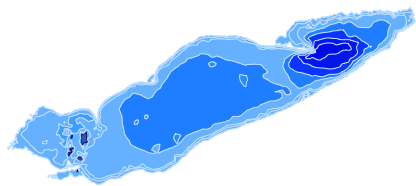


2022 Annual Report



**Ontario Ministry of Natural Resources and Forestry
Lake Erie Management Unit**



The Lake Erie Management Unit of the Ontario Ministry of Natural Resources and Forestry is responsible for managing the fishery resources of the Ontario waters of Lake Erie as well as the upper Niagara River, the Detroit River, Lake St. Clair, and the St. Clair River.

Ontario has been responsible for managing the fishery resources of these waters since 1898. In 1992, the Lake Erie Management Unit was created to improve Ontario's ability to manage these important resources. The Unit is based in Port Dover, Wheatley, and London.

VISION: The Lake Erie Management Unit will contribute to the environmental, social, and economic well-being of the people of Ontario through the sustainable development of fishery resources within the Lake Erie basin.

MISSION: To ensure the long-term health of the Lake Erie ecosystem and to promote the sustainable harvest and development of its fishery resource through sound science, assessment, regulation, and advocacy.

GOAL: To foster and encourage the understanding of all users and partners on the complexity of managing the fishery resource of Lake Erie, to minimize conflict, and to endorse sound fishery management practices.

Under the Joint Strategic Plan for Management of Great Lakes Fisheries, the fisheries resources of Lake Erie and Lake St. Clair are managed cooperatively by Ontario and the four U.S. states – New York, Pennsylvania, Ohio, and Michigan.

Cover Photo (top to bottom):

Left to right; Danielle Hennink, Jacob Coates, Michael Fabiano and Sarah Gough, Port Dover Fisheries Technicians, working in Long Point Bay.

Mick Delorme, Wheatley Fisheries Technician, working on the Habitat Suitability Indices program on the Thames River.

2022 Annual Report

**Ontario Ministry of Natural Resources and Forestry
Lake Erie Management Unit**

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1. FORWARD

The mission of the Lake Erie Management Unit (LEMU) is to provide leadership and direction on sustainable fisheries management for Lake Erie by maintaining and, where possible, enhancing the social, economic, cultural, and environmental benefits of the lake's rich aquatic resources. LEMU works to achieve this through annual fisheries assessment programs, a commercial catch sampling program, and fisheries management activities on the Canadian waters of Lake Erie, Lake St. Clair, and connecting waters.

The Province of Ontario and four U.S. (United States) states share responsibility for managing the fishery resource in Lake Erie; international cooperation is essential to the sustainable management of Lake Erie's fisheries. The Lake Erie Committee (LEC), formed under the auspices of the Great Lakes Fishery Commission, is comprised of representatives from state and provincial fisheries management agencies. This committee works to set harvest levels for the lake.

LEMU consults regularly with resource management partners that have a shared interest in the management of the Lake Erie fishery, namely Ontario sport and commercial fish interests on Lake Erie and Lake St. Clair. The principal venue for this consultation process is the Fisheries Management Zone 19 Council. Within this group, representatives from the sport and commercial fisheries discuss emergent and long-term fisheries issues. In addition, the Lake Erie Management Unit participates in the bi-national Lake Erie Percid Management Advisory Group, which was established to help guide future Walleye and Yellow Perch management in Lake Erie. This group is facilitated by staff from the Great Lakes Fishery Commission and consists of Ontario, Ohio, Pennsylvania, Michigan, New York, agency staff, and stakeholders from all jurisdictions bordering Lake Erie.

In addition, LEMU leads and supports several projects that address native aquatic species restoration, state of resource science, invasive species surveillance and response, as well as ecosystem restoration. Using a collaborative approach, LEMU works across provincial, federal, and state governments, works with academia and various provincial stakeholders.

This report will summarize and present Ontario's fisheries program and ecosystem data for Lake Erie and Lake St. Clair for the 2022 fiscal year. LEMU fisheries datasets are incorporated with similar information from the U.S. jurisdictions and analyses are performed by various bi-national task groups to determine fish population status, and recommended harvest levels that are consistent with LEC fish community objectives.

Our team is pleased to present this report to our stakeholders and colleagues, and welcomes any questions or comments you may have on its content.

2. EXECUTIVE SUMMARY STATUS OF MAJOR STOCKS

In 2022, Ontario commercial landings in Lake Erie totalled 23.8 million pounds (Table 2.1). Total commercial harvest in 2022 increased by 0.5 million pounds from 2021. Landed value in 2022 of \$41.5 million remained above average since 2000 (\$29.9 million). Harvest by Ontario statistical district (OE) and species is presented (Table 2.1, Figure 2.1). Harvest of pounds of fish in 2022 was composed of Walleye (57%), Rainbow Smelt (18%), White Perch (11%), Yellow Perch (9%), White Bass (4%), Lake Whitefish (0.5%), and other species (<1%). The landed value was highest for Walleye (68%) followed by Yellow Perch (21%), White Perch (5%), White Bass (3%), Rainbow Smelt (2%), Lake Whitefish (<1%), and other species (<1%). In addition to commercial harvest summaries, results from Lake Erie Management Unit (LEMU) bottom trawl surveys, hydroacoustic forage species assessment, and Partnership gill net surveys are presented. Partnership gill net surveys were completed annually with Lake Erie's commercial fishing industry since 1989 and in cooperation with the Ontario Commercial Fisheries' Association (OCFA) since 1997. Characteristics of recreational fisheries in Fisheries Management Zone 19 (FMZ19) are described periodically by creel surveys.

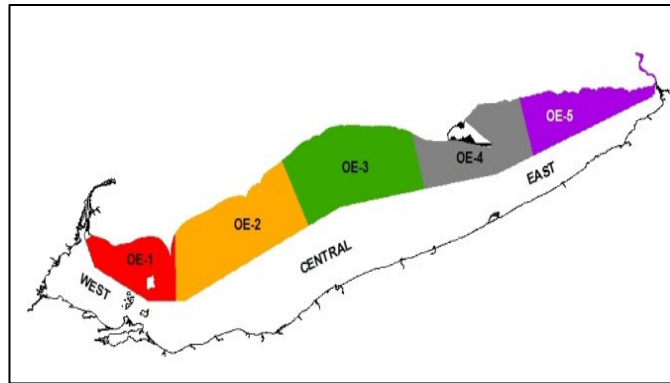


Figure 2.1. Ontario statistical districts (OE 1-5) of Lake Erie.

Table 2.1 Total annual commercial fishery landings (landed weight in pounds) and value in dollars by fish species and statistical district for the Canadian waters of Lake Erie, 2022.

Species	Landings by Statistical District					Total Landing	Total Value
	OE-1	OE-2	OE-3	OE-4 ^a	OE-5		
Burbot	5		940			945	\$616
Carp	3,937	36	381	21		4,375	\$1,639
Catfish	12,392	1,580	2,161	72		16,205	\$10,008
Freshwater Drum	25,041	17,361	13,486	385	2,297	58,570	\$11,605
Gizzard Shad	200	40	25			265	\$0
Lake Whitefish	88,987	10,784	4,601	11,648	1,267	117,287	\$203,207
Rainbow Smelt		10	14	4,060,309	296,050	4,356,383	\$1,016,844
Suckers	5,269	32	447		267	6,015	\$3,937
Walleye	6,693,686	4,660,850	1,800,436	317,602	135,154	13,607,728	\$28,034,634
White Bass	426,392	308,874	125,466	20,001	3,582	884,315	\$1,269,632
White Perch	968,175	1,026,358	494,382	15,921	1,492	2,506,328	\$2,012,534
Yellow Perch	770,476	177,919	847,590	173,592	225,539	2,195,116	\$8,904,395
Mixed ^b	1,818	26		32		1,876	\$1,448
Total Landing (lbs)	8,996,378	6,203,870	3,289,929	4,599,583	665,648	23,755,408	
Total Value (\$)	\$18,281,128	\$11,628,387	\$7,998,419	\$2,363,890	\$1,198,673		\$41,470,498

^a Excludes Inner Long Point Bay.

^b A variety of incidentally caught species of little or no value

The lakewide commercial Walleye harvest of 13.6 million pounds in 2022 represented 99% of lake-wide quota. The 2022 harvest was well above the mean harvest from 2000 to present (6.0 million lbs.) and the mean harvest from the inception of individual transferable quotas (ITQs) (1984 to present; 6.8 million lbs.; Figure 2.2). Walleye harvest (lbs.) across statistical districts OE1 to OE5 during 2022 was 50%, 34%, 13%, 2%, and 1%, respectively. The commercial Walleye fishery age composition (range: 1-19) was dominated by age 3 (49%) (2019 year class), and age 4 (21%) (2018 year class) lakewide.

Walleye catch rates in the 2022 Partnership Gill Net surveys increased from west to east. In the west, west-central, east-central, Pennsylvania Ridge, and east basin surveys, 2022 walleye catch rates were ranked 53rd, 78th, 94th, 93rd, and 97th percentiles respectively. The gill net surveys were comprised of Walleye ranging in age from 0 to 19. Ages 1 and 3 (2021, 2019 year classes respectively) were the most abundant age groups in all surveys except in the east basin where catch rates of age 2 fish marginally exceeded catch rates of age 3 Walleye. Age 0 Walleye catch rates in 2022 were moderate (41st percentile) in the west basin relative to the 33 year time series. In all other surveys, age 0 catch rates were high (time series percentiles >80%). Vulnerability to capture is influenced by growth where age 0 Walleye are not fully recruited to the index gear. Age 7 Walleye catch rates were the highest in their respective time series in the west, east, and Pennsylvania Ridge surveys. In the west-central and east-central surveys, age 7 catch rate percentiles were 81 and 72 respectively.

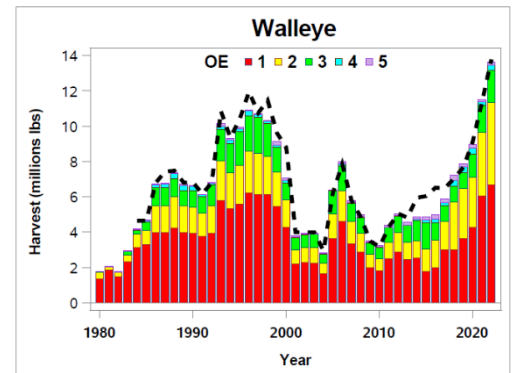


Figure 2.2 Walleye commercial harvest by statistical district in Lake Erie, 1980-2022. Lakewide quota presented as dotted line.

The interagency west basin trawl index of young-of-the-year (YOY) Walleye in 2022 (126 / ha ON waters) represented the 88th percentile over the 35 year time series. Five consecutive strong YOY indices is unprecedented for the west basin trawl survey, although this catch rate was below catch rates during the previous four years. The yearling Walleye catch rate from the 2021 cohort was the 5th highest in the Ontario time series. Mean length and condition of these juvenile Walleye were below average. Smaller size at age was density dependent. This trend was also evident for these cohorts as adult fish assessed by Partnership surveys. Commercial and recreational fishing in 2023 is expected to thrive, benefiting from an abundance of Walleye ages 2, 4, and 8.

Walleye in Lake Erie are assessed and managed cooperatively by Lake Erie jurisdictions and partners. Interagency trawling in the west basin combines YOY Walleye catch rates from Ohio and Ontario waters for population assessment and recommended allowable harvest (RAH). The current exploitation policy adopted in 2014 for the Total Allowable Catch (TAC) area which includes OE1-3 was developed through the Lake Erie Percid Management Advisory Group (LEPMAG) as part of a Walleye Management Plan (WMP)

that was extended to 2024. Walleye migrations from the TAC area into the east basin are evident from Great Lakes Acoustic Telemetry Observation System (GLATOS) and genetic studies. East basin fishery performance is influenced by the abundance of migratory and local stocks. Continuous improvements to our understanding of the lakewide dynamics are accomplished through ongoing cooperative research and assessment for potential incorporation into future management plans.

Yellow Perch

The commercial fishery harvested 2.2 million pounds of Yellow Perch in 2022, attaining 65% of the quota allocated. This Yellow Perch harvest was below the mean harvest from 2000 to present (4.9 million lbs.) and the long term mean harvest from when ITQs were introduced in 1984 (5.5 million lbs.). The distribution of harvest across statistical districts OE1 to OE5 in 2022 was 35%, 8%, 39%, 8%, and 10%, respectively (Figure 2.3). Overall, Yellow Perch harvest increased 1% from 2021. Age 2 (2020 cohort) and age 3 (2019 cohort) Yellow Perch comprised the largest fraction of fish harvested in OE1. Age 3 fish were dominant in OE2 and OE3. Age 3 and age 2 fish were more common in OE4.

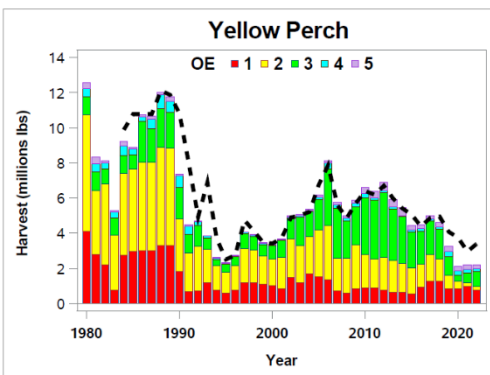


Figure 2.3 Yellow Perch commercial harvest by statistical district in Lake Erie, 1980-2022. Lakewide quota presented as dotted line.

Partnership Yellow Perch gill net indices in 2022 were the highest on record in the Pennsylvania Ridge survey, high in the east and west basin surveys, but 2nd lowest in the time series for both of the west-central and east-central basin surveys. West basin catch rates were high due solely to abundant age 1 fish whereas age 2 and older Yellow Perch catch rates were very low. Yellow Perch age composition ranged from 1 to 14 lakewide. In 2022, age 1 fish achieved a record high catch rate in the Pennsylvania Ridge and was also high in the east basin survey, but age 1 catch rates ranked moderate to low in the west-

central and east-central basin surveys. Age 2 was the most abundant age group in the east basin survey whereas age 3 was most common in the Pennsylvania Ridge and east-central surveys. Mean age of Yellow Perch across the lake was 1.3, 1.7, 2.2, 2.7, and 2.1 for the west, west-central, east-central, Pennsylvania Ridge, and east basin surveys respectively. Length and condition at age for Yellow Perch was generally near or above average for most age groups represented in surveys.

In 2022, the west basin interagency bottom trawl survey experienced high catch rates of YOY (82nd percentile) and yearling (88th percentile) Yellow Perch but low catch rates of older Yellow Perch (12th percentile) in Ontario waters. Ontario trawl and gill net indices forecast high recruitment of age 2 Yellow Perch in the west basin during 2023, with good recruitment expected in 2024, conditional on juvenile survival. Partnership gill net indices

indicate high recruitment of age 2 Yellow Perch in the west and east basins in 2023 but moderate to low recruitment in the west-central and east-central basins.

The 2022 Long Point Bay index trawl survey experienced low to moderate catches of age 0 and low catches of yearling Yellow Perch. Age 0 catches increased from 2021 but were the second lowest in the last five years. Catch rates of yearling Yellow Perch declined compared to 2021 and were the lowest in the last five years.

A bottom trawl survey began in 2016 in Ontario waters of the central basin after fall turnover. In 2022, catch rates of age 0 Yellow Perch were 2.47 fish/ha in the west-central basin, and 6.36 fish/ha in the east-central basin. Catch rates in both areas were below average for the seven year time series. Catch rates of yearling Yellow Perch were above average in the west-central basin (13.71 fish/ha) and below average in the east-central basin (7.33 fish/ha). The benefits of this survey will accumulate over continued years of field work.

Following a process developed by the Lake Erie Percid Management Advisory Group (LEPMAG), a broader assemblage of interagency Yellow Perch recruitment indices are analyzed by the Yellow Perch Task Group using multi model inference to forecast age 2 recruitment by management unit annually. Refer to the 2023 Yellow Perch Task Group Report for more details.

Ontario gill net fishery harvest and effort data, along with trawl and gill net survey data, contribute to interagency assessment and quota recommendations. Ontario commercial and recreational fishery representatives, OMNRF, United States (U.S.) management agencies and stakeholders, and the Quantitative Fisheries Center at Michigan State University have been collaborating in the Lake Erie Percid Management Advisory Group (LEPMAG). Through LEPMAG, Lake Erie agencies designed and implemented a new Yellow Perch harvest policy in 2019 that represents the core of the Lake Erie Yellow Perch Management Plan.

Lake Whitefish

Declining Lake Whitefish recruitment and abundance in Lake Erie resulted in major quota reductions in Ontario beginning in 2014 and continuing until 2017, followed by marginal increases annually (Figure 2.4). The commercial harvest of Lake Whitefish is currently incidental and mainly occurs in large mesh gill net fisheries targeting Walleye and White Bass. Lake Whitefish harvest in 2022 was 117,287 pounds, distributed across OE1 to OE5 as follows: 76%, 9%, 4%, 10%, and 1% (Figure 2.4). The age composition of the large mesh gill net fishery ranged from age 3 to 19, dominated by ages 3, 4, and 7 (2019, 2018, 2015 cohorts).

Lake Whitefish catch rates in the combined central and eastern basin 2022 Partnership survey decreased from 2021, and was well below average. Whitefish catches were composed of ages 1 to 7, with ages 3 (38%), 2 (29%), and 7 (14%) most abundant. Lake Whitefish catch rates in the 2022 Coldwater Assessment (CWA) index gill net survey in eastern Lake Erie ranked 3rd highest in the 38 year international survey. Lake Whitefish catches in Ontario and Pennsylvania waters achieved record highs whereas catches in New York waters represented the 68th percentile. CWA Lake Whitefish age composition ranged from 1 to 29 consisting mostly of ages 7 (25%), 3 (19%), 8 (16%), and 4 (11%). Although status indicators vary widely among sources, the continued presence of juveniles in 2022 surveys supports recovery of Lake Whitefish under continued conservative management. OMNRF is working with partners to improve assessment and develop management strategies for Lake Whitefish through collaborative efforts of the Lake Erie Committee, the Coldwater Task Group, the Great Lakes Telemetry and Observation System (GLATOS) network, and the Great Lakes Fishery Commission.

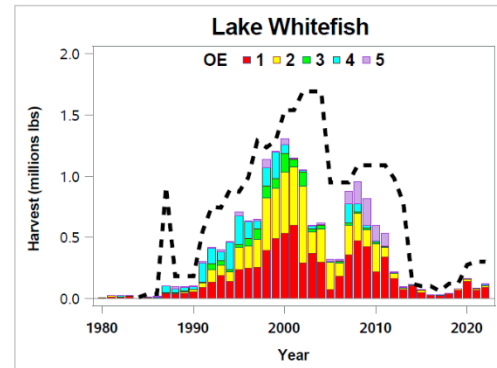


Figure 2.4 Lake Whitefish commercial harvest by statistical district in Lake Erie, 1980-2022. Lakewide quota presented as dotted line.

Rainbow Smelt

Rainbow Smelt are not native to Lake Erie but they are a dominant forage species that contributes significantly to Ontario's commercial fish landings. Rainbow Smelt harvest in 2022 (4.4 million lbs.) amounted to 35% of the lakewide quota (12.4 million lbs.) (Figure 2.5). Smelt harvest declined with fluctuations over decades (Figure 2.5). Harvest in 2022 decreased 10% from 2021. Landings of Rainbow Smelt were primarily in OE4 (93%) and OE5 (7%) with negligible harvest in other statistical districts. Harvest age composition ranged from 1 to 5 with ages 1 and 2 representing the majority of the trawl harvest.

Long Point Bay trawl catch rates of young-of-the-year (YOY) and yearling and older (YAO) Rainbow Smelt were low in 2022. However, YOY Rainbow Smelt catch rates were higher than in 2021, while YAO catch rates exceeded those of the previous six years. Hydroacoustic surveys in eastern Lake Erie describe the abundance and distribution of Rainbow Smelt available as forage and to the Rainbow Smelt fishery. Hydroacoustic surveys in 2022 followed a new random grid design that prioritizes areas with the greatest variability and allows cross-basin comparisons. East basin hydroacoustic survey results indicated that

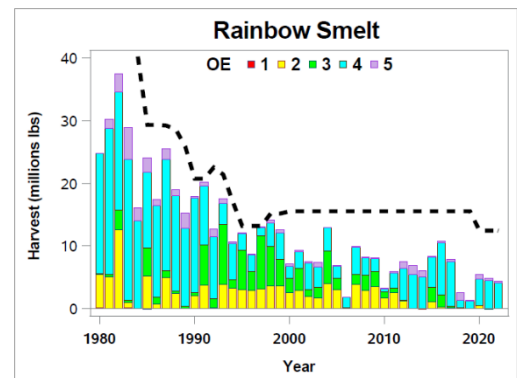


Figure 2.5 Rainbow Smelt commercial harvest by statistical district in Lake Erie, 1980-2022. Lakewide quota presented as dotted line.

yearling and older Rainbow Smelt density (2137 YAO/ha) exceeded the previous four years. The central basin hydroacoustic survey was completed in cooperation with USGS and ODNR. Yearling and older Rainbow Smelt densities (1023 YAO/ha) in the central basin midwater trawls exceeded the 20 year mean (702 YAO/ha) whereas YOY Rainbow Smelt catch rates (65 YOY/ha) were low relative to the time series mean (244 YOY/ha) (2001-2022).

White Bass

White Bass harvest, which is not regulated by quota in Lake Erie, totalled 0.9 million pounds in 2022. This harvest was below the mean harvest from 2000 to present (3.1 million lbs.) and the long term mean harvest since 1984 (2.9 million lbs.). Distribution of harvest across statistical districts OE1 to OE5 in 2022 was 48%, 35%, 14%, 2%, and 0.4%, respectively (Figure 2.6). The White Bass harvest was composed of ages ranging from 1 to 14, with ages 2 and 10 representing the majority of the harvest, followed by ages 3 and 6.

Partnership White Bass catch rates hit a record low in the west-central basin survey and were low in the west (16th percentile), and east-central basin (28th percentile) surveys. The White Bass catch rate in the east basin was fair (74th percentile) and moderate in the Pennsylvania Ridge survey (64th percentile). Age groups present in surveys ranged from ages 0 to 12. Age 1 fish dominated the White Bass age composition of all surveys lakewide. Age 0 White Bass were the next most abundant age group in the west-central and east-central basin surveys. Age 2 White Bass were the second most common age group in the west, east, and Pennsylvania Ridge surveys. August west basin catch rates of White Bass YOY (3.2 fish/ha) in Ontario waters during 2022 were the lowest in the 35 year time series.

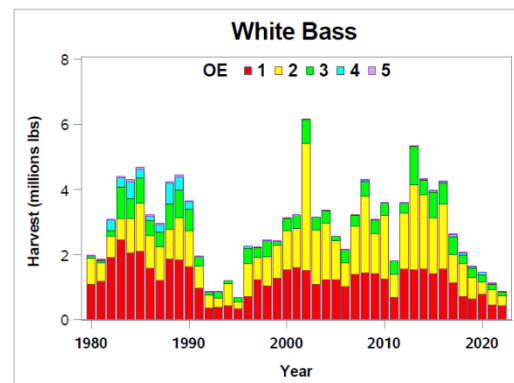


Figure 2.6 White Bass commercial harvest by statistical district in Lake Erie, 1980-2022.

White Perch

White Perch is a non-native species that is not managed by quota. The commercial harvest of White Perch in 2022 totaled 2.5 million pounds. The harvest was more than the mean harvest from 2000 to present (2.2 million lbs.) and the long term mean harvest since 1984 (2.2 million lbs.). White Perch harvest across statistical districts OE1 to OE5 in 2022 was: 39%, 41%, 20%, 1%, and <1% (Figure 2.7).

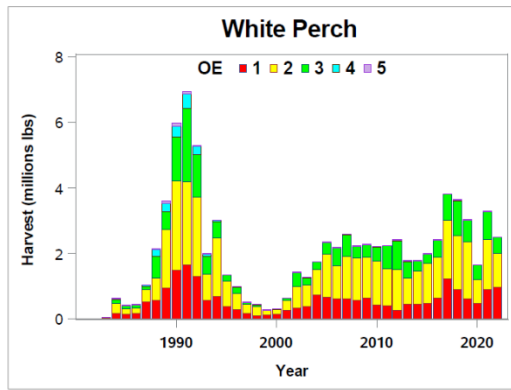


Figure 2.7 White Perch commercial harvest by statistical district in Lake Erie, 1980-2022.

The White Perch harvest was composed of ages ranging from 1 to 15. Ages 4, 2, and 3 were the most common age groups of White Perch sampled from the harvest.

The Partnership gill net survey catch rates of White Perch were moderate in the west (47th percentile) and east basin (58th percentile) surveys, low in the west-central (19th percentile) and east-central (16th percentile) surveys but high in the Pennsylvania Ridge (86th percentile) survey relative to their respective time series. White Perch ages ranged from 0 to 8 and were seen in

surveys lakewide. White Perch ages 1 and 2 were most abundant in the west and west-central basin surveys. In the east-central, east, and Pennsylvania Ridge surveys, ages 2 and 3 contributed most to age compositions. Age 0 White Perch were present in the west, west-central, and east-central basin surveys. Age 0 White Perch catch rates were very low (0.03 fish/gang) in the east basin and 0 fish/gang in the Pennsylvania Ridge survey. Age 0 White Perch catch rates were low (15th percentile, 367 fish/ha) in the August west basin trawl survey whereas yearling and older catch rates were moderate (56th percentile, 79 fish/ha).

3. COMMERCIAL FISHERY

3.1 Lake Erie Commercial Fishery

In 2022, total commercial landings from Ontario waters of Lake Erie was 23.8 million pounds with a total value of \$41.5 million. The slight increase of total landings from 2021 (2%), and the total value (19%), was primarily due to the increased harvest of Walleye (up 2.1 million pounds) (Figure 3.1.1). Walleye value was up by \$6.9 million. Harvest and landed value in 2022 are presented for each species by statistical district (Ontario Erie (OE), Figure 2.1) in Table 2.1.

Total Walleye landings increased 18% to 13.6 million pounds in 2022, resulting in 99% of the 2022 allocated quota being harvested (Table 2.1, Figure 3.1.1). Lakewide Walleye harvest by size category was: Jumbo (20%), Number 1 (76%), and Number 2 (4%). Yellow Perch landings increased minimally, by 14 thousand pounds to 2.2 million pounds in 2022, harvesting 65% of allocated quota (Table 2.1, Figure 3.1.1). The landed value of Yellow Perch increased 8% in 2022 to \$8.9 million.

With total landings of 117,287 lbs, Lake Whitefish harvest increased (39%) from 2021 (Table 2.1, Figure 3.1.1). In 2022, Lake Whitefish continued to be a non-targeted

commercial fish species; all Lake Whitefish were harvested as by-catch. The commercial fishery harvested 39% of the 300,000 lbs of allocated quota. Seventy six percent of the total harvest came from OE-1 (a decrease of 4% from 2021), while 10% was harvested from OE-4, an increase of 9% from 2021. Transfers of Walleye quota out of quota zone 1 (OE-1) continued in 2022 in an attempt to help protect fall spawning Lake Whitefish stocks, however 77% of the total harvest in OE-1 occurred from October to December.

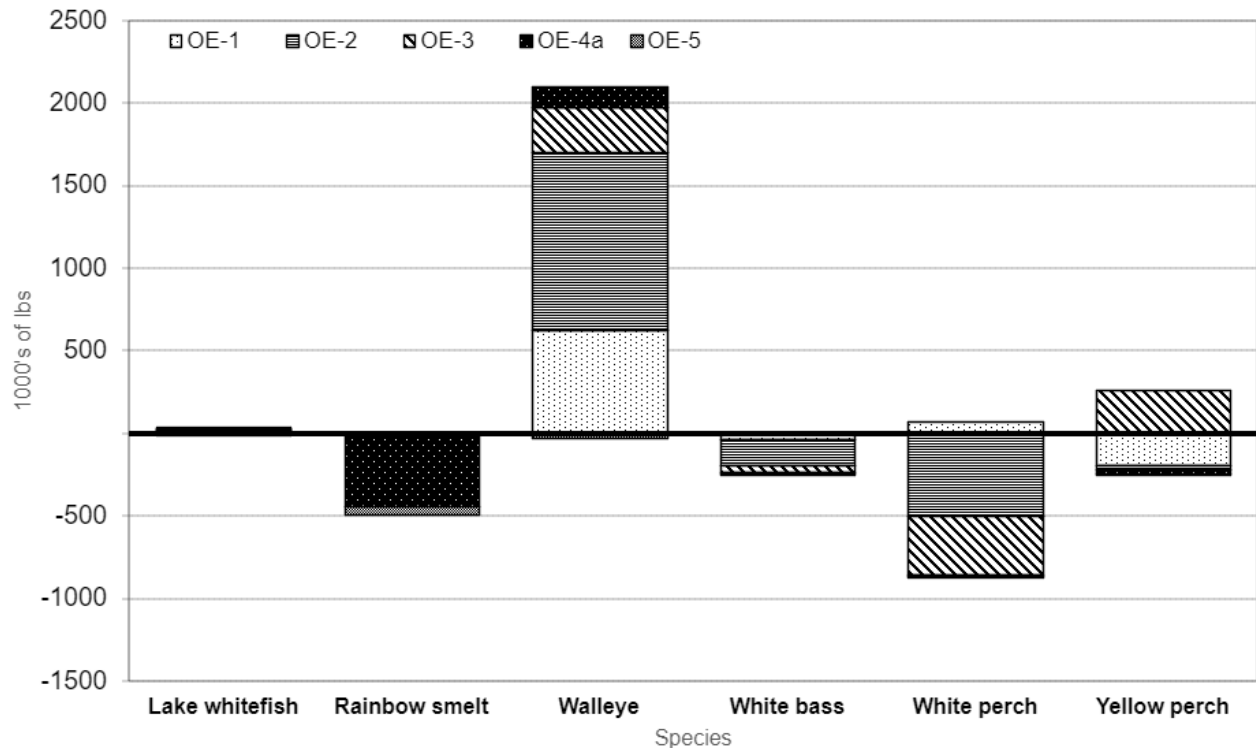


Figure 3.1.1 Change in weight of the annual commercial fishery landings (1000's of lbs.) from 2021 to 2022 for principle species by statistical district, Lake Erie.

The landed value of Lake Whitefish increased 64% to approximately \$203 thousand in 2022 (Table 2.1).

Rainbow Smelt harvest in 2022 declined 10% from 2021 to 4.4 million pounds; 35% of the allocated quota. This was a decrease of almost 500,000 from 2021 (Table 2.1, Figure 3.1.1). Ninety-three percent of the harvest was taken from OE-4 while the remaining 7% was harvested in OE-5. Of the 157 licences with Rainbow Smelt quota, 12 landed Smelt in 2022, 6 of which reached >80% quota. The landed value of Rainbow Smelt decreased 9% to \$1.0 million (Table 2.1).

White Bass and White Perch are commercial fish species currently not regulated by quota. The total landings of White Bass decreased by 21% to 884,000 pounds in 2022, the majority of which occurred in statistical districts OE-1 (48%), OE-2 (35%), and OE-3 (14%) (Table 2.1, Figure 3.1.1). The landed value of White Bass decreased 20% to \$1.3 million in 2022 (Table 2.1). The total landings of White Perch decreased 24% to 2.5 million

pounds in 2022, with harvest occurring primarily in statistical districts OE-2 (41%), OE-1 (39%), and OE-3 (20%) (Table 2.1, Figure 3.1.1). In 2022, White Perch total landed value decreased 21% from 2021, to a value of \$2.0 million (Table 2.1).

Inner Long Point Bay Fishery

The hoop and seine net fishery of Inner Long Point Bay contributes less than one percent (0.6%) by weight of the total annual commercial harvest landed in Ontario waters of Lake Erie. In 2022, total commercial landings were 135,050 pounds (Table 3.1.1), an increase of 17% from 2021. Live fish accounted for 73% of this harvest. The value of the total commercial landings in 2022 was \$194,126, a decrease of 17% from 2021, and 0.6% of the total value of the commercial fishery in Ontario waters of Lake Erie (Table 3.1.1).

In 2022, the total landing of Yellow Perch was 10,043 pounds, an increase of 7% from 2021 and 38% of their allocated quota. The majority of Yellow Perch (85%) were caught in the spring (March through May). The landed value of Yellow Perch in 2022 decreased 12% from 2021 to \$32,875 (Table 3.1.1). In 2022, the total landing of Northern Pike was 5,896 pounds, an increase of 33% from 2021. The Inner Bay commercial fishery harvested 22% of 2022 allocated quota. The majority of Northern Pike (93%) were caught in the spring (March through May). The landed value of Northern Pike in 2022 was \$3,977, an almost 5 fold increase from 2021 (Table 3.2.1).

Table 3.1.1 Total annual commercial fishery landings
(landed weight in pounds) and value (\$)
by fish species for Inner Long Point Bay, 2022

Species	Total Landing^a	Total Value
Bowfin	25,310	\$24,139
Brown Bullhead	25,668	\$12,827
Carp	3,921	\$1,494
Channel Catfish	0	\$0
Freshwater Drum	0	\$0
Lepomis spp.	54,288	\$98,791
Mudpuppy	2,512	\$2,411
Northern Pike	5,896	\$3,977
Pomoxis spp.	3,137	\$12,333
Rock Bass	3,720	\$4,927
White Perch	555	\$352
Yellow Perch	10,043	\$32,875
Total Landing (lbs.)	135,050	
Total Value (\$)		\$194,126

^a Only Inner Long Point Bay.

3.2 Commercial Catch Sampling Program

The commercial catch sampling program is integral to the management of Lake Erie fish stocks. This program provides information such as: age composition of the harvest, recruitment of year classes into fisheries, and growth characteristics. Information from this program is used directly in catch-at-age models used to estimate and project population abundances, which are used to determine total allowable catch. The Lake Erie Management Unit (LEMU) delivers this program using targeted sampling of all species landed by the Lake Erie commercial fishery. The main objectives of catch sampling are to: 1) determine the size and age composition of the fish in the catch; 2) index the abundance of fish species; and 3) determine parasite loading of commercially valuable fish. Fish attributes sampled during this program include: weight, length, age, sex, maturity, parasite loading, tumours, and tags/marks.

A total of 10,591 fish were sampled during the 2022 commercial catch sampling program. Sampling is stratified by area (Ontario-Erie statistical district or OE), season, and gear type. Species sampled include: Yellow Perch, Walleye, Lake Whitefish, White Bass, White Perch, and Rainbow Smelt. Walleye samples are categorized by group based on length (see Table 3.2.1). Walleye, Yellow Perch, White Bass, and White Perch were aged using otoliths. Rainbow Smelt were aged using scales. Lake Whitefish were aged using scales and otoliths.

Lakewide, 4,387 Yellow Perch were sampled during 2022. The most common age group of Yellow Perch was age 3 (2019 year class), which comprised 53% of the harvest lakewide. Age 3 fish comprised 28% of the Yellow Perch harvest in the western basin, 61% in the west-central basin, 74% in the east-central basin, and 54% in the eastern basin. Age 2 (2020 year class) Yellow Perch were also common in the western and eastern basins (50% and 34% of the harvest respectively).

