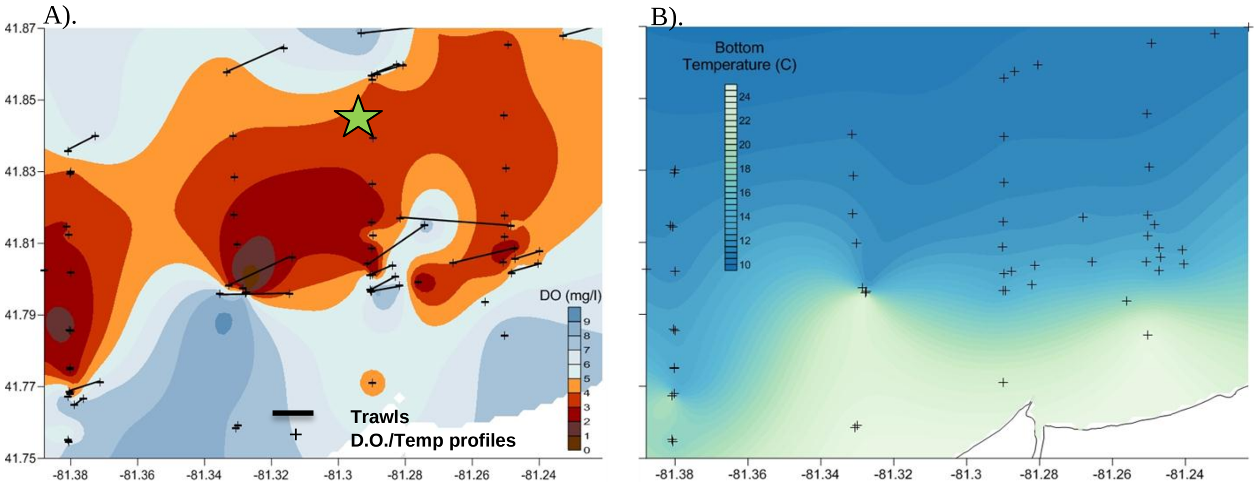

Figure 2c-1. A). Sample design for studying hypoxia over a diel period on August 16-17, 2011 with bottom and midwater trawls (---) across continuous temperature and D.O. monitoring locations (+). The longer lines indicate midwater trawls. The green star represents the location of temperature-D.O. logger installed 1 m from the bottom for the duration of the summer and fall in 2012. Bottom D.O. readings were spatially heterogeneous within the site. B). The corresponding temperature map demonstrates less spatial variability.

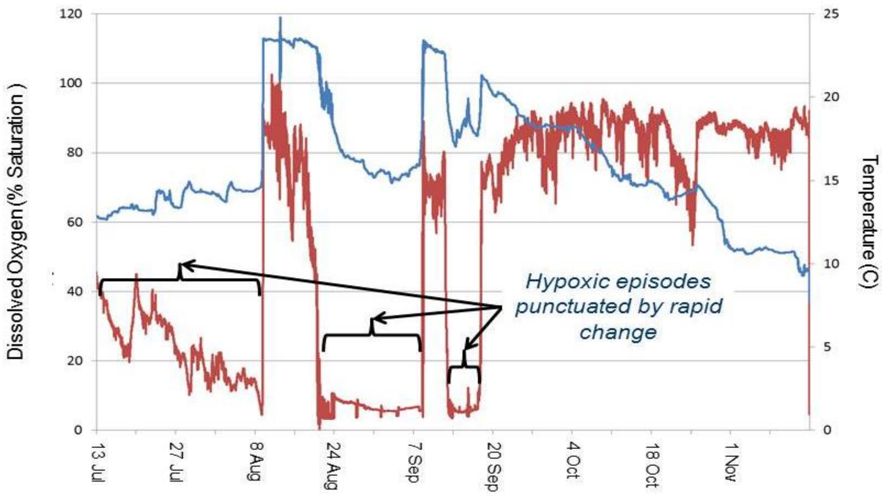

Figure 2c-2. Dissolved oxygen (primary Y-axis, red) and temperature (secondary Y-axis, blue) were highly variable over short time scales at one location in 2012. YSI data logger was installed 1m from the bottom at the Chagrin site in approximately 62 ft of water (see Figure 2c-1).

Upon analyzing the hydroacoustic data from the 4 transects at night in August 2011, we found that fish distributions were also patchy and were related to bottom D.O. (Figure 2c-3 a-c). When we examined the spatially matched target density and water quality data, we found that most cells contained fish targets regardless of D.O. concentration. However, the highest densities of fish were only found in the highest D.O. areas (Figure 2c-3 b). Also, when we examined the data as unique vertical profiles, the highest densities of fish in the epilimnion of any given vertical profile were negatively correlated with the lowest D.O. readings in the hypolimnion at that location (Figure 2c-3 c).

