Lake Ontario Fish Communities and Fisheries:

2023 Annual Report of the Lake Ontario Management Unit

Ontario

Cover Photos:

(Top Left) Tiger Muskellunge caught in the Lake St. Francis Nearshore Community Index Netting (NSCIN) program. For more information see Section 1.3.

(Top Right) LOMU field crew lifting a net as part of the Lake Ontario and Bay of Quinte Community Index Gillnetting program. For more information, see Section 1.1.

(Bottom Left) LOMU field crew lifting a trap net as part of the Thouseand Islands Nearshore Community Index Netting (NSCIN) program. For more information see Section 1.3.

(Bottom Right) Different year-classes of Alewife caught in the Lake Ontario Spring Prey Fish Assessment. For more Information, see Section 1.6.

LAKE ONTARIO FISH COMMUNITIES AND FISHERIES:

2023 ANNUAL REPORT OF THE LAKE ONTARIO MANAGEMENT UNIT

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Lake Ontario Fish Communities and Fisheries: 2023 Annual Report of the Lake Ontario Management Unit

Foreword

The Lake Ontario Management Unit (LOMU) and the Lake Ontario research staff from the Aquatic Research and Monitoring Section (ARMS) operating at the Glenora Fisheries Station, are pleased to provide the 2023 Annual Report of monitoring, assessment, research and management activities.

Lake Ontario fisheries are managed by the Lake Ontario Committee, consisting of the Ontario Ministry of Natural Resources and Forestry (MNRF) in partnership with New York State, under the auspices of the Great Lakes Fishery Commission. The Lake Ontario Fish Community Objectives (2013) provide bi-national fisheries management direction to protect and restore native species and to maintain sustainable fisheries. Our partners include: New York State Department of Environmental Conservation (NYSDEC), Fisheries and Oceans Canada (DFO), the U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS) and many other Ontario provincial ministries and conservation authorities and U.S. state and federal agencies, universities and non-government partners.

Glenora Fisheries Station staff delivered over forty-five field and laboratory projects in 2023 including the comprehensive long-term base monitoring program that spans over five decades. In 2023, assessment of the Canadian waters from the Niagara River to Lake Saint Francis included 206 trap and hoop net sets, 182 gill net sets in 121 sites and 159 trawls. Across all programs, 362,428 fish were captured (comprising more than 50 species) and 2,799 calcified structures were processed for age and growth assessment. Over 45,900 salmon and trout were observed migrating upstream using the Ganaraska River and Credit River video fish counter systems. MNRF Fish Culture Section and partners stocked 1.896 million fish (aprox. 48,000 kg).

We would like to express our sincere appreciation to the many partners and volunteers who contributed to the successful delivery of LOMU initiatives. Special thanks to the Ontario Federation of Anglers and Hunters and the many other partners committed to the Lake Ontario Atlantic Salmon restoration program. LOMU gratefully acknowledges the important contribution of the Lake Ontario Commercial Fishery Liaison Committee, the Fisheries Management Zone 20 Council (FMZ20) members, the Ringwood hatchery partnership with the Metro East Anglers, Chinook Net Pen Committee, Muskies Canada, the Ganaraska River Fishway Volunteers, Napanee and District Rod & Gun Club, Queen's University and the University of Windsor and the participants in the angler diary and assessment programs.

Our team of skilled and committed staff and partners delivered an exemplary program that provides long-term benefits to the citizens of Ontario. We are pleased to share the important information about these activities and findings of the Lake Ontario Management Unit from 2023.

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This Annual Report is available online at: http://www.glfc.org/loc_mgmt_unit/

1. Index Fishing Projects

1.1 Lake Ontario and Bay of Quinte Fish Community Index Gill Netting

S. Beech, Lake Ontario Management Unit

The Lake Ontario and Bay of Quinte annual fish community index gill netting program is used to monitor the abundance and biological characteristics of a diversity of warm, cool and cold-water fish species. Data from the program are used to help manage local commercial and recreational fisheries as well as for tracking long-term changes in the aquatic ecosystem.

Gill net sampling areas are shown in Fig. 1.1.1 and the basic sampling design is summarized in Table 1.1.1. Included in the design are fixed single-depth sites, depth-stratified sampling areas, and depth stratified random sites. In 2023, each site or area was visited once with one to three gill net gangs set during each visit.

The annual index gill netting field work occurs during the summer months based on an understanding of water temperature stability, fish movement/migration patterns, fish growth patterns, and logistical considerations. The time-frames for completion of field work varies among sampling sites/areas (Table 1.1.1). This increases the probability of encountering a wide-range of water temperatures across the depth ranges sampled and in various geographic areas.

Monofilament gill nets with standardized specifications are used (monofilament mesh replaced multifilament in 1992; only catches from 1992-present are tabulated here). Each gill net gang consists of a graded-series of ten monofilament gill net panels of mesh sizes from 38 mm (1½ in) to 152 mm (6 in) stretched mesh at 13 mm (½ in) intervals, arranged in sequence. However, a standard gill net gang may consist of one of two possible configurations. Either all ten mesh sizes (panels) are 15.2 m (50 ft) in length (total gang length is 152.4 m (500 ft)), or, the 38

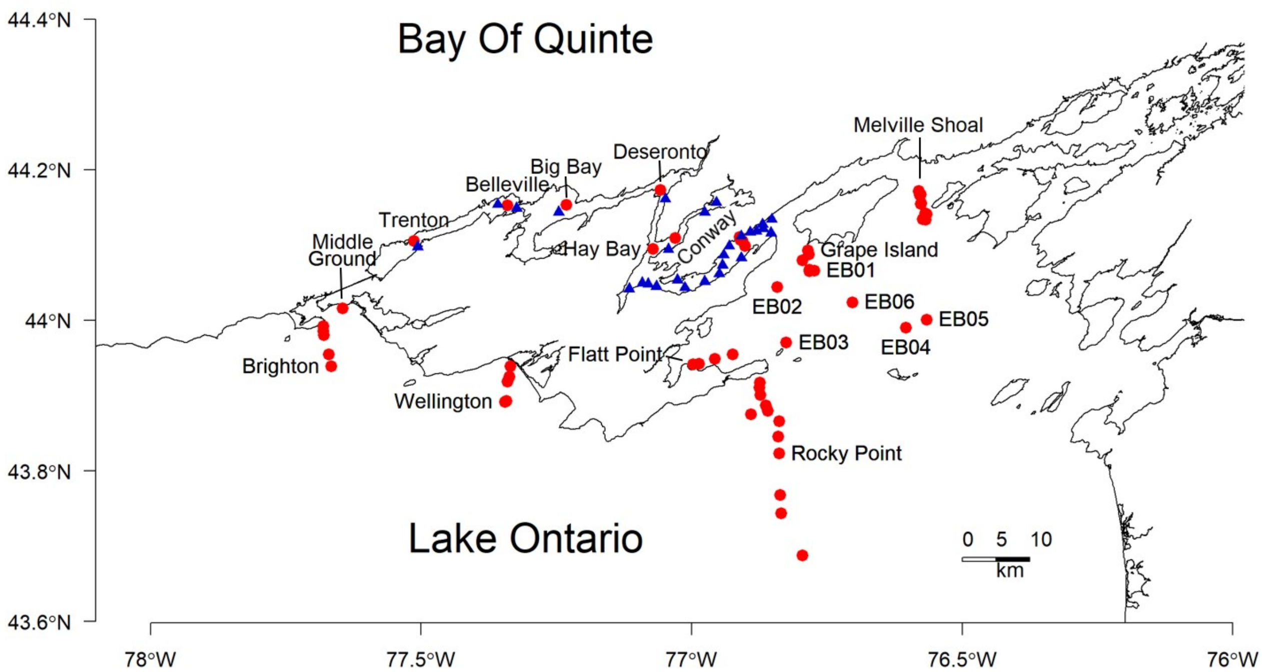

FIG. 1.1.1. Map of Lake Ontario showing fish community index gill netting fixed (red) and random (blue) sites in 2023. Fixed sites are labelled.

TABLE. 1.1.1. Sampling design of the Lake Ontario fish community index gill netting program (Lake Ontario) including geographic and depth stratification, number of visits, number of replicate gill net gangs set during each visit (by gill net length), and the time-frame for completion of visits. Also shown is the year in which gill netting at a particular area/site was initiated and the number of prior years that netting has occurred.

						Replicates by net size[3]		Site location (approx)					
Region name	Area Name (Area code)	Design	Site name	Depth (m)	Visits	465 feet	500 feet	Latitude (dec min)	Longitude (dec min)	No.SAM (Visits x Replicates)	Time-frame	Start-up year	Number years[4]
Northeastern Lake Ontario	Brighton (BR)	Depth stratified area	BR08	7.5	1	2		435955	774058	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Brighton	Depth stratified area	BR13	12.5	1	2		435911	774071	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Brighton	Depth stratified area	BR18	17.5	1	2		435878	774053	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Brighton	Depth stratified area	BR23	22.5	1	2		435777	774034	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Brighton	Depth stratified area	BR28	27.5	1	2		435624	774004	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Middle Ground (MG)	Fixed site	MG05	5	1	2		440054	773906	2	mid July-Aug	1979	44
Northeastern Lake Ontario	Wellington (WE)	Depth stratified area	WE08	7.5	1	2		435622	772011	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Wellington	Depth stratified area	WE13	12.5	1	2		435544	772027	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Wellington	Depth stratified area	WE18	17.5	1	2		435515	772025	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Wellington	Depth stratified area	WE23	22.5	1	2		435378	772050	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Wellington	Depth stratified area	WE28	27.5	1	2		435348	772066	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point (RP)	Depth stratified area	RP08	7.5	1	2		435510	765220	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP13	12.5	1	2		435460	765230	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP18	17.5	1	2		435415	765222	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP23	22.5	1	2		435328	765150	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP28	27.5	1	2		435285	765135	2	mid July-Aug	1988	35
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP40	40	1		3	435190	765040	3	mid July-Aug	2016	7
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP50	50	1		3	435090	765030	3	mid July-Aug	2016	7
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP60	60	1		3	434950	765029	3	mid July-Aug	1997	26
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP80	80	1		3	434633	765006	3	mid July-Aug	1997	26
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP100	100	1		3	434477	764998	3	mid July-Aug	1997	26
Northeastern Lake Ontario	Rocky Point	Depth stratified area	RP140	140	1		3	434122	764808	3	mid July-Aug	1997	26
Kingston Basin (nearshore)	Flatt Point (FP)	Depth stratified area	FP08	7.5	1	2		435665	765993	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP13	12.5	1	2		435659	765927	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP18	17.5	1	2		435688	765751	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP23	22.5	1	2		435726	765541	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Flatt Point	Depth stratified area	FP28	27.5	1	2		435754	765314	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Grape Island (GI)	Depth stratified area	GI08	7.5	1	2		440537	764712	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI13	12.5	1	2		440523	764747	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI18	17.5	1	2		440476	764710	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI23	22.5	1	2		440405	764718	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Grape Island	Depth stratified area	GI28	27.5	1	2		440470	764796	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Melville Shoal (MS)	Depth stratified area	MS08	7.5	1	1		441030	763500	1	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS13	12.5	1	1		441004	763470	1	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS18	17.5	1	2		440940	763460	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS23	22.5	1	2		440835	763424	2	Jun 27-Jul29	1986	37
Kingston Basin (nearshore)	Melville Shoal	Depth stratified area	MS28	27.5	1	2		440792	763424	2	Jun 27-Jul29	1986	37

mm (1½ in) mesh size (panel) is 4.6 m (15 ft) in length and the remaining mesh sizes are 15.2 m (50 ft) each in length (total gang length is 141.7 m (465 ft)) (see Table 1.1.1). Note that use of the shorter 38 mm gill net panel is related to the processing time required to deal with large numbers of small fish (e.g., Alewife and Yellow Perch) caught in this small mesh size. Gill net gangs are connected in series (i.e., cork lines and lead lines attached), but are separated by a 15.2 m (50 ft) spacer to minimize "leading" of fish. The 152 mm (6 in) end of one gang is connected to the 38 mm (1 ½ in) gang of the adjoining gang. The entire gill net strap (all joined gangs) is set within 2.5 m of the site depth listed in Table 1.1.1. Starting in 2019, only one gang was used at each site in the Bay of Quinte. The reduction of fixed sites from one to two gangs allowed for the reallocation of effort to depth stratified random sites.

The gill net set duration target ranges from 18-24 hours. Gill net catches were summed across the ten mesh sizes from 1½-6 inch. In the case where the 38 mm mesh size used was 4.6 m in length, the catch in this mesh was adjusted (i.e., multiplied by 15.2/4.6) prior to summing the ten mesh sizes. Therefore, all reported catches represent the total catch in a 152.4 m (500 ft) gang of gill net.

TABLE 1.1.1. (continued). Sampling design of the Lake Ontario fish community index gill netting program (Bay of Quinte) including geographic and depth stratification, number of visits, number of replicate gill net gangs set during each visit (by gill net length), and the time-frame for completion of visits. Also shown is the year in which gill netting at a particular area/site was initiated and the number of prior years that netting has occurred.

						Replicates by net size[3]		Site location (approx)					
Region name	Area Name (Area code)	Design	Site name	Depth (m)	Visits	465 feet	500 feet	Latitude (dec min)	Longitude (dec min)	No.SAM (Visits x Replicates)	Time-frame	Start-up year	Number years[4]
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB01	31	1	3		440400	764650	3	Jul-Aug	2016	8
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB02	30	1	3		440330	765050	3	Jul-Aug	1968	56
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB03	25	1	3		435820	764950	3	Jul-Aug	2016	8
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB04	27	1	3		435940	763610	3	Jul-Aug	2016	8
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB05	29	1	3		440000	763400	3	Jul-Aug	2016	8
Kinston Basin (offshore)	Eastern Basin (EB)	Fixed site	EB06	30	1	3		440220	764210	3	Jul-Aug	1968	56
Bay of Quinte	Conway	Depth stratified area	CO08	7.5	1	1		440664	765463	1	Jul-Aug	1972	52
Bay of Quinte	Conway	Depth stratified area	CO13	12.5	1	1		440649	765452	1	Jul-Aug	1972	52
Bay of Quinte	Conway	Depth stratified area	CO20	20	1	1		440643	765453	1	Jul-Aug	1972	52
Bay of Quinte	Conway	Depth stratified area	CO30	30	1	1		440620	765440	1	Jul-Aug	1972	52
Bay of Quinte	Conway	Depth stratified area	CO45	45	1	1		440601	765402	1	Jul-Aug	1972	52
Bay of Quinte	Hay Bay (HB)[2]	Depth stratified area	HB08	7.5	1	1		440656	770156	1	Jul-Aug	1959	65
Bay of Quinte	Hay Bay	Depth stratified area	HB13	12.5	1	1		440575	770400	1	Jul-Aug	1959	65
Bay of Quinte	Deseronto (DE)	Fixed site	DE05	5	1	1		441035	770339	1	Jul-Aug	2016	8
Bay of Quinte	Big Bay (BB)	Fixed site	BB05	5	1	1		440920	771360	1	Jul-Aug	1972	52
Bay of Quinte	Belleville (BE)	Fixed site	BE05	5	1	1		440914	772048	1	Jul-Aug	2016	8
Bay of Quinte	Trenton (TR)	Fixed site	TR05	5	1	1		440636	773063	1	Jul-Aug	2016	8
Bay of Quinte	Upper Bay of Quinte (UB)	Random site		1-3	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Upper Bay of Quinte (UB)	Random site		3-6	1	1				1	Jul-Aug	2019	5
Bay of Quinte	Upper Bay of Quinte (UB)	Random site		6-12	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Middle Bay of Quinte (MB)	Random site		1-3	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Middle Bay of Quinte (MB)	Random site		3-6	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Middle Bay of Quinte (MB)	Random site		6-12	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Middle Bay of Quinte (MB)	Random site		12-20	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		1-3	1	1				1	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		3-6	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		6-12	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		12-20	2	1				2	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		20-35	4	1				4	Jul-Aug	2019	5
Bay of Quinte	Lower Bay of Quinte (LB)	Random site		35+	4	1				4	Jul-Aug	2019	5

[1] changed from a fixed site where the gillnet was set perpendicular to shore across contours to a depth stratified site with five depths in 1992
[2] changed from a fixed site where the gillnet was set parallel and close to shore to a depth stratified area with two depths (sites) in 1992
[3] two types of gillnet effort are used; both types consist of a graded series of mesh sizes attached in order by size from 38-153 mm at 13 mm intervals; one type has 15 ft of 38 mm mesh and 50 ft of
[4] the basic sampling design of the program has been largely consistent since 1992; for years prior to 1992 consult field protocols and FISHNET project definitions for changes in sampling design.

In 2023, 142 gill net samples were conducted from June 19th to August 28th. Thirty-one different species and 4,744 individual fish were caught. Sixty percent of the standardized catch (by weight) was Alewife, followed by Yellow Perch (17%), White Perch (10%), Walleye (3%), and Lake Trout (1%) (Table 1.1.2). Species-specific catch across depth ranges is shown for the Bay of Quinte in Table 1.1.3 and for Lake Ontario in Table 1.1.4. Species-specific gill net catch by geographic area is shown in Fig. 1.1.2. Abundance trends for select species caught in Lake Ontario and the Bay of Quinte are shown (Tables 1.1.5-1.1.7 and Figs. 1.1.3-1.1.5). Length distributions are shown for selected species in Fig. 1.1.6. Other biological information is also presented below for Lake Whitefish, Cisco, Lake Trout, Yellow Perch, and Walleye (Table 1.1.8 and Figs. 1.1.7-1.1.8) and described for Northern Pike, Largemouth Bass, and Smallmouth Bass.

Northeast and Kingston Basin, Lake Ontario

Northeast (Brighton, Wellington, Middle Ground and Rocky Point) and Kingston Basin (Melville Shoal, Grape Island and Flatt Point) Nearshore Areas (Table 1.1.5, Fig. 1.1.3)

Six depth-stratified sampling areas (Melville Shoal, Grape Island, Flat Point, Rocky Point, Wellington and Brighton) that employ a common sampling design were used here to provide a broad picture of the warm, cool and cold-water fish community inhabiting the open-coastal waters out to about 30 m water depth in the eastern half of Lake Ontario. Results were

TABLE 1.1.2. Species-specific catch in 2023 gill net sets from June 19th to August 28th. "Standard catch" and "Standard weight" is the observed catch and weight, respectively, expanded to represent the catch in a 50 ft panel length of 1 1/2 inch mesh size in cases where only 15 ft was used.

Species	Observed Catch	Standard Catch	Standard Weight (kg)	Observed Weight (kg)
Lake Sturgeon	2	2	5	5
Longnose Gar	43	59	129	87
Bowfin	4	4	9	9
Alewife	2,074	6,715	231	74
Gizzard Shad	15	15	18	18
Chinook Salmon	26	26	56	56
Atlantic Salmon	1	1	1	1
Brown Trout	6	6	12	12
Lake Trout	157	162	456	444
Lake Whitefish	24	24	24	24
Lake Herring (Cisco)	46	48	30	28
Rainbow Smelt	2	2	<0.1	<0.1
Northern Pike	15	15	43	43
White Sucker	81	83	59	58
Silver Redhorse	10	10	18	18
Common Carp	4	4	8	8
Brown Bullhead	21	23	6	5
Burbot	2	2	4	4
White Perch	794	1,119	100	82
White Bass	6	6	4	5
Rock Bass	41	87	4	3
Pumpkinseed	84	102	5	5
Bluegill	22	45	1	0.7
Smallmouth Bass	28	28	34	34
Largemouth Bass	4	4	4	4
Black Crappie	7	7	2	2
Yellow Perch	711	1,921	107	49
Walleye	354	363	623	623
Round Goby	24	77	3	0.9
Freshwater Drum	128	130	163	160
Deepwater Sculpin	8	26	0.7	0.2

summarized and presented graphically (Fig. 1.1.3) to illustrate abundance trends of the most abundant fish species. Middle Ground is a fixed site and represents one of our longest running gill netting locations.

Northeast (Rocky Point) and Kingston Basin (EB01-EB06) Offshore Areas (Tables 1.1.5 and 1.1.6, Fig. 1.1.4)

The offshore Rocky Point site was initiated in 1997 as part of a lake wide depth stratified effort by sampling area which spans a wide depth range (40-140m). Six single-depth sites (EB01-EB06) are used to monitor long-term trends in the deep-water fish community in the Kingston Basin. Four of these deep gill net sampling sites have been netted since 2016; EB01, EB03, EB04 and EB05. Together, along with EB02 and EB06, this netting provides a more complete description of the Kingston Basin deep-water fish community. Results for these sites were summarized in Tables 1.1.5 and 1.1.6 and sites EB02 and EB06 are presented graphically (Fig. 1.1.4) to illustrate abundance trends of the most abundant species (Alewife, Lake Trout, Lake Whitefish, Yellow Perch, Rainbow Smelt, Cisco, Chinook Salmon, Brown Trout and Round Goby).

Bay of Quinte, Lake Ontario

Bay of Quinte, Fixed Sites (Trenton, Belleville, Deseronto, Conway, Hay Bay and Big Bay; Table 1.1.7)

Three sites are used to monitor long-term trends in the Bay of Quinte fish community. Big Bay is a single-depth site; Hay Bay has two depths and Conway five depths. Average summer catch for the three sites are summarized graphically in Fig. 1.1.5 to illustrate abundance trends of the most abundant species from 1992-2023. Catch per gill net is provided for all 6 sites in the Bay of Quinte for 2023 and means for recent years (Table 1.1.7).

Bay of Quinte, Depth Stratified (Upper, Middle and Lower Bay of Quinte; Table 1.1.3)

In 2019, effort was made to expand the depth and area sampled in the upper, middle and lower Bay of Quinte. To accomplish this, the Lake Ontario and Bay of Quinte Fish Community Index Gill Netting program was redesigned to reallocate a portion of Bay of Quinte fixed site sampling effort to randomly selected sites within six depth strata based on their proportional representation in Bay of Quinte.

Species-specific catch per gill net set by depth strata during the summer months (July/ August) are shown in Table 1.1.3. In 2023, each site in the Bay of Quinte was visited once. Together, along with fixed sites Big Bay, Hay Bay, and Conway, this netting provided a more complete description of the upper, middle, and lower Bay of Quinte fish community.

Species Highlights

Lake Whitefish

Twenty-four Lake Whitefish were caught and interpreted for age in the 2023 index gill nets (Table 1.1.8 and Figure 1.1.7). Fish ranged in age from 4-11 years. Eight year-classes were represented. Eleven (46%) whitefish were from either the 2015 or 2017 year-class.

Cisco

Forty-six Cisco were caught and interpreted for age in the 2023 index gill nets (Table 1.1.8 and Figure 1.1.7). Fish ranged in age from 1-13 years. Eleven year-classes were represented. Twenty-four (52%) were from the 2014 and 2015 year-classes.

Lake Trout

One hundred and fifty-seven Lake Trout were caught and interpreted for age (CWT and age structures combined) in the 2023 index gill nets (Table 1.1.8 and Fig. 1.1.7). Fish ranged in age from 2-21 years. Nineteen year-classes were represented. Seventy (44%) Lake Trout were from either the 2017, 2018, or 2019 year-classes.

Walleye

Three hundred and fifty-four Walleye were caught and interpreted for age in the 2023 summer index gill nets (Table 1.1.8 and Fig. 1.17). Fish ranged from age 1-20 and one hundred seventeen Walleye (33%) were age-3 (2020 year-class). In the Eastern Basin gill nets, 88% of Walleye were age-5 or greater, and in the Bay of Quinte gill nets, 71% were age-4 or less. Gonadal somatic index indicated females were mature at age-4 (Figure 1.1.8).

Northern Pike

Fifteen Northern Pike were caught and interpreted for age in the 2023 index gill nets. Fished ranged in age from 3-11 years (mean of 5.5 years) and 93% of fish were mature. Of these fish, 93% were female.

Largemouth Bass

Four Largemouth Bass were caught and interpreted for age in the 2023 index gill nets. Ages ranged from 3-9 with a mean of 4 years. Of these fish, 50% were mature and 25% were female.

TABLE 1.1.3. Species-specific catch per depth strata (in meters) across areas in the Bay of Quinte. All fixed and random sites were included. The total number of fish caught and number of gill nets set are indicated.

Species	1-3	3-6	6-12	12-20	20-35	>35
Lake Sturgeon	-	-	0.1	0.1	-	-
Longnose Gar	9.2	2.1	0.6	-	-	-
Bowfin	0.5	0.1	-	-	-	-
Alewife	10.7	18.7	96.9	27.7	-	-
Gizzard Shad	3.3	0.3	-	-	-	-
Chinook Salmon	-	-	-	-	0.2	-
Brown Trout	-	-	-	0.1	-	-
Lake Trout	-	-	-	0.3	6.1	5.2
Lake Whitefish	-	-	-	-	0.8	0.2
Lake Herring (Cisco)	-	-	-	1.1	-	-
Northern Pike	0.5	0.6	0.3	-	-	-
White Sucker	0.5	2.3	2.1	5.6	0.6	-
Silver Redhorse	0.8	0.9	-	-	-	-
Common Carp	0.5	0.3	-	-	-	-
Brown Bullhead	2.5	1.4	0.2	-	-	-
White Perch	38.7	90.5	23.0	3.9	-	-
White Bass	0.3	0.5	0.1	-	-	-
Rock Bass	1.9	2.1	0.2	-	-	-
Pumpkinseed	1.3	12.0	0.1	-	-	-
Bluegill	3.8	2.9	0.7	-	-	-
Smallmouth Bass	-	1.0	-	-	-	-
Largemouth Bass	0.5	0.3	-	-	-	-
Black Crappie	1.8	-	-	-	-	-
Yellow Perch	29.0	67.6	80.5	44.4	-	-
Walleye	19.2	16.3	2.5	1.8	-	-
Round Goby	-	-	0.4	0.9	-	-
Freshwater Drum	8.1	10.8	0.7	-	-	-
Total Catch	532	1,844	1,877	602	38	27
Nets Set	4	8	9	7	5	5

TABLE 1.1.4. Species-specific catch per depth strata across areas in Lake Ontario (Middle Ground, Rocky Point, Wellington, Brighton, Flatt Point, Grape Island, Melville Shoal, and Eastern Basin fixed sites), 2023. The total number of fish caught and number of gill nets set are shown.

Species	5	7.5	12.5	17.5	22.5	27.5	40	50	60	80	100	140
Bowfin	-	0.1	-	-	-	-	-	-	-	-	-	-
Alewife	-	114	101	81	80	6	33	32	3	4	62	17
Chinook Salmon	-	-	0.1	0.4	0.1	0.5	0.3	-	-	-	-	-
Atlantic Salmon	-	-	-	0.1	-	-	-	-	-	-	-	-
Brown Trout	-	0.1	0.1	-	-	0.1	-	-	-	-	-	-
Lake Trout	-	-	0.1	0.1	0.4	1	5	5	3	2	0.7	1
Lake Whitefish	-	0.1	0.1	0.1	-	0.5	-	-	-	-	-	-
Lake Herring (Cisco)	-	0.6	0.3	0.7	0.4	0.5	-	-	-	-	-	-
Rainbow Smelt	-	-	-	-	-	0.1	-	-	-	-	-	-
Northern Pike	0.5	0.3	-	-	-	-	-	-	-	-	-	-
White Sucker	-	0.2	-	-	-	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	0.1	-	-	-	-	-	-
White Perch	-	0.4	-	-	-	0.0	-	-	-	-	-	-
Rock Bass	3	3	1	0.2	0.5	-	-	-	-	-	-	-
Smallmouth Bass	-	1	0.3	0.1	-	-	-	-	-	-	-	-
Yellow Perch	9	6	4	4	2	0.1	-	-	-	-	-	-
Walleye	2	8	1.8	0.1	0.3	0.03	-	-	-	-	-	-
Round Goby	-	2	-	0.9	0.5	0.8	-	-	-	-	-	-
Freshwater Drum	2	0.2	-	-	-	-	-	-	-	-	-	-
Deepwater Sculpin	-	-	-	-	-	-	-	-	-	-	-	9
Total Catch	33	1,613	1,303	1,229	1,179	311	114	112	19	19	187	79
Nets Set	2	12	12	14	14	32	3	3	3	3	3	3

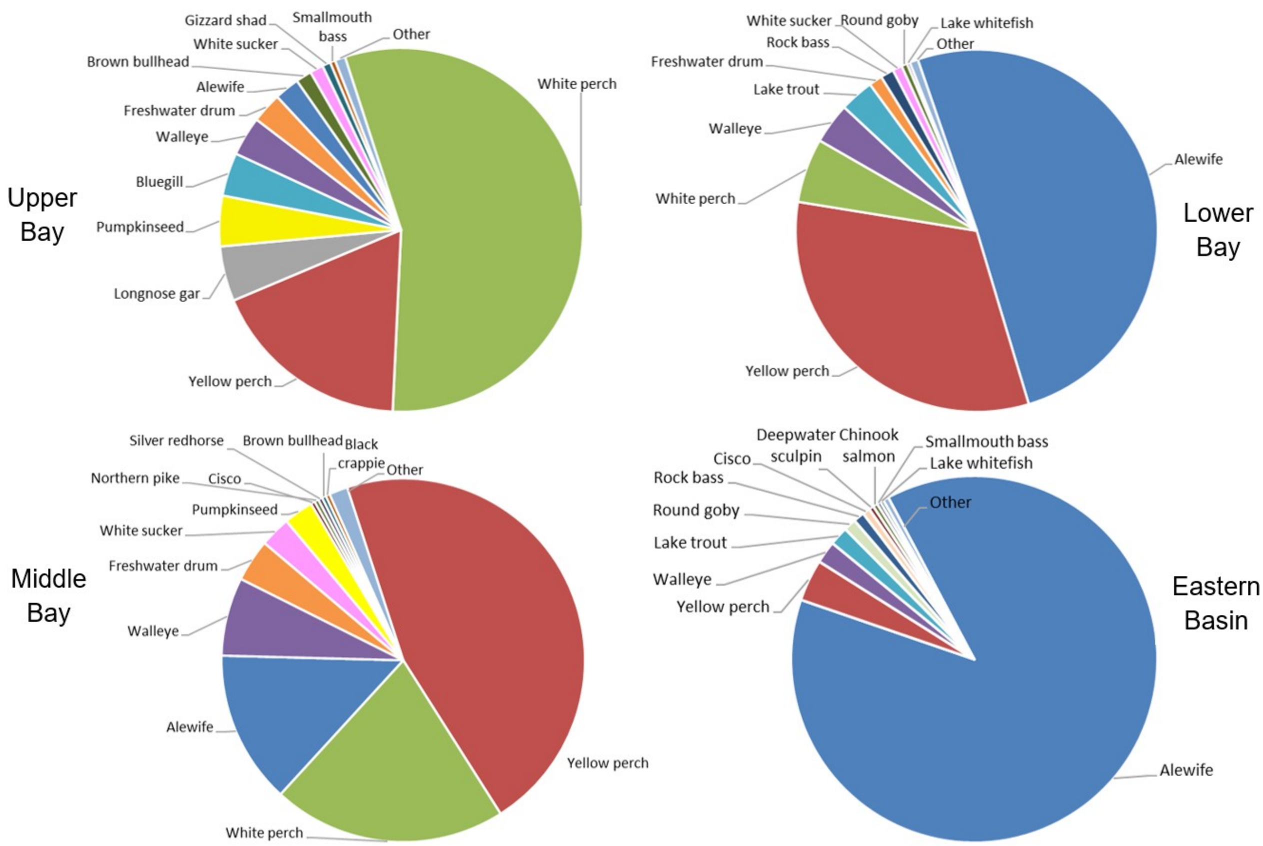

FIG. 1.1.2. Species-specific catch per region in Lake Ontario (Eastern Basin) and the Bay of Quinte (upper, middle and lower sections) displaying the most abundant species (less abundant species were grouped into "other").

TABLE 1.1.5. Species-specific catch per gill net set at **Lake Ontario and Eastern Basin nearshore sites**. Values include the 2023 catch per gill net and the 2018-2022 mean. Annual catches are averages for 1-3 gill net gangs set at each of 5 depths (7.5, 12.5, 17.5, 22.5 and 27.5 m) plus additional depth at Rocky Point deep (40, 50, 60, 80, 100, 140) during each of 1-3 visits during summer.

	Flatt Point		Grape Island		Melville Shoal		Middle Ground		Brighton		Wellington		Rocky Point		Rocky Point deep	
Species	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023
Sea Lamprey	0.01															
Lake Sturgeon	0.02		0.03													
Bowfin									0.03	0.1						
Alewife	287	148	488	146	365	119	53		68	8.8	102	26	72	5.5	8.1	25
Gizzard Shad	0.03						0.56		0.36		0.01					
Chinook Salmon	0.05		0.02		0.05				0.24	1	0.18	0.1	0.25	1.1		0.06
Rainbow Trout									0.01							
Atlantic Salmon		0.1							0.01							
Brown Trout	0.09	0.1	0.12		0.04	0.15	0.06		0.18		0.2		0.45			
Lake Trout	0.44	1.1	0.72	1.8	0.27	0.1	0.31		0.98		0.63	0.2	0.68		5.07	2.78
Lake Whitefish	0.12	0.1	0.31	0.4		0.15					0.01		0.02		0.02	
Lake Herring (Cisco)	0.52	0.4	0.37	1.1	0.16	0.62			0.26	0.7	0.11		0.07	0.3	0.02	
Rainbow Smelt	0.07								0.08		0.04			0.2		
Northern Pike	0.11			0.2			0.44	0.5	0.03	0.2	0.03		0.02			
White Sucker	0.04	0.1	0.16	0.1			0.69		0.08		0.01		0.02			
Silver Redhorse							0.06									
Common Carp	0.02						0.06				0.01					
Brown Bullhead							0.06									
Burbot									0.07	0.2	0.11					
White Perch				0.1			0.06			0.43						
Rock Bass	0.91	0.66	0.28	0.66	0.58	0.93	1.12	3.3	0.23	2.68	0.08		0.72	0.3		
Smallmouth Bass	0.15		1.04	0.3	0.72	0.05			29				0.93	1.6		
Yellow Perch	0.54	1.09	1.35	2.81	5.45	4.24	34.19	8.76		4.07	4.03	6.02	0.22			
Walleye	0.12	0.1	0.81	1	11.02	7.3	1.71	2	0.1	0.6	0.26		1.03	2.7		
Round Goby	0.93	0.99	1.21	0.33	0.39				1.51	2.31	2.81		3.49	2.74		
Freshwater Drum	0.02		0.02				0.38	2	0.01	0.2	0.03		0.03			
Deepwater Sculpin															0.06	1.47

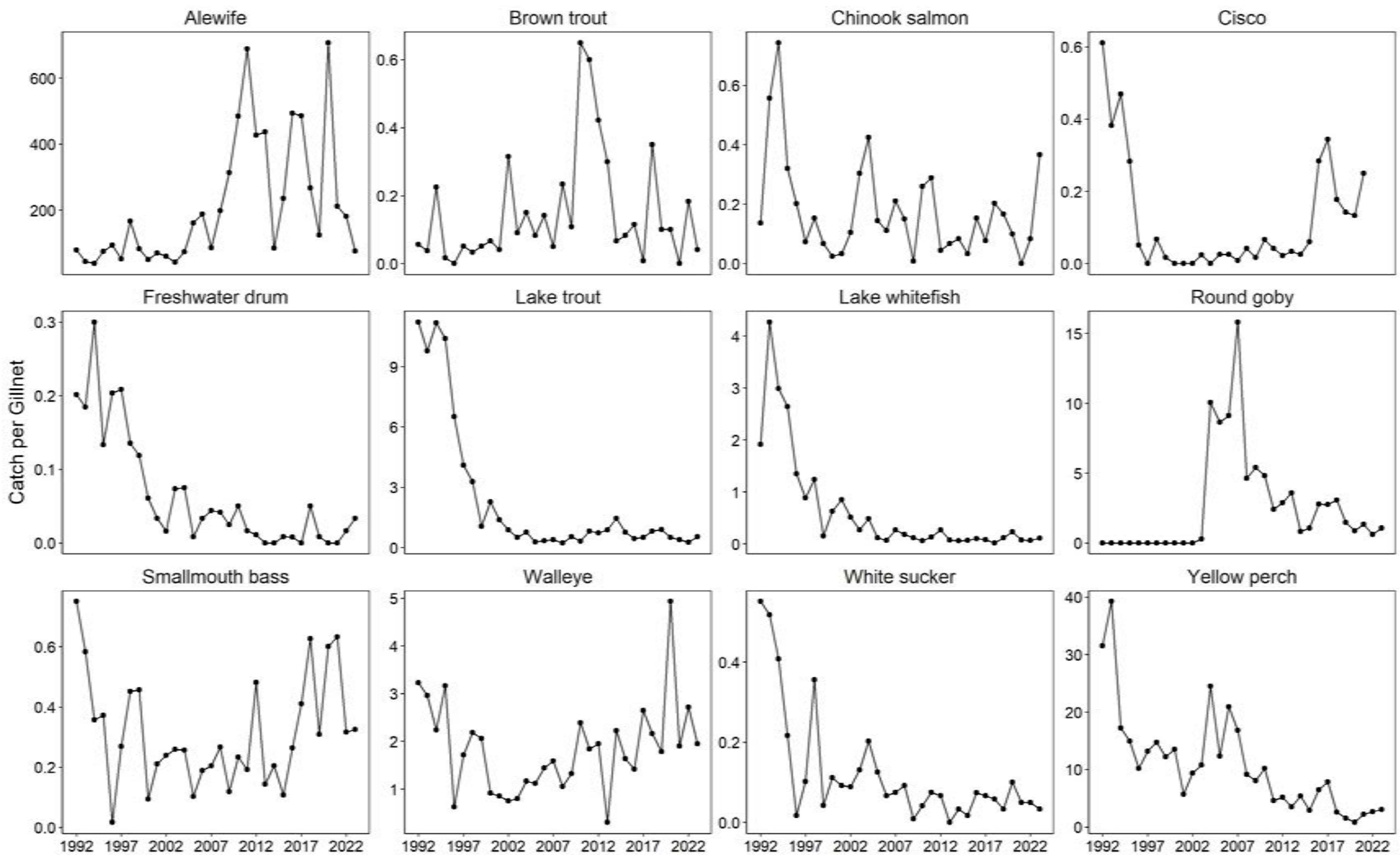

FIG. 1.1.3. Abundance trends for the most common species caught in gill nets at six depth-stratified transects (nearshore out to 30 m) in northeastern Lake Ontario (Melville Shoal, Grape Island, Flatt Point, Rocky Point, Wellington and Brighton; see Fig. 1.1.1). Annual catch per gill net values are unweighted means.

TABLE 1.1.6. Species-specific catch per gill net set at **Eastern Basin Offshore sites.** Values include the 2023 catch per gill net and the 2018-2022 mean. Annual catches are averages for 1-3 gillnet gangs set during each of 1-3 visits during summer.

	EB01		EB02		EB03		EB04		EB05		EB06	
	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023
Lake Sturgeon					0.04							
Alewife	4.67	1.1	102.3		7.8		13		9.9		21.4	
Chinook Salmon	0.19	0.67	0.37		0.19		0.11		0.04		0.1	
Brown Trout					0.19	0.33	0.04					0.33
Lake Trout	2.04	1.67	2.9	1.00	3.78		3.8	1.67	0.41		1.96	2.44
Lake Whitefish	0.3	3	0.37		0.07		1.78		0.11		3.44	0.67
Lake Herring (Cisco)	1.38		0.63		1.7		2.52	0.33	0.48		4.04	0.67
Rainbow Smelt	0.04						0.25		0.12			
White Bass	0.04											
Rock Bass	0.04											
Smallmouth Bass	0.37										0.04	
Yellow Perch	1.16						0.32		3.3			
Walleye	0.22		0.04		0.04	0.33			0.04			
Round Goby						1.1	0.25		0.37			
Freshwater Drum	0.3											
Lake Whitefish x Cisco							0.04					

Smallmouth Bass

Twenty-eight Smallmouth Bass were caught and interpreted for age in the 2023 index gill nets. Ages ranged from 2-11 with a mean of 5.5 years. Of these fish, 82% were mature and 57% were female.

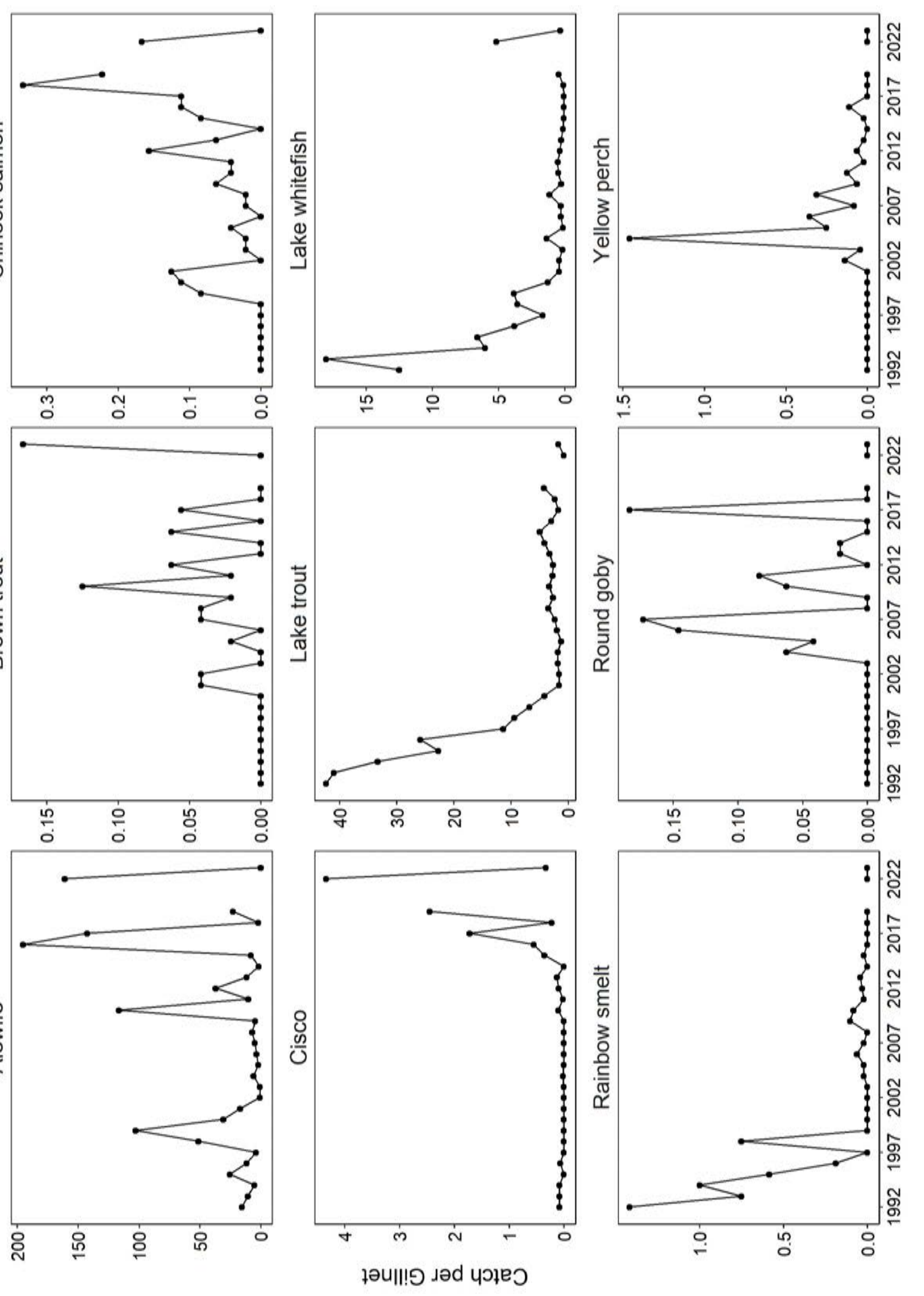

FIG. 1.1.4. Abundance trends (annual means) for the most common species caught in gill nets at the Kingston Basin deep sites in eastern Lake Ontario (EB02 and EB06; see Fig. 1.1.1).

TABLE 1.1.7. Species-specific catch per gill net set at fixed sites in the Bay of Quinte. Values include 2023 catch per gill net and the 2018-2022 mean. Annual catches are averages for 1-3 gill net gangs set during each of 1-3 visits during summer.

	Trenton		Belleville		Big Bay		Deseronto		Hay Bay		Conway	
Species	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023	2018-2022	2023
Lake Sturgeon					0.03							
Longnose Gar	8.8		7.6	10.6	7.1	4.3	0.2					
Bowfin	0.17											
Alewife	5	1	3.84		0.25		7.1	3.3	13.5	15.2	32.2	52.5
Gizzard Shad	24.2		10.3		3.94		6.6		0.53		0.52	
Chinook Salmon											0.25	
Rainbow Trout											0.04	
Brown Trout											0.01	0.2
Lake Trout											2.14	2.8
Lake Whitefish									0.02		0.32	0.2
Lake Herring (Cisco)							0.05		0.52	2	0.12	
Rainbow Smelt									0.1		0.01	
Northern Pike	0.15				0.03	0	0.75	1	1.04	0.5	0.08	
White Sucker	0.8	1	1.55		7.9	8	1.85		4.6	13.5	0.45	
Silver Redhorse					0.03							
River Redhorse	0.05											
Common Carp			0.1				0.4					
Golden Shiner									0.02			
Brown Bullhead	0.83		0.55	5.3	1.33		1.6	4				
Channel Catfish	0.2				0.03							
American Eel							0.17					
White Perch	73	56.5	48.6	117	132	87	109	160	31.6	5.2	5.6	6.4
White Bass	0.65		1.03		1.6		1.44		0.27		0.07	
Rock Bass	0.27	1					0.71				0.33	
Pumpkinseed	5.4	16.3	6.4	2	0.77		18.7	3	1.42	0.5		
Bluegill	26	4	14	8.6	16	4.3	2.3					
Smallmouth Bass	0.3	5	0.2								0.01	
Largemouth Bass	0.33	1										
Black Crappie					0.2							
Lepomis sp.	0.33											
Yellow Perch	47.3	21.8	32.7	13.2	59.9	47.3	134.7	66.5	92.8	112.9	28.2	22.2
Walleye	6.7	9	5.6	3	6		19.1	7	3.0	2.5	2.8	1.8
Round Goby												1.32
Freshwater Drum	4.5	1	8.5	10	10.2		9.1	5	2.28	0.5	1.62	

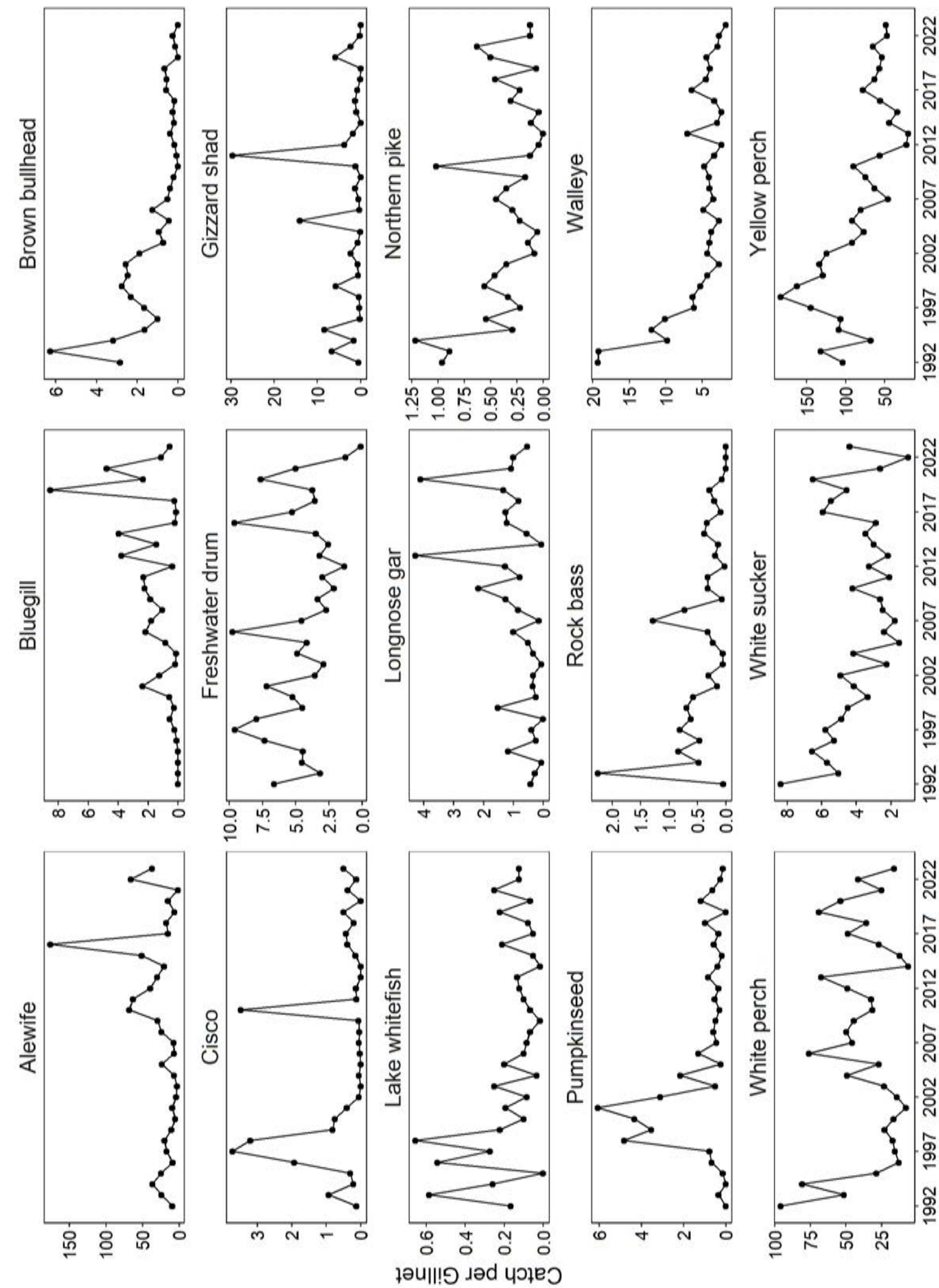

FIG. 1.1.5. Abundance trends (annual means) for the most common species caught in gill nets at three areas in the Bay of Quinte (Conway, Hay Bay and Big Bay; see Fig. 1.1.1).

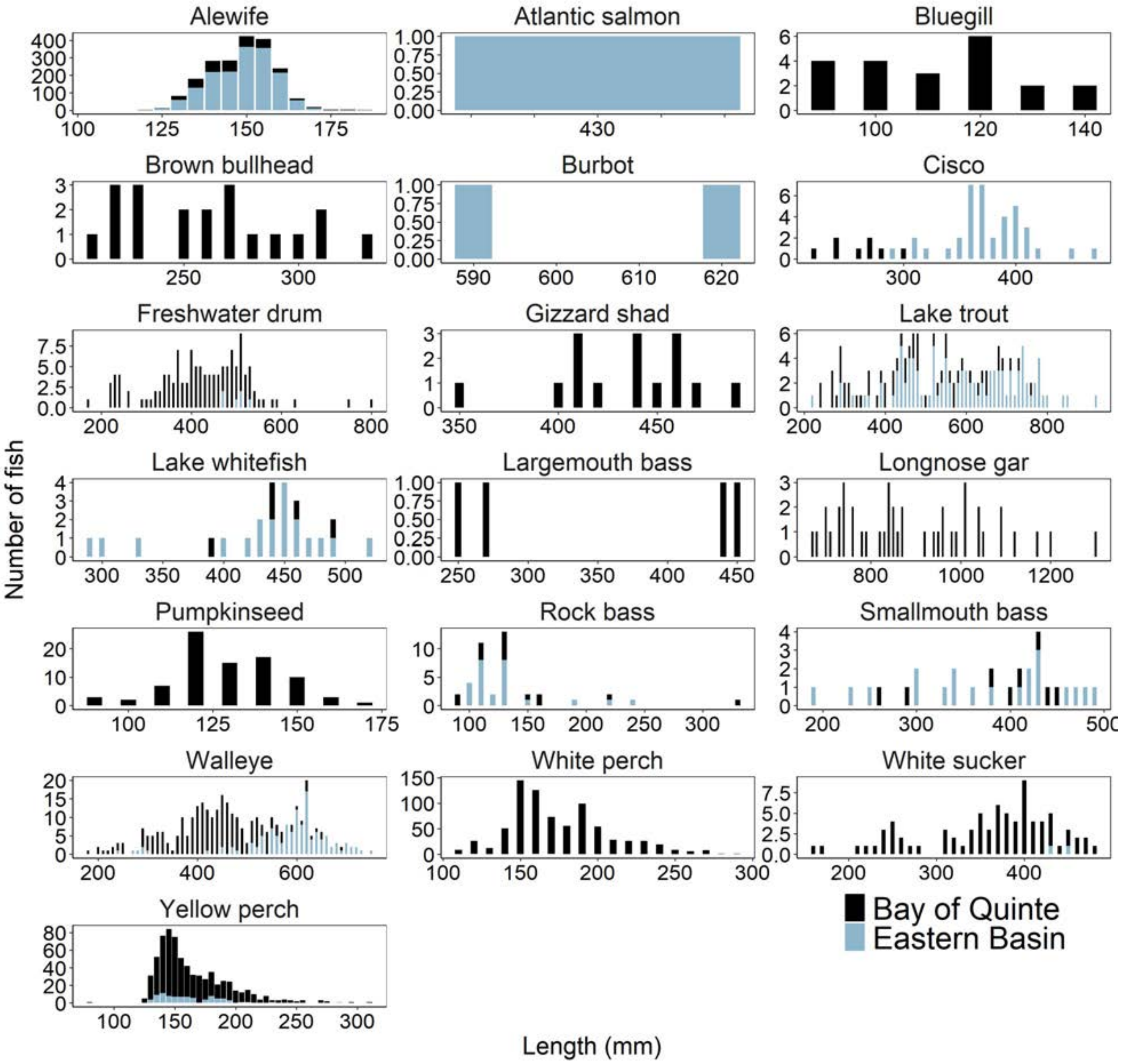

FIG. 1.1.6. Length distributions for commonly caught species in the 2023 gill net sets in the Bay of Quinte (black) and Eastern Basin (blue). Length values are grouped into 10mm bins for all species except Yellow perch and Alewife that are grouped into 5mm bins.

TABLE 1.1.8. Biological attributes across ages for five species **(Walleye, Yellow Perch, Cisco, Lake Trout and Lake Whitefish)** sampled from index gill nets, by region (Bay of Quinte and Eastern Basin), 2023. Attributes include mean fork length (mm), mean round weight (g) and proportion of mature vs. immature fish .

Age		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Year class		2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Lake Trout																						
	Mean Weight (g)	-	328	878	1,281	1,684	2,601	3,262	3,481	4,290	3,686	4,727	5,577	6,214	7,776	5,185	5,511	5,678	6,638	8,992	-	7,243
	Mean Fork Length (mm)	-	292	403	432	484	556	604	606	640	607	680	703	746	800	736	755	737	798	813	-	783
	% mature	-	0	13	33	54	67	79	80	80	86	100	100	100	100	100	100	100	100	100	-	100
Lake Whitefish																						
	Mean Weight (g)	-	-	-	263	912	888	887	1,140	1,050	1,158	1,314	-	-	-	-	-	-	-	-	-	-
	Mean Fork Length (mm)	-	-	-	297	424	409	433	458	449	452	458	-	-	-	-	-	-	-	-	-	-
	% mature	-	-	-	0	67	80	100	100	100	100	100	-	-	-	-	-	-	-	-	-	-
Lake Herring (Cisco)																						
	Mean Weight (g)	130	214	347	478	699	848	707	607	683	1,367	-	-	797	-	-	-	-	-	-	-	-
	Mean Fork Length (mm)	227	265	296	318	370	379	385	373	378	470	-	-	405	-	-	-	-	-	-	-	-
	% mature	50	100	100	100	100	100	100	100	100	100	-	-	100	-	-	-	-	-	-	-	-
Yellow Perch																						
	Mean Weight (g)	-	47	51	76	66	122	211	153	142	-	-	-	-	-	-	-	-	-	-	-	-
	Mean Fork Length (mm)	-	146	151	168	167	202	231	213	210	-	-	-	-	-	-	-	-	-	-	-	-
	% mature	-	0	67	70	85	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Walleye																						
	Mean Weight (g)	156	345	877	1,132	1,716	2,208	2,497	2,703	2,923	3,179	3,677	3,279	3,945	3,514	3,872	3,653	3,422	-	-	2,941	-
	Mean Fork Length (mm)	241	319	421	460	518	558	573	589	603	611	640	626	668	647	669	631	621	-	-	614	-
	% mature	0	0	25	63	93	89	100	100	100	100	100	100	100	100	100	100	100	-	-	100	-

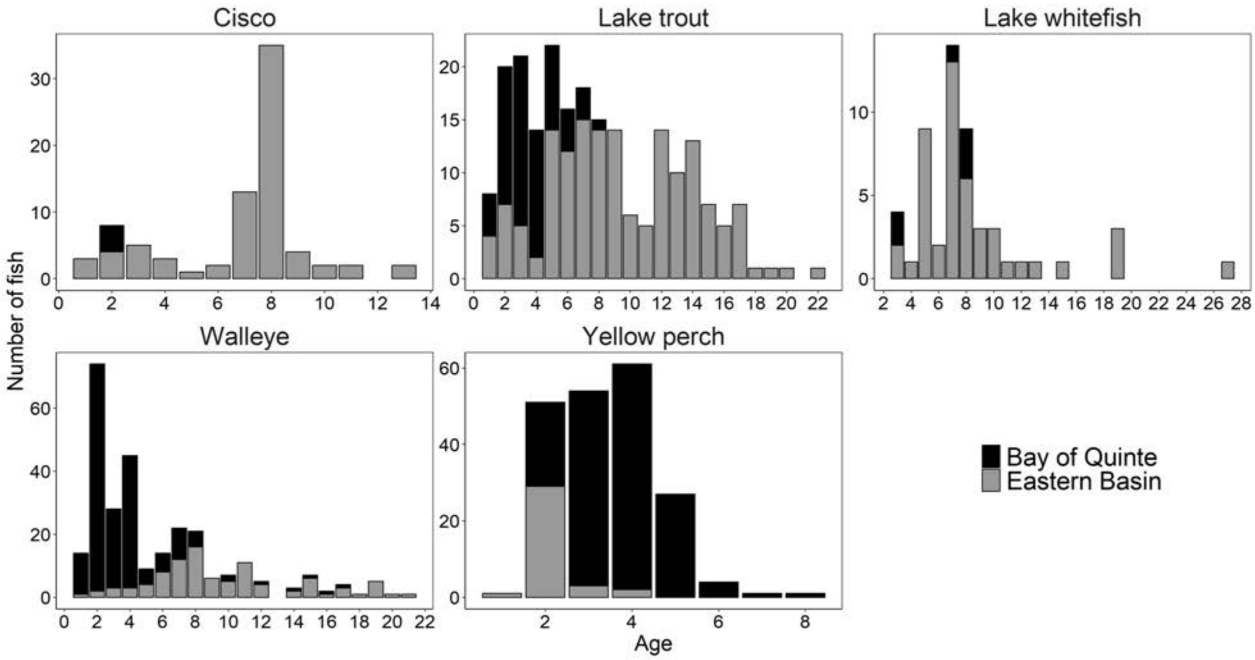

FIG 1.1.7. Age distribution of five species **(Walleye, Yellow Perch, Cisco, Lake Trout and Lake Whitefish)** sampled from index gill nets by region (Bay of Quinte and Eastern Basin), 2023.

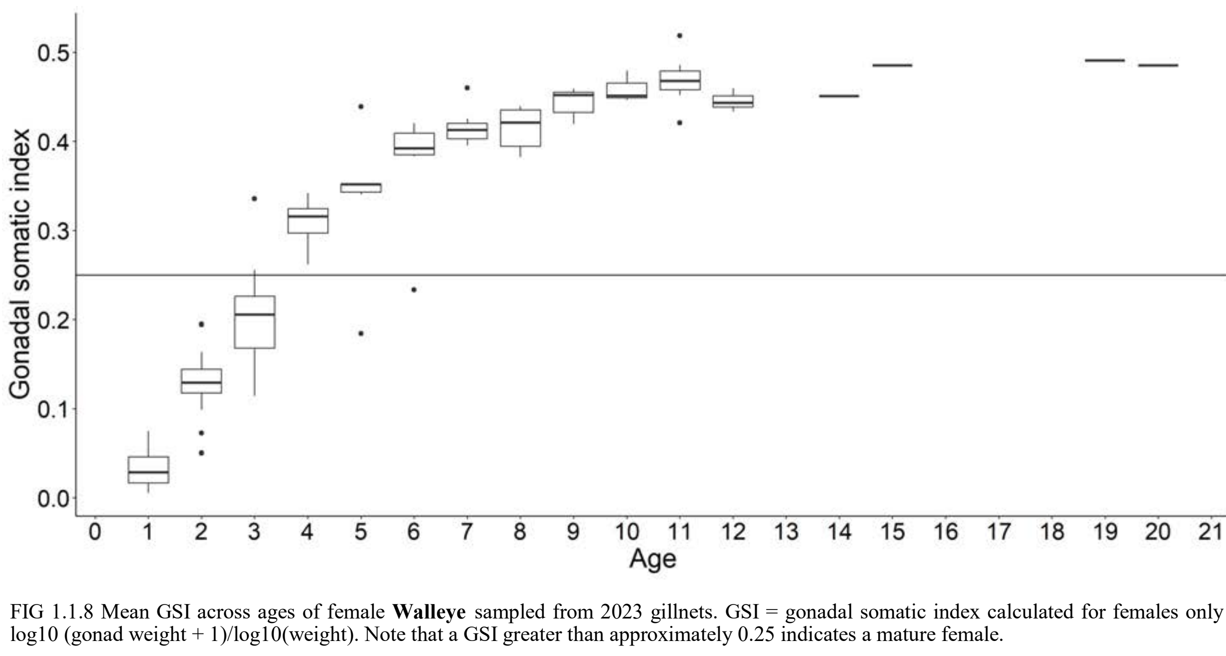

FIG 1.1.8 Mean GSI across ages of female **Walleye** sampled from 2023 gillnets. GSI = gonadal somatic index calculated for females only as log10 (gonad weight + 1)/log10(weight). Note that a GSI greater than approximately 0.25 indicates a mature female.

1.2 Lake Ontario and Bay of Quinte Fish Community Index Trawling

S. Beech, Lake Ontario Management Unit

Bottom trawling has been used to monitor the relative abundance of small fish species and the young of large-bodied species in the fish community since the 1960s. After some initial experimentation with different trawl specifications, two trawl configurations (one for the Bay of Quinte and one for Lake Ontario) were routinely employed (see trawl specifications Table 1.2.1).

In the Kingston Basin of eastern Lake Ontario, six sites, ranging in depth from about 20 to 35 m, were visited about four times annually up until 1992 when three sites were dropped. From 1992 to 2015, three visits were made to each of three sites annually, and four replicate ½ mile trawls were made during each visit. After 1995, a deep water site was added outside the Kingston Basin, south of Rocky Point (visited twice annually with a trawling distance of 1 mile; about 100 m water depth), to give a total of four Lake sites (Fig. 1.2.1). In 2014, a second trawl site/ depth was added at Rocky Point (60 m) and two trawl sites at each of Cobourg and Port Credit (60 and 100 m depths at both locations). In 2015, the Lake Ontario trawling was expanded significantly to include several more sampling depths at each of Rocky Point, Cobourg, and Port Credit. Starting in 2016, the three Kingston Basin sites that were dropped in 1992, were added back in to the sampling design, and trawling was not done at Cobourg and Port Credit (note that these sites were sampled in spring and fall prey fish assessments, see Sections 1.6 and 1.7). Since 2019, trawling was not done at Cobourg, Port Credit and Rocky Point, further, the seasonal component was dropped (note that these sites were sampled in the spring and fall prey fish assessments; see Sections 1.6 and 1.7).

In the Bay of Quinte, six fixed-sites, ranging in depth from about 4 to 21 m, are visited annually on two or three occasions during mid to late-summer. Only one ¼ mile trawl has been conducted at each site during each visit since 2022. The 2023 trawl sampling design is shown in Table 1.2.2.

Twenty-nine species and approximately 25,450 fish were caught in 21 trawls in 2023 (Table 1.2.3). Round Goby (51%), Yellow Perch (14%), Alewife (13%) and White Perch (13%)

TABLE 1.2.1. Bottom trawl specifications used in Eastern Lake Ontario and Bay of Quinte Fish Community sampling.

	3/4 Western (Poly) (Bay Trawl)	3/4 Yankee Standard No. 35 (Lake Trawl)
Head Rope Length (m)	14.24	12
Foot Rope Length (m)	19	17.5
Side Brail Height (m)	2	1.9
Mesh Size (front)	4" knotted black poly	3.5" knotted green nylon
Twine Type (middle)	3" knotted black poly	2.5" knotted nylon
Before Codend	2" knotted black poly 1.5" knotted black nylon 1" knotted black nylon	2" knotted nylon (chafing gear)
Codend Mesh Size	0.5" knotted white nylon	0.5" knotless white nylon
Remarks:	Fishing height 2.0 m FISHNET gear dimensions as per Casselman 92/06/08	Fishing height 1.9 m FISHNET gear dimensions as per Casselman 92/06/08
GRLEN:length of net	N/A	N/A
GRHT:funnel opening height	2.25 m	2.3 m
GRWID:intake width	6.8 m	9.9 m
GRCOL:1 wt,2 bl,3 gn	2	7 (discoloured)
GRMAT:1 nylon,2 ploypr.	2	1
GRYARN:1 mono,2 multi	2	2
GRKNOT:1 knotless,2 knots	2	2

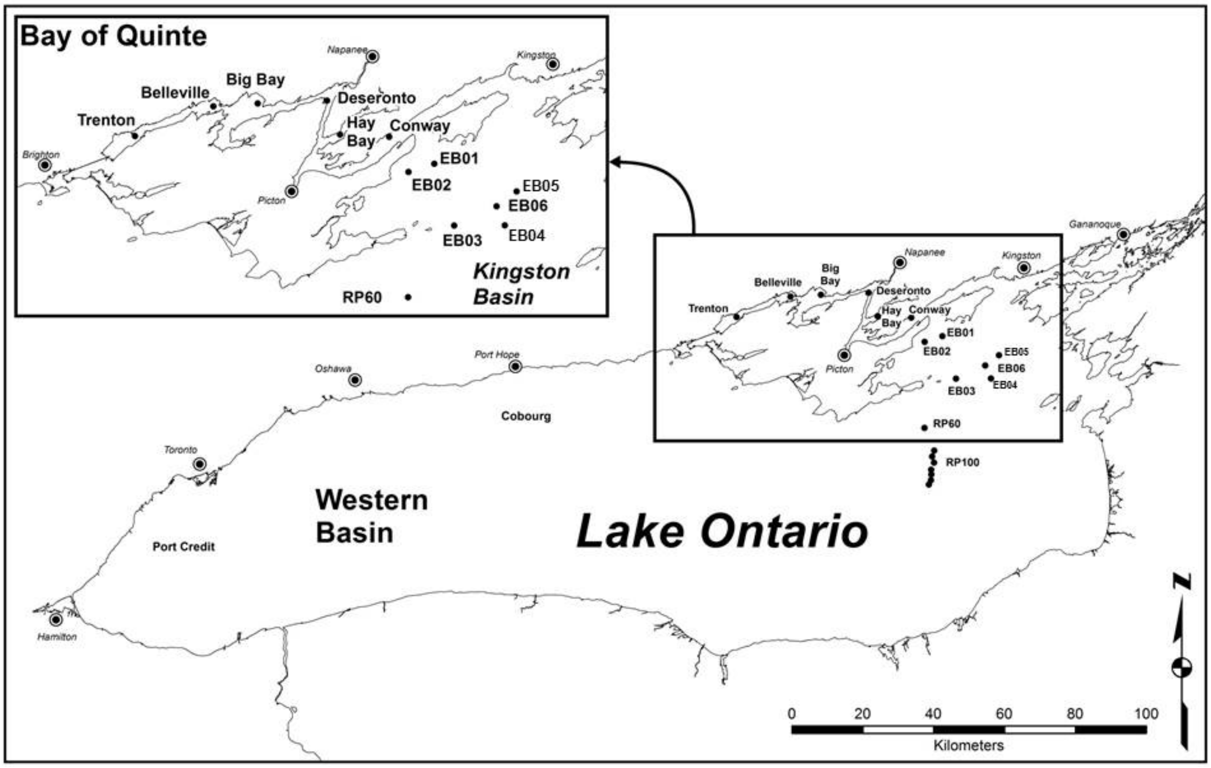

FIG. 1.2.1. Map of north eastern Lake Ontario. Shown are eastern Lake Ontario and Bay of Quinte fish community index bottom trawling site locations.