In total, 3,333 Walleye were sampled from large (n=2,475) and small (n=858) mesh gill nets in 2022. Lakewide, 49% of the commercial Walleye harvested were age 3 (2019 year class) fish. The next most common ages were age 4 (2018 year class) fish with 21% of the lakewide harvest, and age 7 (2015 year class) fish with 14% of the lakewide harvest.

In total, 119 Lake Whitefish were sampled from large mesh gill nets during fall in OE-1. OE-1 ages shown in Table 3.2.1 are from otoliths. Thirty percent of these Lake Whitefish were from the 2019 year class (age 3 fish), 28% were from the 2018 year class (age 4 fish), and 27% were from the 2015 year class (age 7 fish). The oldest Lake Whitefish sampled was 19 years.

In total, 659 White Bass were sampled, from large mesh gill nets. Twenty-four percent of the White Bass sampled were age 10 (2012 year class) and 24% were age 2 (2020 year class). Sixteen percent of White Bass were age 3 (2019 year class, and 15% were age 6 (2016 year class). In total, 978 White Perch were sampled; 540 from large mesh nets

and 438 from small mesh nets. Twenty-seven percent of the White Perch sampled consisted of the 2018 year class (age 4 fish), followed by the 2020 year class (25%, age 2 fish), and the 2019 year class (23%, age 3 fish).

In total, 1,111 Rainbow Smelt were sampled from trawl nets, 48% of the Rainbow Smelt were aged, 9% were unable to be aged due to poor scales, and the remainder did not have scales collected. Thirty-four percent of the aged Rainbow Smelt were age 3 (2019 year class), followed by age 1 (27%, 2021 year class) and age 2 (24%, 2020 year class). Additional species caught incidentally in Rainbow Smelt trawls were also sampled. In 2022, by-catch species sampled included, White Bass, Yellow Perch, and Lake Whitefish.

Table 3.2.1 Number of commercial fish sampled by gear type, species, statistical district (OE) and age, 2022.

Gear Type	Species	Statistical District	Group	Age											Not Aged	Total Sampled
				0	1	2	3	4	5	6	7	8	9	10+	UNK	
Gill Net	Lake Whitefish	OE-1	All				36	33	9		32	5		4		119
	White Perch	OE-1	All	42	133	71	112	11	25	36	8	2	18			458
		OE-2	All	1	29	72	108	5	13	26	10		16			280
		OE-3	All	2	64	72	38	2	6	9	1		5	1		200
		OE-4	All	9	14	13	4									40
	White Bass	OE-1	All	3	55	45	13	5	35	1	5		78			240
		OE-2	All	7	45	42	10	5	42			1	87			239
		OE-3	All	2	49	17	3		19		1		69			160
		OE-4	All		7				6				7			20
	Yellow Perch	OE-1	All	39	654	336	255	22	5	2	6	1			31	1351
		OE-2	All	4	150	392	86	27	5	5	4	1	1	3		678
		OE-3	All	3	114	1049	153	69	18	7	5		2	17		1437
		OE-4	All		115	229	73	10	13							440
		OE-5	All		169	281	17	2	10						1	480
	Walleye	OE-1	Number 1	1	15	287	174	21	8	68	4		1	1		580
			Jumbo			34	27	6	10	180	20		3			280
			Number 2	52	145	152	6							3		358
		OE-2	Number 1		13	362	146	16	2	54	2	1	2	1		599
			Jumbo			23	64	26	12	211	17	2	5			360
			Number 2	36	63	21										120
		OE-3	Number 1		6	168	90	20	3	27	1	1				316
			Jumbo			4	18	6	5	102	2		3			140
			Number 2	81	84	15										180
		OE-4	Number 1		2	85	21	3	2	6	1					120
			Jumbo			5	7	4	1	40			3			60
			Number 2	95	22	3										120
		OE-5	Number 1			11	5	1	3							20
			Jumbo			1		2	12	19	1		5			40
			Number 2	19	20	1										40
Trawl	Rainbow Smelt	OE-4	All	142	127	182	76	3							101	1111
	White Bass	OE-4	All	3												3
	Yellow Perch	OE-4	All		1											1
	Lake Whitefish	OE-4	All										1			1

Walleye Group: Number 1 = generally between 381-533 mm in total length; Jumbo = generally greater than 533 mm in total length; Number 2 = generally less than 381 mm in total length.

UNK = fish were unable to be aged due to poor or missing aging structures.

3.3 Port Observer Program

The commercial fish quota system requires a reliable means of monitoring the fish harvested by individual fishers. Each fisher is allocated an individual transferable quota on their licence that also contains terms and conditions that must be adhered to. Lake Unit Port Observers monitor commercial fishing vessels across the lake for compliance with licence conditions. This is accomplished through on-vessel inspections of the daily harvest against the corresponding Daily Catch Report (DCR), as well as post-harvest audits of the DCR's for completeness and accuracy.

In 2022, 33% (3,430) of Lake Erie's 10,503 DCRs were inspected by Port Observers. Of the 23.7 million pounds landed in 2022, 29% (6.9 million pounds) was inspected or weights were observed. By species, 30% (649,944 pounds) of Yellow Perch, 36% (4.9 million pounds) of Walleye and 36% (324,847 pounds) of White Bass harvested were inspected.

While conducting on vessel inspections, Port Observers correct DCR errors by gathering the correct information from the licensee or designate. Errors identified during audit (post-harvest, not observed) are corrected by the Port Observer in consultation with the licensee (or designate) to ensure the correct information is entered into Commercial Fish Harvest Information System (CFHIS). In 2022, 946 errors were identified and corrected by Port Observers. In addition, 24 verbal and written warnings were issued for failing to comply with conditions of commercial fishing licences.

4. **FISHERIES ASSESSMENT PROJECTS**

4.1 Partnership Index Fishing: Gill Netting

Gill net surveys were completed annually in partnership with Lake Erie's commercial fishing industry since 1989 and in cooperation with the Ontario Commercial Fisheries' Association (OCFA) since 1997. The lakewide assessment is partitioned by project according to the west, west-central, east-central, Pennsylvania Ridge, and eastern basins. In 2022, 133 random, depth-stratified sites were fished across Lake Erie (Figure 4.1.1). Index gill nets fished overnight were 381 m in length, consisting of 14 mesh sizes ranging from 32 mm to 152 mm fished on bottom, suspended (canned) and in surveys fished during thermal stratification, suspended (canned) in the thermocline.

Thirty (30) species from 15 families were caught in index gill nets lake-wide during 2022 (Table 4.1.1). The status (**Low**, **Moderate**, **High**) of species caught in 2022 is presented by basin in Table 4.1.1 based on percentiles of catch in numbers and biomass per index gang. Mean catch rates (fish / gang) are presented graphically for Walleye, Yellow Perch, White Bass, White Perch, Lake Whitefish, and Lake Trout by basin (Figure 4.1.2). Catch

rates were standardized to equal effort among mesh sizes for standard canned nets and nets fished on bottom.

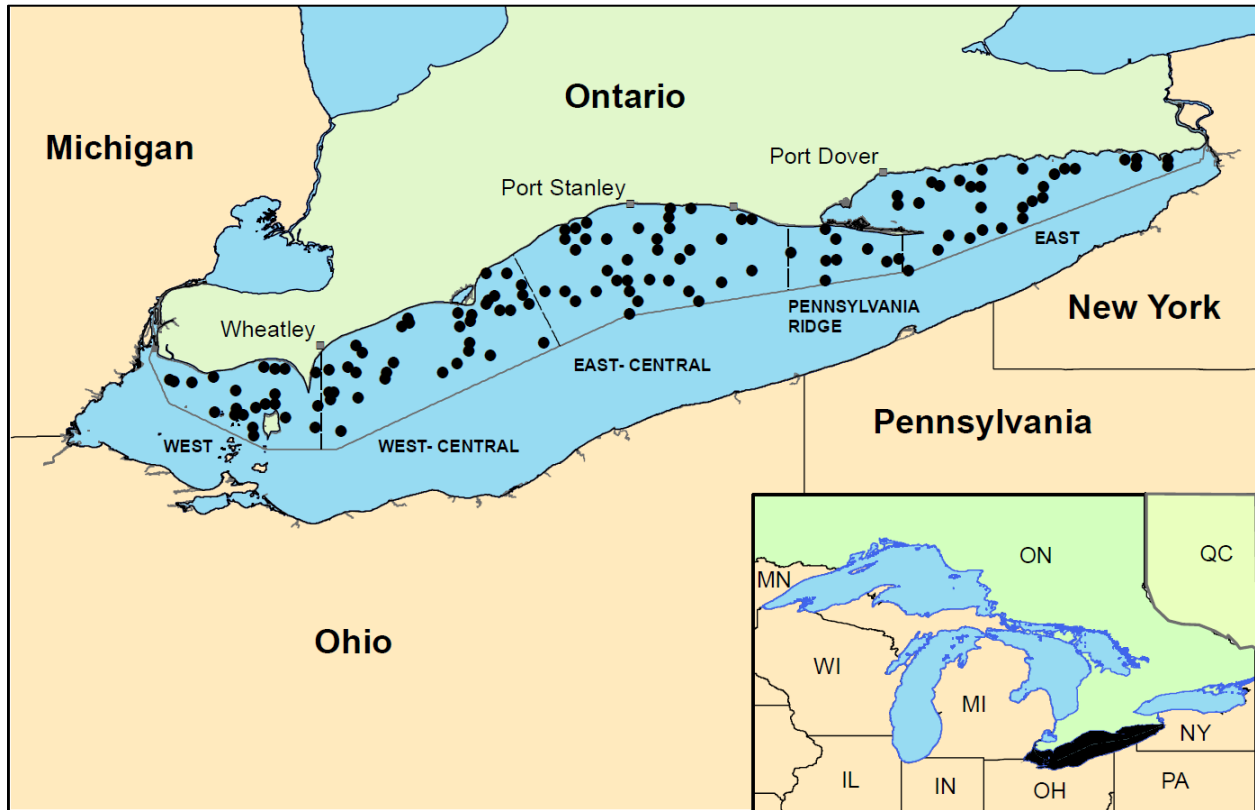


Figure 4.1.1 Locations fished in Partnership index gill net surveys during 2022.

Walleye

Walleye catch rates in 2022 ranged from moderate to high as number and biomass caught per gang (Table 4.1.1, Figure 4.1.2). Catch rates decreased from 2021 in the west, west-central, and east-central surveys while catch rates increased in the east basin and Pennsylvania Ridge surveys (Figure 4.1.2). The lakewide age composition in 2022 ranged from 0 to 19 with ages 1 and 3 most abundant in all surveys except the east basin where catches of age 2 Walleye were marginally higher than age 3 fish. Young-of-the-year (age 0 or YOY) Walleye were present in moderate numbers in the west basin survey but YOY catches were relatively high in all other surveys. Mean length and condition of Walleye ages 1 to 4 were below average in 2022, likely a result of density dependence.

Yellow Perch

Yellow Perch catch rates in 2022 were high in both number and biomass in the west, east, and Pennsylvania Ridge surveys (Table 4.1.1, Figure 4.1.2). In contrast, catch rates in the west-central and east-central basin surveys were low in numbers and biomass (Table 4.1.1, Figure 4.1.2). Yellow Perch abundance indices increased in the west, east, and Pennsylvania Ridge surveys from 2021, whereas decreases occurred in west-central and east-central surveys (Figure 4.1.2). The high status of Yellow Perch in the west basin was attributed solely to age 1 fish (2021 cohort). Age 1 Yellow Perch were also abundant in east and Pennsylvania Ridge surveys with moderate to low catch rates in central basin surveys. Age 2 was the most abundant age group in the east basin survey whereas age 3 comprised the largest fraction of Yellow Perch in the Pennsylvania Ridge and east-central basin surveys. Age representation ranged from 1 to 14 lakewide with the youngest age composition in the west basin, becoming progressively older eastwards. Yellow Perch mean size and condition at age was generally near average or above throughout Lake Erie in 2022.

White Bass

White Bass gill net indices in 2022 were low in the west, west-central, and east-central basin surveys according to number per gang, although biomass indices were moderate in the west and east-central basin surveys (Table 4.1.1, Figure 4.1.2). Numeric indices (number/gang) were high or moderate in the east and Pennsylvania Ridge surveys respectively, whereas biomass indices (kg/gang) were high in both eastern surveys. Lakewide, White Bass ages ranged from 0 to 12 with age 1 dominating the composition of all surveys. Age 2 accounted for the largest fraction of adult White Bass among surveys. White Bass length at age and body condition was generally near average or above in 2022.

White Perch

White Perch catch rates in 2022 were moderate in the west and east basin surveys according to number and biomass (Table 4.1.1, Figure 4.1.2). West-central and east-central White Perch indices were low by number/gang and kg/gang in 2022. Pennsylvania Ridge catch rates were high as number/gang and kg/gang (Table 4.1.1, Figure 4.1.2). Abundance indices in 2022 increased from 2021 in the west, Pennsylvania Ridge, and east basin surveys but declined in central basin surveys (Figure 4.1.2). White Perch age composition lakewide ranged from 0 to 8. Ages 1 and 2 accounted for the majority of west and west-central basin catches. In the east half of the lake (east-central, Pennsylvania Ridge, and east basin), age 2 fish comprised the largest fraction of White Perch caught, followed by age 3 whereas juveniles (age 0,1) were less significant in catches. Mean length at age of White Perch was generally near average or above in all surveys in 2022.

Lake Whitefish

Lake Whitefish are a migratory cold water species vulnerable to capture in index nets in the central, east basin, and Pennsylvania Ridge surveys. Only 20 Lake Whitefish were caught by index gill nets lakewide in 2022. Lake Whitefish catch rates in 2022 were low in central basin and Pennsylvania Ridge surveys but were moderate in the east basin survey as numbers and biomass (Table 4.1.1, Figure 4.1.2). Whitefish were not caught in the west basin survey, which was thermally unfavourable at the time of fishing. Compared to the previous year, Lake Whitefish indices in 2022 decreased in all surveys except the west basin where zero catches occur routinely (status="NA"). Lake Whitefish age groups present in surveys ranged from 1 to 7 with ages 3 (38%), 2 (29%), and 7 (14%) most abundant. None of the Lake Whitefish caught in 2022 had Sea Lamprey wounds or scars. Great Lakes Lake Whitefish are an intermediate host of the Digenean parasite *Ichthyocotylurus erraticus* (Muzzall and Whelan 2011), which populate the surface of the heart with white cysts. Heart cysts were present on 79% of Lake Whitefish examined in 2022. Heart cyst prevalence exceeded 70% since 2016. Prevalence was generally higher among larger fish in 2022 and in prior years of study. In Ireland, snails, Whitefish (Pollan), and gulls represent intermediate (two) and final hosts of this parasite respectively (Harrod and Griffiths 2005). Detrimental impacts of this parasite remain uncertain.

Lake Trout

Lake Trout are a native, cold water species caught mainly in the cold waters of the east basin and Pennsylvania Ridge surveys during thermal stratification. In some years, they are caught occasionally in the east-central basin survey after fall turnover. In 2022, Lake Trout catch rates were moderate (numbers and biomass) in the east basin survey whereas none were caught in the Pennsylvania Ridge survey (Table 4.1.1, Figure 4.1.2). Lake Trout catch rates in 2022 declined from 2021 in the east and Pennsylvania Ridge surveys. In 2022, 22 Lake Trout were caught in index nets; all were caught in nets fished on bottom in the east basin.

Multi-agency efforts to restore Lake Trout in Lake Erie rely on stocking multiple strains; each strain is identified by coded wire tags. Coded wire tags were retrieved from the nares of 15 out of 22 Lake Trout caught in index gill nets, revealing the following strains: Finger Lakes (14%), Slate Islands (54%), and unknown (32%). Seven Lake Trout (32%) caught were of unknown strain as they had adipose fin clips but lacked coded wire tags. Age composition of the 15 Lake Trout with known strains ranged from 1 to 14 with ages 2, 5, and 7 most abundant.

Species at Risk

Four (4) Lake Sturgeon were caught and released alive during the 2022 surveys. The Lake Sturgeon catches in the west basin (3) and Pennsylvania Ridge (1) surveys were considered high relative to the time series of each survey (Table 4.1.1). In 2022, 44 Silver Chub were caught, distributed among the west (38), west-central (2), and Pennsylvania Ridge (4) surveys. For west, west-central, and Pennsylvania Ridge surveys, Silver Chub status was considered moderate, high, and high respectively (Table 4.1.1).

Other species

Smallmouth Bass total catch (92) was distributed between the west (52) and east (40) basin surveys during 2022. Catch rates in numbers and biomass were ranked as moderate and low for the west and east basins respectively. Smallmouth Bass age composition ranged from 0 to 10 and 1 to 17 in west and east basin surveys respectively. Age 1 (2021 year class) was the most abundant age group in the west basin survey whereas age 2 (2020 year class) accounted for the largest fraction of Smallmouth Bass caught in the east basin.

Gizzard Shad status in 2022 was low according to numbers and biomass caught in the west and central basin surveys (Table 4.1.1). Gizzard Shad status was high in numbers and biomass in the Pennsylvania Ridge while Gizzard Shad abundance was moderate with high biomass in the east basin survey. Young-of-the-year Gizzard Shad, based on length distributions, were abundant in the Pennsylvania Ridge survey but were caught in low numbers in other surveys.

In 2022, Freshwater Drum abundance was moderate in west basin, low in central basin surveys but was high in the Pennsylvania Ridge and east basin assessments. Freshwater Drum biomass status matched abundance in 2022 except in the west basin where biomass was high. Based on length distributions, YOY Freshwater Drum were present in the west-central and east-central basin surveys but were absent from other surveys.

During 2022, Channel Catfish status ranged from moderate in central basin surveys to high in all other surveys according to number of fish and biomass caught.

References:

Harrod, C. and D. Griffiths. 2005. *Ichthyocotylurus erraticus* (Digenea:Strigeidae): factors affecting infection intensity and the effects of infection on pollan (*Coregonus autumnalis*), a glacial relict fish. *Parasitology*. 131 5119-519.

Muzzall, P.M. and Whelan, G. 2011. *Parasites of Fish from the Great Lakes: A Synopsis and Review of the Literature, 1871-2010*. Great Lakes Fish. Comm. Misc. Publ. 2011-01.

Table 4.1.1 Species status ranks in 2022 by basin using standardized catch rates (number/gang and kg/gang) in bottom, standard canned, and canned thermocline gangs. Ranks are based on the percentiles in 2022 (Low 0-33, Moderate 33.1-66, High 66.1-100) relative to each time series by species, basin. Status percentile ranks for species with frequent annual catches of zero in a basin are "NA". Refer to lakewide catch for clarification.

Common, Scientific Name		West	West Central	East Central	East	Pennsylvania Ridge	Lakewide Catch (#)	Lakewide Biomass (Kg)
Lake Sturgeon	<i>Acipenser fulvescens</i>	H / H	NA	NA	NA	H / H	4	13.0
Longnose Gar	<i>Lepisosteus osseus</i>	M / H	NA	NA	NA	NA	1	0.7
Alewife	<i>Alosa pseudoharengus</i>	M / M	M / M	M / M	M / M	M / M	323	14.3
Gizzard Shad	<i>Dorosoma cepedianum</i>	L / L	L / L	L / L	M / H	H / H	2,320	794.7
Rainbow Trout	<i>Oncorhynchus mykiss</i>	NA	NA	L / L	H / H	H / H	28	39.3
Brown Trout	<i>Salmo trutta</i>	NA	NA	NA	M / M	NA	1	0.4
Lake Trout	<i>Salvelinus namaycush</i>	NA	NA	NA	M / M	L / L	22	36.0
Lake Whitefish	<i>Coregonus clupeaformis</i>	NA	L / L	L / L	M / M	L / L	20	14.8
Rainbow Smelt	<i>Osmerus mordax</i>	L / L	L / L	L / L	L / L	L / L	83	1.8
Quillback	<i>Carpodes cyprinus</i>	L / M	NA	L / L	H / H	H / H	21	31.9
White Sucker	<i>Catostomus commersonii</i>	H / H	M / M	L / L	L / L	H / H	270	216.8
Silver Redhorse	<i>Moxostoma anisurum</i>	NA	NA	NA	NA	H / H	1	2.4
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>	M / M	M / M	M / M	H / H	H / H	60	52.9
Redhorse	<i>Moxostoma sp.</i>	H / H	NA	NA	H / H	NA	2	1.5
Goldfish	<i>Carassius auratus</i>	H / H	NA	NA	NA	NA	1	1.1
Common Carp	<i>Cyprinus carpio</i>	L / L	L / L	NA	NA	NA	2	2.9
Silver Chub	<i>Macrhybopsis storeriana</i>	M / M	H / H	L / L	NA	H / H	44	2.8
Spottail Shiner	<i>Notropis hudsonius</i>	NA	NA	M / H	NA	NA	1	0.0
Brown Bullhead	<i>Ameiurus nebulosus</i>	NA	NA	H / H	H / H	NA	2	0.9
Channel Catfish	<i>Ictalurus punctatus</i>	H / H	M / M	M / M	H / H	H / H	309	304.6
Burbot	<i>Lota lota</i>	NA	H / M	M / M	M / L	H / M	55	58.5
Troutperch	<i>Percopsis omiscomaycus</i>	NA	NA	H / H	NA	NA	4	0.1
White Perch	<i>Morone americana</i>	M / M	L / L	L / L	M / M	H / H	4,938	802.8
White Bass	<i>Morone chrysops</i>	L / M	L / L	L / M	H / H	M / H	481	179.6
Rock Bass	<i>Ambloplites rupestris</i>	M / M	NA	NA	M / M	L / L	26	2.8
Pumpkinseed	<i>Lepomis gibbosus</i>	NA	NA	NA	H / H	NA	1	0.0
Smallmouth Bass	<i>Micropterus dolomieu</i>	M / M	NA	NA	L / L	NA	92	57.3
Yellow Perch	<i>Perca flavescens</i>	H / H	L / L	L / L	H / H	H / H	17,743	1,769.3
Walleye	<i>Sander vitreus</i>	M / M	H / M	H / H	H / H	H / H	4,073	1,920.8
Round Goby	<i>Neogobius melanostomus</i>	H / H	M / M	L / L	L / L	M / M	20	0.7
Freshwater Drum	<i>Aplodinotus grunniens</i>	M / H	L / L	L / L	H / H	H / H	1,716	1,397.0
All Fish	All Species	M / M	L / L	L / L	H / H	H / H	32,664	7,721.9

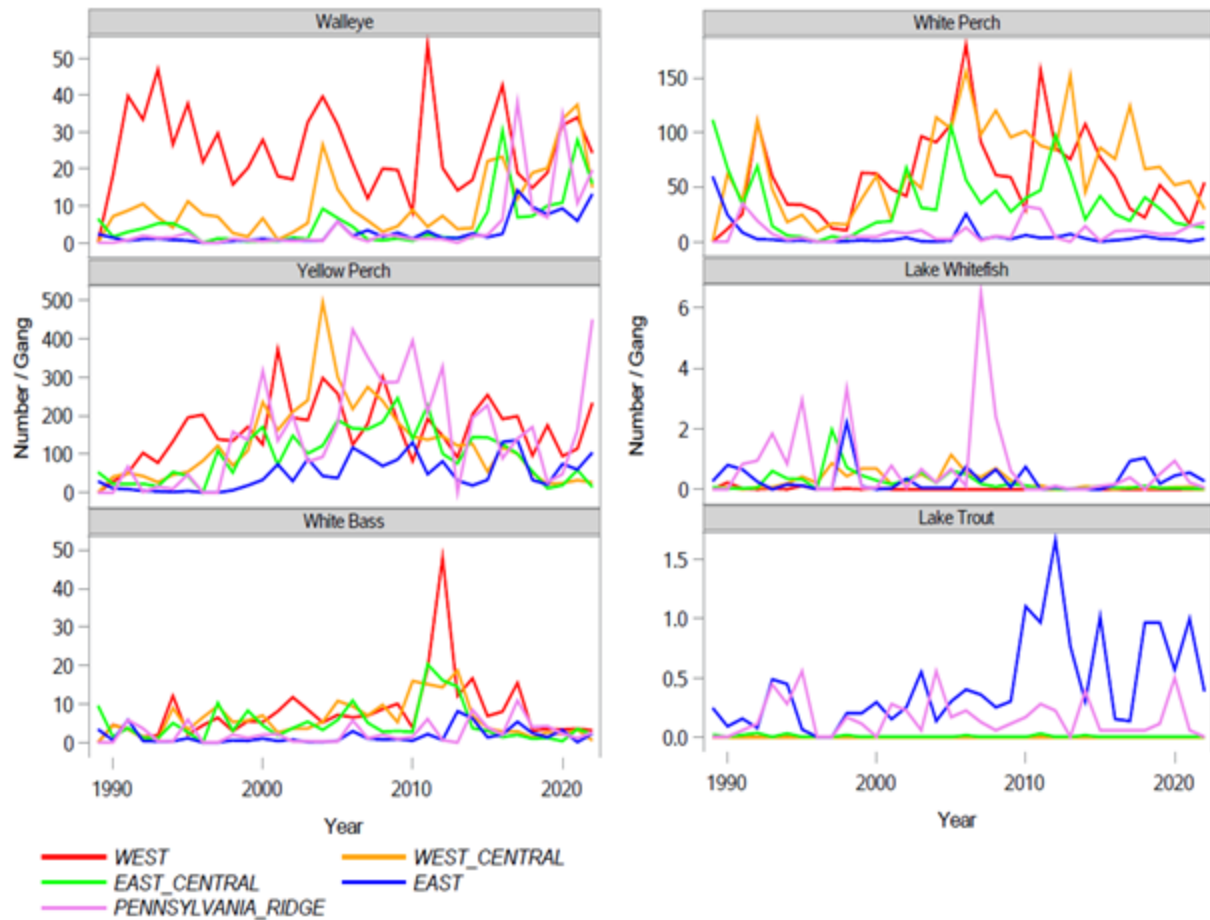


Figure 4.1.2 Mean catch rate (number / gang) by species, and basin for Walleye, Yellow Perch, White Bass, White Perch, Lake Whitefish, and Lake Trout. Includes standard canned and bottom nets standardized to equal effort among mesh sizes.

4.2 Index Trawling: Western Lake Erie

The western basin interagency trawling index, conducted by Ontario and Ohio, occurs annually during August. The study assesses species composition and density of young-of-the-year (YOY), and yearling and older fish (YOA). Catch rates of juvenile Walleye and Yellow Perch are combined with Ohio samples for recruitment indices used by Lake Erie task groups to forecast age 2 abundance. The gear, a two seam, 33' Biloxi bottom trawl (38' ground line) with a ½" cod-end liner, was towed on bottom for 10 minutes at 1.6 knots at 36 stations (Figure 4.2.1). Subsamples of catches from each trawl were measured on board and ages were determined for samples of juvenile Yellow Perch and Walleye. Temperature and dissolved oxygen profiles were recorded at each site. To reduce bias, an interim interagency protocol was implemented to exclude bottom trawl samples with hypoxia (≤ 2 mg / l). Hypoxia was present at 3 sites in 2022 resulting in their exclusion (Figure 4.2.1). Mean number caught per hectare and percentile by species and age group (young-of-the-year, yearling (Walleye), yearling and older, ages 2 and older (Walleye) and all ages combined) are presented for the 2022 field season along with mean catch rates for several time periods (Table 4.2.1).

In Ontario waters, catch rates in 2022 were above average for young-of-the-year (YOY or age 0) Walleye, YOY Yellow Perch and YOY Smallmouth Bass (Table 4.2.1). Catch rates of Freshwater Drum YOY and Gizzard Shad YOY were moderate in 2022 whereas YOY White Perch and YOY White Bass indices were weak in 2022. Mean lengths of YOY and yearling Walleye remained well below time series means in 2022. YOY Yellow Perch mean length was near average in 2022, while yearling Yellow Perch mean length exceeded the time series average.

Yearling, age 2 and older Walleye, and yearling Yellow Perch catch rates were above average in 2022 (Table 4.2.1, Figure 4.2.2). The catch rate of yearling and older (YAO) White Perch was moderate while the YAO Freshwater Drum catch rate was below average in 2022 (Table 4.2.1).

The catch rate of all forage species combined (species that are prey during all life stages, all age groups) in 2022 was below mean catch rates of all time periods (Table 4.2.1). Exceptions during 2022 included Tubenose Goby with the highest catch rate in the time series, above average catch rates of Logperch, and moderate catch rates of Rainbow Smelt (primarily YOY), Silver Chub, Mimic Shiners, Troutperch, and Round Gobies (Table 4.2.1). Emerald Shiner and Spottail Shiner catch rates remained below average in 2022. Alewife, which were historically abundant, collapsed in 2003 and remained rare or absent (2022) from west basin bottom trawls since.

One Lake Sturgeon with a total length of 606 mm, was caught and released unharmed during the 2022 trawl survey.

Table 4.2.1. Number / hectare caught and percentile by fish species and age group in 2022 compared to time period means: 1988-2021, 1988-1999, 2000-2009, 2010-2021.

Age Group(s)	Species	1988-2021	1988-1999	2000-2009	2010-2021	2022	(88-22)
Young of the Year	Gizzard Shad	422.1	637.9	584.1	71.3	145.5	50%
	Quillback	0.0	0.1	-	-	-	0%
	White Sucker	0.0	0.0	-	-	-	0%
	Channel Catfish	0.0	0.1	0.0	0.0	0.1	91%
	White Perch	2,114.0	2,309.9	2,242.6	1,810.8	367.2	15%
	White Bass	90.1	84.2	150.1	46.0	3.2	0%
	Morone sp.	0.0	-	0.0	0.0	-	0%
	Centrarchidae	0.0	-	-	0.0	-	0%
	Rock Bass	0.3	0.2	0.4	0.4	0.1	50%
	Pumpkinseed	0.0	-	0.0	-	-	0%
	Bluegill	0.0	-	-	0.0	-	0%
	Smallmouth Bass	1.7	1.7	2.2	1.4	2.6	82%
	Largemouth Bass	0.1	0.4	0.0	0.0	-	0%
	White Crappie	0.3	0.8	0.0	-	-	0%
	Black Crappie	0.0	-	0.0	-	-	0%
	Poxomis sp.	0.0	-	-	0.0	-	0%
	Yellow Perch	632.5	489.3	454.3	924.2	962.3	82%
	Walleye	53.2	18.1	16.3	119.2	126.2	88%
	Freshwater Drum	22.0	16.2	33.0	18.6	8.4	62%
	All	3,336.4	3,558.7	3,483.1	2,991.9	1,615.5	21%
Yearling	Walleye	11.5	4.8	10.0	19.4	38.7	88%
Yearling and Older	Silver Lamprey	0.0	0.0	0.0	0.0	-	0%
	Lake Sturgeon	0.0	0.0	0.0	0.1	0.1	94%
	Gizzard Shad	1.7	4.6	0.2	0.1	-	0%
	Lake Whitefish	0.0	-	0.0	-	-	0%
	Northern Pike	0.0	0.0	-	0.0	-	0%
	Muskellunge	0.0	-	0.0	0.0	-	0%
	Quillback	0.2	0.2	0.4	0.1	-	0%
	Longnose Sucker	0.0	-	-	0.0	-	0%
	White Sucker	1.2	0.5	1.3	1.7	0.2	9%
	Silver Redhorse	0.0	-	0.0	0.0	-	0%
	Golden Redhorse	0.0	-	0.1	-	-	0%
	Shorthead Redhorse	0.1	0.0	0.3	0.1	0.1	62%
	Moxostoma sp.	0.0	-	-	0.0	-	0%
	Common Carp	0.9	1.4	0.8	0.4	0.2	9%
	Yellow Bullhead	0.0	-	0.0	0.0	-	0%
	Brown Bullhead	0.4	0.5	0.7	0.1	-	0%
	Channel Catfish	1.0	1.2	0.9	1.0	0.4	26%
	Burbot	0.3	0.9	-	-	-	0%
	White Perch	115.8	79.4	204.9	77.9	78.8	56%
	White Bass	2.0	2.0	2.1	2.0	0.2	32%
	Rock Bass	0.7	1.0	0.6	0.3	2.6	100%
	Bluegill	0.0	-	-	0.0	-	0%
	Smallmouth Bass	0.4	0.8	0.2	0.1	-	0%
	Largemouth Bass	0.1	0.1	-	-	-	0%
	White Crappie	0.0	0.0	-	-	-	0%
	Black Crappie	0.0	0.0	0.0	-	0.1	97%
	Yellow Perch	185.7	119.1	286.9	168.0	211.3	74%
	Freshwater Drum	42.9	33.2	62.7	36.1	19.6	12%
	Carp-Goldfish hybrid	0.0	-	0.0	0.0	-	0%
Ages 2 +	Walleye	3.1	2.6	2.9	3.7	3.7	82%
	All	368.0	252.4	575.0	311.2	356.0	65%
Species With All Age Groups Combined	Alewife	268.6	654.3	127.6	0.3	-	0%
	Rainbow Smelt	32.7	9.3	40.9	49.2	3.4	47%
	Cyprinidae	14.0	-	5.3	35.1	2.1	65%
	Goldfish	0.0	0.0	0.0	0.1	-	0%
	Silver Chub	5.7	7.6	3.9	5.2	7.0	68%
	Emerald Shiner	91.1	51.5	176.9	59.2	1.7	9%
	Common Shiner	0.0	-	0.0	-	-	0%
	Spottail Shiner	36.5	72.0	28.9	7.2	8.9	29%
	Spotfin Shiner	0.0	0.0	-	-	-	0%
	Mimic Shiner	4.7	0.0	2.2	11.3	0.1	56%
	Bluntnose Minnow	0.0	-	-	0.1	-	0%
	Blacknose Dace	0.0	0.0	-	-	-	0%
	Nocomis sp.	0.0	0.0	-	-	-	0%
	Notropis sp.	0.0	-	0.0	-	-	0%
	Troutperch	204.3	196.7	259.7	165.8	130.5	47%
	Johnny Darter	0.1	0.3	-	0.0	-	0%
	Logperch	4.1	4.2	2.5	5.2	5.5	76%
	Brook Silverside	0.1	0.1	0.1	0.1	-	0%
	Round Goby	64.1	14.9	125.3	62.4	37.6	38%
	Tubenose Goby	0.1	-	-	0.2	1.5	100%
	All	726.0	1,010.9	773.5	401.4	198.3	9%
Total	All Species, Groups	4,430.5	4,822.1	4,831.6	3,704.5	2,169.8	26%
	Number of Trawls	35	35	35	35	33	

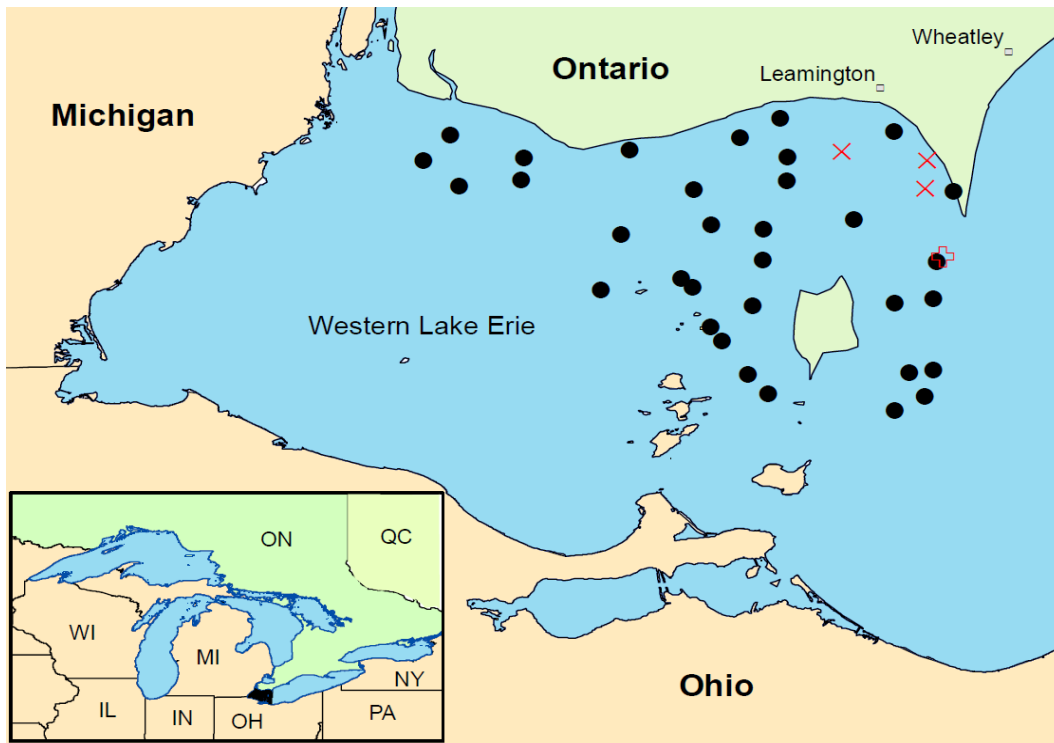


Figure 4.2.1 Bottom trawl sites (black dots) fished in Ontario waters of western Lake Erie, 2022. Trawls excluded due to hypoxia are indicated with a red “x”. The location of a damaged trawl net is indicated by a red cross; this site was repeated successfully.