In 2012, we also wanted to assess the proportion of the catch collected in our bottom trawls that was suspended in the water column and was actually captured during the deployment and retrieval part of the sample. To do this, we compared catches where we only deployed and retrieved the net - the net was not towed on the bottom - to a full 10 minute trawl in the same location. Based on our preliminary work, we found that 11% and 30% of the fish collected in the bottom trawl were caught during deployment and retrieval of the net under normoxic and hypoxic conditions, respectively. This supports that bottom trawling under hypoxic conditions can overestimate fish density, and that trawling for shorter durations would further inflate the estimate. Additional work is planned to better define the proportion of the catch obtained during deployment/retrieval as a function of bottom D.O.

These findings highlight difficulties in characterizing a single trawl sample as hypoxic or normoxic, which has implications for current Task Group proposals to omit trawl samples with low D.O. (<2mg/L) from the calculation of percid recruitment indices. We recommend that future assessment sampling include temperature and D.O. profiles at the beginning and end of each tow and ancillary information such as sonar data in order to support the development of a scientifically-based decision rule.

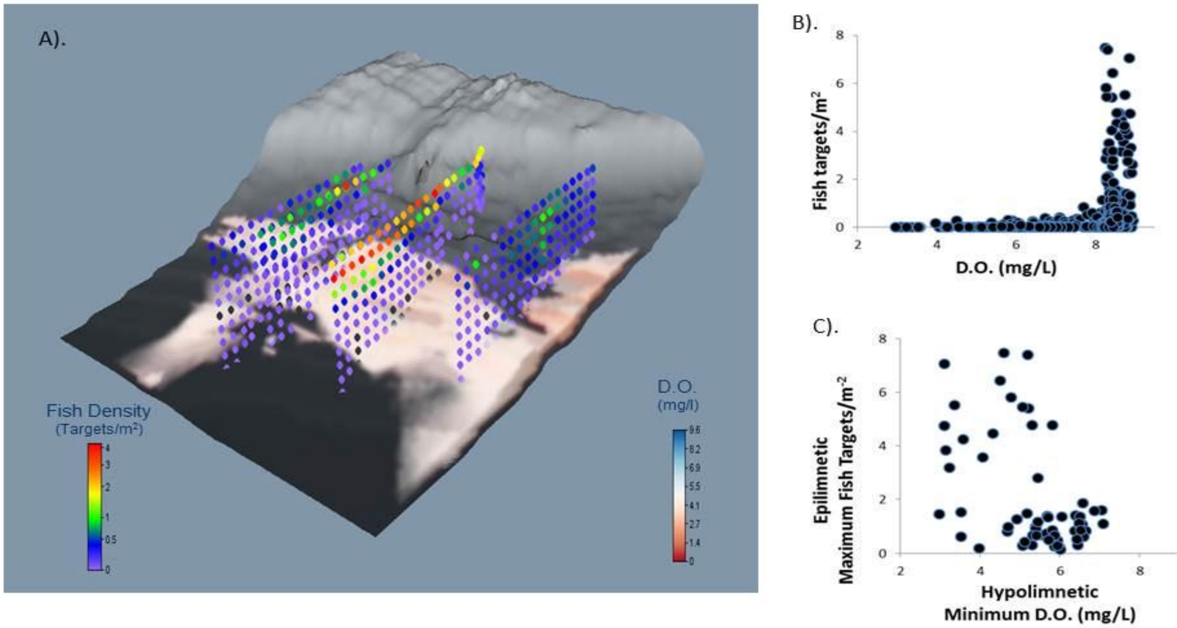

Figure 2c-3. A). When a Voxler 3D interpolation of low dissolved oxygen (D.O.) readings from the intensive sampling conducted at Chagrin in 2011 is overlaid with vertical summaries of fish densities from the hydroacoustics data, we find that the highest densities of fish are in the epilimnion above the lowest D.O. in the hypolimnion. B). When we examined the data on a pixel-by-pixel basis (500m long by 2 deep), most cells contained fish targets regardless of D.O. concentration, but the highest densities of fish were only found in the highest D.O. areas. C). The highest densities of fish in the epilimnion of any given vertical transect are correlated with the lowest D.O. readings at that location.