TABLE 1.2.2. Sampling design of the Lake Ontario fish community index bottom trawling program including geographic stratification, number of visits, number of replicate trawls made during each visit, and the time-frame for completion of visits. Also shown is the year in which bottom trawling at a particular area was initiated and the number of years that trawling has occurred. Note that since 2022 only, 1 replicate trawl was conducted except at EB03.

						Site location					
Region name	Area Name (Area code)	Site name	Depth (m)	Visits	Replicates x duration	Latitude	Longitude	Visits x reps	Time-frame	Start year	Number years
Kingston Basin	Eastern Basin (EB)	EB01	30	1	1 x 5 minute	440400	764720	1	Aug 1-Sep 9	2016	8
Kingston Basin	Eastern Basin (EB)	EB02	30	1	1 x 5 minute	440280	765120	1	Aug 1-Sep 9	1972	52
Kingston Basin	Eastern Basin (EB)	EB03	21	1	4 x 5 minute	435780	764810	4	Aug 1-Sep 9	1972	52
Kingston Basin	Eastern Basin (EB)	EB04	35	1	1 x 5 minute	435680	763700	1	Aug 1-Sep 9	2016	8
Kingston Basin	Eastern Basin (EB)	EB05	33	1	1 x 5 minute	440110	763540	1	Aug 1-Sep 9	2016	8
Kingston Basin	Eastern Basin (EB)	EB06	35	1	1 x 5 minute	435940	763910	1	Aug 1-Sep 9	1972	52
Bay of Quinte	Conway (LB)	BQ17	21	2	1 x 6 minutes	440650	765420	2	Aug 1-Sep 9	1972	52
Bay of Quinte	Hay Bay (MB)	BQ15	5	2	1 x 6 minutes	440650	770175	2	Aug 1-Sep 9	1972	52
Bay of Quinte	Deseronto (UB)	BQ14	5	2	1 x 6 minutes	441000	770360	2	Aug 1-Sep 9	1972	52
Bay of Quinte	Big Bay (UB)	BQ13	5	2	1 x 6 minutes	440975	771360	2	Aug 1-Sep 9	1972	52
Bay of Quinte	Belleville (UB)	BQ12	5	2	1 x 6 minutes	440920	772010	2	Aug 1-Sep 9	1972	52
Bay of Quinte	Trenton (UB)	BQ11	4	2	1 x 6 minutes	440600	773120	2	Aug 1-Sep 9	1972	52

collectively made up 91% of the catch by number. Species-specific catches during 2023 trawling are shown in Table 1.2.3.

Lake Ontario

Kingston Basin (Table 1.2.4)

Bottom trawls were conducted at six sites in Kingston Basin in August 2023. Six species were caught with the most abundant species being Round Goby (Table 1.2.4). Trends in species-specific catch per trawl are shown in Table 1.2.4 (EB01-EB06). Trend through time catches for the most commonly caught species are shown in Fig. 1.2.2.

Bay of Quinte

Conway, Hay Bay, Deseronto, Big Bay, Belleville, and Trenton (Table 1.2.5)

Bottom trawls were conducted at six sites in the Bay of Quinte in August 2023. Species-specific catch per trawl at each site is shown in Tables 1.2.5. Bottom trawl results were summarized across the six Bay of Quinte sites and presented graphically to illustrate abundance trends for major species in Fig. 1.2.3. All species show significant abundance changes over the long-term.

Species Highlights

Length distributions for the most abundant species caught in bottom trawls in 2023 are shown in Fig. 1.2.4. Catches of age-0 fish for selected species and locations are shown in Figs. 1.2.5-1.2.8. Additional age information is provided for all Walleye captured in 2023 in Table 1.2.6.

Cisco and Lake Whitefish

Two Cisco and eleven Lake Whitefish were caught during summer bottom trawling. All Cisco and Lake Whitefish were age-0 and were captured at the EB03 or BQ17 (Conway) sites in the summer (Fig. 1.2.5 and 1.2.6). Visits conducted during the fall trawling program did not capture any age-0 Cisco or Lake Whitefish at EB03 or BW17 (Conway).

Yellow Perch

Sixty-five age-0 Yellow Perch were caught at five of six trawl sites in the Bay of Quinte. Catch per trawl was low compared to previous years (Fig. 1.2.7).

Walleye

Twenty-seven age-0 Walleye were caught in four of six trawl sites in the Bay of Quinte (Table 1.2.6). Overall, age-0 catch per trawl was considered "good" and was similar to 2022 catches (Fig. 1.2.8). Additional age information is provided in Table 1.2.6.

TABLE 1.2.3. Species-specific total bottom trawl catch and biomass in summer 2023. Standard biomass is calculated by standardizing trawls to 6 minutes (¼ mile) in the Bay of Quinte and 12 minutes (½ mile) in Lake Ontario. Frequency of occurrence (FO) is the number of trawls, out of a possible 21, in which each species was caught. Mean weight of each species is also provided.

Species	FO	Catch	Biomass (kg)	Standard Biomass (kg)	Mean Weight (g)
Alewife	17	4,043	26.8	41	11
Gizzard Shad	9	296	3.9	4	11
Lake Trout	1	1	0.1	0.3	110
Lake Whitefish	4	11	0.06	0.09	7
Lake Herring (Cisco)	1	2	0.02	0.02	8
Rainbow Smelt	9	983	3.5	8.1	4
White Sucker	6	13	7.8	7.8	658
Common Carp	1	1			
Golden Shiner	1	2	0.08	0.08	38
Spottail Shiner	8	244	1.7	1.7	7
Brown Bullhead	8	83	18.3	18.3	274
Trout-perch	10	196	0.3	0.3	4
White Perch	10	5,016	58.1	58.1	11
White Bass	4	11	0.2	0.2	13
Rock Bass	1	1	0.01	0.01	10
Pumpkinseed	10	334	11.8	11.8	42
Bluegill	7	34	0.9	0.9	28
Smallmouth Bass	2	2	2.3	2.3	1131
Largemouth Bass	9	66	0.3	0.3	7
Lepomis sp.	7	99	0.02	0.02	0
Yellow Perch	11	5,440	43.7	43.7	10
Walleye	10	59	5.9	5.9	108
Johnny Darter	1	1	0.002	0.002	2
Logperch	3	76	0.1	0.1	1
Round Goby	18	8,255	20.1	48.4	3
Freshwater Drum	9	185	43.4	59.8	1,734

TABLE 1.2.4. Species-specific catch per trawl (12 min duration; 1/2 mile) by year in the fish community index bottom trawling program during summer at six sites in the Eastern Basin, Lake Ontario. Catches are the mean number of fish observed for the number of trawls (one for all sites except EB03 which was sampled four times).

	EB01		EB02		EB03		EB04		EB05		EB06	
Species	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023
Alewife	156		292		71	184	105	39	2,089		1.1	
Freshwater Drum						0.5						
Lake Herring (Cisco)					0.5							
Lake Trout	0.4			1							0.3	
Lake Whitefish	1.2				0.5	0.5						
Rainbow Smelt	9.9		36		2,026	213	12	10	46	6	4	2
Round Goby	1,686	17	667	550	6,073	1,468	857	1,148	456	495	233	6
White Perch	0.4											
Yellow Perch									0.4			

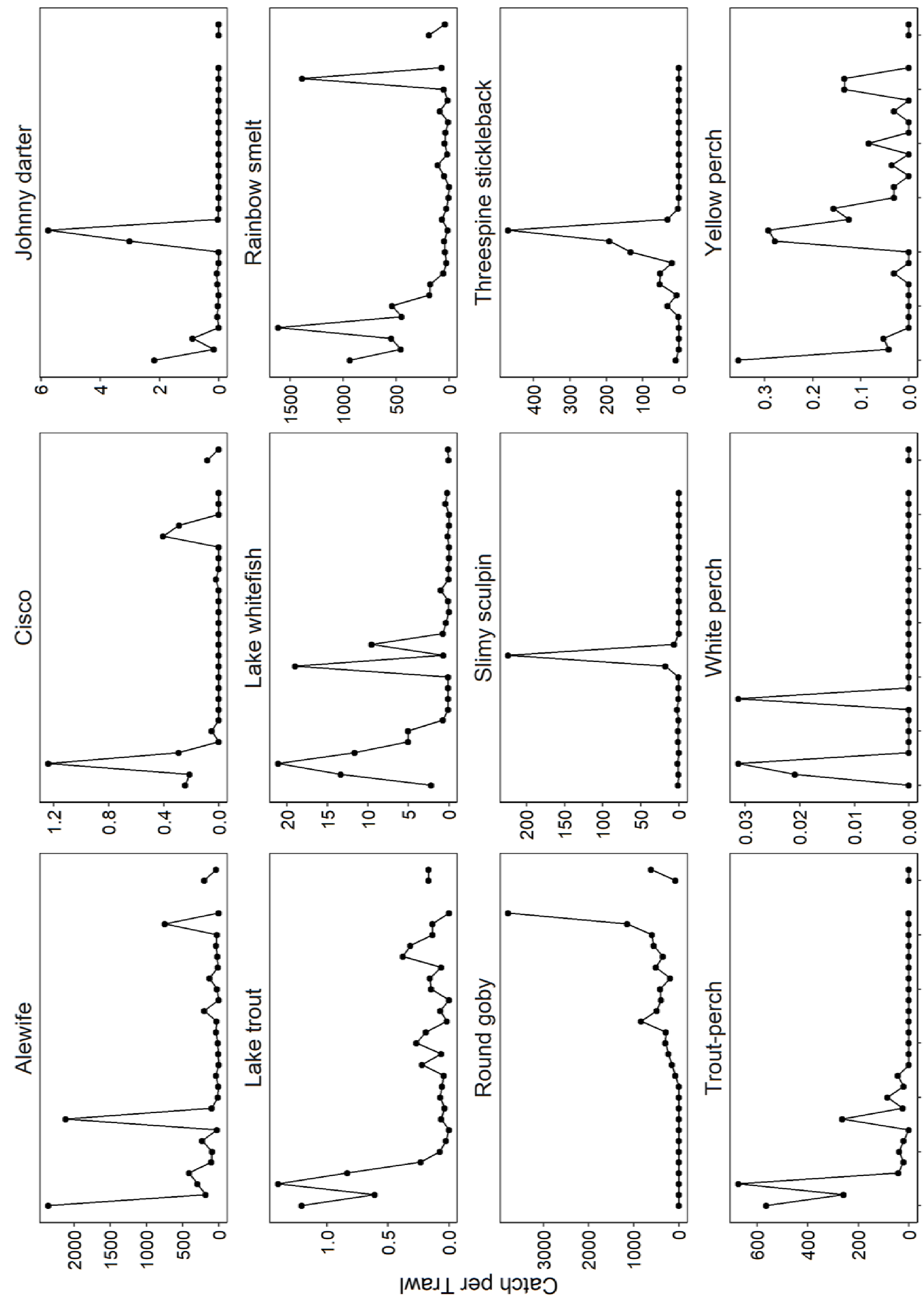

FIG. 1.2.2. Abundance trends (annual means) for the most common species caught in bottom trawls at three to six sites in the Kingston Basin, eastern Lake Ontario (EB01, EB02, EB03, EB04, EB05, EB06); see Fig. 1.2.1).

TABLE 1.2.5. Species-specific catch per trawl (6 min duration; 1/4 mile) by year in the fish community index bottom trawling program at six sites in the Bay of Quinte . Catches are the mean number of fish observed for the two trawls visits.

	Trenton		Belleville		Big Bay		Deseronto		Hay Bay		Conway	
Species	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023	2018-2022 mean	2023
Alewife	132	126	87	143	57	670	230	422	1,329	204	11	71
Gizzard Shad	253	2.5	578	116	45	16	71	13	43	0.5		
Lake Trout											0.9	
Lake Whitefish											0.7	4.5
Lake Herring (Cisco)											1.7	1
Rainbow Smelt			0.03		0.03					0.5	35	57
White Sucker	0.5	1.5	0.3	1	0.7	3.0	1.3	0.5	0.5		2.1	0.50
Common Carp			0.1		0.4	0.5	0.1		0.05			
Golden Shiner										1		
Emerald Shiner					0.4						1.4	
Spottail Shiner	33	47	13	5.5	10.0	12	26	44	45	15		
Brown Bullhead	4.6	5.5	6.3	13	2.1	7.5	13	7.5	0.9	8		
Channel Catfish			0.1		0.3		0.1					
American Eel					0.03		0.7		0.4			
Trout-perch	7.2	1.5	53	30	28	23	30	43	5.8	1	2.5	0.5
White Perch	233	140	261	490	231	698	289	614	109	567	2.1	
White Bass	1.4		2.6		1.3	2.5	5.3	2	2.7	1		
Morone sp.			12		4.4							
Sunfishes	0.03											
Rock Bass	2.9	0.5					0.2		0.2			
Pumpkinseed	35	70	22	20	6.8	10	65	46	10	22		
Bluegill	26	4	13	5.5	16	1	3.8	5.5	2.1	1		
Smallmouth Bass	0.9	0.5		0.5								
Largemouth Bass	11	16	2.5	3.5	1	8.5	2.3	4.5	0.9	0.5		
Black Crappie							0.6		0.6			
Lepomis sp.	14	15	27	30	54	4.5	0.7	0.5	0.6			
Yellow Perch	444	797	146	66	66	37	359	1160	149	655	29	6.5
Walleye	5.3	4	8.8	3.5	7.9	9	11	9	3.5	4	0.5	
Johnny Darter	0.3	0.5	0.08				0.2		0.03			
Logperch	8.9	38	2.5	0.5	0.2		0.9		0.3			
Tessellated Darter	0.06											
Brook Silverside			0.6		0.7		0.2					
Round Goby	9.2	12	11	9	1.1	1.5	4.1		0.4	0.5	190	61
Freshwater Drum	4.3		24	30	24	43	23	2	7.3	18	0.08	

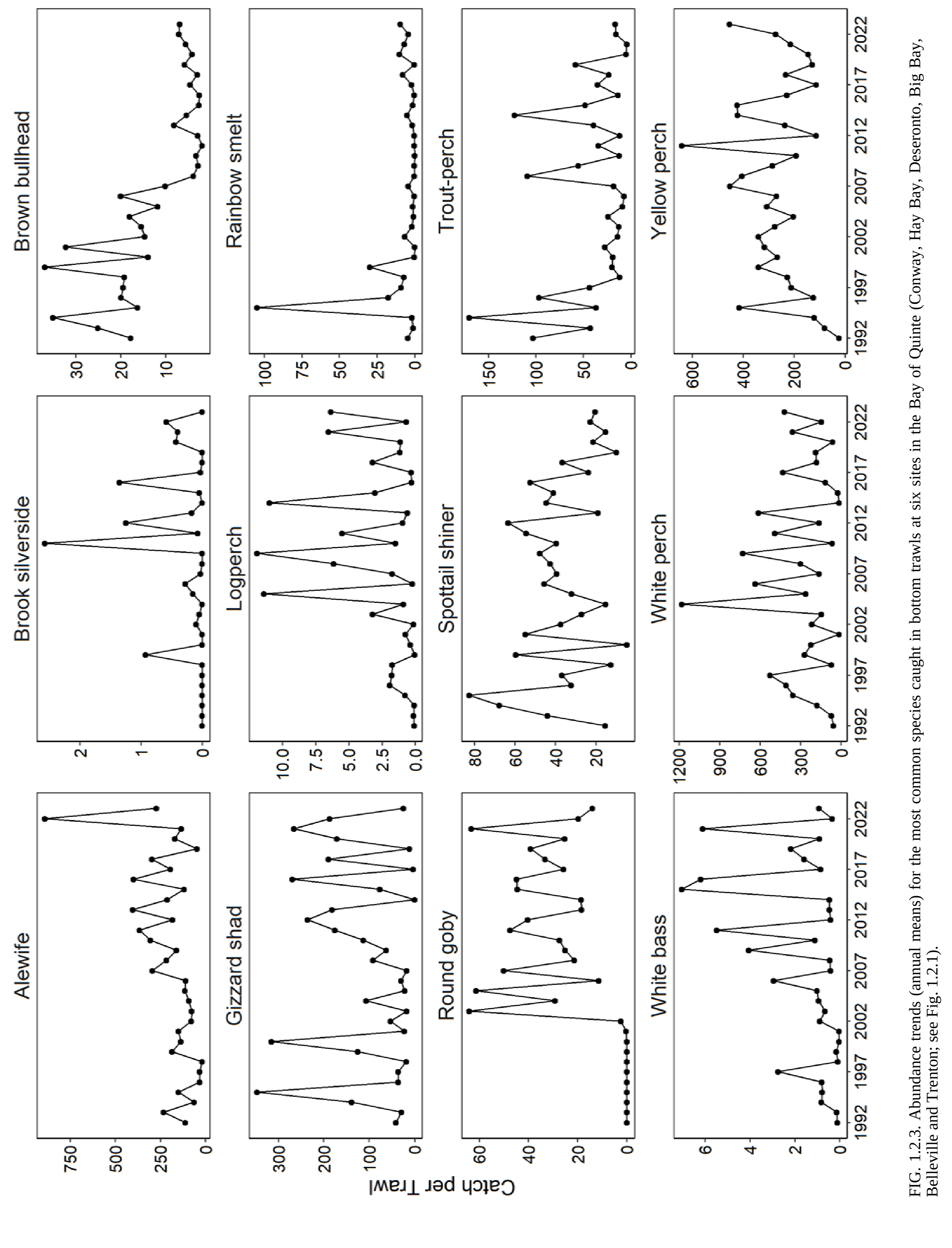

FIG. 1.2.3. Abundance trends (annual means) for the most common species caught in bottom trawls at six sites in the Bay of Quinte (Conway, Hay Bay, Deseronto, Big Bay, Belleville and Trenton; see Fig. 1.2.1).

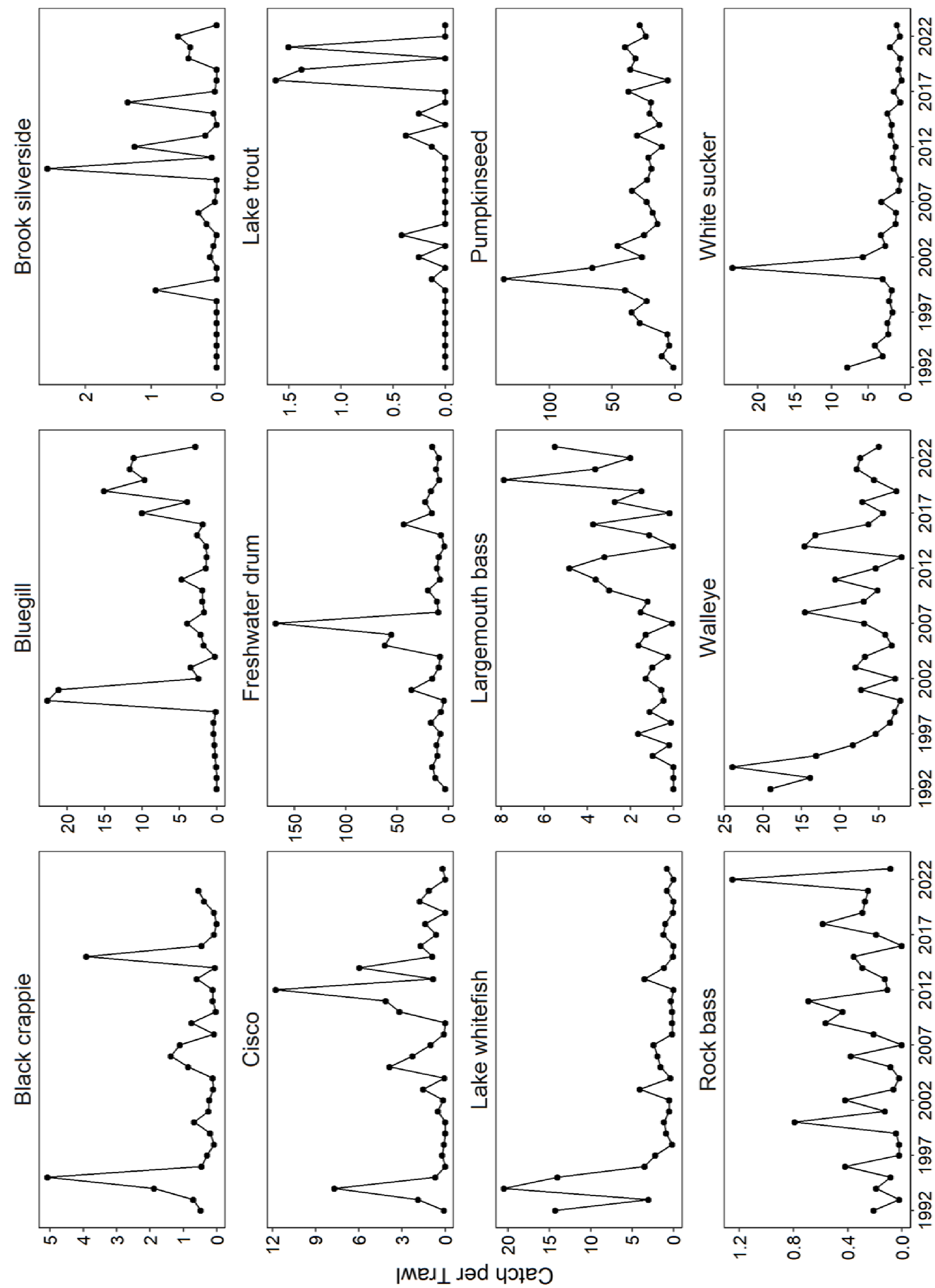

FIG. 1.2.3 (continued). Abundance trends for the most common species caught in bottom trawls at six sites in the Bay of Quinte (Conway, Hay Bay, Deseronto, Big Bay, Belleville and Trenton; see Fig. 1.2.1).

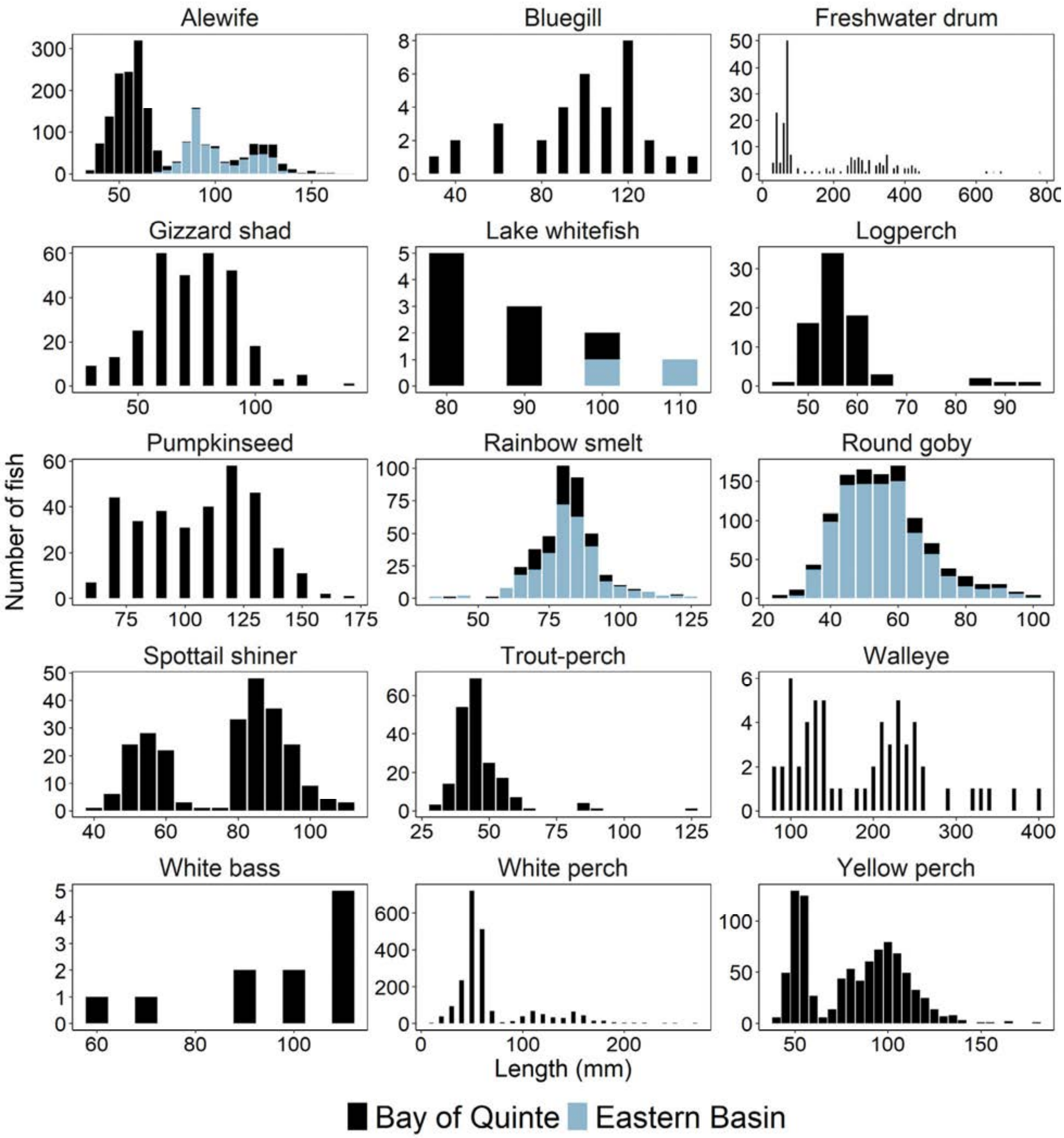

FIG. 1.2.4. Length distributions for the most abundant species caught in trawls in the Eastern Basin (blue) and Bay of Quinte (black) in 2023. Length values were grouped into 10mm bins for all species except Yellow Perch, Spottail Shiner, Rainbow Smelt, Round Goby, Trout-perch and Alewife that were grouped into 5mm bins.

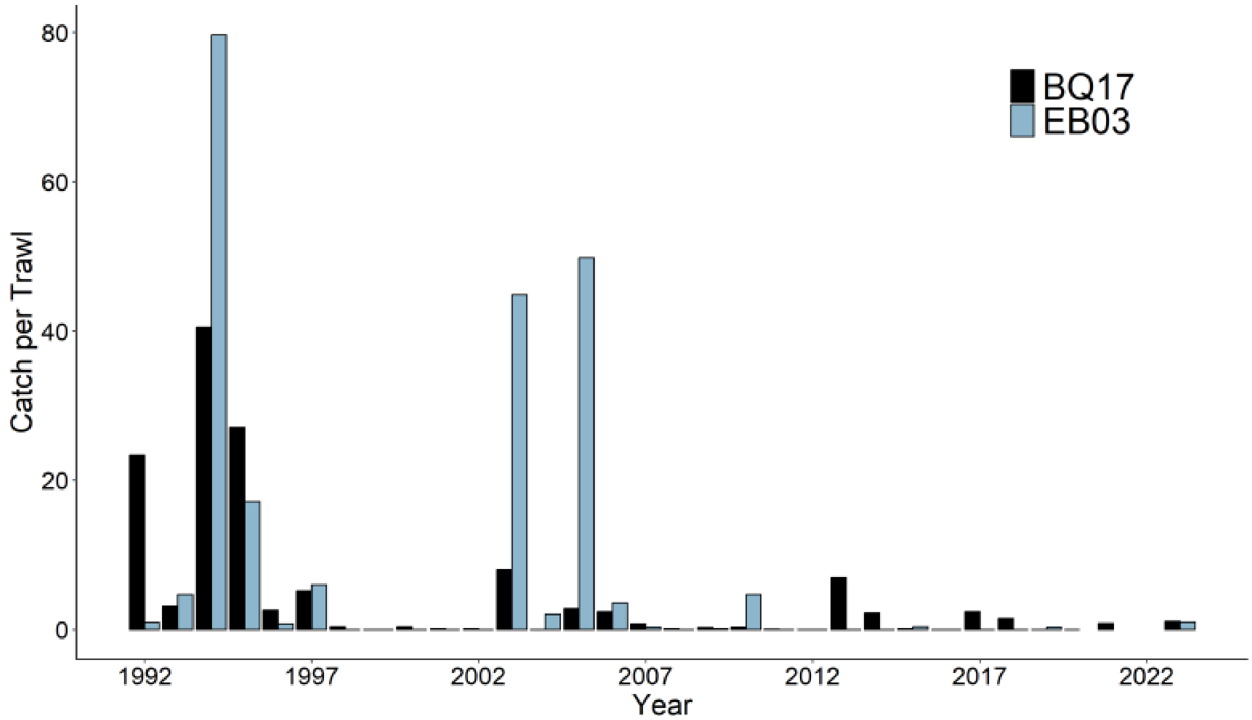

FIG. 1.2.5. Mean catch-per-trawl of **age-0 Lake Whitefish** at two sites, Conway in the lower Bay of Quinte and EB03 near Timber Island in eastern Lake Ontario, 1992-2023. Four replicate trawls on each of two to four visits were made at EB03. Only one replicate per visit to BQ17 was completed starting in 2022. Distances of each trawl drag were 1/4 mile for Conway and 1/2 mile for EB03. No trawls were conducted at EB03 in 2020 or 2021.

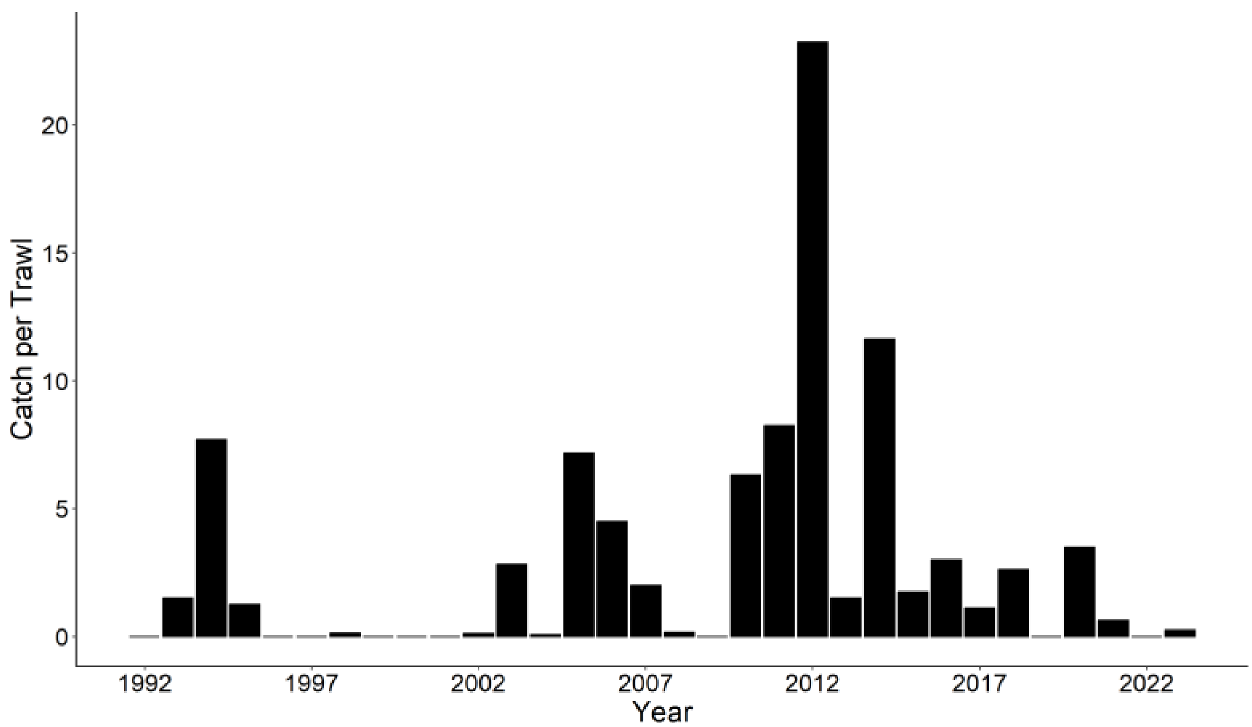

FIG 1.2.6. Mean catch-per-trawl of **age-0 Cisco** at Conway in the lower Bay of Quinte, 1992-2023. In pervious years, four replicate trawls on each of two to four visits during August and early September were made at the Conway site totalling 8-12 trawls per year. This was reduced to one replicate per visit in 2022. Distance of each trawl drag was 1/4 mile.

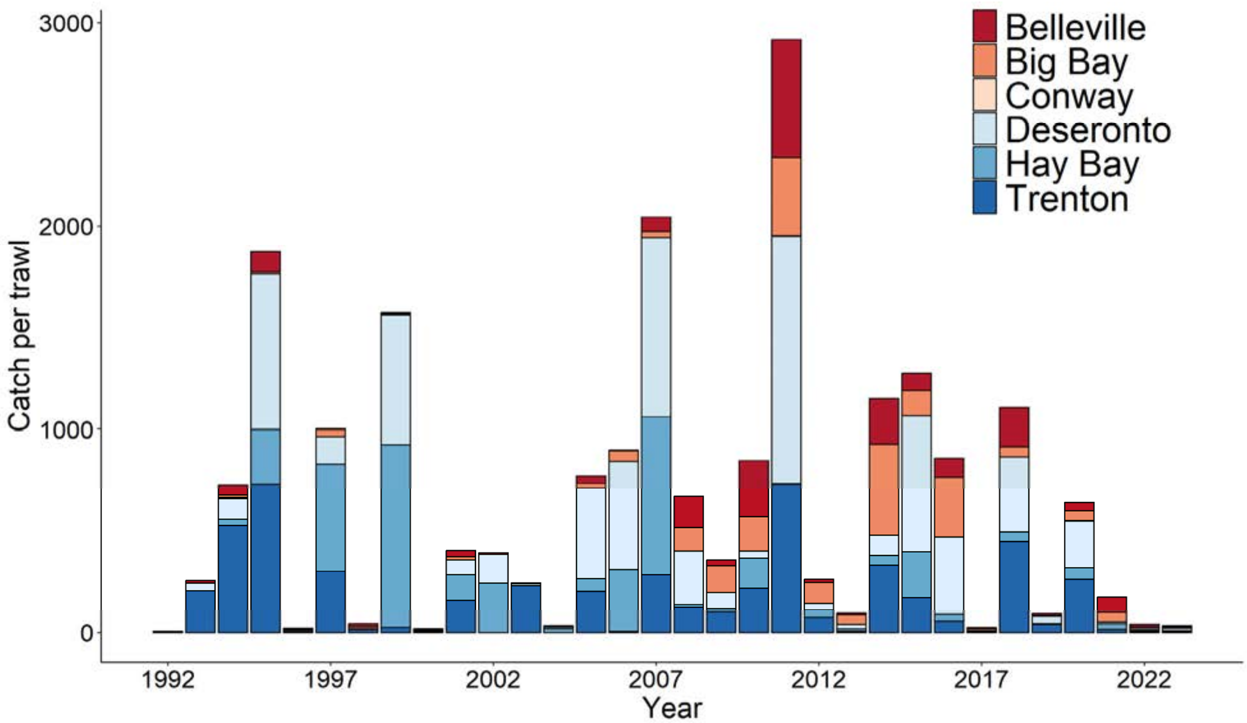

FIG. 1.2.7. Mean catch-per-trawl of **age-0 Yellow Perch** at six Bay of Quinte sites, 1992-2023. One-four trawls on each of two to three visits during August and early September were made at each site. Distance of each trawl drag was 1/4 mile. In previous years 48-52 trawls were conducted per year but in 2022 this was reduced to 12 trawls due to the adjustment from 4 to 1 replicate trawls per visit.

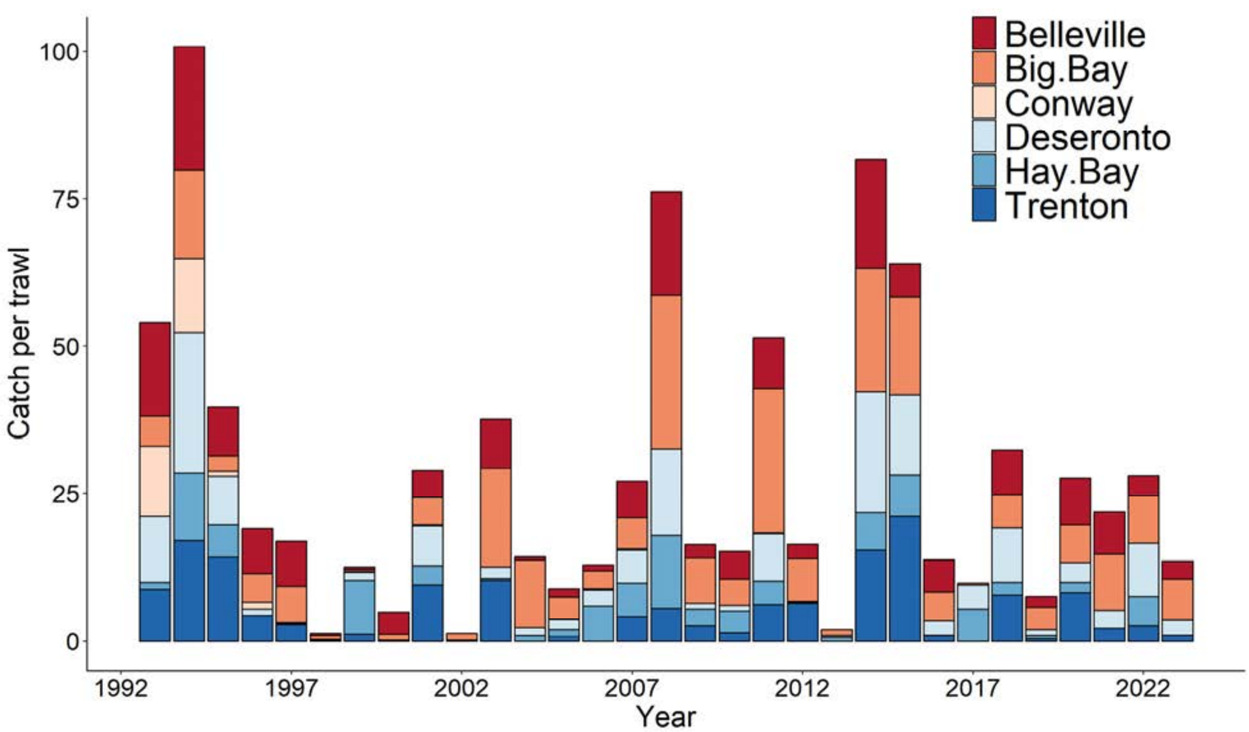

FIG. 1.2.8 Mean catch-per-trawl of **age-0 Walleye** at six Bay of Quinte sites, 1992-2023. One-four replicate trawls on each of two to three visits during August and early September were made at each site. Distance of each trawl drag was 1/4 mile. n previous years 48-52 trawls were conducted per year but in 2022 this was reduced to 12 trawls due to the adjustment from 4 to 1 replicate trawls per visit.

TABLE 1.2.6. Age distribution of 87 **Walleye** sampled from summer bottom trawls, Bay of Quinte, 2023. Also shown are mean fork length, mean weight, mean GSI (females), proportion female (of fish in which sex could be determined) and proportion mature. Fish that were not aged and had a fork length of less than 154 mm fork length were assigned an age of 0.

Age	0	1	2	3	4
Year class	2023	2022	2021	2020	2019
Number	84	37	19	4	1
Mean weight (g)	18.8	107.6	318.4	739.8	1,276.3
Mean length (mm)	124	219	314	404	493
Proportion mature	0	0	0	0.5	1
Proportion female	0.25	0.43	0.47	0.50	1
Mean GSI (females)	0.01	0.05	0.12	0.20	0.30

1.3 Lake Ontario Nearshore Community Index Netting

A. Row and S. Beech, Lake Ontario Management Unit

In 2023, Nearshore Community Index Netting (NSCIN) was completed at three nearshore areas: Lake St. Francis, Thousand Islands, and the North Shore of Kingston (Fig. 1.3.1). This was the first visit back to Lake St. Francis since 2008 and the first visit since 2009 for both the Thousand Islands and the North Shore of Kingston (Table 1.3.1).

NSCIN was first initiated on the upper Bay of Quinte (Trenton to Deseronto), West Lake, and Weller's Bay in 2001, and was expanded to include the middle and lower reaches of the Bay of Quinte (Deseronto to Lake Ontario) in 2002. In 2006, the NSCIN program was conducted on Hamilton and the Toronto Harbour areas thanks to partnerships developed with Fisheries and Oceans Canada and the Toronto and Region Conservation Authority. NSCIN was further expanded to other Lake Ontario nearshore areas in subsequent years (Table 1.3.1).

The NSCIN protocol is a provincial standard methodology which uses 6-foot trap nets and is designed to evaluate the relative abundance and other biological attributes of fish species that inhabit the littoral area. Suitable trap net sites are chosen from randomly selected UTM grids that contain shoreline in the nearshore area. Ecosystem (i.e., Index of Biotic Integrity or IBI) and fish community (e.g., proportion of piscivore biomass or PPB) measures have been developed to assess relative health of Lake Ontario's nearshore areas. These assessments are particularly useful to monitor the on-going status of impaired fish communities in Lake Ontario Areas of Concern (AOCs) such as Hamilton and Toronto Harbours and Lake St. Francis.

Survey information and basic catch statistics for the three nearshore areas sampled in 2023 are given in Table 1.3.2 and Table 1.3.3. Age and length

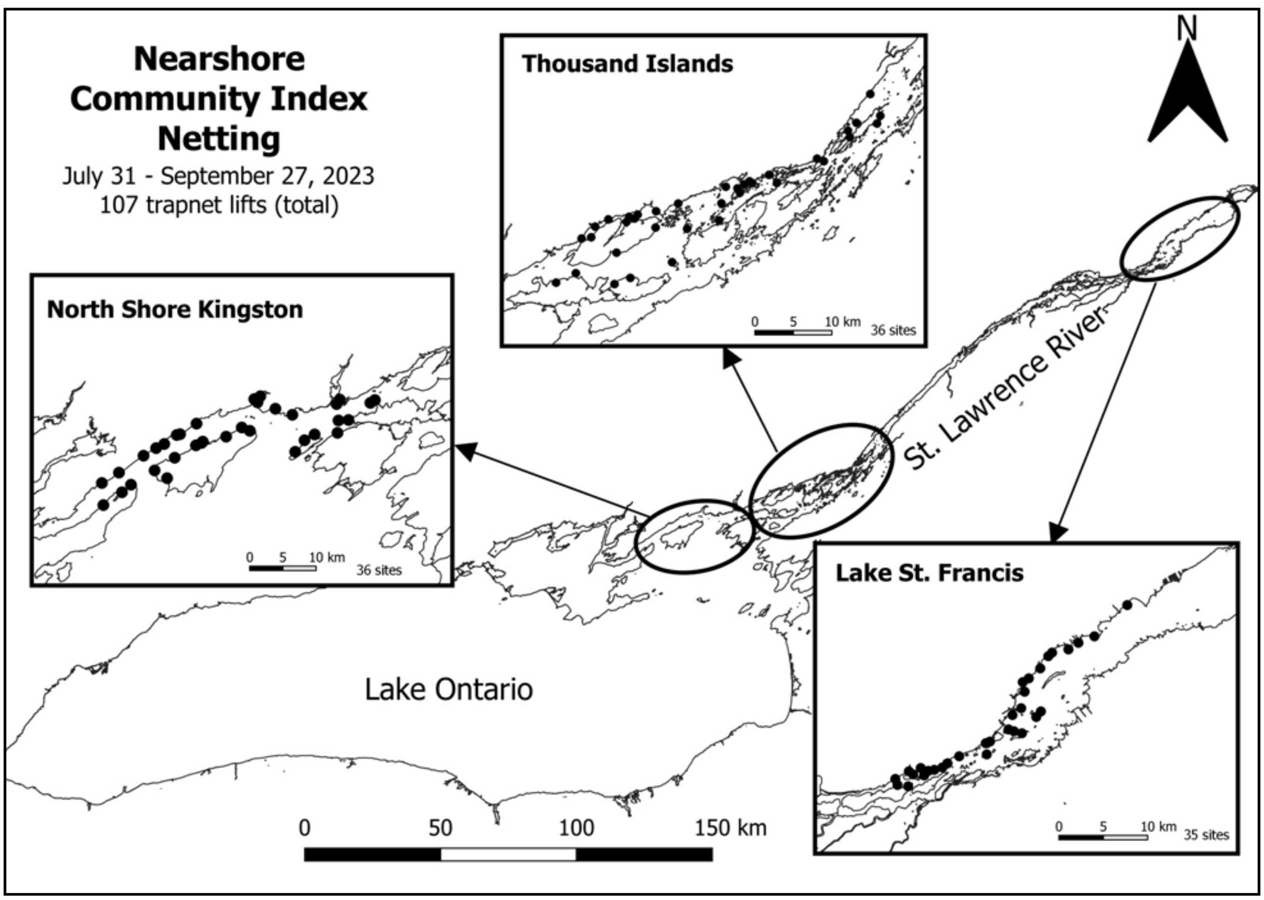

FIG. 1.3.1. Map of NSCIN trap net locations on Lake St. Francis, Thousand Islands, and North Shore Kingston, 2023.

distributions are displayed in Figures 1.3.2 and 1.3.3. Abundance trends for selected species are shown in Fig 1.3.4.

Lake St. Francis

Thirty-five trap net sites were sampled on Lake St. Francis from Aug 1st – Aug 23rd, 2023 (Table 1.3.2). Three nets were compromised and excluded from the data summary and analysis. Just over 2,100 fish comprising 29 species were captured (Table 1.3.3). The most abundant species by number were Bluegill (970), Black Crappie (217), and Longnose Gar (151). Notably, three American Eel, four Tench, three Muskellunge, and one Tiger Muskellunge (Northern Pike and Muskellunge hybrid) were caught.

Thousand Islands

Thirty-six trap net sites were sampled on the Thousand Islands from Aug 29th – Sept 19th, 2023 (Table 1.3.2). Almost 3,500 fish comprising 22 species were captured (Table 1.3.3). The most abundant species by number were Bluegill (1,486), Brown Bullhead (703), and Pumpkinseed (514).

North Shore Kingston

Thirty-six trap net sites were sampled on North Shore Kingston from Sept 6th – Sept 27th, 2023 (Table 1.3.2). Just over 2,100 fish comprising 21 different species were captured (Table 1.3.3). The most abundant species by number were Brown Bullhead (699), Rock Bass (629), and Bluegill (199). Notably, two American Eel were caught.

TABLE 1.3.1. Annual NSCIN trap net schedule for Lake Ontario nearshore areas, 2006-2023. The number of trap net samples at each area in each year are indicated.

Year	Hamilton Harbour	Toronto Harbour	Presqu'ile Bay	Weller's Bay	West Lake	East Lake	Prince Edward Bay	Upper Bay of Quinte	Middle Bay of Quinte	Lower Bay of Quinte	North Channel Kingston	Thousand Islands	Lake St. Francis
2023											36	36	35
2022		24		24				36					
2021	24												
2020													
2019	24	24						36	29	7			
2018	24	24						36					
2017					24	16	24	36					
2016	24	24						36					
2015	24		16	24				36					
2014	24	23						36					
2013					24	16	24	36					
2012	24	24						36					
2011								36	29	7			
2010	24	24						36					
2009							27	36	30	18	25	36	
2008	24		12	24				36					36
2007		24			18	18		36					36
2006	19	24											

TABLE 1.3.2. Survey information for the 2023 NSCIN trap net program on Lake St. Francis, Thousand Islands, and the North Shore of Kingston. Shown for each embayment are the survey dates, the range of observed surface water temperatures, the total number of trap net lifts, mean depth, and the number of trap net lifts broken down by observed substrate and cover types for nets included in the analysis.

		Lake St. Francis	Thousand Islands	North Shore Kingston
Survey dates		July 31-Aug 23	Aug 28-Sept 19	Sept 5-Sept 27
Water temp (°C)		21.0 - 22.7	19.2 - 23.3	18.0 - 23.7
Number of lifts		35	36	36
Average depth		2.2	2.4	2.5
Lifts by substrate type	Hard	12	7	18
	Soft	23	29	18
Lifts by degree cover	None	2	8	7
	Low (1-25%)	21	22	21
	Med (26-75%)	10	6	7
	High (76-100%)	2	0	1

Ecosystem Health Indices

Indices have been developed based on the NSCIN trap netting to evaluate ecosystem health in Lake Ontario nearshore areas. The indices vary among nearshore areas with the degree of exposure of the nearshore area sampled to Lake Ontario, and therefore are presented separately for sheltered, exposed, transitional, and riverine embayments. Lake St. Francis and the Thousand Islands are considered riverine, while North Shore Kingston is considered transitional.

Index of Biotic Integrity

The index of biotic integrity (IBI) is a measure of ecosystem health. IBI classes can be described as follows: 0-20 very poor, 20-40 poor, 40-60 fair, 60-80 good, and 80-100 excellent ecosystem health. The IBIs in 2023 were 64.4 (good), 69.1 (good) and 62.7 (good) for Lake St. Francis, Thousand Islands, and North Shore Kingston respectively. In North Shore Kingston, the IBI increased from 58.6 in 2009 (fair) to 62.8 in 2023 (good). The IBI for the Thousand Islands increased from 62.7 in 2009 to 69.1 in 2023. Lake St. Francis IBI was similar to previous years: 63.9, 65, and 64.4 in 2007, 2008, and 2023 respectively.

The average IBI between 2006-2023 at Lake St. Francis, Thousand Islands, and North Shore Kingston were similar to other embayments except for Areas of Concern: Toronto Islands and Hamilton Harbour (Fig. 1.3.5)

Piscivore Biomass

A proportion of the fish community biomass comprised of piscivores (PPB) greater than 0.20 reflects a healthy trophic structure. The PPBs in 2023 were 36.4, 43.1, and 49.8 in Lake St. Francis, Thousand Islands, and North Shore Kingston, respectively. The average PPB from 2006-2023 remained above 0.2 for each location (Fig. 1.3.6).

TABLE 1.3.3. Species-specific catch in the 2023 NSCIN trap net program on Lake St. Francis, Thousand Islands, and North Shore Kingston. Statistics shown include arithmetic mean catch-per-trap net (CUE), percent relative standard error of mean log10(catch+1) (%RSE = 100*SE/mean), and mean fork or total length (mm).

	Lake St. Francis			Thousand Islands			North Shore Kingston		
	Arithmetic Mean	% RSE	Mean Length	Arithmetic Mean	% RSE	Mean Length	Arithmetic Mean	% RSE	Mean Length
Alewife							0.06	107	135
American Eel	0.09	58	880				0.06	71	790
Black Crappie	6.2	38	237	4.42	20	214	0.11	45	215
Bluegill	27.71	35	159	41.28	36	145	5.53	29	142
Bowfin	0.11	44	628	1.61	20	632	0.94	35	597
Brown Bullhead	1.14	31	249	19.53	30	244	19.42	50	244
Channel Catfish	0.09	70	733				0.42	101	635
Common Carp	1.83	30	674	0.25	32	766	0.56	61	660
Esocidae hybrids	0.03	103	860						
Fallfish	0.34	41	268	0.03	107	190			
Freshwater Drum	0.2	35	680	0.14	43	732	0.33	51	456
Gizzard Shad				0.67	60	149	0.11	45	143
Golden Shiner	0.23	57	139	0.08	60	153			
Greater Redhorse	1.51	28	522	0.03	107	620			
Ichthyomyzon sp.	0.06	70	160						
Largemouth Bass	0.97	28	231	1.64	31	238	0.56	29	255
Lepomis sp.				0.06	107	185			
Longnose Gar	4.31	40	797	0.39	62	824	0.36	55	815
Moxostoma sp.	0.31	64	535						
Muskellunge	0.09	70	1,070						
Northern Pike	0.63	19	643	0.72	19	630	0.47	25	719
Pumpkinseed	4.17	27	133	14.28	26	126	1.81	41	116
River Redhorse	0.03	103	430						
Rock Bass	3.71	19	143	7.64	18	150	17.47	35	163
Shorthead Redhorse	0.31	35	458						
Silver Redhorse	0.23	44	475	0.06	71	490	0.03	107	610
Smallmouth Bass	0.69	32	345	0.72	29	372	2.28	29	353
Tench	0.11	61	393						
Walleye	2.09	19	482	0.08	72	643	0.94	37	428
White Perch	0.11	79	250				1.89	43	183
White Sucker	1.63	17	400	0.72	24	430	0.89	37	414
Yellow Bullhead				0.06	107	225			
Yellow Perch	1.69	23	216	2.03	28	199	4.89	33	195

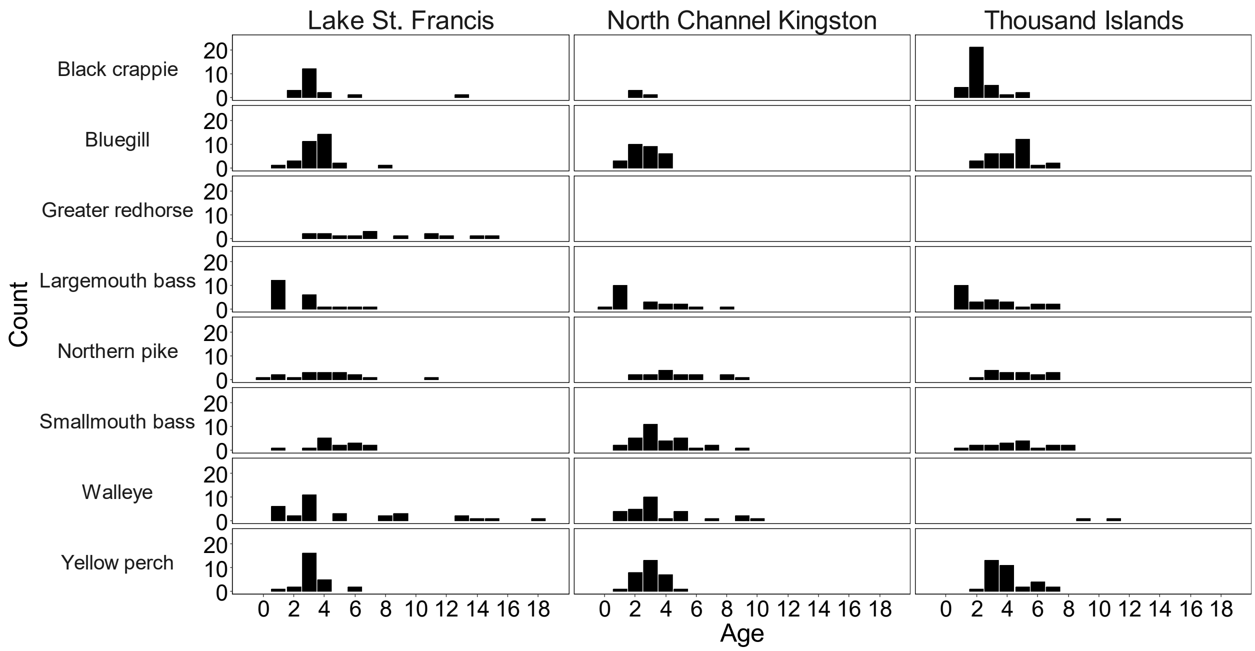

FIG. 1.3.2. Age distribution (years) of selected species caught in Lake St. Francis, Thousand Islands, and North Shore Kingston, 2023.

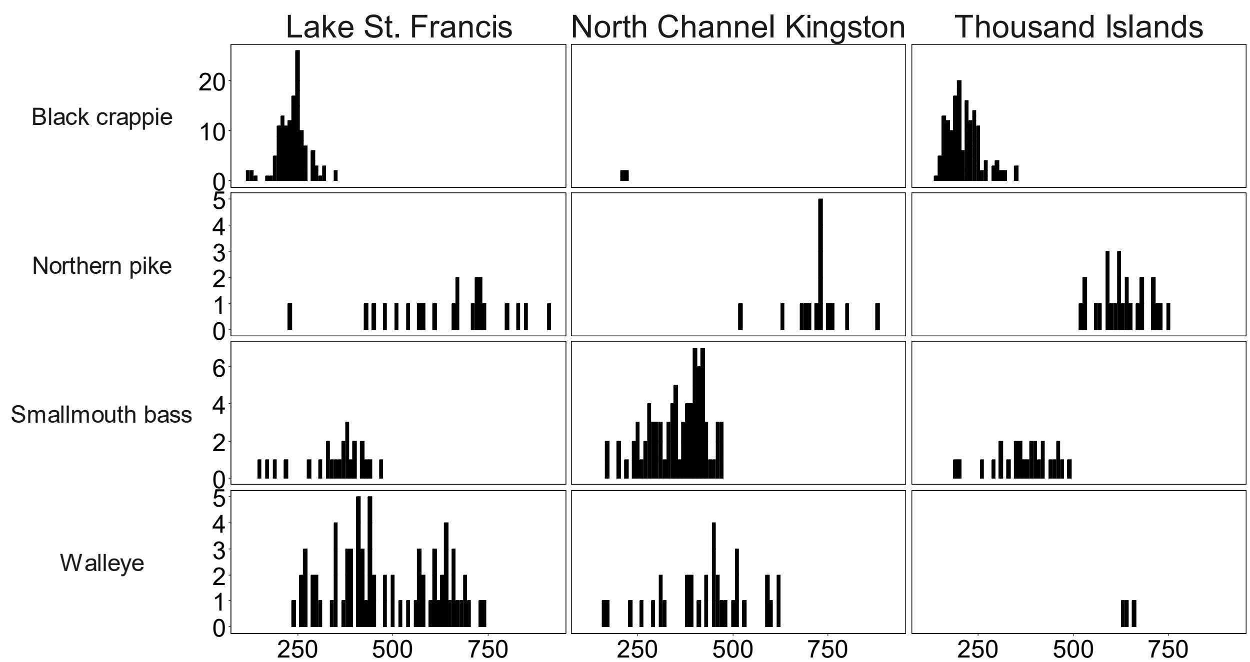

FIG. 1.3.3. Length distribution (mm) of selected species caught in Lake St. Francis, Thousand Islands, and North Shore Kingston, 2023.

Percent Specialist Biomass

A proportion of the fish community biomass comprised of specialists (PSPE) greater than 40 generally indicates a healthy trophic structure. The PSPEs in 2023 were 36.8, 34.8, and 31.8 in Lake St. Francis, Thousand Islands, and North Shore Kingston, respectively. The average PSPE from 2006-2023 remained below 40 for each location (Fig 1.3.7).

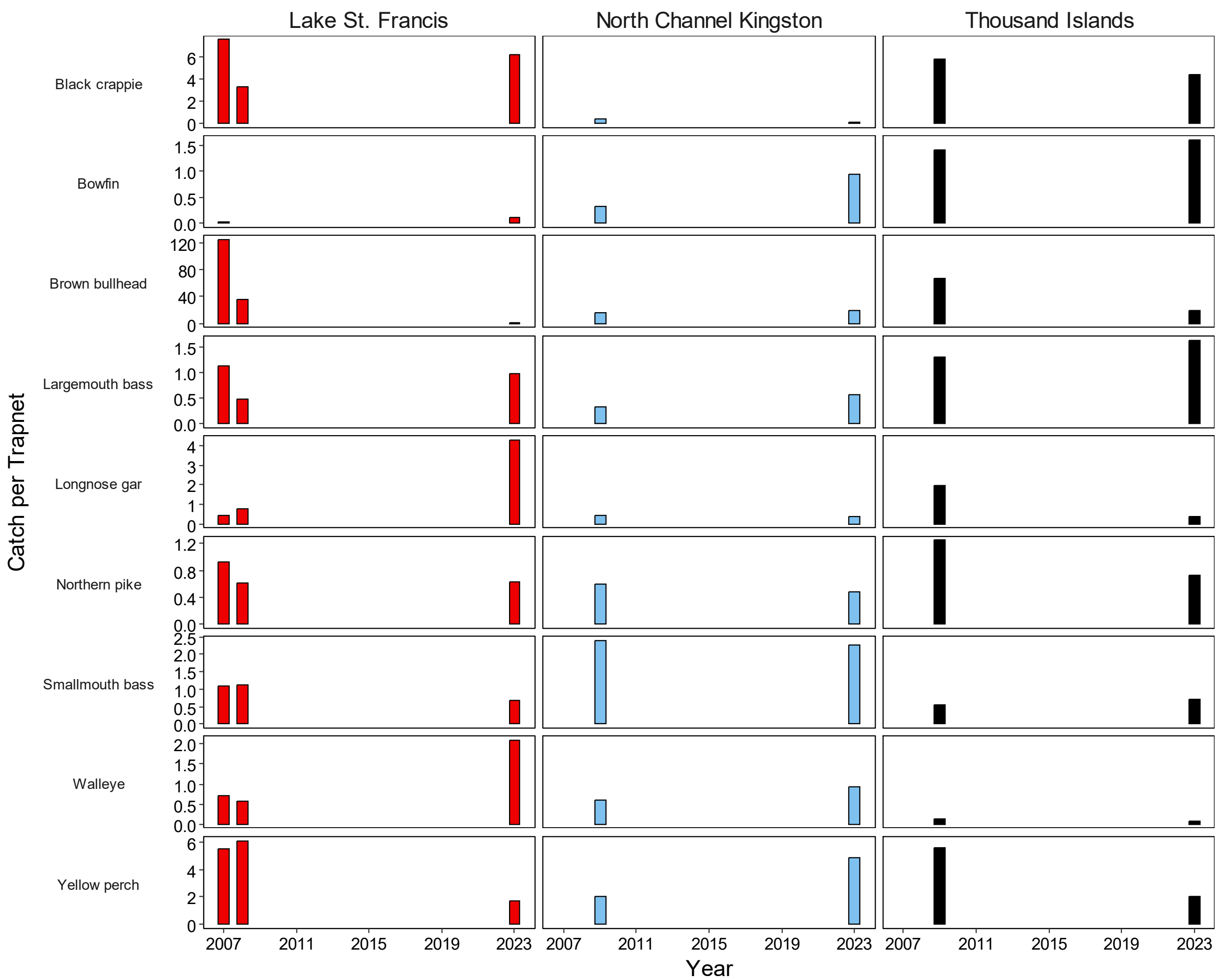

FIG. 1.3.4. Abundance trends for selected species caught in nearshore trap nets in Lake St. Francis, Thousand Islands, and North Shore Kingston. Values shown are annual arithmetic means.

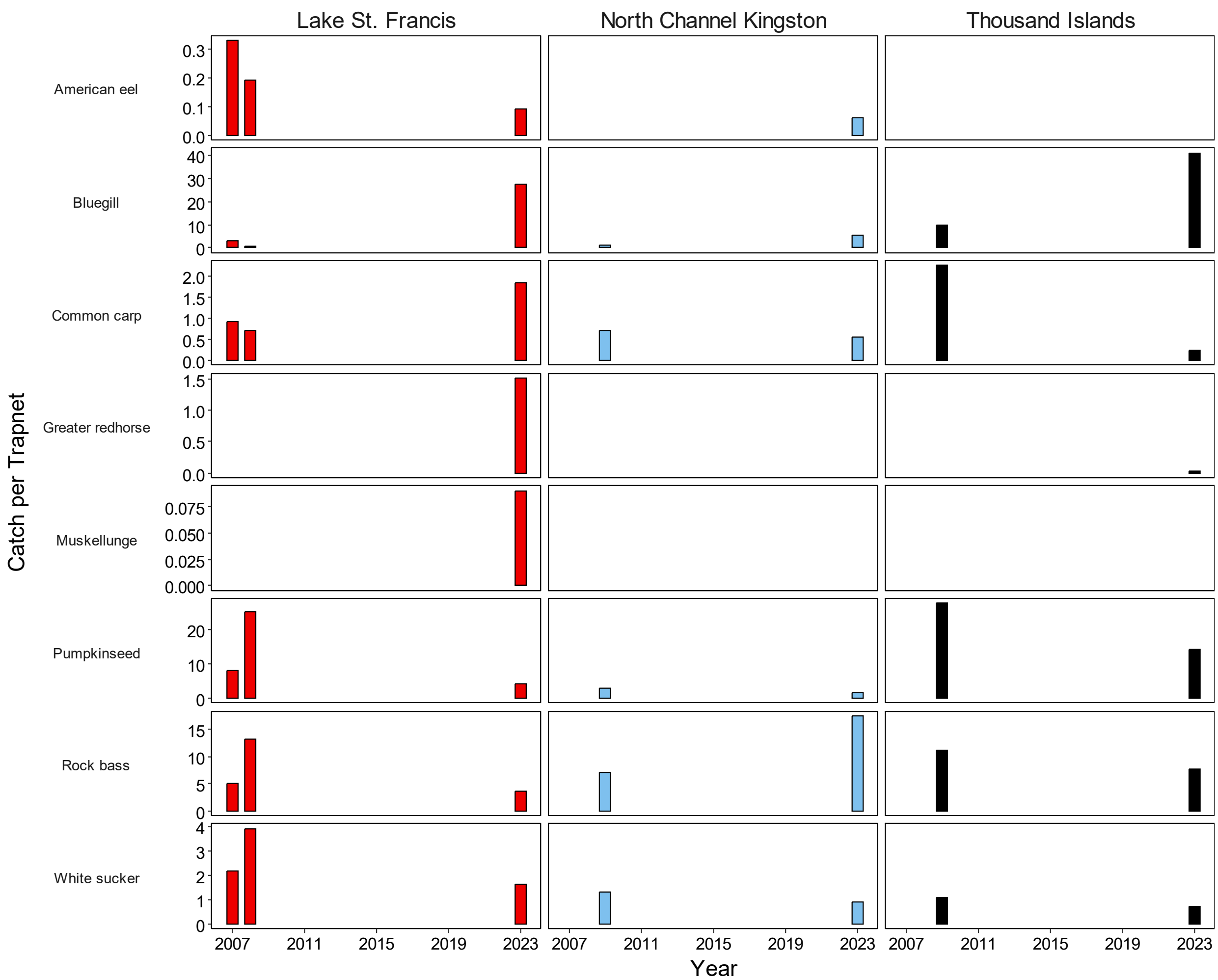

FIG. 1.3.4. (continued) Abundance trends for selected species caught in nearshore trap nets in Lake St. Francis, Thousand Islands, and North Shore Kingston. Values shown are annual arithmetic means.