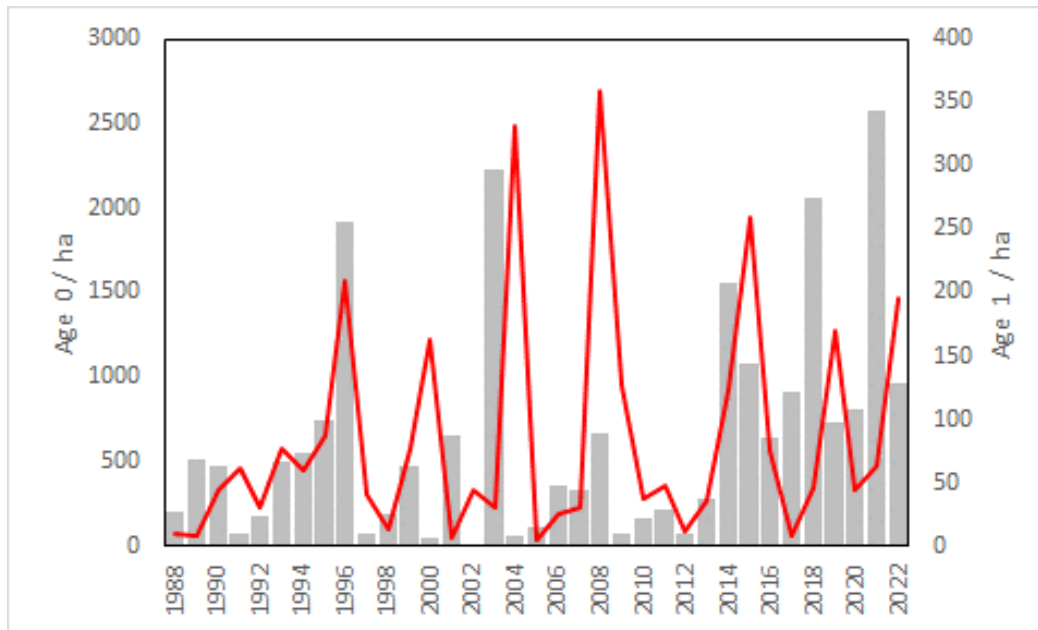


Figure 4.2.2 Yellow Perch number per hectare caught trawling as age 0 (left axis, grey bars) and age 1 (right axis, red line) in Ontario waters of western Lake Erie; 1988-2022.

4.3 Long Point Bay Index Trawl Surveys

Assessment of juvenile fish in Long Point Bay consists of three independent bottom trawl surveys conducted during early fall each year in three areas (Figure 4.3.1). Surveys targeting Yellow Perch have been conducted annually since 1980 in Inner Long Point Bay (Inner Bay Trawl Assessment) at four fixed stations and in the nearshore waters of Outer Long Point Bay (Nearshore Outer Bay Trawl Assessment) at three fixed stations with a 6.1 m modified Biloxi bottom trawl. A third trawl survey was initiated in 1984 to measure recruitment of Rainbow Smelt. In this survey, a 10 m Biloxi bottom trawl is fished in the offshore waters of Outer Long Point Bay (Offshore Outer Bay Trawl Assessment) at four fixed stations. For all surveys, two consecutive trawls are towed for ten minutes at each station during each sample event. Trawling takes place once a week for five weeks. In the nearshore areas it generally occurs from late August to late September and in the offshore from late September to early November.

In addition, a new survey commenced in 2018 to shorten the sampling period to two weeks for each survey and increase the spatial coverage. To maintain the continuity of the data series, both the old and new surveys will be run each year until a correction factor can be established, at which point the old survey will be discontinued. Data presented in this section are from the original survey design.

The 2022 sampling period occurred from September 1st to October 4th at the nearshore sites and from September 29th to October 26th at the offshore sites. Both the old and new surveys were conducted during these sampling periods.

Yellow Perch

An index of Yellow Perch abundance was introduced in 2010. This Long Point Bay composite index (LPBc) combines the annual mean abundance (number per hectare, Fish/ha) estimates from each of the three trawl assessments and assigns a weight to each of the area estimates based on surface area with bottom depths greater than 5 m (78.3%) and less than or equal to 5 m (21.7%).

The estimated density of young-of-the-year (YOY) Yellow Perch in Long Point Bay calculated using the LPBc was 41 fish/ha in 2022, which is low relative to other estimates in the survey timeseries (1984-2021: mean Fish/ha = 84, range = 0-447). Density of age 1 Yellow Perch in 2022 was also low relative to the timeseries estimates at 2 fish/ha (1984-2021: mean Fish/ha = 13, range = 0-110).

Rainbow Smelt

Only the Offshore Outer Bay Trawl Assessment is used to assess Rainbow Smelt abundance. Abundance of young-of-the-year (YOY) was in the 30th percentile (Fish/ha = 184) but below the long-term mean (Table 4.3.1). Abundance of yearling-and-older (YAO)

Rainbow Smelt was in the 45th percentile (Fish/ha = 118) and was also below the time series mean (Table 4.3.1).

Other Species

Inner Bay – In 2022, catches of Banded Killifish, Round Goby, and sunfish were all above the long-term mean (Table 4.3.2). The catches of YOY and YAO Yellow Perch, as well as all other species, were below average.

Nearshore Outer Bay – In 2022, the catch of Round Goby was above the long-term mean (Table 4.3.3). All other species and age classes were below average.

Offshore Outer Bay – In 2022, the catches of all species were below the long-term mean (Table 4.3.1).

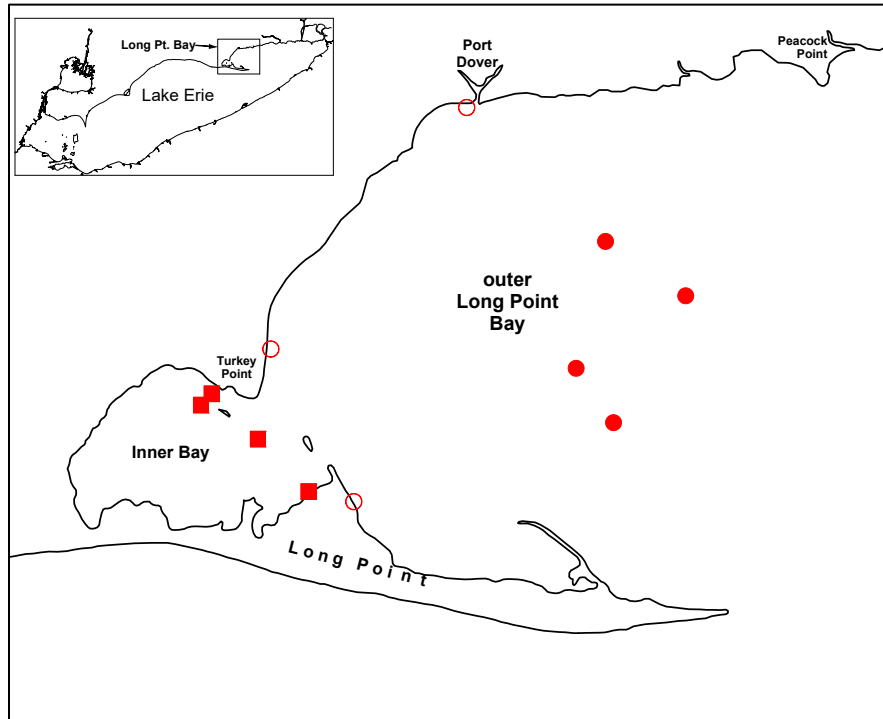


Figure 4.3.1 Location of trawl stations where bottom trawling was conducted in Inner Bay (■), and the nearshore (○) and offshore (●) waters of Outer Long Point Bay, Lake Erie.

Table 4.3.1 Mean number per hectare and percentile of selected young-of-the-year (YOY) and yearling-and-older (YAO) fish species caught in the offshore waters of Outer Long Point Bay, Lake Erie, during index bottom trawl assessments (10 m trawl), September - October 2022, and mean and range of means from 1984 to 2021.

Species	Life Stage	2022		1984-2021	
		Mean	Percentile	Mean	Range
Rainbow Smelt	YOY	183.5	30%	931.8	0.9-7054.1
	YAO	118.2	45%	362.8	0.1-3328.1
Yellow Perch	YOY	20.5	62%	61.9	0.0-551.1
	YAO	8.5	60%	20.1	0.0-201.7
White Perch	YOY	0.3	32%	4.8	0.0-96.1
White Bass	YOY	1.2	52%	10.4	0.0-166.2
Alewife	YOY	11.2	57%	90.8	0.0-2174.5
Gizzard Shad	YOY	1.3	45%	13.5	0.0-86.5
Emerald Shiner	All Ages	4.6	18%	412.0	0.0-4652.6
Round Goby*	All Ages	121.8	52%	169.2	0.2-973.2

*Round Goby was first detected in our surveys in 1999, so means and percentiles are for 1999-2021.

Table 4.3.2 Mean number per hectare and percentile of selected young-of-the-year (YOY) and yearling-and-older (YAO) fish species caught in Inner Long Point Bay, Lake Erie, during index bottom trawl assessments (6.1 m trawl), September - October 2022, and mean and range from 1980 to 2021.

Species	Life Stage	2022		1980-2021	
		Mean	Percentile	Mean	Range
Yellow Perch	YOY	152.0	59%	251.3	0.0-1859.5
	YAO	5.6	16%	82.3	0.2-513.2
Rock Bass	YOY	7.9	66%	14.0	0.0-197.6
Smallmouth Bass	YOY	1.3	7%	13.3	0.0-91.7
Largemouth Bass	YOY	6.8	68%	10.8	0.0-96.6
Sunfish (<i>Lepomis</i> sp.)	YOY	36.5	77%	27.4	0.0-184.5
Spottail Shiner	All Ages	0.1	25%	128.4	0.0-985.1
Banded Killifish	All Ages	90.9	95%	16.8	0.0-243.6
Johnny Darter	All Ages	4.3	57%	9.1	0.0-58.1
Round Goby*	All Ages	143.3	72%	101.7	0.6 - 280.5

*Round Goby was first detected in our surveys in 1999, so means and percentiles are for 1999-2021.

Table 4.3.3 Mean number per hectare and percentile of selected young-of-the-year (YOY) and yearling-and-older (YAO) fish species caught in the nearshore waters of Outer Long Point Bay, Lake Erie, during index bottom trawl assessments (6.1 m trawl), September - October 2022, and mean and range from 1980 to 2021.

Species	Life Stage	2022		1980-2021	
		Mean	Percentile	Mean	Range
Yellow Perch	YOY	73.6	63%	94.0	0.5-739.9
	YAO	3.3	28%	33.7	0.7-391.0
White Perch	YOY	0.0	2%	12.9	0.0-120.9
White Bass	YOY	0.6	65%	6.6	0.0-153.9
Alewife	YOY	0.3	28%	51.4	0.0-869.7
Gizzard Shad	YOY	3.9	44%	10.6	0.0-82.8
Emerald Shiner	All Ages	0.0	2%	35.1	0.0-512.1
Spottail Shiner	All Ages	113.6	51%	357.3	3.1-1604.1
Round Goby*	All Ages	201.8	88%	104.0	0.6-359.1

*Round Goby was first detected in our surveys in 1999, so means and percentiles are for 1999-2021.

4.4 Coldwater Assessment Survey

Since 1986, the Ontario Ministry of Natural Resources and Forestry (OMNRF) has conducted a stratified, random transect design August gill net assessment survey for Lake Trout and other coldwater species in conjunction with multi-jurisdictional partners. According to the standard design, 5 gangs of gill nets were fished on bottom parallel to depth contours, starting at the 10° C isotherm, progressing to greater depths (thermocline). In 2020, the survey design was modified to include 2 standard gangs with additional randomly selected 2.5 minute grid locations in deeper, offshore waters (Figure 4.4.1). The sampling design divides the eastern basin of Lake Erie into eight sampling areas. OMNRF partners with the United States Geological Survey (USGS) to complete the survey in Ontario waters, sampling Areas A5-A8 (Figure 4.4.1). New York State Department of Environmental Conservation (NYSDEC) and the Pennsylvania Fish and Boat Commission (PAFBC) are responsible for sampling in their jurisdictions. Only data from Ontario waters is presented in this report. In 2022, OMNRF and USGS completed 48 net sets in Ontario waters.

The Lake Erie Lake Trout population continues to be supported by bi-national stocking efforts (see Section 5.5). Although there is recent evidence of some reproduction on New York shoals, greater than 99% of fish caught in fishery assessments have marks (clips and/or tags applied before stocking). In 2022, the mean number of Lake Trout caught was 2.4 fish/lift (Figure 4.4.2). Lake Trout caught ranged in age from 1 to 29 years, with a

median age of 12. Rainbow Smelt was the primary prey item identified in Lake Trout stomachs in 2022.

The mean number of Lake Whitefish was 2.4 fish/lift in 2022 (Figure 4.4.2). This was up notably from 2021, and the highest catch rate in the last decade. Less than half of the 113 Lake Whitefish caught in 2022 have been aged to date. Of these, individuals ranged in age from 2 to 7 years old with a median age of 3. The high catch rates and the presence of multiple cohorts is promising, showing evidence of reproduction.

Burbot catches have been consistently low since 2012, below 1 fish/lift. This trend continued in 2022, although mean catch rate in Ontario waters rose slightly to 0.98 fish/lift, the third consecutive year of increases (Figure 4.4.2). In 2019, Burbot caught ranged in age from 2 to 21 years old with a median age of 5. This evidence of younger year classes is promising as catches had been composed of older year classes in the recent past. Rainbow Smelt and Round Goby were the main prey items found in Burbot diets in 2022.

Catch rates of different species vary across the basin. Presented here are results from Ontario waters as collected by the OMNRF and USGS. Some bi-national management decisions by the Lake Erie Committee (LEC) of the Great Lakes Fishery Commission, (e.g., decisions to raise or lower numbers of Lake Trout stocked) are made using area-weighted basin-wide means; using data from all jurisdictions. Basin-wide summaries can be found in the annual report of the Coldwater Task Group of the LEC (Coldwater Task Group, 2022).

Reference:

Coldwater Task Group. 2023. 2022 Report of the Lake Erie Coldwater Task Group, March 2023. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA. 49p.
http://www.glfc.org/pubs/lake_committees/erie/LEC.

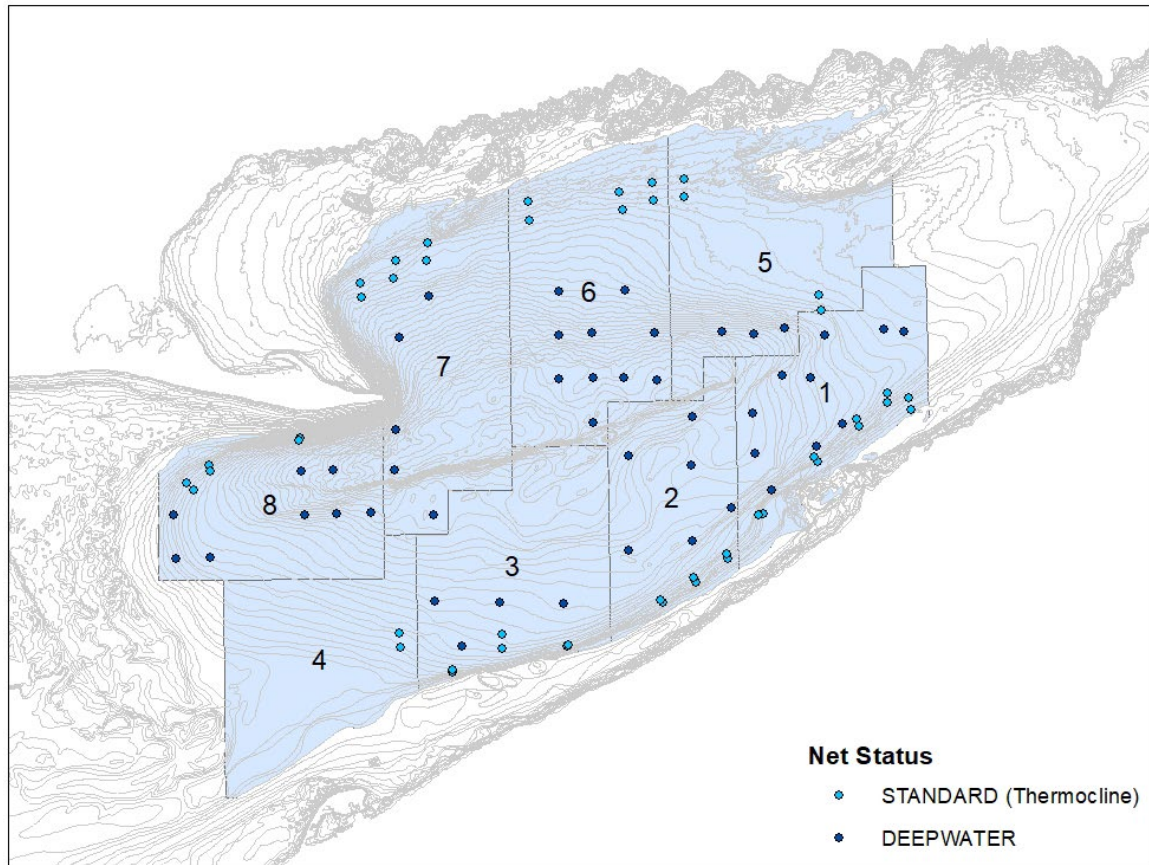


Figure 4.4.1 Standard and Deepwater sampling areas used in the Coldwater Assessment survey in the east basin of Lake Erie. Circles represent the location of net sets in 2022. OMNRF and USGS set nets in Ontario waters (A5-A8), New York in A1 and A2, and Pennsylvania in A3 and A4.

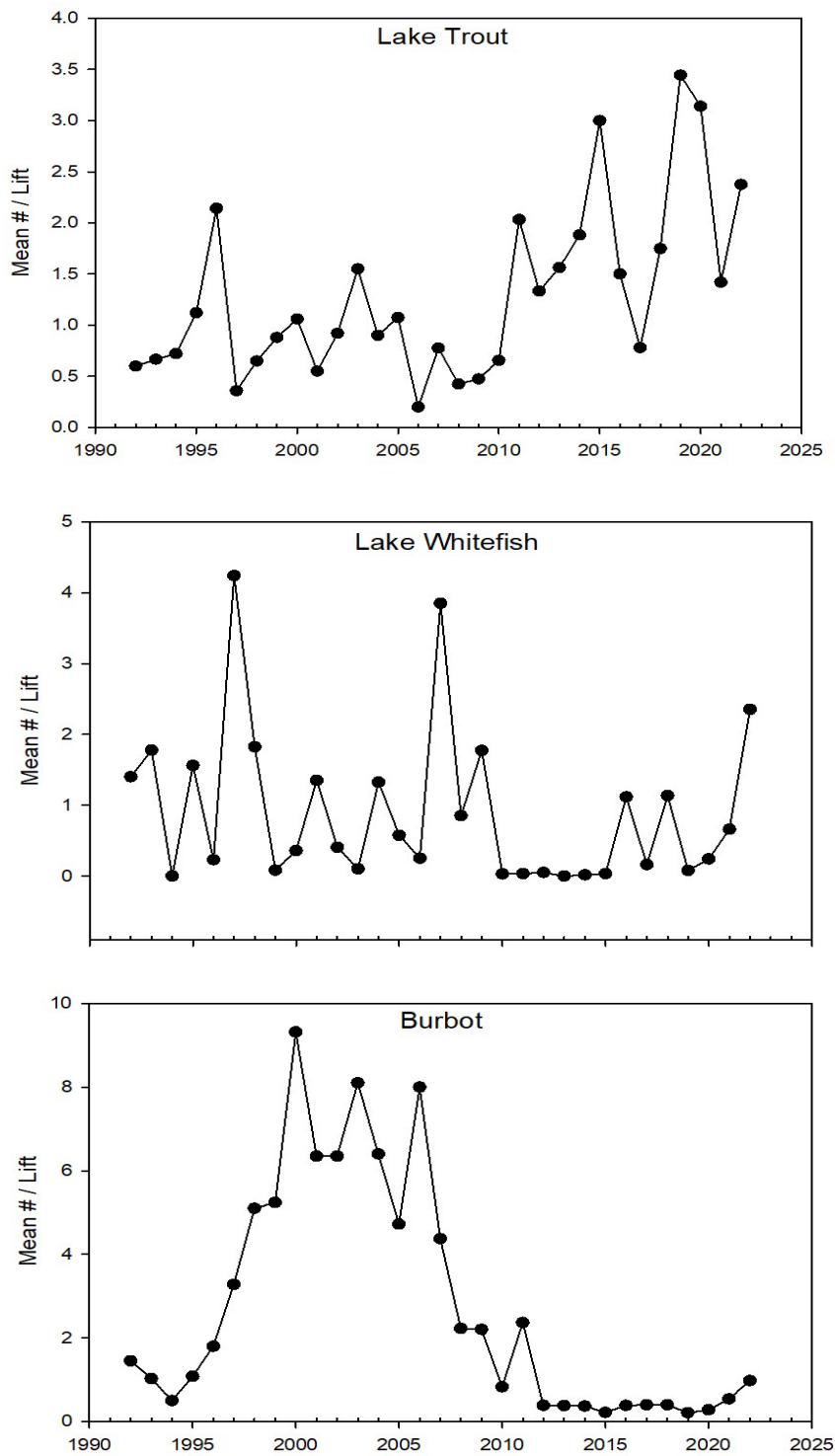


Figure 4.4.2 Mean number of Lake Trout, Lake Whitefish and Burbot caught per net lift during interagency Coldwater Assessment gill netting in Ontario waters of eastern Lake Erie, 1992-2022.

4.5 East Basin Hydroacoustic Survey

The primary purpose of Lake Erie east basin hydroacoustic surveys is to estimate densities of Rainbow Smelt. Lake Erie hydroacoustic surveys have been conducted annually in the east basin since 1993. Historical survey designs were based on cross lake transects that routinely experienced challenges that at times inhibited survey completion. Only four of six strata were sampled in 2014, only three of the strata in 2015, and only Ontario waters in 2018 and 2020. In 2022, the hydroacoustic surveys operating in each of the three basins implemented a new standardized whole lake approach following a multi-year survey evaluation and redesign process. The new approach utilizes a stratified random grid approach and reduces the overall survey effort, emphasizes data collection in strata with the greatest variability and provides greater operational flexibility (Figure 4.5.1).

Hydroacoustic data does not on its own inform species composition. Companion midwater trawls used for species identification and biomass partitioning were initially completed by NYSDEC until 2007. These trawls determined that >95% of the fish caught in cold-water habitat were yearling and older smelt, leading to an analytical approach that vertically splits the echogram based on temperature and target size such that all fish in the age 1+ size range (target strength from -59dB to -40dB) are classified as age 1+ Rainbow Smelt. Midwater trawl catches by OMNRF in 2019 again confirmed this assumption. In situ target strength distribution also support this assumption where targets in the epilimnion are generally smaller than yearling sized fish and are more consistent with age 0 sized fish.

Using the new survey design in 2022 the number of elementary distance sampling units (EDSU) was met or exceeded in all but Strata S16, S20, and S24 where weather or travel distances resulted in being below target by one EDSU (Table 4.5.1). Four grids (2 in S17, 1 in S21, and 1 in S23) did not have hypolimnetic conditions and thus were assumed to not have any yearling and older Rainbow Smelt (0 fish/ha). Strata density are the mean density of all the 500 m EDSU within the Strata (Figure 4.5.2). The highest density of YAO Rainbow Smelt were observed in S17, S22 and S23 (mean Fish/ha = 4803, 3917 and 3758 respectively) (Figure 4.5.3). The time series of yearling and older (YAO) Rainbow Smelt is an index of fish abundance in the hypolimnion that have target strengths consistent with yearling and older sized Rainbow Smelt (-60 dB to -40dB) and is based on an area weighted mean of the combined strata. The east basin index increased to 2137 fish/ha in 2022 from 1432 fish/ha in 2021 (Figure 4.5.4). In situ target strength from each layer support the assumption that targets in the epilimnion are dominated by young-of-the-year sized targets (< -60dB) while targets in the hypolimnion are consistent with age 1 and older sized Rainbow Smelt (-59dB to -40dB) (Figure 4.5.5).

Whole lake indices that pool results from the western, central, and east basin surveys are presented in the 2022 Forage Task Group Report.

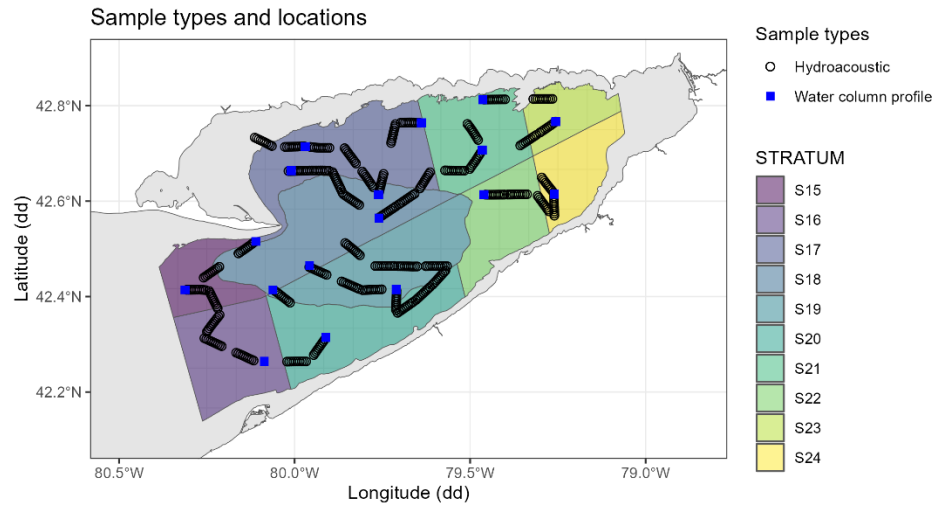


Figure 4.5.1 East basin hydroacoustic strata and sampling locations utilizing the lakewide standardized approach.

Table 4.5.1 East basin hydroacoustic strata sampling targets and complete effort.

Stratum	N Target	N Completed
S15	2	2
S16	4	3
S17	5	12
S18	6	8
S19	5	7
S20	5	4
S21	4	5
S22	3	3
S23	2	2
S24	3	2

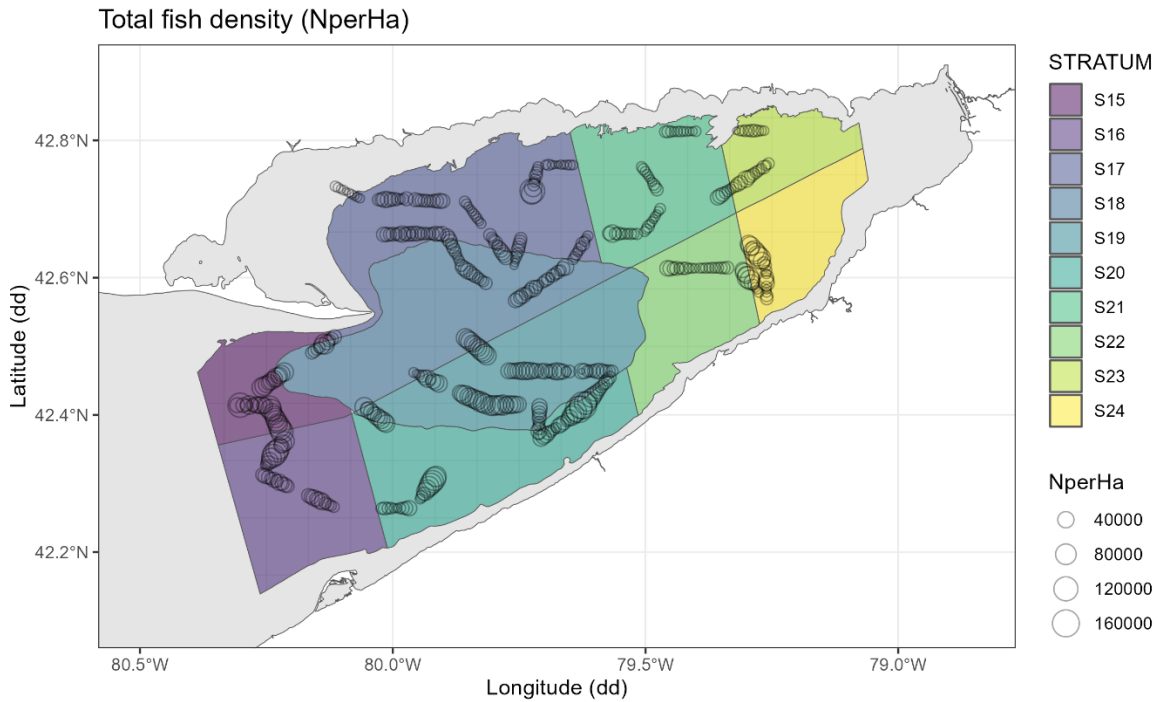


Figure 4.5.2 Whole water column fish density (N per Ha) across all east basin strata

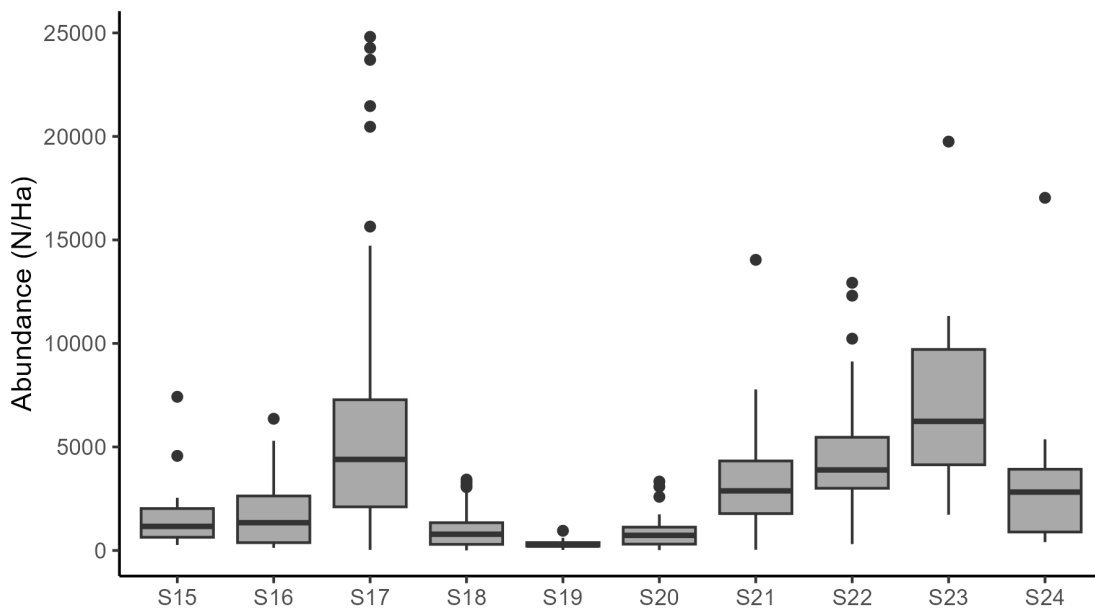


Figure 4.5.3 East basin density estimates of yearling and older Rainbow Smelt by elementary distance sampling unit (EDSU) within each stratum. Solid line represents the median value. Box captures the 50% quantiles while whiskers captures 95% quantiles of the data and points that exceeded the 95% quantiles are indicated with individual points.

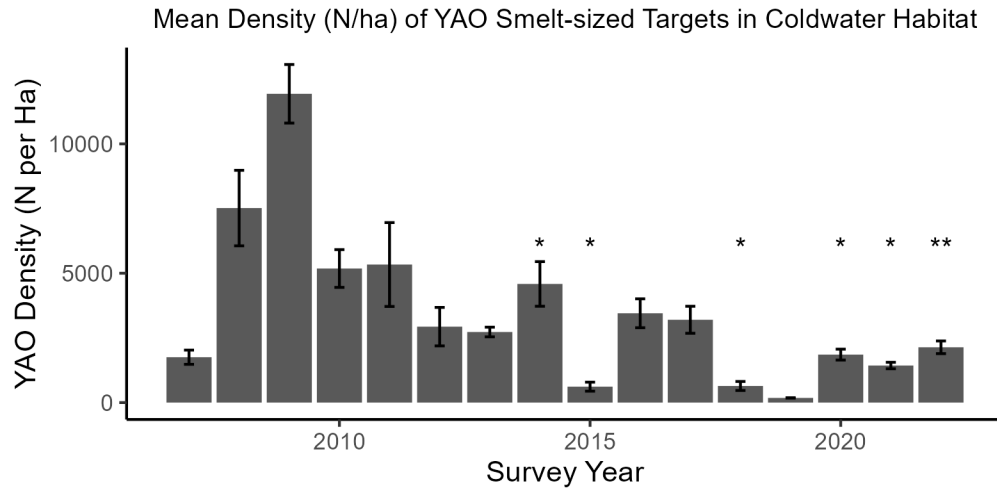


Figure 4.5.4 East basin index of yearling and older Rainbow Smelt. Error bars represent ± 1 standard error. A single asterisk (*) indicates years where all transects were not completed. Double asterisk (**) in 2022 indicates the implementation of the new survey design.