2d. Other Notable Habitat Projects in Brief

E. Weimer, K. Anderson, J. Markham, T. MacDougall

- *Coastal Wetland Re-connection, Middle Harbor (OH) and Erie Marsh (MI).* Work began in late-2011 to reestablish connectivity between these two coastal wetlands and Lake Erie by installing large culverts in dikes to allow natural water exchange and fish passage. In 2012, a large culvert with water control structure, pump, and carp exclusion screen was constructed between Middle and West Harbor. Middle Harbor was partially dewatered during the fall, in preparation for final drawdown in spring 2013. Pre-restoration fish, invertebrate, and plant community monitoring has been completed. In 2013, Middle Harbor will be dewatered to remove fish biomass and seeding with Japanese millet is planned to avoid colonization by invasive macrophytes. Post-reconnection fish, invertebrate, and plant community monitoring will follow. At Erie Marsh, pre-restoration monitoring has been done; the status of construction in currently unknown. (Ducks Unlimited, The Nature Conservancy, ODNR-DOW, Ohio State Parks)
- *PA Fish Passage/Habitat Improvement Projects, Multiple Locations.* Several stream projects were advanced in 2012. The Fourmile Creek fish ladder was officially opened and began passing fish in October. This project constructed bypass structures to allow steelhead passage around two obstacles, opening access to an additional 4 miles of river. The structures can be closed to eliminate sea lamprey passage during summer months. The first of four habitat improvement projects was completed in August at Walnut Creek. These projects include stream bank stabilization, in-stream fish habitat structures, and riparian plantings at previously identified locations. Finally, preparations have been made to begin fish passage projects in 2013 at Crooked Creek and a second un-named Lake Erie tributary, where rock ramps and a culvert replacement will aid in upstream fish movement.
- *Chautauqua Creek, NY, Fish Passage.* Completed in July, this project was sponsored by the NYSDEC through GLFER, and constructed by the Army COE. A lower dam on Chautauqua Creek was notched, while a rock ramp was constructed at an upper dam to allow fish passage. This project opened up an additional ten miles of high-quality spawning habitat for steelhead and other resident stream species.
- *Long Point Causeway Improvement, Long Point Bay, Ont*. Causeway construction between Big Creek marsh and Long Point Bay across several barrier islands reduced aquatic connectivity and increased vehicle mortality of terrestrial organisms. Three of eight proposed passage projects (1 aquatic, 2 terrestrial) were completed in November; additional passage projects (1 aquatic, 4 terrestrial) will be completed as funding becomes available.

Section 3. Lake Erie GIS Status

C. Riseng, L. Mason, E. Rutherford

The Lake Erie GIS has been incorporated into a larger initiative, the Great Lakes Aquatic Habitat Framework (GLAHF). The GLAHF is a GIS database of geo-referenced data for Great Lakes coastal, large rivermouth, and open water habitats being developed by the University of Michigan, along with multiple partner researchers, universities, and agencies. The project is funded for three years by the Great Lakes Fishery Trust. The goal of the GLAHF is to develop and provide access to a Great Lakes aquatic habitat database and classification framework to provide a consistent geographic framework to integrate and track data from habitat monitoring, assessment, indicator development, ecological forecasting, and restoration activities across the Great Lakes. Using coastal and offshore spatial processing zones, a gridded network of cells with attributed data-building blocks are being developed to define ecological habitat units, support classification and assessment, and facilitate linking of offshore, coastal and terrestrial process at multiple spatial and temporal scales. Data from the Great Lakes GIS is being incorporated into the GLAHF.

Charge two to the HTG involves continuing to support the Lake Erie GIS initiative, which is now GLAHF. Data important for fisheries management and restoration will be included in GLAHF including substrate and habitat mapping and walleye and yellow perch harvest by grid data. In 2012 the updated substrate maps created by HTG were incorporated into GLAHF. In 2013, we are planning to update the walleye and yellow perch harvest by grid data and the Forage Task Group Lower Trophic Level Assessment program data. This will initially include a subset of years to determine how best to incorporate these data into the database. The HTG has been utilizing side scan sonar data to map substrate, depth, and other critical fish habitat data in an effort to meet the tasks of other charges. As this technology is becoming cheaper, easier, and more common to use, the HTG will be working with the GLAHF technical staff to determine how the data can be standardized, distributed, and utilized at multiple scales.

The HTG recognizes the need for more regular updates to the lower trophic level and fisheries data components of the GLAHF and will be investigating ways of annually integrating data from LEC member agencies. The current plan is to share a data table template with the LEC agencies. The data can then be submitted to the GLAHF GIS Staff annually. The data table template should allow for easy data preparation by agencies and quick incorporation into the GLAHF. Information about GLAHF, and the overall Great Lakes GIS initiative, can be found at: http://ifrgis.snre.umich.edu/projects/GLAHF/glahf.shtml.

Section 4. Identification of Potential Lake Trout Spawning Habitat in Lake Erie

T. MacDougall and J. Markham

The task group's approach to addressing this charge has evolved along with our understanding of the current ecosystem, the limitations of best available datasets, the relatively small and localized scale of target substrate, the confounding presence of invasive species, and the location and behaviour of lake trout during spawning time. Detailed descriptions of methods and field work accomplished since 2006 can be found in previous HTG annual reports (2007-2012); http://glfc.org/lakecom/lec/HTG.htm.

In brief, past efforts have resulted in:

- Classified and mapped substrate and habitat types for important parts of the eastern basin nearshore; including historic (Brocton Shoal, NY) and potentially new (Nanticoke Shoal, ON) lake trout spawning substrate.
- Coarse scale and cursory information about other areas based on sidescan sonar reconnaissance surveys (e.g. Maitland Ridge) and underwater video explorations (e.g. 18 mile Creek, NY).
- Documentation that otherwise good structure may be compromised by fouling from dreissenid mussels, filamentous-attached algae, and sedimentation.
- Recognition that lake trout may be utilizing non-conventional habitat.