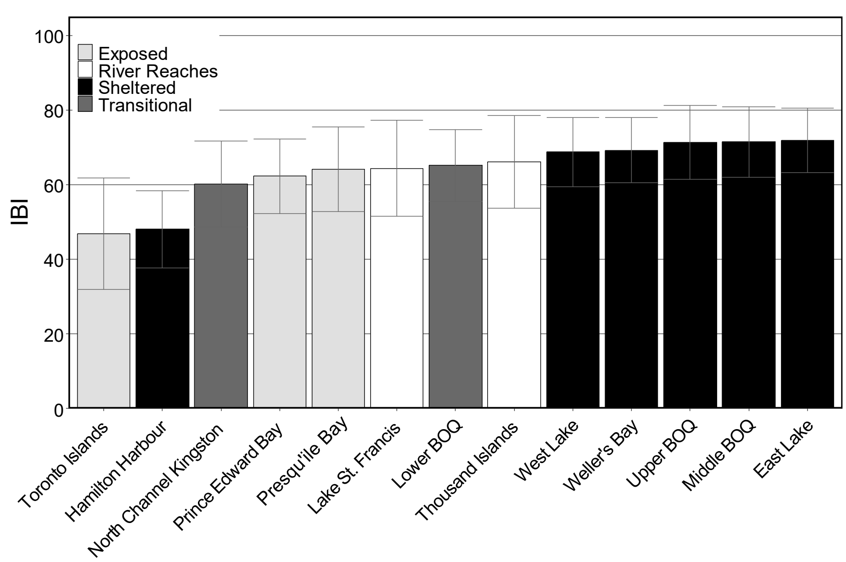

FIG. 1.3.5 Index of biotic integrity (IBI), as a measure of ecosystem health, in the nearshore trap net surveys across four different embayment types (2006-2023). Error bars are ±2SD.

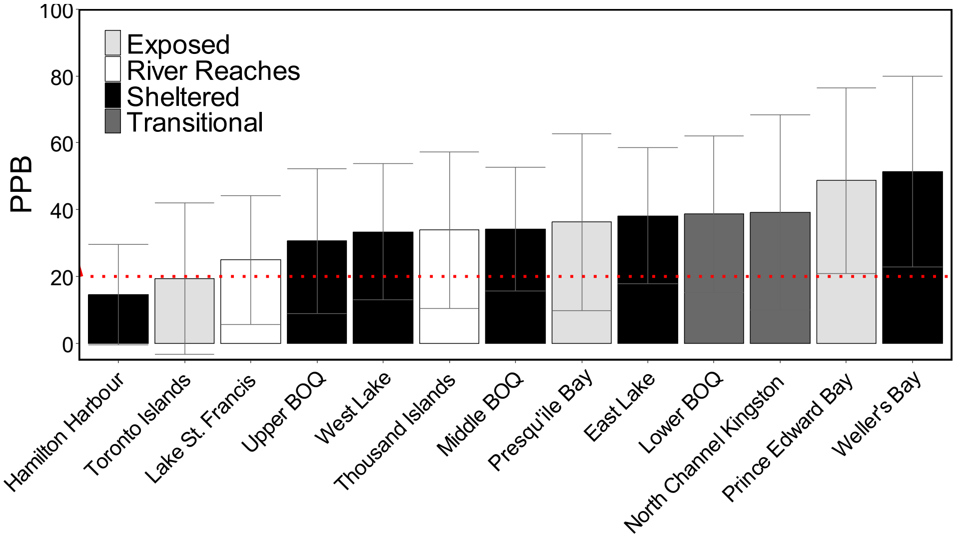

FIG. 1.3.6. Proportion of total fish community biomass represented by piscivore species (PPB) in the nearshore trap net surveys across four different embayment types (2006-2023). A PPB>0.2 is depicted by a dashed line. Piscivore species included Longnose Gar, Bowfin, Northern Pike, Smallmouth Bass, Largemouth Bass, and Walleye. Error bars are ±SD.

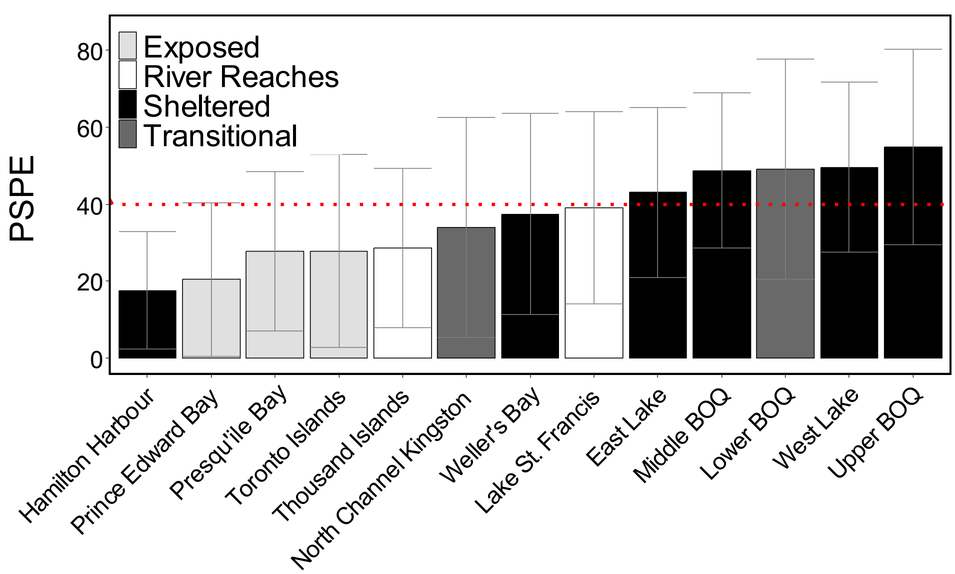

FIG. 1.3.7. Proportion of total fish community biomass represented by specialist species (PSPE) in the nearshore trap net surveys across four different embayment types (2006-2023). Specialist species included Alewife, Gizzard Shad, White Sucker, Redhorses, White Perch, White Bass, Rock Bass, Bluegill, Pumpkinseed, Black Crappie, Yellow Perch and Freshwater Drum. Error bars are ±SD.

1.4 Ganaraska River Fishway Migratory Salmon and Trout Assessment

T. Gristey and M. J. Yuille, Lake Ontario Management Unit

The tributaries of Lake Ontario provide spawning habitats for several migratory salmon and trout species, such as Rainbow Trout, Brown Trout, Chinook Salmon, and Coho Salmon. In spring 2016, the Lake Ontario Management Unit (LOMU) acquired new technology to count and assess fish in the Ganaraska River during their spawning migration. The Riverwatcher is an in-river fish counting system installed at the fishway at Corbett Dam in Port Hope. Riverwatcher technology automatically counts daily observations of fish as they pass through the counting tunnel and records a silhouette image and a short, high-resolution video for each fish. The raw detection data is available online for previous years and throughout the camera's operation window. It can be accessed here: http://www.riverwatcherdaily.is/?I=133. After removal from the river, LOMU staff review the videos and silhouettes using the Riverwatcher software to identify species and parse out individual observations. Apart from Atlantic Salmon, the spawning runs of migratory salmon and trout are completely naturalized on the Ganaraska River. Monitoring and counting these fish during their spawning migration provides LOMU with an assessment index of naturalized salmon and trout populations in Lake Ontario. Understanding migration timing and patterns of these species is critical to evaluating the success of restoration efforts and annual abundance metrics. This section includes an annual summary of the reviewed Ganaraska Riverwatcher data, a species-specific breakdown of the migration run, Rainbow Trout assessment and the Chinook Salmon Spawning Index assessment program.

Ganaraska River Fish Counter (Riverwatcher)

The Ganaraska River Fish Counter was installed and operational on March 31st, 2023. The counter continued to operate through November 20th, 2023. A total of 43,487 upstream and downstream river events were recorded, with a total of 37,147 mature salmon and trout observed migrating upstream through the fishway. The number of events recorded is a conservative estimate. During periods of heavy rainfall, river flows increase, making the water cloudy. As the water becomes more turbid, the infrared counting sensors are not able to penetrate the water; thus, some fish could not be counted. During high flow and turbid water periods, the ability to accurately count fish as they moved through the fishway decreases. Additionally, this year, high volumes of fish were migrating through the fishway, exceeding the system's ability to count them individually. This emphasizes the necessity of reviewing the recorded videos to increase the accuracy of the counts. The most active day during the 2023 monitoring occurred on September 14th, with a total of 2,106 fish observed migrating through the fishway system. Throughout the monitoring period, the observations were parsed out to identify and summarize Rainbow Trout, Chinook Salmon, Coho Salmon, Brown Trout and Atlantic Salmon observations.

Rainbow Trout

The number of Rainbow Trout migrating up the Ganaraska River during spring to spawn has been estimated at the fishway on Corbett Dam, Port Hope, ON, since 1974. Before 1987, the Rainbow Trout counts at the fishway were based entirely on hand lifts and visual counts. Between 1987 and 2016, fish counts were made with a Pulsar Model 550 electronic fish counter. Based on visual counts, the Pulsar counter was about 85.5% efficient, and the complete size of the run was estimated accordingly. The run was estimated using a virtual population analysis over the years without direct observations. The counter is usually operated from mid to late March until early May. Starting in 2018, the count of Rainbow Trout migrating upstream through the Corbett Dam was determined using the Riverwatcher fish counting system. The Riverwatcher actively counted and recorded fish from March 31st to May 21st, 2023, when the Rainbow Trout spawning run ended.

In the spring of 2023 (March 31st to May 21st), 5,126 Rainbow Trout were observed passing through the Ganaraska Fishway (Fig. 1.4.1, Fig. 1.4.2 and Table 1.4.1). Due to unforeseen technical difficulties with the Riverwatcher system, the spring Rainbow Trout run value should be considered a conservative estimate. The software issue was resolved by mid-April and would not impact observations for the rest of the 2023 season. The Rainbow Trout observations are below the previous 10-year average (7,146 fish average from 2011 to 2022, 2020 was omitted). The observed peak number of Rainbow Trout occurred on April 7th, with 907 fish observed swimming through the fishway. The observed total run size for 2023 decreased 43% from the previous spring assessment (Table 1.4.1). In the spring, the fishway was most active in early April (Fig. 1.4.1). Through March 31st to April 18th, 2023, 90% of the spring Rainbow Trout (4,642 fish) passed through the fish counter (Fig. 1.4.2). Rainbow Trout were observed utilizing the fishway after the spring monitoring period throughout the year with another peak of observations occurring in the fall. Another 397 Rainbow Trout migrated through the fishway after the primary spring run, making a total of 5,847 Rainbow Trout identified migrating upstream through the Ganaraska Fishway in 2023.

Rainbow Trout were measured and weighed during the spawning run most years since 1974. The estimated weight (based on a log-log regression) of a 635 mm or 25" (total length) Rainbow Trout is used as an index of condition factor. The condition factor is a fish's relative robustness or degree of well-being. Variations in a fish's condition primarily reflect the state of sexual maturity and degree of nourishment acquired throughout its lifetime. In 2023, the Rainbow Trout condition factor of males (2,397 g, n = 91) and females (2,604 g, n = 167) increased from the previous 2022 survey and were 6% and 3% (respectively) below the previous 10-year average (Fig. 1.4.3 and Table 1.4.2).

The proportion of Rainbow Trout with Sea Lamprey marks in the Ganaraska River has been reported since 1974. In 2023, 29% of fish had Lamprey marks (wounds or scars), an increase from 2022, which was 27%. Lamprey wounds on Ganaraska River Rainbow Trout in 2023 are

TABLE 1.4.1. Observed count and estimated run of Rainbow Trout moving upstream at the Ganaraska River fishway at Port Hope, Ontario during spring, 1974-2023. Estimates for 1980, 1982, 1984, 1986, 1992, and 2002 were interpolated from adjacent years with virtual population analysis.

Year	Observed	Estimated
1974	527	527
1975	591	591
1976	1,281	1,281
1977	2,237	2,237
1978	2,724	2,724
1979	4,004	4,004
1980	--	5,817
1981	7,306	7,306
1982	--	10,127
1983	7,907	7,907
1984	--	8,277
1985	14,188	14,188
1986	--	12,785
1987	10,603	13,144
1988	10,983	15,154
1989	13,121	18,169
1990	10,184	14,888
1991	9,366	13,804
1992	--	12,905
1993	7,233	8,860
1994	6,249	7,749
1995	7,859	9,262
1996	8,084	9,454
1997	7,696	8,768
1998	3,808	5,288
1999	5,706	6,442
2000	3,382	4,050
2001	5,365	6,527
2002	--	5,652
2003	3,897	4,494
2004	4,452	5,308
2005	4,417	5,055
2006	5,171	5,877
2007	3,641	4,057
2008	3,963	4,713
2009	3,290	4,502
2010	4,705	6,923
2011	6,313	9,058
2012	7,256	8,486
2013	8,761	12,021
2014	8,218	9,611
2015	5,890	6,669
2016	4,225	4,987
2017	6,952	--
2018	9,023	--
2019	6,051	--
2020	--	--
2021	6,985	--
2022	8,929	--
2023	5,126	--

above the previous 10-year average of 22% (Table 1.4.3).

In addition to the Sea Lamprey assessment, technicians also visually assessed gill lice/ maggots (*Salmincola* spp.) infestations on Rainbow Trout. Gill lice, a small copepod, parasitizes the gills of Pacific salmon and trout. From 2018 to 2022, the survey evaluated the presence/absence of infestation. In 2023, the severity of the infestation was graded into four levels: Absent, Light, Moderate and Heavy (Fig. 1.4.4), depending on the amount of gill lice visually present on the gills. The percent of observed gill lice infestation in 2023 was 53% (n = 139/259), a decrease from the 2022 assessment (66%; Fig. 1.4.5). Of the 2023 gill lice infestation levels (n = 139), 40% were classified as light, 9% were considered moderate, and 4% were heavy.

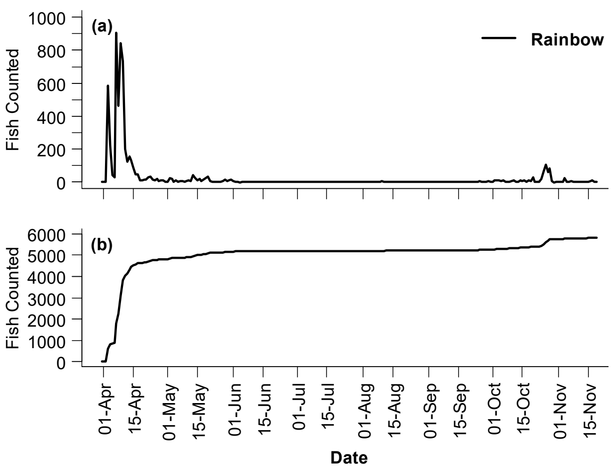

FIG. 1.4.1. (a) Daily and (b) cumulative observed counts of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario from April 1st to November 21st, 2023.

Coho Salmon

The first Coho Salmon observed at the Ganaraska Fishway in 2023 was on August 19th. A total of 2,491 Coho Salmon were identified moving upstream from the Corbett Dam (Fig. 1.4.6); this is an increase from 1,991 observed in 2022 and is the most observed during the Riverwatcher's operational history (2017). Peak observations occurred on September 20th, with 258 fish counted moving upstream. The last Coho was observed on November 7th.

Brown Trout

The first Brown Trout observed at the Ganaraska Fishway in 2023 was on April 3rd. From that time, 161 Brown Trout were identified moving upstream from the Corbett Dam (Fig. 1.4.7). Of the Brown Trout identified passing through the fishway, the majority were observed through the summer months (July to the beginning of September). Peak observations of Brown Trout through the fishway occurred on July 6th, 2023, with 16 upriver observations.

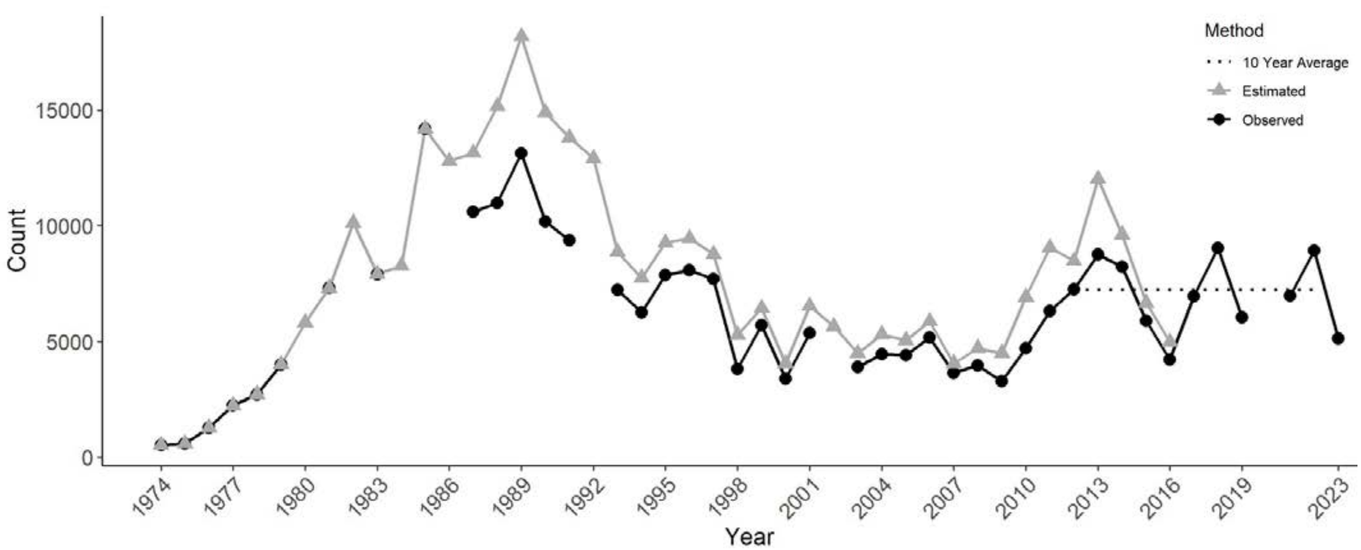

FIG. 1.4.2. Estimated and observed run of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring 1974-2023.

Atlantic Salmon

The first Atlantic Salmon observed at the Ganaraska Fishway in 2023 was on August 17th. Sixteen Atlantic Salmon successfully navigated upstream from the Corbett Dam (Fig. 1.4.8). Peak counts occurred from the end of July through August of 2023.

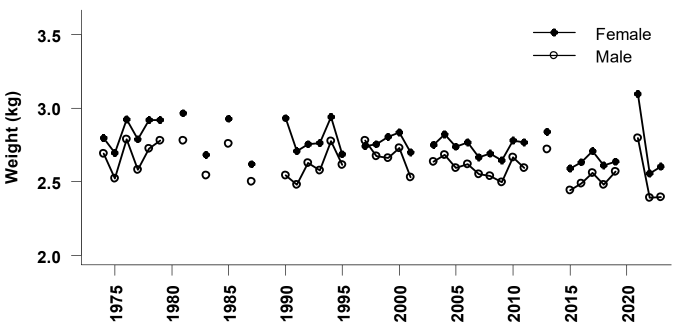

FIG. 1.4.3. Body condition (estimated weight at 635 mm total length) of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring 1974-2023. Open and closed circles represent male and female Rainbow Trout (respectively).

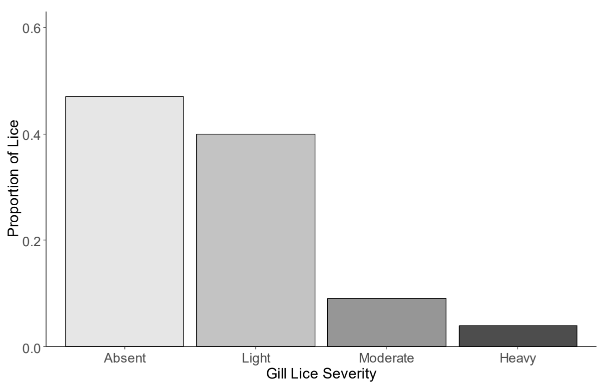

FIG. 1.4.4. Gill lice severity observed in Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario, during spring 2023.

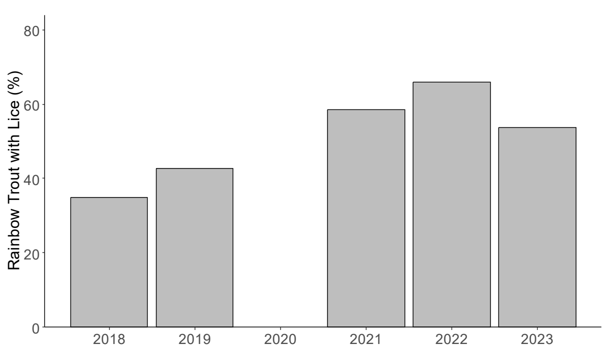

FIG. 1.4.5. Gill lice levels observed in Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario, during spring 2018-2023.

Chinook Salmon

A total of 28,295 Chinook Salmon were identified migrating upstream through the Riverwatcher in the Ganaraska Fishway during the 2023 monitoring period (Fig. 1.4.9), representing the largest run observed during the Riverwatcher's operation. The second largest run

TABLE 1.4.2. Body condition (estimated weight at 635 mm total length) of Rainbow Trout at the Ganaraska River fishway at Port Hope, Ontario during spring, 1974-2023.

Year	Male		Female	
	Weight (g)	Sample Size	Weight (g)	Sample Size
1974	3,024	183	3,133	242
1975	2,826	202	3,018	292
1976	3,144	447	3,280	624
1977	2,906	698	3,128	1,038
1978	3,053	275	3,271	538
1979	3,132	372	3,285	646
1981	3,131	282	3,304	493
1983	2,884	327	3,025	481
1985	3,118	446	3,274	760
1987	2,875	84	2,966	110
1990	2,851	261	3,043	198
1991	2,793	127	3,032	289
1992	2,946	142	3,072	167
1993	2,899	89	3,093	172
1994	3,088	116	3,274	181
1995	2,947	147	3,019	155
1997	3,107	157	3,109	148
1998	3,014	131	3,081	262
1999	2,990	182	3,149	293
2000	3,049	125	3,190	234
2001	2,865	308	3,022	299
2003	2,972	93	3,095	144
2004	3,008	143	3,155	248
2005	3,911	145	3,061	176
2006	2,936	102	3,099	217
2007	2,854	75	2,972	131
2008	2,846	125	2,996	148
2009	2,753	78	2,954	211
2010	2,989	74	3,102	156
2011	2,913	94	3,083	204
2013	3,044	163	3,178	217
2015	2,752	86	2,921	119
2016	2,801	105	2,942	132
2017	2,877	94	3,016	106
2018	2,785	249	2,930	407
2019	2,853	123	2,956	188
2021	3,091	56	3,404	113
2022	2,394	126	2,558	221
2023	2,397	91	2,604	167
Average	2,944		3,072	

occurred in 2019, with 19,250 Chinook Salmon observed migrating upstream. Last year (2022), 8,060 Chinook were observed migrating upstream, with 2023 marking a 251% increase to the previous year. The first Chinook Salmon was observed on July 17th, 2023. This marked the start of a series of early migration pulses, leading up to the main run, which started on September 11th (Fig. 1.4.9). The last Chinook Salmon migrating upstream through the fishway was observed October 29th, 2023. Detailed sampling of the Ganaraska River Chinook Salmon spawning population occurred from 2016 to 2019 but was put on pause due to the COVID-19 pandemic. In

TABLE 1.4.3. Lamprey marks on Rainbow Trout in spring 1974-2023, at the Ganaraska River fishway, at Port Hope, Ontario. Since 1990, A1 and A2 marks were called wounds and the remainder of marks were called scars to fit with historical classification.

Year	Wounds / fish	Scars / fish	Marks / fish	% with wounds	% with scars	% with marks	Sample Size
1974	0.083	0.676	0.759	7.0	33.2	37	527
1975	0.095	0.725	0.820	8.0	37.2	40	599
1976	0.090	0.355	0.445	6.6	23.3	28	1,280
1977	0.076	0.178	0.254	6.4	13.5	18	2,242
1978	0.097	0.380	0.476	8.1	28.4	34	2,722
1979	0.122	0.312	0.434	10.3	22.8	30	3,926
1981	--	--	0.516	--	--	36	5,489
1983	0.113	0.456	0.569	9.7	33.4	39	833
1985	0.040	0.154	0.193	3.7	11.5	14	1,256
1990	0.030	0.071	0.101	2.8	5.8	8	466
1991	0.026	0.076	0.103	2.4	6.4	8	419
1992	0.079	0.117	0.197	6.3	11.1	17	315
1993	0.077	0.126	0.203	6.9	11.5	17	261
1994	0.044	0.141	0.185	4.0	12.4	15	298
1995	0.036	0.026	0.063	3.6	2.6	6	303
1996	0.028	0.025	0.053	2.8	2.5	5	396
1997	0.035	0.132	0.167	3.5	10.3	13	311
1998	0.075	0.092	0.168	6.8	8.5	13	400
1999	0.057	0.157	0.214	5.5	12.4	16	477
2000	0.091	0.191	0.283	8.0	16.9	24	361
2001	0.118	0.138	0.257	10.0	12.5	19	608
2003	0.063	0.134	0.197	5.9	10.9	16	238
2004	0.227	0.316	0.543	17.6	25.0	38	392
2005	0.231	0.433	0.664	17.1	33.6	41	321
2006	0.282	0.379	0.661	22.6	30.1	45	319
2007	0.199	0.534	0.733	15.5	39.3	49	206
2008	0.274	0.682	0.956	18.6	43.8	51	274
2009	0.256	0.377	0.633	20.4	29.8	42	289
2010	0.134	0.394	0.528	10.4	31.2	38	231
2011	0.124	0.235	0.359	10.7	21.8	30	298
2013	0.229	0.071	0.300	17.4	6.8	22	380
2015	0.058	0.238	0.296	4.9	16.5	20	206
2016	0.075	0.280	0.356	7.5	21.8	27	239
2017	0.109	0.183	0.292	10.9	16.8	27	202
2018	0.093	0.108	0.201	8.5	9.9	17	658
2019	0.103	0.186	0.289	8.7	16.4	23	311
2021	0.083	0.065	0.148	8.3	6.5	15	169
2022	0.264	0.106	0.370	5.2	1.4	28	349
2023	0.110	0.230	0.340	10.4	19.6	29	260

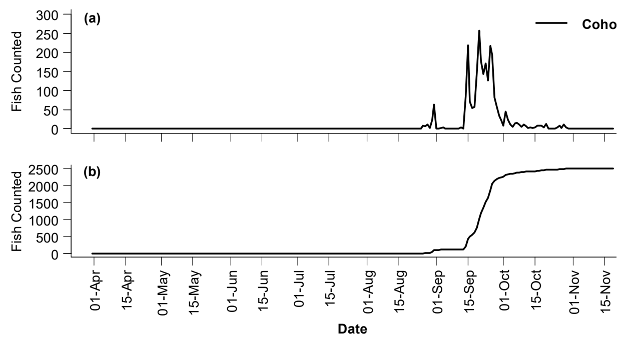

FIG. 1.4.6. (a) Daily and (b) cumulative observed counts of Coho Salmon at the Ganaraska River fishway at Port Hope, Ontario from April 1st to November 21st, 2023.

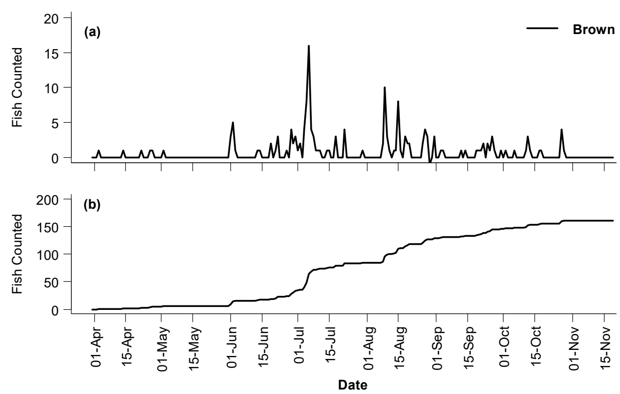

FIG. 1.4.7. (a) Daily and (b) cumulative observed counts of Brown Trout at the Ganaraska River fishway at Port Hope, Ontario from April 1st to November 21st, 2023.

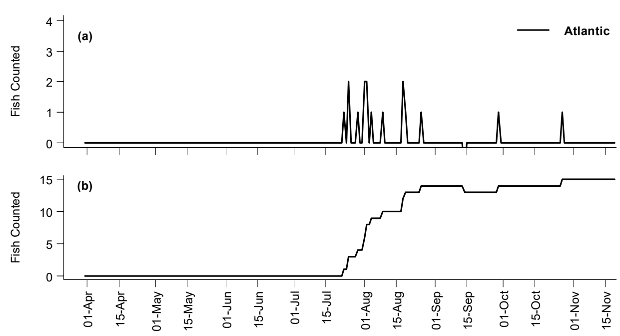

FIG. 1.4.8. (a) Daily and (b) cumulative observed counts of Atlantic Salmon at the Ganaraska River fishway at Port Hope, Ontario from April 1st to November 21st, 2023.

2023, sampling of the Ganaraska Chinook Salmon spawning population resumed (see below).

Chinook Salmon Spawning Index

In addition to the Riverwatcher system, the fishway contains a deployable cage/basket downstream of the camera that can be removed and replaced by an overhead crane. This basket allows for the collection of fish moving through the fishway before entering the camera system. This basket was used to intercept migrating Chinook Salmon during the 2023 fall migration. Captured fish were selected, measured, and checked for clips before detailed sampling. Detailed sampling included collecting data on size, weight, fin clips, coded-wire tags, lamprey marks, and otolith collection for age determination. This program is designed to provide a detailed analysis of the age, growth, lamprey wounds, and condition of the returning naturalized Chinook Salmon population on the Ganaraska River. It complements historical assessment programs conducted in the fall on the Ganaraska River. The fieldwork associated with the Chinook Salmon assessment started on September 26th and ran until October 13th. The program assessed 299 Chinook Salmon, 20 Coho Salmon, six Rainbow and one Brown Trout over eight days of sampling. A total of 135 Chinook otoliths were sampled for age interpretations.

In Lake Ontario, Chinook Salmon typically return to spawn at age-2 and age-3. In 2023, there was an increase in the proportion of age-1 and age -2 Chinook observed in the Ganaraska River (Fig. 1.4.10). Ten percent of the Chinook were age-3 and 66% were age-2.

The average fork length of Chinook Salmon for age-3 males was 857mm, which decreased from observed values in 2019 (880mm; Fig. 1.4.11). The average fork length for age-2 males in 2023 was 805mm, an increase from 645mm in 2019. The average fork length of an age-3 female Chinook in 2023 decreased to 814mm from 847mm in 2019. Age-2 females' average fork length in 2023 increased to 837mm from 665mm in 2022.

The estimated weight (based on a log-log regression) of a 914mm or 36" (total length) Chinook Salmon is used as an index of condition factor (Fig. 1.4.12). Female Chinook condition in 2023 (7,463 g) decreased from 2019 (7,536 g), while male condition in 2023 (6,911 g) increased from 2019 (6,866 g).

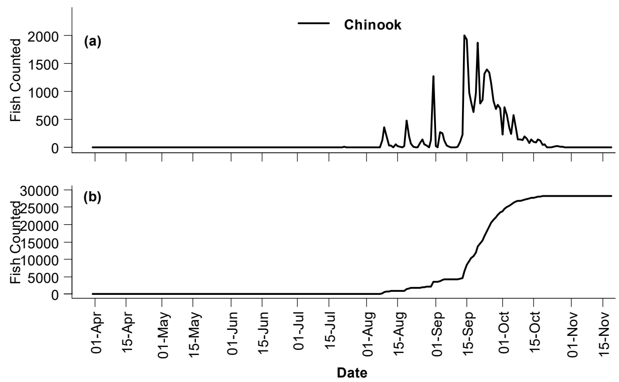

FIG. 1.4.9. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Ganaraska River fishway at Port Hope, Ontario from April 1st to November 21st, 2023.

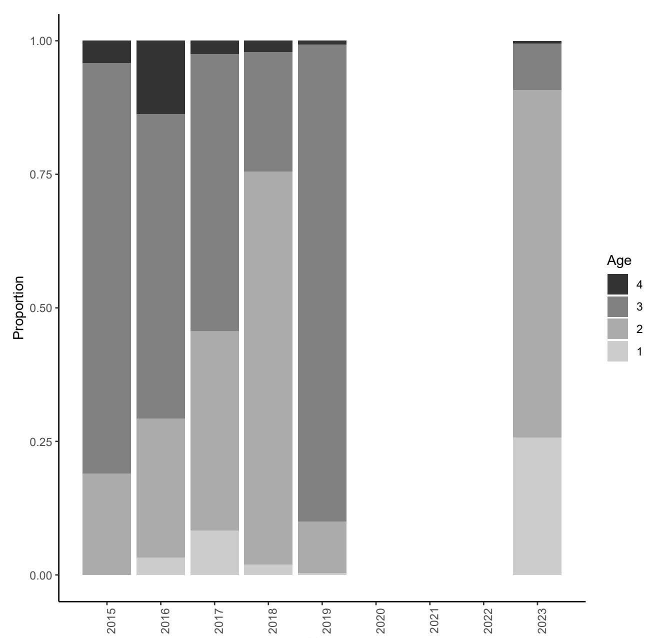

FIG. 1.4.10. Age proportions of spawning Chinook Salmon (males and females pooled) sampled during the fall Ganaraska River fishway at Port Hope, Ontario. The four grey colours correspond to each age, with age-1 being the lightest and age-4 being the darkest.

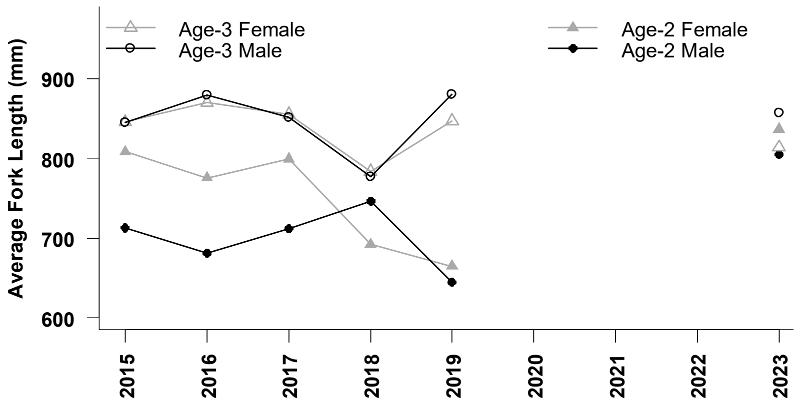

FIG. 1.4.11. Mean fork length of age-2 and age-3 Chinook Salmon by sex, caught for spawn collection in the Ganaraska River fishway during the fall spawning run, 2015-2023.

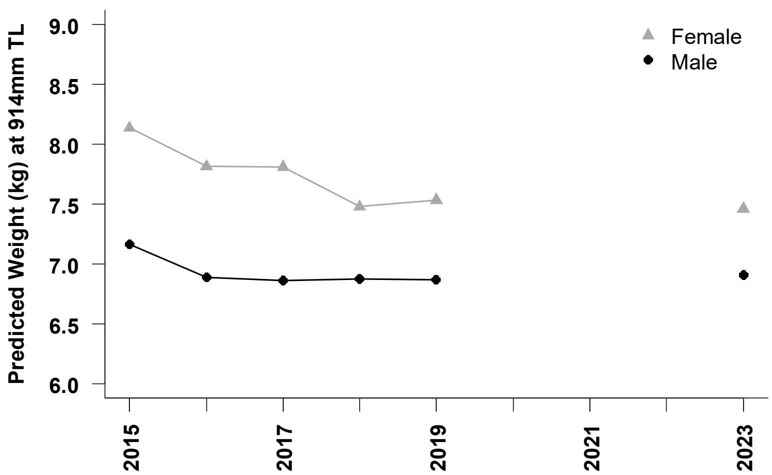

FIG. 1.4.12. Condition index as the mean weight of a 914 mm / 36 inch (total length) Chinook Salmon in the Ganaraska River fishway during the spawning run, 2015-2023.

1.5 Credit River Trout and Salmon Assessment

T. Gristey and M. J. Yuille, Lake Ontario Management Unit

The Credit River, below the Kraft Dam in Streetsville, has been the long-term sampling site for the Chinook Salmon gamete collection program. In August 2018, the Lake Ontario Management Unit (LOMU) completed infrastructure upgrades and construction on the Streetsville Fishway. During upgrades, a second Riverwatcher Fish Counting System was installed to access migratory trout and salmon in the Credit River. For 2023, the Credit River Riverwatcher was operational on April 3rd and continued to collect data through November 24th. The following section includes a summary of the Credit River Riverwatcher data (available at www.riverwatcherdaily.is?I=143) along with the annual Credit River Chinook Salmon Spawning Index.

Pre-2018, the Streetsville Fishway was closed in the fall, effectively blocking all fish passage from mid-September to the end of the Chinook Salmon Egg Collection (see pg. 44). The Aurora District implemented experimental selective passage trials in 2018 using fishway jump height (see LOMU 2018 Annual Report), whereby the fishway was left open. However, jump heights were manipulated to facilitate the passage of migratory salmonids with superior jumping abilities. Selective passage using jump height was abandoned by the district in 2019, and the district did not close the fishway, allowing LOMU to monitor and quantify the migratory salmon and trout spawning run for an entire ice-free season. In 2023, the Streetsville fishway was opened for free fish passage throughout the ice-free season.

This section includes an annual summary of the reviewed Credit River Riverwatcher data, a species-specific breakdown of the spawning migration run, and the Credit River Chinook Salmon Spawning Index.

Credit River Fish Counter (Riverwatcher)

The Credit River Riverwatcher was installed at the exit of the Streetsville Fishway on April 3rd, 2023. This in-river fish counter technology automatically counts fish as they pass through the counting tunnel and records a silhouette image and a short, high-resolution video for each fish. After installation, data were uploaded to the Riverwatcher Daily website every hour until the system was removed from the river on November 24th, 2023. The camera made 14,089 observations, of which 11,468 were upriver movement detections. After reviewing the data, 8,781 mature salmon and trout were observed moving upstream through the Streetsville Fishway (Fig. 1.5.1).

During heavy rainfall, river flows increase, making the water cloudy. As the water becomes less clear, the light from the infrared counting sensors cannot penetrate through the water, impacting the system's ability to detect movement. During these periods of high flow and turbid water, the system does not have the capacity to count fish as they move through the fishway. Additionally, during the monitoring period, the volume of fish moving through the fish counter can exceed the system's ability to count them individually. October 1st through to October 3rd, woody debris was deposited in the exit of the counter by a beaver, potentially blocking fish passage through the camera.

September 24th, 2023, marked the most active day on the Credit River fishway with a

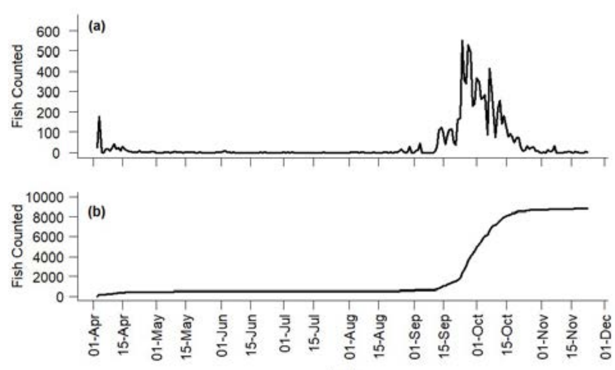

FIG. 1.5.1. (a) Daily and (b) cumulative observed fish counts at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

total of 551 salmon and trout observed migrating upstream through the Riverwatcher (Fig. 1.5.1). Throughout the monitoring period, data on Rainbow Trout, Chinook Salmon, Coho Salmon, Brown Trout and Atlantic Salmon were collected. The following paragraphs provide species-specific observations.

Rainbow Trout

A total of 584 Rainbow Trout were identified migrating upstream through the Streetsville Fishway from April 3rd to November 23rd, 2023 (Fig. 1.5.2). During the spring migration (April 3rd to May 21st, 2023), 383 Rainbow Trout (65% of all observed Rainbow Trout in 2023) moved upstream through the Streetsville Fishway. The most observations of Rainbow trout occurred on April 4th, with a total of 152 fish observed swimming up the fishway.

Chinook Salmon

A total of 7,938 Chinook Salmon were identified migrating upstream through the Riverwatcher in 2023. The 2023 Chinook observations represent a 124% increase from 2022, in which 3,541 Chinook Salmon were observed travelling upriver. The first Chinook Salmon was observed on June 20th, 2023, and the last on November 18th, 2023 (Fig. 1.5.3). The most active day for fish observed swimming through the counter occurred on September 24th, with 543 Chinook observed.

Coho Salmon

The first Coho Salmon observed at the Streetsville Fishway in 2023 was on September 14th. Sixty-five Coho Salmon were identified exiting the Streetsville Fishway upriver (Fig. 1.5.4). The last Coho Salmon observed moving through Streetsville Fishway was on November 5th, 2023. No Coho Salmon that passed through the Streetsville Fishway were recorded as having an adipose clip. The most active day for Coho migration through the fishway occurred on September 27th, with a total of six Coho observed.

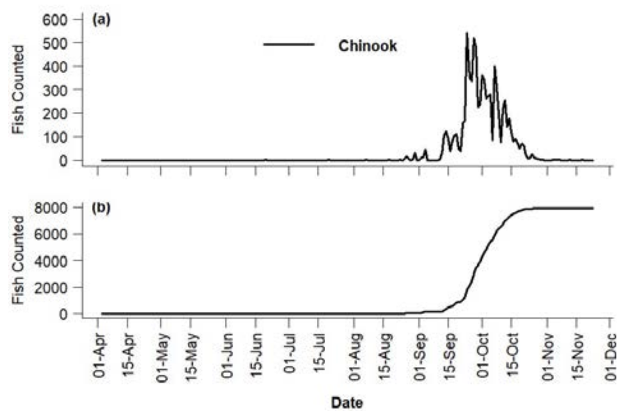

FIG. 1.5.3. (a) Daily and (b) cumulative observed counts of Chinook Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

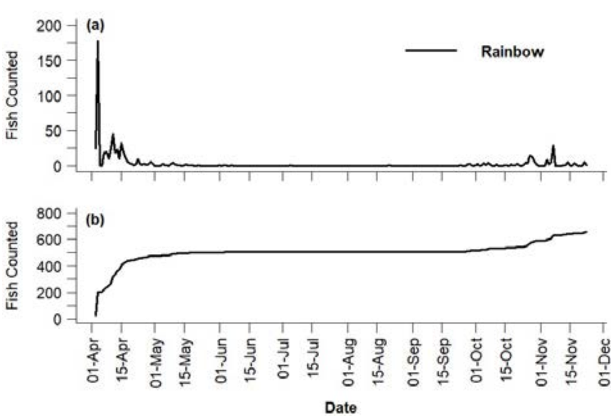

FIG. 1.5.2. (a) Daily and (b) cumulative observed counts of Rainbow Trout at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

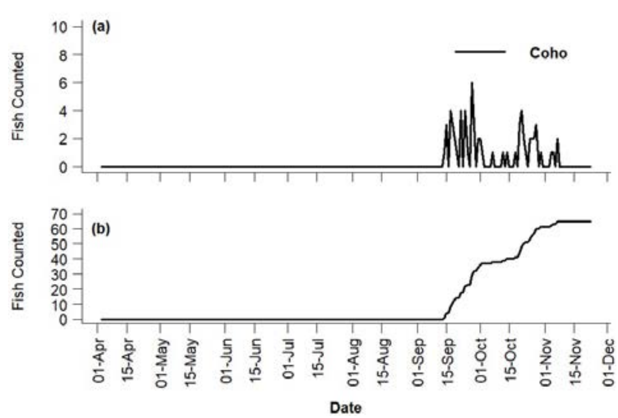

FIG. 1.5.4. (a) Daily and (b) cumulative observed counts of Coho Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

Brown Trout

The first Brown Trout observed at the Streetsville Fishway in 2023 was on May 30th, and the last was observed on November 4th. A total of 30 Brown Trout were identified exiting upstream of the Streetsville Fishway (Fig. 1.5.5). The most observations of Brown Trout occurred on September 28th, with a total four fish observed passing through the counter.

Atlantic Salmon

The first Atlantic Salmon observed at the Streetsville Fishway in 2023 was on May 16th, and the last was observed on October 28th. In total, 40 Atlantic Salmon were identified exiting upstream of the Streetsville Fishway (Fig. 1.5.6). In addition to the Riverwatcher observations, 22 Atlantic Salmon were also collected and sampled during the Chinook Salmon Spawning Index. The sampling included collecting fin clips for genetic analysis and complete biological sampling. These sampled Atlantic Salmon may contribute to the total observations made by the camera system.

Credit River Chinook Salmon Spawning Index

Each year, at the beginning of October, Chinook Salmon are captured during the fall spawning run on the Credit River, below Streetsville Dam, using electrofishing gear for gamete collections. LOMU staff have utilized the fish collections to index the growth, condition, and lamprey marking of Chinook Salmon. The Credit River Chinook Salmon Spawning Index program ran between September 26th and October 13th with eight sampling days. Length measurements were taken for 299 Chinook Salmon (non-detailed sampling) and detailed sampling occurred for 138 fish. Weight and otoliths are collected from the fish used in the gamete collection, which has the potential to be biased toward larger fish. A representative length sample of the spawning population was further sampled to mitigate this bias. The representative sample was completed by sampling 50 fish per day, which were randomly selected, measured, and checked for clips before fish were sorted for spawn collection and detailed sampling. Detailed sampling included collecting data on length, weight, fin clips, coded-wire tag (CWT), and lamprey marks, with a further subsample also having otoliths collected for age determination.

In Lake Ontario, Chinook Salmon typically return to spawn at age-2 and age-3, with some age -4 fish observed. In 2023, an increase in the proportion of age-2 Chinook was observed in the Credit River (Fig. 1.5.7).

In 2023, the average fork length of Chinook Salmon for age-3 males was 865mm, which decreased from observed values in 2022 (880mm; Fig. 1.5.8). The average fork length for age-2 males in 2023 was 757mm, a decline from 800mm in 2022. The average fork length of an age-3 female Chinook in 2023 increased to 861mm from 849mm in 2022, while the fork length of age-2 females decreased to 771mm from 786mm in 2022.

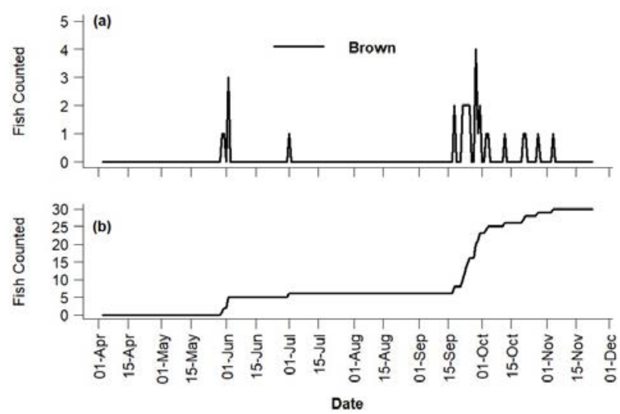

FIG. 1.5.5. (a) Daily and (b) cumulative observed counts of Brown Trout at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

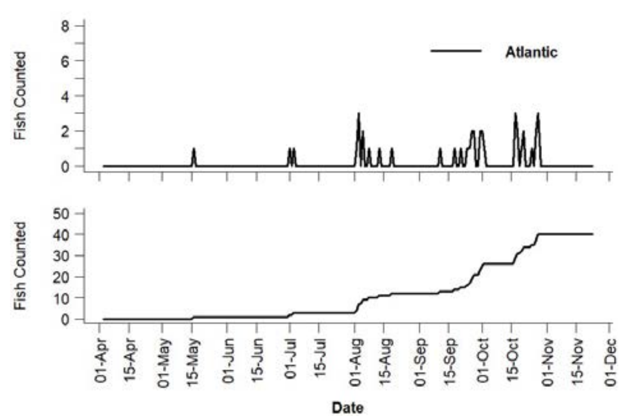

FIG. 1.5.6. (a) Daily and (b) cumulative observed counts of Atlantic Salmon at the Streetsville Fishway, Credit River, Mississauga, Ontario, from April 3rd to November 24th, 2023.

The estimated weight (based on a log-log regression) of a 914mm or 36" (total length) Chinook Salmon is used as an index of condition. In 2023, both male and female condition measures increased from 2022 (the lowest value in the time series; Fig. 1.5.9). Female condition in 2023 (7,275 g) showed an increase from 2022 (7,164 g). However, it is below the previous 10-year average (7,608 g). Male condition in 2023 (7,228 g) increased from 2022 (6,797 g) and is above the previous 10-year average (7,209 g). The absolute difference between the observed maximum and minimum conditions on the Credit River for female (1995 and 2022) and male (2016 and 2022) Chinook Salmon in this time series is 1,539 g and 760 g, respectively.

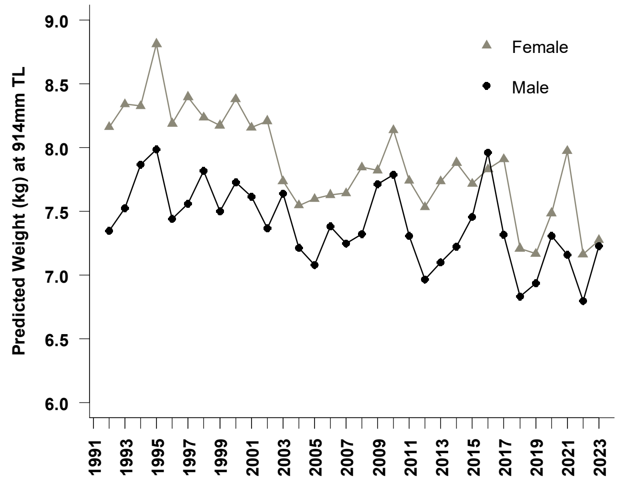

FIG. 1.5.9. Condition index as the mean weight of a 914 mm / 36 inch (total length) Chinook Salmon in the Credit River during the spawning run (approximately first two weeks of October), 1989 – 2023.

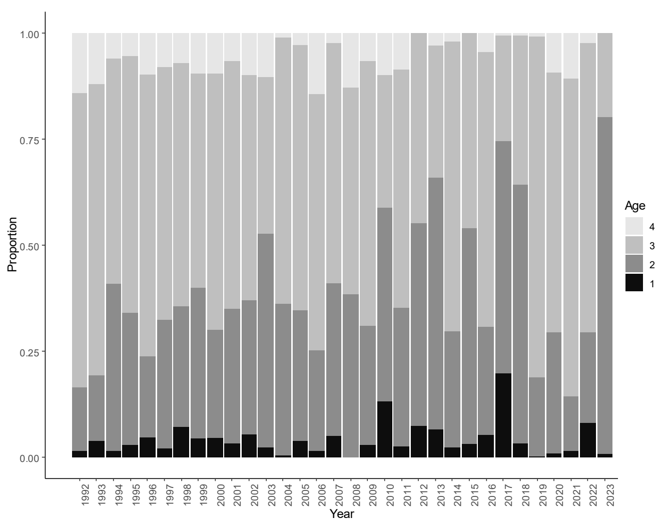

FIG. 1.5.7. Age proportions of spawning Chinook Salmon (males and females pooled) sampled during the fall Credit River Chinook Salmon Spawning Index, Credit River, Mississauga, Ontario, from 1992 – 2023. The four grey colours correspond to each age, with Age 1 being the darkest and Age 4 being the lightest.

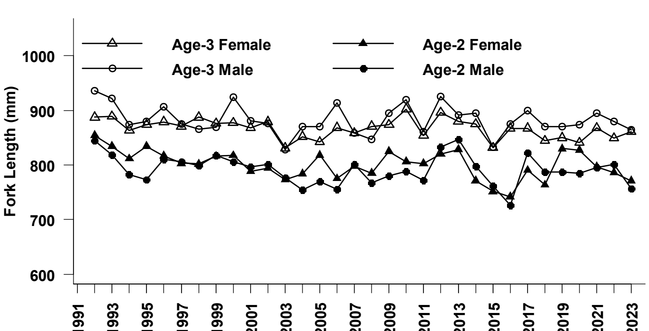

FIG. 1.5.8. Mean fork length of age-2 and age-3 Chinook Salmon by sex, caught for spawn collection in the Credit River during the fall spawning run (approximately first week of October), 1989 – 2023.

1.6 Lake Ontario Spring Prey Fish Assessment

J. P. Holden, Lake Ontario Management Unit

Since 1978, the New York State Department of Environmental Conservation (NYSDEC) and the US Geological Survey (USGS) have annually conducted 100-120 bottom trawl tows, primarily in US waters in April, to provide an index of Alewife abundance as well as biological attributes such as age distribution and body condition. As the dominant prey species in Lake Ontario, understanding Alewife abundance and age structure is important for assessing predator-prey balance and establishing stocking levels of predator species (i.e. Chinook Salmon, Lake Trout).

Since 2016, the survey has been expanded to Canadian waters with the Ontario Ministry of Natural Resources and Forestry (OMNR) trawling a portion of the Canadian sites (Fig. 1.6.1). A total of 51 sites were sampled by the OMNR vessel in 2023 spanning bottom depths from 17.4 - 159.4 m between March 28th and April 17th.

The survey generally samples depths in proportion to the lake area however there are differences in how those samples are distributed between depths and jurisdictions. The south shore has well distributed coverage of depths between 8 - 200 m that can be surveyed at multiple transects. Bottom trawling along the north shore is less uniform due to a lack of suitable soft sediment trawl sites at shallower depths. Attempts to trawl at depths shallower than 80 m in the main basin have consistently resulted in snags and torn trawls. During the day, in early spring, most Lake Ontario Alewife are found near the lake bottom in the warmer, deeper water (75 m – 150 m) thus trawl sites at depths greater than 80 m provide suitable index sites for Alewife. Additionally, shallow tows (<40 m) in Ontario waters occur disproportionately in the Kingston Basin. Efforts continue to identify suitable trawl locations along the north shore habitats of the main lake.

All vessels followed a standard trawl protocol that utilized a polypropylene mesh bottom trawl referred to as “3N1” (see Table 1.6.1 for trawl dimensions) equipped with rubber discs that elevate the footrope off bottom to minimize catches of Dreissenid mussels. NYSDEC and USGS vessels used USA Jet slotted, metal, cambered trawl doors (1.22 m x 0.75 m) while OMNR used comparable Thyborne doors to spread the trawl. Trawl mensuration gear was used to record door spread, bottom time and headrope depth. Sampling protocol seeks a target tow time of 5 minutes but actual bottom time is known to vary with depth.

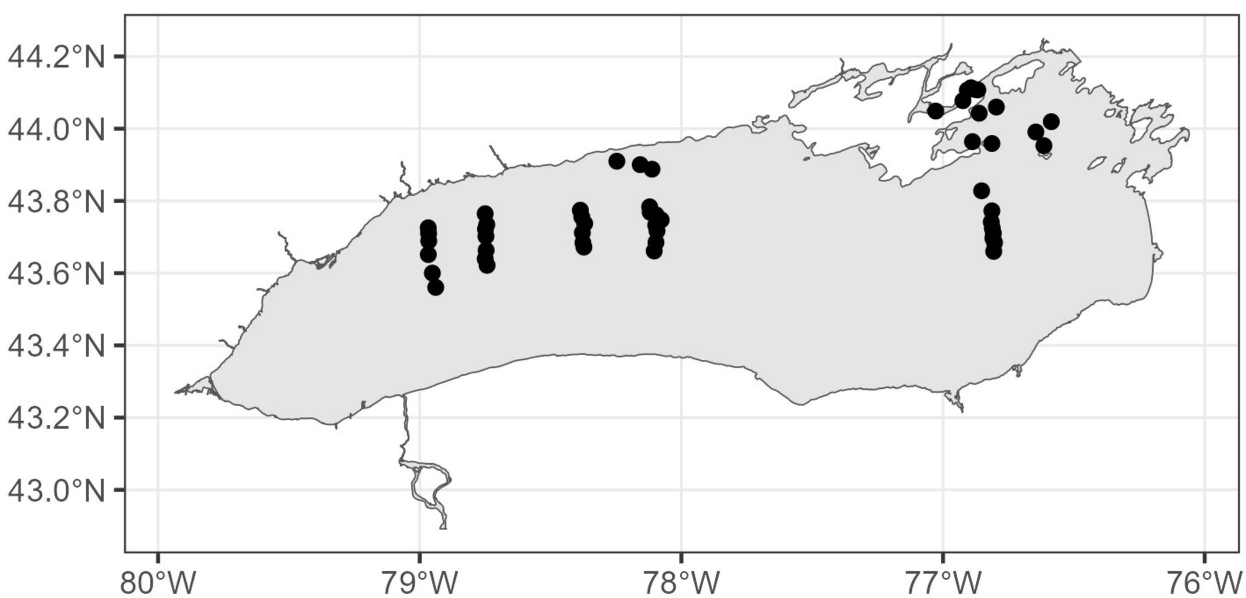

FIG. 1.6.1. Tow sites conducted in the Ontario waters of Lake Ontario by the MNRF vessel Ontario Explorer during the Spring Prey Fish Survey. Additional sites in the US and in Canada were conducted by USGS and NYSDEC.

Sites were further expanded in 2019 to include more embayments throughout the lake. Within Ontario waters, the majority of these sites were within the Bay of Quinte. Throughout the survey, Alewife were the most abundant species caught (N = 259,137) followed by Deepwater sculpin (N = 17,421); and Rainbow smelt (N = 5,435). Full catch data is presented in Table 1.6.2.

The Lake Ontario Spring Prey Fish Survey is a subset of a binational prey fish assessment program. The complete data set is available through the Ontario Open Data Catalogue (https://data.ontario.ca/en/dataset/lake-ontario-prey-fish-trawl-data).

TABLE 1.6.1. Gear specifications for the polypropylene mesh bottom trawl referred to as "3N1" and equipped with rubber discs that elevate the footrope off bottom to minimize catches of Dreissenid mussels.

Component	Description
Headrope length	20 m
Footrope length	22 m
Codend mesh	15.2 mm knotless nylon
Gear height	3.5 m
Fishing width	7 m
Cookie sweep description	Composed of 100 mm diameter rubber discs that sit 0.3 m below the footrope
Door weight	125 kg
Door area	0.93 m^2
Door height	1.2 m

TABLE 1.6.2. Species composition across all trawl sites conducted in Ontario waters by the MNRF vessel Ontario Explorer during the Spring Prey Fish Survey.

Species	Total Number	Total Weight (kg)	Number of tows that captured the species
Alewife	259,137	4,053.21	38
Deepwater Sculpin	17,421	452.03	30
Rainbow Smelt	5,435	30.85	47
Round Goby	509	3.60	11
Threespine Stickleback	53	0.08	12
Yellow Perch	49	1.18	5
Slimy Sculpin	34	0.14	7
White Perch	29	3.04	5
Lake Whitefish	28	3.58	3
Freshwater Drum	9	13.28	2
Cisco (Lake Herring)	8	1.79	2
Spottail Shiner	7	0.05	2
Trout-perch	6	0.07	2
Walleye	5	0.70	1
Rock Bass	2	0.04	2
Lake Trout	1	0.03	1
White Sucker	1	0.14	1

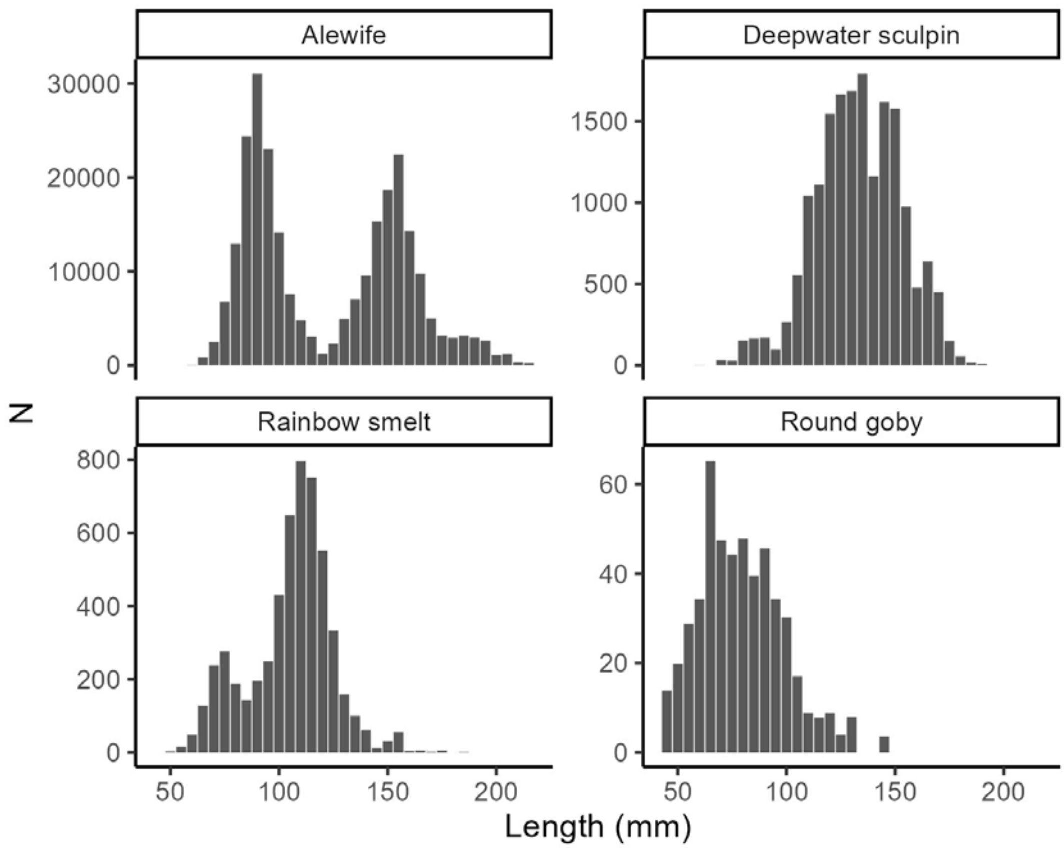

FIG. 1.6.2. Size distribution of Alewife, Deepwater Sculpin, Rainbow Smelt and Round Goby captured across all trawl sites conducted in Ontario waters by the MNRF vessel Ontario Explorer during the Spring Prey Fish Survey. Length is recorded as total length to the nearest millimeter.

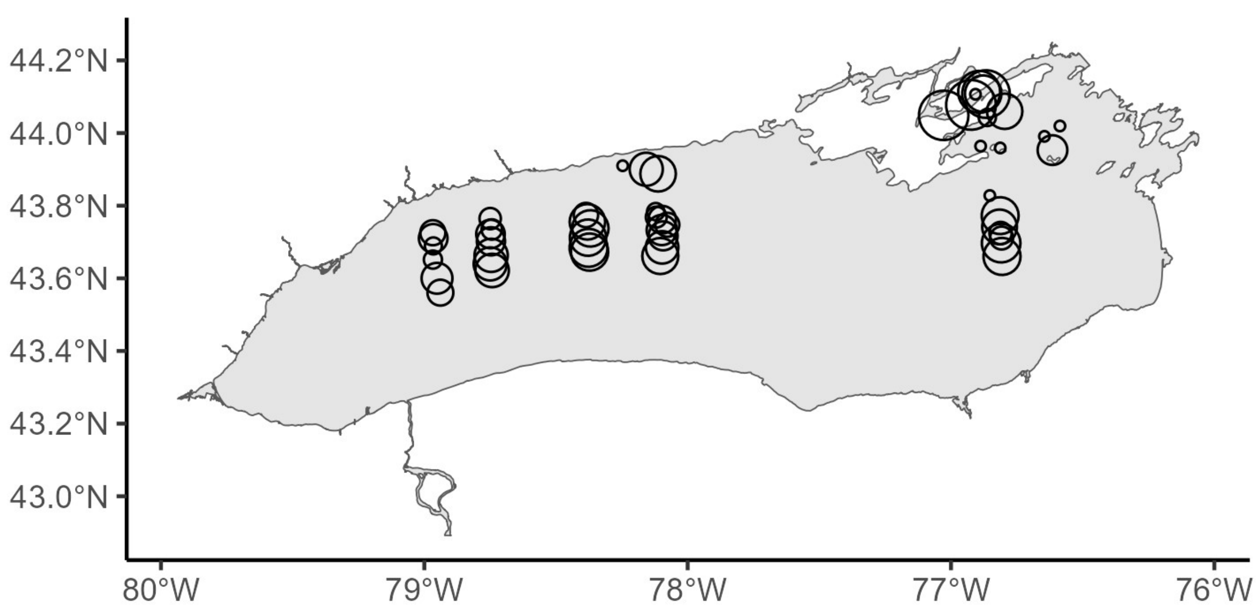

FIG. 1.6.3. Shannon-Weaver Diversity Index from trawl catches across all trawl sites conducted in Ontario waters by the MNRF vessel Ontario Explorer during the Spring Prey Fish Survey. Size of the bubble indicates the species diversity captured at the site. Diversity score is a function of the number of species captured at a site and the relative abundance of each species. Larger values indicate greater species richness and even-ness of each species abundance. Species richness (number of species captured) ranged from 0 to 10.