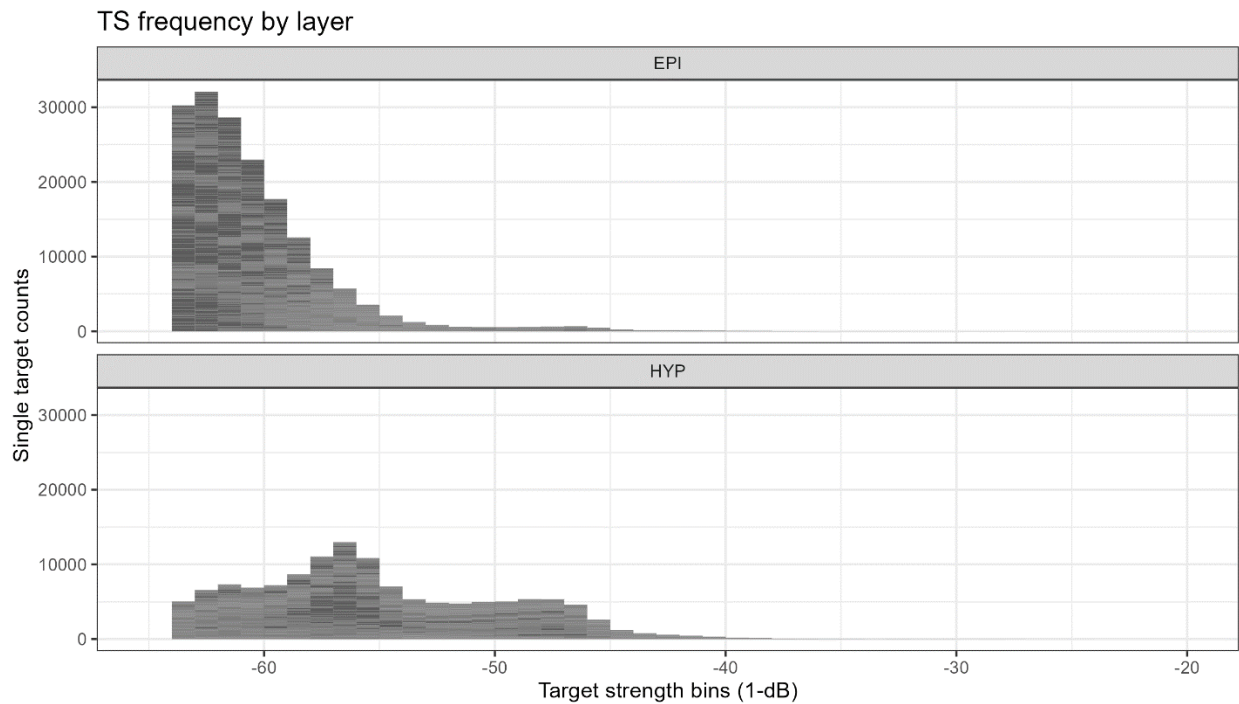


Figure 4.5.5. Target strength (TS) distribution for the epilimnetic layer (EPI) and hypolimnetic layer (HYP) with the east basin. Rainbow Smelt density is based on targets in the hypolimnetic layer and having a target strength between -59dB and -40dB.

4.6 Central Basin Midwater Trawling: Hydroacoustic Survey

A hydroacoustic survey began in 2001 to describe trends in forage abundance and composition in the central basin of Lake Erie. Historically, the survey consisted of hydroacoustic data collection accompanied by midwater trawling along transects that crossed nearshore and offshore strata. After a random grid / transect design comparison was found to be comparable in 2021, the random, stratified 5 minute grid design was adopted for Lake Erie hydroacoustic surveys in 2022. In Ontario waters of central Lake Erie, hydroacoustic data collected by the USGS R/V Musky II was informed by species and size/age composition of pelagic trawl catches over a range of depths fished by the RV Keenosay. The midwater trawl net has a 3 m square opening, with 102, 76, 51, and 25 mm graded meshes running from the gape to the 13 mm cod-end.

From July 18 to July 27, 2022, 33 twenty minute trawls at 3 knots were completed from ½ hour before sunset to ½ hour before sunrise (Figure 4.6.1). Water temperature and dissolved oxygen profiles were measured for each trawl sample to describe thermal layers and dissolved oxygen status. Trawls targeted forage concentrations in the hypolimnion (deep, cold layer below the thermocline), near the thermocline (thermal transition layer) and in the epilimnion (warm layer above the thermocline) in randomly selected 5 minute grids.

The catch rate of yearling and older (YAO) Rainbow Smelt in the central basin was generally above average in 2022. Adult Smelt occurred in low densities west of Erieau but with higher catches eastward, including a very large catch south of Port Stanley (Figure 4.6.1). Age 0 Rainbow Smelt (YOY) catches were low relative to previous years, with higher catch rates in the eastern half of the central basin (Figure 4.6.1). Although Emerald Shiner catches in 2022 exceeded previous years that followed 2014, catch rates remained generally low. Emerald Shiner densities were highest in the west half of the central basin (Figure 4.6.1). Gizzard Shad young-of-the-year (YOY) were caught in abundance during 2022, with densities greatest in the west half of the central basin (Figure 4.6.1). Age 0 Yellow Perch catch rates were relatively low in 2022, distributed throughout the central basin (Figure 4.6.1). Walleye YOY catch rates in 2022 exceeded all previous years, with higher catches in the western portion of the central basin (Figure 4.6.1). Midwater trawl total catch consisted mostly of yearling and older Rainbow Smelt (70%), YOY Gizzard Shad (16%), YOY Rainbow Smelt (5%), and Emerald Shiners (4%).

For more information concerning central basin hydroacoustics and forage assessment, please refer to the Report of the Lake Erie Forage Task Group (2023), available online: <http://www.glfc.org>.

Reference:

Forage Task Group. 2023. Report of the Lake Erie Forage Task Group, March 2023. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

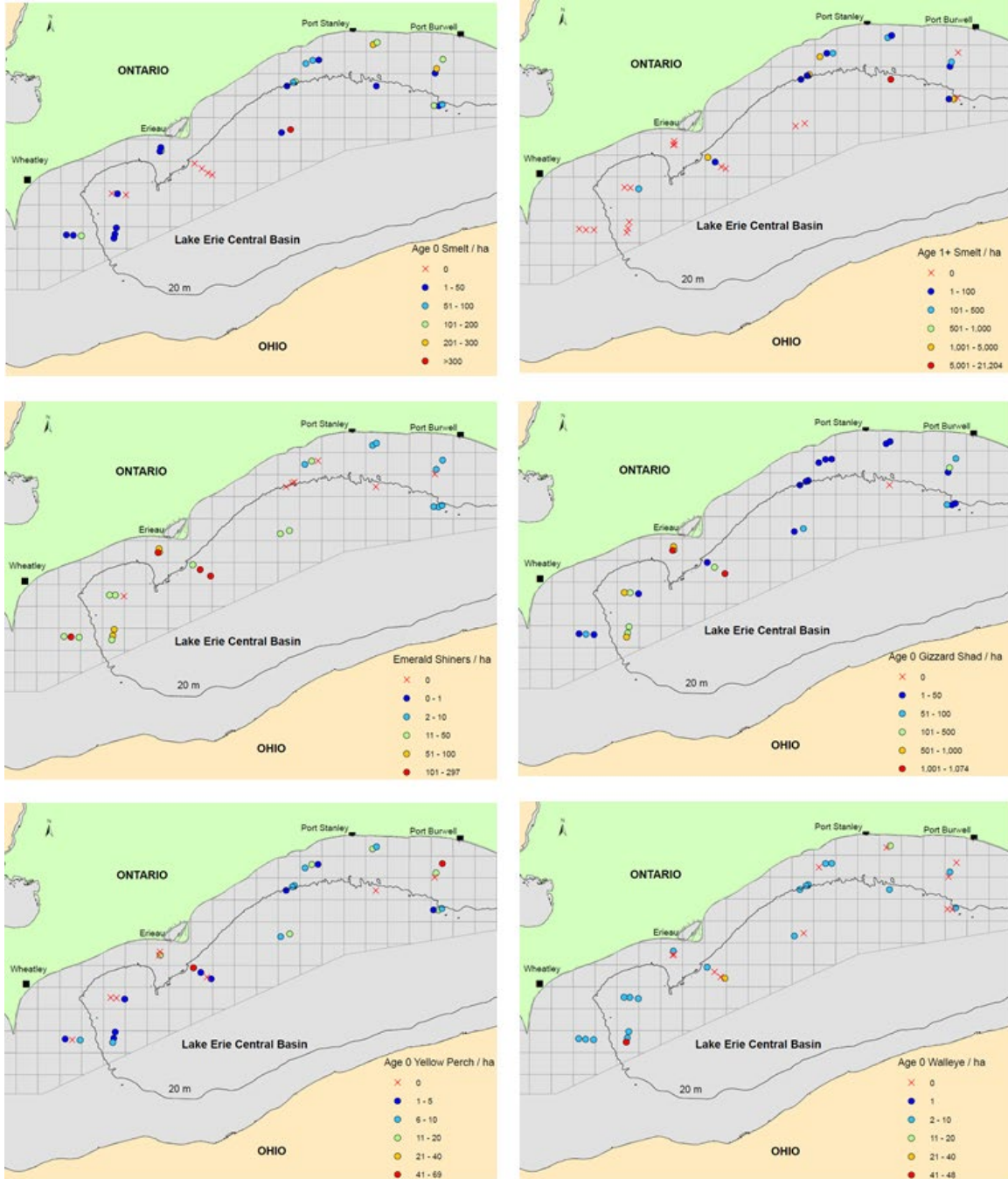


Figure 4.6.1. Midwater trawl catch per hectare of age 0 Rainbow Smelt (top left), yearling and older (1+) Rainbow Smelt (top right), Emerald Shiners (mid left), age 0 Gizzard Shad (mid right), age 0 Yellow Perch (bottom left) and age 0 Walleye (bottom right).

5. FISHERIES MANAGEMENT PROJECTS

5.1 Lake Erie Invasive Carp Surveillance Program

The Invasive Carps of concern to Great Lakes managers include four species of fish: Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*Hypophthalmichthys molitrix*), Black Carp (*Mylopharyngodon piceus*), and Grass Carp (*Ctenopharyngodon idella*). Three of these species (Bighead, Silver, and Grass Carp) have become naturalized in the United States. Two of these species (Bighead and Silver Carps) have dispersed north up the Mississippi River basin and have the potential to colonize the Great Lakes. Grass Carp have been observed within Lake Erie and have spawned in United States waters of the Lake Erie watershed (Embke et al, 2016).

Environmental DNA (eDNA) is genetic material which is shed by living or dead organisms into the environment. The presence of eDNA in the environment indicates that the organism may have been present. The collection of eDNA provides a method for detecting species present in low abundance, which may not be found through conventional surveys. In September 2012, the Lake Erie Management Unit (LEMU) commenced a field program utilizing eDNA to assess if Invasive Carps are present in the Canadian waters of Lake Erie or the St. Clair System. This program has continued through 2022, with water samples tested for Bighead, Silver, Black, and Grass Carp eDNA.

The LEMU Invasive Carp surveillance program 2022 sampling locations focused on rivers and nearshore areas with previous eDNA detections and captures of Invasive Carps. Water samples were taken from 169 sites in Lake Erie, Lake Erie tributaries, Lake St. Clair, Thames River, and Sydenham River (Figure 5.1.1). Each site was sampled once.

Environmental DNA water sampling followed the University of Notre Dame protocol (Mahon et al, 2010). Three water samples were taken during each sampling event, for a total of 507 individual water samples, in order to verify any potential positive results. The LEMU Wheatley and Port Dover offices filtered the water samples. Filtered samples were sent to Dr. Chris Wilson (Aquatic Research and Monitoring Section, Trent University) for DNA amplification by Polymerase Chain Reaction (PCR) and enzyme gel electrophoresis.

In 2022, there were no positive detections for eDNA of any Invasive Carp species. In addition to the directed eDNA sampling, LEMU index netting programs (described in this report) found no Invasive Carp in Lake Erie and Lake St. Clair.

References:

Embke, H.S., P.M. Kocovsky, C.A. Richter, J.J. Pritt, C.M. Mayer, and S.S. Qian. 2016. First direct confirmation of Grass Carp spawning in a Great Lakes tributary. *Journal of Great Lakes Research*, 42(4): 899-903.

Mahon, A. R., A. Rohly, M. Budny, E. Elgin, C. L. Jerde, W. L. Chadderton, and D. M. Lodge. 2010. Environmental DNA Monitoring and Surveillance: Standard Operation Procedures. Report to the United States Army Corps of Engineers, Environmental Laboratories, Cooperative Environmental Studies Unit, Vicksburg, Mississippi. CESU agreement #W912HZ-08-2-0014, modification P00007.

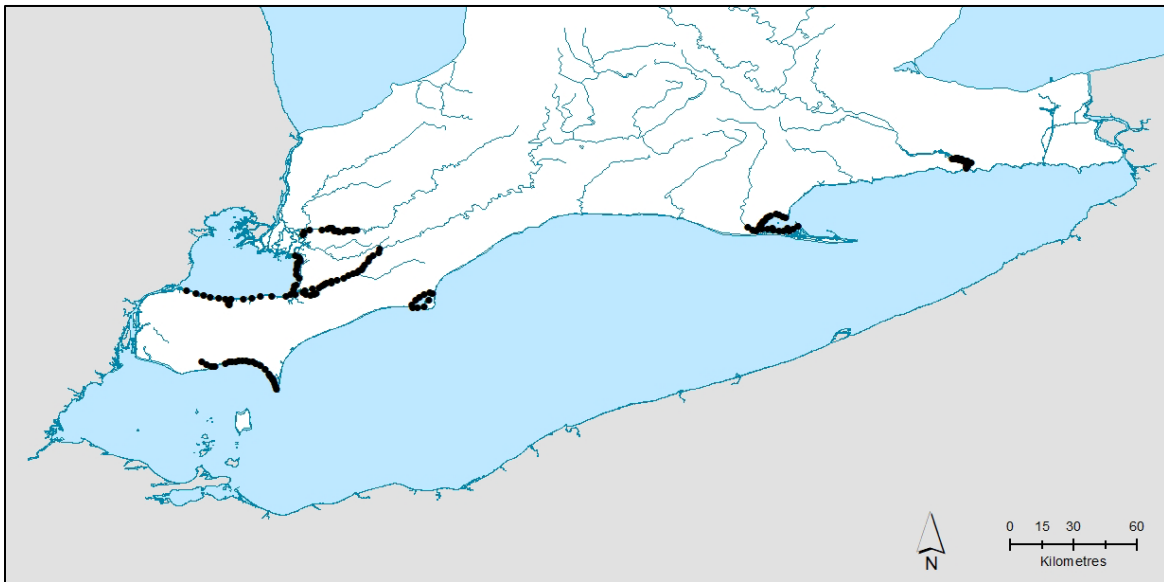


Figure 5.1.1 Location of eDNA sample sites for 2022 Invasive Carp surveillance program.

5.2 Central Basin Bottom Trawling

In 2016, Lake Erie Management Unit (LEMU) began a trawling survey to assess young-of-the-year and yearling and older fish in the Ontario waters of Lake Erie's central basin. This survey was devised as a response to a lack of recruitment data for Yellow Perch in particular.

In 2022, thirty-nine sample locations were chosen based on a Universal Transverse Mercator (UTM) 5 minute grid. Two boats were used in the survey: Ontario Ministry of Natural Resources and Forestry (OMNRF) RV Erie Explorer, and OMNRF RV Keenosay (Figure 5.2.1). The Erie Explorer fished 16 sites in the east-central basin using a 33 foot Biloxi bottom trawl with 1 inch cod-end with 0.5 inch liner. The trawl duration of the Erie Explorer was 10 minutes on the bottom at 1.6 knots. The Keenosay fished 23 sites in the west-central basin using a two seam 33 foot Biloxi bottom trawl, with a 38 foot ground line

and a 1 inch cod-end with 0.5 inch liner. The trawl duration of the Keenosay was 10 minutes on bottom at 1.6 knots. The survey occurred in the fall in order to fish after lake turnover and avoid hypoxia in the central basin.

Trawl catches were sorted by species and age group. Age groups based on length were classified as young-of-the-year (YOY), yearling, yearling and older (YAO), age 2 and older, and all ages. Catch rates by boat may not be directly comparable to each other due to differences in fishing gear and fishing method. However, relative abundance indices, for both boats, were expressed as arithmetic mean catch per hectare for the entire central basin and for the west and east central basins separately (Table 5.2.1).

Overall, catches were lower in 2022 compared to the previous year, mainly due to decreased catches of Rainbow Smelt. In 2022, the most commonly caught species was Rainbow Smelt (all ages) with 296.59 fish/ha. The second most common species caught was White Perch (YAO) with 23.64 fish/ha, followed closely by Round Goby (all ages) with a catch rate of 22.81 fish/ha.

In 2022, 4.07 YOY Yellow Perch were caught per hectare, this was lower than the catch in 2021 (13.41 fish/ha). Catch rates for YOY Yellow Perch were higher in the east-central basin (6.36 fish/ha), compared to the west-central basin (2.47 fish/ha) (Table 5.2.1). The catch of yearling Yellow Perch increased in 2022 to 11.09 fish/ha from 3.85 fish/ha in 2021. Catch rates for yearling Yellow Perch were higher in the west-central basin (13.71 fish/ha), compared to the east-central basin (7.33 fish/ha). The 2022 catch rate of age 2 and older Yellow Perch (11.35 fish/ha) was higher than 2021 (5.68 fish/ha). Catch rates of age 2 and older Yellow Perch were higher in the east-central basin (17.19 fish/ha) compared to the west-central basin (7.29 fish/ha) (Table 5.2.1).

The catch of YOY Walleye in 2022 (13.36 fish/ha) was lower than the record high value observed in 2021 (41.66 fish/ha). Catch rates of YOY Walleye were higher in the west-central basin (19.28 fish/ha) compared to the east-central basin (4.84 fish/ha) (Table 5.2.1). Catch rates of yearling Walleye increased in 2022 (11.86 fish/ha) compared to 2021 (2.64 fish/ha), with higher catches in the west-central basin (13.06 fish/ha) compared to the east-central basin (10.13 fish/ha) (Table 5.2.1).

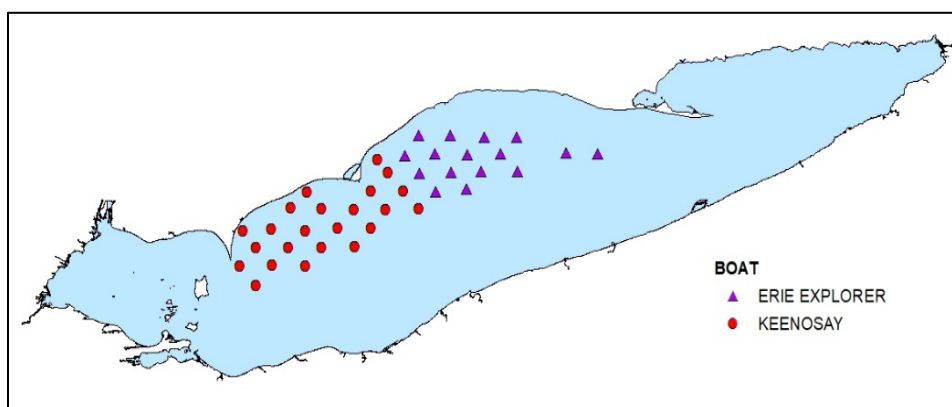


Figure 5.2.1 2022 Central Basin Bottom Trawl Program sites by boat.

Table 5.2.1 Catch per hectare by species and lifestage in the Central Basin Bottom Trawl Program west-central and east-central basins, 2016 to 2022.

Species (lifestage)	West-Central Basin							East-Central Basin						
	2016	2017	2018	2019	2020	2021	2022	2016	2017	2018	2019	2020	2021	2022
Alewife (all ages)					0.17	0.19		0.07	0.08					
Bluegill (YAO)													0.25	
Burbot (all ages)													0.26	0.52
Channel Catfish (YAO)	0.38	0.24	0.16		0.35	0.17	0.47	0.21						
Common Carp (all ages)		0.17	0.16											
Cyprinidae (all ages)				0.73			0.65							
Emerald Shiner (all ages)	7.97	6.82	1.17		31.05	1.00	2.27	45.71		2.70	0.25		1.77	1.00
Freshwater Drum (YOY)	1.58	0.33	15.63	5.99	11.19	2.44	2.41	0.20		0.68	0.24	0.23		0.78
Freshwater Drum (YAO)	21.53	16.70	13.45	25.81	23.41	8.95	5.62	4.70	6.41	8.35	12.69	7.89	2.77	9.71
Gizzard Shad (YOY)	0.41	1.40	0.33	2.70	6.13	1.71	0.62	2.68	0.74	0.67	2.22	9.07	1.54	0.98
Gizzard Shad (YAO)	0.62		0.86		0.00			3.76		0.10	0.99	0.23		0.26
Lake Whitefish (YOY)													0.26	
Lake Whitefish (YAO)	0.17	0.05					0.18			0.08				
Mimic Shiner (all ages)	0.36	3.93	0.30		0.35				0.63					
Quillback (YAO)					0.17									
Rainbow Smelt (all ages)	243.55	242.50	130.56	196.12	17.11	1513.14	327.70	439.51	407.18	116.57	431.41	18.49	1357.83	251.86
Round Goby (all ages)	25.39	40.37	8.32	29.58	10.99	5.38	33.92	10.48	16.44	10.94	25.48	29.54	119.10	6.84
Silver Chub (all ages)								0.09						
Spottail Shiner (all ages)		0.38		1.13					0.28					
Trout-perch (all ages)	0.15	3.93	0.44		0.18	0.17	0.17							0.25
Walleye (YOY)	1.04	1.27	30.68	36.51	12.63	58.70	19.28	0.07		2.09	15.35	4.43	17.17	4.84
Walleye (yearling)	12.58	0.51	0.71	2.51	16.41	2.52	13.06	13.31			1.22	10.18	2.81	10.13
Walleye (age 2 and older)	5.06	3.06	2.59	0.73	2.56	2.82	1.00	6.95	1.37	1.97		0.93	1.81	0.52
White Bass (YOY)	2.84	1.77	8.21	3.63	5.04	10.73	1.62	4.03	0.19	0.54	1.99	1.17	9.13	1.54
White Bass (YAO)	1.75	0.78	1.49	0.37	0.84	0.51	0.31	2.97	0.71	0.28	0.51	0.71	0.52	0.26
White Perch (YOY)	15.63	65.10	28.35	14.34	9.70	8.27	4.42		0.60	2.89	10.75	0.70	0.51	0.26
White Perch (YAO)	65.63	40.47	11.04	14.60	11.51	9.58	24.01	27.46	52.63	42.55	20.35	12.78	4.10	23.10
White Sucker (YAO)	0.05	0.15			0.16		0.34			0.17	0.75			
Yellow Perch (YOY)	4.59	33.40	11.75	2.51	6.42	16.41	2.47	5.70	24.80	19.42	32.45	10.64	9.09	6.36
Yellow Perch (yearling)	12.06	4.86	2.34	4.72	6.98	3.16	13.71	6.98	8.58	18.32	3.24	16.02	4.85	7.33
Yellow Perch (age 2 and older)	38.96	28.59	6.98	3.19	3.92	4.64	7.29	11.97	20.04	16.61	7.51	6.51	7.16	17.19

5.3 Lake Erie & Lake St. Clair Limnology

Overview

The Lake Erie Management Unit (LEMU) uses several sources of information to monitor the base of the food web and the environmental conditions which impact it. Collectively referred to as the Limnology Program, this monitoring includes standardized sampling as part of a bi-national lakewide initiative, coordinated through the Forage Task Group (FTG) of the Lake Erie Committee (LEC), but it also involves sampling which occurs in association with a host of other programs and projects conducted independently by LEMU. In addition to monitoring the trophic status of the lake, components are used to inform such things as the timing of fisheries assessments (e.g., Partnership Index netting relative to thermal stratification; Section 4.1) or to link environmental cues to fish behaviour (e.g., Acoustic telemetry projects; Section 6). This section details information from the lakewide program. Additionally, limnological sampling in Lake St. Clair, as well as exploratory investigations using temperature/dissolved oxygen loggers in the east basin in 2022 are included.

Lakewide FTG-coordinated limnology, referred to as Lower Trophic Level Assessment (LTLA), has occurred annually since 1999 and involves, minimally, sampling at each of six core Ontario stations bi-weekly, between May and October. These six core stations compliment sampling conducted at 8 stations in US waters in order to describe lake- and basin-wide trophic conditions and trends through time (Figure 5.3.1). Metrics such as temperature, dissolved oxygen, and light attenuation are measured at regular depth intervals from the surface to the lake bed in order to construct a profile through the water column. Other parameters such as total phosphorus (TP), chlorophyll-a (CHL-a), and zooplankton and phytoplankton samples, are collected from the entire water column by consolidated sampling; however, at stations and times where the water column is thermally stratified only the productive and warmer upper layer (epilimnion) is sampled. Benthic invertebrates sampling was discontinued in 2019, a consensus agreement between FTG agencies and the LEC.

2022 Assessment

With few exceptions, core LTLA stations were sampled bi-weekly for the entire May-Oct sampling season. East, West-Central, West, and Lake St. Clair stations were sampled on 12, 11, 10, and 9, of the 12 planned sampling events, respectively. All LTLA data was compiled and uploaded to the FTG database in February 2023. Phytoplankton samples were archived for future analysis. Zooplankton samples from W5, W8, WC1, WC3, E2 and E3, as well as the 6 Lake St. Clair stations were analysed during winter 2023.

Basin-wide LTLA summaries, using the bi-national core-station data, are prepared by the FTG annually and reported each March. One focus of the report is a description of the trophic state (level of productivity) of the lake relative to the LEC's Environmental

Objectives (Ryan et al., 2003; Davies et al., 2005). These objectives aim for moderate productivity (mesotrophy) in the west, central, and east basin nearshore, while targeting lower productivity (oligotrophy) for the colder, deeper, eastern basin offshore.

For 2022, using an index of trophic state based on TP, water transparency and CHL-a, averaged by basin from all bi-national sites, the FTG determined both the west and central basins were in the desired state (mesotrophy). The low productivity of the east basin was indicative of an oligotrophic state which is desired for the offshore but below the mesotrophic target for the nearshore. According to the long term LTLA dataset, trends across Lake Erie in recent years indicate that overall productivity has been slowly declining (Forage Task Group, 2023).

In recent years individual metrics of productivity (nutrients and algal biomass) have been notably lower at LEMU stations in Ontario waters, relative to bi-national basin averages. In 2022, annual mean TP concentrations in Ontario waters, relative to FTG-reported basin averages were lower in the west, central, and east basins by 49%, 34%, and 32%, respectively. Algal biomass (as indexed by CHL-a) was similarly lower than the LTLA basin averages by 19% and 7% in the west and central basins, respectively. In the east, nearshore and offshore averages in Ontario waters were 30% and 12% lower than basin averages for the nearshore and offshore, respectively.

For most of the program's time series, annual mean TP concentrations have indicated relatively stable eutrophic conditions in Ontario waters of the west and central basins while in the east, values have been slowly declining over the past decade, being indicative of overall oligotrophy since 2016 (Figure 5.3.2). Annual mean TP declined drastically in 2021 in the west and west-central basins and dropped again in 2022 to 8.5 and 10.3 ug/L, respectively; both now are on the lower limit of the desired mesotrophic state.

Mean annual CHL-a concentrations have remained relatively stable in the Ontario waters of all three basins however, as noted for TP, values dropped considerably in 2021 (Figure 5.3.2) in the west and west-central basins. In 2022, while CHL-a rebounded moderately to 4.7 ug/L in the west basin, the west central saw a further decline from the previous year to 3.3 ug/L.

While mean and median values for both metrics in 2022 generally indicate desired mesotrophy in the west and west-central basin waters, the seasonal range of values at each station has been trending downward, indicating lower than desired productivity more frequently through the season (Figure 5.3.3). The eastern basin nearshore in 2022 was oligotrophic as indicated by both TP and CHL-a. High values for TP in the west-central basin nearshore (higher than west basin values) was driven by large variation at this site in 2022. Expected trends in nearshore-offshore productivity for Lake Erie are better reflected by CHL-a where declining values are seen nearshore to offshore within basin and from west to east overall.

In addition to influencing basin-wide reporting, low productivity in Ontario waters may be indicative of regional concerns regarding the lower trophic food-web, not properly captured by lakewide averages.

Lake St. Clair

The higher density of limnology stations in Lake St. Clair, relative to Lake Erie, reflects an attempt to capture the dynamic nature of this shallow (mean 3.7m), low retention time (7 days) basin fed by flows from both nutrient poor (St. Clair River) and nutrient elevated (Sydenham River; Thames River) tributaries. In 2022 Station 6, directly influenced by outflow from the Thames River, showed the largest range of TP and CHLa concentrations (Figure 5.3.4) as well as the highest annual means (16.1 ug/L TP; 4.5 ug/L CHLa). Offshore, Station 3 had the lowest variability and lowest mean TP and CHLa (5.0 ug/L and 0.5 ug/L; respectively). Outside of the nearshore areas directly influenced by the Thames and Sydenham Rivers, which experience mesotrophic conditions, the lake has low nutrient levels comparable to the east basin of Lake Erie. Much of this can be attributed to the high through-flow of low nutrient waters from Lake Huron outflow.

Oxygen at Depth: Eastern Lake Erie

Even though the east basin of Lake Erie experiences thermal stratification during summer, it has generally been characterized as having sufficient dissolved oxygen (DO) at depth based on profiles of the water column collected as part of the LTLA limnology sampling program. Only two instances of DO <2 mg/L in the eastern basin have been recorded in the 24-yr history of the program (both in summer 2010).

However, none of the east limnology stations occur in areas of the basin where a shallow hypolimnion might be susceptible to oxygen depletion from (for example) sediment oxygen demand. In such areas, low oxygen at depth has more frequently been detected during sampling associated with fishery surveys.

In 2021 and 2022, miniDOT loggers (recording temperature and DO every 10 minutes) were deployed in association with three acoustic telemetry receiver locations with bottom depths of 14, 20, and 26 metres; depths within, or just below the thermocline during a typical summer stratification period (Figure 5.3.1). The two deeper loggers, in both years, recorded drawdowns of dissolved oxygen during summer months, reaching concentrations of <4 mg/L by mid September. Both years experienced multiple days of DO concentrations <2 mg/L in September but reverted to 100% saturation by November, following the breakdown of thermal stratification and mixing of the water column. Oxygen concentrations at 26 m depth, associated with acoustic telemetry receiver station LEG-222, offshore of Tecumseh Reef, are shown in Figure 5.3.5. Low oxygen at depth may have implications for fishery independent surveys, particularly those involving bottom set gillnets in association with waters below the thermocline. A more thorough survey of bottom oxygen is to take place in 2023.

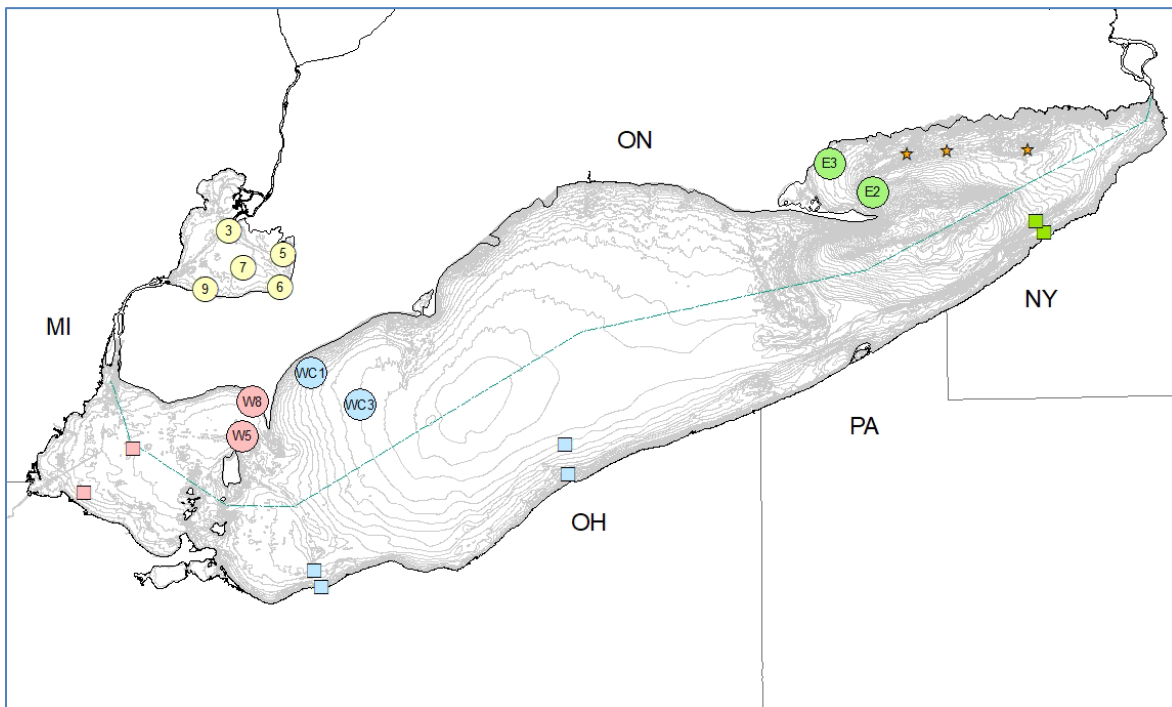


Figure 5.3.1 Limnology Program sampling locations. Core Lake Erie stations are colour coded by basin as: west – red; west-central – blue; east – green. LEMU sampling stations are indicated with circles. For reference, locations of complementary sampling in US wastewaters are indicated with squares. Lake St. Clair stations are indicated with yellow circles. East basin locations of experimental miniDOT loggers, deployed in 2021-22 are shown with orange stars.

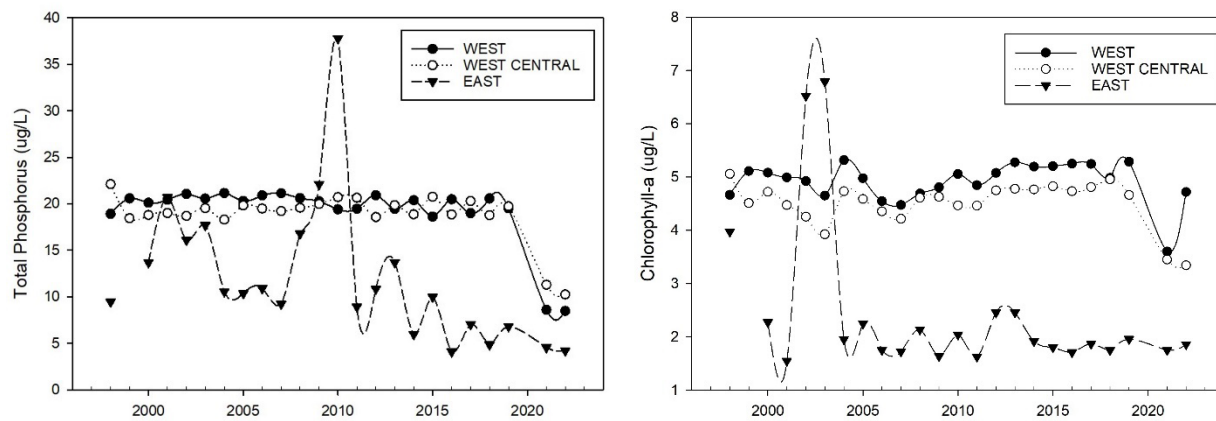


Figure 5.3.2 Annual mean values for Total Phosphorus (left) and Chlorophyll-a (right) in the Ontario waters of the west, west-central and eastern basins of Lake Erie, 1998 to 2022. Nearshore and Offshore values in each basin are combined.