In 2012 direct actions related to this past work included: i) using areas identified as having spawning habitat potential to stock fish and ii) conducting gillnet surveys during lake trout spawning period (late fall) to document presence/absence of lake trout; as an indication of attraction to these areas (if not actual successful spawning).

Nanticoke Shoal, Ontario

Boat stocking of yearling lake trout over Nanticoke Shoal occurred on April 17-19, 2012, representing the 5th consecutive annual stocking event at this location. Stocking locations are chosen based on areas of suitable habitat. Surveys of the area using random drift with underwater video suggest that newly stocked fish disperse quickly (within days), likely to deeper waters, and therefore the window for imprinting may be brief. For details on this stocking, in relation to the history of stocking at this location and Lake Erie lake trout stocking in general, see the Coldwater Task Group annual report (http://glfc.org/lakecom/lec/CWTG.htm).

Gillnetting during late fall, to detect the presence and condition of lake trout during spawning period, occurred for the third consecutive year at Nanticoke Shoal in November 2012. Gillnet locations were chosen based on the location of the cleanest cobble substrate, a shallow ridge that runs NW-SE across the shoal. Four gangs of gillnet were used to "surround" the ridge and fishing took place on three separate occasions (November 15, 21, and 27; Figure 4-1). Lake trout were caught on the 15th and 21st, the first observations of lake trout since the fall fishing began at this location in 2010. While lake trout were caught at each of the four gillnet locations, most (>80%) were taken from nets to the west and south of the cobble ridge, proximal to a deeper trench orienting toward deeper waters, and to other areas of potential based on identified scarp debris (accumulations with interstitial spaces at the bottom of steep scarp faces) and areas of fractured bedrock.

Notably, ten of the twelve lake trout captured were originally stocked at this location at some point between 2008 and 2012. Male and female fish caught on the 15th were in pre-spawning conditions (water temperatures 9-10.6 ^{o}C) while the males caught on the 21st were in spawning conditions (water temperatures 9-9.5 ^{o}C). Details of the lake trout catch appear in the 2012 report of the Coldwater Task Group. The relative abundance of additional species found at this location in fall 2012 is shown in Figure 4-2. The most abundant species over this habitat was smallmouth bass, followed by white sucker. This was also reflected in continuous underwater video logging which took place concurrent with gillnetting and which only captured smallmouth bass on camera (< 7 minutes of smallmouth bass occurrences in > 51 hours of surveillance).

<u>18 Mile Creek Shoal, New York</u>

Underwater video surveys revealed a potential high quality lake trout spawning area off Eighteen Mile Creek (Figure 4-3). This nearshore site is relatively large and appears to possess many of the necessary attributes that lake trout need for successful reproduction, including cobble-sized rock piles, a substrate relatively clean of silt, and large interstitial spaces. The notable negative characteristic of this site, which is also true of all other known sites along New York's Lake Erie coastline, is that it is subject to the strong westerly winds and waves that buffet the area during fall and winter months. However, because this site is shallower and closer to the eastern end of the lake, it often becomes ice covered during winter, potentially diminishing some of these effects.

Fall gillnetting in both 2011 and 2012 found that spawning-phase lake trout visited this site, and while the numbers of lake trout caught were not as high as on other nearshore sites sampled in recent years, sampling confirmed that spawning lake trout did find this habitat and were apparently using it despite its distance (25 miles) from the nearest stocking locations (Figure 4-4). Moreover, the presence of ripe female lake trout indicates that it is a probable spawning area. To date, this site appears to have the best quality habitat for spawning lake trout that we have surveyed in the NY waters of Lake Erie.

<u>Future Plans</u>

Future investigations will involve the monitoring and assessment of other previously identified habitat areas, use by fish in late fall, and evidence of spawning attempts using egg traps.

LT spawning habitat collaborators past and present include:
S.D. Mackey, and A.M. Gorman (ODNR), and P. Kocovsky (USGS), H. Biberhofer (EC), and Jim Grazio, (PADEP) .

Fall surveys on Nanticoke Shoal were partially funded with assistance from the Canada Ontario Agreement; Respecting the Great Lakes Basin Ecosystem.