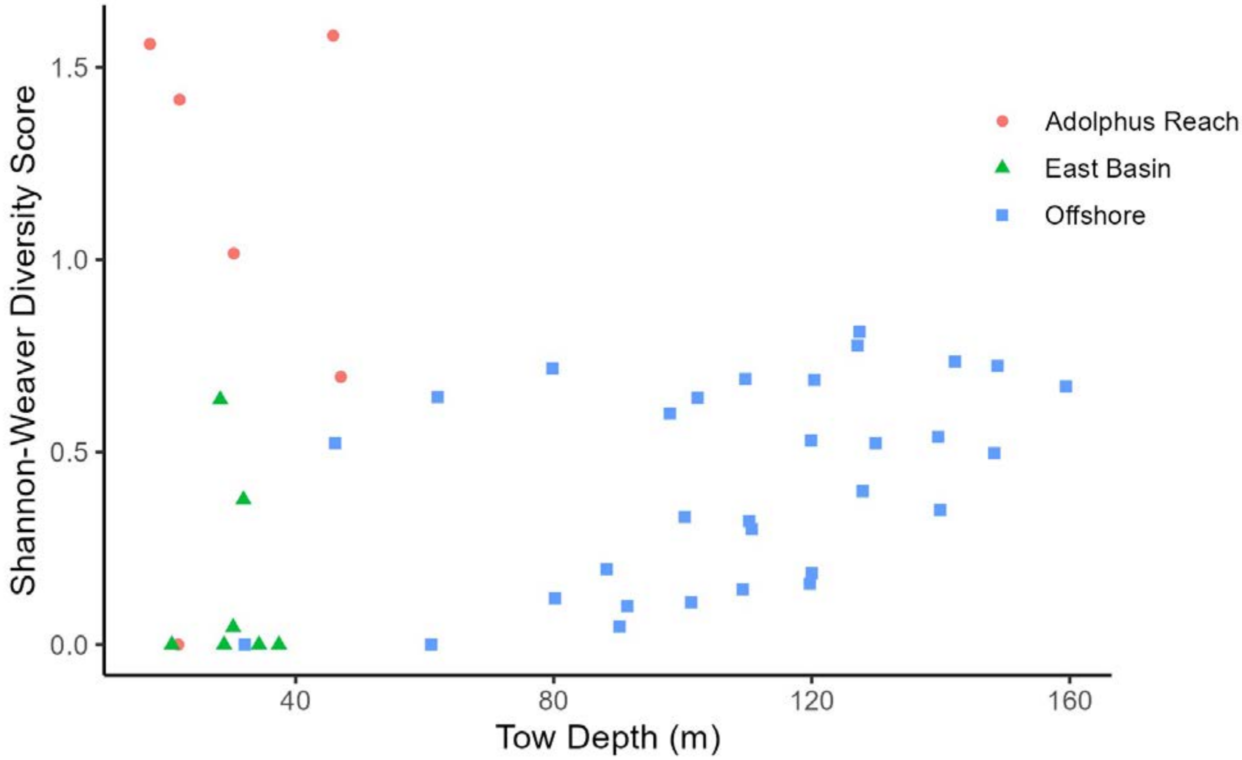

FIG. 1.6.4. Shannon-Weaver Diversity Index by trawl depth for trawl site in the spring prey fish trawls conducted by the OMNR vessel. Diversity score is a function of the number of species captured at a site and the relative abundance of each species.

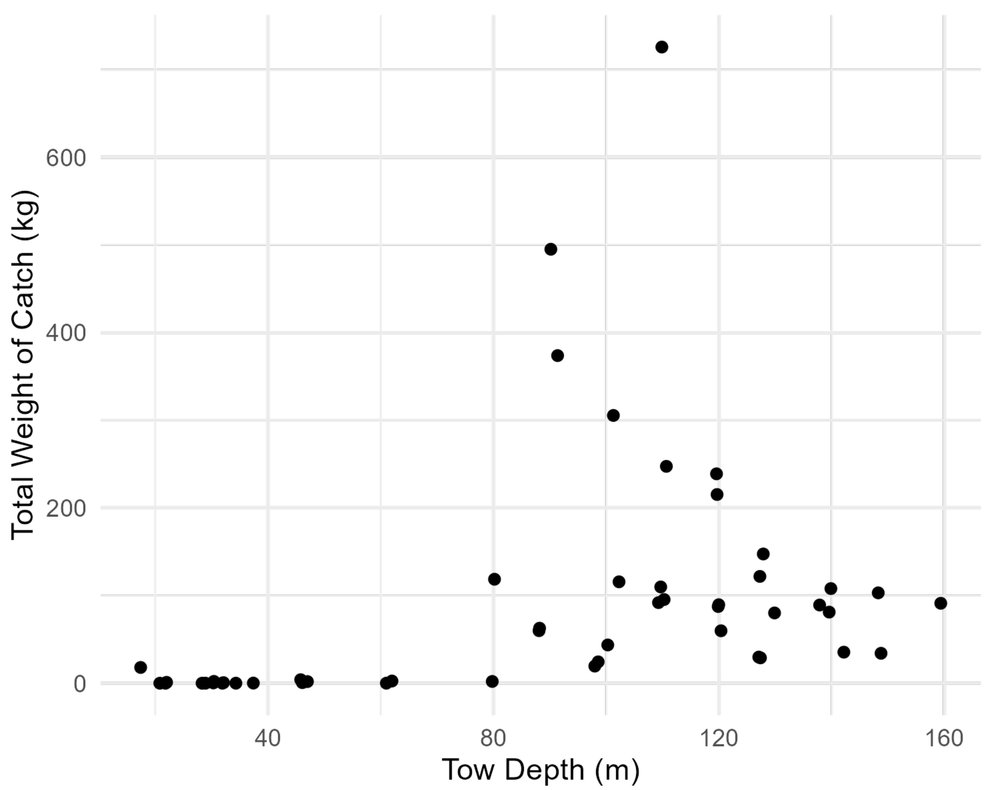

FIG. 1.6.5. Total trawl catch (kg) by station depth illustrates that the majority of the Lake Ontario prey biomass is offshore during the spring survey. The single high abundance site was from the Bay of Quinte and was dominated by White Perch and Freshwater Drum.

1.7 Lake Ontario Fall Benthic Prey Fish Assessment

J. P. Holden, Lake Ontario Management Unit

The Lake Ontario offshore prey fish community was once a diverse mix of pelagic and benthic fish but by the 1970s the only native fish species that remained abundant was Slimy Sculpin. Recent invasions of dressenid mussels and Round Goby have further changed the offshore fish community. The Lake Ontario Fall Benthic Prey Fish Survey provides an index of how prey fish abundance, distribution and species composition has adapted through time in response to environmental change and species invasions.

A benthic prey fish assessment in the main basin of Lake Ontario has historically only been conducted by the US Geological Survey (USGS). The survey assessed prey fish along six southern-shore, US transects in depths from 8 - 150m. However, the restricted geographic and depth coverage prevented this survey from adequately informing important benthic prey fish dynamics at a whole-lake scale, including monitoring the reappearance of Deepwater Sculpin. In 2015, this program was expanded to include additional trawl sites conducted by OMNR and New York Department of Environmental Conservation (NYSDEC) with additional support provided from the US Fish and Wildlife Service (USFWS). The current survey provides abundance indices for Sculpin sp., Round Goby and Bloater with survey techniques comparable to Lake Michigan.

The Ontario portion of the 2023 survey consisted of 53 trawls conducted from September 18th through October 20th at transects across the north shore and in the Kingston Basin (Fig. 1.7.1). Shallow tows (<40m) in Ontario waters are largely confined to the Kingston Basin due to limited suitable sites across the north shore. Past efforts to trawl these areas have resulted in snags and damaged gear due to rocky substrate and large boulders.

The survey is conducted with a 3/4 Yankee Standard using Thyborne metal doors. Depth loggers and wing sensors were used on all trawls to provide estimates of true bottom time and net opening to standardize catches with historical surveys and with US vessels. Sites within the Bay of Quinte use a different trawl design (3N1) that has special foot gear to prevent the trawl from filling with mud.

Round Goby were the most abundant species caught (N = 14,095), followed by Deepwater Sculpin (N = 8,693) and Alewife (N = 3,050). Full catch data is presented in Table 1.7.1.

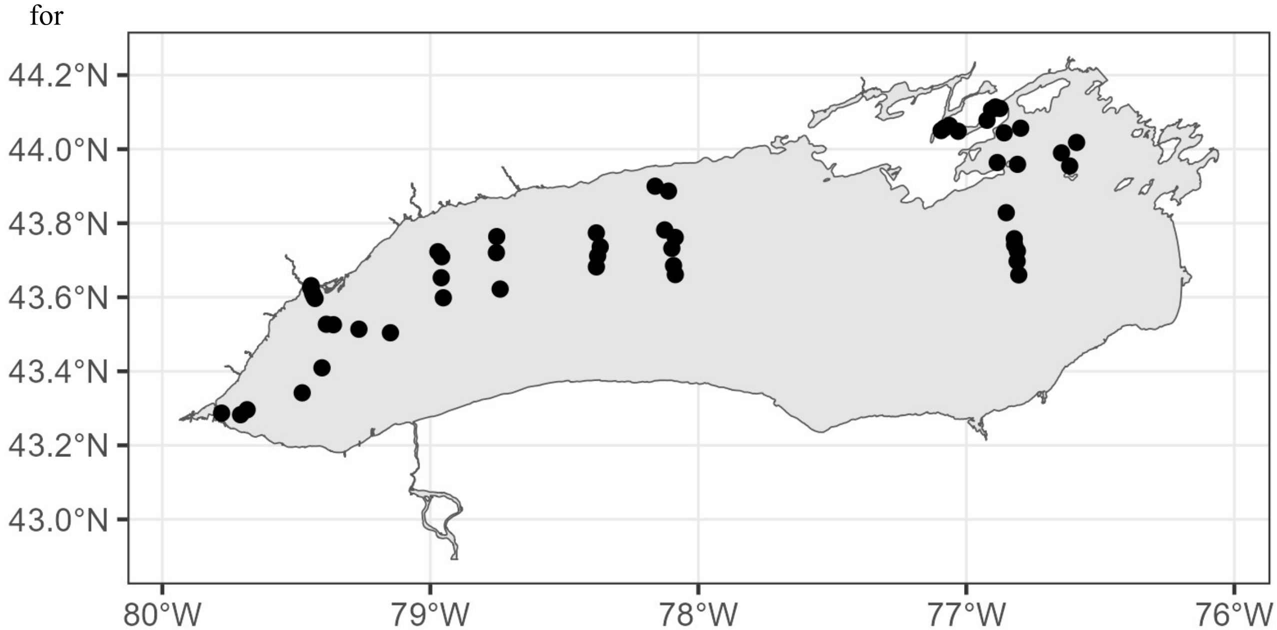

FIG. 1.7.1 Tow sites conducted in the Ontario waters of Lake Ontario by the MNRF vessel Ontario Explorer during the Fall Benthic Prey Fish Survey. Additional sites in the US were conducted by USGS and NYSDEC.

The Lake Ontario Fall Benthic Prey Fish Survey is a subset of a binational prey fish assessment program. The complete data set is available through the Ontario Open Data Catalogue (https://data.ontario.ca/en/dataset/lake-ontario-prey-fish-trawl-data).

TABLE 1.71. Species composition across all trawl sites conducted in Ontario waters by the MNRF vessel Ontario Explorer during the Fall Benthic Prey Fish Survey.

Species	Total Number	Total Weight (kg)	Number of tows that captured the species
Round Goby	14,095	32.120	25
Deepwater Sculpin	8,693	189.137	29
Alewife	3,050	101.911	34
Rainbow Smelt	2,273	13.627	29
White Perch	989	94.525	5
Slimy Sculpin	265	2.209	18
Yellow Perch	144	2.503	4
Trout-perch	107	1.354	5
Brown Bullhead	34	13.017	2
Freshwater Drum	23	7.252	5
Gizzard Shad	22	1.367	2
Spottail Shiner	15	0.146	1
Walleye	12	9.405	2
White Bass	11	0.542	1
Lake Whitefish	9	3.808	2
White Sucker	6	2.914	2
Threespine Stickleback	3	0.004	1
Lake Trout	2	4.361	2
Cisco (Lake Herring)	1	0.020	1

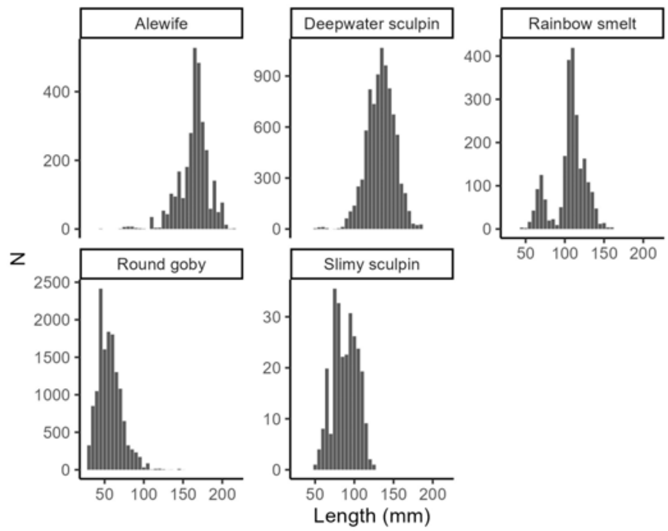

FIG. 1.7.2. Size distribution of Alewife, Deepwater Sculpin, Rainbow Smelt, Round Goby and Slimy Sculpin captured across all trawl sites conducted in Ontario waters by the MNRF vessel Ontario Explorer during the Fall Benthic Prey Fish Survey. Length is recorded as total length to the nearest millimeter.

1.8 Experimental Nearshore Midwater Trawl Program for Age-0 Salmon and Alewife

J. P. Holden, Lake Ontario Management Unit

Midwater trawl surveys are used extensively in marine surveys to provide an index of year-class strength based on a young-of-year catch per unit effort. In 2018, as part of the lake wide Cooperative Science and Monitoring Initiative, a September acoustic and midwater trawl survey was undertaken to supplement the annual July survey. A small number of juvenile Chinook were caught in the midwater trawl at sites near Cobourg and Port Hope. In 2020, a small number of tows (N = 10) were conducted in late September near Cobourg. No Chinook were caught during those experimental tows. It is suspected that those tows were too late in the season (surface temperatures had started to drop) and too far off-shore. A smaller midwater trawl was used in 2021 and the timing window was moved to late August. This approach allowed tows to be conducted near the surface and in shallower depths (<20m) not previously surveyed with the larger trawl gear. Fifty tows were completed during the survey window with a heavy emphasis on nearshore areas (depths < 20m). Of the 50 tows, nine captured Chinook Salmon (N total = 12). Unlike in the ocean surveys that use large nets and tow near the surface, the tows that did result in Chinook Salmon catches seemed to be nearshore sites (9 to 15m bottom depth) and where the net was fished close to bottom (7 to 13m fishing depth). Fish were captured across a wide range of temperatures between 10 to 20°C. In 2023, the project was expanded to a binational effort with sites in the USA being surveyed by the US Geological Survey (USGS) and New York Department of Environmental Conservation (NYSDEC) and designed to target the nearshore areas. Given the proximity of salmon to bottom in the 2021 survey; the USGS opted to test the effectiveness of a large bottom trawl (3N1 typically used in spring trawl survey) rather than attempt to fish a midwater trawl in close proximity to bottom. Only results from the Ontario portion of the survey are reported here.

The project had 34 net tows along the north central portion of the lake near Cobourg and Port Hope. The average effort duration was 12 minutes (range: 6 to 18 minutes). Tows were conducted at site depths ranging from 12.2 to 34 m and surface temperatures ranging from 20.2 to 23.1°C. Midwater tows were conducted in depths ranging from 12.2 to 34 m at temperatures ranging from 7.4 to 19.7°C.

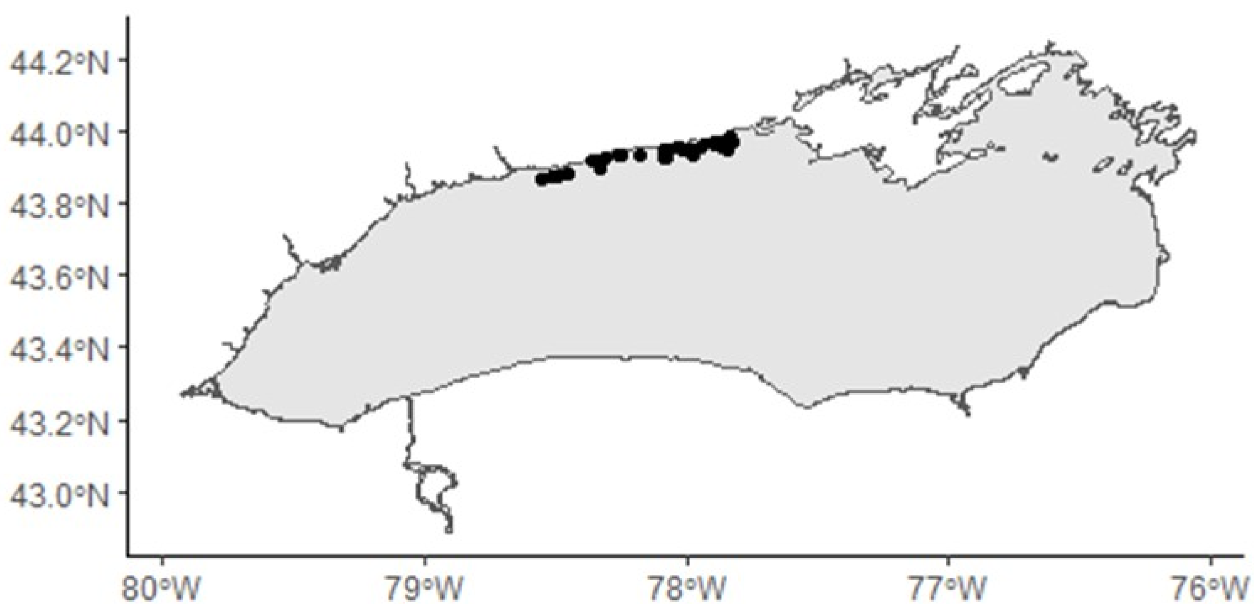

FIG. 1.8.1. Location data for Lake Ontario Experimental Nearshore Midwater Trawling

There were 5 species and 5,847 fish caught over the duration of this project, 537 of which were biologically sampled for length and weight as well as 2,267 sampled for length only. The majority of species caught were Round Goby (N = 4,751), followed by Alewife (N = 492) and Rainbow Smelt (N = 470). No juvenile salmonid species were captured during this survey despite tows being conducted in similar areas, depths and temperatures as in 2021. Despite not catching any salmonid species the survey did capture age-0 Alewife. Further research is required to determine whether catches of age-0 Alewife at this time have the potential to be an early indicator of year-class strength.

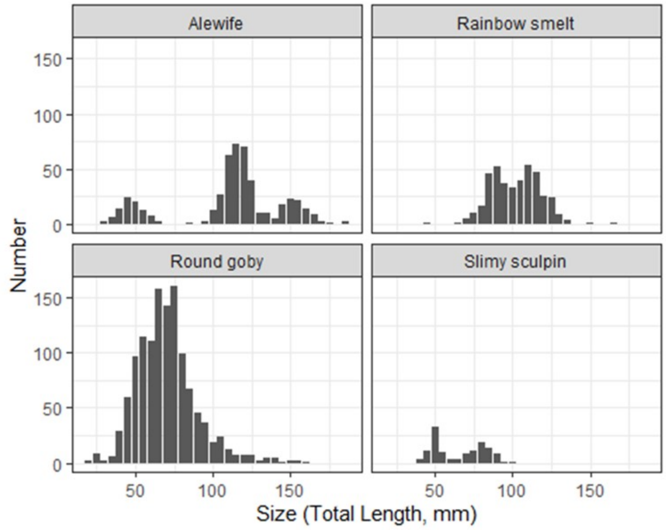

FIG. 1.8.2. Size distribution for common prey species captured in the Lake Ontario Experimental Nearshore Midwater Trawling.

1.9 Lake St. Francis Community Index Gill Netting

T. Gristey and M. J. Yuille, Lake Ontario Management Unit

The Lake Ontario Management Unit (LOMU) conducts a Fish Community Index Gill Netting Survey in Lake St. Francis every other year in early fall. Since 2019, the St. Lawrence River Fish Community Index Gill Netting Survey (Lake St. Francis and Thousand Islands) has been redesigned and conducted annually. The netting effort is allocated to randomly selected sites within four depth zones based on their proportional representation within the study area. The catches are used to estimate fish abundance and measure biological attributes. Structures and tissues are collected for age determination, stomach content analyses, contaminant analyses and pathological examinations. The survey is part of a larger collaborative effort between the Ontario Ministry of Natural Resources (OMNR) and the New York State Department of Environmental Conservation (NYSDEC) to monitor changes in the fish communities in four distinct sections of the St. Lawrence River: Thousand Islands, Middle Corridor, Lake St. Lawrence and Lake St. Francis.

In 2023, the survey was conducted from September 5th to 13th. Fifteen nets were deployed using standard multi-panel gill nets with monofilament meshes ranging from 1½ to 6 inches at half-inch increments (Fig. 1.9.1). Due to potential net fouling and other issues that could impact the net's efficiency and results, six nets were removed from the final analysis, and nine nets were used. The nets were fished for approximately 24 hours. To standardize netting between OMNR and NYSDEC, gill net specifications changed from using multifilament

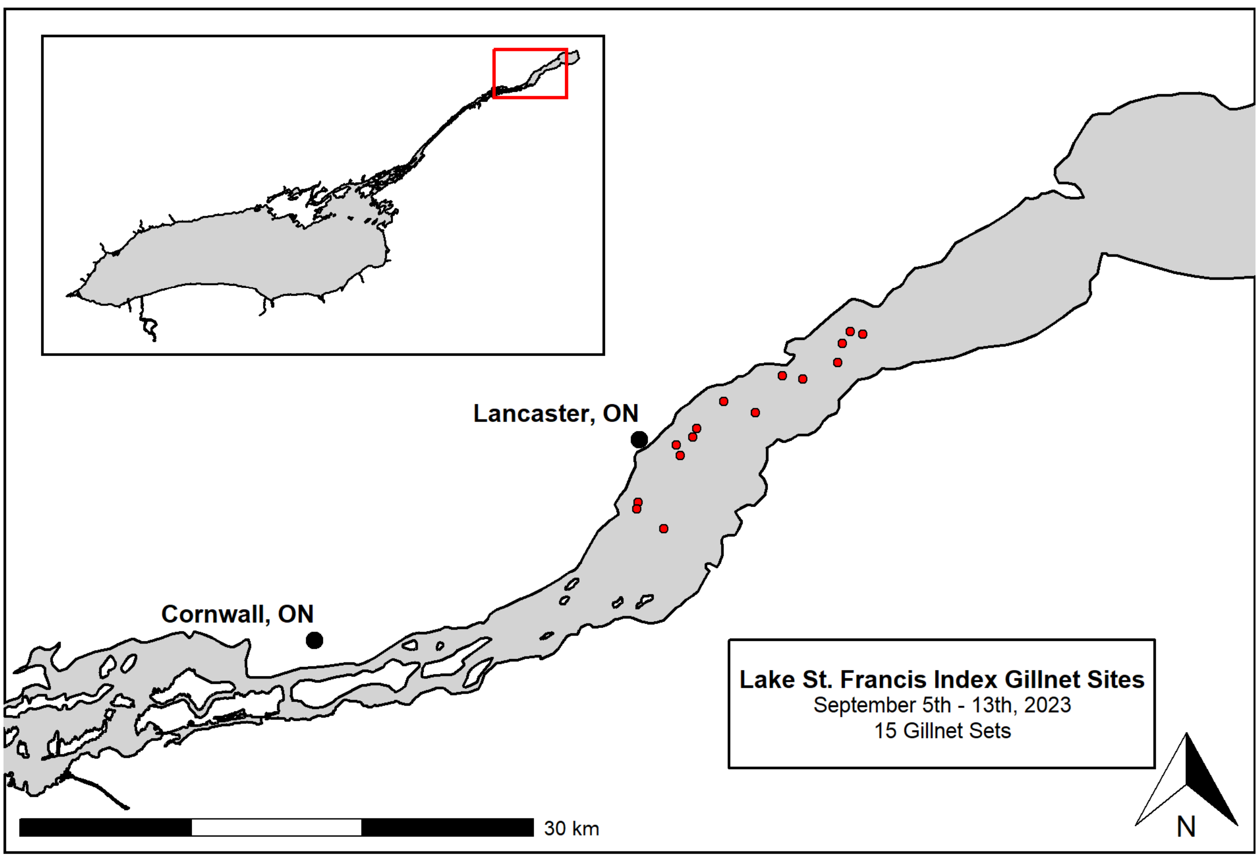

FIG. 1.9.1. Map of Lake St. Francis Community Index Gill net locations.

to monofilament in 2002. All catches in the OMNR data series using multifilament in the St. Lawrence River before 2002 were increased by a factor of 1.58 to account for the gear change.

In total, 163 fish were caught, which included 12 different fish species (Table 1.9.1). The number of fish per net in 2023 (18 fish per standard gill net; Fig. 1.9.3) increased from the 2022 survey and remained below the time series average (Fig. 1.9.2). The dominant species caught was Yellow Perch, constituting 39% of the total catch and 14% of the catch by weight (Fig. 1.9.2). The dominant species in weight or biomass was Walleye, representing 32% of the total catch weight and 9% of the total fish caught (Fig. 1.9.2).

Species Highlights

Yellow Perch

Catches of Yellow Perch have declined from peak levels seen in 2008 and 2010 (Fig. 1.9.4). In 2023, catches of Yellow Perch (7.00 fish per net) declined compared to 2022 levels (8.20 fish per net) and remained below the time series average (14.28 fish per net; Table 1.9.1). The proportion of large fish (> 220 mm) observed in catches (20% of the catch in 2023) is consistent with the previous year's surveys (21% in 2022); however, overall abundance remains low (Fig. 1.9.4). Yellow Perch catches in 2022 contained fish from age-1 to age-5, with age-3 being the most dominant (Fig. 1.9.5).

Centrarchids

The centrarchids are represented by six species in Lake St. Francis: Rock Bass, Pumpkinseed, Bluegill, Smallmouth Bass, Largemouth Bass and Black Crappie (Figs. 1.9.5 and 1.9.6). Rock Bass remain the most abundant of the centrarchids, with catches in 2023 (5.22 fish per net) indicating an increase from the previous 2022 survey (2.20 fish per net) and an increase to the previous 10-year average (2.18 fish per net). Smallmouth Bass catches decreased in 2023 compared to the 2022 survey (0.78 compared to 0.87 fish per net, respectively) and are above the previous 10-year average (0.47 fish per net; Fig. 1.9.5). Smallmouth Bass caught in the 2023 survey ranged from age-2 to age-6, with the highest proportion of fish being age-3. Largemouth Bass and Pumpkinseed catches have been sporadic over the past eight surveys. In 2023, Largemouth Bass catches per net (0.78 fish

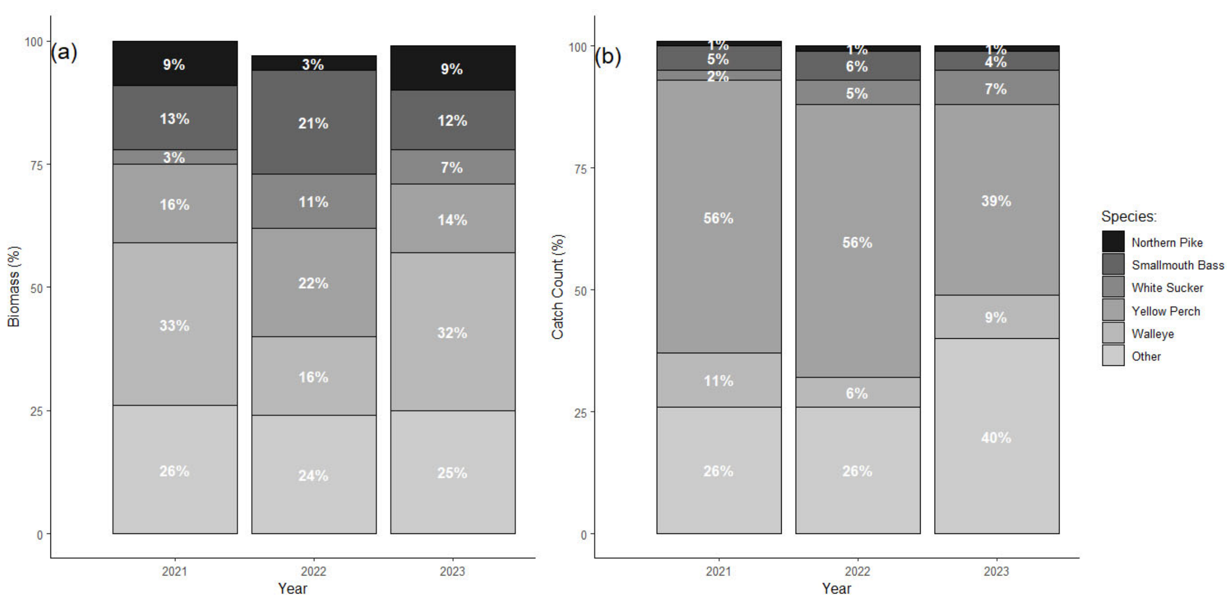

FIG. 1.9.2. Species composition by (a) catch and (b) biomass in the Lake St. Francis community index gill netting program from 2021 to 2023.

per net) are above the previous 10-year average (0.37 fish per net). Pumpkinseed catches (0.22 fish per net) are similar to the previous 10-year average (0.21 fish per net). In the 2023 survey, no Bluegill or Black Crappie were caught (Figs. 1.9.5 and 1.9.6).

Northern Pike

Northern Pike catches in 2023 (0.22 fish per net) are consistent with catches over the previous ten years (an average of 0.17 fish per net). Northern Pike abundance has declined since the early 1990s and is below the historical average of 1.82 fish per net (Table 1.9.1). Two Northern Pike were caught in 2023, and both were considered large (> 500 mm); one was age 3, and the other was age 5. No Muskellunge were caught in 2023.

Walleye

Walleye represented 9% of the total catch and 32% of the total biomass caught in 2023, with 15 individuals caught (Fig. 1.9.2 and Table 1.9.1). The average catch per net declined from 2021 and is currently equal to the previous 10-year average (0.87 fish per net). Generally, catches of small (≤ 500 mm) and large (>500 mm) Walleye have been equally represented. In 2023, small fish represented 85% of the catch, while large fish represented the remaining 15% (Fig. 1.9.8). Walleye ages ranged from 1 to 6 years, with the majority being age 3 (Fig. 1.9.9).

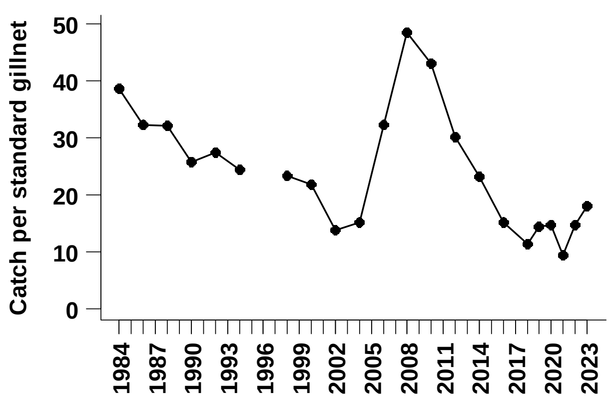

FIG. 1.9.3. Average catch per standard gill net set of all species combined, Lake St. Francis, 1984 - 2023. The survey was not conducted in 1996.

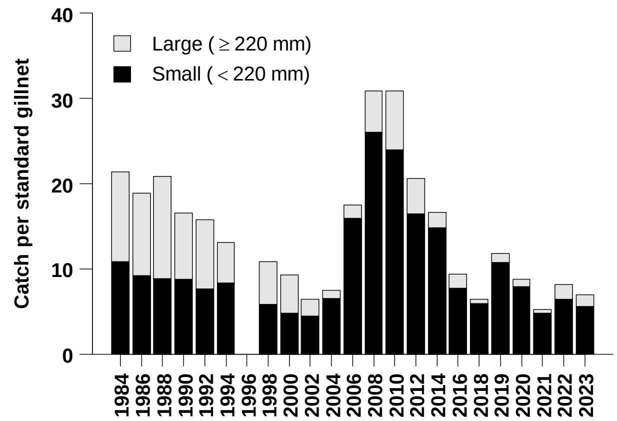

FIG.1.9.4. Catches of small (< 220 mm total length) and large (≥ 220 mm total length) Yellow Perch in the Lake St. Francis community index gill netting program, 1984 - 2022. The survey was not conducted in 1996.

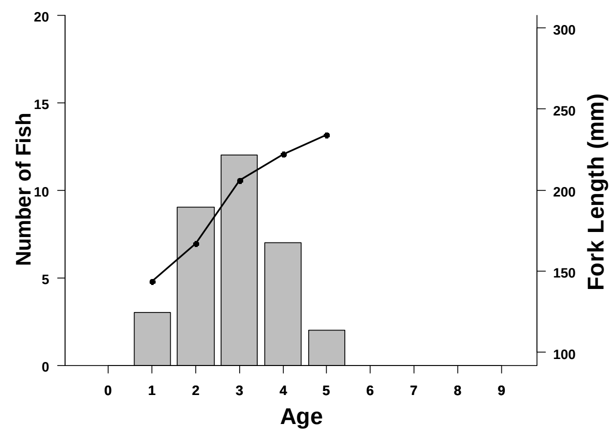

FIG. 1.9.5. Age distribution (bars) and mean fork length at age (mm) of Yellow Perch caught in Lake St. Francis, 2023.

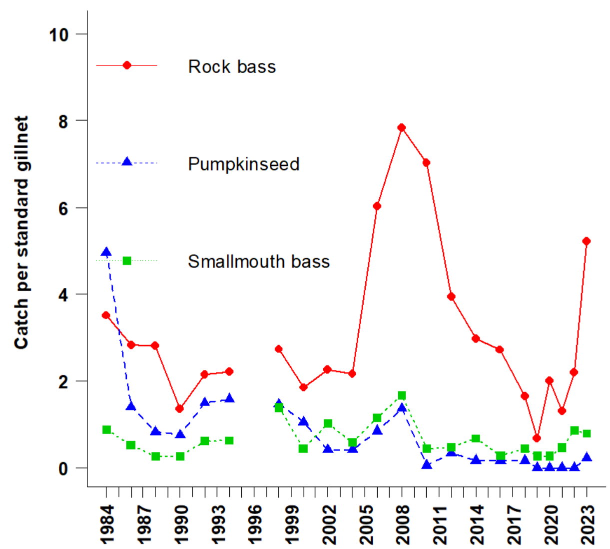

FIG. 1.9.6. Rock Bass (circle, red), Pumpkinseed (triangle, blue) and Smallmouth Bass (square, green) catch per standard gill net set in Lake St. Francis, 1984 - 2023.

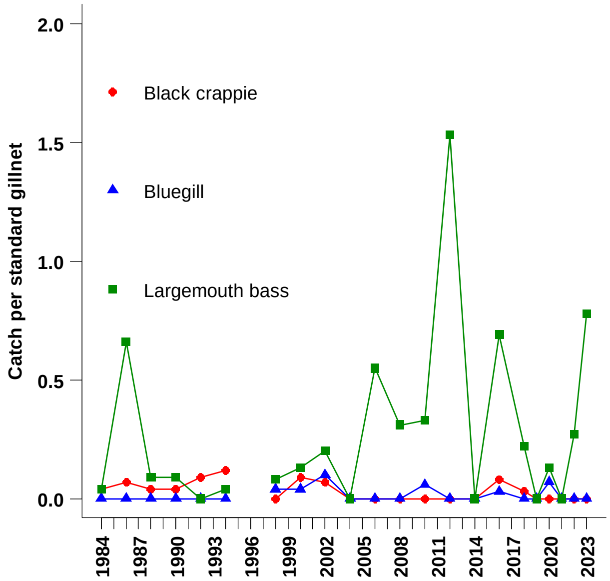

FIG. 1.9.7. Black Crappie (circle, red), Bluegill (triangle, blue), and Largemouth Bass (square, green) catch per standard gill net set in Lake St. Francis, 1984 - 2023.

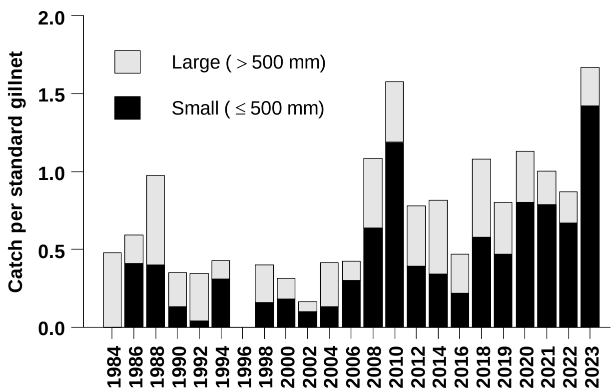

FIG. 1.9.8. Catches of small (≤ 500 mm total length) and large (> 500 mm total length) Walleye in the Lake St. Francis community index gill netting program, 1984 - 2023. The survey was not conducted in 1996.

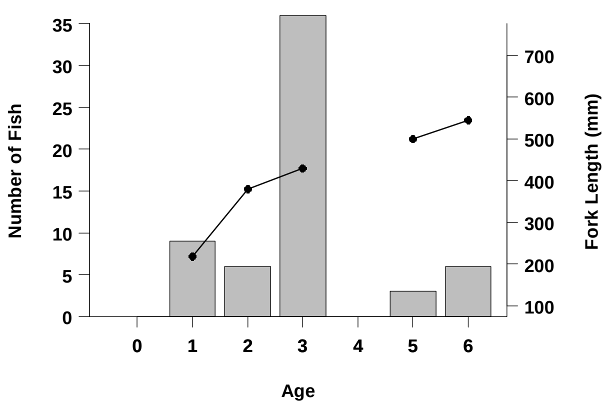

FIG. 1.9.9. Age distribution (bars) and mean fork length (circles) of Walleye caught in Lake St. Francis, 2023.

TABLE 1.9.1. Summary of catches per gill net set in the Lake St. Francis Fish Community Index Gill netting Program, 1984 - 2023. All catches prior to 2002 were adjusted by a factor of 1.58 to be comparable to the new netting standard initiated in 2002. No survey was conducted in 1996.

Species	1984 - 2010	2012	2014	2016	2018	2019	2020	2021	2022	2023
Lake Sturgeon	0.01	0.03	--	0.03	--	--	--	--	--	--
Longnose Gar	0.14	0.22	--	0.28	--	0.07	1.13	0.15	0.20	0.11
Bowfin	--	--	--	--	--	--	--	--	--	--
Alewife	0.03	0.14	0.03	--	--	0.20	--	--	--	--
Gizzard Shad	--	--	--	0.06	--	--	--	--	--	--
Salvelinus sp.	0.00	--	--	--	--	--	--	--	--	--
Northern Pike	2.85	0.19	0.31	0.14	0.14	0.20	0.13	0.08	0.13	0.22
Muskellunge	0.01	--	0.03	--	--	--	--	--	--	--
White Sucker	1.45	1.17	1.25	0.56	0.47	0.33	0.67	0.15	0.80	1.22
Silver Redhorse	0.03	0.06	0.03	0.06	0.11	--	0.07	--	0.13	--
Shorthead Redhorse	--	0.28	0.06	0.03	0.03	0.07	--	0.38	0.27	0.33
Greater Redhorse	0.01	--	--	--	--	--	--	--	0.07	--
River Redhorse	0.02	--	--	--	--	--	--	--	--	--
Moxostoma sp.	0.03	--	--	--	0.11	--	--	--	--	--
Common Carp	0.04	--	--	--	--	--	--	--	--	--
Golden Shiner	0.01	--	--	0.06	0.22	--	--	--	--	--
Creek Chub	0.01	--	--	--	--	--	--	--	--	--
Fallfish	0.01	--	--	0.03	0.14	--	0.13	0.54	0.53	0.33
Brown Bullhead	1.18	0.25	0.14	0.03	--	--	--	--	0.13	0.11
White Perch	--	--	--	0.03	--	--	0.07	--	--	--
Rock Bass	3.44	3.94	2.97	2.72	1.64	0.67	2.00	1.31	2.20	5.22
Pumpkinseed	1.28	0.33	0.17	0.17	0.17	--	--	--	--	0.22
Bluegill	0.02	--	--	0.03	--	--	0.07	--	--	--
Smallmouth Bass	0.76	0.47	0.67	0.28	0.44	0.27	0.27	0.46	0.87	0.78
Largemouth Bass	0.19	1.53	--	0.69	0.22	--	0.13	--	0.27	0.78
Black Crappie	0.04	--	--	0.08	0.03	--	--	--	--	--
Yellow Perch	16.92	20.64	16.67	9.36	6.50	11.80	8.80	5.23	8.20	7.00
Walleye	0.58	0.78	0.81	0.47	1.08	0.80	1.13	1.00	0.87	1.67
Freshwater Drum	0.01	--	--	0.03	--	--	--	--	--	--
All Species	29.06	30.03	23.14	15.14	11.30	14.41	14.60	9.30	14.67	17.99
Count of Species	12.85	14	12	20	14	9	12	9	13	12

1.10 St. Lawrence River Fish Community Index Netting – Thousand Islands

A. J. Row and M. J. Yuille, Lake Ontario Management Unit

Traditionally, the Lake Ontario Management Unit (LOMU) conducts a Fish Community Index Gill Netting Survey in the Thousand Islands every other year in early fall. In 2019, the St. Lawrence River Fish Community Index Gill Netting Survey (Thousand Islands and Lake St. Francis) was redesigned to be conducted annually. Netting effort is allocated to randomly selected sites within four depth zones based on their proportional representation in the study area. The catches are used to estimate abundance, measure biological attributes, and collect materials for age determination, stomach contents and tissues for contaminant analysis and pathological examination. The survey is part of a larger collaborative effort with New York State Department of Environmental Conservation (NYSDEC), monitoring changes in the fish communities in four sections of the St. Lawrence River (Thousand Islands, Middle Corridor, Lake St. Lawrence, and Lake St. Francis) to provide comprehensive assessment of the river's fisheries resources. In 2023, the survey was conducted between September 18th and September 27th. Twenty-five nets were deployed, using standard gill nets consisting of 25-foot panels of monofilament meshes ranging from 1.5 to 6 inches in half-inch increments (Fig. 1.10.1). The nets were fished for approximately 24 hours. The overall catch was 857 fish comprising 18 species (summary in Table 1.10.1). The average number of fish per set was 38.97, an increase from the previous 10-year average (33.7 fish per set; Fig. 1.10.2). Yellow Perch remained the dominant species caught in the nets followed by Smallmouth Bass and Rock Bass (Fig. 1.10.3).

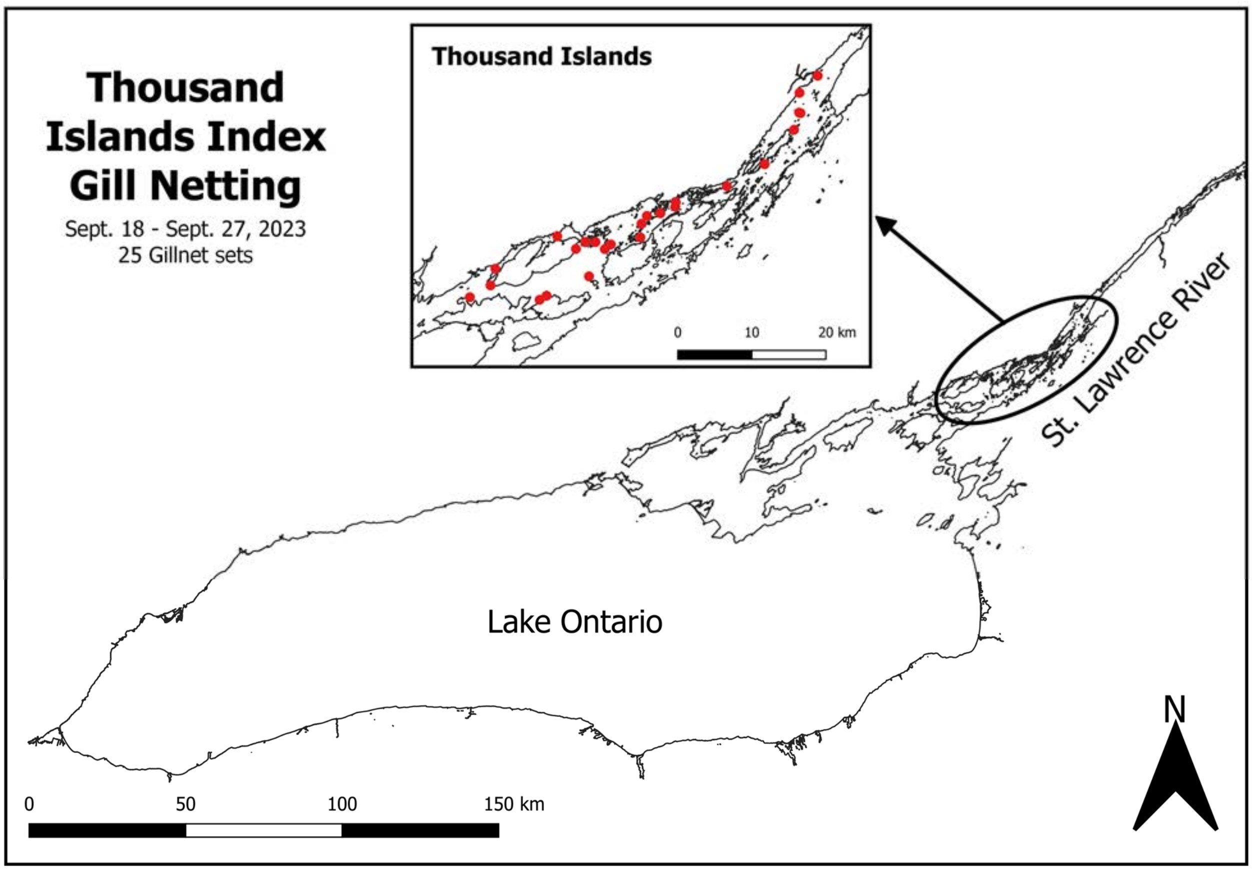

FIG. 1.10.1. Gill net site locations during the 2023 St. Lawrence River fish community index netting in the Thousand Islands.

Species Highlights

Yellow Perch

In 2023, Yellow Perch catch estimates decreased 22.9% from 24.6 fish per net in 2022 to 19 fish per net. Yellow perch represented 49% of the total catch by number and 14% by biomass in 2023 (Table 1.10.1, Figs. 1.10.3 and 1.10.4). Catches of Yellow Perch in the 2023 Thousand Islands survey are comparable to the previous 10-year average (average of 19.1 from 2013 to 2022). Age distributions and mean length at age for 2023 catches of Yellow Perch are summarized in Tables 1.10.2 and 1.10.4, respectively.

Centrarchids

The centrarchids are represented by six species in the upper St. Lawrence: Rock Bass, Pumpkinseed, Bluegill, Smallmouth Bass, Largemouth Bass and Black Crappie (Figs. 1.10.5 and 1.10.6). Rock Bass were the most abundant centrarchid species in the 2023 survey, representing 19% of the total catch by number, whereas Smallmouth Bass represented 36% of the total biomass (Figs. 1.10.3 and 1.10.5). The catch of Smallmouth Bass increased in 2023 from 2022, nearly reaching the peak catch in 2020 (Fig. 1.10.5). Length at age for Smallmouth Bass is above the time series average for age-1, age-3, and age-5 (Table 1.10.3 and Fig. 1.10.7). Size at age-1 and age-3 increased compared to 2022, while age-5 declined towards the time series average (Fig. 1.10.7). Catches of Pumpkinseed declined slightly in 2023. The decline in 2023 follows the first increase in catch per net for 20 years in 2022 (Fig. 1.10.5). Bluegill, Largemouth Bass and Black Crappie are historically at much lower levels than the former three species. Largemouth Bass catches in 2023 decreased from the previous survey and are below the previous 10 -year average (0.38 fish per net; Fig. 1.10.6).

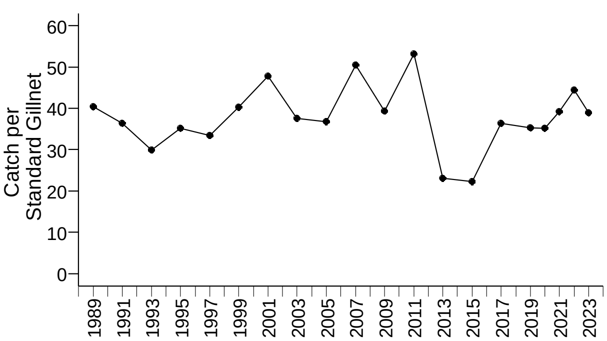

FIG. 1.10.2. Total number of fish (all species) per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

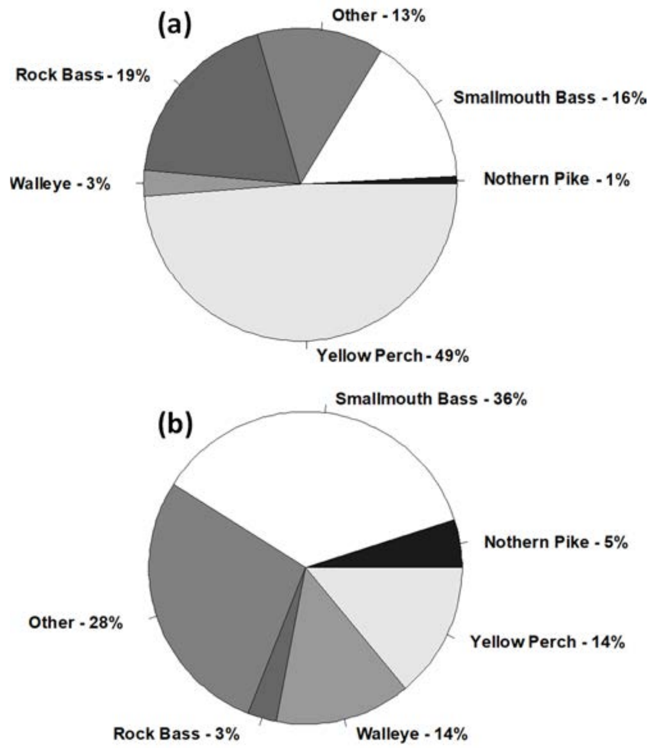

FIG. 1.10.3. Species composition by (a) catch and (b) biomass in the 2023 gill net survey in the Thousand Island area of the St. Lawrence River.

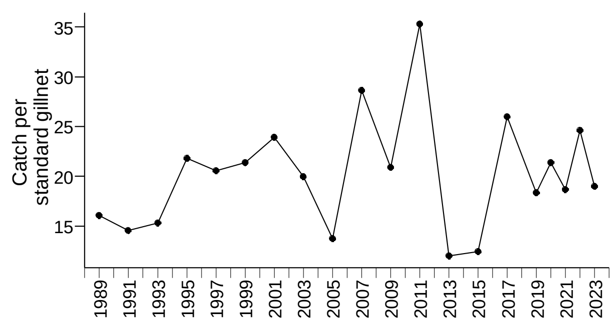

FIG. 1.10.4. Yellow Perch catch per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

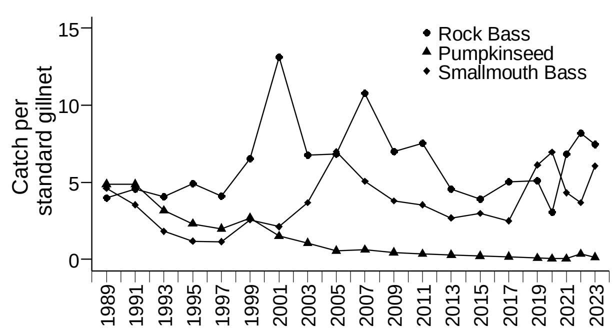

FIG. 1.10.5. Rock Bass (circle), Pumpkinseed (triangle) and Smallmouth Bass (diamond) catches per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

Northern Pike

Northern Pike remain at low levels, reached after a slow steady decline spanning almost the entire history of the Thouand Islands survey (Fig. 1.10.8). Total catches of Northern Pike in 2023 were consistent with the previous six surveys dating back to 2015 (Fig. 1.10.8). Catches of small Northern Pike (≤ 500 mm) have been limited over the past 16 surveys, with only five caught in the last five surveys (one in 2023; Fig. 1.10.8). Condition as determined by mean lengths of age-4, age-5 and age-6 Northern Pike was mixed in 2023 with condition being above, comparable, and below (respectively) the time-series average (Fig. 1.10.9, Tables 1.10.2 and 1.10.3). In general, Northern Pike condition has remained above the time-series average over the past five surveys.

Walleye

Walleye represented 3% of the total catch and 14% of total biomass caught in 2023 with 23 individuals caught. The average catch per net was 1.05, which is above the previous 10-year average (0.63 Walleye per gill net). Catches of small (≤ 500 mm) and large (>500 mm) fish remain stable with 66% and 34% of the catch representing small and large fish, respectively (Fig. 1.10.10). Walleye ages ranged from 2 to 23 years old (Table 1.10.2).

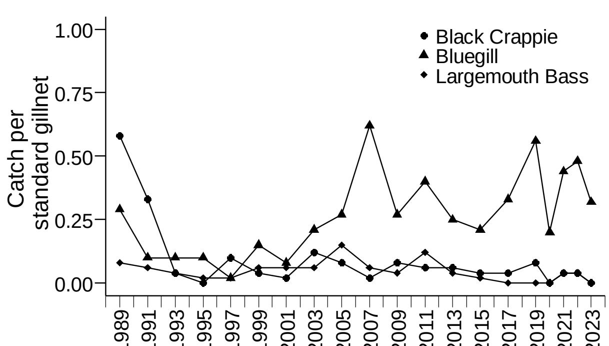

FIG. 1.10.6. Black Crappie (circle), Bluegill (triangle) and Large-mouth Bass (diamond) catches per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

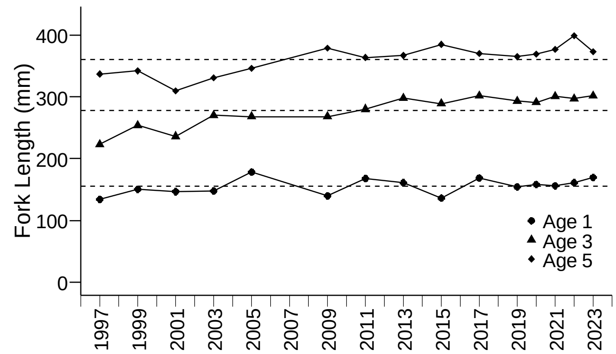

FIG. 1.10.7. Mean fork length (mm) of age-1 (circle), age-3 (triangle) and age-5 (diamond) Smallmouth Bass from 1997 to 2023. Dashed lines represent the average fork length from 1997 to 2023 for the aforementioned ages.

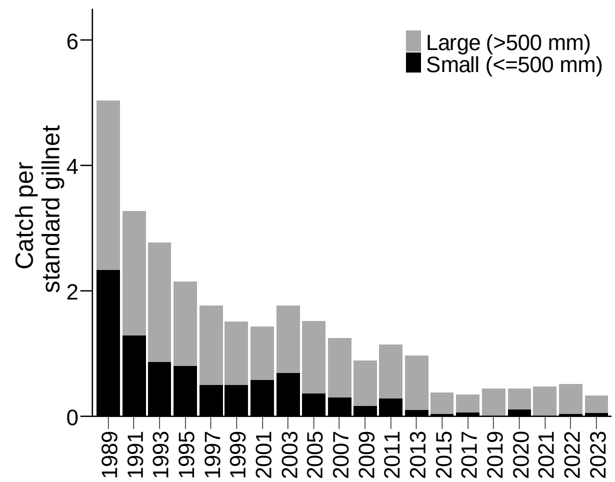

FIG. 1.10.8. Catches of small (≤ 500 mm fork length) and large (> 500 mm fork length) Northern Pike per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

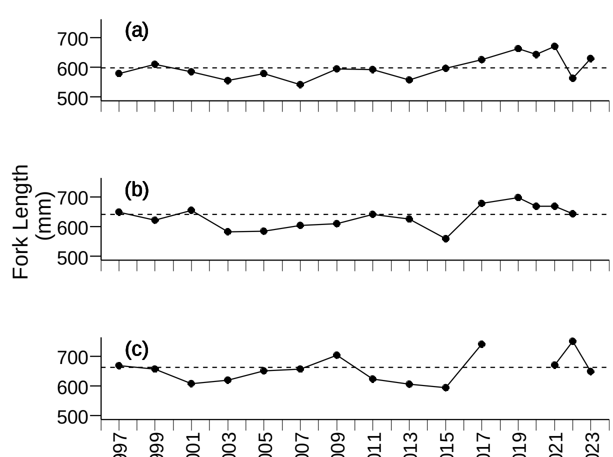

FIG. 1.10.9. Mean fork length (mm) of (a) age-4, (b) age-5 and (c) age-6 Northern Pike from 1997 to 2023. Dashed lines represent the average fork length from 1997 to 2023 for the aforementioned ages.

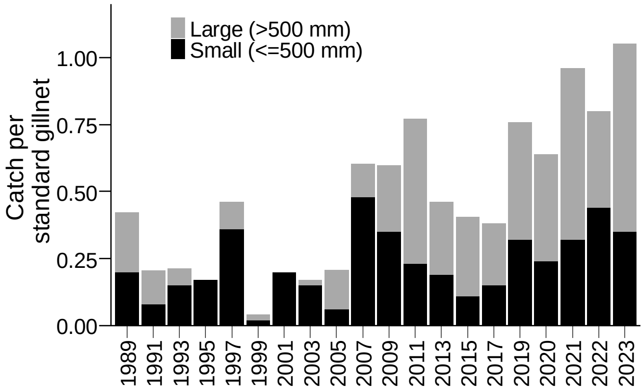

FIG. 1.10.10. Catches of small (≤ 500 mm fork length) and large (> 500 mm fork length) Walleye per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023.

TABLE 1.10.1. Catches per standard gill net set in the Thousand Islands area of the St. Lawrence River, 1989-2023. Catches from multifilament nets (all catches prior to 2001, and a portion of catches from 2001-2005) were increased by a factor of 1.58 to adjust to the modern monofilament netting standards initiated in 2001.

Species	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019	2020	2021	2022	2023
Lake sturgeon	-	-	-	-	-	0.02	-	0.02	0.02	0.02	0.04	0.04	-	-	-	0.12	-	0.04	0.04	0.05
Longnose gar	-	0.02	-	-	0.02	-	-	0.06	0.04	-	0.04	0.04	-	-	-	0.08	0.08	-	-	0.86
Bowfin	0.08	-	0.04	0.02	0.04	-	0.02	0.06	0.04	0.08	0.06	0.12	0.02	0.02	0.02	0.04	0.08	-	-	-
Alewife	-	0.06	0.02	0.02	-	-	-	-	0.02	0.12	0.06	-	0.10	0.23	0.46	1.32	-	0.52	0.40	0.50
Gizzard shad	0.29	0.38	-	-	-	0.02	0.08	-	0.04	0.02	-	0.08	0.12	0.10	0.08	-	0.12	5.64	0.72	-
Chinook salmon	-	0.02	-	-	-	0.02	0.02	-	-	-	-	0.02	-	-	-	-	-	-	-	-
Rainbow trout	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown trout	0.02	-	-	-	-	-	-	-	-	-	-	0.04	0.02	-	-	-	-	-	-	-
Lake trout	0.10	-	0.12	0.08	0.08	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-
Lake herring	0.02	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chub	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern pike	5.04	3.27	2.77	2.15	1.77	1.52	1.43	1.77	1.52	1.25	0.88	1.15	0.98	0.38	0.35	0.44	0.44	0.48	0.52	0.32
Muskellunge	-	0.02	-	0.02	-	-	0.02	0.04	-	-	-	-	-	-	-	-	-	0.04	-	-
Chain pickerel	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-
Quillback	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White sucker	1.60	1.06	1.10	1.06	0.88	1.31	0.80	0.75	0.52	0.38	0.23	0.58	0.27	0.19	0.33	0.40	0.20	0.28	0.52	0.27
Silver redhorse	-	-	-	-	-	0.17	0.04	-	0.06	0.06	0.02	0.10	0.06	0.02	-	0.04	-	-	-	-
Shorthead redhorse	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-
Greater redhorse	-	-	-	-	-	-	0.04	0.08	-	-	-	-	-	-	-	-	-	-	-	-
Moxostoma sp.	0.10	0.04	0.08	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common carp	0.06	0.06	0.02	0.06	0.27	0.08	0.08	0.10	0.04	0.02	-	0.04	-	-	-	0.04	0.04	0.04	0.08	0.05
Golden shiner	0.02	-	0.04	0.02	-	0.02	-	-	0.04	0.06	0.31	0.12	0.08	0.23	0.42	0.12	0.36	0.16	0.68	0.09
Fallfish	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	0.04	0.12	0.23
Yellow bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-
Brown bullhead	1.42	2.02	0.73	0.69	1.60	3.25	3.71	2.35	4.23	1.12	3.58	1.67	0.58	0.48	0.17	1.24	1.04	0.44	2.40	2.05
Channel catfish	0.08	0.42	0.10	0.21	0.23	0.38	0.29	0.25	0.17	0.67	0.54	0.62	0.25	0.19	-	0.08	0.08	-	-	-
White perch	-	0.29	0.02	0.04	-	0.04	0.12	0.02	0.15	-	-	-	0.10	-	-	0.04	0.04	0.04	0.20	0.27
White bass	0.54	0.42	0.15	-	0.04	-	-	-	-	-	-	0.29	-	0.02	-	0.04	0.04	-	-	-
Rock bass	4.00	4.58	4.06	4.90	4.12	6.54	13.14	6.75	6.85	10.77	7.00	7.54	4.56	3.92	5.04	5.12	3.08	6.84	8.20	7.45
Pumpkinseed	4.88	4.88	3.17	2.31	1.98	2.69	1.51	1.06	0.56	0.62	0.44	0.35	0.29	0.21	0.17	0.08	0.04	0.04	0.36	0.14
Bluegill	0.58	0.33	0.04	-	0.10	0.04	0.02	0.12	0.08	0.02	0.08	0.06	0.06	0.04	0.04	0.08	-	0.04	0.04	-
Smallmouth bass	4.60	3.54	1.81	1.19	1.15	2.56	2.12	3.67	7	5.06	3.79	3.54	2.69	2.98	2.50	6.12	6.96	4.32	3.68	6.05
Largemouth bass	0.29	0.10	0.10	0.10	0.02	0.15	0.08	0.21	0.27	0.62	0.27	0.4	0.25	0.21	0.33	0.56	0.20	0.44	0.48	0.32
White crappie	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black crappie	0.08	0.06	0.04	0.02	0.02	0.06	0.06	0.06	0.15	0.06	0.04	0.12	0.04	0.02	-	-	-	0.04	0.04	-
Yellow perch	16.08	14.54	15.31	21.79	20.56	21.38	23.94	19.94	13.71	28.65	20.88	35.27	11.98	12.42	25.96	18.36	21.36	18.68	24.64	19.00
Walleye	0.42	0.21	0.21	0.17	0.46	0.04	0.20	0.17	0.21	0.60	0.60	0.77	0.46	0.40	0.38	0.76	0.64	0.96	0.80	1.05
Round goby	-	-	-	-	-	-	-	-	0.69	0.19	0.19	0.02	0.02	0.04	0.02	0.12	0.16	0.08	-	0.09
Freshwater drum	0.02	0.06	-	0.02	0.06	-	0.08	0.04	0.27	0.04	0.21	0.12	0.08	0.19	0.02	0.12	0.16	0.08	0.56	0.18
Total Catch	40.38	36.38	29.93	35.16	33.42	40.29	47.8	37.52	36.72	50.43	39.28	53.1	23.01	22.29	36.35	35.32	35.12	39.24	44.48	38.97

TABLE 1.10.2. Age distribution of selected species caught in the 2023 Thousand Islands Community Index Gill Netting program.

	Year-class/Age																						
	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Northern Pike	1	-	-	-	1	1	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Smallmouth Bass	-	17	1	17	8	10	5	10	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	-	2	9	15	14	8	7	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walleye	-	3	-	26	-	6	-	-	-	3	-	11	6	3	-	2	3	3	2	-	-	-	1

TABLE 1.10.3. Mean fork length (mm) of selected species caught in the 2023 Thousand Islands Community Index Gill Netting program.

	Year-class/Age																						
	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Northern Pike	214	-	-	-	630	765	648	650	-	815	-	-	-	-	-	-	-	-	-	-	-	-	-
Smallmouth Bass	-	170	211	302	323	373	400	428	444	442	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	-	120	148	175	201	222	260	329	316	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walleye	-	366	-	452	-	553	-	-	-	617	-	627	652	701	-	688	683	580	631	-	-	-	658

1.11 Spring Muskellunge Netting

T. Gristey and C. Lake, Lake Ontario Management Unit

The Spring Muskellunge Netting (SMN) program, established in 2022, was conducted for the second time in 2023. The goal of the program is to acquire information on the distribution, relative abundance and biological characteristics of Muskellunge (*Esox masquinongy*) and Northern Pike (*Esox lucius*) populations in the Canadian waters of the upper St. Lawrence River. In 2005, wide-scale mortality of adult muskellunge was observed in St. Lawrence River populations and attributed to viral hemorrhagic septicemia virus (VHSV) (Casselman et al., 2017, Farrell et al., 2017), which was detected in the Great Lakes (Elsayed et al., 2006). Monitoring and assessing Muskellunge populations is important to understand the population's response to VHSV and other habitat and fish community changes. SMN utilizes live capture gears, including standardized Nearshore Community Index 6-foot trap nets and 4-foot hoop nets which are set in known or presumed Muskellunge spawning habitat areas. Captured fish are PIT-tagged, and biological metrics such as sex, condition, length and weight are recorded. This year, the program also explored utilizing vessel-based electrofishing surveys for Muskellunge capture. Two days were devoted to this effort. No Muskellunge were captured during the electrofishing surveys. However, the effort proved promising and will be further explored in future years.

The 2023 SMN program was conducted from the east end of Wolfe Island downstream to approximately Landon's Bay. The program ran for 24 days over five weeks, from May 1st to June 2nd. Ninety-nine nets were set, and two days of vessel-based electrofishing were conducted. Fig. 1.11.1 shows the 2023 sampling locations. A total of 3,714 fish were caught, with most of the species encountered being Brown Bullhead, Rock bass, Yellow Perch and Northern Pike in respective abundance. See Table 1.11.1 for a total catch and gear method summary.