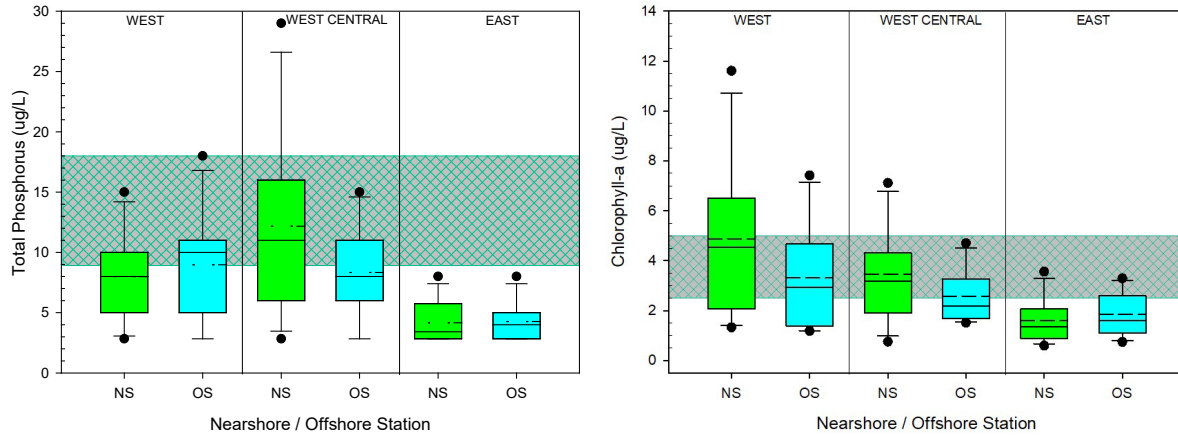


Figure 5.3.3 Distribution of Total Phosphorus and Chlorophyll-a concentrations, relative to Lake Erie targets, measured at Nearshore (NS) and Offshore (OS) core LTLA stations in Ontario waters between May and October 2022. Box upper and lower extents indicate the 75th and 25th percentile value, respectively; the within-box lines indicate median (solid) and mean (dashed) values. Outliers are shown with dots. The range of values indicative of Mesotrophic conditions is shown with a stippled box. Note: All areas have a mesotrophic target except OS east basin where the target is oligotrophic (TP < 9 ug/L; CHL-a < 2.5 ug/L).

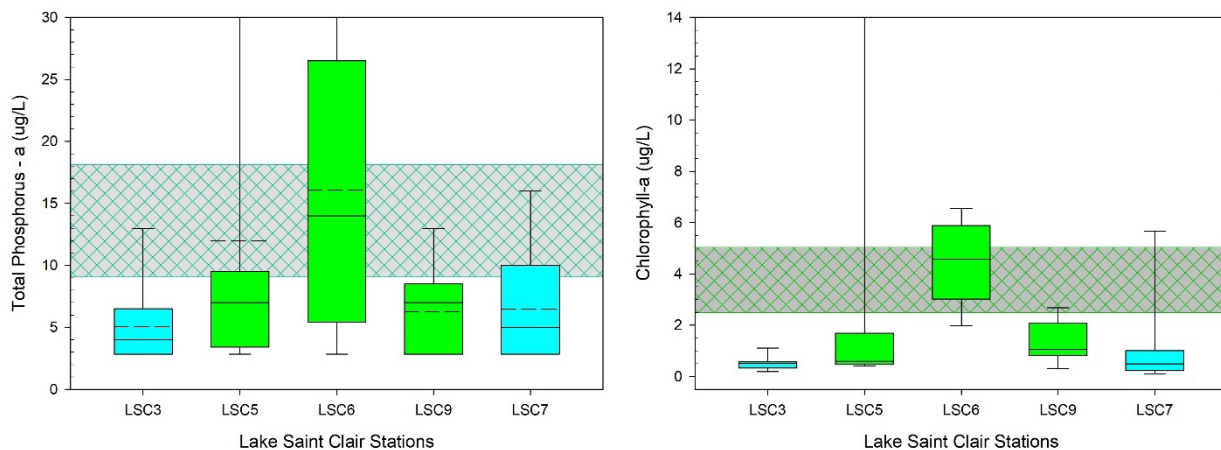


Figure 5.3.4 Distribution of Total Phosphorus and Chlorophyll-a concentrations measured at limnology stations in Lake St. Clair between May and October 2022. Box upper and lower extents indicate the 75th and 25th percentile value, respectively; the within-box lines indicate median (solid) and mean (dashed) values. More nearshore stations are indicated with green boxes while deeper, offshore locations are indicated with blue boxes. The range of values indicative of Mesotrophic conditions is shown with a stippled box.

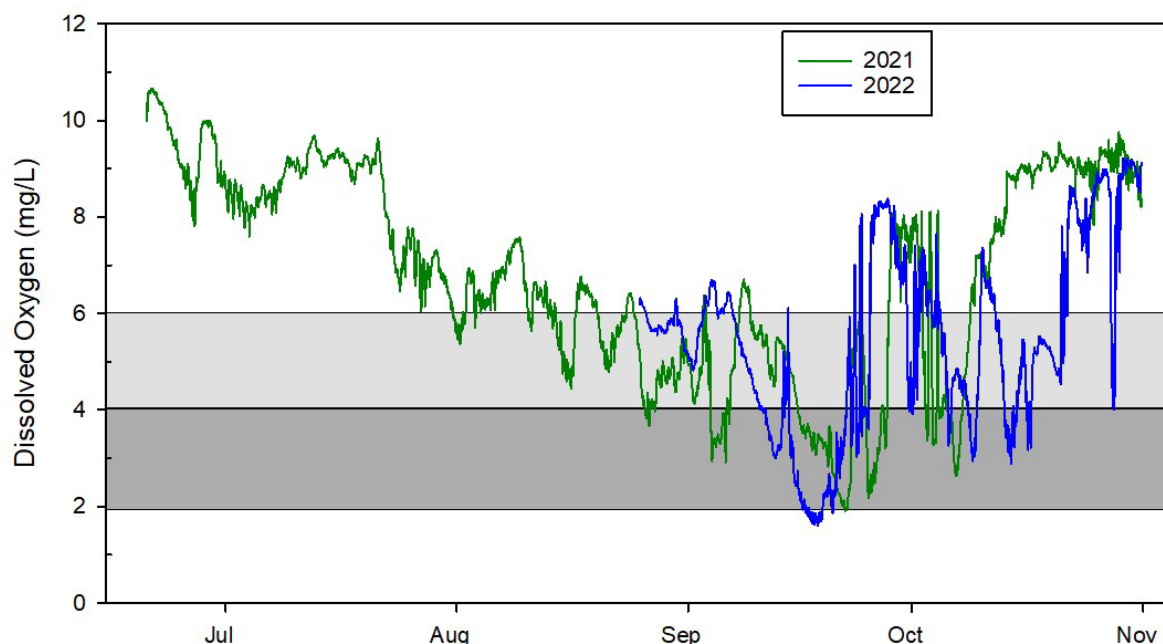


Figure 5.3.5 Dissolved oxygen recorded at 10-minute intervals, 1 m from bottom, in water depth 23 m, offshore from Tecumseh Reef, Lake Erie during 2021 (June 20 - Nov 1; green line) and 2022 (Aug 25 - Nov 1; blue line).

References:

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5.4 Inner Long Point Bay Adult Fish Community Hoop Net Survey

The Lake Erie Management Unit implemented a new fishery-independent survey in 2018 to monitor the portion of the Long Point Bay fish community susceptible to capture in the commercial hoop and seine net fishery. Catches associated with the fishery are reported in Table 3.1.1 of this report. A minimum of 30 hoop nets (3' high x 4' wide x 19' long) are set each survey year at randomly assigned sites within the bay, with the number of nets chosen based on recommendations in the Nearshore Community Index Netting Protocol (Stirling, 1999). All nets are set perpendicular to the shoreline with the opening of the net facing the shore and are fished for approximately 24 hours. The sampling period for the program is March - April, which corresponds with the peak timing of the commercial fishery.

The 2022 field season was cancelled due to a combination of staffing issues and scheduling conflicts. The program is planned to occur in 2023.

Reference:

Stirling, M.R. 1999. Manual of Instructions: Nearshore Community Index Netting (NSCIN). Ontario Ministry of Natural Resources, Lake Simcoe Fisheries Assessment Unit, Sutton West, ON. 50pp. [Also available from: <https://www.ontario.ca/page/nearshore-community-index-netting-instructions>]

5.5 Lake Trout Rehabilitation

Overview

The LEMU stocks Lake Trout (*Salvelinus namaycush*) into Lake Erie as part of a binational effort to rehabilitate the species. Numbers stocked and strains selected follow guidance developed and endorsed by the Lake Erie Committee of the Great Lakes Fishery Commission (LEC/GLFC). Between 2006 and 2019, the LEMU annually stocked > 50,000 *Slate Island* strain, Lake Trout between April and May, at Nanticoke Shoal in the east basin of the lake. Fish for stocking are supplied as yearlings (~ 18 months in age) and are produced at Chatsworth Fish Culture Station. These stockings are designed to compliment annual stockings of up to 200,000 yearling Lake Trout in US waters; In New York and Pennsylvania primarily, but also experimental stocking in Ohio waters.

An examination of 12-years of stocking and assessment under Lake Erie's Lake Trout Management Plan (Markham et al., 2008) resulted in a revised plan (Lake Erie Committee, 2021) initiated in 2021. Under the new plan, Ontario's contribution changed in three ways: i) the annual target was raised from 50,000 to 80,000 fish; ii) the preferred strain stocked changed from *Slate Island*, a Lake Superior strain, to *Seneca*, a strain originating in the Finger Lakes region of New York; and iii) pulsed stocking was initiated

whereby a second stocking location, at Tecumseh Reef, would be stocked on alternate years.

In 2022, the LEMU stocked 74,866 *Seneca* Lake Trout at Tecumseh Reef, over four days between May 16 and 24. Fish were received onto the OMNRF vessel Erie Explorer at Port Maitland and transported approximately 10 kms to the east side of the reef where they were released sub-surface (10ft depth) by hose. All fish were adipose clipped and snout-tagged with coded wire. The average weight of each fingerling was 32.8 grams. The temperature of the receiving waters was between 12°C and 13°C.

During some years, Lake Trout additional to stocking targets were stocked by Ontario into Erie for a variety of reasons including supplementing failed year classes at US partner agency hatcheries and the acceptance of over-production within the Ontario fish culture system. In total 4 strains have now been stocked and totals per year, since 2006, have ranged from 0 to 115,375 (Figure 5.5.1). Since 2006, a total of 1,042,829 Lake Trout have been stocked into the Ontario waters of Lake Erie.

Ontario contributions relative to US stocking numbers can be found in the annual report of the Coldwater Task Group of the Lake Erie Committee (Coldwater Task Group, 2023).

Stocking records for Lake Erie are uploaded to Ontario's Fish Stocking Information System (FSIS) database and to the Great Lakes Fish Stocking Database (GLFSD) annually.

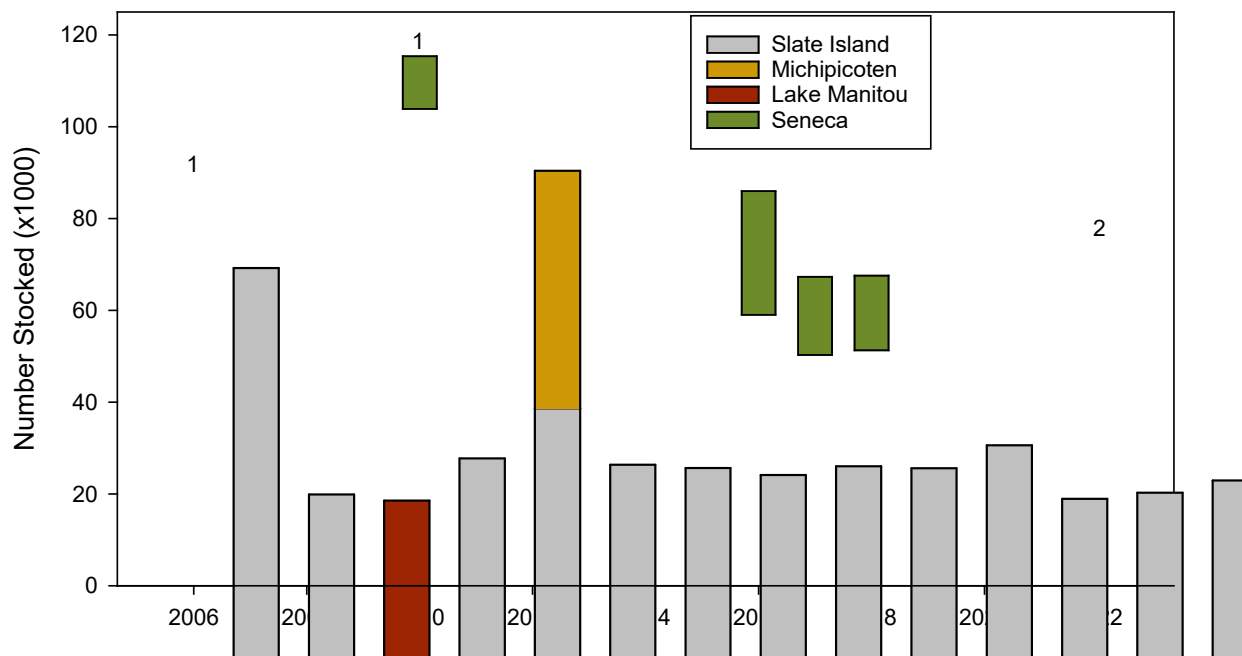


Figure 5.5.1 Numbers of Lake Trout stocked, by strain, into the Ontario waters of Lake Erie, 2006-2022. All fish were stocked by boat at Nanticoke Shoal except for 2006 and 2010 when some shore stocking occurred at Port Maitland (1), and 2022, the first year of boat stocking at Tecumseh Reef (2).

References:

http://www.glfc.org/pubs/lake_committees/erie/LEC.

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Markham, J., Cook, A., MacDougall, T., Witzel, L., Kayle, K., Murray, C., Fodale, M., Trometer, B., Neave, F.B., Fitzsimons, J., Francis, J., and Stapanian, M. 2008. A Strategic Plan for the Rehabilitation of Lake Trout in Lake Erie, 2008-2020. 27pp.

5.6 Connecting Waterways Fish Community Assessment – Niagara River

The St. Clair, Detroit, and Niagara River systems connect Lake Huron, Lake St. Clair, Lake Erie, and Lake Ontario in a network of waterways which span nearly 600 km of the Great Lakes – St. Lawrence Seaway System. These connecting waterways serve as crucial transportation networks and drinking water sources, while also supporting important recreational and subsistence fisheries. Extensive development within the connecting waterways has led to significant environmental changes that resulted in their designation as Areas of Concern within the Great Lakes Water Quality Agreement (2012) between the U.S. and Canada. Despite this, these rivers have been identified as biodiversity hotspots and represent important spawning, nursery, refuge, and foraging habitat for a variety of native fish species. The objective of the connecting waterways fish community assessment is to monitor the small and large bodied fish communities present in the Detroit, Niagara, and St. Clair Rivers using a standardized methodology. The program uses a combination of boat electrofishing, large-mesh gill nets, and small benthic trawls to sample the fish community. In 2022, the program was conducted in the Niagara River.

A total of 23 and 20 sites were sampled using boat electrofishing and large mesh gill nets, respectively (Figure 5.6.1). Rocky substrate in the Niagara River prevented the use of benthic trawling. Sample sites for each gear were selected randomly. Shallow waters (< 3 m) were sampled using boat electrofishing, whereas deeper waters (≥ 3 m) were sampled using bottom set gill nets. Boat electrofishing was conducted along 250 m shoreline transects in a downstream direction. North American standard large-mesh gill nets were set parallel to shore for 24 hours (two gangs per net; mesh sizes: 38, 51, 64, 76, 89, 102, 114, and 127 mm).

The catch from each gear type was identified to the lowest taxonomic group possible (species or genus), counted, and up to 30 randomly selected individuals were sampled for total length. Additionally, scale samples were taken from Yellow Perch, Walleye, Smallmouth Bass, Largemouth Bass, White Bass, Muskellunge, and Northern Pike for age interpretation. Fish processing was conducted in the field and live fish were released.

A total of 2,447 fish representing 42 species were captured using boat electrofishing, while 90 fish and 10 species were captured by gill nets (Figure 5.6.2, 5.6.3). Several individuals captured by boat electrofishing were identified down to the family (Petromyzonitidae - Lampreys) and genus level (*Moxostoma* sp.; *Lepomis* sp.). No species at risk were captured. The most common species captured by boat electrofishing were White Sucker (20%), Emerald Shiner (16%), Yellow Perch (11%), and Spottail Shiner (9%; Figure 5.6.2), whereas Smallmouth Bass (68%), Rock Bass (16%), and Stonecat (6%) were the most common species in gill nets (Figure 5.8.3). Most of the Yellow Perch (59%), Walleye (93%), Largemouth Bass (65%), and Smallmouth Bass (93%) captured in the nearshore waters by electrofishing were young-of-the-year fish. Gill nets captured age 1 and older sportfish in the deeper waters of the Niagara River.

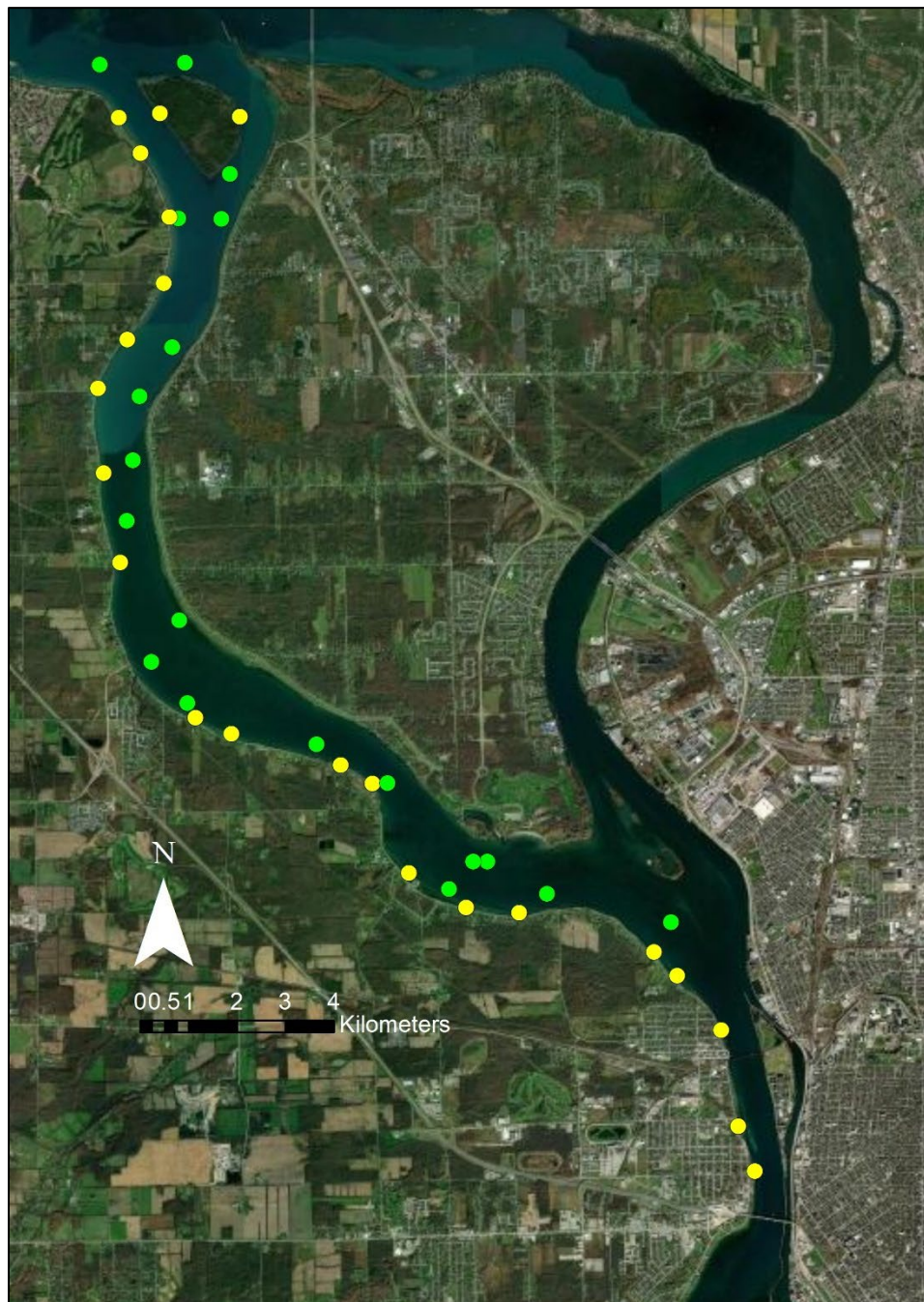


Figure 5.6.1 Boat electrofishing (yellow) and gill net (green) sample locations in the Niagara River. The points are located at the start of a boat electrofishing transect or gill net set.

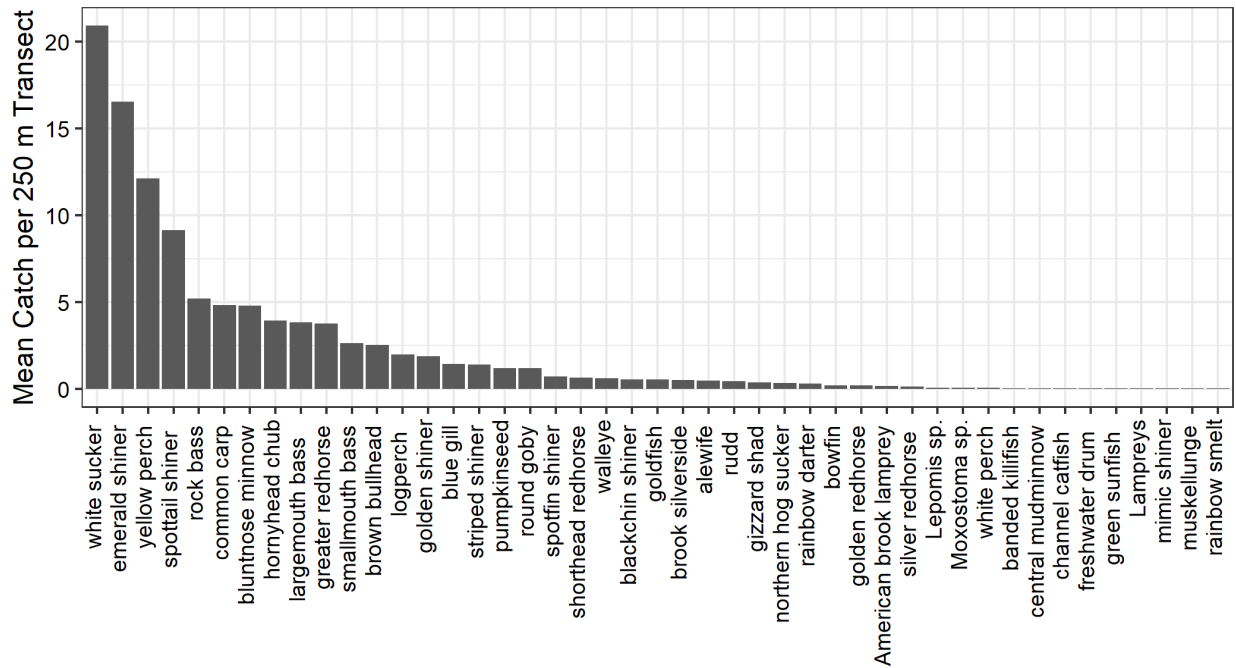


Figure 5.6.2 Mean catch per 250 metre boat electrofishing transect by species for the nearshore waters (< 3 m) of the Niagara River in 2022.

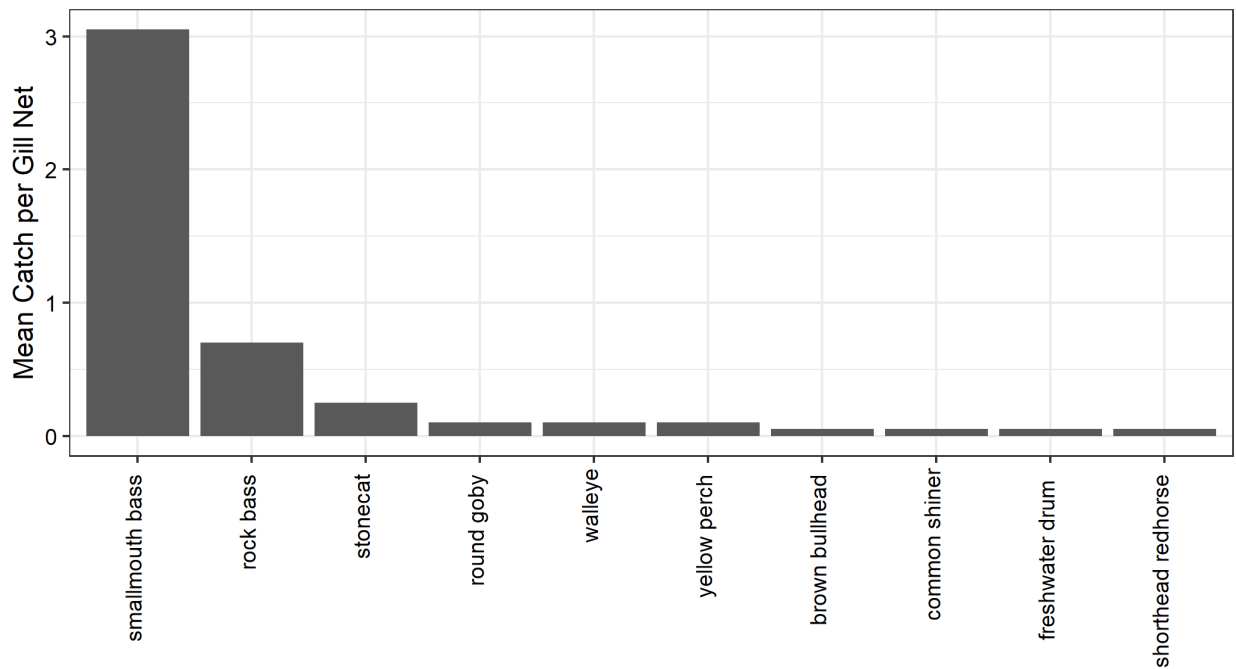


Figure 5.6.3 Mean catch per gill net by species for the deep waters (≥ 3 m) of the Niagara River in 2022.

5.7 Lake Erie Smallmouth Bass Nesting Survey

The Lake Erie Management Unit implemented a multi-year project to outline the timing of nest stage development for Smallmouth Bass in Lake Erie. The objective is to use a science-based approach to correlate nest development with temperature and evaluate results in the context of the timing of the angling closure. The early life stages of Smallmouth Bass will be assessed using snorkeling surveys occurring in May and June, with data loggers deployed in survey areas to provide a continuous record of temperature. The project is planned to occur around Long Point Bay and Pelee Island with the survey location alternating between years.

The 2022 field season occurred around Long Point Bay and was the first full field season for the project. The season ran from May 2 - June 30 with surveys occurring on 14 days. A total of 70, ~350m transects were completed (Figure 5.7.1). Snorkellers identified 30 nests with early life-history stages, 144 potential nests, as well as 551 nest-like structures (no bass present for confirmation) (Figure 5.7.2, 5.7.3). The number of degree days $>10^{\circ}\text{C}$ by the opening date of the bass season on June 25th, 2022 (4th Saturday in June) was between 437-493 within the Inner Bay and 347 in the outer section around Bluff Bar.

This season was also the first to deploy data loggers in the west basin of Lake Erie. Data loggers were deployed at four sites around Pelee Island, at one site near Point Pelee, and at one site near Chicken Island. The number of degree days $>10^{\circ}\text{C}$ by the opening date of the bass season was between 378-399 across the entire area, signifying a similar temperature regime.

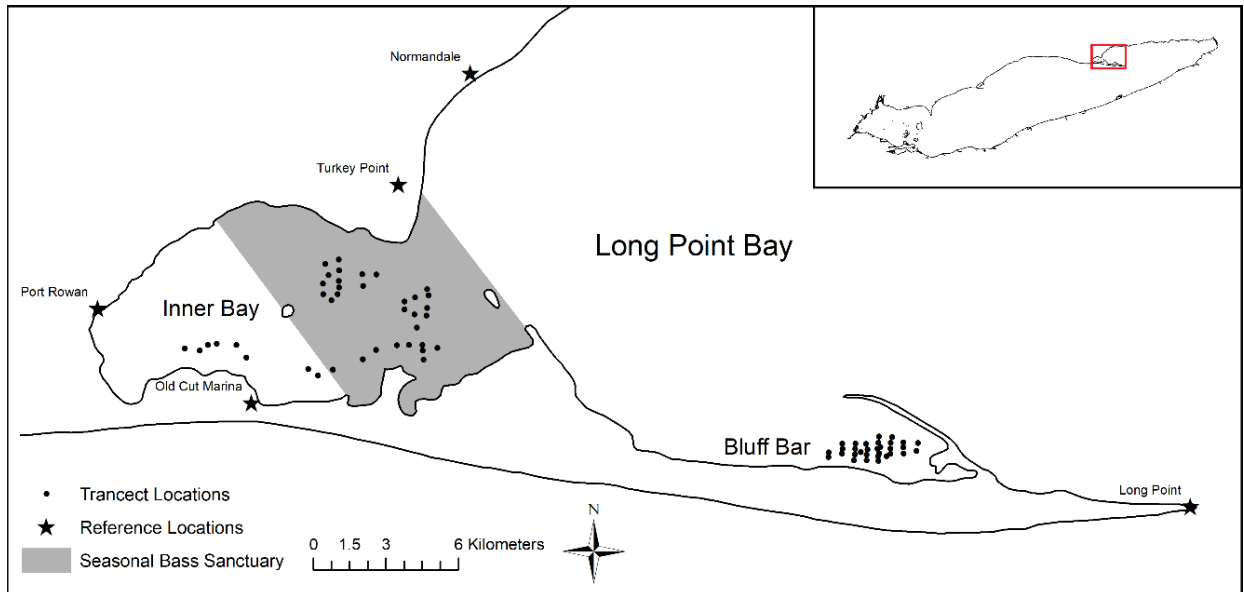


Figure 5.7.1 Transect locations surveyed during the Lake Erie Smallmouth Bass Nesting Survey in 2022. The location of the seasonal fish sanctuary has also been provided, which is in place from May 15th to the 4th Saturday in June.

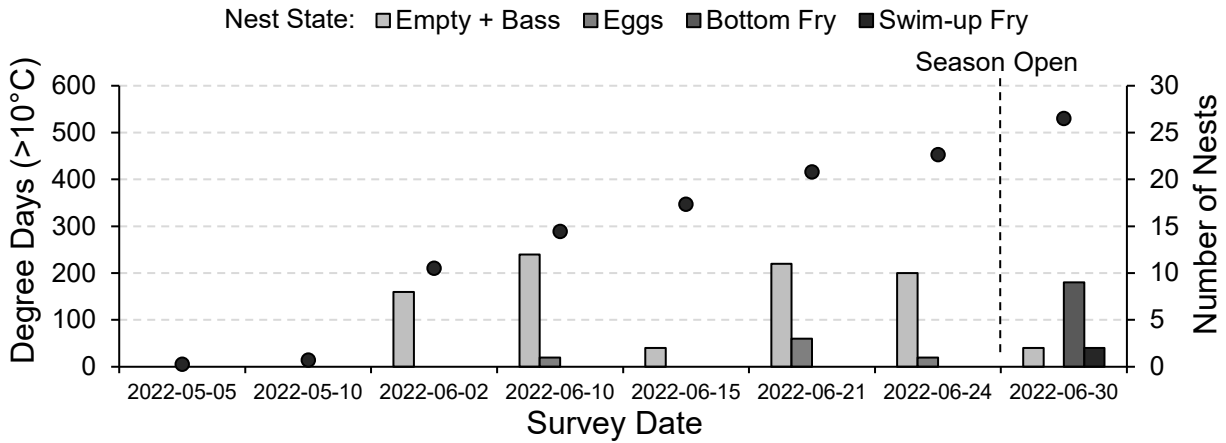


Figure 5.7.2 The number of nests found in the Inner Bay at each developmental stage, as well as the number of degree days >10°C within the area (black circles). The timing of the season opener for Smallmouth Bass (4th Saturday in June) has also been provided.

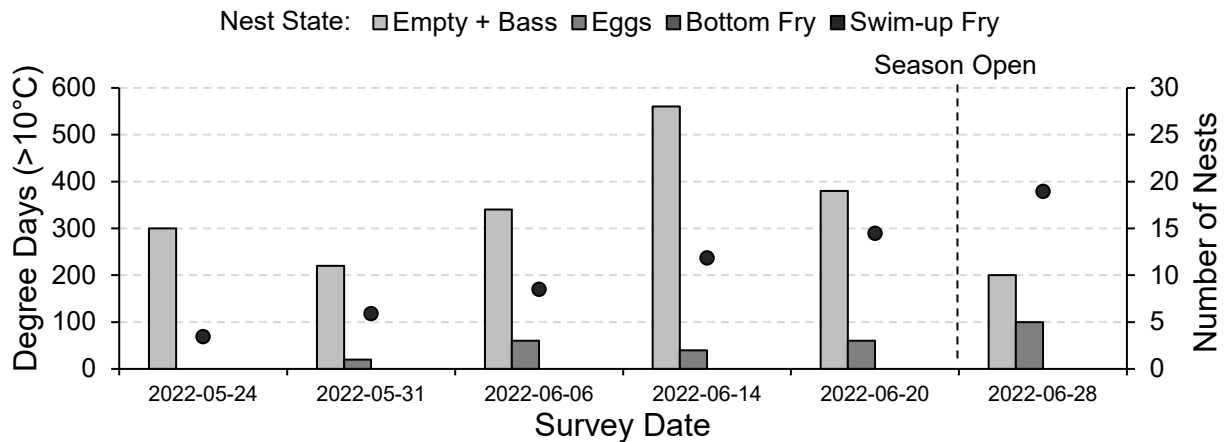


Figure 5.7.3 The number of nests found at Bluff Bar at each developmental stage, as well as the number of degree days >10°C within the area (black circles). The timing of the season opener for Smallmouth Bass (4th Saturday in June) has also been provided.