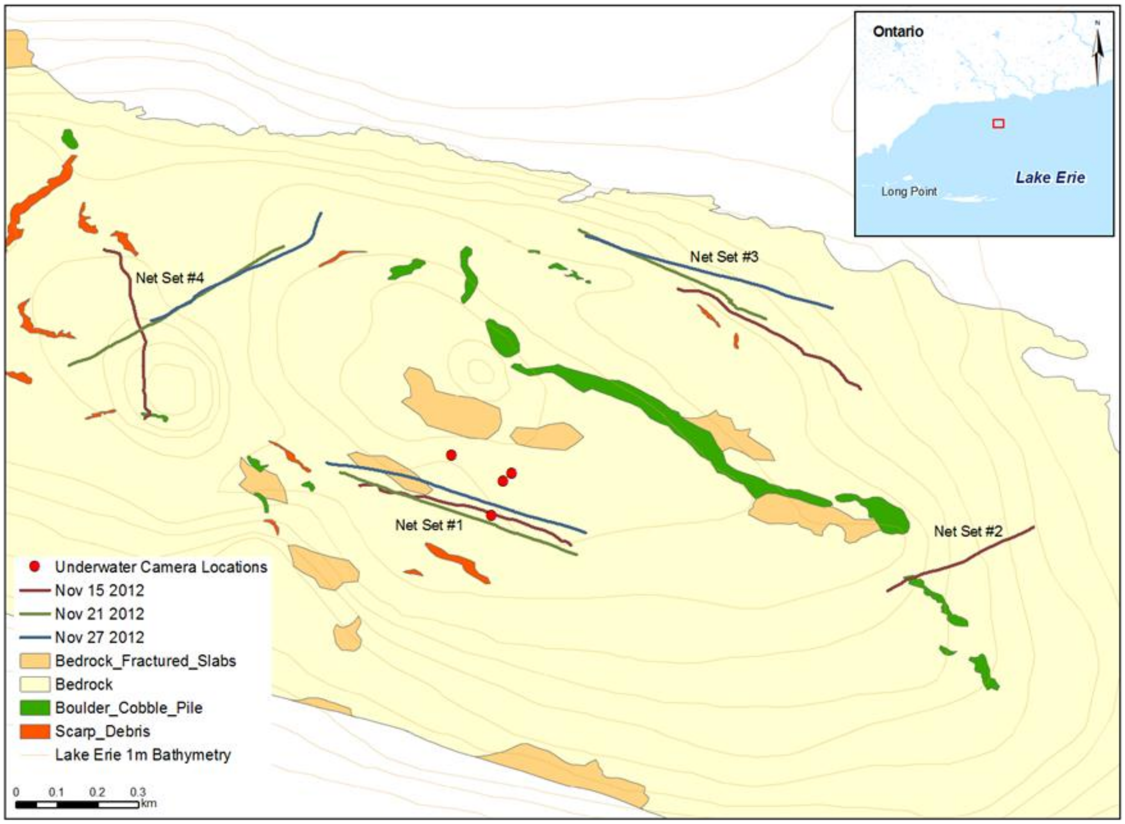

Figure 4-3. Locations of gillnet sets relative to key substrate and habitat features, during fall lake trout assessments at Nanticoke Shoal, ON, 2012.

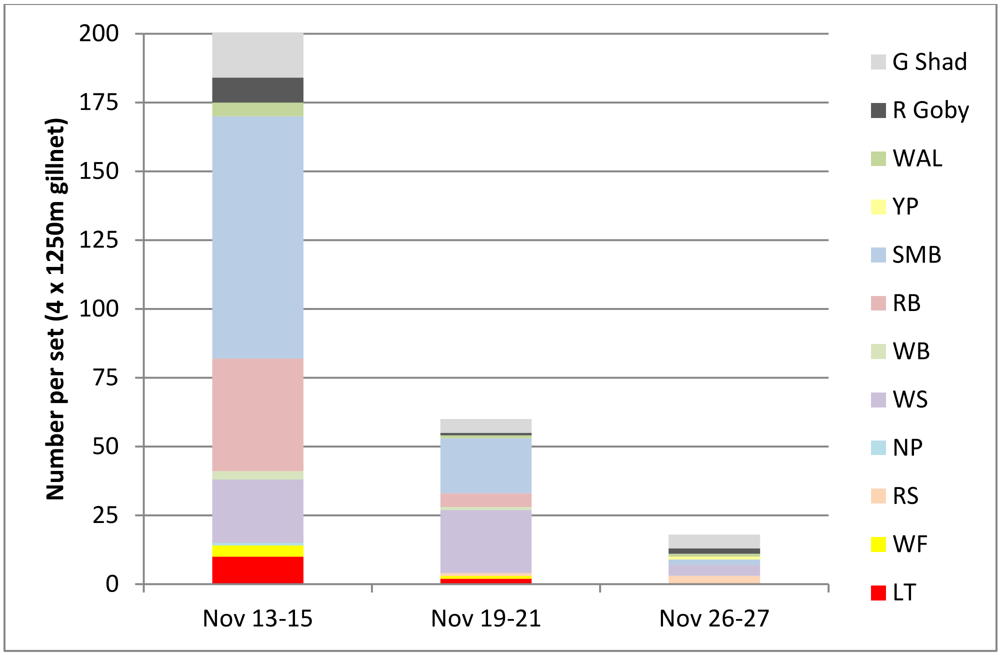

Figure 4-2 Relative abundance of species caught on Nanticoke Shoal, ON, for three periods in November, 2012

Figure 4-3. Underwater photo of bottom habitat off 18 Mile Creek in Lake Erie, July 2011.