Temperature data was collected throughout the program and is presented in Fig. 1.11.2. Muskellunge are the primary target species of this project; however, the other Esocids, such as Northern Pike and Chain Pickerel (*Esox niger*), are also of interest. Northern Pike is of particular interest in the Thousand Island area as historical

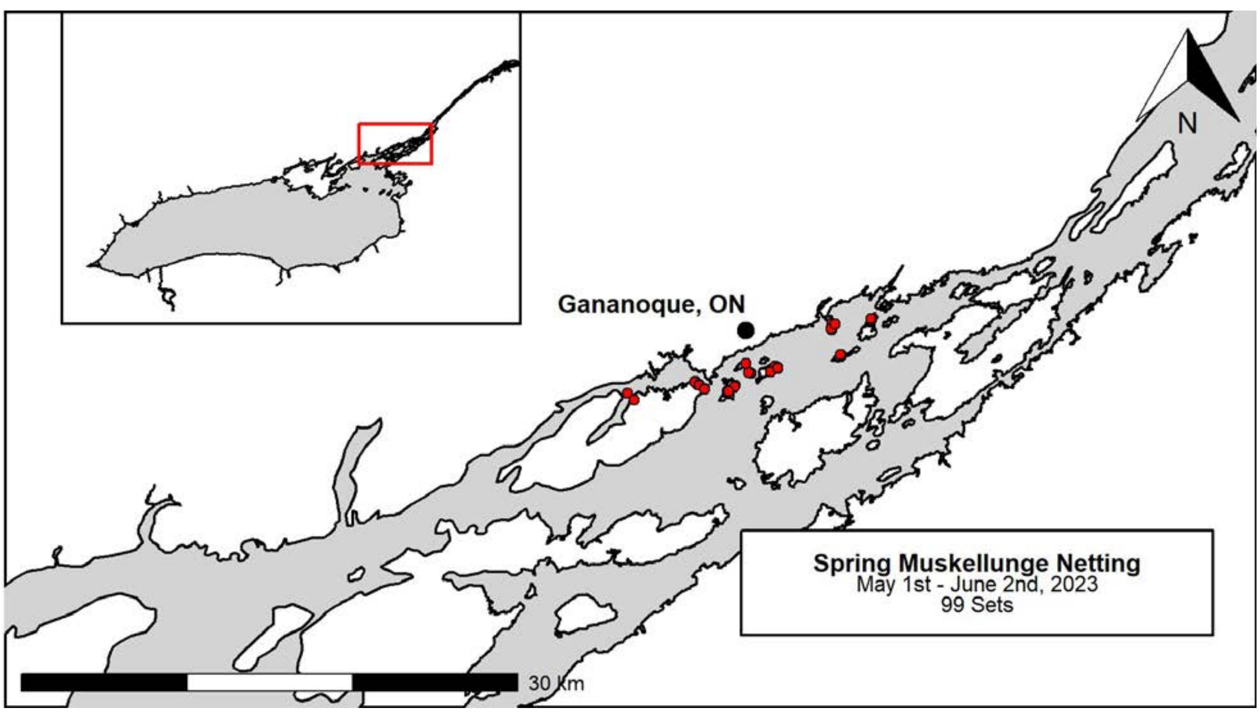

FIG. 1.11.1. Map of the 2023 Spring Muskellunge set locations.

catch rates have been in decline (See Section 1.10), with gill net catches of small Northern Pike (≤ 500 mm) being limited over the past 16 surveys, and only five caught in the last five surveys. Northern Pike was assessed for biological metrics such as sex, condition, length and weight.

Northern Pike were abundant and in spawning condition at the beginning of the survey, and catches in 2023 appear to reflect the peak and decline of spawning activity as the water temperature increased. Daily catch rates for Northern Pike for 2022 and 2023 are displayed in Fig. 1.11.3. Daily and overall catch rates were slightly higher in 2022 when compared to 2023. However, different sites were used between years which may impact the comparability of these metrics between years.

Two Muskellunge were captured during the 2023 program. Both muskellunge were captured in the program's first week, between May 1st and 4th. The largest fish measured 1,380 mm in total length and weighed 21.1 kg. The smallest fish measured 965 mm in total length and weighed 6.5 kg. Both fish were PIT tagged and released for mark and recapture analysis. Genetic fin clips were acquired from each fish for future genetic analysis through a collaborative effort with Dr. John Farrell at the Thousand Island Biological Station and New York State Department of Environmental Conservation (NYSDEC). Future work will involve the acoustic tagging of captured Muskellunge.

TABLE. 1.11.1. Catch summary for the 2023 Muskellunge Program.

Species	Trap	Hoop	Total
Brown Bullhead	1,300	177	1,477
Rock Bass	632	516	1,148
Yellow Perch	410	28	438
Northern Pike	151	21	172
Smallmouth Bass	132	15	147
Longnose Gar	128	1	129
White Sucker	92	1	93
Bowfin	24	9	33
Largemouth Bass	14	6	20
Pumpkinseed	8	9	17
Golden Shiner	13	2	15
Bluegill	9	2	11
Common Carp	5	0	5
American Eel	3	0	3
Muskellunge	2	0	2
Walleye	2	0	2
Greater Redhorse	1	0	1
Round Goby	0	1	1
Total	**2,926**	**788**	**3,714**

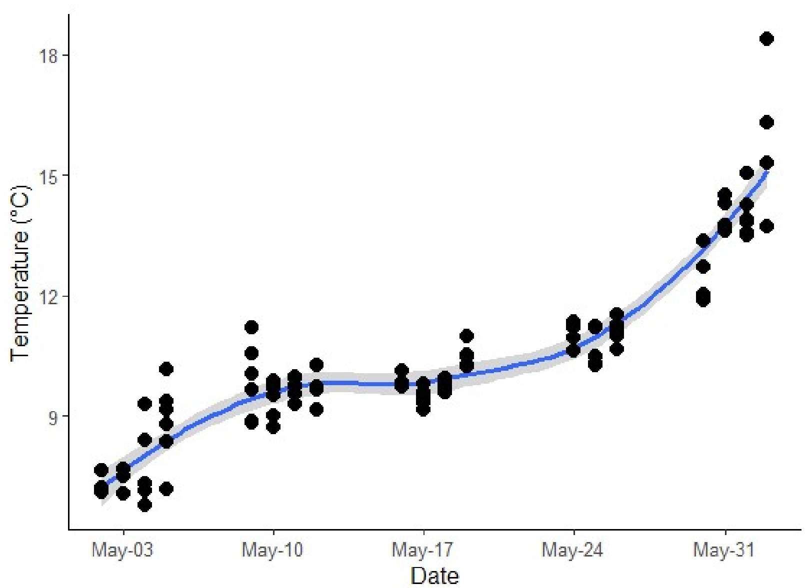

FIG. 1.11.2. Surface water temperature recorded at net lift.

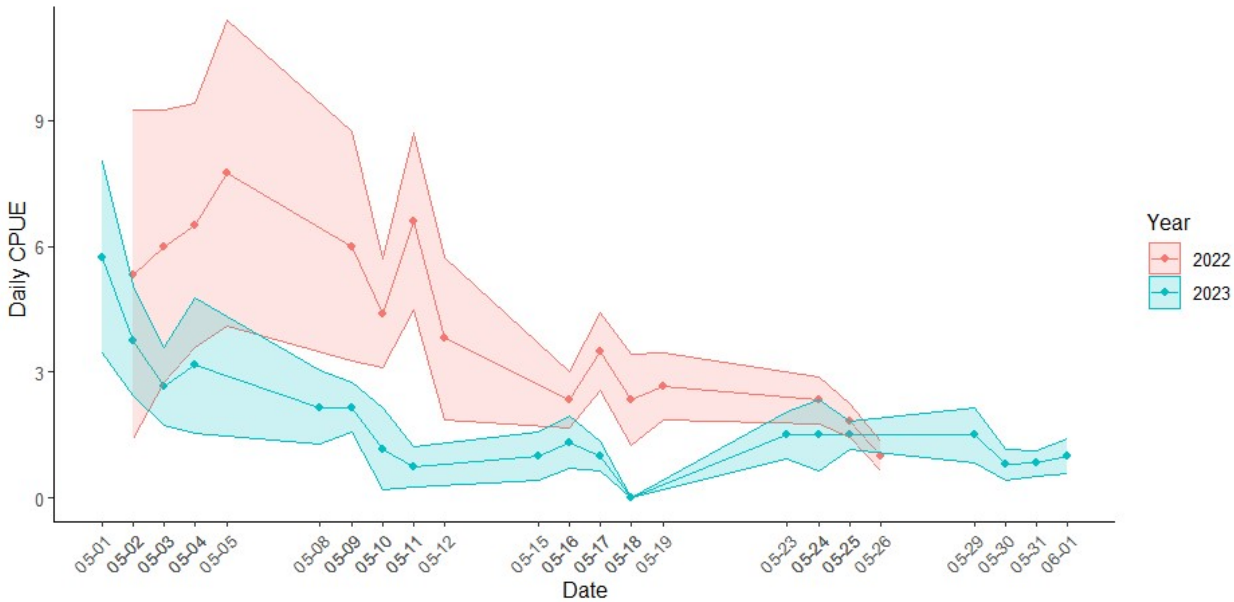

FIG. 1.11.3. Daily catch rates for Northern Pike for 2022 and 2023. The line represents the average catch rate, and the error bars represent the variation in the daily catch rate.

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2. Recreational Fishery

2.1 Fisheries Management Zone 20 Council (FMZ 20) / Volunteer Angling Clubs

C. Lake, Lake Ontario Management Unit

Fisheries Management Zone 20 (FMZ20) Council provides advice to the Lake Ontario Management Unit regarding the management of Lake Ontario recreational fisheries. The FMZ20 Council, established in 2008, has been instrumental in shaping the future of the Lake Ontario recreational fishery. Over the past decade, the FMZ20 Council has been involved in renewing the Fish Community Objectives, developing a stocking plan, identifying issues and concerns, and acting as liaison to improve broader public awareness about the fishery.

FMZ20 Council members represent a broad spectrum of interests across the zone including: Muskies Canada, competitive bass anglers, Bay of Quinte and Upper St. Lawrence River Guides, Central Lake Ontario Sport Anglers, Metro East Anglers, Port Credit Salmon and Trout Association, Halton Region Salmon and Trout Association, St. Catharines' Game and Fish Association, Ontario Sportfishing Guides Association, Ontario Commercial Fish Association, Ontario Federation of Anglers and Hunters, tributary anglers, academia, environmental interests and several unaffiliated anglers.

Many of our volunteer clubs (council-affiliated and others) also help with the physical delivery of several management programs. Multiple clubs help with planning and implementation of Lake Ontario's net pen rearing initiatives for Chinook Salmon.

Other groups help with the annual delivery of our stocking program through the operation of community-based hatcheries. The Napanee Rod and Gun Club, Credit River Anglers and Metro East Anglers stock various species including Rainbow Trout, Brown Trout and Coho Salmon. The Islington Sportsman Club, Belfountain Community Hatchery and Ontario Streams stock Atlantic Salmon.

Volunteers at the Ganaraska River-Corbett Dam Fishway assist MNRF staff to maintain and operate the fish counter. Numerous anglers and clubs also participate regularly by supplying catch and harvest information in our volunteer angler diary programs.

2.2 Bay of Quinte Open-Water Angler Survey

S. Beech, Lake Ontario Management Unit

The Bay of Quinte open-water recreational angling survey was conducted from May 6th (Walleye opening day) until August 11th, 2023.

A roving survey design spanning from Trenton to Lake Ontario was implemented. Angling effort was measured using on-water fishing boat activity counts. Boat angler interviews provided information on catch/harvest rates and biological characteristics of the harvest. In 2023, sampling was stratified by geographic area (12 sampled out of 21; Fig. 2.2.1), season (three sampled: (1) May 6th - 7th, (2) May 9th - Jun 16th, (3) Jun 17th - Aug 11th), and day-type (weekdays and weekend days). Geographic area included zones 29-34 and 91-96 in the upper and middle Bay of Quinte, respectively. Sampling was conducted four days per week (two weekdays and both weekend days).

A total of 2,272 anglers in 1042 boats were interviewed by field crews during the survey (Table 2.2.1). Forty-three percent of anglers interviewed were local (Brighton to Gananoque, south of HWY 401), 52% were from Ontario (outside the local area), 2% were from elsewhere in Canada, and 3% were from USA. Total angling effort was estimated to be 136,984 angler hours for all anglers.

Anglers caught 21 different species (Table 2.2.2). Sixty-four percent of anglers indicated that they were targeting Walleye, 13% were targeting Largemouth Bass, 6% were targeting Northern Pike, 3% were targeting Smallmouth Bass, and 5% were targeting Yellow Perch. Fishing effort was 114,689 hours for anglers targeting Walleye, 10,814 hours for anglers targeting Northern Pike, 22,724 hours for anglers targeting Largemouth Bass, 5,810 hours for anglers targeting Smallmouth Bass, and 8,408 for anglers targeting Yellow Perch (Table 2.2.2 and Table 2.2.3).

Numbers of Walleye caught and harvested were 38,576 and 23,754 respectively. Numbers of Walleye caught and harvested per hour by anglers targeting Walleye were 0.336 and 0.207, respectively. 17,300 and 4,093 Largemouth Bass were caught and harvested, respectively. Largemouth Bass caught and harvested per hour by anglers targeting Largemouth Bass were 0.69 and 0.18, respectively. Anglers also caught and harvested 5,326 and 294 Northern Pike, respectively, as well as 1,475 and 0 Smallmouth

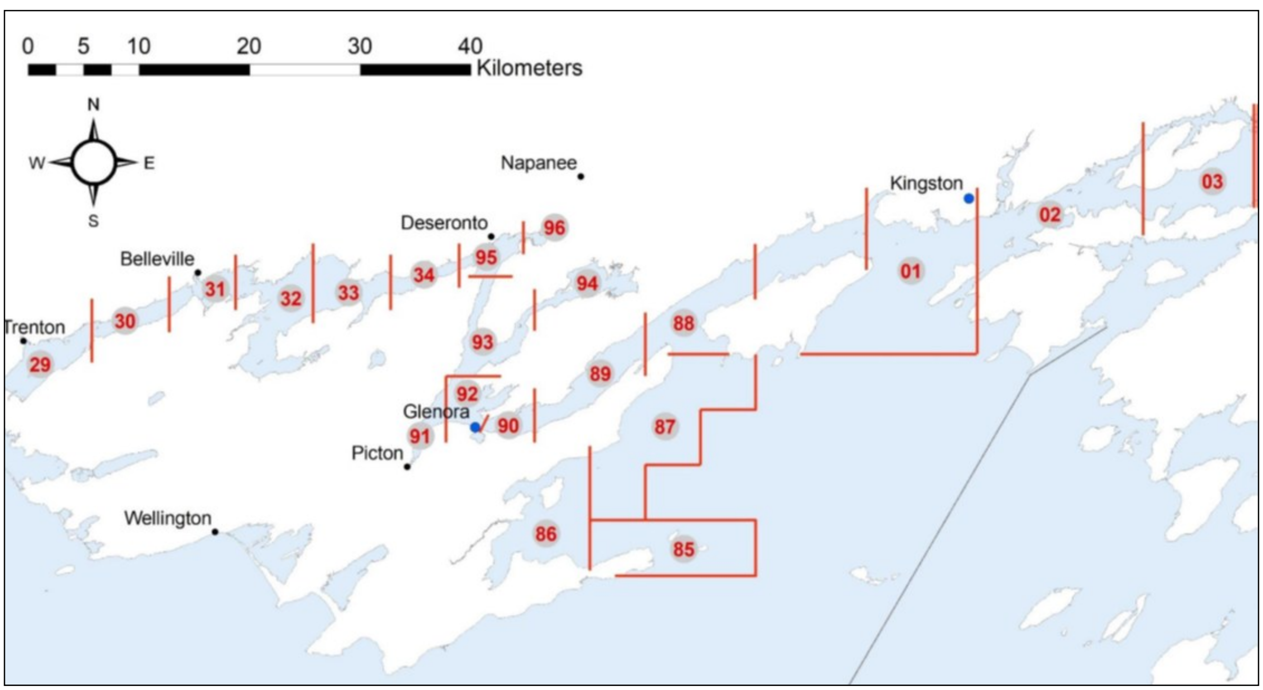


FIG. 2.2.1. Map of the Bay of Quinte - Eastern Lake Ontario showing angling survey areas. 2023 survey areas included zones 29-34 and 91-96 .

Bass, respectively (Table 2.2.2 and 2.2.3). Open-water Walleye angling fishery trend statistics from 1988-2023 are shown graphically in Fig. 2.2.2 and from 1957-2023 in Table 2.2.4.

The regional and seasonal patterns of Walleye, Yellow Perch, Black Crappie, and Northern Pike angling effort are depicted in Fig. 2.2.3. Targeted Walleye angling was highest in season 2. Compared to 2019 in season 1-3, targeted Walleye effort decreased from 134,776 to 114,698 angler hours and harvest decreased from 25,132 to 23,754 fish. However, Walleye catch, increased from 37,664, to 38,485 fish. During season 3 in 2023, Walleye effort, catch and harvest increased relative to season 3 in 2022.

The size distributions of Largemouth Bass and Yellow Perch harvested by anglers and sampled by field crews are shown in Fig. 2.2.4. Northern Pike were not included because only three fish were sampled. The size distribution of Walleye harvested in the upper and middle Bay of Quinte is shown in Fig. 2.2.5. The size distribution of Walleye (three categories: less than 19 inches total length, 19 to 25 inches and greater than 25 inches) reported to be released by anglers is shown in Fig. 2.2.6. No Walleye >25 inches was sampled in 2023. The age distributions of Walleye and Largemouth Bass sampled are shown in Fig. 2.2.7. Age-3 and 4 year-old Walleye dominated the harvest whereas ages were variable in the Largemouth Bass harvest.

TABLE 2.2.1. Total estimated angler effort (angler hours), number of boats checked and anglers interviewed, number of anglers per boat, and number of rods per angler for the open-water recreational fishery on the Bay of Quinte, 2023.

Total angling effort (hours)	136,984
Number of boats checked	1042
Number of anglers interviewed	2272
Anglers per boat	2.18
Rods per boat	1

TABLE 2.2.2. Species-specific statistics for the open-water recreational fishery on the Bay of Quinte 2023. Statistics shown are: estimated targeted angling effort (angler hours), proportion of anglers targeting each species, catch and harvest (number of fish) by all anglers, proportion of fish caught by anglers targeting that species, proportion of fish kept, and the number of fish caught per angler hour (CUE) by anglers targeting that species.

Species	Estimated Effort	Proportion Targeted	Estimated Catch	Proportion Targeted	Estimated Harvest	Proportion Kept	CUE Targeted
Longnose Gar	481	<0.01	96.6	0	0	0	0
Bowfin	-	-	17.9	-	0	0	
Brown Trout	21	<0.01	0	-	0	-	0
Lake Trout	21	<0.01	0	-	0	-	0
Cisco	-	-	246	-	0	0	-
Northern Pike	10,814	0.06	5,326	0.36	294	0.06	0.18
Common Carp	-	-	117	-	0	0.0	-
Brown Bullhead	118	<0.01	286	0.07	3	0.01	0.18
Channel Catfish	424	<0.01	775	0.20	0	0.0	0.36
White Perch	3,713	0.02	44,195	0.12	5,200	0.12	1.41
White Bass	188	<0.01	1,219	0.33	302	0.25	2.14
Rock Bass	432	<0.01	1,566	0.05	0	0	0.17
Pumpkinseed	-	-	107	-	0	0	-
Bluegill	-	-	132	-	0	0	-
Smallmouth Bass	5,810	0.03	1,475	0.68	0	0	0.17
Largemouth Bass	22,724	0.13	17,300	0.91	4,093	0.24	0.69
Black Crappie	1,071	0.01	1,032	0.38	148	0.14	0.37
Sunfish sp.	1,548	0.01	13,410	0.09	754	0.06	0.75
Bass sp.	-	-	16	-	0	0	-
Yellow Perch	8,408	0.05	66,700	0.12	3,540	0.05	0.99
Walleye	114,689	0.64	38,575	1.00	23,754	0.62	0.34
Round Goby	-	-	847	-	150	0.18	-
Freshwater Drum	2,278	0.01	11,282	0.05	179	0.02	0.24
Any species	6,623	0.04	0	-	0	-	0

TABLE 2.2.3. Angling statistics for Walleye, Largemouth Bass, and Northern Pike surveyed during the open-water recreational fishery on the Bay of Quinte, 2023. “Targeted” statistic refers to the anglers targeting the indicated species.

	Season			
	(1) May 7-8	(2) May 9-June 17	(3) June 17-August 18	Total
Northern Pike				
Targeted effort (angler hours)	3,426	1,989	5,399	10,814
Targeted effort (rod hours)	3,470	1,989	5,399	10,857
Catch by targeted angler	219	237	1,446	1,902
Harvest by targeted anglers	49	29	81	159
Catch by all anglers	428	2,526	2,372	5,326
Harvest by all anglers	65	147	81	294
Targeted CUE	0.0640	0.1189	0.2679	0.18
Targeted HUE	0.0142	0.0145	0.0151	0.02
All anglers CUE	0.0031	0.0184	0.0173	0.04
All anglers HUE	0.0005	0.0011	0.0006	0.002
Largemouth Bass				
Targeted effort (angler hours)			22,724	22,724
Targeted effort (rod hours)			22,724	22,724
Catch by targeted angler			15,727	15,727
Harvest by targeted anglers			4,093	4,093
Catch by all anglers	185	833	16,281	17,300
Harvest by all anglers	0	0	4,093	4,093
Targeted CUE			0.69	0.69
Targeted HUE			0.18	0.18
All anglers CUE	0.001	0.006	0.12	0.13
All anglers HUE	0	0	0.03	0.03
Walleye				
Targeted effort (angler hours)	14,343	41,371	58,975	114,698
Targeted effort (rod hours)	14,352	41,371	58,975	114,698
Catch by targeted anglers	4,305	12,860	21,320	38,485
Harvest by targeted anglers	2,488	8,477	12,789	23,754
Catch by all anglers	4,305	12,927	21,343	38,576
Harvest by all anglers	2,488	8,477	12,789	23,754
Targeted CUE	0.3	0.3	0.4	0.336
Targeted HUE	0.2	0.2	0.2	0.207
All anglers CUE	0.0	0.1	0.2	0.282
All anglers HUE	0.0	0.1	0.1	0.173

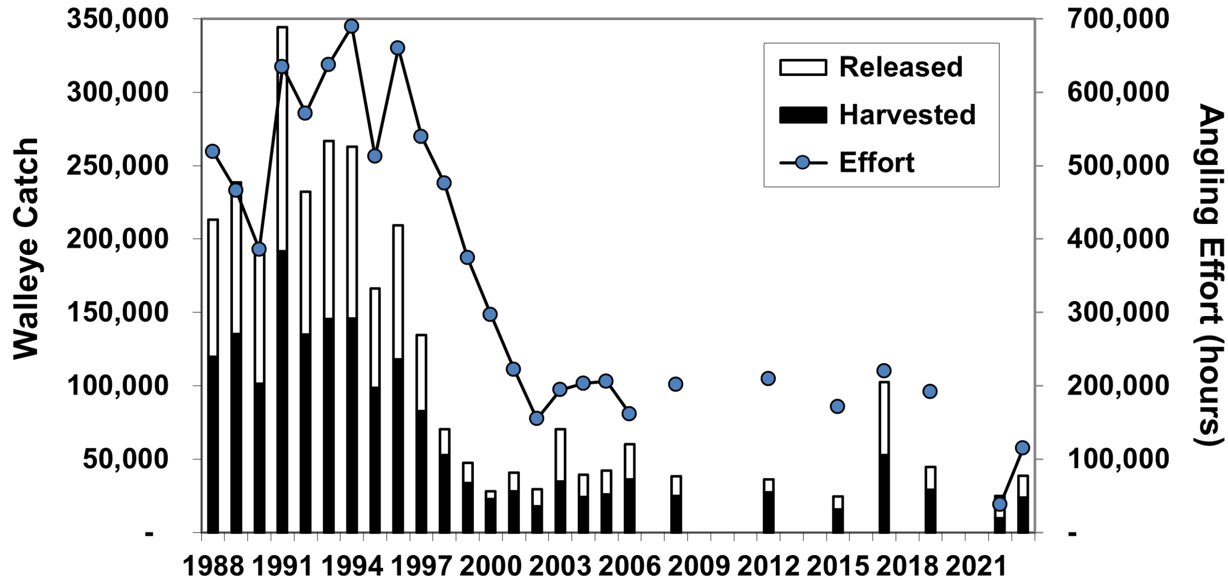


FIG. 2.2.2. Trends in Walleye angling effort and catch (release and harvested), 1988 - 2023 for the open-water recreational fishery on the Bay of Quinte (note 2017 and 2019 include the eastern Lake Ontario region and season 5 and 2022 only includes season 3).

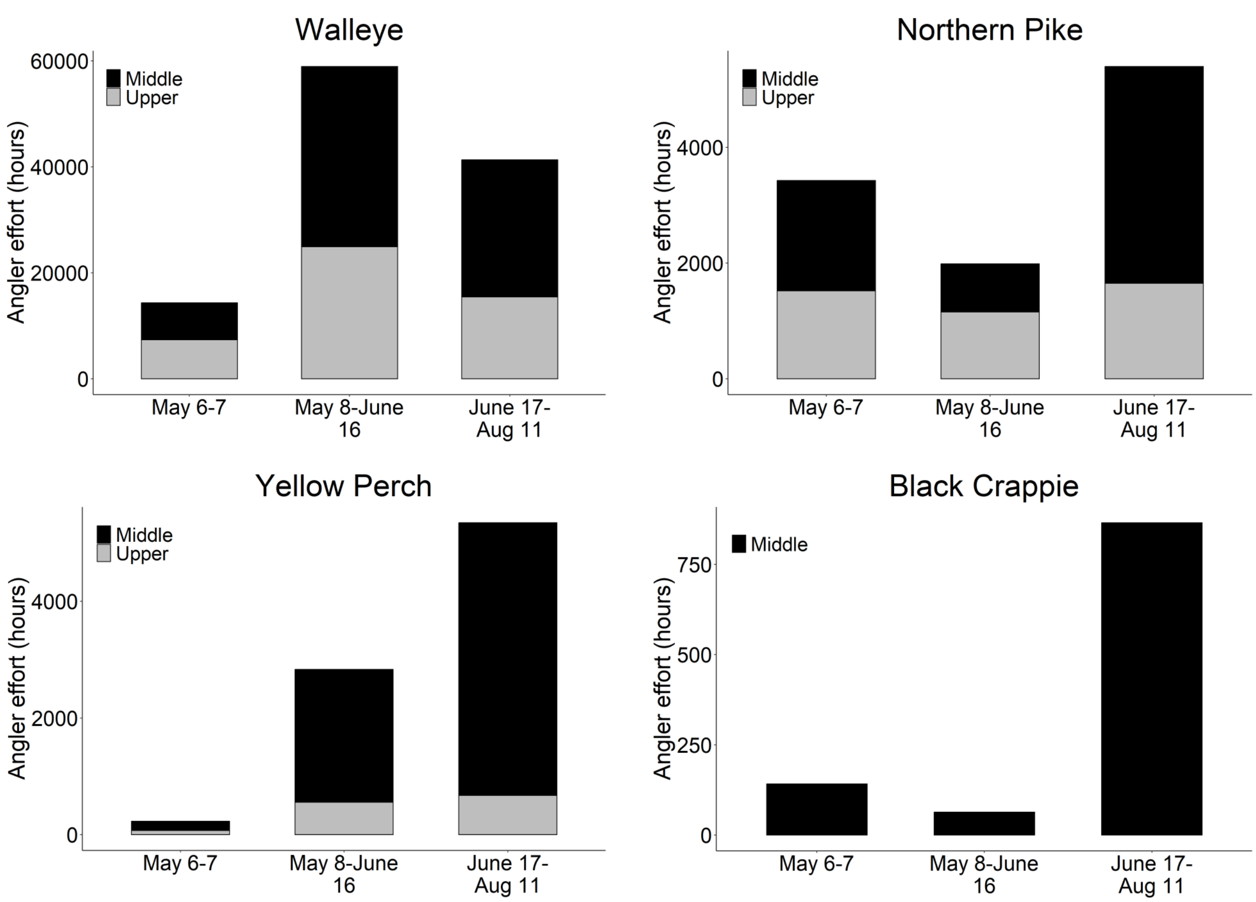


FIG. 2.2.3. Targeted Largemouth Bass, Northern Pike, Smallmouth Bass, Walleye, Yellow Perch and Black Crappie angling effort (hours) by region and season surveyed in the open-water recreational fishery on the Bay of Quinte, 2023 (regions include the survey areas as follows: Upper = 29, 30, 31, 32, 33, 34, 95, 96; Middle = 93, 94, 92, 91;).

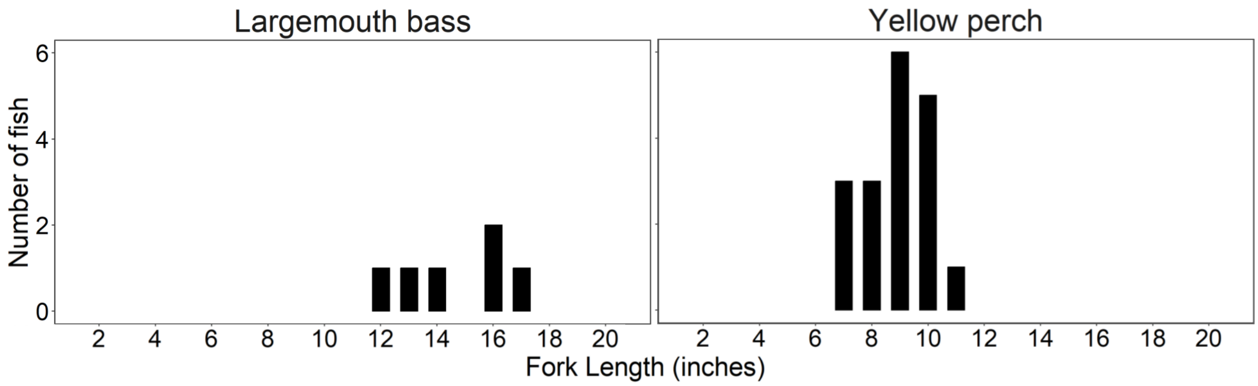


FIG. 2.2.4. Size distribution of Yellow Perch and Largemouth Bass sampled during the open-water recreational fishery on the Bay of Quinte, 2023.

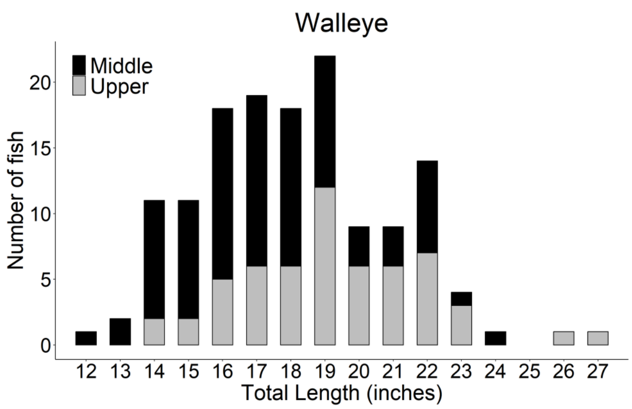


FIG. 2.2.5. Size distribution of Walleye sampled and reported harvested during the open-water recreational fishery on the Bay of Quinte, 2023. Also depicted is the survey areas where Walleye were sampled (Upper = 29, 30, 31, 32, 33, 34, 95, 96; Middle = 93, 94, 92, 91).

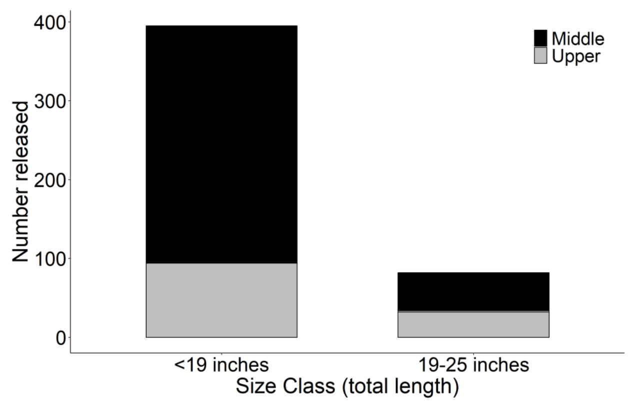


FIG. 2.2.6. Size distribution of Walleye reported to be released by anglers during the open-water recreational fishery on the Bay of Quinte, 2023. Also depicted is the survey areas where Walleye were sampled (Upper = 29, 30, 31, 32, 33, 34, 95, 96; Middle = 93, 94, 92, 91).

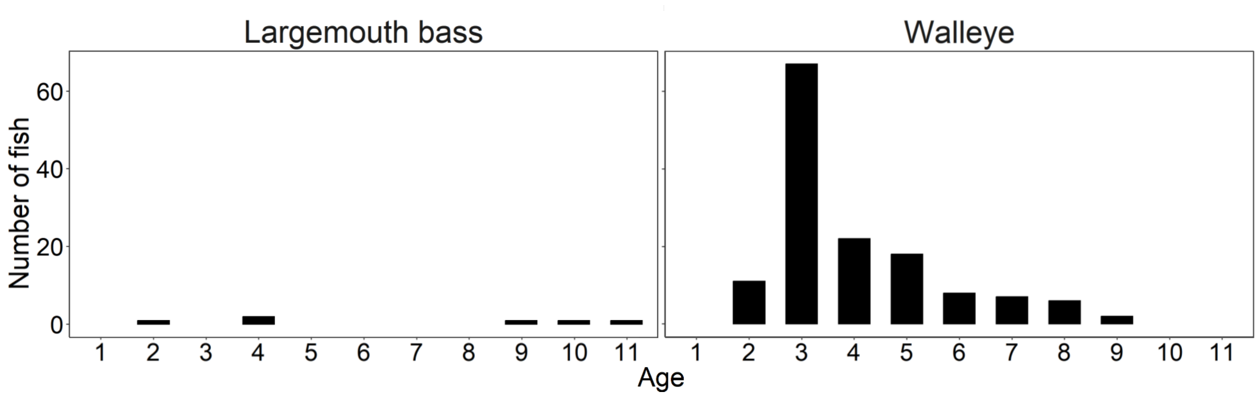


FIG. 2.2.7. Age distribution of Walleye and Largemouth Bass sampled during the open-water recreational fishery on the Bay of Quinte, 2023.

TABLE 2.2.4. Bay of Quinte 1957-2023, open-water recreational fishery statistics including angling effort (angler hours), both for all anglers and targeted Walleye anglers, Walleye catch and harvest rates (number of fish per hour), Walleye catch and harvest (number of fish), and the mean weight (kg) of harvested Walleye.

	All Anglers, Total Effort	Walleye Anglers					
		Effort	Catch Rate (CUE)	Harvest Rate (HUE)	Catch	Harvest	Mean Weight (kg)
1957		128,040		0.299		38,318	0.638
1958		105,219		0.155		16,274	0.818
1959		67,000		0.254		17,037	0.963
1960						10,467	0.939
1961						22,117	0.596
1962						9,767	0.795
1963						2,466	1.422
1976		64,096		0.064		4,089	
1979		114,637		0.132		15,133	0.631
1980		321,388		0.598		192,305	0.464
1981		319,401		0.508		162,140	0.741
1982		382,306		0.236		90,182	1.03
1984		451,581		0.227		102,379	0.912
1985		442,717		0.263		116,415	0.859
1986		554,213		0.232		128,341	0.933
1987		589,163		0.172		101,092	0.756
1988		518,404	0.411	0.231	213,144	119,608	0.785
1989		466,008	0.512	0.29	238,549	135,151	0.76
1990		385,656	0.497	0.263	191,496	101,422	0.71
1991		634,101	0.543	0.302	344,156	191,785	0.789
1992		571,079	0.407	0.236	232,179	135,040	0.952
1993	644,477	637,401	0.417	0.227	265,551	144,476	0.912
1994	693,731	689,543	0.378	0.209	260,805	144,449	0.763
1995	519,276	512,054	0.32	0.189	163,875	96,631	0.71
1996	665,436	660,005	0.317	0.179	209,303	117,999	0.781
1997	544,476	539,276	0.25	0.154	134,672	82,821	0.747
1998	481,553	475,678	0.148	0.111	70,489	52,810	0.67
1999	379,012	374,128	0.127	0.09	47,562	33,575	0.958
2000	309,259	296,841	0.094	0.077	28,004	22,791	0.939
2001	247,537	222,052	0.182	0.126	40,512	28,037	0.916
2002	177,092	154,570	0.186	0.113	28,813	17,480	0.915
2003	219,684	194,169	0.344	0.178	66,706	34,543	0.637
2004	241,700	203,082	0.193	0.119	39,155	24,260	0.87
2005	225,385	205,933	0.204	0.125	42,031	25,757	0.693
2006	180,907	161,190	0.372	0.225	59,966	36,329	0.7
2008	209,153	201,669	0.187	0.124	37,710	24,929	1.069
2012	235,937	209,040	0.173	0.13	36,208	27,222	1.012
2015	186,081	171,337	0.142	0.091	24,370	15,632	1.399
2017	279,006	219,731	0.461	0.239	101,211	52,460	0.726
2019	258,019	191,519	0.234	0.152	44,793	29,169	0.883
2022	54,997	37,675	0.403	0.26	15,173	9,814	0.795
2023	136,984	114,689	0.34	0.207	38,575	23,754	0.972

3. Commercial Fishery

3.1 Lake Ontario and St. Lawrence River Commercial Fishing Liaison Committee

A. Todd, Lake Ontario Management Unit

The Lake Ontario and St. Lawrence River Commercial Fishery Liaison Committee (LOLC) consists of Ontario Commercial Fishing License holders that are appointed to represent each of the quota zones as well as representatives of the Ontario Commercial Fisheries' Association and the MNRF. This committee provides advice to the Lake Ontario Manager on issues related to management of the commercial fishery and provides a forum for dialogue between the MNRF and the commercial industry.

The Lake Ontario Commercial Fishery Annual General Meeting (CFAGM) was held on March 31st in Picton. The CFAGM agenda included a report on the status of commercial fish stocks, a review of the 2022 turtle bycatch audit results and a Yellow Perch historical harvest summary. Guest speaker David Stanley from Ontario Power Generation (OPG) presented information about American Eel conservation efforts, including an update on the eel guidance light array study conducted in 2022.

The LOLC met twice during 2023 (February 16th and November 30th). Topics of discussion at these LOLC meetings included commercial fish license administration and updates, commercial fish modernization updates, commercial harvest summaries, an overview of the eel trap and transport program, and a preliminary discussion on the incidental bycatch of Lake Trout in gill nets targeting Lake Whitefish.

3.2 Quota and Harvest Summary

S. Beech, Lake Ontario Management Unit

Lake Ontario supports a commercial fish industry in the Canadian waters of Lake Ontario east of Brighton (including the Bay of Quinte, East and West Lakes) and the St. Lawrence River (Fig. 3.2.1). The waters west of Brighton (quota zone 1-8) currently have no commercial licences. Commercial harvest statistics for 2023 were obtained from the commercial fish harvest information system (CFHIS) which is managed by MNRF. Commercial quota, harvest and landed value statistics for Lake Ontario, the St. Lawrence River and East and West Lakes, for 2023, are shown in Tables 3.2.1 (base quota), 3.2.2 (issued quota), and 3.2.3 (harvest, landed value, and price per pound).

The total harvest (landed value) of all species was 366,344 lb ($657,806) in 2023, slightly higher than 2022 (337,971 lb and $574,204). The harvest (landed value) for Lake Ontario, the St. Lawrence River, and East and West Lakes was 286,133 lb ($507,510), 46,820 lb ($100,279), and 33,392 lb ($50,017), respectively. Yellow Perch, Lake Whitefish, and Sunfish were the dominant species in the harvest for Lake Ontario (including East and West Lakes) (Fig. 3.2.2). Yellow Perch was dominant in the St. Lawrence River followed by Brown Bullhead (Fig. 3.2.3).

Fishery Trends

Annual harvest and landed value for Lake Ontario (including East and West Lakes) and the St. Lawrence River from 1993-2023 is shown in Fig. 3.2.4. Commercial harvest declined in the early 2000s and appeared to stabilize between 2003-2013 at about 400,000 lb and 150,000 lb for Lake Ontario and the St. Lawrence River, respectively. After 2013, harvest showed a declining trend but was variable annually, particularly in Lake Ontario. Harvest increased

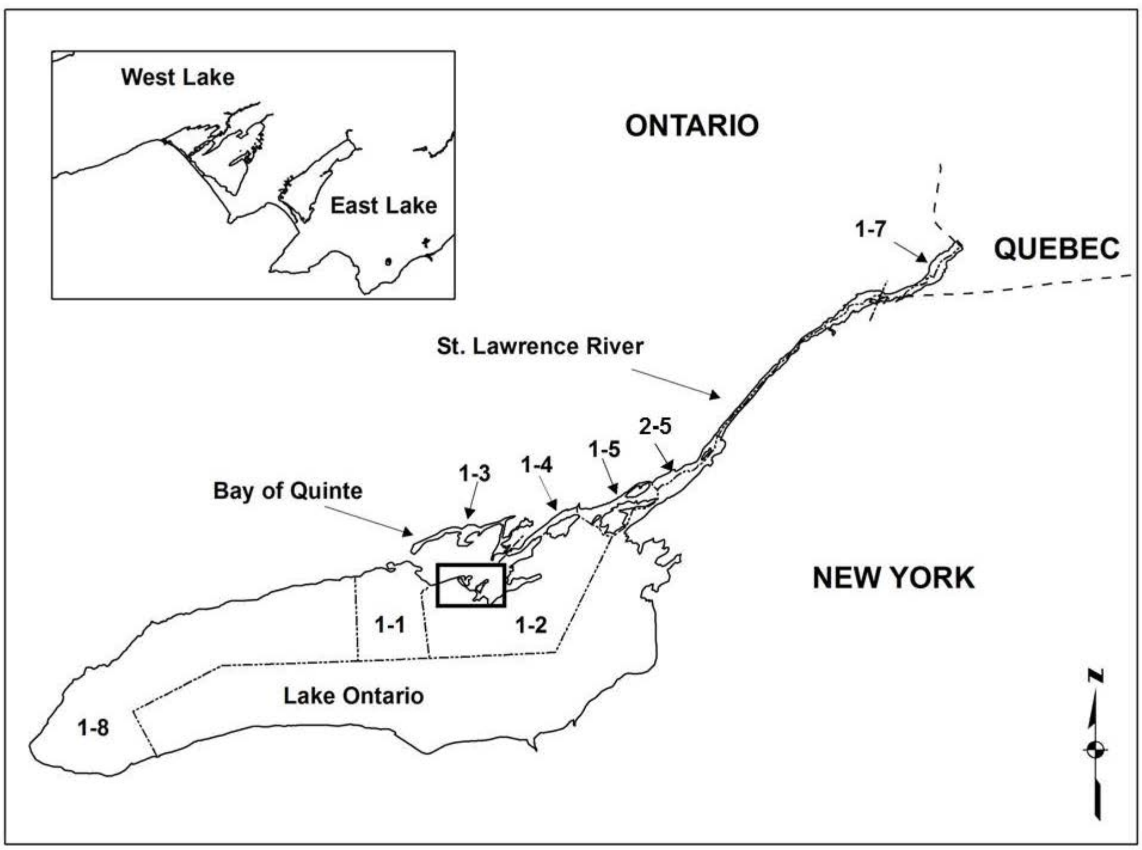


FIG. 3.2.1. Map of Lake Ontario and the St. Lawrence River showing commercial fishing quota zones in Canadian waters.

TABLE 3.2.1. Commercial fish **base quota** (lb), by quota zone, in the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2023.

	East Lake	West Lake	Lake Ontario				St. Lawrence River			Total
Species			1-1	1-2	1-3	1-4	1-5	1-7	2-5	
Black Crappie	3,100	9,850	4,540	3,000	14,823	1,100	14,170	4,840	17,590	73,013
Lake Whitefish			6,549	97,744	12,306	18,282				134,881
Sunfish	14,600	18,080	28,130							60,810
Walleye			4,210	32,933		10,952				48,095
Yellow Perch	896	2,829	18,223	73,459	88,818	88,822	51,787	14,438	53,000	392,272
Total	18,596	30,759	61,652	207,136	115,947	119,156	65,957	19,278	70,590	

TABLE 3.2.2. Commercial fish **issued quota** (lb), by quota zone, in the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2023.

	East Lake	West Lake	Lake Ontario				St. Lawrence River			Total
Species			1-1	1-2	1-3	1-4	1-5	1-7	2-5	
Black Crappie	3,100	9,850	2,270	1,500	14,145	550	7,935	4,840	8,795	44,190
Lake Whitefish			2,068	117,575	11,506	13,321				144,470
Sunfish	14,600	18,080	28,130							60,810
Walleye			687	11,860		30,945				43,492
Yellow Perch	896	2,829	10,353	38,833	72,747	69,144	38,568	11,550	33,655	244,920
Total	18,596	30,759	43,508	169,768	98,398	113,960	46,503	16,390		

TABLE 3.2.3. Commercial **harvest** (lb), by quota zone, for fish species harvested from the Canadian waters of Lake Ontario and the St. Lawrence River, East and West Lakes (two Lake Ontario embayments), 2023.

	East Lake	West Lake	Lake Ontario				St. Lawrence River					
Species			1-1	1-2	1-3	1-4	1-5	1-7	2-5	Total Harvest	Total Landed Value	Price per lb
Black Crappie	99	2,846	78		8,882	36	1,048	666	225	13,879	44,229	3.29
Bowfin		610			211		509	132	1,114	2,576	1,467	0.55
Brown Bullhead			19	3	3,470	4	1,479	3,007	1,722	9,705	3,753	0.34
Cisco		89		3,297	3,690	194				7,271	1,810	0.24
Common Carp	23			4	302	11				339	54	0.16
Freshwater Drum			26	22	6,931	13,788				20,767	2,050	0.10
Grass Carp						45				45		
Buffalos						10				10		
Lake Whitefish				76,029	5,492	5,240				86,761	138,605	1.60
Sunfish	6,121	12,713	1,088	3	23,963	227	495	1,670	265	46,546	71,128	1.46
Redhorses			7							7	1	0.20
Northern Pike	524	1,687	689	424	4,684	1,640	583			10,233	3,649	0.35
Rock Bass	1,752	2,069	1,277	2,860	3,917	1,009	433	70	245	13,629	8,724	0.63
Suckers			10							10	2	0.20
Walleye			244	1,272		20,994				22,509	45,203	2.01
White Bass				2	24	873				899	559	0.62
White Perch	414	2,041	29	210	12,544	4,254	53			19,544	8,483	0.47
White Sucker	182		39	13	6,090	3,090	16			9,428	1,223	0.12
Yellow Perch	255	1,967	1,495	5,208	29,433	30,740	7,376	9,006	16,708	102,188	326,866	3.17
Total Harvest	9,370	24,022	5,000	89,345	109,633	82,155	11,992	14,550	20,278			
Total Landed Value	11,794	38,223	8,741	145,154	189,850	163,765	25,001	29,323	45,955			

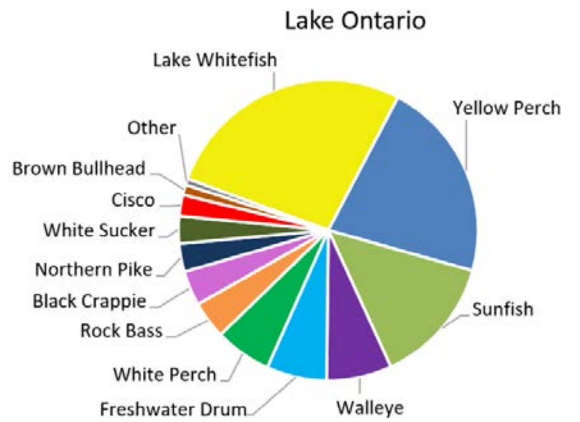


FIG. 3.2.2. Commercial harvest by species in **Lake Ontario** (Quota Zones 1-1, 1-2, 1-3, 1-4 and 1-8) and embayments (East Lake and West Lake), 2023.

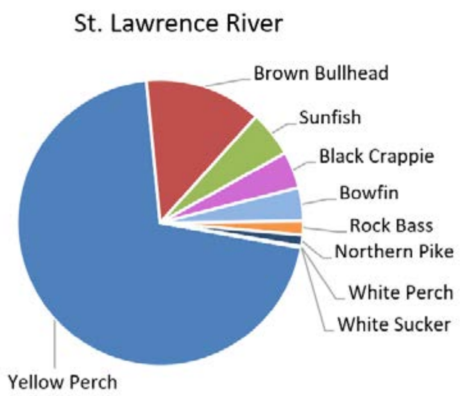


FIG. 3.2.3. Commercial harvest by species in **the St. Lawrence River** (Quota Zones 1-5, 1-7 and 2-5), 2023.

significantly in both areas in 2016-2017 and declined in 2018 in both geographic areas. Overall, average harvest over the past decade in both geographic areas has declined from the 2003 -2013 average.

Major Species

For major species, annual trends of commercial harvest, landed value and quota, across quota zones or geographic areas, is shown in Fig. 3.2.5 to Fig. 3.2.11. Species-specific price-per-lb values are means across quota zones and waterbodies.

Yellow Perch

Yellow Perch 2023 commercial harvest relative to base quota by quota zone is shown in Fig. 3.2.6. Overall, 26% (102,188 lb) of the Yellow Perch base quota (392,272 lb) and 37% of issued quota (278,575 lb) was harvested in 2023. The highest Yellow Perch harvest came from quota zone 1-4. Trends in Yellow Perch quota (base), harvest and landed value are shown Fig. 3.2.6. In 2019, quota was reduced 20% in quota zone 1-7 and left unchanged in all other quota zones. Harvest increased in 2023 in quota zones

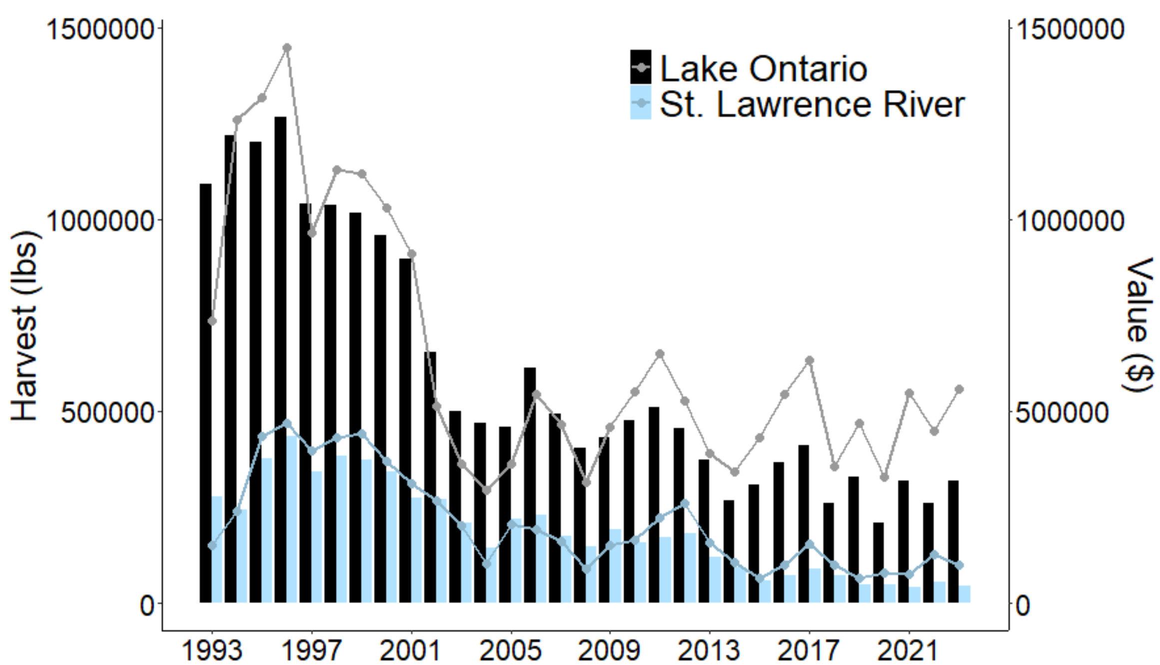


FIG. 3.2.4. Total commercial fishery harvest (bars) and value (points) for **Lake Ontario** (Quota Zones 1-1, 1-2, 1-3 ,1-4 and 1-8) and Embayments (East Lake and West Lake), and the **St. Lawrence River** (Quota Zones 1-5, 2-5 and 1-7), 1993-2023.

2-5, 1-2 and 1-4 and decreased in all other zones (Fig. 3.2.6). Yellow Perch price-per-lb has generally increased since 2018 reaching $3.17 in 2023.

Lake Whitefish

Lake Whitefish 2023 commercial harvest relative to base quota by quota zone is shown in Fig. 3.2.5. Overall, 68% (86,761 lb) of the Lake Whitefish base quota (128,332 lb) and 60% of the issued quota (144,470 lb) was harvested in 2023. Most of the Lake Whitefish harvest came from quota zone 1-2. Lake Whitefish is managed as one population across quota zones. Therefore, quota can be transferred among quota zones. Trends in Lake Whitefish quota (base), harvest and landed value are shown in Fig. 3.2.5. Base quota remained unchanged in 2023 compared to 2022.

Seasonal whitefish harvest and biological attributes (e.g., size and age structure) information are reported in Section 3.3. Lake Whitefish price-per-lb was $1.6 in 2023 and has had a slightly decreasing trend since 2018 but increased in 2023.

Walleye

Walleye 2023 commercial harvest relative to base quota by quota zone is shown in Fig. 3.2.7. Walleye harvest increased slightly in 2023. Overall, 47% (22,509 lb) of the Walleye base quota (48,095 lb) and 52% of the issued quota (43,492 lb) was harvested. The highest Walleye harvest came from quota zone 1-4. Very small proportions of base quota were harvested in quota zones 1-1 and 1-2. Walleye (like Lake Whitefish) is managed as one fish population across quota zones. Therefore, quota can be transferred among quota zones 1-1, 1-2 and 1-4. In 2023, this resulted in issued quota and harvest being considerably higher than base quota in quota zone 1-4 (Fig. 3.2.7). Quota has remained constant since the early 2000s (just under 50,000 lb for all quota zones combined). Walleye price-per-lb increased between 2011 and 2018 but declined in subsequent years averaging $2.01 in 2023.

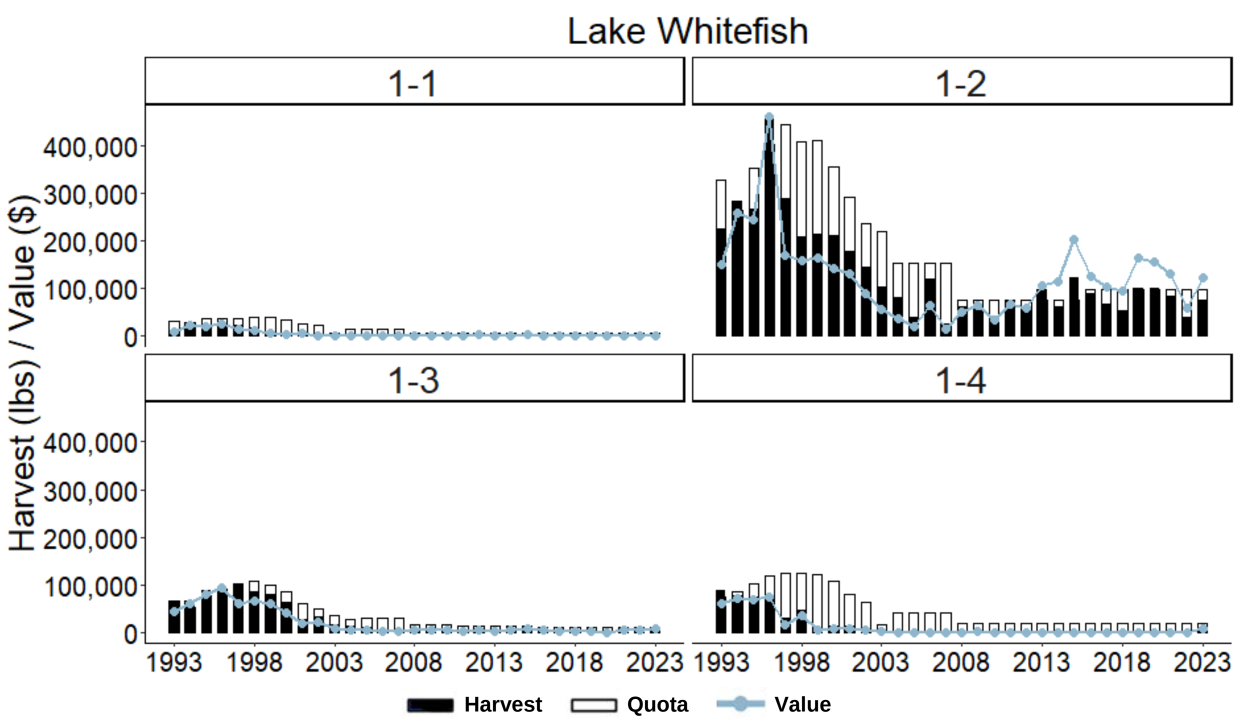


FIG. 3.2.5. Commercial base quota, harvest and value for **Lake Whitefish** in Quota Zones 1-1, 1-2, 1-3 and 1-4, 1993-2023.

Black Crappie

Black Crappie 2023 commercial harvest relative to base quota for Lake Ontario, East and West Lakes, and the St. Lawrence River is shown in Fig. 3.2.10. Overall, 20% (13,879 lb) of the Black Crappie base quota (73,013 lb) was harvested in 2023. The highest Black Crappie harvest came from quota zone 1-3 and West Lake. Trends in quota (base), harvest and landed value are shown in Fig. 3.2.10. Black Crappie harvest has been generally trending down in all geographic areas since the early 2010's but increased in 2023 in all areas. Average price-per-lb remains high, reaching a new high of $3.29 in 2023.

Sunfish

Sunfish 2023 commercial harvest for Lake Ontario, East and West Lakes, and the St. Lawrence River is shown in Fig. 3.2.9. Only quota zones 1-1 (embayment areas only), East Lake and West Lake have quotas for Sunfish; quota is unlimited in the other zones. Most Sunfish harvest was from quota zone 1-3. Trends in Sunfish quota (base), harvest and landed value are shown in Fig. 3.2.9. In 2023, harvest decreased in the St. Lawrence River and increased in Lake Ontario and East and West Lakes. Price-per-lb declined between 2018-2020 but increased between 2021 and 2023 ($1.46 in 2023).

Cisco

Cisco 2023 commercial harvest for quota zones 1-1, 1-2, 1-3 and 1-4 is shown in Fig. 3.2.8. The majority of harvest was taken from quota Zone 1-3 and 1-2 with minimal amounts taken from other zones. Trends in Cisco quota (base), harvest and landed value are shown in Fig. 3.2.8. Current harvest levels have increased relative to the early 2000's, particularly in quota zone 1-3. Price-per-lb increased in 2023 to $0.24. compared to $0.21 in 2022.

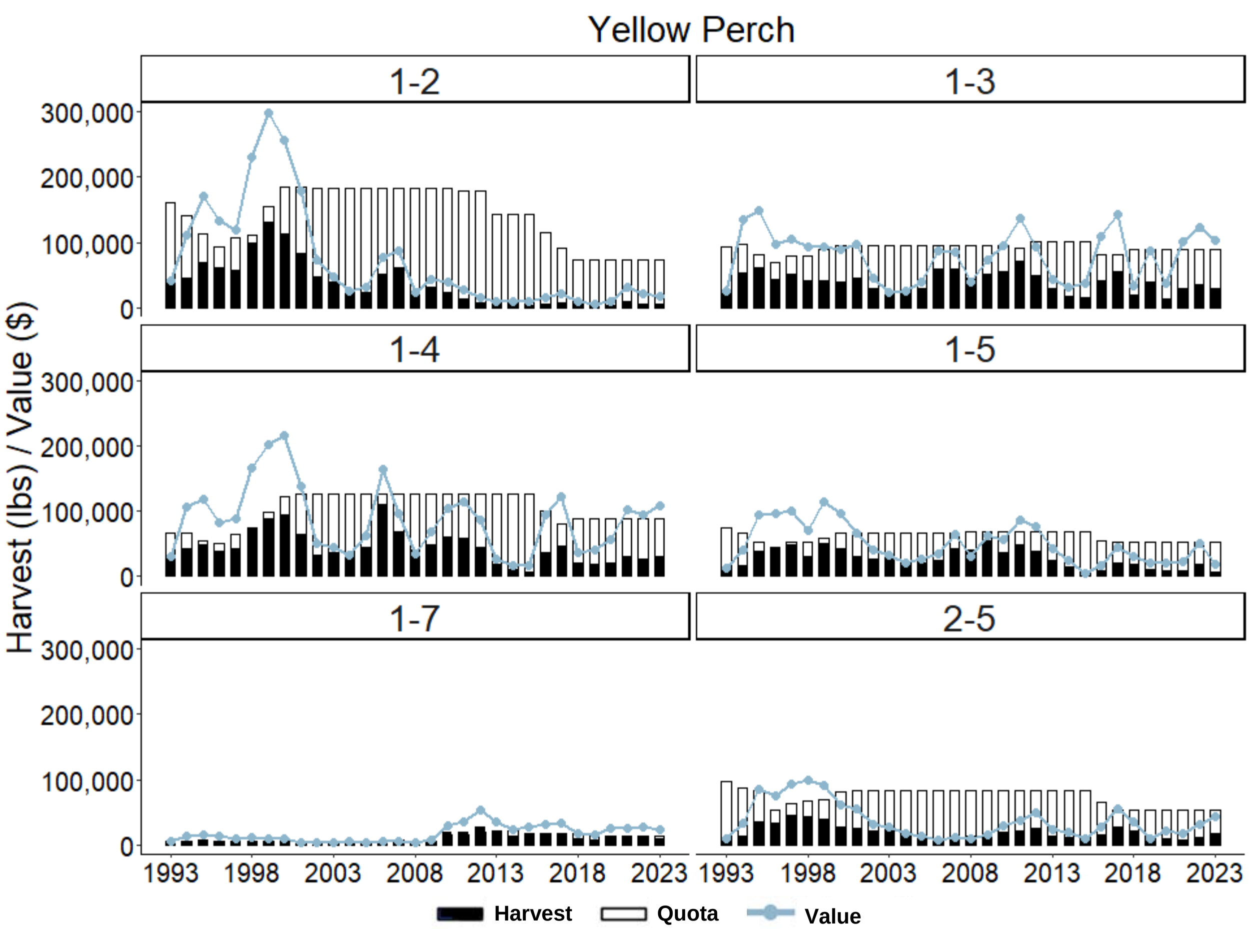


FIG. 3.2.6. Commercial base quota, harvest and value for **Yellow Perch** in Quota Zones 1-2, 1-3, 1-4, 1-5, 1-7 and 2-5, 1993-2023.

Northern Pike

Northern Pike commercial harvest and landed value trends for Lake Ontario, East and West Lakes, and the St. Lawrence River is shown in Fig. 3.2.11. The highest pike harvest came from quota zone 1-3. Harvest remains low since peaking around 2010. Northern Pike is managed as an incidental harvest fishery. In 2018-2023, the harvest season was closed from April 1st to the first Saturday in May. Historically, this time period accounted for a significant amount of the annual harvest.

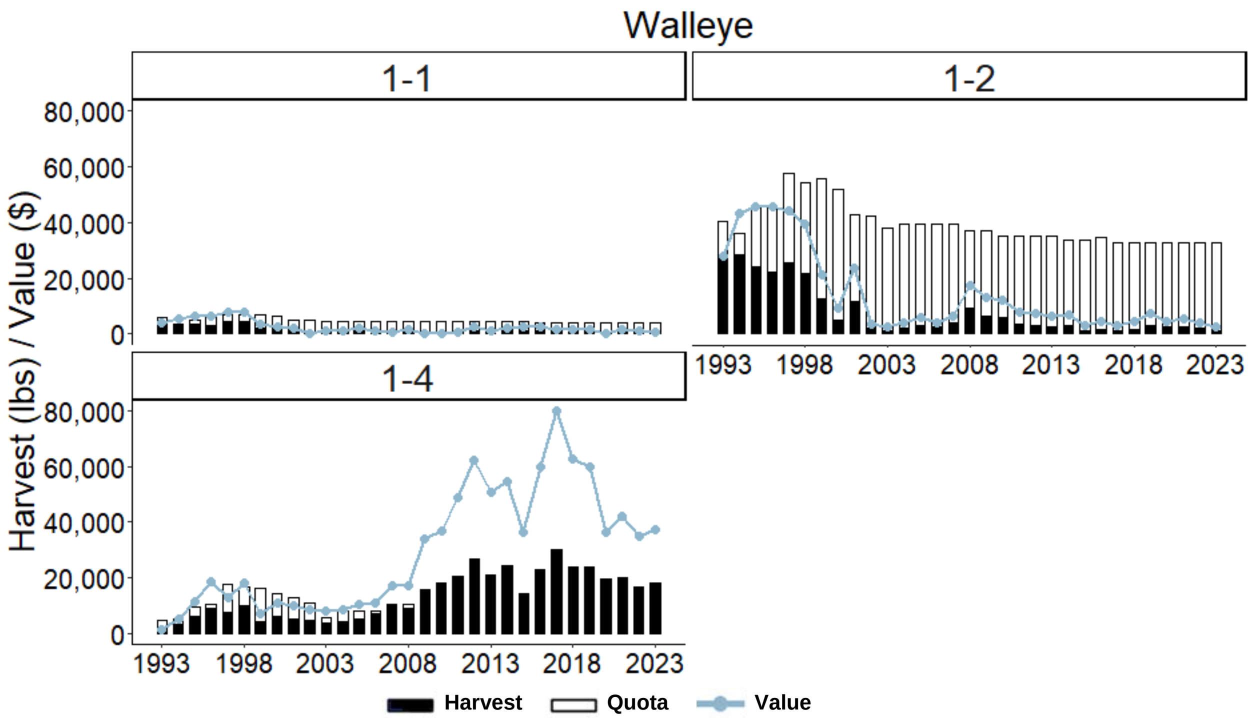


FIG. 3.2.7. Commercial base quota, harvest and value for **Walleye** in Quota Zones 1-1, 1-2 and 1-4, 1993-2023.

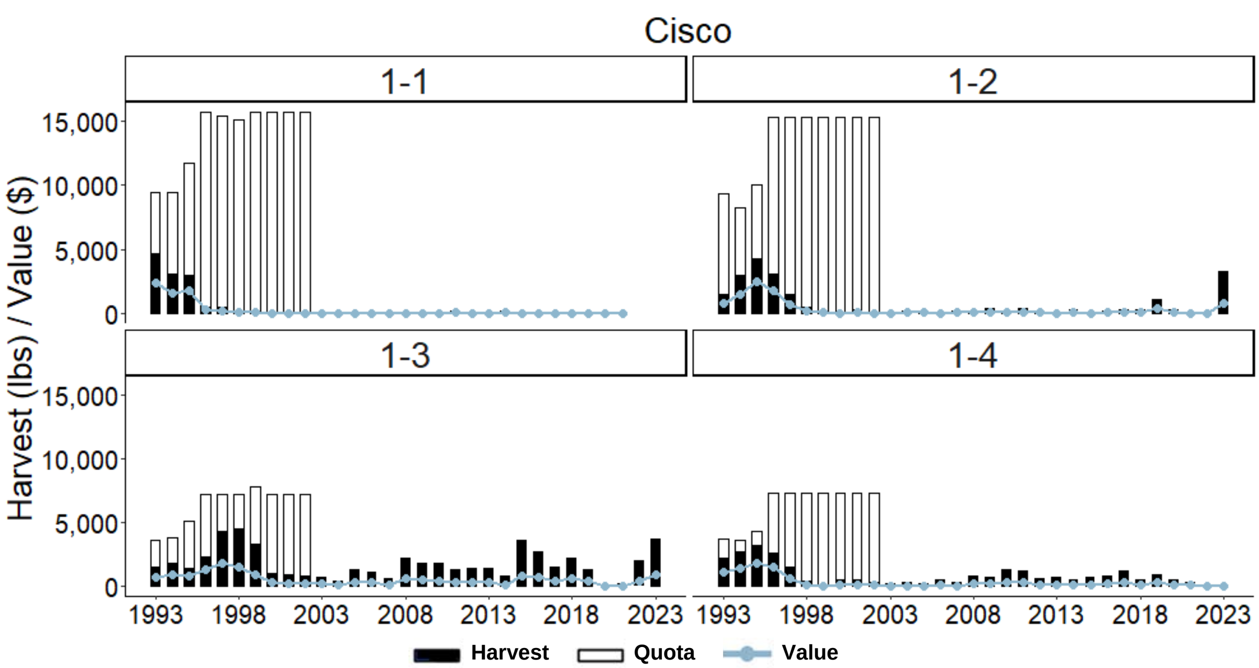


FIG. 3.2.8. Commercial base quota, harvest and value for **Cisco** in Quota Zones 1-1, 1-2, 1-3, 1-4 1993-2023.