5.8 Lake St. Clair Fish Community Assessment

Lake St. Clair is a large, highly productive body of water that is connected to two Great Lakes and straddles an international border. On both sides of the border, Lake St. Clair supports a significant recreational fishery of Walleye, Yellow Perch, Smallmouth Bass, and Muskellunge. Thousands of angler hours are spent on Lake St. Clair in pursuit of recreational fish, which contributes to the local economy through job creation and revenue generation. In 2018, the Lake Erie Management Unit developed the Lake St. Clair Fish Community Assessment to monitor the abundance and biological characteristics of recreationally important fish species in Lake St. Clair. A secondary objective of the program was to collect information about the broader fish community. The program was repeated in 2022 as a lakewide assessment conducted in collaboration with Michigan Department of Natural Resources, and U.S. Fish and Wildlife Service. Only data from the Ontario side of Lake St. Clair was used for this report.

In 2022, a total of 45 gill net sets were fished on the Ontario side of Lake St. Clair between June 20th and July 15th (Figure 5.8.1). A net set consisted of two gill nets strapped together using a 3 metre spanner. Each gill net was 1.8 metres tall and 25 metres long with panels of 38, 51, 64, 76, 89, 102, 114, 127 mm mesh (panel: 1.8 H x 3.1 W). The total length of the full set was ~ 53 metres. The gill net sets were fished on bottom for a period of 16-22 hours.

Sites were allocated using a depth stratified, random design. The depth strata used for this program were 1-4 metres and 4-8 metres, whereby 15 and 30 sites were allocated to each strata, respectively. The sites were also allocated on a relative basis to three sampling areas within Lake St. Clair (Figure 5.8.1). These areas were selected as spatial extents that could be reasonably traversed by a sampling crew in a day. Crews rotated through the sampling areas on a weekly basis until all the sampling was complete. The crews visited the sampling areas in a random order to prevent any temporal bias in the data.

All captured species were identified, enumerated, and measured for total length. Recreationally important species were also weighed, sexed, assessed for gonad condition, and had aging structures removed. Species considered recreationally important were Walleye, Yellow Perch, Smallmouth Bass, White Bass, Muskellunge, Northern Pike, and Muskellunge x Northern Pike hybrids.

A total of 1,318 individuals were captured representing 26 species (Table 5.8.1). Three species at risk were captured during the program: Lake Sturgeon (1 fish), River Redhorse (1), and Silver Chub (1). The Lake Sturgeon was released alive after measuring for total length. The most abundant species in the catch were Yellow Perch (18% of total catch), Gizzard Shad (14%), Longnose Gar (13%), White Perch (12%), and Shorthead Redhorse (11%). The catch per net of Muskellunge, Smallmouth Bass, and White Bass in 2022 was

comparable to that in 2018, whereas the catch rate of Northern Pike, Yellow Perch, and Walleye decreased between the sampling events (Table 5.8.1).

The median total length and age composition of Smallmouth Bass, Walleye, and Yellow Perch remained relatively consistent between 2018 and 2022 (Table 5.8.2). White Bass showed a decrease in median length and age from 2018 to 2022. The White Bass population was primarily composed of age 3 (29%) and age 6 (26%) fish in 2018, whereas young age 2 (43%) fish composed most of the population in 2022. It must be noted that the interpretation of this data is limited because only two years of data are available; however, the data generated from the program will eventually allow for a rigorous assessment of recreational fish populations as more years of data are added.

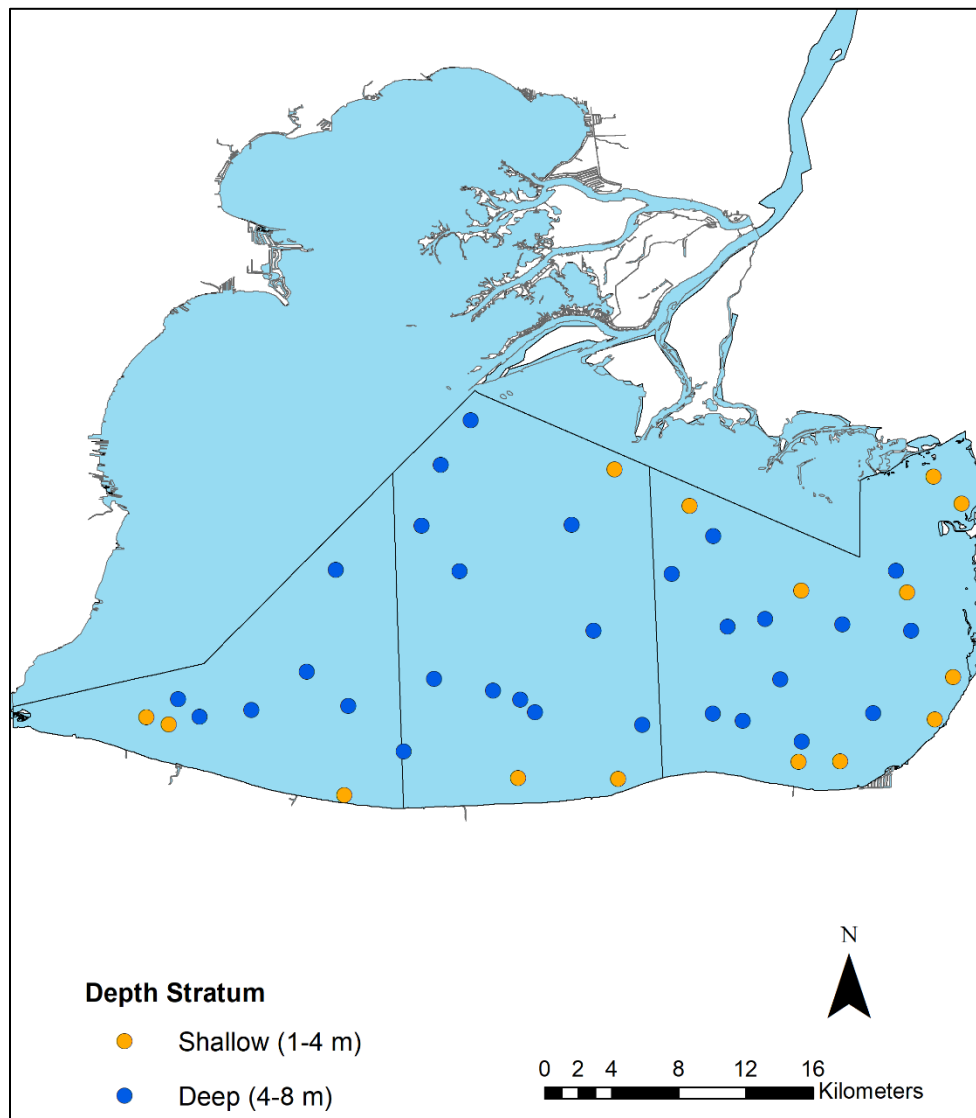


Figure 5.8.1 Map of the Lake St. Clair Fish Community Assessment sample sites in 2022. The outlined sections indicate the sampling areas on the Ontario side of the lake.

Table 5.8.1 Common name and catch per net of each species captured by the Lake St. Clair Fish Community Assessment in 2018 and 2022.

Common Name	Catch Per Net	
	2018	2022
Silver Lamprey	0.04	0.00
Lake Sturgeon	0.00	0.02
Longnose Gar	2.58	3.64
Bowfin	0.01	0.02
Gizzard Shad	6.96	3.77
Rainbow Trout	0.01	0.00
Northern Pike	0.75	0.15
Muskellunge	0.08	0.06
Mooneye	0.06	0.04
Quillback	0.02	0.02
White Sucker	0.02	0.00
Silver Redhorse	0.38	0.05
Golden Redhorse	0.18	0.02
Shorthead Redhorse	2.72	3.21
River Redhorse	0.00	0.02
Moxostoma sp.	0.02	0.00
Common Carp	0.08	0.52
Silver Chub	0.00	0.02
Yellow Bullhead	0.00	0.04
Brown Bullhead	0.00	0.02
Channel Catfish	1.73	1.04
White Perch	2.19	3.59
White Bass	1.48	1.11
Rock Bass	1.19	0.58
Pumpkinseed	0.01	0.09
Blue Gill	0.01	0.00
Smallmouth Bass	1.10	1.90
Largemouth Bass	0.00	0.04
Yellow Perch	10.04	5.43
Walleye	3.50	2.04
Freshwater Drum	1.50	1.59
Esox lucius x Esox masquinongy	0.06	0.00

Table 5.8.2 Median (minimum-maximum) total length and age of recreationally important fish species captured during the Lake St. Clair Fish Community Assessment in 2018 and 2022. Northern Pike and Muskellunge are excluded due to low catches.

Species	Total Length (mm)		Age	
	2018	2022	2018	2022
Walleye	399 (208-661)	401 (268-651)	3 (1-15)	3 (2-18)
Yellow Perch	200 (139-325)	213 (135-325)	4 (2-9)	4 (2-8)
Smallmouth Bass	379 (210-428)	387 (231-510)	4 (2-17)	5 (2-15)
White Bass	341 (255-418)	304 (218-425)	6 (2-10)	3 (1-10)

6. ACOUSTIC TELEMETRY / TAGGING PROJECTS

The spatial ecology and movement of fish has remained a mystery for many researchers and fisheries managers. Whether known or assumed, where, when, and how fish move through their environment forms the basis of their ecological niche and the foundation for defining biologically relevant management units and defining stocks in fisheries management. Contemporary telemetry technology has begun to open opportunities for tracking the movements of fish previously not possible.

Acoustic telemetry shows great promise as a tool for tracking movements of fish through the aquatic environment. Acoustic telemetry systems work by implanting an acoustic transmitter (or tag) into a fish and deploying acoustic receivers throughout a body of water. The transmitter emits a distinct acoustic “ping” which the receiver picks up when the transmitter is in proximity (Figure 6.0.1). The distinct acoustic pings are then translated into unique identifications of individual fish. By strategically placing a series of receivers throughout a water body a researcher can determine positions (Figure 6.0.2) and examine movements of individual fish to test scientific hypotheses and answer questions relevant to fisheries research and management.



Figure 6.0.1 How acoustic telemetry works.

In 2010, the Great Lakes node of the Ocean Tracking Network known as the Great Lakes Acoustic Telemetry Observatory System (GLATOS) was established. This collaborative effort of Canadian and United States (U.S.), state/provincial federal and academic partners oversees projects tagging fish, the deployment and maintenance of acoustic receivers and most importantly handling a database that stores the millions of detections created annually. To date, the network of GLATOS receivers in Lake Erie has been the most extensive across the Great Lakes basin. From 2013 to 2015, lines of receivers were deployed across the lake from the Canadian to U.S. coast to identify movements of fish between west, central, and east basins. In 2016, receiver deployment shifted to a grid pattern to increase coverage and detection efficiency. In 2017, the extensive central basin grid of receivers expanded to include parts of the east and west basins (Figure 6.0.2). LEMU is actively involved in several acoustic telemetry projects including Lake Erie Lake Whitefish Acoustic Telemetry Tagging (Section 6.1), and Grand River Walleye/East Basin Mixed Fishery (Section 6.2. Other telemetry projects that LEMU actively supports or are involved with include, Thames River Walleye Acoustic Tagging (Section 6.5) and Lake St. Clair–Detroit River Muskellunge Spawning Survey (Section 6.4).

In addition to acoustic telemetry studies, conventional tagging projects on Lake Erie and connecting waters have used external Monel, metal jaw, and Floy tags, and internal Passive Integrated Transponder (PIT) tags to describe fish stock movements, survival and exploitation, and estimate the size of populations. The LEMU projects that used traditional tagging techniques include Thames River Walleye Acoustic Tagging (Section 6.5) and Lake St. Clair–Detroit River Muskellunge Spawning Survey (Section 6.4), described in further detail below.

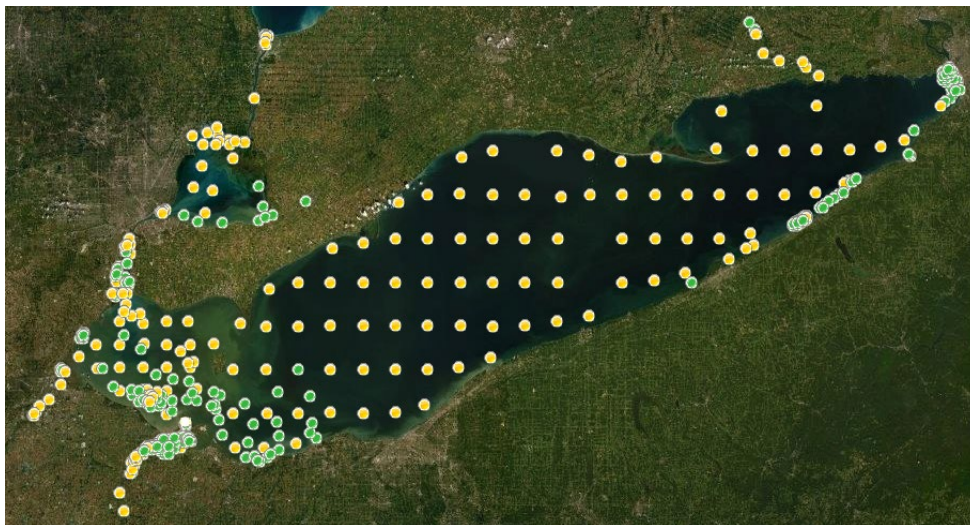


Figure 6.0.2 Network of GLATOS acoustic receivers in 2019. (Maps retrieved from <http://glatos.glos.us/map>, March 20, 2020). Green circles are retrieved receivers (may or may not have been redeployed), yellow circles are currently operating receivers.

6.1 Lake Erie Lake Whitefish Acoustic Telemetry Tagging

In Lake Erie, Lake Whitefish are sought mainly by commercial fisheries. Lake Whitefish abundance declined recently in Lake Erie due to poor recruitment. Lake Whitefish are managed by quota in Ontario waters of Lake Erie; however, a formal harvest policy has not been implemented. An acoustic telemetry - tagging study was initiated to support assessment and management of Lake Whitefish. Using Great Lakes Telemetry Observation System (GLATOS) acoustic receivers throughout Lake Erie and connecting waters, OMNRF, ODNR, USGS, USFWS, and GLFC began an acoustic telemetry study to monitor movements associated with spawning, post spawning, seasonal habitat use, and emigration from Lake Erie. Also, harvest of tagged fish may provide spatial and temporal patterns of exploitation to inform assessment models and management options.

The acoustic tagging project began in Ohio waters of western Lake Erie in 2015 expanding into Ontario waters in 2016. Internal acoustic transmitters and external Floy tags were applied to Lake Whitefish. Rewards (\$100 U.S.) were provided to fishers for the return of the tagged Lake Whitefish acoustic and Floy tags. Since 2015, 378 Lake Whitefish were tagged in Lake Erie with 52 tagged Lake Whitefish recaptured by Ontario (47) and Ohio (5) commercial fishers up to 2023 (Table 6.1.1). The coverage of GLATOS receivers has grown during the Whitefish tagging study (Figure 6.1.1). Annual detections of tagged Lake Whitefish during 2015 to 2022 are plotted by receiver in Figure 6.1.1. Increased detections over years reflect the greater number of receivers deployed and Lake Whitefish tagged as the study accumulates data over time. Tagged Whitefish were detected in all basins of Lake Erie seasonally, favouring southern portions of Lake Erie (Figure 6.1.1). Seasonal migrations related to spawning were observed from acoustic detections. In addition to detections near spawning reefs in the west basin during November-December, Lake Whitefish ascended the Detroit River from 2018-2021 (Figure 6.1.1, Figure 6.1.2).

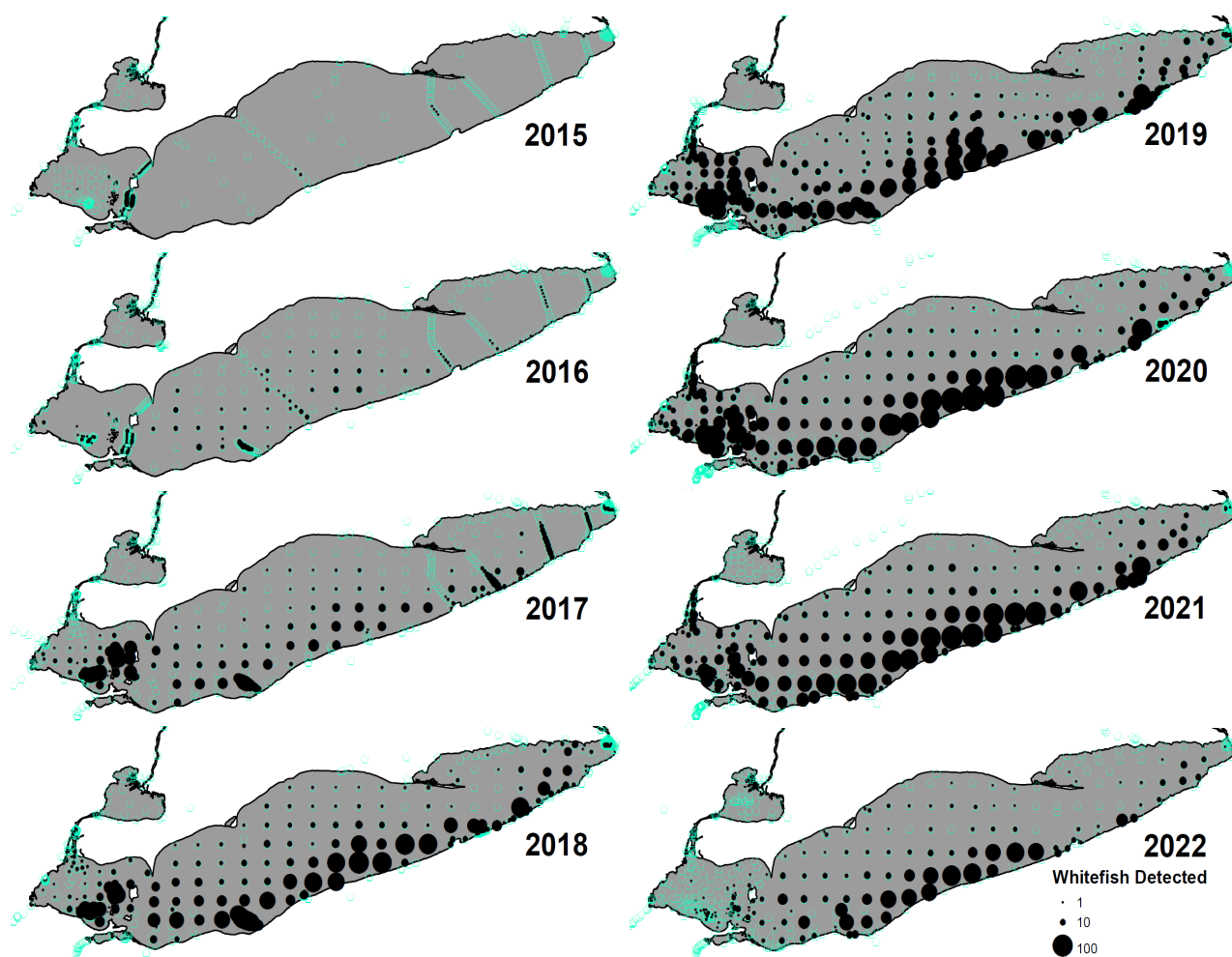


Figure 6.1.1 Acoustic detections of Lake Whitefish with implanted transmitters (black dots) at acoustic receiver stations (blue pentagons) in the GLATOS network 2015-2022. Symbol (dot) size varies with the number of individual Lake Whitefish detected. Detections during 2022 are incomplete.

Table 6.1.1 Number of Lake Whitefish tagged and recaptured by year from 2015-2023. Recaptures during 2023 are incomplete.

Tag Year	Location	Number of Tagged Whitefish Harvested by Year										
		Whitefish Tagged	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
2015	Maumee Bay	10			1							1
2016	Hen Island - Little Chicken	37		3			1	1				5
2017	Crib Reef	25			1		1	1	1			4
2017	Hen Island - Little Chicken	55			5	1	1	1	1	1		10
2017	Niagara Reef	25						2			1	3
2018	DR mouth	2										0
2019	Crib Reef	50						3	2			5
2019	SW Colchester	35					4	1	2			7
2019	Western Lake Erie, Turtle I	15							1	4		5
2020	Pelee Island	20						1		2		3
2020	SW Colchester	14										0
2021	Pelee Island	16										0
2022	Hen Island - Little Chicken	45								5		5
2022	Pelee Island	29								4		4
All Years	All Locations	378	0	3	7	1	7	10	7	16	1	52

Excludes 4 acoustic tags found on beaches in 2021 - 2022

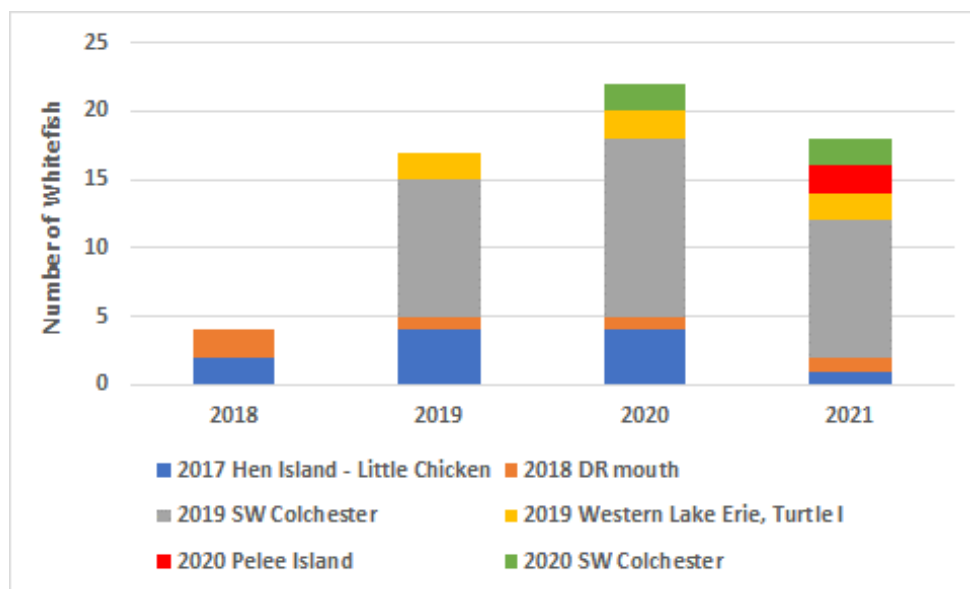


Figure 6.1.2 Number of Lake Whitefish detected in the Detroit River by year, tag location, and year of tagging.

6.2 Grand River Walleye / East Basin Mixed Fishery

Overview

Walleye originating in the Grand River, Ontario are known to be genetically distinct within Lake Erie and are thought to contribute to fisheries in the east basin of the lake. The following project involves the ongoing use of acoustic telemetry together with genetic stock analysis to investigate the behavioural ecology of Grand River Walleye as it pertains to: i) requirements for, and impediments to, spawning; and ii) contributions to eastern basin commercial fisheries.

Acoustic telemetry is accomplished by surgical implantation of 69-Khz acoustic transmitters into Walleye captured in the river in late March or early April.

A series of acoustic receivers are deployed seasonally at 12 locations between the lake embayment at the river mouth and the town of Caledonia, 42 km upstream. Detecting fish in the lake proper is accomplished through the networking of receivers from multiple projects as coordinated by the Great Lakes Acoustic Telemetry System (GLATOS; detailed in Section 6.0).

Annual spring tagging of the Grand River Walleye spawning aggregation can be divided into two distinct periods:

During 2015-2018: Up to 70 fish per year were targeted for tagging with equal numbers to be released above and below the dam at Dunnville, with the intent of characterizing use of both river and lake habitat. These fish, together with Walleye tagged at spawning locations throughout the lake, have been used in several analyses examining migratory movements, homing, and thermal preferences of Lake Erie Walleye. In general, Walleye from the Grand River were observed to have a much more limited range than other Lake Erie stocks; avoiding deeper areas of the lake and only ranging along the east basin nearshore during June - December (Matley et al., 2020),

During 2019-2022: A smaller number of fish (12-22) were targeted annually for tagging and release exclusively above the dam at Dunnville. These fish would be used to help detail preferred spawning habitat in the Grand River together with model outputs from a Habitat Suitability Index project (Section 7.1). Preliminary HSI modelling suggests that minimal Walleye spawning habitat exists downstream of Dunnville. In 2021, three additional receivers were deployed to obtain better resolution in a section of river between the towns of Cayuga and York, based on preliminary telemetry analysis and habitat modelling.

2022 Telemetry

In 2022, 22 pre-spawning Walleye were tagged on April 6th. As in previous years, fish were captured by electrofishing downstream of the four weirs that comprise the Dunnville dam and released above the dam immediately after recovering from surgery.

All 22 fish were detected on receivers between Dunnville and the furthest upstream receiver location at Caledonia. Most Walleye placed above the Dunnville dam since 2015 drop back below within the first year after release. In 2022, seven fish tagged in previous years were detected above the dam and contributed to the assessment of 2022 spawning behaviour. This included fish tagged in 2021 (n=3), 2019 (n=2), 2018 (n=1) and 2017 (n=1). Patterns and timing of movement was similar to that observed previously.

Except for one fish, all Walleye tagged in 2022 and placed above the dam moved upstream from 22 to 38 km above the release location at Dunnville (Figure 6.2.1). Locations of maximum upstream extent corresponded with previously identified potential spawning habitat (Ecologistics, 1982). Movement to the maximum upstream extent took, on average, 6.3 days (range 1.6 - 18.3 days). Individual fish remained at their upstream extent for anywhere from 0.9 to 56.9 days before beginning to move back downstream. Females spent notably less time at their maximum upstream extent (average 5.6 days) than males (average 25.7 days). An example of differences in movement between the sexes is shown in Figure 6.2.2. Five of the seven fish tagged and moved above the dam in previous years were already at upstream locations (Cayuga to Caledonia) when receivers were deployed, suggesting that Walleye unimpeded by the barrier at Dunnville would choose to move to spawning areas earlier than the window of the study.

Movement from above to below the dam at Dunnville can be delayed for long periods of time. There have been no observations of individuals moving from below the dam to above unassisted. The Denil fishway built into the third weir of the Dunnville dam is generally considered to be non-functional for most species.

All acoustically tagged fish are marked with an external tag and labelled to indicate a \$100 reward for the return of the internal acoustic tag. Given the value of the reward, the assumption is made that the reporting rate for recapture will be near 100%. Of the 222 Walleye tagged and released above the dam since 2015, 47 have been recaptured by fishers. Of those, 38% have been caught immediately above the Dunnville dam, a popular angling spot. Seven of the 22 Walleye tagged in 2022 were recaptured within the first 5 months post-release. Of those, 4 were captured immediately above the dam.

Eighty of the 183 Walleye, tagged in the Grand River between 2017 and 2022, were detected within the river and the east basin of Lake Erie in 2022. In the lake, few ranged deeper than the 20 m depth contour and Long Point Bay was favoured over the more eastern end of the basin (Figure 6.2.3).

Genetic Analysis

Collections of tissues from individual fish harvested by the commercial fishery in the east basin continued in 2022. Genetic analysis would be used to categorize contributions to the catch as having originated in the west basin, the east basin (NY), or the Grand River (ON). Whereas a previous assessment of the 2017 fisheries did not detect any Grand River Walleye in the harvest (Euclide et al., 2021), results from the telemetry assessment have emphasized the need to sample fishery harvests from nearshore as well as offshore waters. The sampling strategy in 2022 was altered from 2021 to recognize that Walleye are harvested in both a targeted fishery and as bycatch in the Yellow Perch fishery, the latter tending to harvest younger, smaller fish, in shallower waters. Genetic analysis will continue through 2023.

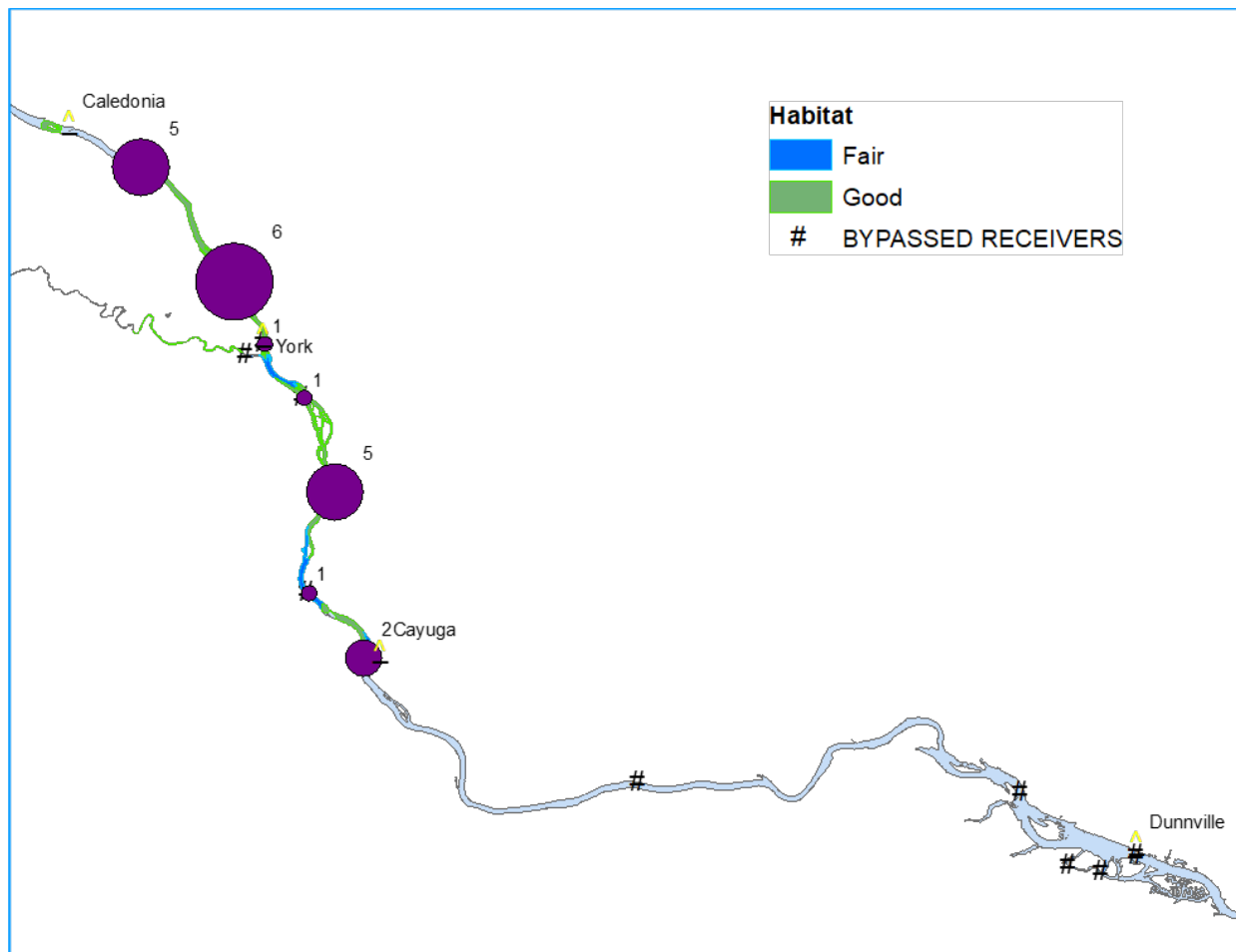


Figure 6.2.1 Locations observed to be the maximum upstream extent of acoustically tagged Walleye in the Grand River, spring 2022. The number of Walleye stopping their upstream migration at each location is indicated by the relative size of each purple circle and adjacent noted number. Classification of substrate suitability for spawning Walleye, as proposed by Ecologistics (1982) shown as Green (Good) or Blue (Fair).

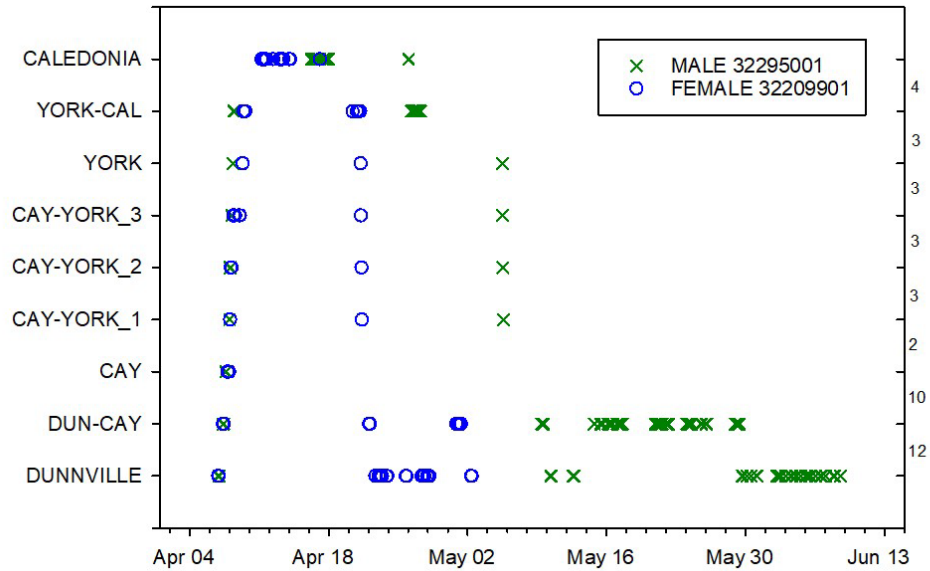


Figure 6.2.2 Detection events for two Walleye tagged in the Grand River and Released above the Dunnville dam on April 6, 2022. Receivers are listed from bottom to top in order, moving upstream from Dunnville to Caledonia. Distance between receivers in kilometers is shown on the right y-axis. The male individual is indicated with a green X. The female individual is indicated with a blue circle.

Figure 6.2.3 Locations of acoustic receivers that detected Grand River-tagged Walleye in 2022. Numbers of individual Walleye detected on each receiver is related to the size of the circle as indicated in the legend.

References:

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6.3 Lake Erie Walleye Mixed Stock Fisheries Acoustic Telemetry Tagging

Walleye in Lake Erie are assessed and managed cooperatively by agencies from Ontario, Michigan, Ohio, Pennsylvania, and New York. Internationally, Lake Erie is partitioned into a Total Allowable Catch (TAC) area consisting of the west and central basins of Lake Erie and a non-TAC area represented by eastern Lake Erie. TACs are determined annually by the Lake Erie Committee (LEC) consensus on outcomes from the Recommended Allowable Harvest (RAH) and harvest control rules specified in the current Walleye Management Plan. For practical reasons, Walleye harvested in the TAC area are considered a single stock for assessment and allocation. However, Walleye are a homing species that spawns on reefs and in rivers throughout the Lake Erie watershed. Lake Erie Walleye spawning aggregations during spring and dispersal after makes it difficult to assess the contributions of local stocks to fisheries that may vary temporally and spatially. In addition, the existence of multiple smaller stocks in the east and the lakewide mixture of stocks during summer and fall increases the challenge of understanding Walleye population dynamics in Lake Erie.