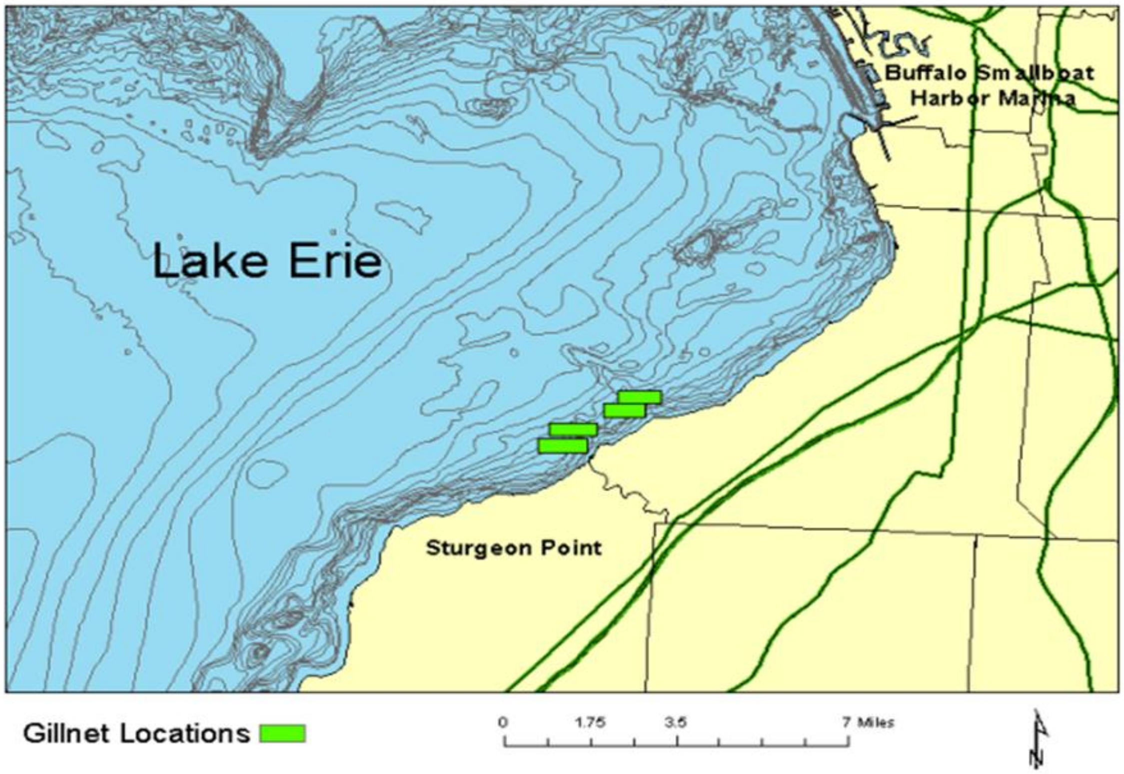

Figure 4-4. Gill net survey locations off Eighteen Mile Creek, NY sampled for spawning lake trout, November 2011 and 2012.

Section 5. Identify Metrics Related to Walleye Habitat

A.M. Gorman, S. Pandit, Y. Zhao, and C. Knight

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. This information may ultimately be used to quantify the amount of preferred adult walleye habitat by jurisdiction, thereby providing the Lake Erie Committee (LEC) with an alternate way to allocate fishery quota for walleye. Presently, quotas are allocated proportionally based on surface area of waters less than or equal to 13 m deep by jurisdiction (Figure 5-1; STC 2007). This strategy, adopted in 2008, reflects an effort to utilize advances in spatial analysis (GIS) and newly compiled data (LEGIS) and to recognize expanding populations and changing distributions relative to the original strategy established in 1988. 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.