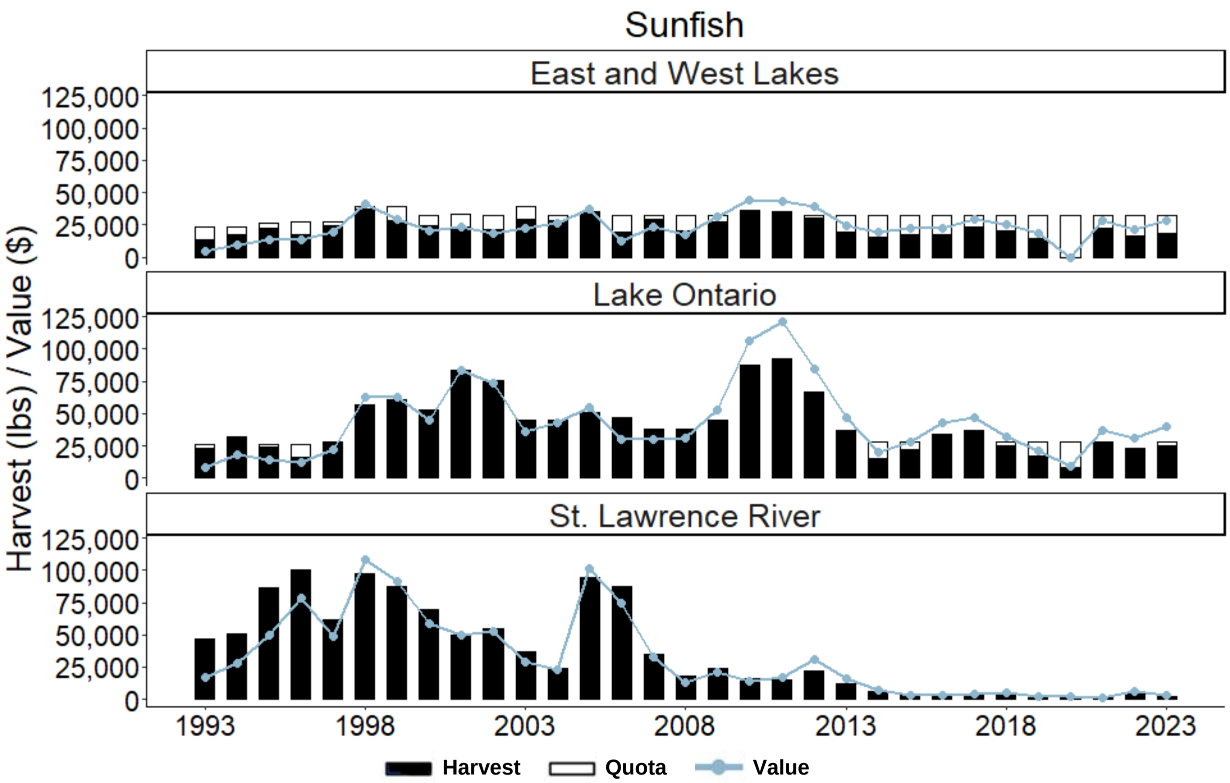


FIG. 3.2.9. Commercial base quota, harvest and value for **Sunfish** in East and West Lakes, Lake Ontario (Quota Zones 1-1, 1-2, 1-3, and 1-4) and St. Lawrence River (Quota Zones 1-5, 1-7 and 2-5), 1993-2023.

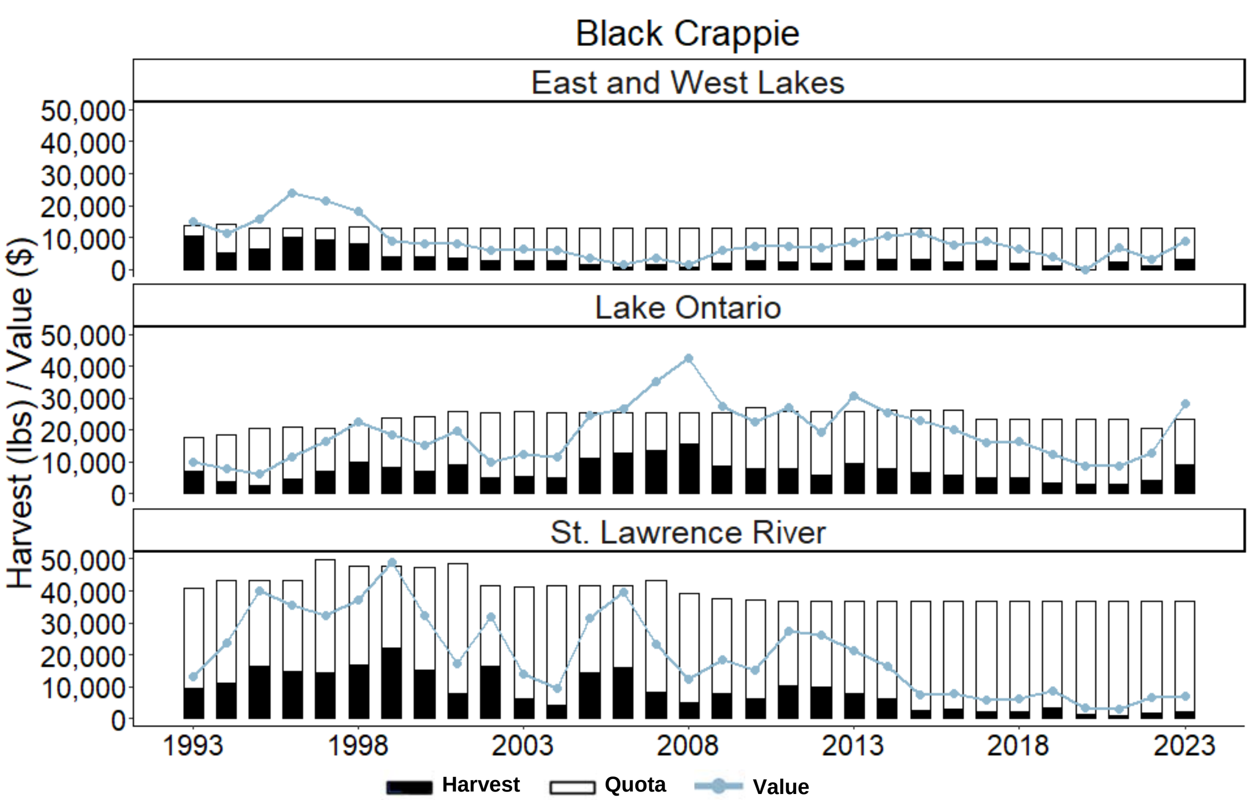


FIG. 3.2.10. Commercial base quota, harvest and value for **Black Crappie** in East and West Lakes, Lake Ontario (Quota Zones 1-1, 1-2, 1-3, and 1-4) and St. Lawrence River (Quota Zones 1-5, 1-7 and 2-5), 1993-2023.

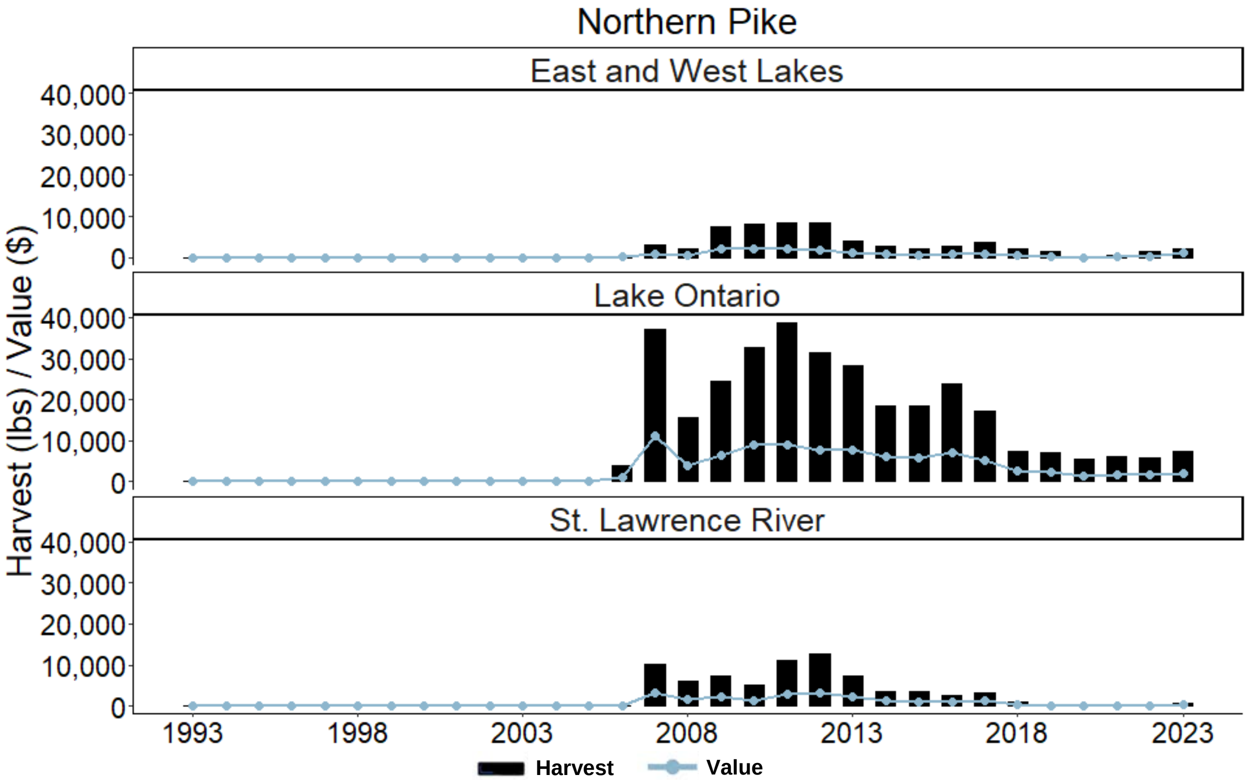


FIG. 3.2.11. Commercial harvest and value for **Northern Pike** in East and West Lakes, Lake Ontario (Quota Zones 1-1, 1-2, 1-3, and 1-4) and St. Lawrence River (Quota Zones 1-5, 1-7 and 2-5), 1993-2023.

3.3 Lake Whitefish and Cisco Commercial Catch Sampling

S. Beech, Lake Ontario Management Unit

Commercially harvested Lake Whitefish and Cisco are sampled annually (when possible) for biological information. Biological sampling of the catch is necessary to breakdown total harvest (see Section 3.2) into size and age-specific harvest.

Commercial catch sampling collected biological information from spawning-time fisheries in the Bay of Quinte (quota zone 1-3) from October 31st to November 21st and the south shore of Prince Edward County (quota zone 1-2) from November 20th to December 6th. Biological information is obtained through taking large numbers of length tally measurements as well as a length-stratified sub-sample for more detailed biological sampling for each quota zone. Lake Whitefish length and age distribution information is presented in Fig. 3.3.1 and Fig. 3.3.2. In total, fork length was measured for 3,434 fish and age was interpreted using otoliths for 254 fish (Table 3.3.2 and Table 3.3.3).

Lake Whitefish

Commercial Lake Whitefish harvest and fishing effort by gear type, month and quota zone for 2023 is reported in Table 3.3.1. Total Lake Whitefish harvest for 2023 was 86,761 lb; 60% of the issued quota.

Most of the Lake Whitefish harvest was taken in gill nets, 94% by weight; 6% of the harvest was taken in impoundment gear. Ninety-four percent of the gill net harvest occurred in quota zone 1-2. Twenty-six percent of the gill net harvest in quota zone 1-2 was taken in November. In quota zone 1-3 most impoundment gear harvest and effort occurred in November (Table 3.3.1).

Lake Ontario Gill Net Fishery (quota zone 1-2)

The mean fork length and age of Lake Whitefish harvested during the gill net fishery in quota zone 1-2 were 486 mm and 11.9 years respectively (Fig. 3.3.2). Fish ranged from ages 5-

TABLE 3.3.1. 2023 Lake Whitefish harvest (lbs) and fishing effort (yards of gill net or number of impoundment nets) by gear type, month and quota zone. Harvest and effort value in ***bold italic*** represent months and quota zones where whitefish biological samples were collected.

		Harvest (lbs)			**Effort (# of yards or nets)**		
Gear type	Month	1-2	1-3	1-4	1-2	1-3	1-4
Gillnet							
	Apr	92			1,000		
	May	6,209			24,400		
	June	9,358			36,000		
	Jul	12,189			35,600		
	Aug	5,019			16,000		
	Sept	5,522		4,719	29,200		8,715
	Oct			107			1,325
	Nov	***18,249***		37	***21,240***		440
	Dec	***19,391***		377	***17,600***		2,319
Impoundment							
	Apr						
	May		5				
	June		5				
	Jul						
	Aug						
	Sept						
	Oct		***430***			***1***	
	Nov		***5,052***			***16***	
	Dec						

32 years (Table 3.3.2). The most abundant age-classes in the fishery were ages 6-18 years which together comprised 90.8% of the harvest by number (85.8% by weight). It was determined through diet analysis that 100% of fish had empty stomachs.

Bay of Quinte Impoundment Gear Fishery (quota zone 1-3)

Mean fork length and age for Lake Whitefish harvested in quota zone 1-3 were 462 mm and 8.3 years, respectively (Fig. 3.3.1). Fish ranged from ages 3-29 years. The most abundant age-classes in the fishery were ages 4-16 years which together comprised 96.4% of the harvest by number (88.2% by weight). It was determined through diet analysis that 94% of fish had empty stomachs. Those that didn't had diets comprised of Gastropods, Molluscs, Bivalves and Hydrachnidae (water mites).

Condition

Lake Whitefish (Bay of Quinte and Lake Ontario spawning groups; sexes combined) relative weight (see Rennie et al. 2008[1]) is shown in Fig. 3.3.3. Condition declined markedly in 1994 and has remained low but stable. Visceral fat index was generally higher for the Lake group (1.7) than the Bay group (0.93), with a higher score (4 maximum) indicating more fat present.

TABLE 3.3.2. Age-specific vital statistics of Lake Whitefish sampled and harvested including number aged, number measured for length, proportion by number of fish sampled, mean weight (kg) and fork length (mm) of fish sampled, and harvest by number and weight (kg) for quota zone 1-2 and 1-3, 2023.

Quota zone 1-2 (Lake)								Quota zone 1-3 (Bay)							
	Sampled			Harvested					Sampled			Harvested			
Age (years)	Number aged	Number lengthed	Propor-tion	Number	Weight (kg)	Mean weight (kg)	Mean length (mm)	Age (years)	Number aged	Number lengthed	Propor-tion	Number	Weight (kg)	Mean weight (kg)	Mean length (mm)
3								3	1	12	0.010	21	17	0.823	430
4								4	7	101	0.083	175	170	0.973	445
5	1	34	0.021	532	523	0.984	443	5	12	171	0.141	296	280	0.945	442
6	1	36	0.023	569	712	1.251	497	6	9	123	0.101	212	193	0.907	434
7	5	100	0.063	1,573	1,918	1.219	477	7	7	80	0.066	138	131	0.948	444
8	13	316	0.200	4,976	5,686	1.143	468	8	3	37	0.031	65	60	0.922	446
9	10	251	0.158	3,947	4,721	1.196	476	9	36	405	0.334	702	798	1.137	474
10	8	183	0.116	2,884	3,007	1.043	472	10	11	100	0.083	173	204	1.179	479
11	5	125	0.079	1,966	2,735	1.391	495	11	7	85	0.070	148	182	1.232	476
12	2	41	0.026	641	776	1.211	478	12	4	24	0.020	42	68	1.625	522
13	4	84	0.053	1,317	2,256	1.713	498	13	1	4	0.003	7	12	1.798	545
14	6	105	0.067	1,660	2,595	1.564	509	14	1	4	0.003	7	11	1.641	547
15	-	1	0.0003	8	12	1.584	518	15	2	14	0.011	24	33	1.397	499
16								16	2	21	0.017	36	55	1.548	507
17	5	63	0.040	989	2,005	2.028	543	17	2	8	0.007	14	29	2.051	569
18	4	53	0.033	834	1,474	1.767	535	18	1	1	0.001	2	3	1.922	556
19	2	48	0.030	754	1,149	1.523	508	19	1	2	0.002	3	5	1.639	557
20	1	25	0.016	394	482	1.224	509	20	2	15	0.012	26	46	1.764	550
21	1	10	0.006	150	272	1.819	555	21							
22	1	26	0.016	406	484	1.193	490	22							
24								24	1	2	0.002	3	8	2.210	604
25	-	1	0.0005	12	24	2.051	559	25	1	2	0.002	3	7	2.207	593
27	1	4	0.003	63	108	1.708	567	27							
29	1	4	0.003	67	115	1.715	573	29	1	2	0.002	3	8	2.314	585
30	2	43	0.027	676	1,096	1.622	514	30							
31	2	32	0.020	507	875	1.727	538	31							
32	-	1	0.0005	12	28	2.399	610	32							
Total	75	1,583	1	24,934	33,053			Total	112	1,213	1	2,100	2,321		
Weighted mean						1.38		Weighted mean					1.19		

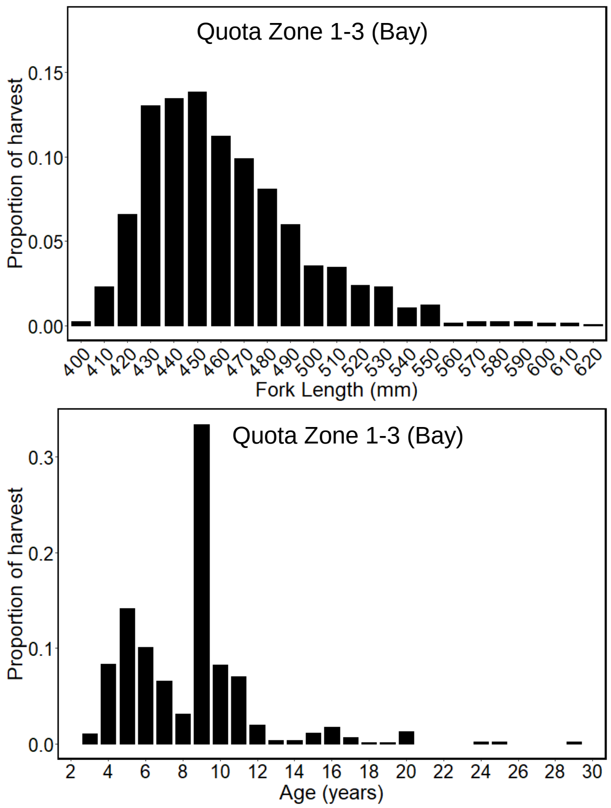


FIG. 3.3.1. Size and age distribution (by number) of Lake Whitefish sampled in quota zone 1-3 during the 2023 commercial catch sampling program.

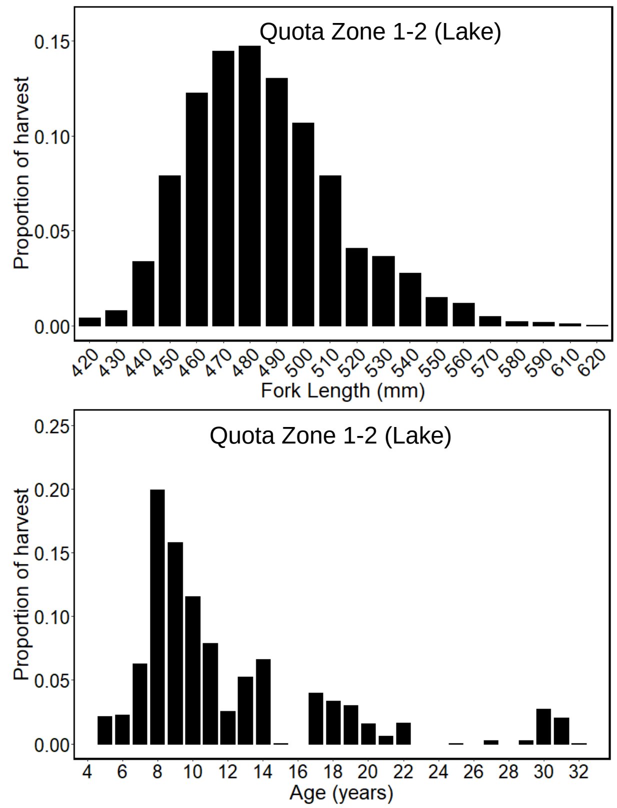


FIG. 3.3.2 Size and age distribution (by number) of Lake Whitefish sampled in quota zone 1-2 during the 2023 commercial catch sampling program.

Cisco

Commercial harvest of Cisco in 2023 was 7,271 lb with 51% harvested (by weight) in quota zone 1-3 and the majority of the harvest taken in November. Harvest in all quota zones has been minimal since 2000 but has increased in recent year, particularly in quota zone 1-3.

Bay of Quinte Impoundment Gear Fishery (quota zone 1-3)

Mean fork length and age for Cisco harvested in quota zone 1-3 were 356 mm and 6.4 years, respectively (Fig. 3.3.4 and Fig. 3.3.5). Fish ranged from ages 2-17 years (Table 3.3.3). The most abundant age-classes in the fishery were ages 3-10 years which together comprised 93.3% of the harvest by number (89% by weight).
Diet analysis indicated 96% of stomachs were empty, those that weren't contained Cladocera (water flea) and unidentified invertebrates.

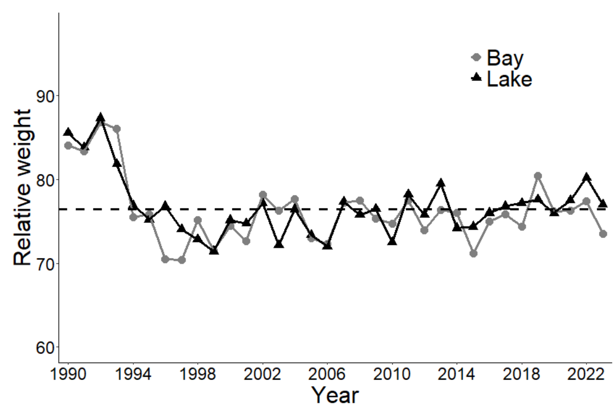


FIG. 3.3.3. Lake Whitefish (sexes combined) relative weight for the Lake Ontario and Bay of Quinte spawning groups (see Rennie et al. 2008), 1990-2023.

TABLE 3.3.3. Age-specific vital statistics of Cisco sampled and harvested including number aged, number measured for length, proportion by number of fish sampled, mean weight (kg) and fork length (mm) of fish sampled, and harvest by number and weight (kg) for quota zone 1-3, 2023.

Quota Zone 1-3 (Bay) Cisco							
	Sampled			Harvested			
Age (years)	Number aged	Number Lengthed	Proportion	Number	Weight (kg)	Mean weight (kg)	Mean length (mm)
2	-	3	0.005	13	5	0.355	304
3	4	72	0.113	267	142	0.531	341
4	12	134	0.210	496	307	0.620	352
5	5	50	0.078	184	128	0.697	366
6	6	130	0.203	480	325	0.677	362
7	4	32	0.050	118	87	0.741	368
8	4	21	0.034	80	65	0.820	392
9	16	121	0.190	449	323	0.719	378
10	8	35	0.055	130	111	0.854	399
11	2	17	0.026	61	36	0.584	366
12	2	21	0.033	79	51	0.652	370
13	-	1	0.0005	1	1	0.897	405
14	-	-	-	-	-	-	-
15	1	1	0.002	4	4	1.184	449
Total	64	639	1	2361	1,673		
Weighted mean						0.710	

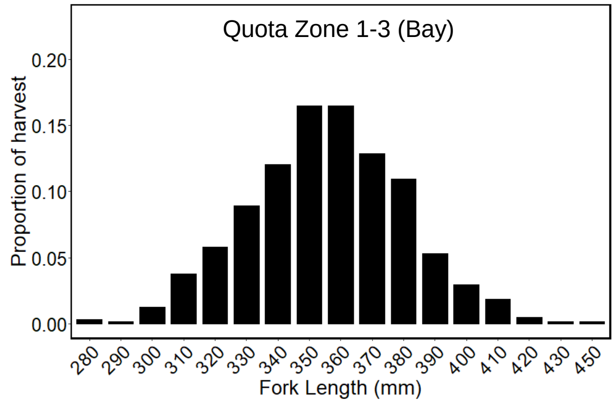


FIG. 3.3.4. Size distribution (by number) of Cisco sampled in quota zone 1-3 during the 2023 commercial catch sampling program.

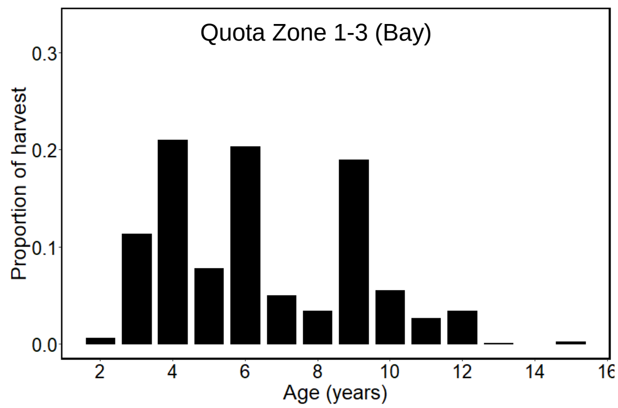


FIG. 3.3.5. Age distribution (by number) of Cisco sampled in quota zone 1-3 during the 2023 commercial catch sampling program.

Reference

Rennie, M. D., & Verdon, R. (2008). Development and evaluation of condition indices for the lake whitefish. *North American Journal of Fisheries Management*, *28*(4), 1270-1293.

4. Age and Growth Summary

B. Maynard and S. Beech, Lake Ontario Management Unit

Biological sampling of fish from Lake Ontario Management Unit field projects routinely involves collecting and archiving structures used for such purposes as age interpretation and validation, origin determination (e.g., stocked versus wild), life history characteristics and other features of fish growth. In 2023, a total of 2,799 structures were processed from 13 different field projects (Table 4.1).

TABLE 4.1. Project-specific summary of age and growth structures interpreted for age (n=2,799) in support of 13 different Lake Ontario Management Unit field projects, 2023.

Project	Species	Structure	N
Lake Ontario and Bay of Quinte Community Index Gill Netting			
	Lake Whitefish	Otoliths	24
	Walleye	Otoliths	294
	Walleye	Scales	54
	Pike	Cleithra	15
	Largemouth Bass	Scales	4
	Smallmouth Bass	Scales	28
	Black Crappie	Scales	7
	Silver Redhorse	Operculum	10
	White Bass	Scales	6
	Bluegill	Scales	20
	Pumpkinseed	Scales	84
	Yellow Perch	Scales	100
	Cisco	Otoliths	45
	Deepwater Sculpin	Otoliths	8
	Burbot	Otoliths	2
	Brown Trout	Otoliths	6
	Atlantic Salmon	Otoliths	1
	Chinook Salmon	Otoliths	26
	Lake Trout	Otoliths	156
Lake Ontario and Bay of Quinte Community Index Trawling			
	Lake Whitefish	Otoliths	11
	Cisco	Otoliths	2
	Lake Trout	Otoliths	1
	Yellow Perch	Scales	100
	Smallmouth Bass	Scales	2
	Largemouth Bass	Scales	66
	Walleye	Scales	59
Bay of Quinte Open Water Creel			
	Northern Pike	Scales	3
	Largemouth Bass	Scales	6
	Walleye	Scales	142
Lake St. Francis Nearshore Community Index Netting			
	Walleye	Otoliths	32
	Yellow Perch	Scales	26
	Smallmouth Bass	Scales	14
	Largemouth Bass	Scales	22
	Bluegill	Scales	32
	Tench	Otoliths	4
	Black Crappie	Otoliths	19
	Moxastoma sp.	Operculum	25
	Northern Pike	Scales	17
	Northern Pike	Anal fin	17
	Northern Pike	Cleithra	17

TABLE 4.1. *continued.*

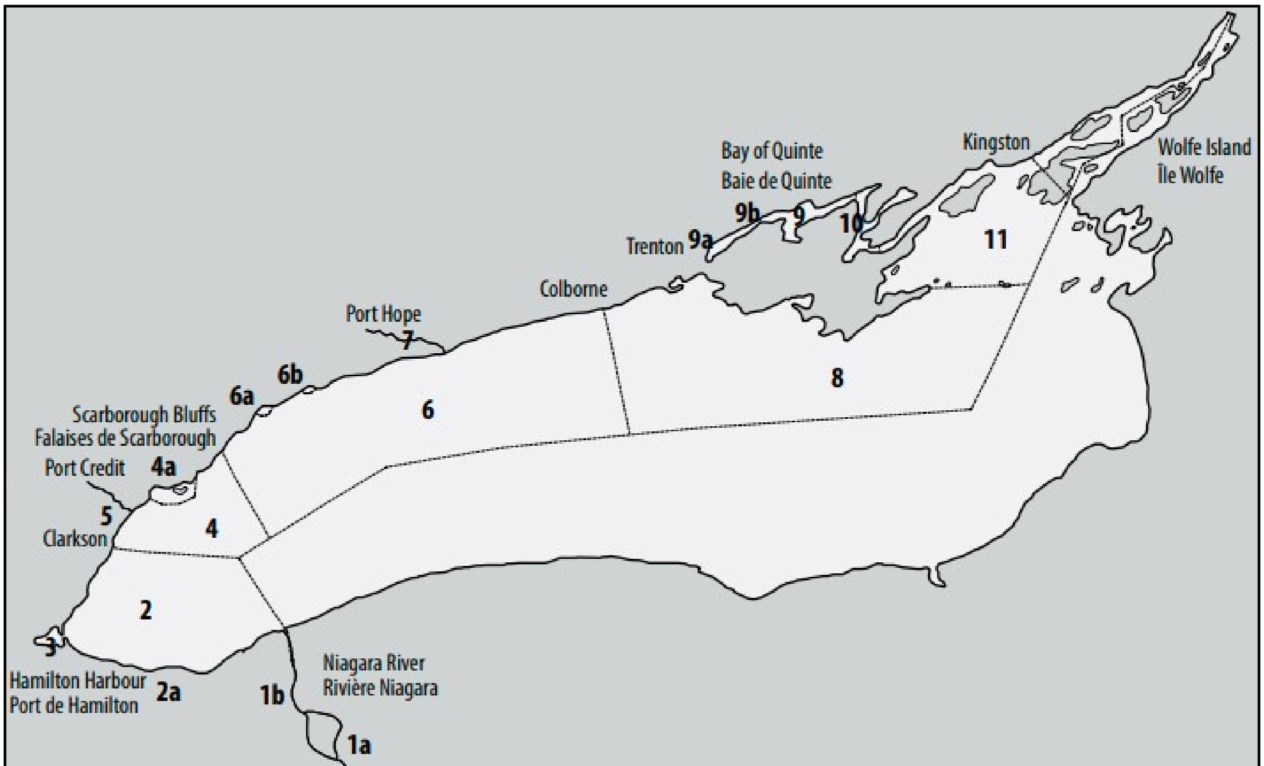
Project	Species	Structure	N
Thousand Islands Nearshore Community Index Netting			
	Walleye	Otoliths	2
	Northern Pike	Anal fin	16
	Northern Pike	Scales	16
	Northern Pike	Cleithra	16
	Bluegill	Scales	30
	Smallmouth Bass	Scales	18
	Largemouth Bass	Scales	25
	Black Crappie	Otoliths	33
	Yellow Perch	Scales	33
North Channel Kingston Nearshore Community Index Netting			
	Walleye	Otoliths	28
	Northern Pike	Anal fin	15
	Pumpkinseed	Scales	29
	Bluegill	Scales	28
	Smallmouth Bass	Scales	32
	Largemouth Bass	Scales	20
	Black Crappie	Otoliths	4
	Northern Pike	Cleithra	15
	Silver Redhorse	Operculum	1
	Yellow Perch	Scales	30
Commercial Catch Sampling			
	Lake Whitefish	Otoliths	189
	Cisco - Bay	Otoliths	65
Lake St. Francis Community Index Netting			
	Northern Pike	Cleithra	5
	Smallmouth Bass	Scales	28
	Largemouth Bass	Scales	30
	Walleye	Otoliths	28
Thousand Islands Community Index Netting			
	Northern Pike	Cleithra	7
	Smallmouth Bass	Scales	79
	Largemouth Bass	Scales	8
	Walleye	Otoliths	58
Credit River Chinook Assessment			
	Chinook Salmon	Otoliths	145
Ganaraska River Chinook Assessment			
	Chinook Salmon	Otoliths	134
Lake Ontario Atlantic Salmon Assessment			
	Atlantic Salmon	Otoliths	22
Ganaraska River Spring Rainbow Trout Spawn Index			
	Rainbow Trout	Scales	103
Total			2,799

5. Contaminant Monitoring

B. Maynard and S. Beech, Lake Ontario Management Unit

Lake Ontario Management Unit (LOMU) cooperates annually with several agencies to collect fish samples for contaminant testing. In 2023, 227 contaminant samples were collected for Ontario's Ministry of the Environment, Conservation and Parks (MECP) Sport Fish Monitoring program (Table 5.1). Samples were primarily collected using existing fisheries assessment programs on Lake Ontario, Bay of Quinte and the St. Lawrence River. Fig. 5.1 is a map showing locations ("Blocks") for contaminant sample collections.

A summary of the number of fish samples collected by species for contaminant analysis by the MECP from 2000 to 2023 is shown in Table 5.2.



2. Western Lake Ontario – open water from Niagara River to Clarkson Harbour

4a. Toronto Waterfront Area – nearshore area from the west side of Humber Bay Park to the east side of Ahsbridges Bay Park (including Toronto Islands)

6. Northwestern Lake Ontario – from east of Scarborough Bluffs to Colborne

8. Northeastern Lake Ontario – from east of Colborne to south of the area from Main Duck Island across to Point Traverse

9. Upper Bay of Quinte – open water from Trenton to County Road 49 Bridge

9a. Upper Bay of Quinte – Trenton nearshore Area

9b. Upper Bay of Quinte – Belleville nearshore Area

10. Middle Bay of Quinte – from County Road 49 bridge to Glenora

11. Lower Bay of Quinte/Eastern Lake Ontario – from east of Glenora to Kingston as well as the open water from north of Main Duck Island to Wolfe Island and from across the Main Duck sill to Point Traverse

12. Thousand Islands area – St. Lawrence River from east of Kingston to Brockville

FIG. 5.1. Map showing locations ("Blocks") for contaminant sample collections.

TABLE 5.1. Number of fish samples provided to MECP for contaminant analysis, by region and species, 2023.

Region	Block	Species	Total
Lake Ontario and Bay of Quinte Community Index Gill netting			
	8	Chinook Salmon	10
		Lake Trout	10
		Freshwater Drum	1
	9	White Perch	10
		Walleye	2
	9b	Bluegill	1
	10	Black Crappie	4
		Northern Pike	5
		Common Carp	2
		Smallmouth Bass	1
		Freshwater Drum	10
		White Sucker	8
		Yellow Perch	10
	11	Freshwater Drum	10
		Northern Pike	4
		Smallmouth Bass	5
Lake St. Francis Nearshore Community Index Netting			
	15	Bluegill	10
		Silver Redhorse	3
		Shorthead Redhorse	2
		Greater Redhorse	5
		Channel Catfish	3
		Pumpkinseed	10
Thousand Islands Nearshore Community Index Netting			
	12	Black Crappie	10
		Bluegill	10
		Pumpkinseed	5
North Channel Kingston Nearshore Community Index Netting			
	11	Bluegill	10
		Northern Pike	6
		Pumpkinseed	1
		Channel Catfish	5
		Smallmouth Bass	5
		Largemouth Bass	10
Lake Ontario and Bay of Quinte Community Index Trawling			
	9	Brown Bullhead	10
		Walleye	3
		Pumpkinseed	1
Spring Prey Fish Trawling			
	9	Rainbow Smelt	5
Commercial Catch Sampling			
	9	Lake Whitefish	10
		Cisco	10
Total			227

TABLE 5.2. Summary of the number of fish samples collected, by species, for contaminant analysis by the MECP, 2000 - 2023.

	Year																							
Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Black Crappie			20	20	3	20		20		20	29			35	2	14				8		1	23	14
Bluegill		26		20	10	23			102	88		40	40	3		10			10	10		7	32	31
Bowfin																							6	
Brown Bullhead		40	44	40	25	30	33	40	68	63	56	81	34	78	53	52			9	50		15	40	10
Brown Trout	40	3	20		31		22	6	29	34	34	12	20	6	10	1			20	6			5	
Centrarchidae hybrids																							2	
Channel Catfish	20	20	7	23		17				8		15	20	4	10			10		9		4	4	8
Chinook Salmon	40	3	16		48		29	1	36		39	1	21	6	19	2			21	10				10
Cisco																18		20		20				10
Coho Salmon		1	3																10					
Common Carp				7													14	8		7		1	7	2
Freshwater Drum			43		16		13	2	32	20	37			42	2		12	18		10			11	21
Gizzard Shad																	7	10					1	
Greater Redhorse																								5
Lake Trout			42		54		38	17	46	20	33	13	18	20	49	10	28	10	29	10				10
Lake Whitefish	20													20	17	19	8	11	10	22	5			10
Largemouth Bass		4	25	28	20	9	8	89	26	40	28	55	20	11	7	18	20	4	10	37		27	17	10
Longnose Gar																							8	
Northern Pike		53	39	60	22	40	22	94	35	28	31	20	34	47	16	18	24	35	5	13		4	27	15
Pumpkinseed		60	25	57	8	11	23	78	92	105	19	43	31	14			15	20		12			40	17
Rainbow Smelt																3			4	5		12	45	5
Rainbow Trout	40	37	28	20	37	20	29	20	21	20	33		1	22		20			2	11			1	
Rock Bass		36	30	38	11	21	27	30	20	40	42	80	5	24			20	20	17	57		2	31	
Shorthead Redhorse																				5				2
Silver Redhorse							1												9	1	1			3
Smallmouth Bass		20	87	22	21	28	35	23	39	40	31	58	15	19	20	20	25	37	16	22		20	32	11
Walleye		42	51	40	61	30	62	98	61	40	70	71	24	73	59	67	56	29	53	72		30	55	5
White Bass											20									11		8	2	
White Perch		40		40	40	14	21	20	35	20	7			40	8	11	4		4	43		10	12	10
White Sucker							1								25	7	21	30	16	14			21	8
Yellow Perch	20	60	66	58	75	40	86	90	60	91	80	20	44	81	22	20	39	50	20	31		18	48	10
Total	180	445	546	473	482	303	450	628	702	677	589	509	327	545	319	310	293	312	265	496	6	159	470	227

6. Stocking Program

6.1 Stocking Summary

C. Lake , Lake Ontario Management Unit

Fish stocking is a fisheries management tool used to meet specific goals including supporting recreational fisheries and species restoration. In 2023, 1,896,216 fish were stocked into Lake Ontario, equaling 47,672 kilograms of biomass (Fig. 6.1.1 and Table 6.1.1). Fish are allocated to one of seven sub-zones based on several factors, including: natural reproduction within the zone, size of local fisheries, and suitable available habitat (Fig. 6.1.2). More detail on the stocking zones and fish allocation can be found in the Stocking Strategy for the Canadian Waters of Lake Ontario (2015). The St. Lawrence River is not stocked.

The Stocking Strategy provides production targets for MNRF Fish Culture Stations (Table 6.1.2). These facilities also provide healthy, disease-free fish (eggs and fry) to several facilities participating in the Community Hatchery Program (Table 6.1.3). Stocking events are summarized by species, life stage, and location for native species (Table 6.1.4) and for introduced species (Table

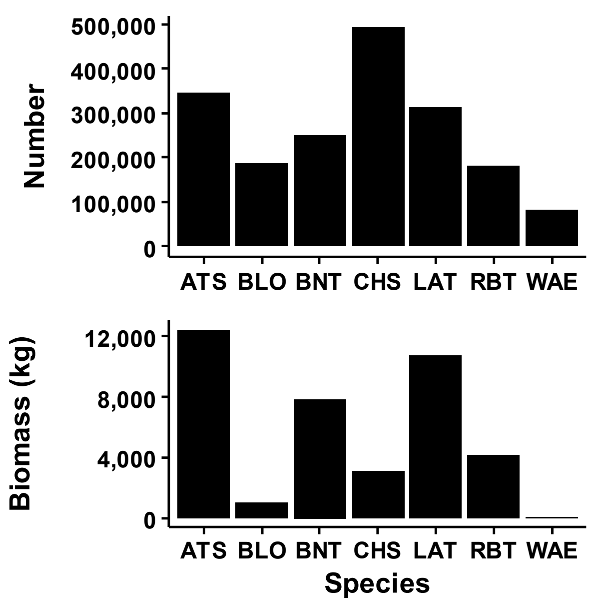
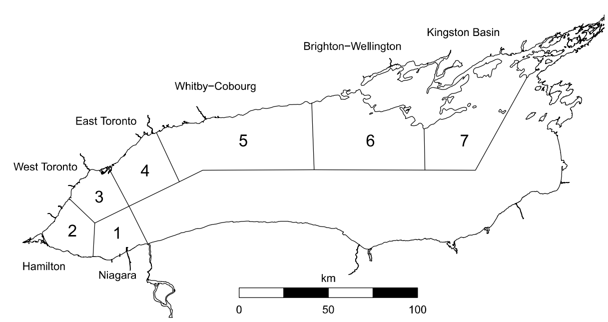


FIG. 6.1.1. **TOP**: Number of fish stocked into the Ontario waters of Lake Ontario in 2023 (total = 1,896,216). **BOTTOM**: Biomass of fish stocked into the Ontario waters of Lake Ontario in 2023 (total = 47,672 kg.). Adult, egg and Nonfeeding fry life stages not included in totals. ATS = Atlantic Salmon, BLO = Bloater, BNT = Brown Trout, CHS = Chinook Salmon, LAT = Lake Trout, RBT = Rainbow Trout, WAE = Walleye.

TABLE 6.1.1. Numbers of fish stocked into the Ontario waters of Lake Ontario in 2023. Numbers reflect both MNRF-produced fish and those raised by community groups.

Species	Life stage	Number	Biomass (kg)
Atlantic Salmon	Spring Fingerling	186,102	1,014
	Fall Fingerling	55,615	2,015
	Spring Yearling	93,657	6,679
	Fall Yearling	10,247	2,724
	Adult	3,235	6,416
Bloater	Fall Fingerling	171,641	513
	Fall Yearling	16,390	400
	Sub-adult	117	63
	Adult	37,177	1,954
Brown Trout	Spring Fingerling	35,000	70
	Fall Fingerling	40,000	1,200
	Spring Yearling	176,490	6,570
Chinook Salmon	Spring Fingerling	494,543	3,121
Lake Trout	Spring Yearling	312,836	10,738
Rainbow Trout	Spring Yearling	181,157	4,159
Walleye	Summer Fingerling	81,939	33



6.1.5). Stocking data for 2023 can be found for all of the Great Lakes on the Great Lakes Fisheries Commission stocking data portal at: http://fsis.glfc.org/stocking/events/2023/.

Fig. 6.1.3 shows salmon and trout stocking trends in the Ontario waters of Lake Ontario for the most recent five years, broken down by species and stocking zone. Tables 6.1.4 and 6.1.5 provide detailed information on fish stocking by species, location, and life stage for 2023.

Atlantic Salmon (348,856; 18,848 kg.) were stocked in support of an ongoing program to restore self-sustaining populations of this native species to Lake Ontario. Atlantic Salmon are produced at MNRF hatcheries, with some eggs being delivered to academic and community volunteer facilities for rearing. In addition to these regular stocking activities, surplus brood Atlantic Salmon (adults) are occasionally available for release. These fish are tagged and tracked as part of an angler outreach program (Section 6.3).

Bloater (225,325; 2,930 kg.) were stocked in 2023. This small relative of the Lake Whitefish was an important prey item for Lake Trout until the late 1950's when both species were extirpated. A coordinated program involving staff from the US and Canada resulted in the initial stocking of approximately 15,000 Bloater in 2013. MNRF Fish Culture Section staff continue to work with our partner agencies to advance our understanding of the complicated process of rearing Bloater.

Chinook Salmon spring fingerlings (494,543; 3,121 kg.) were stocked to provide put-grow-and-take fishing opportunities. All Chinook Salmon for the Lake Ontario program were produced at Normandale Fish Culture Station. A significant number of Chinook were transferred to volunteer-run net pens to enhance imprinting and growth during the last month of captivity. See Section 6.2 for a full description of the 2023 net pen program.

Coho Salmon are produced by stocking partner Metro East Anglers at the Ringwood Fish Culture Station. No Coho were produced in 2023.

Lake Trout spring yearlings (312,906; 10,741 kg.) were stocked in 2023 as part of an established, long-term rehabilitation program, supporting the Lake Trout Stocking Plan.

TABLE. 6.1.2. MNRF fish stocking targets and actual numbers stocked in 2023 (MNRF-produced fish only).

Species / Life Stage	Stocked	Target	Percent
Atlantic Salmon			
Spring Fingerling	181,345	205,000	88%
Fall Fingerling	55,615	70,000	79%
Spring Yearling	93,657	95,000	99%
Fall Yearling	10,247	10,000	102%
Bloater			
All Life Stages	225,325	250,000	90%
Brown Trout			
Spring Yearling	176,490	165,000	107%
Chinook Salmon			
Spring Fingerling	494,543	467,000	106%
Lake Trout			
Spring Yearling	312,906	282,000	111%
Rainbow Trout			
Spring Yearling	168,157	180,000	93%
Walleye			
Summer Fingerling	81,939	100,000	82%

TABLE 6.1.3. Fish provided to community hatcheries by MNRF.

Species / Life Stage	Target	Partner
Atlantic Salmon		
Egg	20,000	Belfountain Hatchery
Egg	16,600	Classroom Hatchery Program
Egg	20,000	Islington Sportsman Club
Egg	10,000	Ontario Streams
Egg	70,000	SSFC
Brown Trout		
Egg	96,000	Metro East Anglers
Egg	50,000	Napanee Rod and Gun Club
Coho Salmon *		
Spring Fingerling	80,000	Metro East Anglers
Rainbow Trout		
Egg	19,000	Metro East Anglers
Egg	5,000	S. Central Ont F&W Assoc.

* Coho Salmon eggs are collected by Metro East Anglers, and are not provided by MNRF.

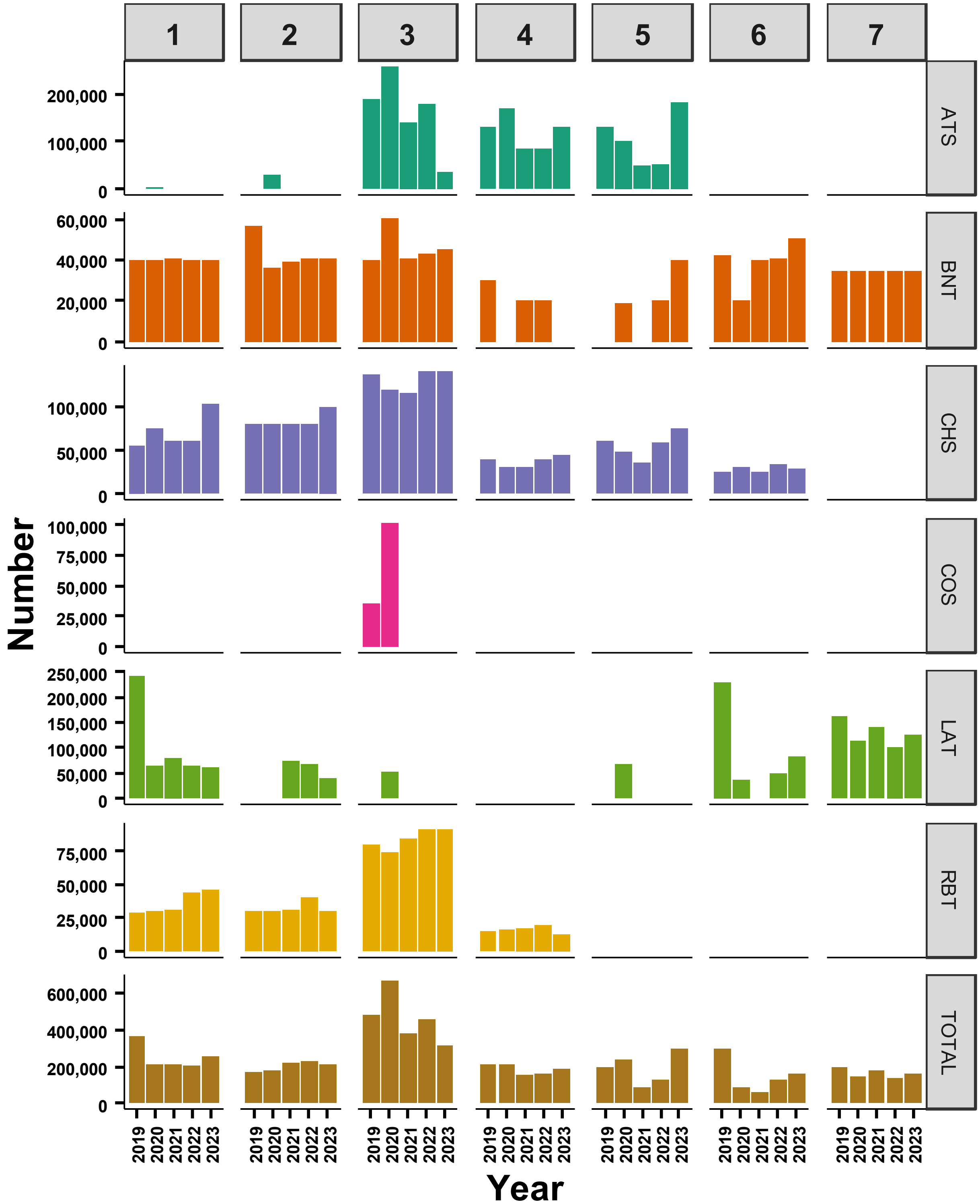


FIG. 6.1.3. Numbers of salmon and trout stocked in the Ontario waters of Lake Ontario for the most recent five years. Data are presented by species (rows) and by stocking zone (columns). The bottom panel ("Total") shows the total for all six species for the same time frame. Note that the y-axes are variable.

ATS = Atlantic Salmon, BNT = Brown Trout, CHS = Chinook Salmon, COS = Coho Salmon, LAT = Lake Trout, RBT = Rainbow Trout.

TABLE 6.1.4. Native fish species stocked into the Ontario waters of Lake Ontario and its tributaries in 2023.

Species / Life Stage	Waterbody	Site	Hatchery	Strain	Marks	Stocking Month	Age (Months)	Weight (g)	Biomass (kg)	Number
Atlantic Salmon										
Spring Fingerling	Credit R.	Forks	Belfountain	LaHave R.	--	4	4	0.2	0.2	1,344
Spring Fingerling	Credit R.	Goyech Property	Belfountain	LaHave R.	--	4	4	0.2	0.3	1,775
Spring Fingerling	Credit R.	W. Credit - Shaw's Cr. Rd.	Belfountain	LaHave R.	--	4	4	0.2	0.3	1,638
Spring Fingerling	Duffins Cr.	E. Duffins Cr. - 5th Conc.	MNR-NM	Sebago Lk.	--	5	5	6.7	134.1	19,930
Spring Fingerling	Duffins Cr.	E. Duffins Cr. - Durham Outdoor Centre	MNR-NM	Sebago Lk.	--	5	5	7.0	139.0	19,999
Spring Fingerling	Duffins Cr.	E. Duffins Cr. - Hwy 7	MNR-NM	Sebago Lk.	--	5	5	4.9	168.1	34,967
Spring Fingerling	Duffins Cr.	W. Duffins - Whitevale Bridge	MNR-NM	Sebago Lk.	--	5	5	4.9	73.0	14,988
Spring Fingerling	Ganaraska R.	Carscadden Rd.	MNR-NM	Sebago Lk.	--	5	5	5.7	85.8	15,002
Spring Fingerling	Ganaraska R.	Kendal - MNR Property	MNR-NM	Sebago Lk.	--	5	5	5.3	79.3	14,988
Spring Fingerling	Ganaraska R.	Newtonville Rd.	MNR-NM	Sebago Lk.	--	5	5	5.6	112.8	19,994
Spring Fingerling	Ganaraska R.	Quays Branch - 5th Line	MNR-NM	Sebago Lk.	--	5	5	6.3	94.4	14,961
Spring Fingerling	Ganaraska R.	Shiloh Rd.	MNR-NM	Sebago Lk.	--	5	5	4.4	72.0	16,519
Spring Fingerling	Ganaraska R.	Soper Rd.	MNR-NM	Sebago Lk.	--	5	5	5.5	54.8	9,997
Fall Fingerling	Duffins Cr.	E. Duffins Cr. - 5th Conc.	MNR-NM	Sebago Lk.	--	10	10	50.5	701.7	17,157
Fall Fingerling	Ganaraska R.	Quays Branch - 4th Line	MNR-NM	Sebago Lk.	--	10	10	34.6	965.4	27,647
Fall Fingerling	Shelter Valley Cr.	Doig Property	MNR-NM	Sebago Lk.	--	9	9	32.2	347.8	10,811
Spring Yearling	Central Basin	Port Hope - Eldorado Place	MNR-NM	LaHave R.	--	5	16	64.7	180.0	2,759
Spring Yearling	Central Basin	Port Hope - Eldorado Place	MNR-NM	Sebago Lk.	--	5	16	77.7	3,535.7	46,002
Spring Yearling	Credit R.	Don Rowing Club	MNR-NM	LaHave R.	--	5	16	68.8	619.1	8,996
Spring Yearling	Duffins Cr.	Rotary Park Ramp	MNR-NM	LaHave R.	--	4	16	63.7	1,420.0	22,343
Spring Yearling	Western Basin	Lakefront Promenade	MNR-NM	LaHave R.	--	5	16	66.2	924.0	13,557
Fall Yearling	Western Basin	Lakefront Promenade	MNR-NM	Sebago Lk.	--	11	24	266.0	2,627.3	9,886
Fall Yearling	Western Basin	Port Dalhousie East	MNR-NM	Sebago Lk.	--	12	24	269.0	97.1	361
Adult	Ganaraska R.	Port Hope - Mill St. Boat Ramp	MNR-HW	LaHave R.	--	1	52	2,006.7	3,861.1	2,318
Adult	Ganaraska R.	Port Hope - Mill St. Boat Ramp	MNR-HW	Sebago Lk.	--	12	30	1,200.0	334.8	279
Adult	Western Basin	Grimsby - Forty Mile Cr. Park	MNR-NM	Sebago Lk.	--	7	44	3,600.0	706.4	191
Adult	Western Basin	Port Dalhousie East	MNR-NM	Sebago Lk.	--	8	44	3,325.7	1,049.7	277
Adult	Western Basin	Port Dalhousie East	MNR-NM	Sebago Lk.	--	2	50	2,750.0	464.0	170

MNRF Fish Culture Stations: HW = Harwood, NM = Normandale.
Volunteer and other hatcheries: Belfountain = Belfountain Hatchery

TABLE 6.1.4. (cont.) Native fish species stocked into the Ontario waters of Lake Ontario and its tributaries in 2023.

Species / Life Stage	Waterbody	Site	Hatchery	Strain	Marks	Stocking Month	Age (Months)	Weight (g)	Biomass (kg)	Number
Bloater										
Fall Fingerling	Central Basin	Cobourg Hrbr. Pier	MNR-NM	Lk. Michigan	--	12	8	2.9	351.5	124,129
Fall Fingerling	Central Basin	Cobourg Hrbr. West	MNR-HW	Lk. Michigan	--	11	9	3.4	161.5	47,512
Fall Yearling	Central Basin	Cobourg Hrbr. Pier	MNR-CH	Lk. Michigan	--	12	21	26.7	268.7	10,053
Fall Yearling	Eastern Basin	Amherst Isl. - Ferry	MNR-WL	Lk. Michigan	--	10	19	20.7	131.2	6,337
Sub-adult	Central Basin	Cobourg Hrbr. West	MNR-WL	Lk. Michigan	--	5	86	537.7	62.9	117
Adult	Central Basin	Cobourg Hrbr. Pier	MNR-CH	Lk. Michigan	--	12	33	45	1,630.0	36,205
Adult	Central Basin	Cobourg Hrbr. West	MNR-WL	Lk. Michigan	--	5	86	366.8	323.7	972
Lake Trout										
Spring Yearling	Central Basin	Ogden Point	MNR-CH	Seneca Lk.	RVAD	4	14	24.8	1,485.0	59,806
Spring Yearling	Central Basin	Ogden Point	MNR-HW	Seneca Lk.	RVAD	4	16	41.8	998.4	24,005
Spring Yearling	Eastern Basin	Amherst Isl. - Big Bar Shoal	MNR-HW	Seneca Lk.	RVAD	5	17	55	775.9	14,107
Spring Yearling	Eastern Basin	Amherst Isl. - Ferry	MNR-WL	Slate Is.	RVAD	5	18	41	1,259.0	30,707
Spring Yearling	Eastern Basin	Amherst Isl. - Grape Isl.	MNR-HW	Seneca Lk.	RVAD	5	17	54	805.2	14,912
Spring Yearling	Eastern Basin	Amherst Isl. - Grape Isl.	MNR-WL	Slate Is.	RVAD	5	18	39	735.9	18,869
Spring Yearling	Eastern Basin	Amherst Isl. - K10 Buoy	MNR-HW	Seneca Lk.	RVAD	5	17	51	380.1	7,452
Spring Yearling	Eastern Basin	Amherst Isl. - Pig Pt.	MNR-WL	Slate Is.	RVAD	5	18	38.5	965.4	25,076
Spring Yearling	Eastern Basin	Pigeon Isl.	MNR-HW	Seneca Lk.	RVAD	5	17	52	777.0	14,943
Spring Yearling	Western Basin	Beacon Inn	MNR-CH	Slate Is.	RVAD	4	16	23.9	1,459.6	61,045
Spring Yearling	Western Basin	Grimsby - Forty Mile Cr. Park	MNR-CH	Slate Is.	RVAD	4	16	26.2	1,099.9	41,984
Walleye										
Summer Finger-ling	Western Basin	Toronto Hrbr. - Polson St.	MNR-WL	Bay of Quinte	--	6	3	0.4	32.8	81,939

MNRF Fish Culture Stations: CH = Chatsworth, HW = Harwood, NM = Normandale, WL = White Lake. Marks (fin clips): AD = adipose, RV = right ventral.

Rainbow Trout (181,157; 4,159 kg.) and Brown Trout (251,490; 7,840 kg.) were stocked at various locations to support shore and boat fisheries. Community hatcheries contribute to the stocking of both species. See Table 6.1.5 for details. Walleye stocking began in 2012 to re-establish this native, predatory fish to the fish communities of Hamilton Harbour and Toronto Harbour and to promote urban, near-shore angling.

Walleye stocking alternates annually between Toronto Harbour and Hamilton Harbour. In 2023, 81,939 Walleye (33 kg.) were stocked in Toronto Harbour.

TABLE 6.1.5. Introduced fish species stocked into the Ontario waters of Lake Ontario and its tributaries in 2023.

Species / Life Stage	Waterbody	Site	Hatchery	Strain	Marks	Stocking Month	Age (Months)	Weight (g)	Biomass (kg)	Number
Brown Trout										
Spring Fingerling	Eastern Basin	Finkle's Shore Ramp	Springside	Ganaraska R.	--	4	4	2.0	70.0	35,000
Fall Fingerling	Bowmanville Cr.	CLOCA Ramp	MEA-RW	Ganaraska R.	--	11	11	30.0	1,200.0	40,000
Spring Yearling	Central Basin	Ogden Point	MNR-CH	Ganaraska R.	AD	4	15	38.8	1,950.0	50,296
Spring Yearling	Western Basin	Bronte Hrbr.	MNR-CH	Ganaraska R.	AD	3	14	32.5	1,310.0	40,346
Spring Yearling	Western Basin	Humber Bay Park	MNR-CH	Ganaraska R.	AD	3	14	38.3	1,760.0	45,554
Spring Yearling	Western Basin	Port Dalhousie East	MNR-CH	Ganaraska R.	AD	3	14	38.5	1,550.0	40,294
Chinook Salmon										
Spring Fingerling	Bronte Cr.	4th Side Rd. Bridge	MNR-NM	Credit R.	--	5	5	4.8	146.5	30,206
Spring Fingerling	Bronte Cr.	5th Side Rd. Bridge	MNR-NM	Credit R.	--	5	5	5.0	151.1	30,032
Spring Fingerling	Central Basin	Bluffer's Park - Netpen	MNR-NM	Credit R.	--	5	5	7.3	330.3	45,241
Spring Fingerling	Central Basin	Oshawa Netpen	MNR-NM	Credit R.	--	5	5	10.2	255.9	25,092
Spring Fingerling	Central Basin	Port Darlington - Netpen	MNR-NM	Credit R.	--	5	5	7.9	198.5	25,092
Spring Fingerling	Central Basin	Wellington - Netpen	MNR-NM	Credit R.	--	5	5	7.0	205.1	29,340
Spring Fingerling	Central Basin	Whitby Netpen	MNR-NM	Credit R.	--	5	5	7.5	188.6	25,146
Spring Fingerling	Credit R.	Eldorado Park	MNR-NM	Credit R.	--	5	5	4.9	243.2	50,041
Spring Fingerling	Credit R.	Norval	MNR-NM	Credit R.	--	5	5	5.1	256.2	50,033
Spring Fingerling	Hamilton Harbour	Grindstone Cr. - Hidden Valley	MNR-NM	Credit R.	--	5	5	5.0	50.0	10,085
Spring Fingerling	Humber R.	Boyd Conservation Area	MNR-NM	Credit R.	--	5	5	5.0	151.4	30,049
Spring Fingerling	Western Basin	Bronte Netpen	MNR-NM	Credit R.	--	4	5	5.7	171.4	30,065
Spring Fingerling	Western Basin	Port Credit - Netpen	MNR-NM	Credit R.	--	5	5	5.7	57.4	10,032
Spring Fingerling	Western Basin	Port Dalhousie - Netpen	MNR-NM	Credit R.	--	5	5	7.9	474.4	60,276
Spring Fingerling	Western Basin	Port Dalhousie East	MNR-NM	Credit R.	--	5	5	5.5	241.0	43,813
Rainbow Trout										
Spring Yearling	Bronte Cr.	4th Side Rd. Bridge	MNR-WL	Ganaraska R.	--	5	13	23.3	349.5	15,000
Spring Yearling	Bronte Cr.	5th Side Rd. Bridge	MNR-HW	Ganaraska R.	--	5	13	22.4	333.0	14,852
Spring Yearling	Credit R.	Eldorado Park	MNR-WL	Ganaraska R.	--	5	13	26.0	846.0	32,538
Spring Yearling	Credit R.	Norval	MNR-WL	Ganaraska R.	--	5	13	18.6	465.0	25,000
Spring Yearling	Humber R.	E. Branch Islington	MNR-WL	Ganaraska R.	--	6	13	25.6	489.0	19,269
Spring Yearling	Humber R.	King Vaughan Line	MNR-WL	Ganaraska R.	--	5	13	24.4	366.0	15,000
Spring Yearling	Niagara R.	Queenston	MNR-HW	Ganaraska R.	--	6	14	24.6	520.2	22,007
Spring Yearling	Rouge R.	Rouge R.	MEA-RW	Ganaraska R.	--	4	12	25.0	325.0	13,000
Spring Yearling	Western Basin	Port Dalhousie East	MNR-HW	Ganaraska R.	--	5	13	19.0	465.3	24,491

MNRF Fish Culture Stations: CH = Chatsworth, HW = Harwood, NM = Normandale, WL = White Lake.
Volunteer and other hatcheries: MEA-RW= Metro East Anglers- Ringwood, Springside = Springside Park Hatchery. Marks (fin clips): AD = adipose

6.2 Chinook Salmon Net Pen Program

C. Lake, Lake Ontario Management Unit

The stocking net pen is a floating enclosure that is tied to a pier or other near shore structure used to temporarily house and acclimatize young Chinook Salmon prior to their release into Lake Ontario.

The fish are held in the net pen for approximately 4-5 weeks and are tended by local angler groups who monitor the health of the fish and ensure that the fish are fed, and the pens are cleaned regularly. Several of the clubs also use the net pens as an outreach tool, involving their local community during delivery and/or release of the fish. Up to eight net pen sites are located around the lake (Fig. 6.2.1), however not every site is necessarily used each year. In 2023, all sites participated.

Compared to fish released directly from the hatchery, net pen fish are larger, survive better and may have a greater degree of site fidelity, or imprinting, to the stocking site based on marking experiments conducted by the New York Department of Environmental Conservation (NYSDEC). Because of their time in the net pens as young fish, it is expected that sexually mature fish will return to the area and provide a quality nearshore fall fishery for anglers. A thorough review of the history of the program was described in the 2014 Annual Report.

A total of 250,284 Chinook Salmon were released from 8 sites (18 net pens, total) in 2023. This represents 50.6% of the total number (494,543) of Chinook Salmon stocked in the Ontario waters of Lake Ontario in 2023 (Fig. 6.2.2).

Fish were reared and delivered by MNRF staff at the Normandale Fish Culture Station, and survival and growth were good at all sites. Fish were delivered at an average size of 2.8g. and kept in the net pens for an average of 33.1 days, gaining an average of 4.7g across all sites. In 2023, volunteers spent a total of 265 days feeding and caring for the penned fish. See Table 6.2.1 for site-specific data on project duration and growth. Long-term trends in pen duration and growth are illustrated in Figs. 6.2.3 and 6.2.4, respectively.

For the duration of the time in the net pen, fish health is paramount. To help ensure fish remain healthy, a maximum of 15,000 fish are placed in each net pen, keeping the overall density under the guideline of 32g of fish per litre

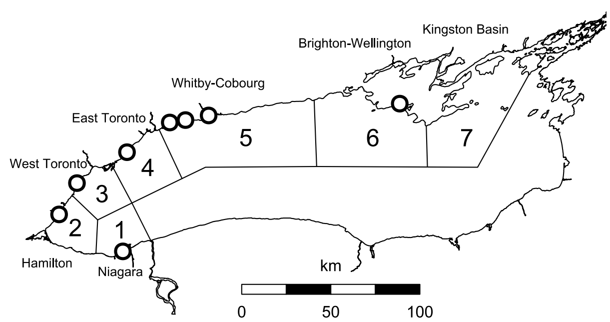


FIG. 6.2.1. Map of Lake Ontario stocking zones and net pen sites (open circles).