Beginning in 2017, Ohio Department of Natural Resources, New York State Department of Environmental Conservation, United States Geological Survey, Michigan State University, Ohio State University, and the Ontario Ministry of Natural Resources and Forestry began a mixed stock tagging assessment of Lake Erie Walleye. The primary objective is to quantify the relative contribution of individual Walleye stocks to commercial and recreational fisheries in Lake Erie. Over several years, the study will describe temporal and spatial variability of Walleye stock contributions to fisheries.

Walleye were collected by angling and gill netting to estimate the spatial and temporal contribution of each stock to Lake Erie's recreational and commercial fisheries. Tagging took place during seasons when stocks were believed to be mixed. Walleye were tagged

with internal V13-1H 69kHz acoustic transmitters and external Floy tags. Tagged fish are detected by acoustic receivers distributed broadly throughout the Great Lakes, including near Walleye spawning reefs and in rivers that are part of the Great Lakes Acoustic Telemetry Observation System (GLATOS). Rewards (\$100 US) are provided to fishers returning acoustic transmitter tags to fishery management agencies.

From 2017 to 2021, 812 Walleye were tagged in western and central Lake Erie. To date, 300 tagged Walleye were harvested by the recreational (156) and commercial (144) fisheries (Figure 6.3.1). Tagging is complete and data analyses are ongoing. Additional information is available at <https://glatos.glos.us/home/project/WAEMF>.



Figure 6.3.1 A Walleye that was tagged in the mixed stock fishery acoustic telemetry study and harvested in 2022.

6.4 Lake St. Clair – Detroit River Muskellunge Spawning Survey

Muskellunge are an important top predator and sportfish in the Lake St. Clair – Detroit River (LSC-DR) system. The LSC-DR system supports one of the largest Muskellunge fisheries in the province. Despite this, little is known about their life history in the LSC-DR system. Spawning represents a particularly important life history stage for Muskellunge because they spawn in shallow, vegetated habitat that is highly vulnerable to present and future stressors in the LSC-DR system, including water level fluctuations, sedimentation, shoreline augmentation, and the loss of coastal wetlands. Thus, the spawning habitat of Muskellunge represents a priority habitat for the protection and management of the species. The objective of the LSC-DR Muskellunge Spawning Survey is to determine when and where Muskellunge spawn in the LSC-DR system. A secondary objective is to evaluate the degree of spatial overlap between spawning aggregations of Northern Pike and Muskellunge.

The 2022 LSC-DR Muskellunge Spawning Survey took place in the Detroit River. A boat electrofishing crew sampled 1 km shoreline segments between May 4 and June 3, 2022. The crew spent 30 minutes sampling each shoreline segment. Transects were fished during a mixture of night and daytime sampling events. The crew had assigned sample sites to complete each week that were distributed throughout the Detroit River and, if the assigned sites were completed before the week was over, the crew was free to sample

additional segments known or suspected to hold Muskellunge. All adult Muskellunge, Northern Pike, and hybrids captured were measured for total and fork length, externally assessed for gonad condition, checked for lamprey wounds, and tagged using both an external loop tag and an internal pit tag. The external tag was an orange loop tag placed through the back muscle below the posterior edge of the dorsal fin. Each fish was assigned a unique external and PIT tag number. Juvenile fish were measured for total length and released.

A total of 15 Muskellunge and 102 Northern Pike were captured during the spawning survey (Figure 6.4.1, 6.4.2). Of these fish, 10 Muskellunge and 97 Northern Pike were tagged. The remainder of the captured fish consisted of untagged adult fish (1 Northern Pike), recaptured fish (3 Muskellunge and 1 Northern Pike), and juveniles (TL < 380 mm: 2 Muskellunge and 3 Northern Pike). Of the Muskellunge tagged, only 1 female and 6 males were observed to be in spawning condition (i.e., loose gametes). Most Northern Pike captured were not in spawning condition and presumed to be in a post spawning state (87 of 97 fish). Adult Muskellunge and Northern Pike were primarily captured around Fighting Island, Grassy Island, and LaSalle (Figure 6.4.1, 6.4.2). Juvenile Muskellunge and Northern Pike were captured along the main shoreline near LaSalle and the River Canard.



Figure 6.4.1 Number of Muskellunge captured at each transect in the Detroit River between May 4 to June 3, 2022. Points are located at the start of a transect.

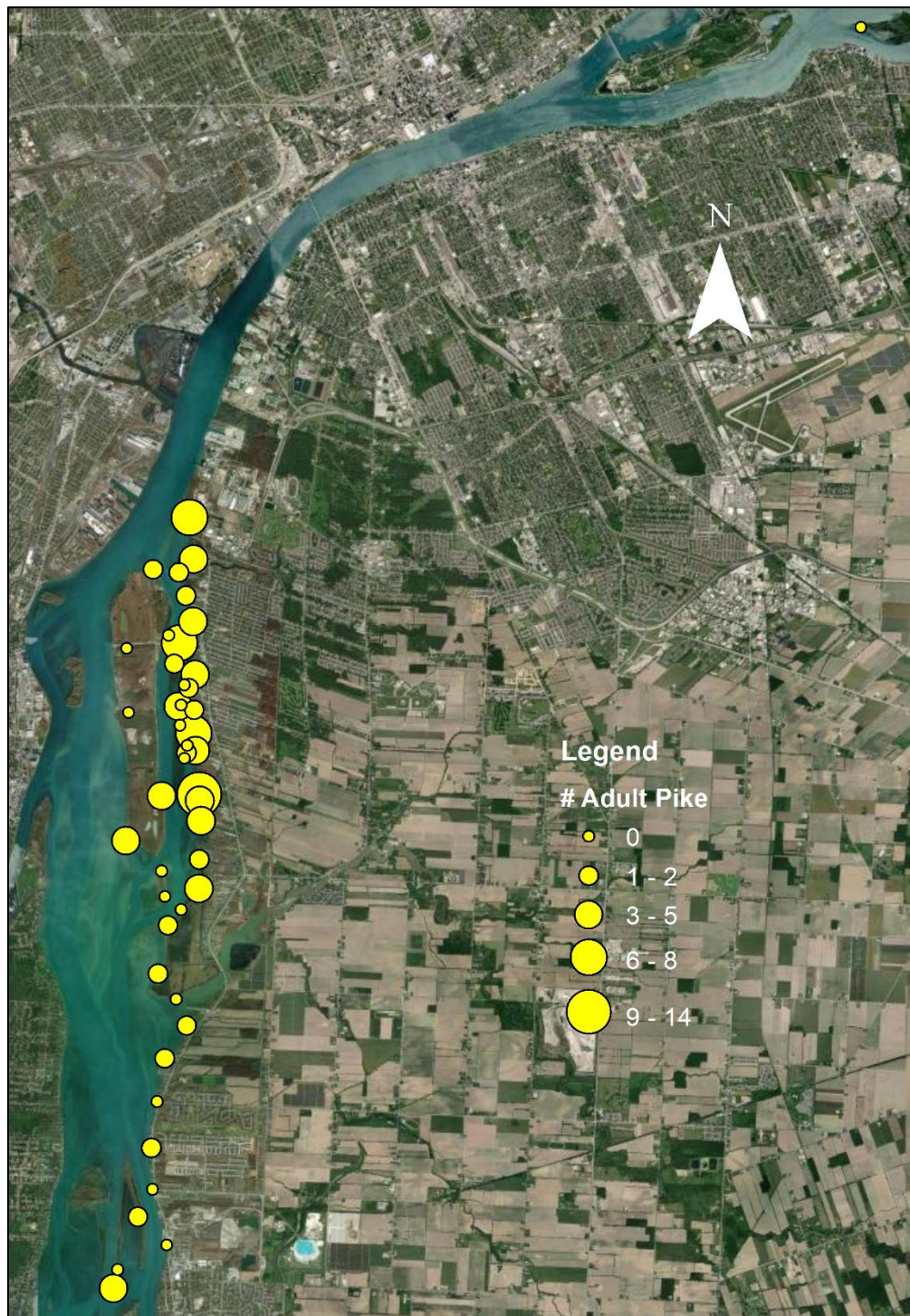


Figure 6.4.2 Number of Northern Pike captured at each transect in the Detroit River between May 4 to June 3, 2022. Points are located at the start of a transect.

6.5 Thames River Walleye Acoustic Tagging

The Thames River Walleye stock supports indigenous, recreational and commercial fisheries that range from the Thames River to international waters of Lake St Clair, the Great Lakes and connecting waters. Historically, the Thames River Walleye population experienced fluctuations that may be related to changes in spawning (river) habitat and lake conditions. To evaluate river habitat used by Walleye, a Canada-Ontario Agreement (COA) funded acoustic telemetry study began in 2021-2022 with deployment of seventeen 69 kHz acoustic receivers from the river mouth to Fanshawe Dam in London (Figure 6.5.1). Two additional receivers were deployed to replace a lost receiver and a receiver discontinued due to limited river access. Acoustic receivers were also deployed in Lake St. Clair and throughout the Great Lakes by OMNRF and partner agencies as part of the Great Lakes Acoustic Telemetry Observation System (GLATOS) network to monitor movements of fish species implanted with transmitters (tags). Acoustic receivers store data sent from implanted transmitters when tagged fish are in close proximity to receivers. Innovasea acoustic transmitters (V16 69 kHz) used in this study are capable of transmitting acoustic signals to receivers for 5 years. Acoustic detections can describe seasonal movements of Walleye throughout the Thames River, Lake St. Clair, the Great Lakes, and connecting waters.

Walleye were collected from April 19 to May 2, 2022 from the Thames River upstream of Chatham using a 21 foot Smith Root electrofishing vessel with a live well to hold Walleye for tagging. Walleye were sedated/immobilized using a Tens Unit at a low strength (3) while a Floy tag was applied dorsally and a transmitter (or tag) was implanted surgically, stitched with 2-3 sutures. Tags were labelled with unique ID numbers, reward and contact information. Length, sex, maturity, and gonad condition were recorded for each fish; anterior dorsal spines and pelvic fin clips were collected and preserved in 95% ethanol for age determination and genetic stock identification. Water temperature, dissolved oxygen concentration, and secchi transparency were measured at each sample location. During tagging, average water temperature was 9.4 °C with a range of 7.0-13.2 °C. Average dissolved oxygen was 11.6 mg/l with a range of 10.6-12.5 mg/l. Turbidity was high during tagging, with an average secchi depth of 0.4 m and a range of 0.2 to 0.8 m.

A total of 59 Walleye were tagged by OMNRF with external orange Floy loop tags and internal acoustic transmitters in 2022. Males represented the largest fraction of Walleye tagged (66%) followed by fish of unknown sex (27%) and females (7%). Most Walleye of undetermined sex were likely female since males are often conspicuous with milt running. Age composition of tagged Walleye ranged from 3 to 9 with age 4 accounting for 51% of tagged fish.

Receiver data uploaded from the GLATOS network described movements of Walleye by month from April to December, 2022 (Figure 6.5.2). Detections during 2022 may be incomplete until additional data are retrieved or uploaded. Most (58/59) Walleye tagged

in 2022 were detected by receivers in 2022. After spawning, most Walleye dispersed from the Thames River to Lake St. Clair, the Detroit River, Lake Erie, the St. Clair River, and Lake Huron from April to December (Figure 6.5.2).

In 2022, five (5) tagged Walleye were harvested by anglers in Lake St. Clair. Four (4) from the lake and one (1) from the St. Clair River (Figure 6.5.2). Harvest of tagged fish occurred during June (3), July (1), and October (1). The Great Lakes Fishery Commission (GLFC) awards \$100 U.S. to fishers that return these tags to OMNRF.

Additional information about this telemetry study and others can be viewed online at <https://glatos.glos.us/>.

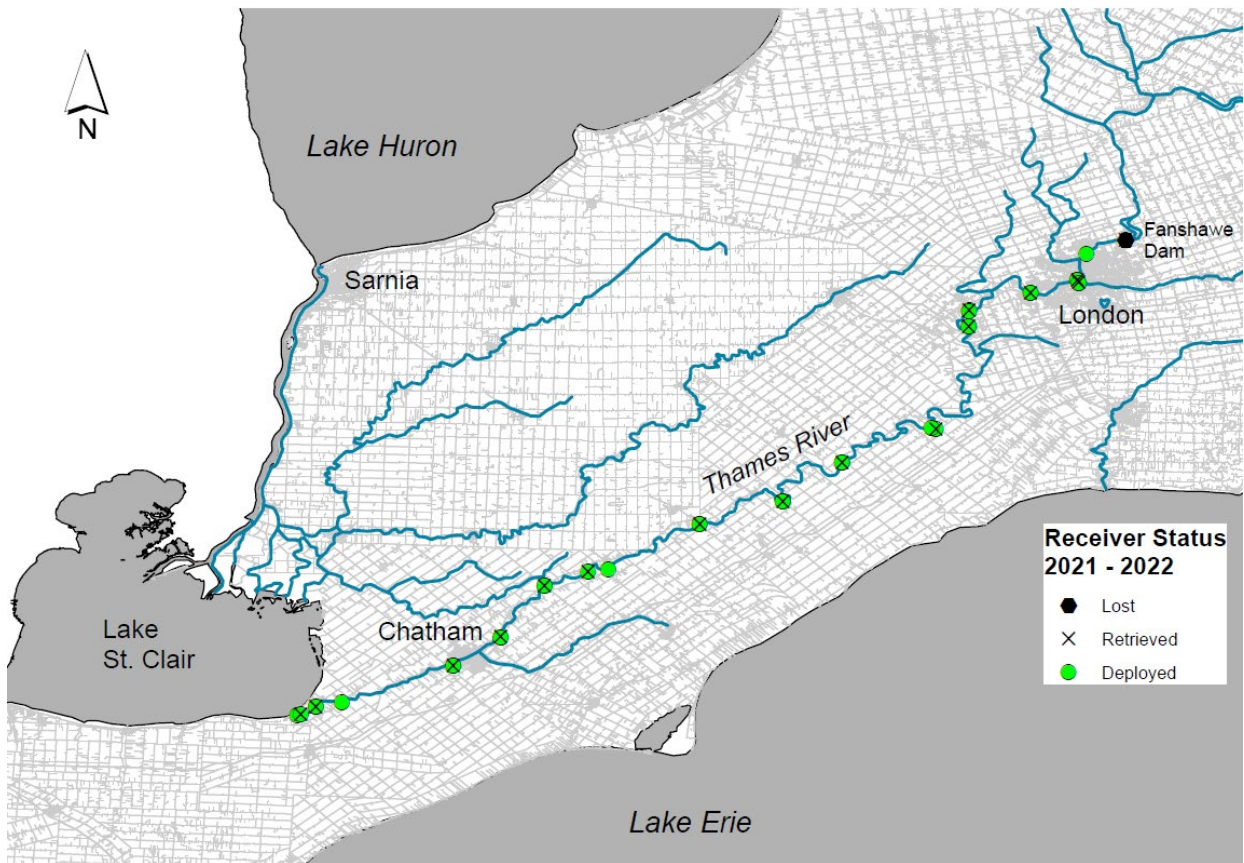


Figure 6.5.1 Locations where 69 kHz acoustic receivers were deployed and retrieved during 2021-2022 in the Thames River to monitor Walleye movement and habitat use.

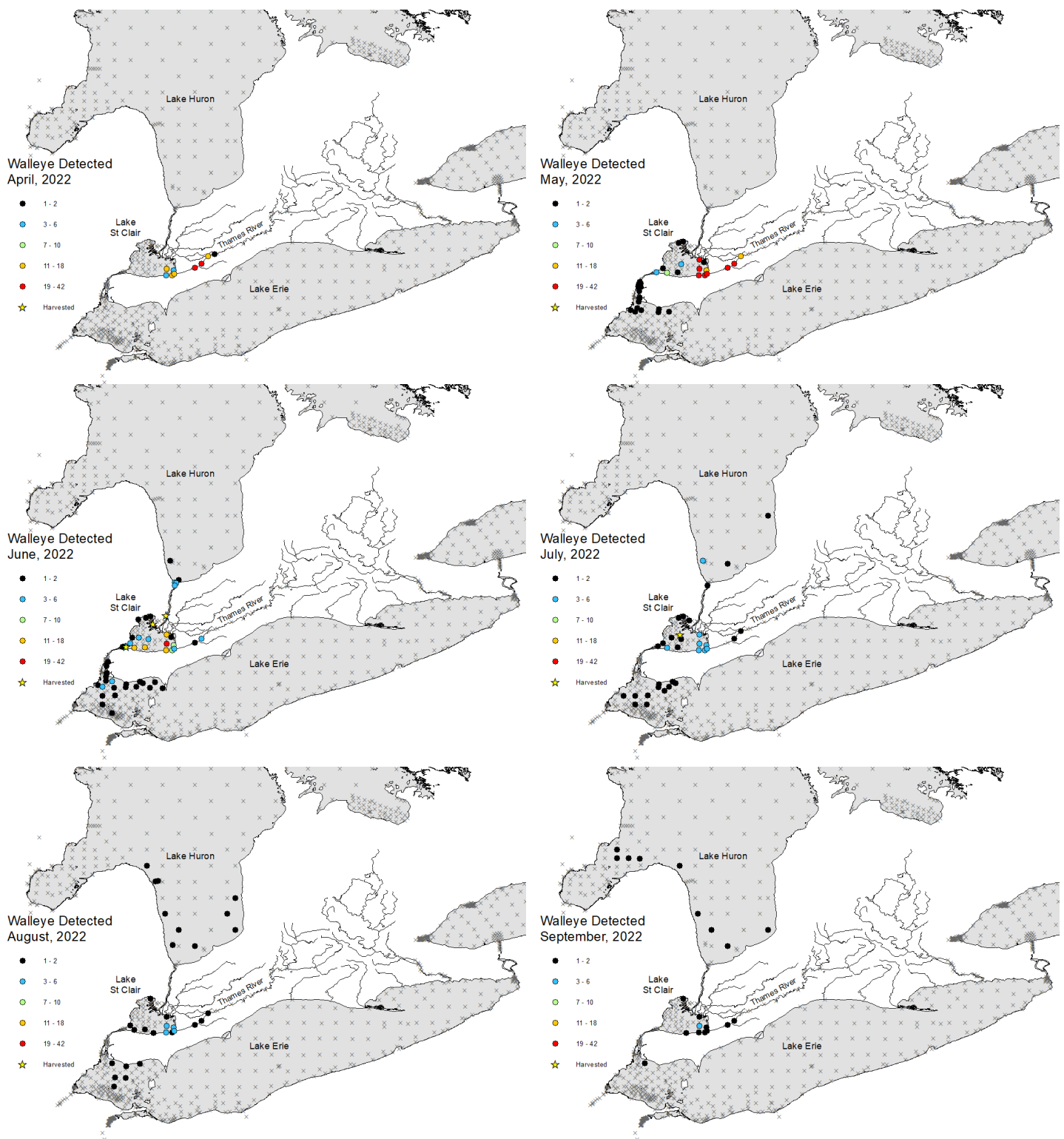


Figure 6.5.2 Number of individual Walleye tagged in 2022 that were detected monthly by receivers from April to September, 2022 in the Thames River, Lake St. Clair, the Great Lakes, and connecting waters. Locations where tagged Walleye were harvested in 2022 are shown by month (stars). Continued in next figure.

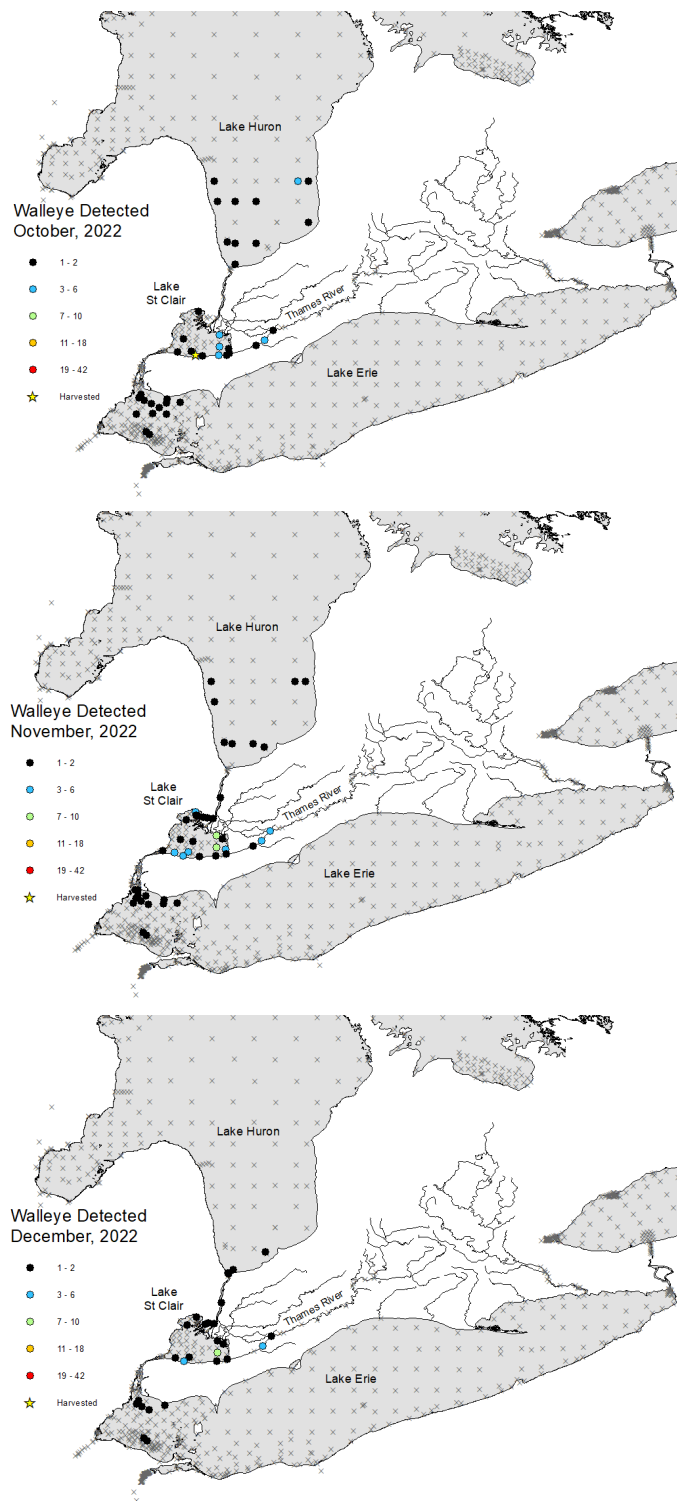


Figure 6.5.2 (continued) Number of individual Walleye tagged in 2022 that were detected monthly by receivers from October to December, 2022 in the Thames River, Lake St. Clair, the Great Lakes, and connecting waters. Locations where tagged Walleye were harvested in 2022 are shown by month (stars).

7. CANADA – ONTARIO AGREEMENT ON GREAT LAKES WATER QUALITY AND ECOSYSTEM HEALTH

The Lake Erie Management Unit (LEMU) hosts the Ontario Ministry of Natural Resources and Forestry (OMNRF) Great Lake Protection Fund (GLPF) coordinator for the Lake Erie Basin. The role of the coordinator is to facilitate OMNRFs commitments to the Canada - Ontario Agreement (COA) on Great Lake Water Quality and Ecosystem Health, commonly referred to as the COA agreement. The COA agreement specifies the roles and responsibilities of the federal and provincial governments as they collectively meet the Canadian commitments of the bi-national Great Lakes Water Quality Agreement (GLWQA). The primary role of the GLPF coordinator is to coordinate the OMNRF-GLPF work plan for the Lake Erie Basin among various OMNRF units/sections.

In 2022-23, the LEMU COA projects that were delivered were: Invasive Carp Surveillance, Habitat Suitability Index (HSI), Predator Diets, Identifying Priority Habitat of Native Species and Identifying Vulnerability of local Walleye to Eastern Fisheries.

7.1 Habitat Suitability Indices (HSI) For Native Species in Southern Ontario Tributaries

In 2022, the Lake Erie Management Unit (LEMU) continued the development of the Habitat Suitability Index (HSI) models for native species in Southern Ontario Tributaries. The goal of the project is to identify and map critical spawning and juvenile nursery habitat for the protection and restoration of native migratory fish species. The project analyzes the substrate, depth, flow, and temperature in 4 ecologically significant tributaries including the Grand, Thames and Sydenham Rivers, and Big Otter Creek (Figure 7.1.1).

The main goals for 2022 were to complete our side scanning for the Thames and Sydenham Rivers, and Big Otter Creek, for developing our substrate layers for these systems, and to begin trialing the development of a temperature layer. The LEMU HSI crews completed most of the side scanning, which to date totals 333 kms (Table 7.1.1.), leaving only a few gaps in data. Working with Chesapeake Technology (<https://chesapeake.tech.com/>) and their program SonarWiz, we continued to explore substrate delineation using the Seabed Classification. This software uses statistics from the recorded side scan images to identify differences in substrate and define polygon patches. Additionally, our crews began substrate sampling Big Otter Creek to ground-truth the analyzed patch polygons. In the Grand River, we piloted methods for developing a temperature layer using the Water Quality Modeling tool in the program HEC-RAS ([HEC-RAS \(army.mil\)](https://www.hec-ras.com/)). This pilot project deployed temperature loggers throughout the system to record hourly temperature data to analyze the thermal habitat that our native species have access to. Collaborative efforts with local Conservation Authorities continue as we develop HEC-RAS models that will allow us to complete depth and flow layers for our HSI, including the co-development of the HEC-RAS model from Tillsonburg to Calton Line with LPRCA in 2023. Unfortunately, after an exhaustive field effort by the crew, including the use of a canoe to side scan, Big Creek has been removed from the project due to many barriers (e.g., log jams) in the river preventing data collection.

Upcoming 2023 field plans include the completion of all outstanding side scanning, substrate sampling, expanded deployment of the temperature loggers across to all four rivers, assisting in HEC-RAS development with LPRCA, and finally the deployment of GLATOS receivers to assess fish movement in our systems and to validate our findings. Substrate delineation will also be a major task for 2023 using the completed side scan work and SonarWiz with the goal of having all rivers delineated. We are working to finalize the HSI in all rivers by the end of 2024.

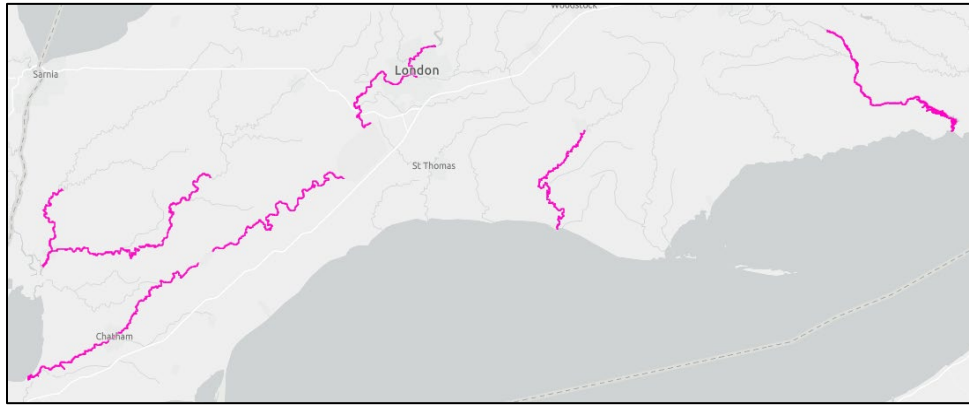


Figure 7.1.1 Map of side-scanned areas of Grand River, Thames River, Sydenham River, and Big Otter Creek in Ontario, Canada

Table 7.1.1 Side-scan distances completed in each of the study rivers for the Habitat Suitability Index project.

River	Distance (Approx.) (Km)
Grand	50
Big Otter	41
Big Creek	22
Thames	147
Sydenham	73
Total	333

7.2 Lake Erie Predator Diet Study

The forage base has declined across Lake Erie with evidence of impacts on the Lake Erie ecosystem. Decreasing weight-at-length in Walleye and potential prey switching to higher proportions of spiny-rayed fish in piscivores diets may be indication of limitations in prey availability for the apex-predators and food web instability (FTG 2019).

The objective of this project was to examine the stomach contents of key Lake Erie predators to establish baseline conditions and better understand impacts of low forage abundances to the Lake Erie fish community. This project collects and visually identifies stomach contents from key predators (Walleye, Yellow Perch, White Perch, White Bass, and Lake Trout) across Lake Erie.

To date, sampling efforts have primarily focused on sub-sampling fish collected in the commercial catch sampling program between April - June and September - November.

No spring sampling occurred in 2020 due to the COVID global pandemic. Supplemental sampling from other assessment programs occurred opportunistically throughout the year for species such as Lake Trout, Lake Whitefish, Rainbow Trout, other salmonids, and Burbot because these species are not captured in sufficient numbers by the commercial fishery. Additional supplemental sampling have been added to the program to explore questions of interest including:

- 1) Sampling of yearling Walleye samples from April – Nov in 2021 to explore consumption of young-of-the-year Yellow Perch.
- 2) Sampling sucker species (*Catostomidae* and *Moxostoma* spp.) during the 2022 Lake Whitefish acoustic tagging program to look for evidence of egg predation.

Sampling efforts have collected 7,226 stomach from various species over the past 3 years (Table 7.2.1).

Table 7.2.1: Summary of samples collected lake wide by species

Species	2020	2021	2022
Walleye	403	2100 (including 1085 yearling)	851
Yellow Perch	183	1068	550
White Bass	64	380	196
White perch	64	512	202
Lake Trout		49	103
Lake Whitefish	28	273	132
Other salmonids		8	10
Burbot		11	15
White Sucker			12
Shorthead Redhorse			12

For the past three years the largest impacts from the COVID global pandemic on the project have been delays to the visual identification of stomach content. By mid-summer 2022 diet visual identifications were backlogged with all 2021 and most 2022 samples requiring processing. During fall and winter 2022, a concerted effort by a team of 5 technicians cleared the backlog by visually identifying the contents of 6,484 stomach samples.

To summarize the stomach content data, percent composition by prey item was calculated based on amalgamated stomach content wet weights from non-empty stomachs by species and basin within year. One limitation of examining diet composition based on percent weight is that a few large prey items can disproportionately represent

importance of prey items to diets. To overcome this the Index of Relative Importance (IRI) scores were also calculated.

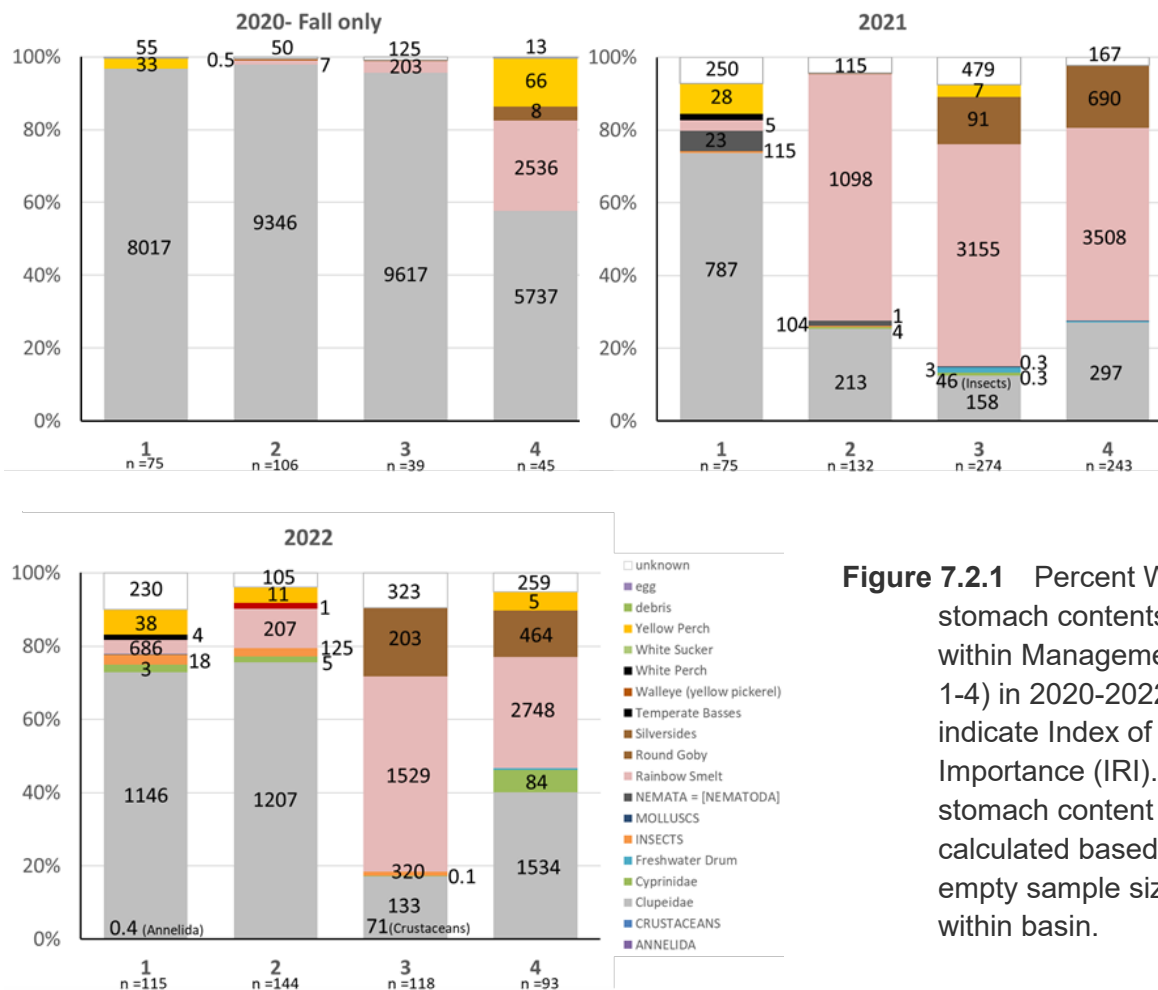
$$\text{IRI} = (\% \text{ by number} + \% \text{ by weight}) \times (\% \text{ frequency of occurrence})$$

IRIs incorporate the numbers and frequency of occurrence in addition to total weights of prey items to provide relative scores that are comparable across prey items within sampling strata to evaluate importance of the prey item in the diets of the species. The following provides selected summaries from 2020-2022 sampling.

Results

Walleye

For adult Walleye, Gizzard Shad (*Clupeidae*), and Rainbow Smelt were the primary prey items across the lake between 2020-2022 (Figure 7.2.1). Round Gobies are also important prey items in the east basin (MU4). There is some evidence of consumption of Yellow Perch and temperate basses (*Morone* sp.), but the IRI scores indicated that these species contribute minimally to their overall diets across the lake.



For yearling Walleye collected in 2021 (April – Nov), Gizzard Shad, and Rainbow Smelt were the primary prey item across the lake with Round Gobies also being important in the east basin (MU4) (Figure 7.2.2). Yellow Perch made up a significant component of the diet in the west basin (MU1) and were present in diets in west- (MU2) and east-central basins (MU3). Temperate basses also appeared in west basin (MU1) diets although did not contribute as significantly as Yellow Perch.