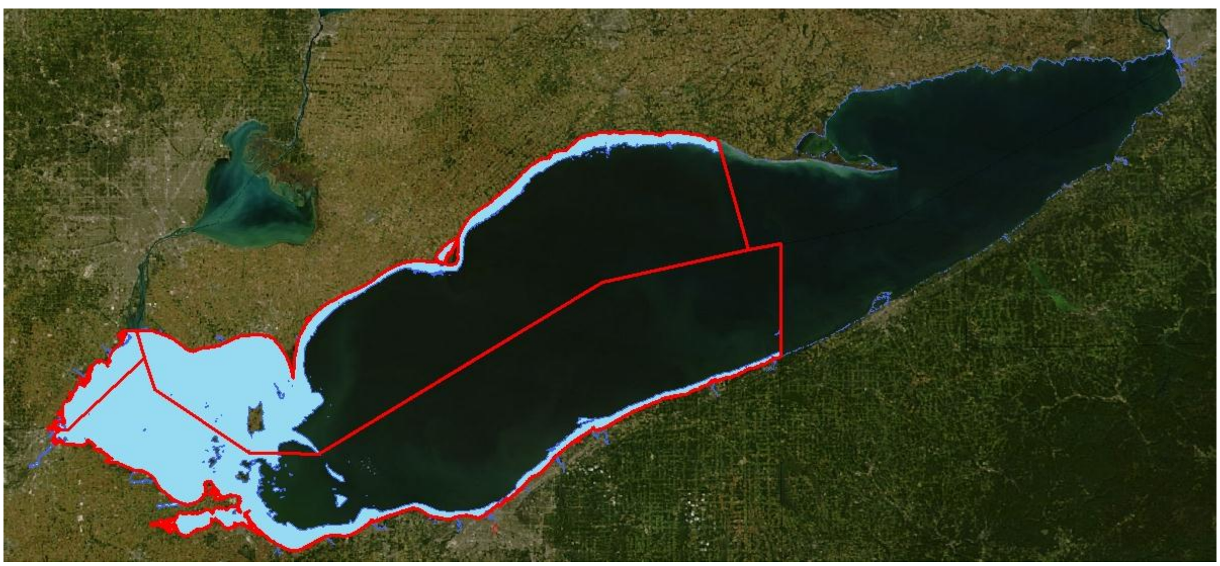

Figure 5-1. This map represents the present quota sharing allocation, which is proportionally based on surface area of waters less than or equal to 13 m deep (area in light blue) by jurisdiction for Ohio, Ontario and Michigan (outlined in red).

Currently, work on this charge has been completed. A summary on findings is located in the 2012 HTG Report, and a manuscript has been accepted for publication in the *Journal of Great Lakes Research*.

References

STC. 2007. Quota Allocation Strategies. Report of the Standing Technical Committee to the Lake Erie Committee. 8pp.

Section 6. Strategic Research Direction for the Environmental Objectives

S.D. Mackey

Introduction

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 FCGOs will be achieved. For Lake Erie, the Environmental Objectives sub-committee (now the Habitat Task Group or HTG) identified ten Environmental Objectives in support of the thirteen Fish Community Goals and Objectives. The rationale behind each of the Environmental Objectives was described in a white paper released in July 2005.

<u>Protect and Restore Physical Processes</u>

1. Restore natural coastal systems and nearshore hydrological processes;
2. Restore natural hydrological functions in Lake Erie rivers and estuaries; and
3. Recognize and anticipate natural water level changes and long-term effects of global climate change and incorporate these into management decisions.

<u>Recover and Restore Fish Communities</u>

4. Re-establish open water transparency consistent with mesotrophic conditions that are favorable to walleye in the central basin and areas of the eastern basin;
5. Maintain dissolved oxygen conditions necessary to complete all life history stages of fishes and aquatic invertebrates;
6. Restore submerged aquatic macrophyte communities in estuaries, embayments, and protected nearshore areas; and
7. Minimize the presence of contaminants in the aquatic environment such that the uptake of contaminants by fishes is significantly reduced.

<u>Halt Habitat Degradation</u>

8. Halt cumulative incremental loss and degradation of fish habitat and reverse, where possible, loss and degradation of fish habitat;
9. Improve access to spawning and nursery habitat in rivers and coastal wetlands for native and naturalized fish species; and
10. 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.

Aquatic habitats are the product of interactions between physical and biological processes. These processes contribute to the creation and maintenance of habitat through the interaction of energy with broad-scale geologic, geomorphic, and hydrologic features on the landscape over varying spatial and temporal scales. The pattern and distribution of habitats are controlled, in part, by the underlying physical characteristics of the basin and interactions between energy, water, and the landscape (e.g., Sly and Busch 1992; Higgins *et al.* 1998; Mackey and Goforth 2005; Mackey 2008). Moreover, the physical characteristics and energy conditions that define habitats are created by the interaction of climate (energy), geology (geomorphology and substrate), and hydrology (water mass characteristics and flow) – the same variables and processes that maintain physical integrity. Habitats are created when there is an intersection of a range of physical, chemical, and biological characteristics that meet the life stage requirements of an organism.

However, both anthropogenic and natural stressors (including climate change), can alter the physical characteristics and energy conditions that create and maintain Lake Erie aquatic habitats. Effective implementation strategies and actions to achieve sustainable Environmental Objectives will require anticipating the impacts of both anthropogenic and natural stressors on aquatic habitat.

Process

The HTG continues to use a scenario process designed to systematically identify and address data gaps, knowledge gaps, and lack of understanding by evaluating 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 the stated Lake Erie FCGOs.

The HTG reviewed three primary drivers: 1) anthropogenic stressors, 2) climate-change stressors, and 3) invasive species stressors from the perspective of past and current work in order to provide direction for future work. The objective was to determine what data, information, and knowledge is *required to address the questions* that arise as a result of an analysis of existing and anticipated threats and trends that impact the ability to achieve Environmental Objectives.

Discussion

As a result of this analysis, there was recognition that fishery management agencies do not (for the most part) have the authority to directly address the *physical stressors* affecting attainment of FCGOs and the underlying Environmental Objectives. This is clearly evident in nearshore and coastal areas where very few in-water habitat enhancement or restoration projects have been implemented by the HTG or associated resource management agencies. The same could be said for deep water open-lake habitats as well.

Moreover, even though preliminary Priority Management Areas (PMAs) were identified in the July 2005 Environmental Objectives white paper, inadequate information and data exist to identify specific habitat restoration opportunities within these PMAs. 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. 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.