TABLE 6.2.1. Fish delivery and release dates, delivery size, growth and total numbers by net pen site.

Site	Club	Pens	Delivery	Release Date	Duration	Stocking Size (g)	Release Size (g)	Growth (g)	Number
Bronte	HRSTA	2	April 01	April 30	30	2.6	5.7	3.1	30,065
Credit	PCSTA	1	April 01	May 03	33	2.6	5.7	3.1	10,032
Wellington	CLOSA	2	April 04	May 03	33	2.7	7	4.3	29,340
Darlington	MEA	2	April 04	May 03	33	2.7	7.9	5.2	25,092
Oshawa	MEA	2	April 05	May 08	34	2.7	10.2	7.5	25,092
Whitby	MEA	2	April 05	May 11	37	2.8	7.5	4.7	25,146
Bluffers	MEA	3	April 06	May 08	33	2.8	7.3	4.5	45,241
Dalhousie	SCFGC	4	April 11	May 12	32	3.1	7.9	4.8	60,276

CLOSA = Central Lake Ontario Salmon Association, HRSTA = Halton Region Salmon and Trout Association, MEA = Metro East Anglers, PCSTA = Port Credit Salmon and Trout Association, SCGFA = St. Catharines Game & Fish Association of water. Net pen sizes have been standardized, and each have a volume of approximately 4,000 litres. Fig. 6.2.5 shows the average density of fish (at time of release) in the net pens. Each site is issued a combination temperature/dissolved oxygen data logger, allowing the various sites' water quality to be monitored and compared (see Fig. 6.2.6 for temperature; see 6.2.7 for dissolved oxygen). The loggers are suspended mid-depth inside the net pen, and measurements are recorded every five minutes. Unfortunately, in 2023 the data logger failed at the Bluffers net pen site, so no data were recorded.

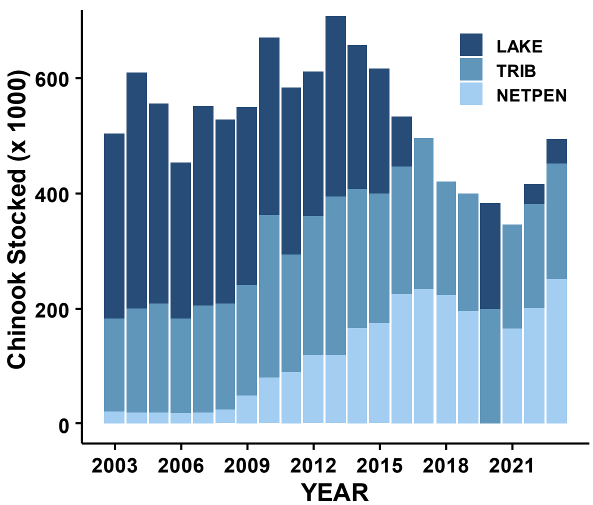


FIG. 6.2.2. Number of Chinook Salmon released from Ontario net pens versus those stocked in tributaries or directly into Lake Ontario.

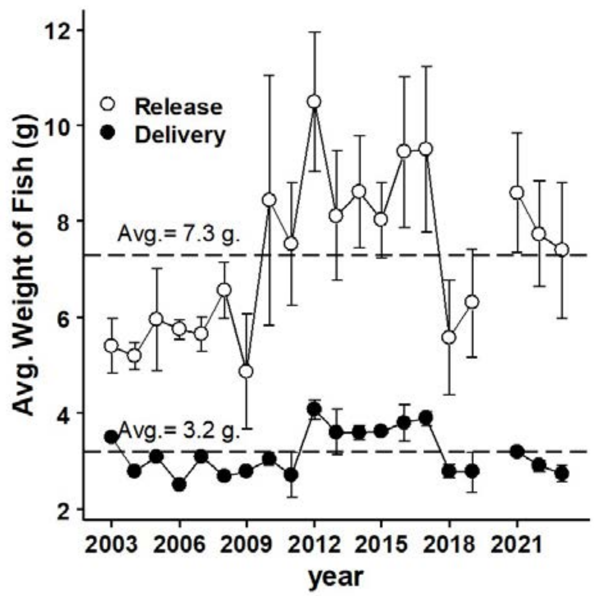


FIG. 6.2.4. Chinook size at delivery and release size for all years of the net pen program.

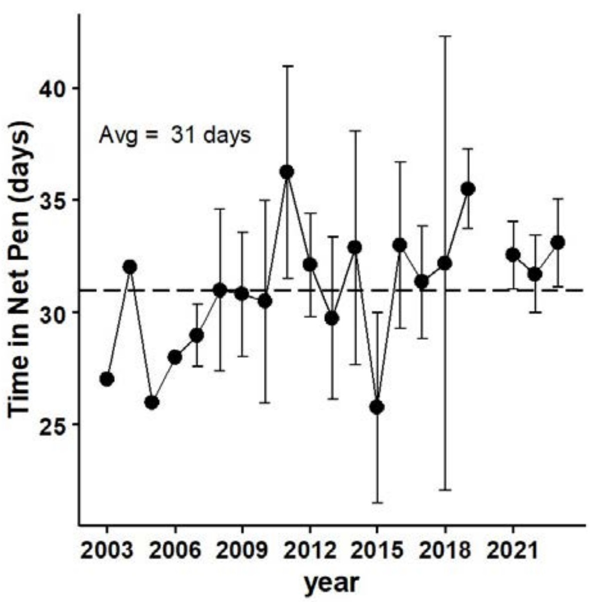


FIG. 6.2.3. Average duration for all years of the stocking net pen program.

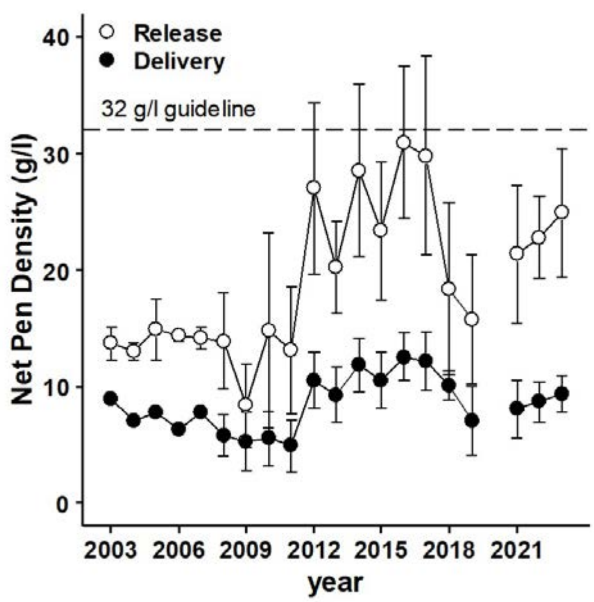


FIG. 6.2.5. Average density (g/l) of Chinook Salmon held per net pen. The guideline is represented by the dashed line.

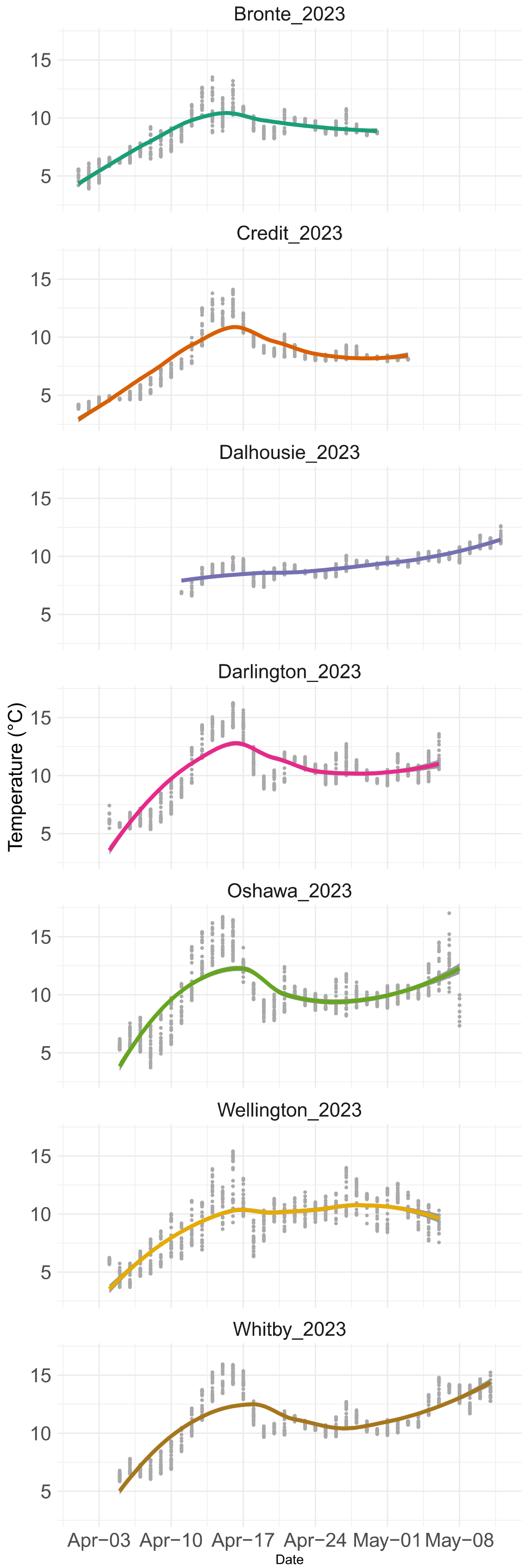


FIG. 6.2.6. Temperature data for the net pen program.

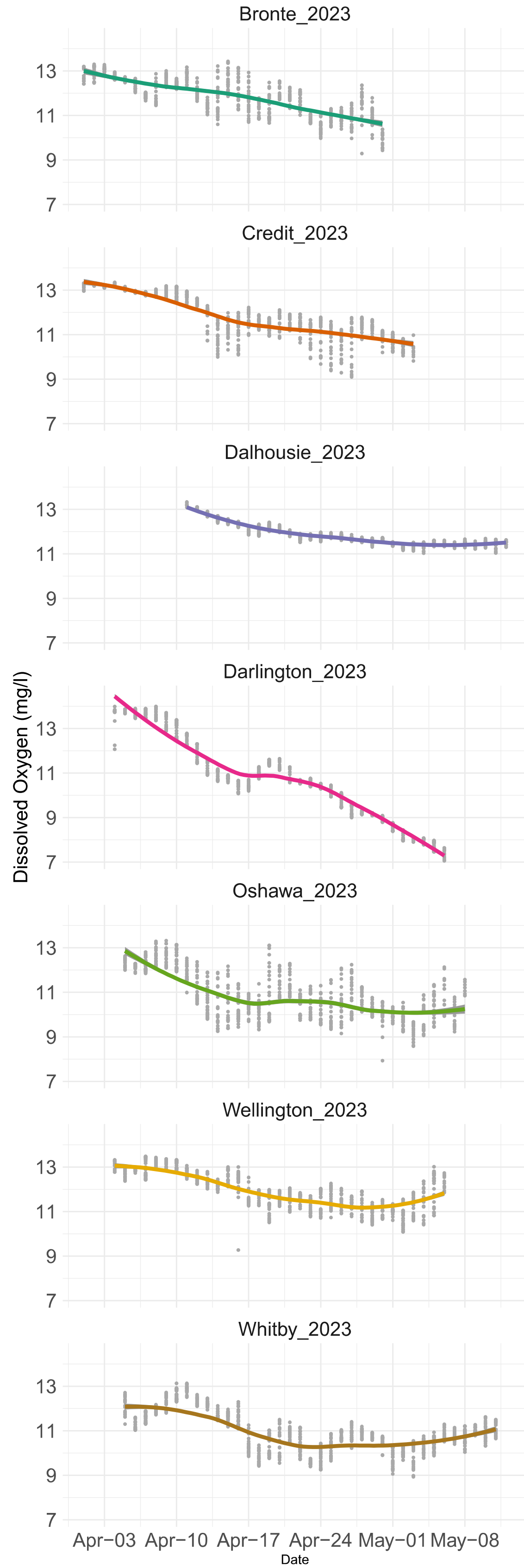


FIG. 6.2.7. Dissolved oxygen data for the net pen program.

6.3 Atlantic Salmon Surplus Brood Stock Tagging

C. Lake, Lake Ontario Management Unit

To support ongoing restoration efforts, the Ministry of Natural Resources and Forestry maintains Atlantic Salmon 'brood stock' in several provincial fish culture stations. Brood stock are adult (sexually mature) fish that are kept in the hatchery so that their offspring can be raised and eventually stocked at various life stages. As brood stock age, the quality of their gametes may decline. Keeping these large fish in a hatchery environment right up to the end of their lives is costly in terms of space and food – it's more efficient to 'retire' these fish a bit early in favour of younger, more productive individuals.

To make the best use of these 'surplus' fish, they are released into Lake Ontario to provide angling opportunities. To better understand survival and movement, fish were tagged near the dorsal fin with a coloured streamer tag labelled with a unique identifying number and phone number printed on it.

The total number of tagged fish released in 2023 was 1,248. Reported recapture locations by release site are shown in Fig. 6.3.1. Note that a small number (n=86) of fish were stocked in Grimsby in 2023, however, a recapture map was not produced for this stocking event.

When anglers report catching one of these fish, basic information on movement and survival can be calculated. See Table 6.3.1 for numbers released since the start of the brood stock retirement project. Numbers caught by year and location are given in Table 6.3.2, and the resulting recapture rate is given in Table 6.3.3. Note: fish may be caught in years after their stocking year, so recapture values may be updated and change slightly in future reports.

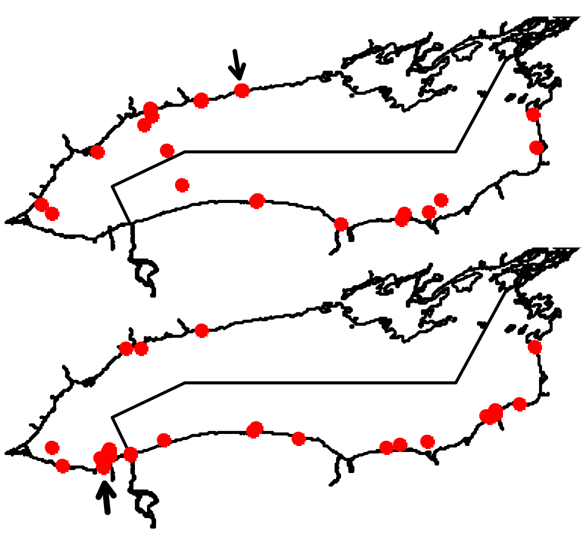


FIG. 6.3.1. Recapture locations of tagged fish released at Port Hope (TOP) and Port Dalhousie (BOTTOM) in 2023.

The tagging and release of Atlantic Salmon brood stock is opportunistic, and dependent on the operational needs of the fish culture stations. Many factors that possibly affect survival after stocking (hatchery of origin, strain, age of fish, stocking location, stocking date) are not independent, preventing more extensive statistical analyses of the recapture data. All project data can be found here - https://geohub.lio.gov.on.ca/datasets/ mnrf::lakeontario - tagged-atlantic-salmon/about.

TABLE 6.3.1. Numbers of tagged brood stock Atlantic Salmon stocked by location and year.

Location	2018	2019	2020	2021	2022	2023	Total
Bronte Harbour	196	--	--	--	--	--	196
Cobourg Marina	--	556	--	--	--	--	556
Grimsby	--	300	--	--	--	86	386
Newcastle	--	249	--	--	--	--	249
Port Dalhousie	96	164	313	1,081	267	393	2,314
Port Hope	--	93	215	600	343	769	2,020
Total	292	1,362	528	1,681	610	1,248	5,721

TABLE 6.3.2. Numbers of tagged brood stock Atlantic Salmon recaptured by stocking location and year.

Location	2018	2019	2020	2021	2022	2023	Total
Bronte Harbour	6	--	--	--	--	--	6
Cobourg Marina	--	24	--	--	--	--	24
Grimsby	--	14	--	--	--	1	15
Newcastle	--	14	--	--	--	--	14
Port Dalhousie	5	13	13	64	8	26	137
Port Hope	--	--	10	51	17	35	113
Total	11	65	23	115	25	62	309

TABLE 6.3.3. Recapture percentages of tagged brood stock Atlantic Salmon by stocking location and year.

Location	2018	2019	2020	2021	2022	2023	Total
Bronte Harbour	3.1%	--	--	--	--	--	3.1%
Cobourg Marina	--	4.3%	--	--	--	--	4.3%
Grimsby	--	4.7%	--	--	--	1.2%	3.9%
Newcastle	--	5.6%	--	--	--	--	5.6%
Port Dalhousie	5.2%	7.9%	4.2%	5.9%	3.0%	6.6%	5.9%
Port Hope	--	--	4.6%	8.5%	5.0%	4.6%	5.6%
Total	3.8%	4.8%	4.4%	6.8%	4.1%	5.0%	5.4%

7. Research Activities

7.1 Station 81: Long-term monitoring at the base of Lake Ontario's food web

Project Leads: Rylie Robinson, Emma Bloomfield, and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)
Collaborators: Heather Niblock and Kelly Bowen (Fisheries and Oceans Canada)

Lower trophic level organisms (microscopic organisms that form the base of the aquatic food web), like phytoplankton and zooplankton, are essential components of Lake Ontario's aquatic ecosystem. Prey fish (e.g., Cisco [*Coregonus artedi*] and Alewife [*Alosa pseudoharengus*]) rely on zooplankton for energy and they in turn provide energy to top consumers (e.g., Chinook Salmon [*Oncorhynchus tshawytscha*] and Walleye [*Sander vitreus*]). Ecological changes such as climate change and nutrient reductions can rapidly impact lower trophic levels with impacts extending from bottom to top consumers. Therefore, continued monitoring of lower trophic organisms and the factors that impact them is essential for fisheries management.

Long-term data about lower trophic organisms and some variables that impact them is collected in eastern Lake Ontario through the Station 81 program. Sampling was conducted at Station 81 from 1981 – 1995 by Fisheries and Oceans Canada (DFO). Sampling resumed in 2007 as a partnership between MNRF's Aquatic Research and Monitoring Section, MNRF's Lake Ontario Management Unit, and DFO. Station 81 is a sampling site in eastern Lake Ontario near the geographic centre of the Canadian waters of the Kingston Basin (44° 01.02'N, 76° 40.23'W; ~34m water depth). In 2023, Station 81 was sampled every other week, between May and November for a total of 14 sample days. During each visit, the lake's physiochemical properties are measured (i.e., temperature, dissolved oxygen,

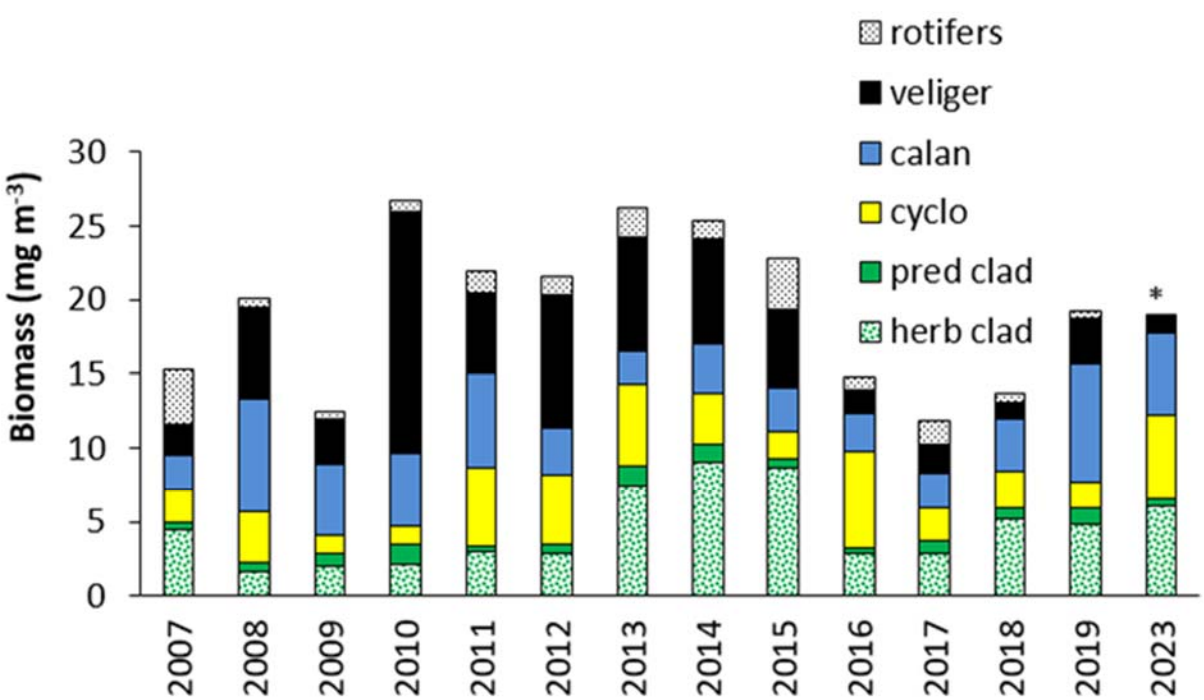


FIG. 7.1.1. Mean May to October biomass of dominant zooplankton groups in the total water column at Station 81. Rotifer biomass was taken from the epilimnion, with no available data for 2023 (indicated by *).

water clarity, nutrients) alongside the collection of phytoplankton and zooplankton to determine species composition and biomass.

Since 2007, the zooplankton community has shown shifts in biomass, abundance, and composition (Figs. 7.1.1 and 7.1.2) – which has implications for prey fish diet, energy transfer, and overall food web structure. There are noticeable long-term (> 5 year) changes, such as veliger (larval dreissenid) decline from 2016 onwards. There has also been a slight recovery in herbivorous cladocerans, from low abundance (mean = 12.4%) in 2008 – 2012, to high (mean = 31.4%) from 2013 – onwards. Short-term (< 1 year) trends are more difficult to identify, which highlights the importance of long-term, consistent sampling regiments. However, it is clear to see that zooplankton communities differ from year to year, likely a result of various environmental factors.

The lower trophic levels of food webs (e.g., zooplankton) provide the foundation for understanding higher trophic individuals (e.g., fish). It is important to note that not all available prey is preferred prey and fish species can be relatively selective in what they consume. Therefore, large changes in planktonic communities can have a significant bottom-up effect on fish populations. Continued maintenance and analysis of these long-term datasets will ensure that resource managers are best equipped to identify and respond to changes that may impact Lake Ontario's ecosystem and fisheries.

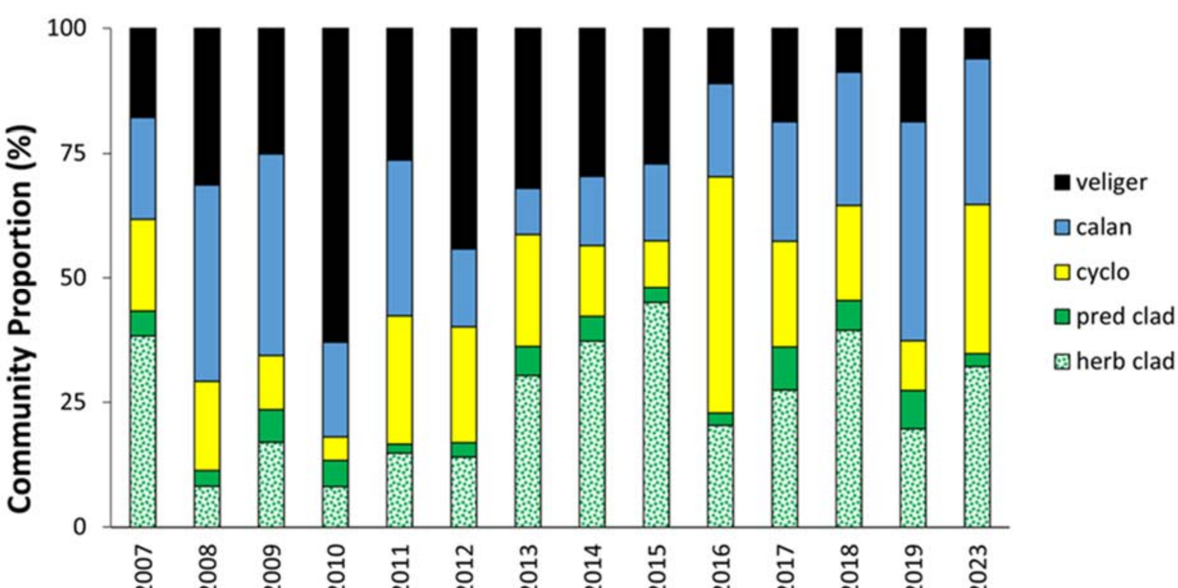


FIG. 7.1.2. Community composition (in proportion of 100% total) of major zooplankton groups sampled from the entire water column of Station 81 across 2007 - 2023, excluding 2020-2022 (no data available). Community does not include rotifers.

7.2 Identifying spatial patterns of seasonal stratification and turnover across Lake Ontario

Project Leads: Rylie Robinson and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)
Collaborators: Mathew Wells and Yulu Shi (University of Toronto); Jon Midwood (Fisheries and Oceans Canada); Brian Lantry (US Geological Survey); Dimitry Gorsky (US Fish and Wildlife Service); Bruce Tufts (Queen's University)

Water temperature is a dynamic factor that has a powerful effect on all waterbodies and dependent organisms. Two related physical processes that cause change in water column temperature is: (i) thermal stratification and (ii) thermal turnover.

Stratification occurs when large, deep lakes form distinct temperature layers in the water column. During warmer months, the sun warms the upper metres of the water column, creating a warmer, less dense surface layer (epilimnion), while the deeper layer remains cooler and dense (hypolimnion). In winter, deeper depths can become warmer than the upper layers – called inverse or winter stratification.

Turnover plays a key role in nutrient cycling and oxygen distribution. Mixing brings nutrients up and brings oxygen down, important for the incoming winter season. In stratified lakes, the surface layer serves as a habitat for plankton – foundational components of aquatic food webs (e.g., plankton are often food for small fish). Turnover influences the distribution of these organisms, affecting the availability of food for fish.

To describe the temporal and spatial variability of temperature throughout Lake Ontario, 13 temperature-measuring moorings were deployed to monitor fluctuations in these variables (Fig. 7.2.1). The moorings extended from 10m below the lake surface to the bottom of the lake at local depth. In 2023, this completed the second-year of a three-year commitment to maintain and collect subsurface temperature-light data from these stations.

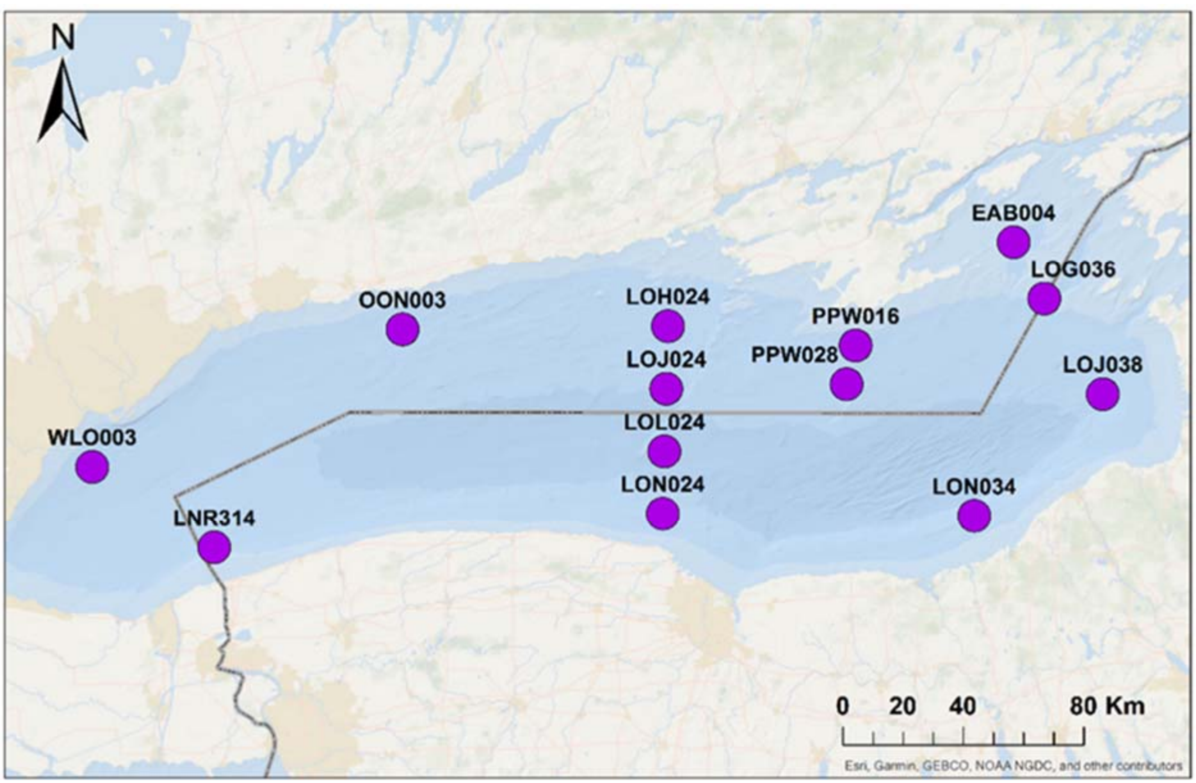


FIG. 7.2.1. Map showing 13 temperature/light profile monitoring stations (violet circles) across Lake Ontario.

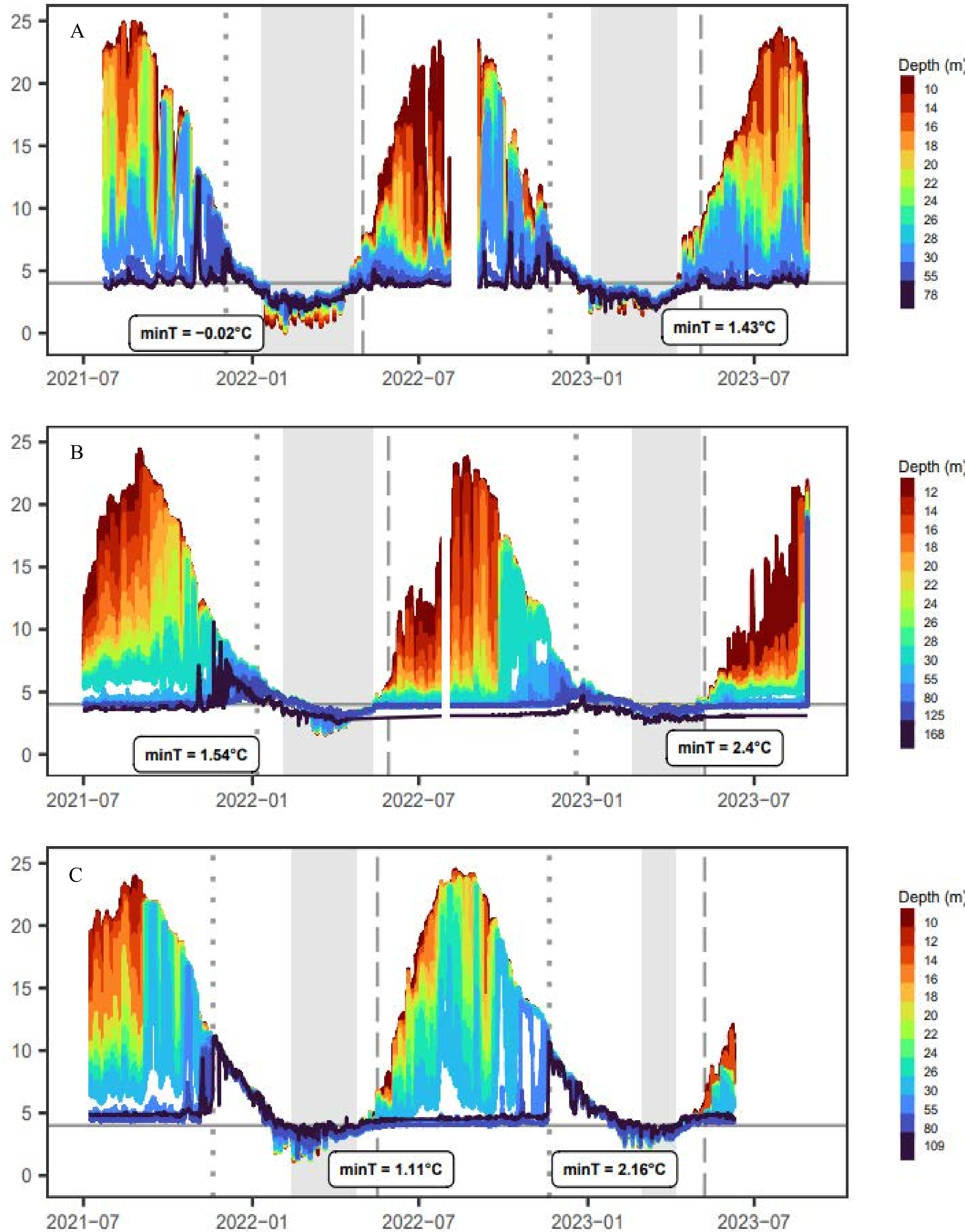


FIG. 7.2.2. Temperature profiles for three of the thirteen moorings for the west, central, east sections of Lake Ontario: A) West station depth 80m; B) Central station depth 170m; C) East station depth 110m. Dotted lines (vertical) represent the start of fall turnover. Shaded area represents the winter duration where water temperatures are < 4°C. Dashed lines (vertical) annotate the start of spring/summer stratification. Solid line (horizontal) marks the 4°C isotherm.

In comparison to 2021, 2022 data showed warmer average winter water temperatures, alongside earlier dates of fall turnover across Lake Ontario (Fig. 7.2.2). Timing of stratification and mixing events were also different across the lake. Nearshore, shallow stations were found to heat faster and have earlier dates of turnover. Offshore, deeper stations were found to heat slower and have later dates of turnover. The duration of winter (when water column temperatures drop below 4°C) was shorter and occurred slightly later at the eastern end of the lake resulting in a delayed spring warming. We found that inverse stratification did not occur uniformly across the lake, with it being weakest near the center of the lake (Fig. 7.2.3). With warmer waters and reduced ice coverage likely to be more frequent in the future, we are likely to see less inversely stratified waters, even in the nearshore areas. This could result in one turnover event (fall) instead of two (fall and spring), which could impact lifecycle events of all aquatic organisms. Specific to Lake Ontario's fish community, behaviours could change due to seasonal shifts in stratification and turnover. These processes are integral to regulating ecological dynamics, nutrient cycling, and fish habitat suitability, which affect ecosystems at both local and regional scales. It is important to monitor changing temperature patterns to predict consequences this may have on fish in the future.

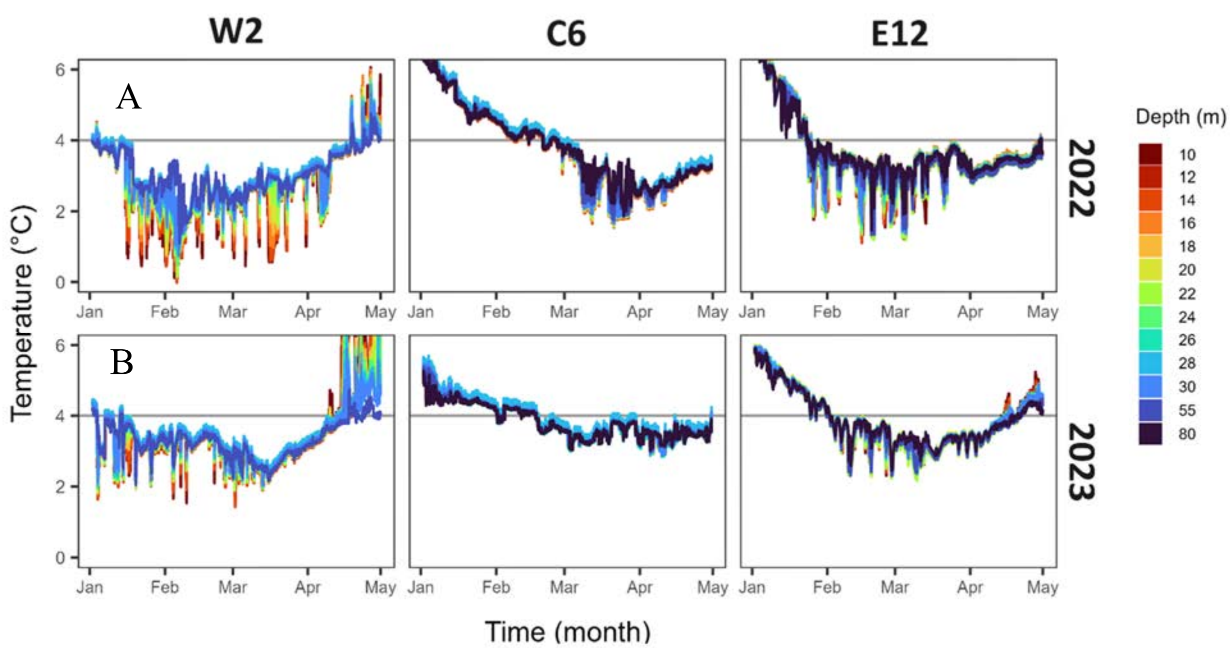


FIG. 7.2.3. Temperature profiles from January to May in 2022 (A) and 2023 (B) for three of the thirteen moorings for the west (W2 - West station depth 80m), central (C6 - Central station depth 170m), and east sections of the lake (E12 - East station depth 110m). Solid line indicates the 4°C isotherm representing 'winter' temperatures. Note: the degree difference between depths below the 4°C isotherm, the greater the magnitude difference, and the stronger the inverse stratification.

7.3 Understanding the relationship between phosphorous and fish production

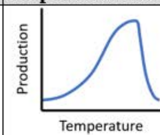
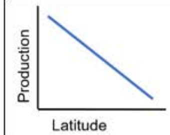
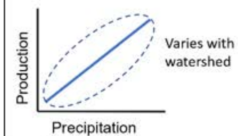
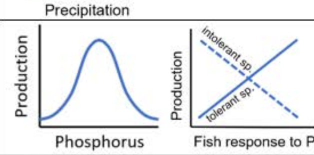
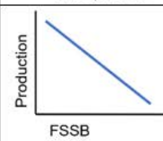
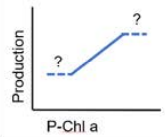
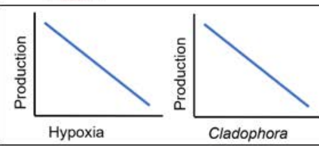
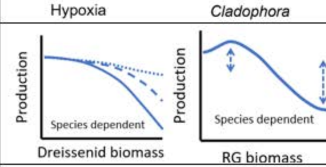
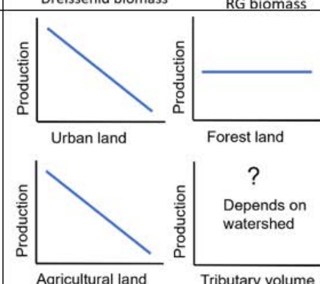
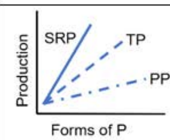
Project Leads: Carolina Taraborelli and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)

We undertook a review of the literature to describe some of the major sources of uncertainty in the relationship between phosphorous and fish production. Phosphorus is the major nutrient limiting production (how much new material is produced) in aquatic systems. However, too much phosphorous produces many undesirable consequences such as excessive algae growth and production of harmful algae blooms, or low oxygen and deteriorating water quality, all of which can affect the composition and the production of fish communities. Different species of fish achieve their maximum production at different levels of phosphorous – with Salmonids (trout, salmon) and Coregonids (whitefish) at lower levels of phosphorus, Percids (perch and walleye) at moderate levels, and Cyprinids (carp and related species) at higher levels.

The Great Lakes Water Quality Agreement was developed in the early 1970s to address poor water quality and low fish production related to excessive phosphorous levels. Binationally agreed upon phosphorous loading targets and concentrations led to controls that saw rapid improvements in water quality and increases in desired fishes. However, on-going ecological change, including invasive species, climate change, and urbanization of the watershed led to a change in phosphorous dynamics in the lakes, including major changes in phosphorous distribution – with high levels returning to the nearshore while offshore concentrations are currently half of the target. Canadian and American agencies are working to better understand what appropriate targets and loads are given existing and emerging ecological changes. The goal is to find ways to manage phosphorous to achieve both water quality and fisheries objectives to satisfy ecological and economic interests.

Our literature review identified many competing factors that all affect the relationship between phosphorus and fish (Table 7.3.1). Some of these factors can be managed while many cannot. Identifying one lakewide phosphorous concentration or load that will achieve multiple objectives to support a diverse fishery consisting of both phosphorus tolerant (e.g., perch and walleye) and phosphorus intolerant (e.g., trout and salmon) species will be difficult. Actions to achieve nearshore objectives (drinking water, swimming, etc.) will be different to those for the offshore (fisheries). MNRF will continue to work with other government and academic experts to identify optimal phosphorous targets for the benefit of all Ontarians.

TABLE 7.3.1. List of factors that influence the relationship between phosphorous and fish (P-fish). Expected relationship with fish production are graphed. Chl-a refers to chlorophyl a. Intolerant sp. are fish species that prefer low concentrations of phosphorous. Tolerant sp. can handle higher concentrations.

Factor	Mechanisms	Expected relationship	References
Temperature	Thermodynamics: Temperature increases fish growth until optimum.		Winberg (1960) Wootton (1991)
Latitude	Production: higher at the equator lower at the poles.		Rypel and David (2017)
Climate	Temperature + Precipitation influence production.		Deines et al. (2005)
Response to P	Fish species have optimal P concentration.		Hurley and Christie (1977) Ludsin et al. (2001) Gerdeaux et al. (2006)
Fish standing stock biomass (FSSB)	FSSB regulates production by intraspecific competition.		Thomas and Eckman (2007)
P-Chl *a* relationship	Relationship changes with temperature and P.		Dillon and Rigler (1974) Quinlan et al. (2020)
Negative effects of P	1) Hypoxia decreases fish recruitment. 2) *Cladophora* negatively impacts nearshore habitat.		Müller (1992), Tellier et al. (2022) Higgins et al. (2008, 2012)
Invasive species and P	1) Dreissenids are altering P cycling. 2) Round goby (RG) density increased with dreissenid density.		Hecky et al. (2004) Hui et al. (2021) Pennuto et al. (2012)
Sources of P	1) Urbanization increases P load. 2) Forests do not increase P load. 3) Agriculture increases P loading 4) Tributaries vary on P loading		Dolan and Chapra (2012) Sly (1991) Makarewicz et al. (2012a) Pauer et al. (2022)
Forms of P	Total phosphorous (**TP**) = soluble reactive phosphorous (**SRP**) + particulate phosphorous (**PP**) **SRP**: ~100% bioavailable **PP**: ~28% bioavailable		Sly (1991) Baker et al. (2014) Vidon and Cuadra (2010)

7.4 Mortality and behaviour of hatchery-reared juvenile Bloater stocked across bathymetric depths in Lake Ontario

Project Leads: Lydia Paulic, Silviya Ivanova, and Aaron Fisk (University of Windsor); Dimitry Gorsky and John Sweka (US Fish and Wildlife Service); Tim Johnson (OMNR, Aquatic Research and Monitoring Section)

More than 10 million native and non-native fish species are stocked into the Great Lakes annually in restoration efforts and to support commercial and recreational fisheries. Bloater (*Coregonus hoyi*), a deep-water planktivore extirpated from Lake Ontario in the 1980s, have been stocked annually into the lake since 2012 in a binational restoration effort between the Ontario Ministry of Natural Resources and Forestry (OMNR), the New York State Department of Environmental Conservation (NYSDEC), the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey (USGS), and the Great Lakes Fishery Commission (GLFC) with the goal of re-establishing a self-sustaining population.

Previous research has identified poor survival and dispersal through the lake, a consequence of high predation and possible maladaptive behaviour (i.e., compression barotrauma) related to a hatchery-raised species reintroduced into a foreign environment. In 2022, a passive acoustic telemetry receiver array (underwater moored devices that listen for acoustic "pinging" fish tags) was deployed in Lake Ontario, covering approximately 42 km^2, and was expanded in 2023 to cover approximately 250 km^2 of lake bottom, in water depths ranging from 5 to 150m to assess the influence of depth on survival. Bloater were tagged with acoustic predation tags (tags that can signal when the host fish has been eaten) and stocked at three depths (5, 50, and 100m) in both 2022 (n=120) and 2023 (n=120) to assess survival and to quantify sources of mortality at each depth.

Results from 2022 indicated that overall mortality of stocked fish was high and did not vary with depth. However, the sources of mortality did vary with depth: fish predation was highest at the shallowest depth and decreased with increasing stocking depth. The opposite was found for non-predation mortality: highest at the deepest depth and decreased with decreasing stocking depth. Bird predation was found to be a significant source of mortality in 2022 and was independent of stocking depth.

Preliminary results from 2023 indicated tagged Bloater dispersed rapidly and appear to have had higher overall survival across all depths than the previous year (Fig. 7.4.1). Like 2022, fish predation was highest at the shallower sites and bird predation occurred across all depths. Mortality was highest at the 50m stocking depth due to both predation and non-predation related mortality (Fig. 7.4.2), potentially influenced by the "soft release" of Bloater held for a week in a net pen prior to the tagged fish stocking event. The fish held in the net pen could have influenced the increased presence of predators around this site during the time of stocking.

Restoration stocking of Bloater and other deep-water fishes will require careful consideration of stocking practices to minimize the different sources of mortality that vary with depth. On-going work with Bloater and Lake Trout (*Salvelinus namaycush*) are evaluating day vs. night stocking, shore stocking, and the use of net pens to pre-condition fish prior to release.

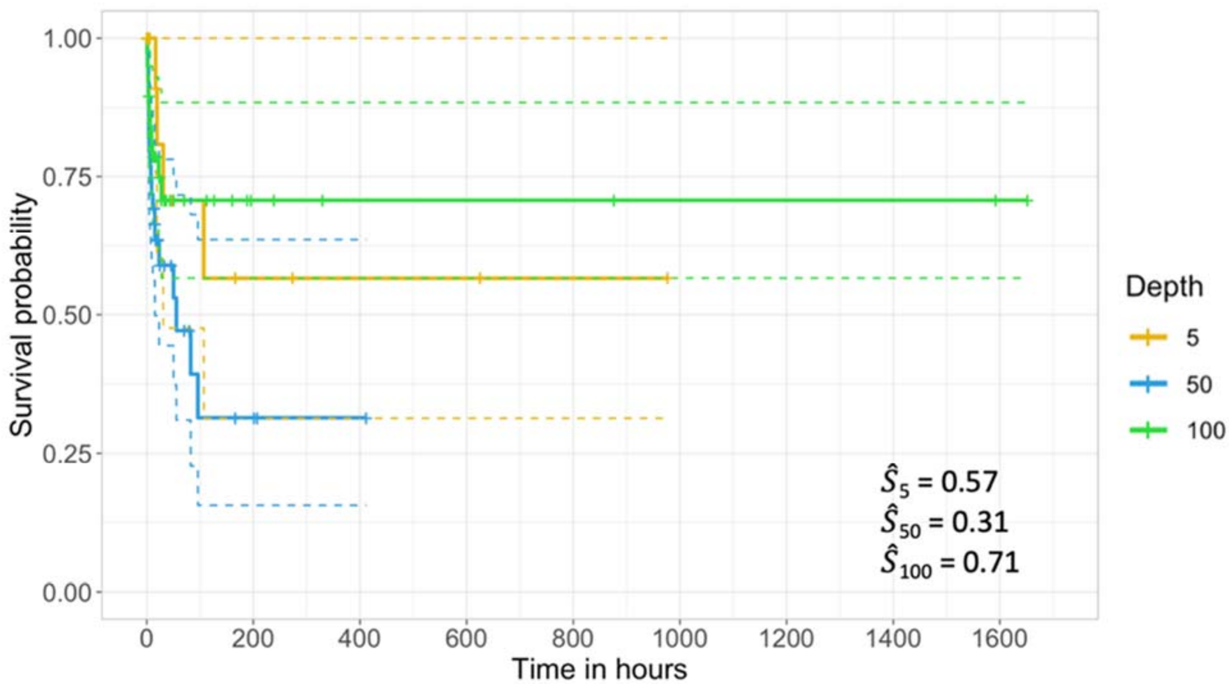


FIG. 7.4.1. Kaplan-Meier survival estimate for Bloater (Coregonus hoyi) stocked into the array throughout entire detection period of 2023. Yellow indicates 5m stocking depth, blue indicates 50m stocking depth, and green indicates 100m stocking depth. Dashed lines indicate 95% confidence intervals.

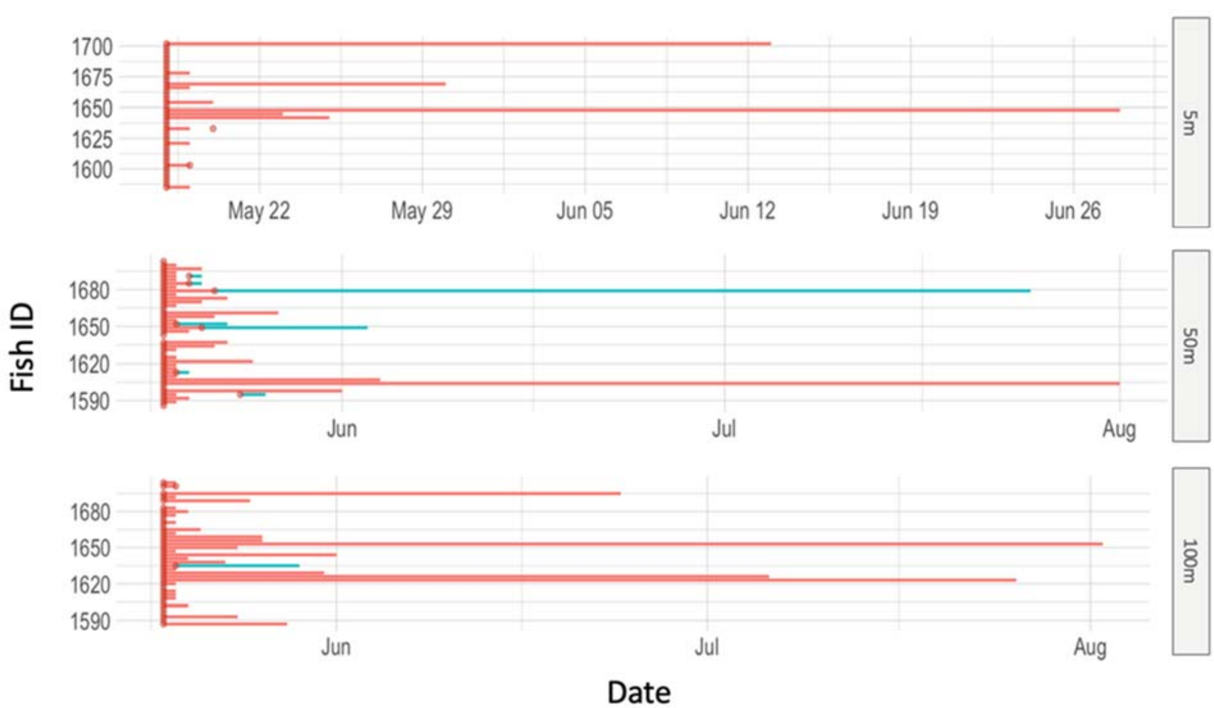


FIG. 7.4.2. Temporal record of detection for all Bloater (*Coregonus hoyi*) following release into southeastern Lake Ontario from May 18, 2023, to August 1, 2023. Red circles indicate the start of either non-predated detections (pink) or predated detections (blue). Note: X-axis scale changes for 5m treatment group.

7.5 Energy density of Lake Ontario fishes

Project Leads: Sarah King, Nash Green, Claire Mathews, Sofia Pereira, Emma Bloomfield, and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)

Fish require energy for growth, reproduction, and survival. The energy density of a fish refers to the amount of energy stored / amassed within its tissues (per unit mass). Energy density is an indicator of fish health and condition as well as a critical input to bioenergetic models that are used to describe the transfer of energy within an ecosystem. Energy density is typically measured by bomb calorimetry, which involves combusting a small amount of dried fish tissue and precisely measuring the amount of energy released (as heat).

In 2023, we continued ongoing work to describe species, life stage, seasonal, and spatial variation in energy density of Lake Ontario fishes. Since 2013, we have measured the energy density from 19 different fish species, including forage fish (e.g., Alewife [*Alosa pseudoharengus*], Rainbow Smelt [*Osmerus mordax*], sculpins [*Cottidae*]) and commercial/sport fish (e.g., Lake Whitefish [*Coregonus clupeaformis*], Chinook Salmon [*Oncorhynchus tshawytscha*], Lake Trout [*Salvelinus namaycush*]). Small fish (round weight less than 30g) were dried whole, while larger fish were homogenized and a subsample of 30-50g was dried. Water content was calculated as the difference in weight before and after drying. Dried fish were ground into powder and energy density was measured using a Parr 6200 Isoperibol calorimeter.

The energy density of forage fish varied by species and life stage (Fig 7.5.1), which could have implications for the diet quality of larger fish. As not all forage fish are energetically equivalent, a shift from high energy dense prey to low energy dense prey will yield less energy intake from the same amount of food. Knowledge of the energy content of different prey items will help us understand how the quality of piscivore diets may change in response to shifts in fish community composition resulting from variable recruitment, establishment of new species, and other ecological changes.

Despite individual differences in energy density, there was a relationship between energy density and water content of fish whole body homogenate that was consistent among the species we analyzed (Fig. 7.5.2). This relationship provides a much more time and cost-effective way to estimate energy density and could be incorporated into assessment programs to evaluate fish condition.

Understanding variation in energy content of prey and predators provides valuable insight into reasons for change in growth and production of important fish species. We will continue to explore different approaches to describe energy dynamics needed to understand fishery response to ecological change.

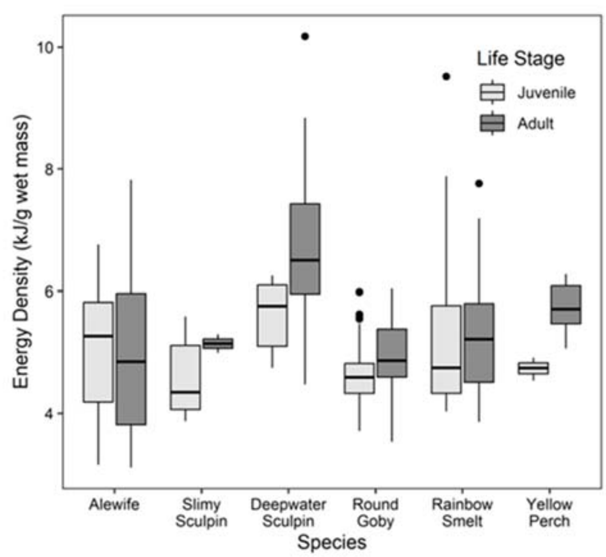


FIG. 7.5.1. Energy density of different life stages of Lake Ontario forage fish. Box represents the middle 50% of values, center band represents the median value, and whiskers represent the range of values excluding outliers.

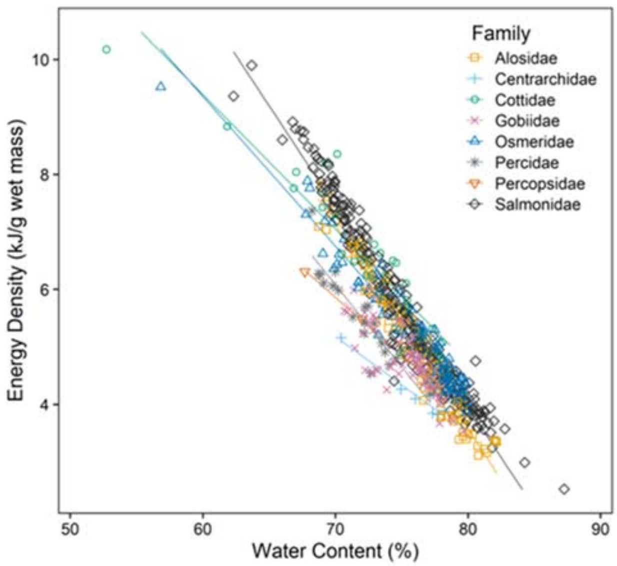


FIG. 7.5.2. Relationship between water content (%) and energy density (kJ/g wet mass) for fish whole body homogenate by taxonomic family. Linear regression lines are provided for each family.

7.6 Refining methods for estimation of energy density

Project Leads: Nash Green, Claire Mathews, Sarah King, Emma Bloomfield, and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)

Energy density represents the amount of energy contained within an organism (similar to labels on food that report the number of calories in an item). Organisms with higher energy density (more energy per unit of mass) are often in better condition, having consumed more or higher quality food, and therefore are more likely to grow better, endure sub-optimal conditions, produce more or better-quality offspring, or in the case of prey organisms, provide more energy to the predator that consumes it. Thus, understanding variation in energy density is important for describing and forecasting status and trends in fish populations.

Energy density can be directly measured using a technique called bomb calorimetry (fish tissue of a known weight is burned and the amount of heat [or energy] released during combustion is measured), but the process can be time consuming and requires specialized equipment. Energy density can be estimated from water content, as there is a well documented inverse relationship between water in body tissues and energy density (e.g., a stressed or starved fish will use stored lipids for energy, replacing or re-filling the cellular space with water). Alternatively, electronic devices can be used to estimate lipid (fat) content of tissues, with lipid levels strongly related to energy density. As part of a project studying the ecology of Lake Whitefish (*Coregonus clupeaformis*; see Section 7.7 of this report for details), we explored the potential of these alternative methods in generating reliable estimates of energy in Lake Whitefish, an ecologically and economically important fish. Additionally, we explored energy content of different commonly collected tissue types to see how energy density is affected by tissue type.

Thirty Lake Whitefish were obtained from a commercial fisher each month from April - December 2023 and a subsample of these fish were analysed for lipid content using a Distell Fish Fatmeter, energy density using an isoperibol calorimeter, and moisture content with a freeze drier. Energy density was determined for three different tissue types: whole body (the entire fish homogenized), dorsal muscle (skinless and boneless; commonly used for stable isotope and biochemical analyses), and belly fat (commonly used for fatty acid and nutritional analyses). For each tissue type, both calorimetry and moisture analyses were conducted, and results compared.

Not surprisingly, energy density was highest in the lipid-rich belly fat, lower in the whole-body homogenate, and lowest in the dorsal muscle sample. The expected strong inverse relationship between energy density and water content was evident for all tissue types (Fig. 7.6.1). While the whole-body homogenate is likely the best representation of the fish's total energy (and thus well being), with the relationships developed for the other tissue types we can reliably convert estimated energy from samples collected for stable isotopes (i.e., skinless, boneless dorsal muscle) or fatty acids (i.e., belly fat) to whole body equivalents.

The Distell Fish Fatmeter is a non-intrusive, non-lethal method of estimating lipid content in a fish that has potential to allow researchers to assess fish condition / health in a field setting. Lipid content of Lake Whitefish measured with the fat meter was compared with energy densities determined with the calorimeter. Fat meter readings declined from head to tail as

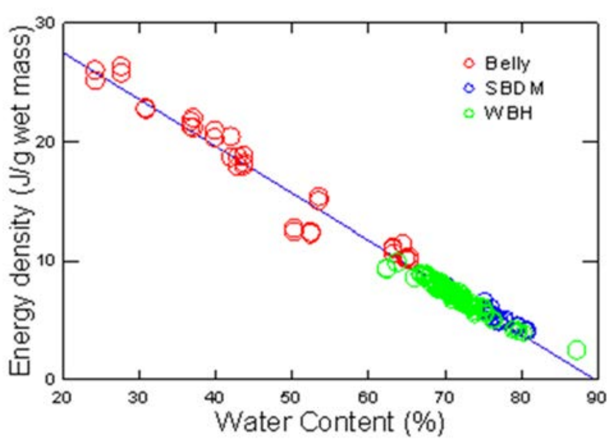


FIG. 7.6.1. Relationship between water content (%) and energy density (J/g wet mass) for different Lake Whitefish tissues. The common regression is 35.362 - 0.394 water ($F_{1,186}$ = 10,984, P<0.001). Belly = belly fat; SBDM = skinless, boneless dorsal muscle; and WBH = whole-body homogenate.

the meter was moved posteriorly, producing variability in the estimated lipid levels, and suggesting care must be taken in selecting the body location for fat meter sampling. A positive relationship was observed between the fat meter estimates of lipid content and energy density (with no difference between male and female readings; Fig. 7.6.2). While more work needs to be done to refine the sampling methodology, including expanding the standardization data set to include seasonal variation in lipid and moisture content, the fish fat meter shows promise as a non-invasive tool to estimate lipid levels (and energy density) in live fishes in the field. Developing and validating methods to provide cost-effective and accurate tools to inform managers of the health and well being of fishes is important step to better understanding and managing the Great Lakes fish community.

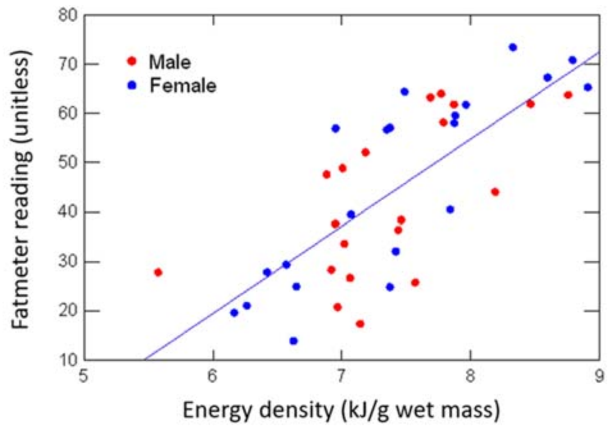


FIG. 7.6.2. Relationship between energy density (kJ/g wet mass) and fat meter reading for male (red circles) and female (blue circles) Lake Whitefish from Lake Ontario, July-December 2023. The common regression is FM = -86.5 + 17.66 ED, R^2=0.56, $F_{1,39}$ = 50.65, P<0.001.

7.7 Seasonal diet of Lake Whitefish in Lake Ontario

Project Leads: Emma Bloomfield and Tim Johnson (OMNR, Aquatic Research and Monitoring Section)
Collaborators: Sarah King, Sofia Pereira, and Brent Metcalfe (OMNR, Aquatic Research and Monitoring Section)

Lake Whitefish (*Coregonus clupeaformis*) are an ecologically, economically, and culturally important species in Lake Ontario. Their abundance and condition declined in the 1990s following the establishment of dreissenid (zebra [*Dreissena polymorpha*] and quagga [*Dreissena bugensis*]) mussels. These declines were largely attributed to diet changes following the loss of Diporeia, a benthic amphipod (tiny bottom-dwelling shrimp-like animal) that was an important food item. Additional ecological changes have occurred since the loss of Diporeia, including the establishment of invasive Round Goby (*Neogobius melanostomus*) and changes in the abundance of benthic invertebrates. The impacts of these more recent ecological changes on Lake Whitefish diet in Lake Ontario are largely unknown.

We investigated Lake Whitefish diet through detailed stomach content and stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) of 30 fish monthly from eastern Lake Ontario. While stomach contents are a direct method to determine recent (past hours or days) diet, stable isotopes are a tool to reveal longer term (past months) energy sources based on chemical analysis of fish tissue. Stomach contents were grouped into Spring (April, May, June), Summer (July, August, September), and Fall (November and December). We also used stomach contents and the energy density of prey items (similar to the calories on a food label) to calculate the average energy content of Lake Whitefish stomach contents.

We found Lake Whitefish have a seasonally variable diet (Fig. 7.7.1). In spring, the diet is dominated by chironomids (a type of midge). In summer, Lake Whitefish diet includes zooplankton (small, suspended animals) and Round Goby, with Round Goby dominating the stomach contents by volume. In the fall, amphipods, dreissenid mussels, and zooplankton are important prey items, particularly predatory zooplankton (invasive Spiny Water Flea [*Bythotrephes longimanus*] and Fishhook Water Flea [*Cercopagis pengoi*]). Nitrogen isotope ratios ($\delta^{15}N$) increased from April to December, indicating that Lake Whitefish occupy a higher trophic (feeding) level later in the year (Fig. 7.7.2). This result is consistent with Lake Whitefish eating higher trophic level prey, like

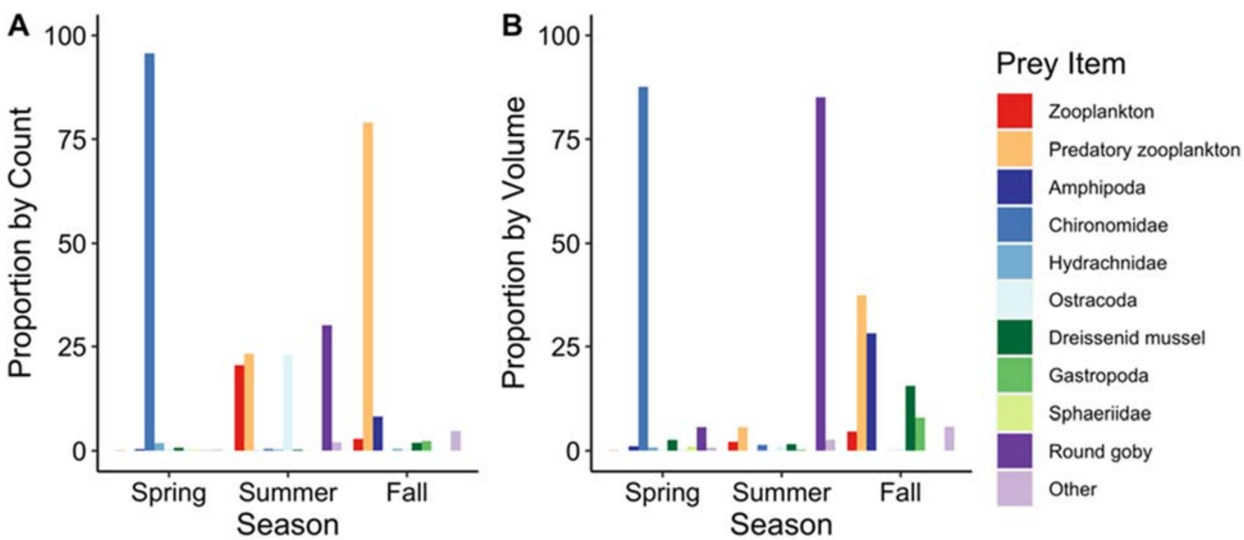


FIG. 7.7.1. Stomach contents of Lake Whitefish from eastern Lake Ontario by count (A) and volume (B) for spring (April, May, June), summer (July, August, September), and fall (November, December). Zooplankton contents are red, arthropods are blue, mollusks are green, and Round Goby and other prey are purple. The zooplankton category includes Copepoda and herbivorous Cladocera. Predatory zooplankton are Spiny Water Flea (*Bythotrephes longimanus)* and Fishhook Water Flea (*Cercopagis pengoi*). All dreissenid mussels that could be identified to species were Quagga Mussels (*Dreissena bugensis).* Amphipods did not include any *Diporeia*.

fish and predatory zooplankton in the summer and fall compared to lower trophic level chironomids in the spring. Carbon isotope ratios ($\delta^{13}C$) decreased and variance increased in the late summer and early fall, reflecting the increase in prey diversity and prey using pelagic (offshore) versus nearshore (littoral) energy (Fig. 7.7.2). Further analysis of stable isotope ratios will complement stomach content analysis by using mixing models to estimate the long-term contribution of prey to Lake Whitefish diet.