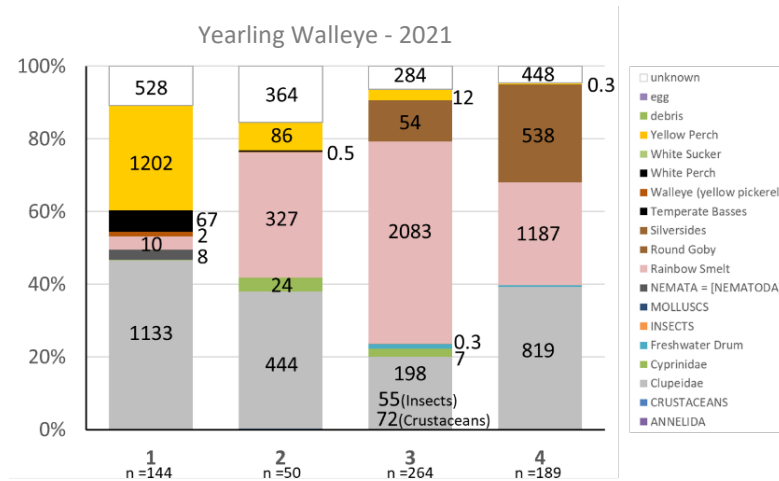
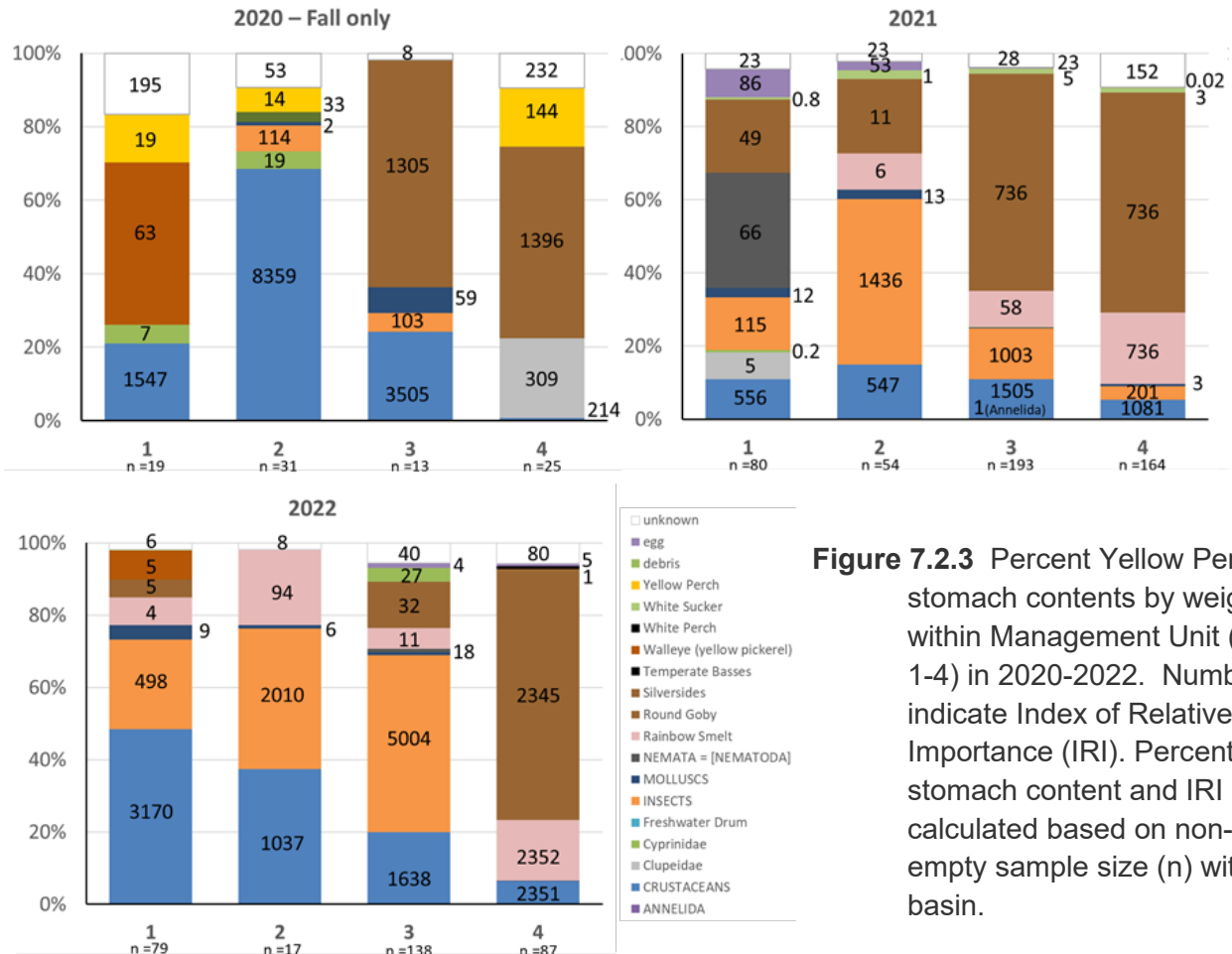


Figure 7.2.2 Percent yearling Walleye stomach contents by weight within Management Unit (MU 1-4) in 2020-2022. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

Yellow Perch

The primary prey of Yellow Perch consisted of Crustaceans and Insects. Round Gobies were also important prey items in the east-central (MU3) and east basin (MU4) (Figure 7.2.3). Results from the three years also provide evidence of Walleye and eggs consumption as well as some evidence of cannibalism of Yellow Perch.



White Bass

White Bass showed a diverse array of prey items. Similar to Walleye, Gizzard Shad and Rainbow Smelt appear to be important prey items for White Bass, however Insects, Crustaceans, Round Gobies, and Cyprinids also contribute significantly to the diets (Figure 7.2.4). Interestingly, Yellow Perch were also an important prey item in east basin (MU4) in fall 2020 but this may be an artifact of a low sample size (n = 14) and the limited spatial and temporal extent of sampling that year.

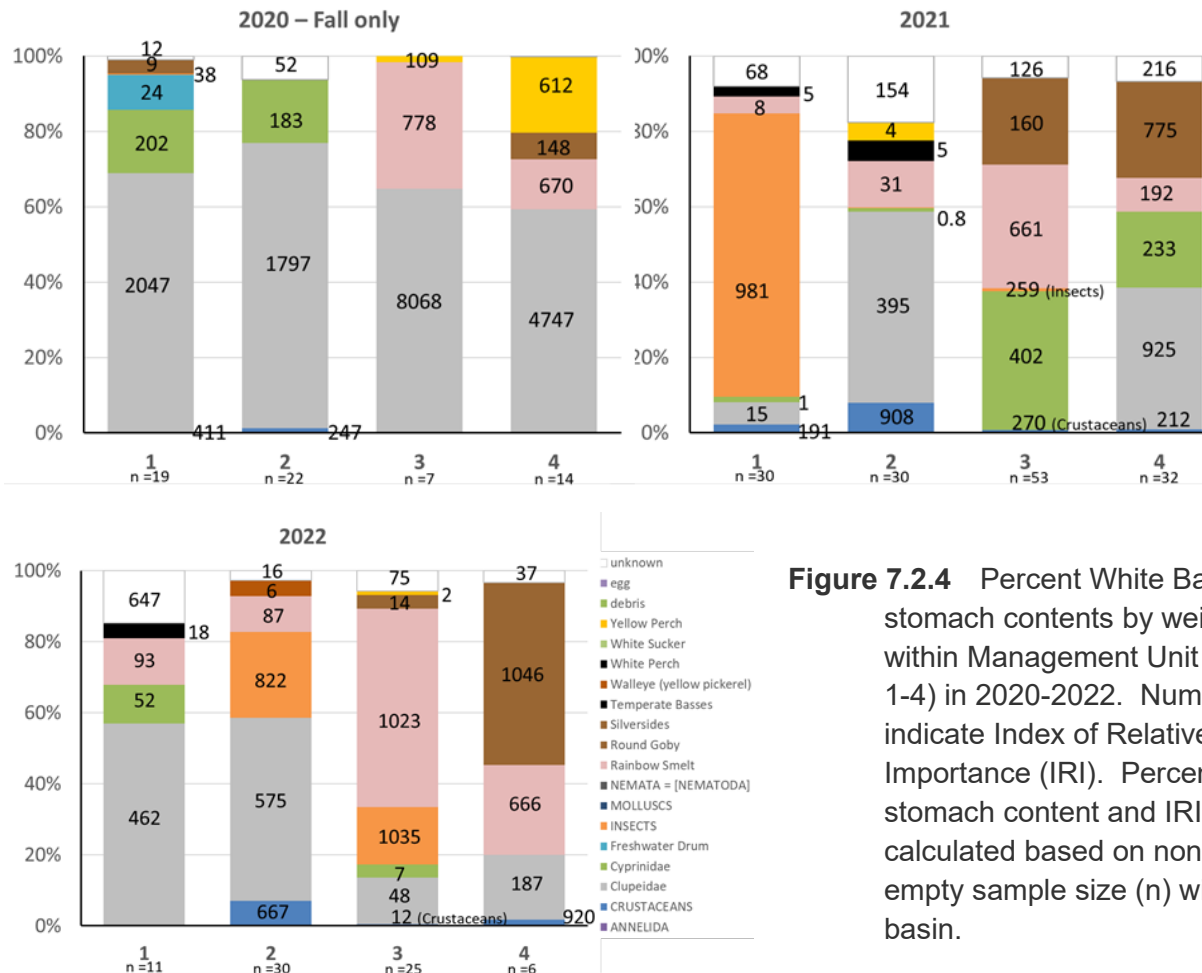


Figure 7.2.4 Percent White Bass stomach contents by weight within Management Unit (MU) 1-4 in 2020-2022. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

White Perch

Crustaceans and Insects were the primary prey items of White Perch. Similar to other species, Round Gobies also became important in east basin (MU4) (Figure 7.2.5). In the west basin (MU1), Gizzard Shad (Clupeidae) and egg predation also appear to, at times (e.g., 2020 and 2021 respectively), provide some contributions to diets.

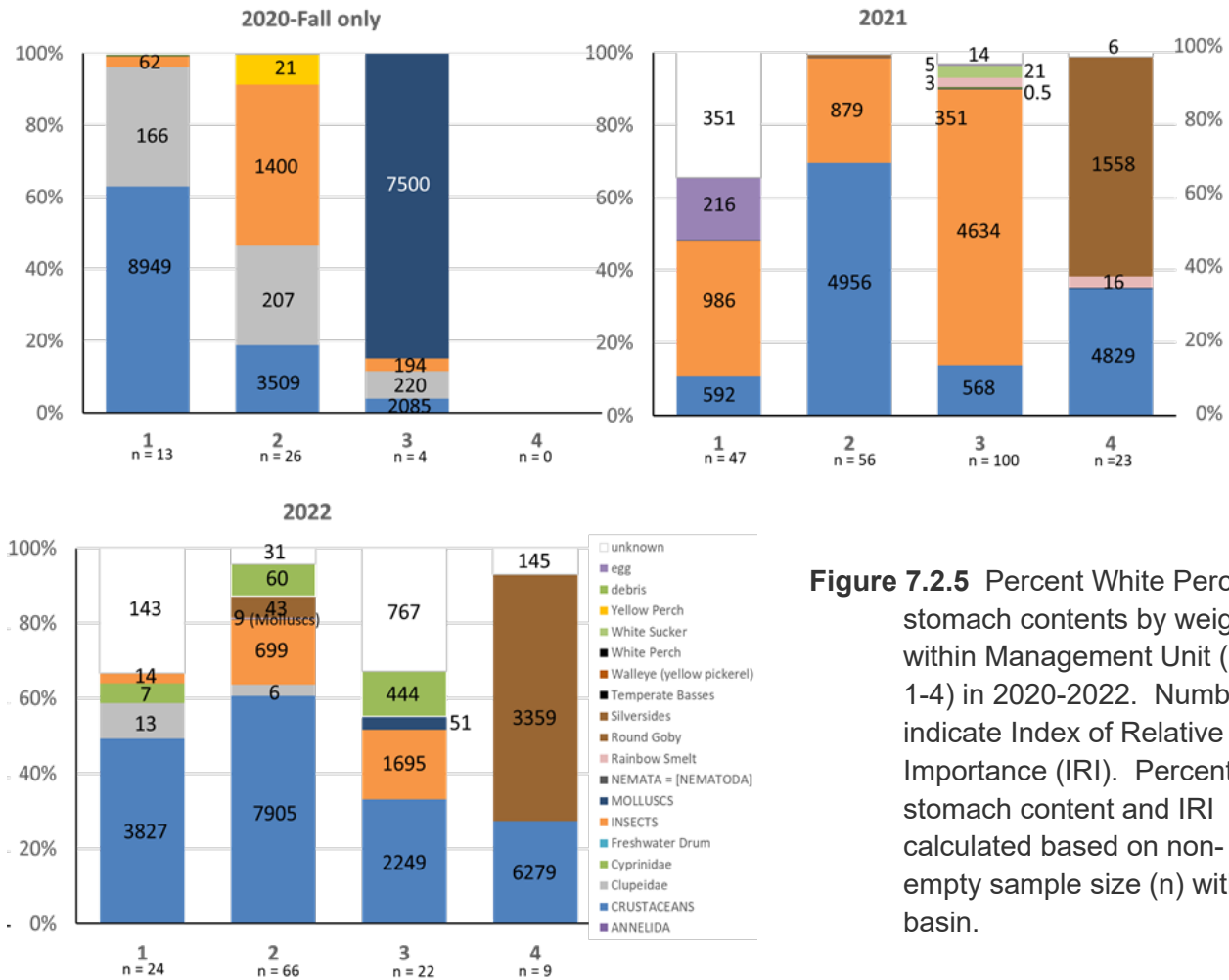


Figure 7.2.5 Percent White Perch stomach contents by weight within Management Unit (MU 1-4) in 2020-2022. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

Lake Whitefish

Many Lake Whitefish stomachs sampled were empty (100% in 2020, 84% in 2021, and 87% in 2022 of fish sampled). This may simply reflect the time of year and location of sampling. The ability to use opportunistic sampling opportunities of Lake Whitefish have proven to be seasonally and spatially limited. Alternatively, this may reflect faster digestion rates of invertebrate prey over larger piscivorous prey items, which may be further reflected in the high levels of observed “Unknown” prey items. From the limited identifiable contents in Lake Whitefish stomachs, invertebrates such as Mollusks, Crustaceans, and Nematodes made up the primary diets (Figure 7.2.6). There is some evidence of consumption of Rainbow Smelt but the relative importance of this to overall diets is uncertain because of an extremely low samples size (n = 2).

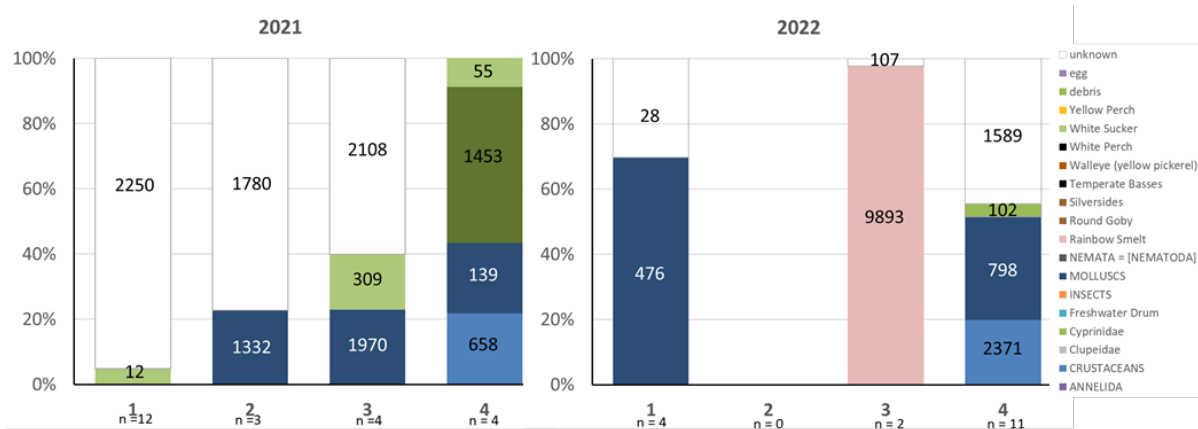


Figure 7.2.6 Percent Lake Whitefish stomach contents by weight within Management Unit (MU 1-4) in 2021-2022. Fish sampled in 2020 were all empty. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

Lake Trout

Most Lake Trout samples originate from the Coldwater Assessment Program which occurs annually in August (Section 4.4). This sampling was spatially and temporally limited and results are presented with that caveat. Based on the samples collected the primary prey items of Lake Trout were Rainbow Smelt and Round Gobies (Figure 7.2.7).

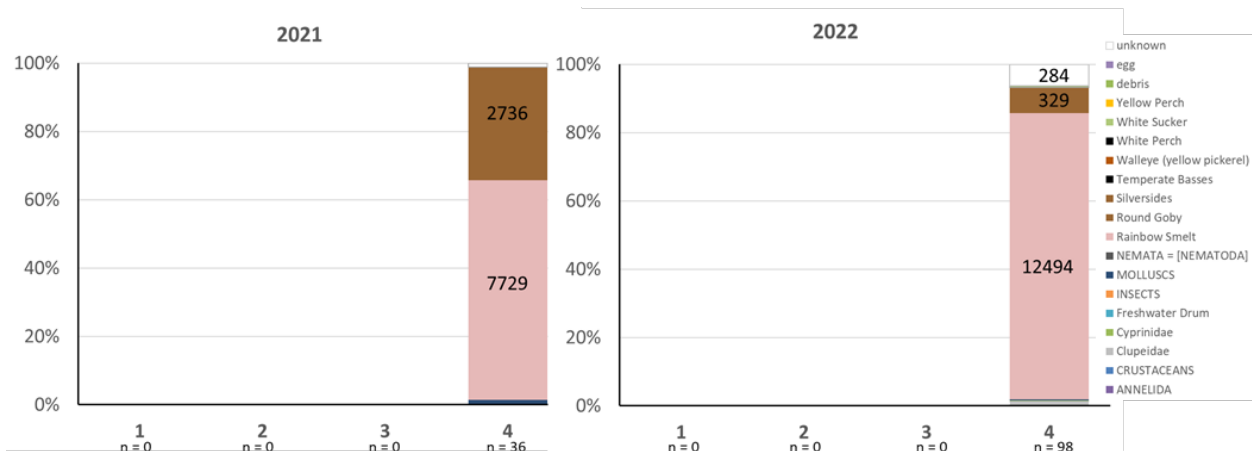


Figure 7.2.7 Percent Lake Trout stomach contents by weight within Management Unit (MU 1-4) in 2021-2022. 2020 samples were all empty. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

Sucker species

In 2022, Suckers species (*Catostomidae* and *Moxostoma* spp.) were sampled during the Lake Whitefish Acoustic tagging project (Nov 2022; Section 6.1). These samples were collected to look for evidence of Lake Whitefish egg predation. Based on the stomach contents of limited numbers of fish ($n = 15$) there was evidence of egg predation by White Suckers but none by Shorthead Redhorse (Figure 7.2.8). Eggs in stomach are presumed to be Lake Whitefish eggs because no other species are expected to be spawning at this location at this time of year. Eggs were the fourth most important stomach content based on the IRI score in White Suckers behind Insects, unknown/unidentifiable material, and Crustaceans.

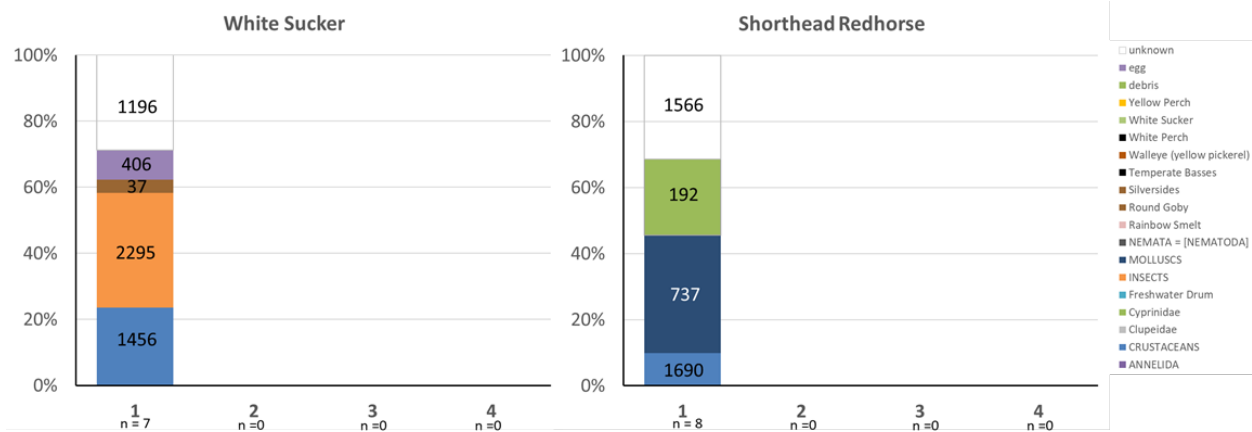


Figure 7.2.8 Percent White Sucker and Shorthead Redhorse stomach contents by weight within Management Unit (MU 1-4) in 2022. Numbers indicate Index of Relative Importance (IRI). Percent stomach content and IRI calculated based on non-empty sample size (n) within basin.

7.3 Rondeau Bay – McLean Coastal Wetland Restoration

The McLean Drain is a slow-moving, mud bottomed waterway flowing into Rondeau Bay. At the mouth of this drain lies the Mclean property (Figure 7.3.1). It is 130.2 hectares (Ha) or 321.7 acres and consists of mostly agricultural land, with portions containing provincially significant wetland, mowed lawn/garden, forested area, and tall grass prairie habitat. Given Lake Erie's recent high-water levels, the St. Clair Region Conservation Authority (SCRCA), and the land owner, developed plans for the property, including coastal wetland restoration (Figure 7.3.2).

A pre-construction assessment found a flooded agricultural land site in the early stages of natural coastal wetland succession (Figure 7.3.4). The site contained 17 aquatic plant and 4 reptile (i.e., turtle), 3 amphibian, and 29 fish species including 3 Species-At-Risk (SAR) fishes (Pugnose Shiner, Spotted Gar, and Warmouth). Using Canada-Ontario Agreement funding, OMNRF-LEMU supported SCRCA's work at the site in 2022 which included:

- 1) Retirement of 16.1 Ha of agriculture land leaving Site A in Figure 7.3.2 for agricultural practices.
- 2) Re-naturalization of 1.6 Ha of coastal wetland habitat (Site B in Figure 7.3.2).
- 3) The construction of 0.4 Ha of retention wetlands and berm features (Site C in Figure 7.3.2).
- 4) Planting of 2.7 Ha of native Carolinian tree and shrub species, with potential additional planting in the area possible (Green areas in Figure 7.3.2).

The work completed in 2022 complemented previous OMNRF funded wetland restoration projects on the south-eastern side of the property (~12 Ha, Figure 7.3.3) and the Bates Wetland to the south-west (~13 Ha, Figure 7.2.3) to form the largest continuous coastal wetland in Rondeau Bay outside of Rondeau Provincial Park. A failure of the McLean Drain's berm in 2022 created additional open water habitat and the potential for further enhancements to this coastal wetland complex in the future (Site D in Figure 7.3.2).

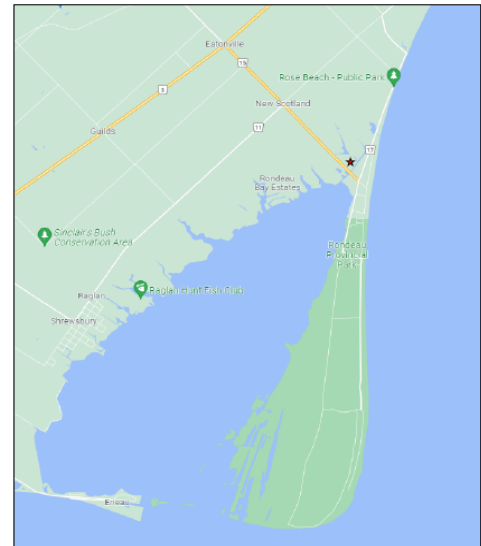


Figure 7.3.1 Location of McLean property (red star) on Rondeau Bay relative to Rondeau Provincial Park

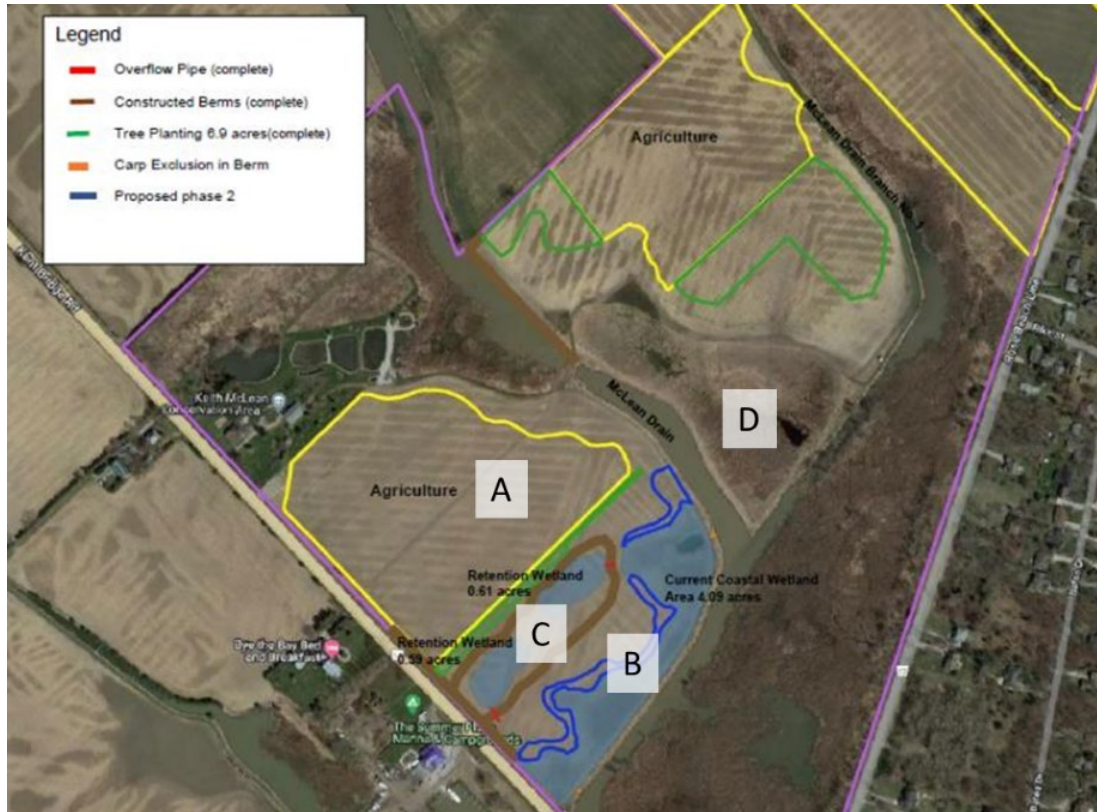


Figure 7.3.2 Detailed site plan for the 2022 McLean Coastal wetland Project. Yellow highlighted area identifies the land that will remain in agricultural production, the remaining land at the site will be restored with landscape features specified in this site plan

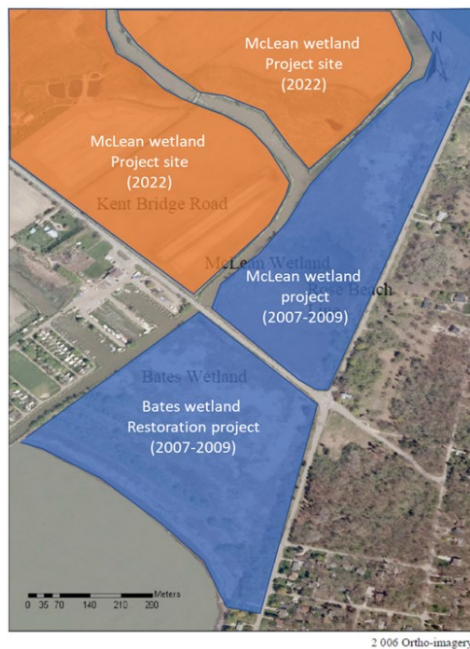


Figure 7.3.3 2022 Mclean wetland restoration project relative to the 2008-2009 OMNRF COA funded wetland restoration projects

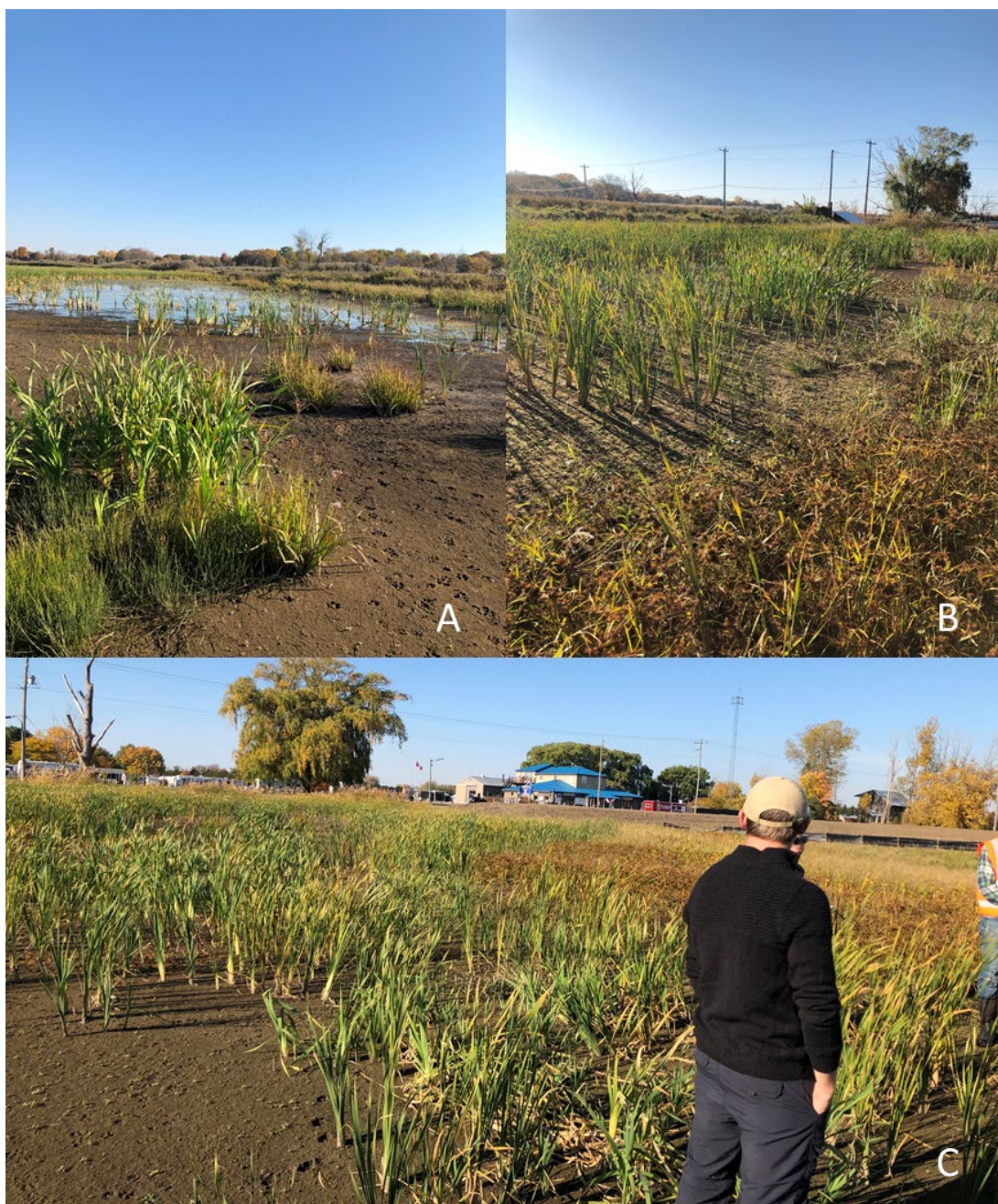


Figure 7.3.4 Re-naturalized coastal wetland on the McLean Property (Site B on Figure 7.3.2.), This land was last actively farmed in 2018. Pictures were taken during summer/fall low water (Oct 24, 2022). Panel (A) is an eastward facing view of the naturally formed deep water/wetted area. Panel (B) is a south-west facing view on emergent wetland vegetation (cattails). This vegetation emerged from the natural seed bank in the soil. The Mclean Drain's berm can be seen in the background. Panel (C) North-west facing view of emergent wetland, Kent Bridge Rd and Summer Place Marina can be seen.

APPENDIX A – LAKE ERIE MANAGEMENT UNIT STAFF 2022

WHEATLEY

320 Milo Road, Wheatley, ON N0P 2P0
Tel: 519-825-4684 Fax: 519-825-3163

Brian Locke – Lake Manager
Emily Slavik – Assessment Supervisor
Stephen Marklevitz – A/COA Coordinator
Tyler Genereaux – Operations Coordinator
Steve Mailloux – Port Observer Coordinator
Andy Cook – Assessment Biologist
Megan Belore – Assessment Biologist
Karen Soper – Systems Officer
Craig McDonald – Vessel Master
Chris Gignac – Fisheries Technician
Lily Sands – Admin & Data Entry Clerk

Seasonal Staff:

Mike Thorn – Aquatic Ecosystem Biologist
Nathan Staels – Fisheries Technician
Chris Thomas – Fisheries Technician
Mary Lynn Emmerton – Fisheries Technician
Michael Delorme – Fisheries Technician
James Watkins – Fisheries Technician
Chase Cabral – Fisheries Technician
Jessica Klack – COA Fisheries Technician
Abimbola Asaju – SEO Fisheries Technician
Mike Broser – Port Observer
Mike Oosterhuis – Port Observer
Jarrett McIntyre – Port Observer
Tracey Hebert – Data Entry Clerk
Gillian Pollard – Data Entry Clerk

SCIENCE AND RESEARCH SECTION

Yingming Zhao – Research Scientist

LONDON

659 Exeter Road, London, ON N6E 1L3
Tel: 519-488-9871 Fax: 519-873-4645

Richard Drouin – Lead Management Biologist
Jeremy Holden – Assessment Biologist

PORT DOVER

49 Passmore Avenue, Unit 7
P.O. Box 429, Port Dover, ON N0A 1N0
Tel: 519-583-0090 Fax: 519-583-1547

Jake Reugg – A/Fisheries Ecology Supervisor
Paulette Penton – A/Lake Manager
Gord Ives – Vessel Master
Tom MacDougall – Rehabilitation Ecologist
Jannette Risi – Administrative Assistant

Seasonal Staff:

Arthur Bonsall – Assessment Biologist
George Morgan – Assessment Biologist
Rachel Henderson – Assessment Biologist
Rebecca Poisson – COA Biologist
Ty Gehrke – COA Biologist
Duncan Norrie – Fisheries Technician
Tina Werner – Fisheries Technician
Daniel Werner – Fisheries Technician
Emily Cowie – Fisheries Technician
Sarah Gough – Fisheries Technician
Michael Fabiano – Fisheries Technician
Taylor Cooke-Brown – Fisheries Technician
Nathan Trebych – Fisheries Technician
Danielle Hennink – COA Fisheries Technician
Jacob Coates – SEO Fisheries Technician
Logan Burns – Port Observer

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