There are three primary groupings of Environmental Objectives – Protect and Restore Physical Processes, Recover and Restore Fish Communities, and Halt Habitat Degradation. Review of the Environmental Objectives suggests that the best potential implementation opportunities exist by addressing the first two stress groupings, climate change and anthropogenic stressors, with a focus on those Environmental Objectives that Protect and Restore Physical Processes and Halt Habitat Degradation (see Figure 6-1).

Charge 5 - Draft EO Stressor Matrix

		Climate Change Stressors				Anthropogenic Stressors					Invasive Species Stressors				
	Protect and Restore Physical Processes	Levels	Storms	Precip	Thermal	Land Use	Flow Regime	Loadings	Chan Alt	Shore Alt	Dreissenids	Gobies	Asian Carp	Phragmites	SAV
1	Restore natural coastal systems and nearshore hydrological processes;	X	X	X		X	X		X	X					
2	Restore natural hydrological functions in Lake Erie rivers and estuaries; and		X	X		X	X	X	X						
3	Recognize and anticipate natural water level changes and long-term effects of global climate change and incorporate these into management decisions.	X	X	X	X	X	X	X	X	X				X	X
	Recover and Restore Fish Communities														
4	Re-establish open water transparency consistent with mesotrophic conditions that are favorable to walleye in the central basin and areas of the eastern basin;		X	X	X			X			X				
5	Maintain dissolved oxygen conditions necessary to complete all life history stages of fishes and aquatic invertebrates;	X	X	X	X	X	X	X							
6	Restore submerged aquatic macrophyte communities in estuaries, embayments, and protected nearshore areas; and	X	X					X	X	X			?	X	X
7	Minimize the presence of contaminants in the aquatic environment such that the uptake of contaminants by fishes is significantly reduced.	X	X	X		X		X			X	X			
	Halt Habitat Degradation														
8	Halt cumulative incremental loss and degradation of fish habitat and reverse, where possible, loss and degradation of fish habitat;					X	X	X	X	X	X	X	?	X	X
9	Improve access to spawning and nursery habitat in rivers and coastal wetlands for native and naturalized fish species; and	X	X	X	X		X		X	X				X	X
10	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.										X	X	X	X	X

Figure 6-1. Draft Environmental Objective stress matrix. Environmental Objectives highlighted in green and stressors outlined in red will be the initial priority focus areas of HTG implementation efforts.

This is based on the premise that changes in hydrology and coastal processes are the result of physical changes to the landscape induced either by anthropogenic activities or potential changes in climate. On-the-ground implementation projects can mitigate anthropogenic activities and restore natural processes. Even though fishery management agencies generally do not have the authority to directly implement these types of projects, the insertion of Environmental Objectives into ongoing programs/authorities will provide a way for the HTG (and LEC) to influence and track projects/programs of other non-fishery management agencies in support of the Lake Erie Environmental Objectives.

For example, Environmental Objectives will be incorporated into ongoing jointly funded non-point and natural flow regime restoration projects of the Ohio Division of Soil and Water and the Office Coastal Management under the CZM 6217 non-point program. Environmental Objectives will also be considered during review of proposed coastal and nearshore projects (structures) that have the potential influence coastal habitats and coastal processes.

Results and Recommendations (Ongoing)

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.
    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).

2. Data collection efforts must be designed to support identification of potential habitat enhancement/restoration projects.
    a. Identification, validation, and mapping of existing habitats within Priority Management Areas.
    b. Encourage continued sampling of fish communities in shallow-water coastal and nearshore habitats.
    c. Build linkages between coastal processes, hydrology, and habitat structure to promote sustainable habitat enhancement/restoration projects.

3. The best potential implementation opportunities exist within Environmental Objectives that Protect and Restore Physical Processes and Halt Habitat Degradation.
    a. Changes in hydrology and coastal processes are the result of physical changes to the landscape induced either by anthropogenic activities or potential changes in future climate.
    b. On-the-ground implementation projects can mitigate anthropogenic activities and restore natural processes thereby increasing habitat resiliency.

4. Develop habitat impact scenarios based on anticipated extreme events (ongoing work).
    a. Fluctuations in Lake Erie water levels (extremes)
    b. Storm magnitude, frequency, timing, and direction
    c. Seasonal precipitation and timing of flood pulses
    d. Thermal structure of the Lake and tributaries
    e. Fluctuations in winter ice cover

5. Science-based information and guidance *should be a key outreach strategy* of the HTG to promote sound restoration projects and practices in riverine, coastal, and nearshore environments.
    a. Most habitat restoration projects are implemented by non-fishery management agencies/programs. They are unaware that Environmental Objectives exist for Lake Erie.
    b. Guidance and Environmental Objectives need to be *actively* distributed to other agencies/programs for inclusion in ongoing and proposed projects, i.e. just posting the Environmental Objectives on the GLFC website is *not enough*.

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

- The Habitat Task Group (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 thank Dr. Hans Biberhofer (NWRI, Environment Canada), for his collaboration on the lake trout habitat charge. Jim Grazio's (PADEP) knowledge of lake trout spawning in PA waters and assistance in data collection has been invaluable. Dr. Shubha Pundit's modeling work is proving to be a key component in addressing the HTG's walleye habitat charge.