Compared to the last comprehensive Lake Ontario Lake Whitefish diet study conducted twenty years ago, Lake Whitefish summer diet has changed from being dominated by dreissenid mussels to Round Goby. Consumption of fish by Lake Whitefish has historically been rare and data on the consumption of Round Goby by Lake Whitefish in Lake Ontario has not been previously published. Round Goby have a higher energy density than dreissenid mussels, so this change has led to an increase in the average energy content of Lake Whitefish stomachs in the summer from ~ 4,000 to ~10,000 Joules. The implications of this diet change on Lake Whitefish growth rate and condition will be further investigated though bioenergetics modelling (a description of energy gain and use).

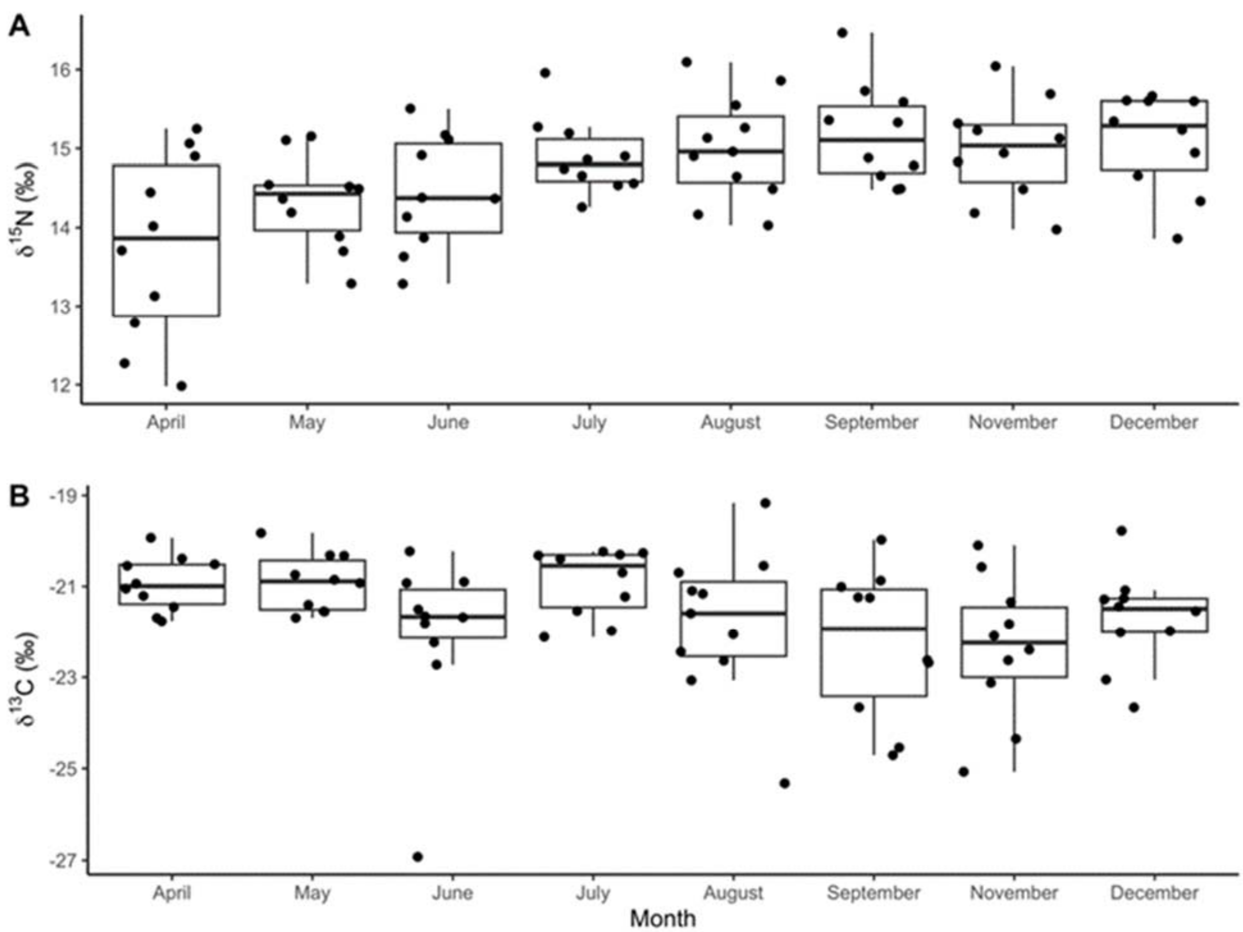


FIG. 7.7.2. Boxplots of nitrogen stable isotope ratios ($\delta^{15}N$; A) and lipid corrected carbon stable isotope ratios ($\delta^{13}C$; B) for the muscle tissue of Lake Whitefish from eastern Lake Ontario. The solid line is the median value, the box is the inter-quartile range, whiskers extend to the highest or lowest value within 1.5 times the inter-quartile range, and points beyond 1.5 times the interquartile range are represented individually.

7.8 Assessing impediments to Lake Trout restoration in Lake Ontario

Project Leads: Tim Johnson, Emma Bloomfield, and Brent Metcalfe (OMNR, Aquatic Research and Monitoring Section)
Collaborators: Alex Gatch and Lucas Le Tarte (US Geological Survey); Collin Farrell and Dimitry Gorsky (US Fish and Wildlife); Chris Legard (NYS Department of Environmental Conservation); Sarah Larocque (Fisheries and Oceans Canada); Silviya Ivanova (University of Windsor); Steve Cooke (Carleton University); Stacy Furgal (NY Sea Grant)

Restoration of the Lake Trout (*Salvelinus namaycush*) population in Lake Ontario has been a priority for fishery managers since its collapse in the mid 1900s. However, reestablishment of a wild-produced, self-sustaining population remains an unrealized goal. Factors affecting spawning and early-life survival are suspected to be limiting natural production. To learn more about where the current stock of adult Lake Trout spawn in Lake Ontario, and the current state and quality of the spawning habitat, telemetry tags and underwater cameras were deployed in the first year of a multi-year, multi-agency, lake-wide collaborative project.

Acoustic telemetry has the potential to show managers where Lake Trout are congregating during spawning season. Once potential spawning grounds have been identified, detailed investigations can be carried out in succeeding years (e.g., fine-scale telemetry arrays can be erected on suspected spawning grounds to identify exact locations where spawning activities occur). An extensive, large-scale array of acoustic receivers currently exists in Lake Ontario (Fig. 7.8.1). With the deployment of long-life (~10 year) acoustic tags in Lake Trout and the addition of some receivers in the nearshore areas of the lake, the fish should reveal their chosen spawning locations when the receiver data is downloaded in subsequent years.

In the spring and summer of 2023, the Aquatic Research and Monitoring Section at the Glenora Fisheries Station surgically implanted acoustic telemetry transmitters (that identify fish location, as well as depth and temperature for some fish) in 64 Lake Trout captured near Scotch Bonnet and Big Bar Shoal (Fig. 7.8.1). These fish formed part of a larger lake-wide sample of 320 Lake Trout tagged by collaborating agencies at various locations around Lake Ontario (Fig. 7.8.1). Acoustic receivers (underwater moored devices that detect tagged fish) will be serviced and downloaded in Summer 2024, and the data analyzed to see where potential spawning locations exist. Additionally, substrate maps and lake characteristics used to predict the location of spawning habitat (Fig. 7.8.2) will be compared to telemetry data to see if fish congregate in areas of

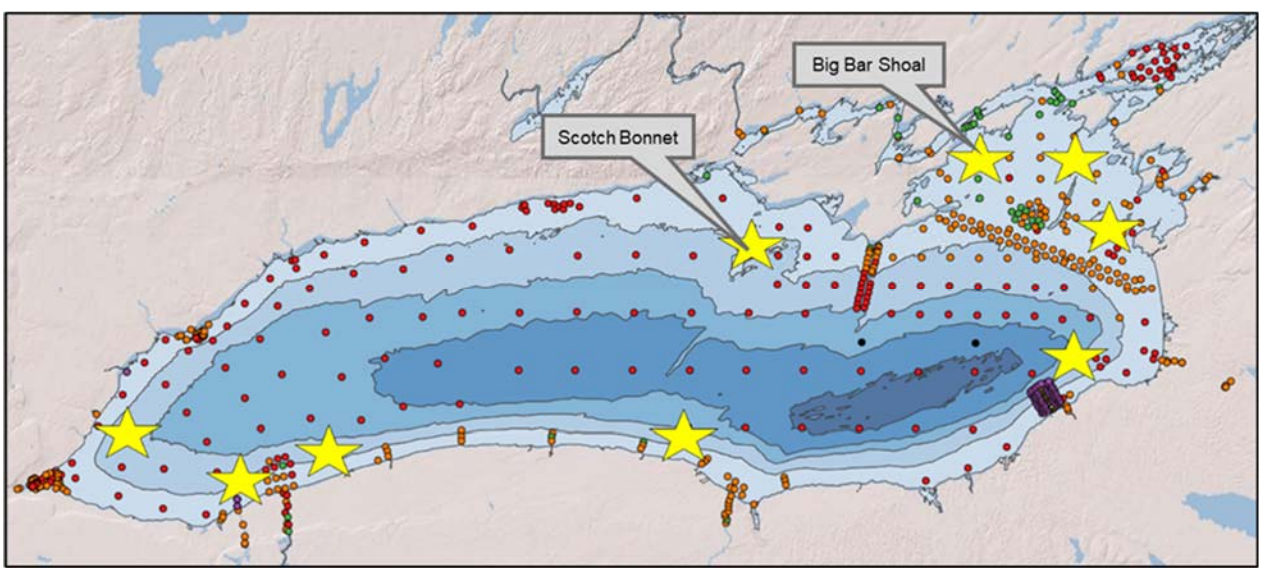


FIG. 7.8.1. Map of Lake Ontario showing acoustic receiver placement (red, green, violet, orange circles) and fish capture / tagging locations by collaborating agencies (yellow stars). Base map courtesy of USFWS.

suspected high-quality spawning habitat. Lastly, substrate surveys began in 2023 using underwater videography to characterize the quality and quantity of benthic habitat found at predicted spawning locations. In some cases, contemporary imagery will also be compared to historical footage to assess changes through time. The Aquatic Research and Monitoring Section recorded approximately 400 videos in the first year of the project (with more videography planned for 2024). These videos contributed to the larger collaborative lake-wide undertaking of recording approximately 5,400 substrate videos. Initial results suggest that high-quality potential spawning habitat is extremely limited, generally located in waters of 5 – 8m depth. Many predicted quality sites appear to be degraded or unsuitable for egg brooding due to siltation and significant Driessenid mussel shell debris (Fig. 7.8.3). Habitat assessment will continue in future years.

Identifying the location of current spawning sites, as well as the quality and quantity of spawning habitat in Lake Ontario are the first steps in better understanding what factors are limiting spawning and early-life survival of Lake Trout. Understanding and overcoming this survival bottleneck is key to rehabilitating Lake Ontario's wild Lake Trout population.

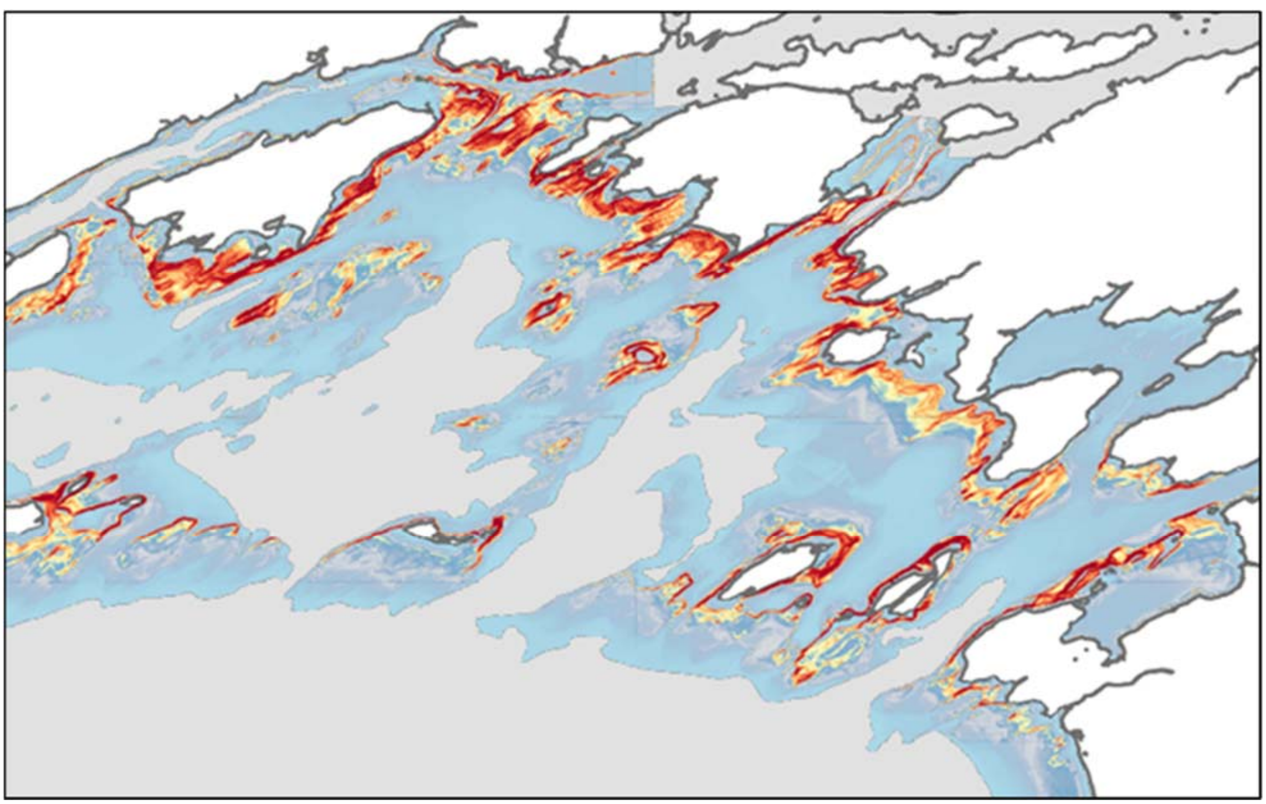


FIG. 7.8.2. Map of Kingston Basin, Lake Ontario, highlighting predicted Lake Trout spawning habitat (intensity of colour corresponds to quality rating of habitat). Figure generated / provided by USGS.

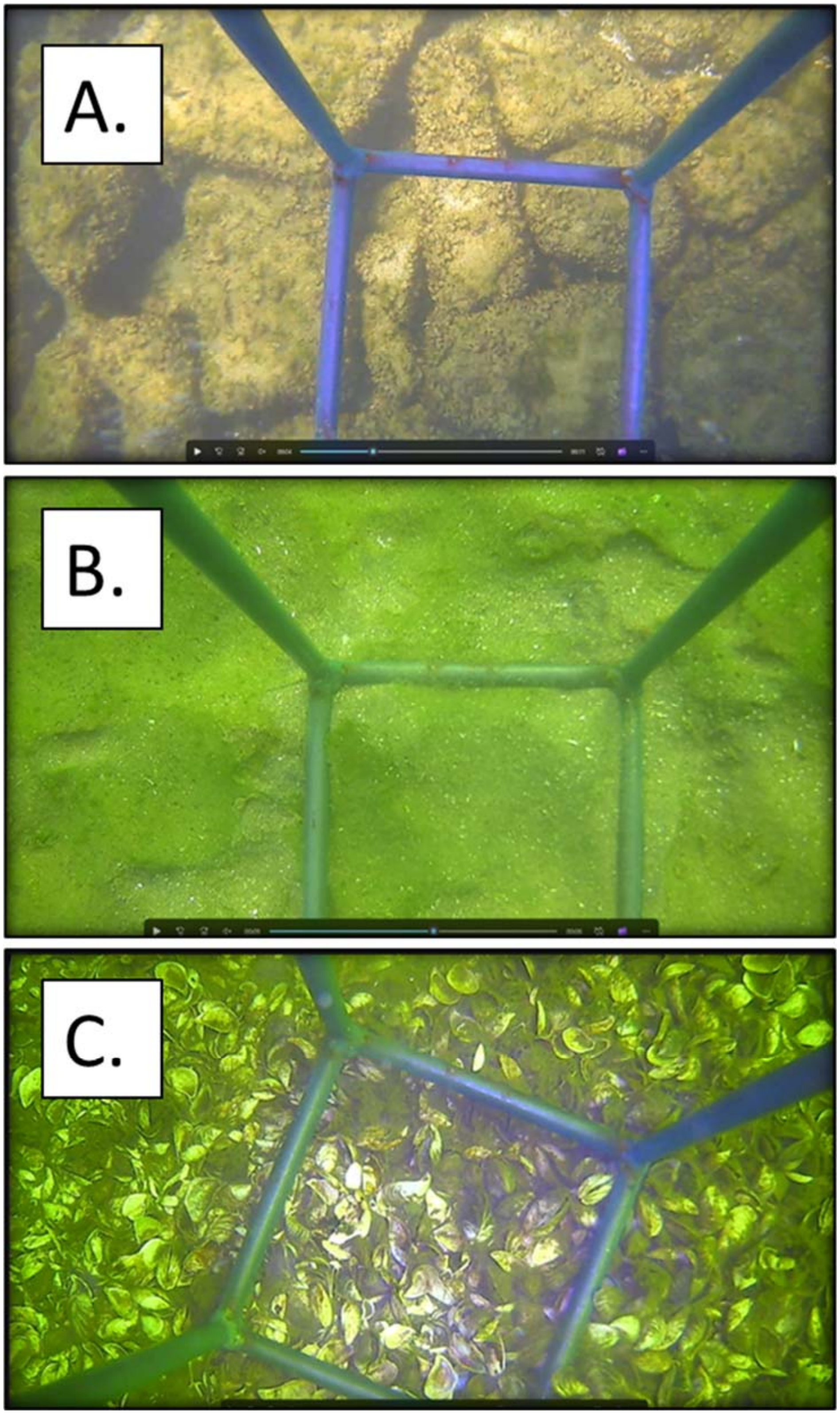


FIG. 7.8.3. Visual assessments of potential Lake Trout spawning habitat using underwater videography suggest limited high quality spawning habitat (A.), with many sites likely unfavorable for proper egg brooding / development due to silt (B.) or Driessenid mussel shell debris (C.). Images provided by USGS.

7.9 Multi-species acoustic telemetry synthesis to identify and characterize fish biodiversity hotspots and the associated habitat in Lake Ontario

Project Leads: Silviya Ivanova and Aaron Fisk (University of Windsor); Tim Johnson (OMNR, Aquatic Research and Monitoring Section); Steve Cooke (Carleton University); Jake Brownscombe, Sarah Larocque, and Jon Midwood (Fisheries and Oceans Canada); Dimitry Gorsky (US Fisheries and Wildlife Service), Chris Vandergoot (Michigan State University, Department of Fisheries and Wildlife)

Ecosystems are complex and often comprised of variations in, for example, bathymetric depth, substrate, surface and bottom temperatures, and exposure to wind and wave energy among others. These physical and chemical properties interact in unique ways to form different habitats. Animals have specific preferences for the type of habitat they occupy that are associated with requirements of the different stages of their life and this habitat preference may change through time, seasonally or annually. Thus, linking species' behaviours and distributions to environmental characteristics would help us understand drivers of population and community function, and pinpoint essential habitat for fish across guilds.

Large bodies of water have been notoriously difficult to study due to logistical and technical challenges. As a result, most studies have historically focused on species with nearshore distributions and shallower depth occupancy. Additionally, research focus has largely remained on single species (except for trophic ecology studies) either due to interest in informing specific management objectives or funding limitations. These constraints are also true for Lake Ontario which has surface area >19,000 km^2 and a maximum depth of 244m and thus, has many varied habitats ranging from large, developed harbours in the west to offshore shoals and islands in the east. Since 2010, a number of studies have used acoustic telemetry to enhance our understanding of species movements, dispersal, home ranges, and post-stocking mortality for a variety of species. Fewer studies have examined species interactions from a spatial ecology perspective. Further, studies have also generally been conducted in a relatively small, localized area and may not represent the variation in habitat that may be occupied by the species across a large and spatially variable ecosystem, such as Lake Ontario. Thus, the shift of focus from single/paired species to multi-species and ecosystem-wide perspective in Lake Ontario and the rest of the Great Lakes is lagging. Given this, here we established a large collaboration between nine institutions and organizations to synthesize 95% of the acoustic telemetry data for 19 fish species in Lake Ontario and identify and characterize the essential fish habitat (i.e., biodiversity hotspot).

Distributions for each of the 19 species were obtained using species distribution modelling (a machine learning approach), based on near and offshore species characterization, and overlapped to extract hotspots. Our results showed that hotspots were associated with the transition zone between nearshore and offshore areas (15-26m; Fig. 7.9.1) and had relatively high seasonal consistency (Fig. 7.9.2). Overall, the environmental properties that showed the strongest influence to characterizing the hotspots were the absence of reefs, medium exposure to wind and wave action, shallow-to-moderate depth, silt and sand substrate, and largely northern direction of bottom hydrology.

Biodiversity hotspots are areas used by a great variety of species and where intensity of interactions are higher than anywhere else and thus reinforce niche and resources partitioning and maintenance of biodiversity. As such, these results provide a better understanding of the drivers of different species' behaviours and provide insights on influences on their populations from both an environmental and biological (species interactions) perspective. Further, this work highlights the importance of a broader lake-wide multi-species perspective to understanding fish community function and ecosystem dynamics.

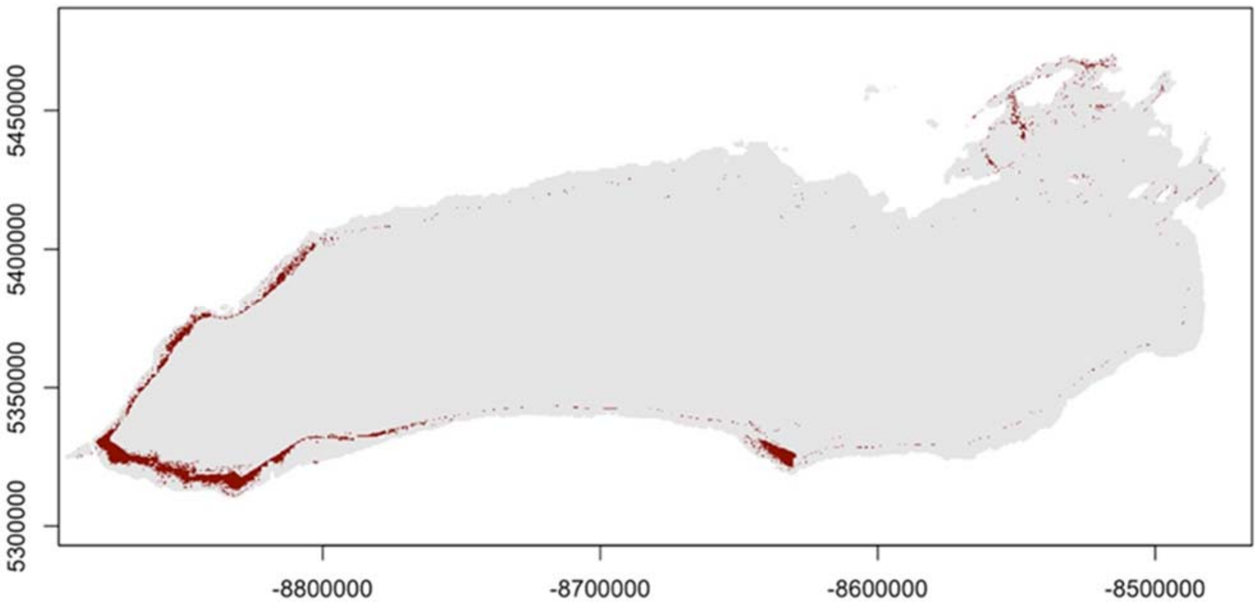
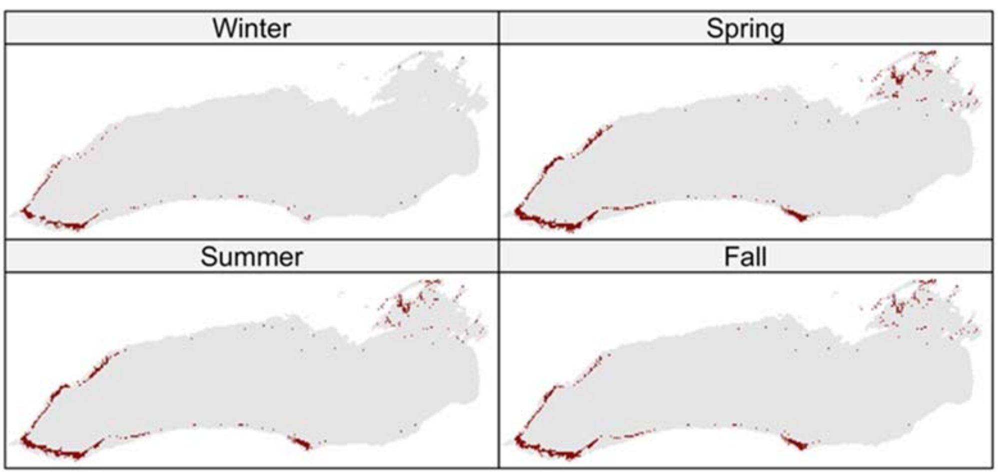


FIG. 7.9.1. General biodiversity hotspots in Lake Ontario based on the following 19 species: Atlantic salmon (*Salmo salar*), Bowfin (*Amia calva*), Brown trout (*Salmo trutta*), Chinook salmon (*Oncorhynchus tshawytscha*), Cisco (*Coregonus artedi*), Coho salmon (*Oncorhynchus kisutch*), Common carp (*Cyprinus carpio*), Freshwater drum (*Aplodinotus grunniens*), Goldfish (*Carassius auratus*), Lake sturgeon (*Acipenser fulvescens*), Lake trout (*Salvelinus namaycush*), Largemouth bass (*Micropterus salmoides*), Longnose gar (*Lepisosteus osseus*), Northern pike (*Esox lucius*), Rainbow trout (*Oncorhynchus mykiss*), Smallmouth bass (*Micropterus dolomieu*), Walleye (*Sander vitreus*), White sucker (*Catostomus commersoni*), Yellow perch (*Perca flavenscens*).



	Area size (% of whole lake)
Winter	**0.5**
Spring	**0.5**
Summer	**1.1**
Fall	**1**

FIG. 7.9.2. Seasonal biodiversity hotspots in Lake Ontario based on 19 different species.

8. Partnerships

8.1 Lake Ontario Aquatic Invasive Species Surveillance Through Environmental DNA Sampling

L. Sunderland, Lake Ontario Management Unit

Lake Ontario has experienced multiple significant ecosystem disruptions due to the introduction of aquatic invasive species. For example, the invasions of Dreissenid mussels and Round Goby have drastically altered the trophic structure of the benthic environment. Preventing the spread of an invasive species is more effective than attempting to eradicate an already established population, making the early detection of invasive organisms vital.

Environmental DNA (eDNA) sampling is a technique used to detect the presence of aquatic plant and animal species, which has been used by the MNRF as early as 2015. Organisms shed genetic material into their environment (e.g. mucus, scales, pollen or excrement) which can be isolated from surface water samples and analyzed to determine species of origin. In freshwater environments, DNA remains viable for 7-21 days, during which time it can be transported great distances by currents. Therefore, the detection of DNA from a species of interest acts as evidence of their potential presence in an area, although it does not indicate the exact location of the organism or whether the DNA was shed by a living organism or transported to the area via the waste of a predator. In addition, the failure to detect DNA from a species of interest does not serve as definitive proof of its absence.

The current eDNA sampling program is the result of collaboration between three sections of the MNRF. The Lake Ontario Management Unit is responsible for collecting and processing water samples which are analyzed for eDNA by the Aquatic Research and Monitoring Section. The Biodiversity and Invasive Species Section selects areas of interest for sampling and receives the results of the eDNA analysis.

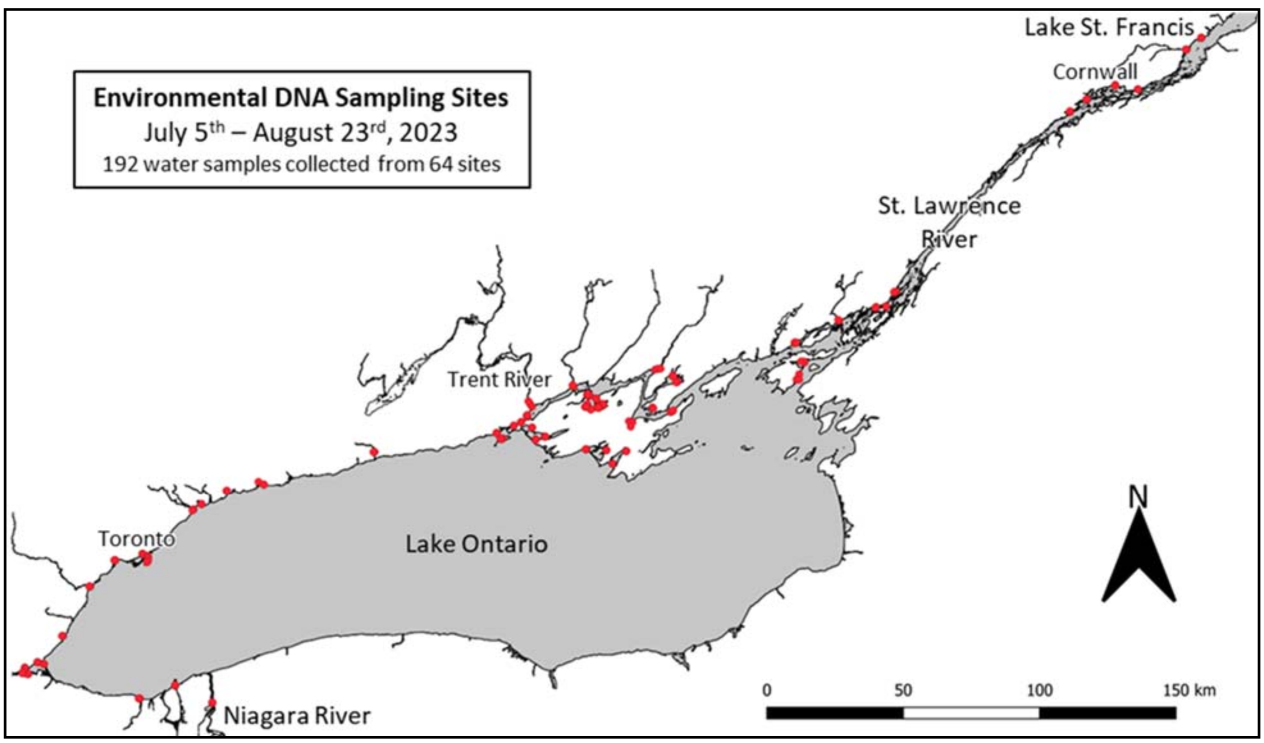


FIG. 8.2.1. Map of sites sampled for environmental DNA by the Lake Ontario Management Unit in 2023.

In 2023, eDNA sample collection efforts consisted of 64 sites spanning across Lake Ontario and its tributaries and occurred between July 5th and August 23rd (Fig. 8.2.1). Primarily focusing on areas of concern, sites were chosen due to hydrologic factors (e.g. connectivity to other water bodies) or for their proximity to known populations of invasive species. Species of interest include Grass Carp (*Ctenopharyngodon idella*), Tench (*Tinca tinca*), Marbled Crayfish (*Procambarus virginalis*), Water Solider (*Stratiotes aloides*) and Hydrilla (*Hydrilla verticillata*). Table 8.2.1 shows information about the areas that were sampled, including the dates and number of samples collected.

Capture of Grass Carp in the Bay of Quinte

On July 3rd, 2023, the Lake Ontario Management Unit received a report of a Grass Carp that was captured by a commercial fisher in the Bay of Quinte and relinquished to Fisheries and Oceans Canada (DFO). Examination by DFO revealed the Grass Carp to be a fertile (diploid) female that had yet to spawn (Fig. 8.2.2). As part of a coordinated response, eDNA sampling within the Bay of Quinte was expedited to support heightened Grass Carp surveillance efforts. Initial eDNA sampling of the lower and upper Bay of Quinte was conducted on July 18th and 20th, respectively, and yielded a positive detection for Grass Carp in the eastern portion of Muscote Bay (Fig. 8.2.3a). A second round of eDNA sampling focusing on Muscote Bay was conducted on July 27th, which yielded a positive detection in the western portion of the bay (Fig. 8.2.3b). A third sampling date of August 14th yielded no positive detections (Fig. 8.2.3c).

The absence of diploid Grass Carp in targeted netting and limited eDNA detections suggest that the captured Grass Carp was an isolated occurrence. The eDNA program will continue to be used as part of targeted investigations and routine monitoring to limit the establishment and spread of invasive species.

FIG. 8.2.2. Photograph of the Grass Carp that was captured by a commercial fisher in the Bay of Quinte in 2023.

TABLE. 8.2.1. Areas sampled, dates sampled and number of water samples collected for environmental DNA analysis by the Lake Ontario Management Unit in 2023.

Area Name	Area Name Code	Date Sampled	Number of Sites	Number of Samples
Port Hope and Oshawa Area	OS	July 5th	5	15
St. Lawrence River and Lake St. Francis	SLR	July 11th	7	21
Lower Bay of Quinte	LB	July 18th	6	18
Upper Bay of Quinte	UB	July 20th, 27th & August 14th	15	45
Thousand Islands	TH	July 25th	3	9
Toronto Harbour and Tributaries	TOR	August 1st	6	18
Niagara River and Welland Canal	NIA	August 9th	3	9
Hamilton Harbour	HAM	August 9th	5	15
Prince Edward County Lakes and Embayments	PEC	August 15th & 16th	11	33
Wolfe Island	WF	August 23rd	3	9
Total			64	192

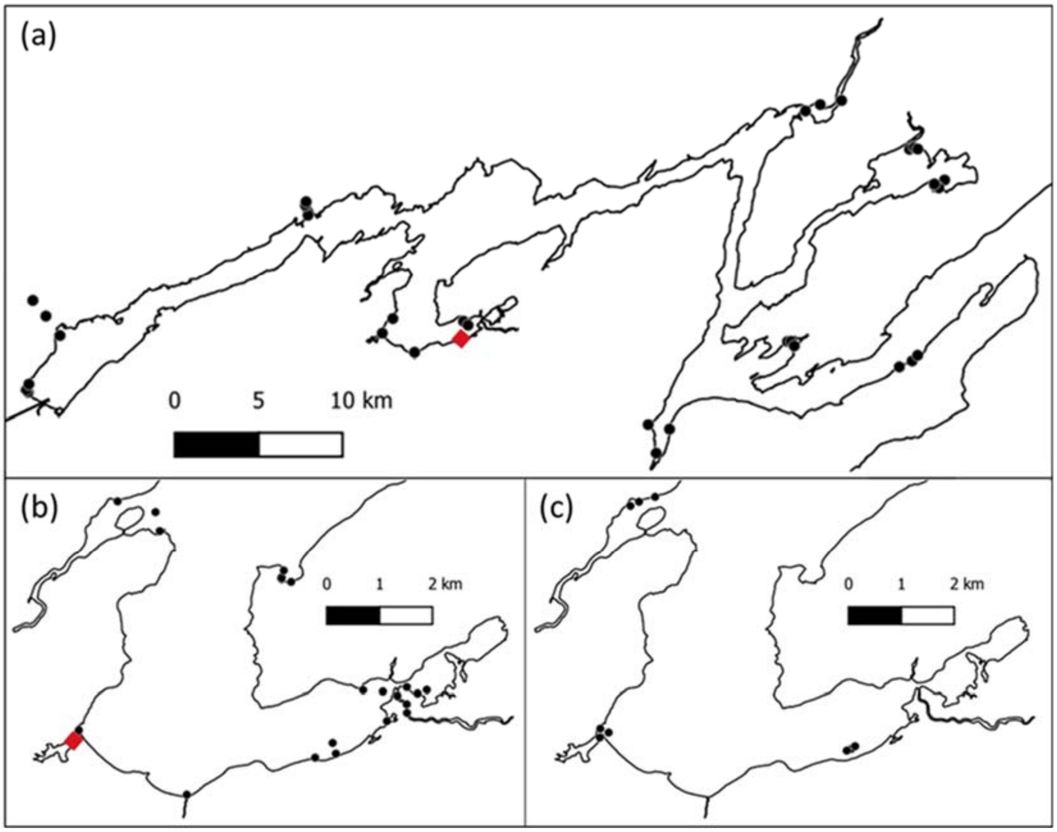


FIG. 8.2.3. Map of sites within the Bay of Quinte sampled for Grass Carp environmental DNA by the Lake Ontario Management Unit on (a) July 18th and 20th, (b) July 27th and (c) August 14th. Red diamonds indicate sites with a positive Grass Carp detection and black circles indicate sites at which Grass Carp was not detected.

9. Environmental Indicators

9.1 Water Temperature

L. Sunderland, Lake Ontario Management Unit

Winter Severity Index

Winter severity is often correlated with year-class strength in temperate fish species. Winter severity is measured as the number of days in December through April with a mean water temperature less than 4°C. Mean daily surface water temperature was obtained from the Belleville (Upper Bay of Quinte) Water Treatment Water Facility. The temperature data comes from water drawn from the bottom at a depth of approximately 3.2m. Water temperatures are homothermous in this section of the bay.

A long-term (1944-2023) winter severity index is presented in Fig. 9.1.1. The winter of 2022/23 was more severe than the long-term average. Eight of the last 20 years have been more severe than the long-term average.

Mid-summer Water Temperature

Summer water temperatures can impact fish distribution and influence growth and survival of young of the year fish. Mid-summer water temperature is calculated using daily temperatures in July and August (mean of 62 days).

Bay of Quinte

A long-term (1943-2023) mid-summer water temperature index is presented in Fig. 9.1.2. Mean daily surface water temperature was obtained from the Belleville Water Treatment Facility as described for the winter severity index.

Water temperatures in the summer of 2023 were warmer than the long-term average. Fifteen of the last 20 years were above the long-term average.

Lake Ontario

Main lake surface water temperatures have been collected by the National Oceanic and Atmospheric Administration's National Data Buoy Center (www.ndbc.noaa.gov) at Station 45012 (East Lake Ontario – 20 nautical miles north of Rochester, NY). Mean summer water temperatures in 2023 were below the average for the time series (2002-2023; Fig. 9.1.3).

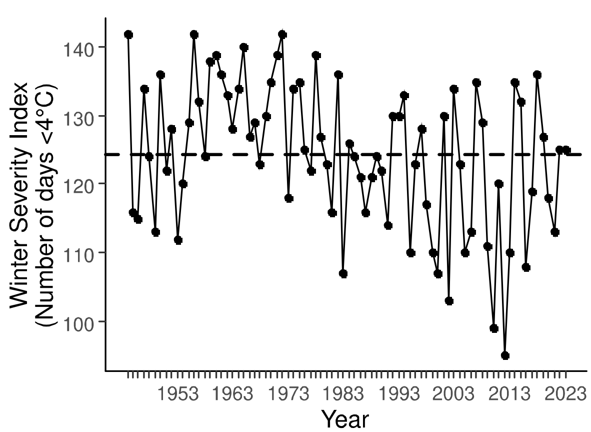


FIG. 9.1.1. Winter severity index for the Bay of Quinte, 1944-2023. The long-term average index is depicted with a dashed line. Mean daily surface water temperature data was obtained from the Bellville (Bay of Quinte) Water Treatment Facility.

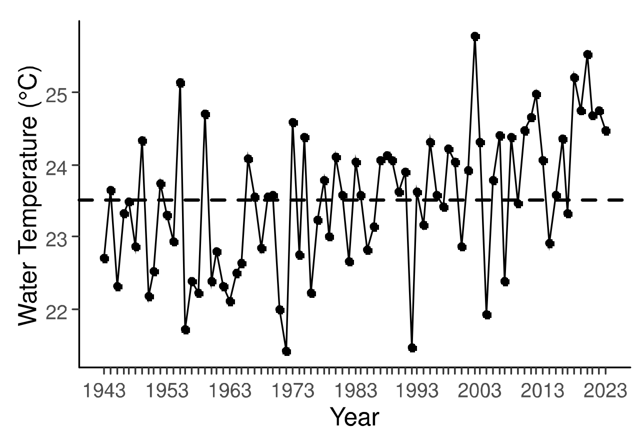


FIG. 9.1.2. Mean mid-summer water temperature for the Bay of Quinte, 1943-2023. The long-term average is depicted with a dashed line. Mean daily surface water temperature data was obtained from the Bellville (Bay of Quinte) Water Treatment Facility.

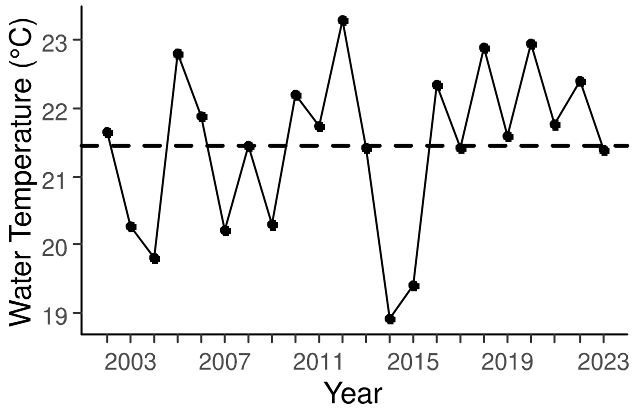


FIG. 9.1.3. Mean mid-summer water temperature for Lake Ontario, 2002-2023. The average for the time series is depicted with a dashed line. Data provided by National Data Buoy Center NOAA (http://www.ndbc.noaa.gov/).

9.2 Wind

T. Gristey, Lake Ontario Management Unit

The National Oceanic and Atmospheric Administration (NOAA) records multiple weather variables using a variety of weather buoys deployed throughout Lake Ontario. Buoy data are available through the National Data Buoy Center webpage hosted by NOAA (www.ndbc.noaa.gov). The Rochester weather buoy (Station ID# 45012; located 37 km offshore, north-northeast of Rochester) records several environmental variables, including wind direction and velocity ($m \cdot s^{-1}$). Wind direction and velocity can affect the Lake Ontario ecosystem (e.g., thermal mixing, fish distribution) and the recreational fishery (e.g., total angler effort and the distribution of effort on Lake Ontario).

Wind rose plots were generated using the Rochester Weather Buoy for 2021 through 2023, showing the general wind direction and speed annually (Fig. 9.2.1). The circular format of the wind rose shows the direction the winds blew from and the length of each "spoke" around the circle shows how often the wind blew from that direction. The different grey scales of each spoke provide details on the wind velocity of the wind from each direction in meters per second (1 meter per second = 3.6 kph). In the bottom right of each yearly wind rose plot is the mean wind speed for that year and the percentage of calm events registered as windspeed below 0.5 meters per second. For 2023, just under 25% of the annual wind direction was from the west, and most wind speed was between 6-18 meters per second. This is consistent with the previous two years at this location. In 2023, there was an increase in wind from the north, along with increased wind speed compared to 2022 and 2021.

Two indices were developed to provide a wind index on Lake Ontario from 2002 – 2023 (Fig. 9.2.2). Small Craft Wind Warnings are issued for Lake Ontario by Environment Canada

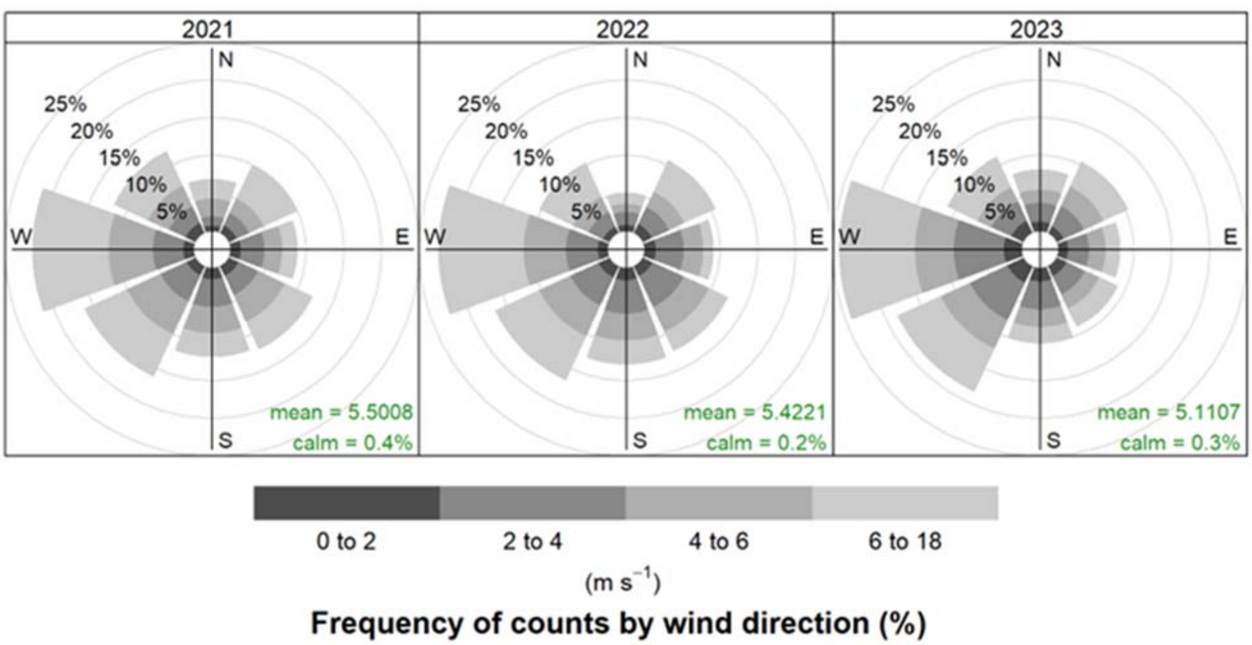


FIG. 9.2.1. Annual Wind Rose for the Rochester Weather Buoy for 2021-2023. The circular plot shows the direction the winds blew from, and the length of each "spoke" around the circle shows how often the wind blew. The different grey scales of each spoke provide details on the wind velocity of the wind from each direction in meters per second (1 meter per second = 3.6 kph). Data provided by the National Data Buoy Center, NOAA (http://www.ndbc.noaa.gov/).

when wind velocities measure 20 – 33 knots (http://weather.gc.ca/marine/). The Small Craft Index represents the total number of hours from July 1st to August 31st each year, where the wind velocity was greater than or equal to 20 knots, and the wave height was greater than 2 meters. Wave height (meters) is calculated as the average of the highest one-third of all the wave heights during the 20-minute sampling period. This index shows that in the last ten years, 2010, 2011, 2014, 2017, 2020, and 2023 had higher than average small craft warnings (Fig. 9.2.2a). In 2023, the number of small craft warning hours was significantly higher than 2022 and well above the average for the time series (Fig. 9.2.1a). A second index, the East Wind Index, was calculated to determine the relative contribution of east winds to the July/August open-water fishing season (Fig. 9.2.2b). This index shows a decrease from 2022 to 2023, but the relative contribution of east winds was below the time series average (Fig. 9.2.2b).

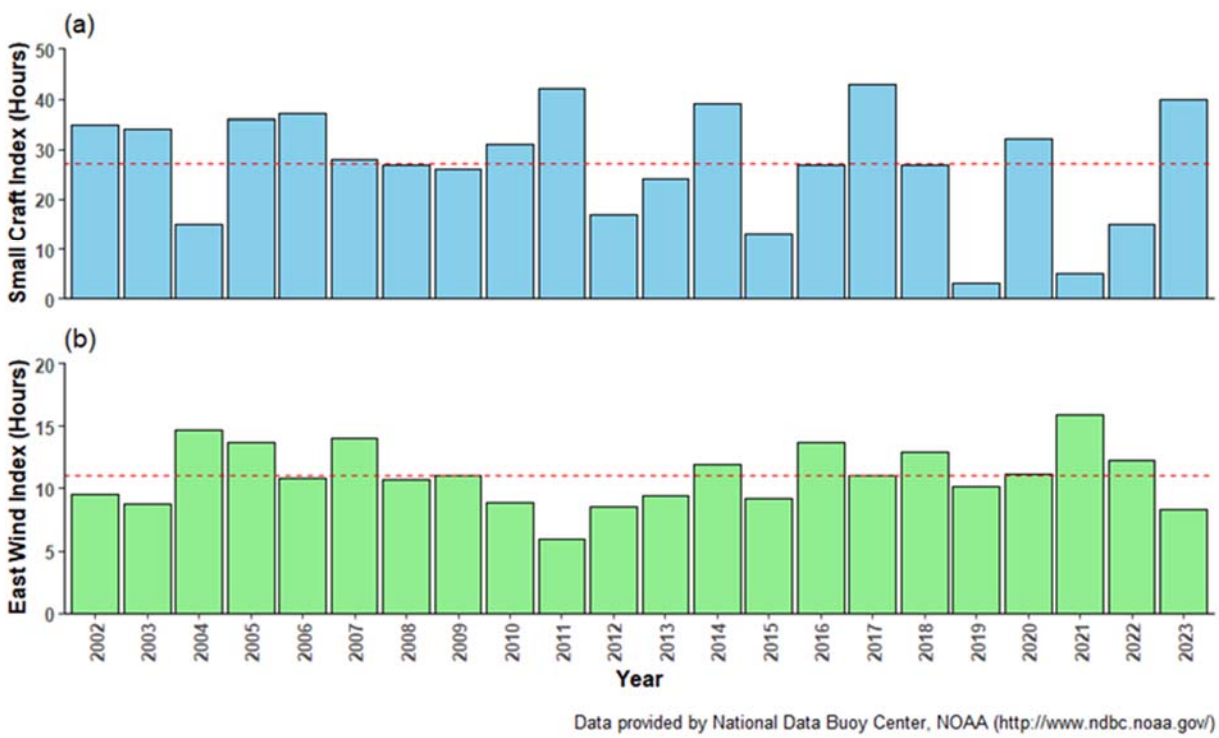


FIG. 9.2.2. Lake Ontario wind as characterized by the Small Craft Index (a) and East Wind Index (b). The Small Craft Index represents the total number of hours from July 1st to August 31st each year (2002 – 2023), where the wind velocity was ≥ 20 knots and wave height was greater than 2 meters. The East Wind Index represents the number of hours from July 1st to August 31st each year (2002 – 2023) that an eastern wind predominated. Data provided by the National Data Buoy Center, NOAA (http://www.ndbc.noaa.gov/).

9.3 Tributary Water Flow

L. Sunderland, Lake Ontario Management Unit

Tributary water flow regimes can impact fish species that use Lake Ontario's tributaries for spawning and rearing. For example, migratory salmonid species such as Rainbow Trout and Chinook Salmon rely on cold water tributaries during the spring and fall in areas where natural reproduction occurs. Native cool water species such as Walleye, Northern Pike, and Lake Sturgeon may also use tributary areas for spawning during the spring. Though flow regimes can be described using several metrics, in this report, annual discharge data (m^3s^{-1}) and central flow timing (i.e. date at which half the annual discharge has been exceeded) are used. Average annual discharge is used to describe large-scale comparison in flow among years, whereas central flow timing is used to indicate whether the annual discharge occurred early or late in the season relative to the long-term average.

Water Surveys of Canada (WSC) collects hydrometric data from gauges across Canada, which are available through the Environment Canada webpage (http://wateroffice.ec.gc.ca/index_e.html). Discharge data from three stations (listed and described Table 9.3) were retrieved in February 2024 and summarised to characterise tributary water flow regimes. At the time of this report, 2023 daily discharge data are considered provisional by the Environment and Climate Change Canada and subject to change.

The Credit River drains into the western end of Lake Ontario and provides fishing opportunity for migratory salmonids within the river and lake basin. In 2023, the average annual discharge at the Credit River (Station ID: 02HB029) was 8.87 m^3s^{-1}. This was above the long-term average (Fig. 9.3.1). The central flow Julian day date was 120, indicating that flows occurred earlier relative to the 5-year average (131).

The Ganaraska River receives annual runs of naturalized Chinook Salmon and Rainbow Trout and both of these species reproduce naturally within this river system. In 2023, the average annual discharge at the Ganaraska River (Station ID: 02HD012) was 3.92 m^3s^{-1}. This was above the long-term average (Fig. 9.3.2). The central flow Julian day date was 91, indicating that flows occurred earlier relative to the 5-year average (135).

The Salmon River drains into the Bay of Quinte near Shannonville, Ontario. The lower reaches of this system provide spawning and rearing habitat for warm and coolwater species that inhabit the Bay of Quinte and Lake Ontario (e.g. Walleye). In 2023, the average annual discharge at the Salmon River (Station ID: 02HM003) was 14.04 m^3s^{-1}. This was above the long-term average (Fig. 9.3.3). The central flow Julian day date was 97, indicating that flows occurred earlier relative to the 5-year average (107).

TABLE 9.3. Information of three Lake Ontario tributaries used in the stream flow analysis including river name, station ID, latitude and longitude (Degree Decimal Minutes), gross drainage area (km^2), and daily discharge time series for each tributary.

River	Station ID	Latitude	Longitude	Gross Drainage Area (km^2)	Daily Discharge Time Series
Credit	02HB029	44°34.933 N	79°42.517 W	774.24	2005-2023
Ganaraska	02HD012	43°59.450 N	78°16.683 W	241.87	1976-2023
Salmon	02HM003	44°12.433 N	77°12.550 W	906.73	1958-2023

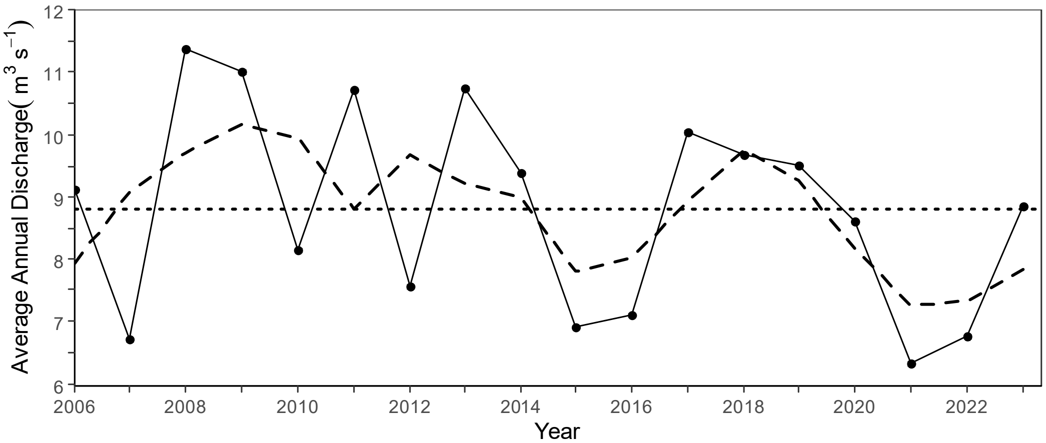


FIG. 9.3.1. Average annual discharge (m^{3}s^{-1}) for the Credit River, Ontario (Station ID: 02HB029) from 2006 to 2023. The horizontal dotted line is the historical average discharge and the dashed line represents the 3-year running mean.

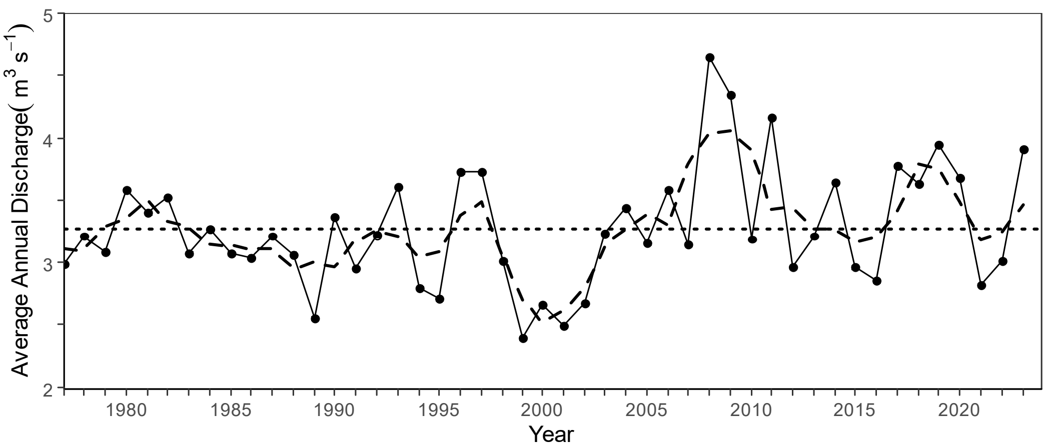


FIG. 9.3.2. Average annual discharge (m^{3}s^{-1}) for the Ganaraska River, Ontario (Station ID: 02HD012) from 1977 to 2023. The horizontal dotted line is the historical average discharge and the dashed line represents the 3-year running mean.

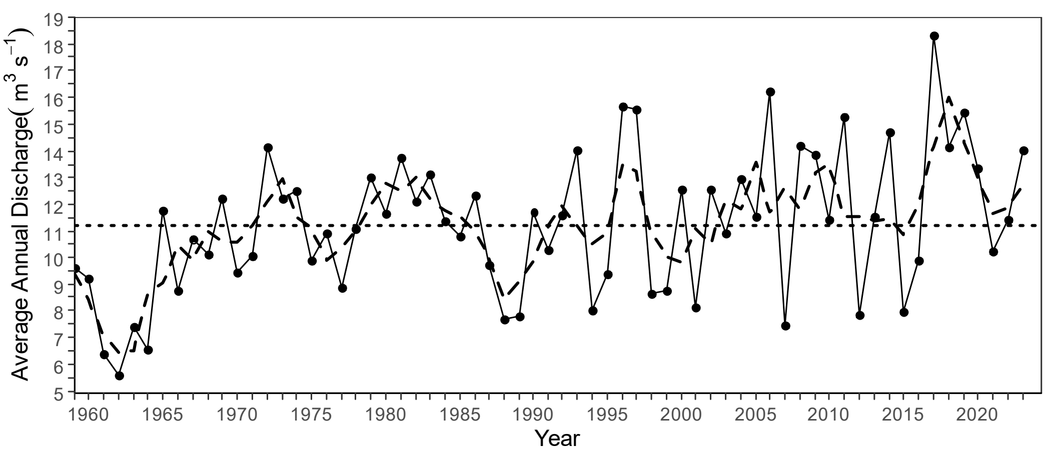


FIG. 9.3.3. Average annual discharge (m^{3}s^{-1}) for the Salmon River, Ontario (Station ID: 02HM003) from 1977 to 2023. The horizontal dotted line is the historical average discharge and the dashed line represents the 3-year running mean.

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Claire Matthews	Summer Student

11. Operational Field and Lab Schedule, 2023

Operational Field and Lab Schedule, 2023 (SPA = Special Purpose Account; COA = Canada Ontario Agreement; OPG = Ontario Power Generation).

Field and Lab Projects	Dates	Species Assessed, Monitored or Stocked	Project Lead	Operational Lead	Funding Source
Public Outreach - Toronto Sportsman Show	March	Public Outreach/Education	Kranzl	Kranzl/Maynard	SPA
Ganaraska River Fish Counter Salmon and Trout As-	Mar-Nov	Migratory Trout & Salmon	Yuille	Sweeting/	SPA
Credit River Fish Counter Salmon and Trout Assess-	Mar-Nov	Migratory Trout & Salmon	Yuille	Sweeting/	COA/SPA
Ganaraska Fishway Rainbow Trout Assessment	Mar-Apr	Rainbow Trout	Yuille	Sweeting/ Balogh	SPA
Lake Ontario Spring Prey Fish Trawling Survey	April	Alewife/Smelt	Holden	Montgomery/ Campbell	SPA
Walleye Egg Collection	Mar-Apr	Walleye	Beech	Maynard	SPA
Bluegill Broodstock Collection	May	Bluegill	Lake	Maynard	SPA
Commercial Fishery Daily Catch Record Collection	April-December	Multiple Species	Todd	Kranzl/Maynard	SPA
Environmental DNA collection	May-Sept	Multiple Species	Sunderland	Balogh	COA
Foodweb Dynamics in Lake Ontario	Apr-Nov	Fish Community	Dr. Johnson	Metcalfe/ Bloomfield	COA/SPA
Invasive Species Emergency Response	Apr-Nov	Grass Carp	McNevin	Maynard	SPA
Spring American Eel Trap and Transfer	April-June	American Eel	LaRose	Anstey	OPG
Chinook Salmon Net Pens	April	Chinook Salmon	Lake	Lake	SPA
Lake Trout Tagging	April	Lake Trout	Johnson	Metcalfe/Sholz	COA/SPA
Fish Contaminant Sampling (MOECP)	Apr-Dec	Sport Fish	Beech/Maynard	Huff	SPA
St. 81 - Offshore Limnology and Zooplankton Survey	May-Oct	Lower Food Web	Dr. Johnson	Metcalfe/ Bloomfield	SPA
Bay of Quinte Open Water Creel Survey	May-Aug	Fish Community	Beech	Ballingall	SPA
Muskellunge Index Netting	May	Esocids	Lake	Gristey	SPA
Lake Trout Tug Stocking	May	Juvenile Lake Trout	Lake	Perry	SPA
Public Outreach - Belleville Cops for Kids	June	Public Outreach/Education	McNevin	Mindle	SPA
Eastern Lake Ontario and Bay of Quinte Fish Community Index Netting	Jun-Nov	Fish Community	Beech	Maynard	SPA
Eastern Lake Ontario and Bay of Quinte Fish Communi-	Jun-Sep	Fish Community	Beech	Maynard	SPA
Acoustic Telemetry Receiver Servicing	Jun-Aug	Multiple Species	Dr. Johnson	Perry/Scholz	COA/SPA
Lake St. Francis Acoustic Receiver deployment/	June, November	Multiple Species	MFFP/Lake	Gristey/Row	SPA
North Channel Nearshore Community Index Netting	September	Nearshore Fish Community	Beech	Mindle	COA
Thousand Island Nearshore Community Index Netting	Aug-Sept	Nearshore Fish Community	Beech/Row	Gristey/Row	COA
Lake St. Francis Nearshore Community Index Netting	September	Nearshore Fish Community	Beech/Row	Gristey/Row	COA
Genetic Markers of Thermal Stress in Yellow Perch	September	Yellow Perch	Patricia Voyer (MSc student at U Windsor)	Metcalfe	COA/SPA

Operational Field and Lab Schedule, 2023, Continued. (SPA = Special Purpose Account; COA = Canada Ontario Agreement; OPG = Ontario Power Generation).

Field and Lab Projects	Dates	Species Assessed, Monitored or Stocked	Project Lead	Operational Lead	Funding Source
Genetic Markers of Thermal Stress in Yellow Perch	September	Yellow Perch	Patricia Voyer (MSc student at U Windsor)	Metcalfe	COA/SPA
St. Lawrence River Fish Community Index Netting	September	Fish Community	Yuille	Chan	COA
Lake St. Francis Fish Community Index Netting	September	Fish Community	Yuille	Chan	COA
Fall American Eel Trap and Transfer	Sept-Oct	American Eel	Sunderland	Anstey	OPG
Public Outreach - Port Hope Salmon Festival	September	Public Outreach/Education	Maynard	Maynard	SPA
Juvenile Chinook Trawling	October	Salmonids	Holden	Perry/Campbell	COA
Lake Ontario Fall Benthic Prey Fish Trawling Survey	Sept-Oct	Round Goby/Slimy and Deep-water Sculpin	Holden	Perry/Campbell	COA
Credit River Chinook Salmon Assessment and Egg Collection	October	Chinook Salmon	Yuille	Ballingall	SPA
Atlantic Salmon sampling - Lakefront Promenade	October	Atlantic Salmon	Gristey	Perry	SPA
Eastern Basin Lake Ontario, Lake Whitefish Acoustic Tagging	November	Lake Whitefish	Dr. Johnson	Huff/Metcalfe	COA / SPA
Bay of Quinte Lake Whitefish Acoustic Tagging	November	Lake Whitefish	Queens University/Beech	Huff	Queens/SPA
Lake Whitefish Commercial Catch Sampling	Oct-Nov	Lake Whitefish	Beech	Anstey	SPA
Cisco Commercial Catch Sampling	Oct-Nov	Cisco	Beech	Anstey	SPA
Age and Growth (Lab)	Year-Round	Multiple Species	Maynard	Sholz/Maynard	SPA/COA
Great Lake Information System (GLIS) development	Year-Round	-	Beech	Jakobi	-

12. Primary Publications 2023

Primary Publications of Glenora Fisheries Station Staff[1] in 2023

Brown, T.A., L.G. Rudstam, **J.P. Holden,** B.C. Weidel, A.S. Ackiss, A.J. Ropp, M.A. Chalupnicki, J.E. McKenna Jr., and S.A. Sethi (2023). Larval cisco and lake whitefish exhibit high distributional overlap within nursery areas. *Ecology of Freshwater Fish*, *32*(4), 804-823.

Elliott, C.W., M.S. Ridgway, E. Brown, and B.L. Tufts (2023). High degree of individual repeatability found in the annual migrations of walleye (*Sander vitreus*) in eastern Lake Ontario. *Journal of Great Lakes Research, 49*(3), 725-736.

Mohit, S., **T.B. Johnson**, and S.E. Arnott (2023). Watercraft decontamination practices to reduce the viability of aquatic invasive species implicated in overland transport. *Scientific Reports, 13*, 7238.

Nawrocki, B.N., **S. Beech**, **E. Brown**, and **T.B. Johnson** (2023). Descriptive population metrics of fishes in eastern Lake Ontario and the Bay of Quinte. Ontario Ministry of Natural Resources and Forestry; Science and Research Branch; Peterborough, ON. Science and Research Technical Report TR-54.

Sadeghi, J., S.R. Chaganti, **T.B. Johnson**, and D.D. Heath (2023). Host species and habitat shape fish-associated bacterial communities: phylosymbiosis between fish and their microbiome. *Microbiome, 11*, 258.

Shimoda, Y., C. Haibin, Y. Fernando, A. Okoli, Z. Xu, M. Koops, **T.B. Johnson**, and G.B. Arhonditsis (2023). How influential is the role of oligotrophication on the integrity of fish assemblages in the littoral zone? *Journal of Great Lakes Research, 49*(4), 847-861.

Zhang, H., D.M. Mason, E.S. Rutherford, M.A. Koops, **T.B. Johnson**, A.M. Gorman, M. Rowe, X. Zhu, M. Hossain, and H.A. Cook (2023). Modelling effects of nutrients and hypoxia on Lake Erie's central basin food web. *Aquatic Ecosystem Health and Management, 26*(3), 5-16.

[1] Names of staff of the Glenora Fisheries Station are indicated in bold font.

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