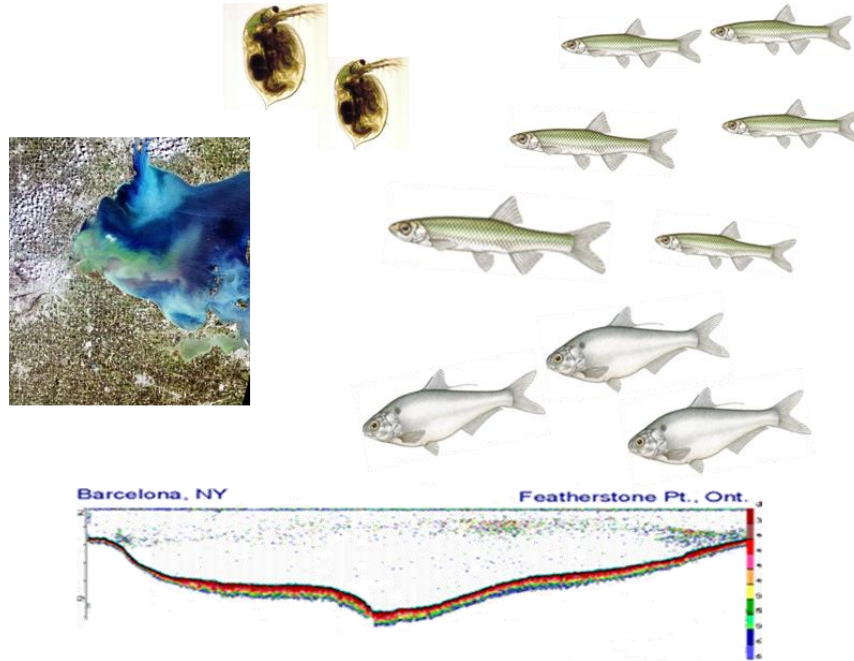


# Report of the Lake Erie Forage Task Group

March 2018



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## Presented to:

**Standing Technical Committee  
Lake Erie Committee  
Great Lakes Fishery Commission**

## **Charges to the Forage Task Group 2017-2018**

1. Report on the results of the interagency lower trophic level monitoring program and status of trophic conditions as they relate to the Lake Erie Fish Community Goals and Objectives.
2. Describe the status and trends of forage fish in each basin of Lake Erie.
3. Continue hydroacoustic assessment of the pelagic forage fish community in Lake Erie, incorporating new methods in survey design and analysis while following the GLFC's Great Lakes Hydroacoustic Standard Operating Procedures where possible/feasible.
4. Report on the use of forage fish and new invasive species in the diets of selected commercially or recreationally important Lake Erie predator fish.
5. Develop and maintain a database to track new or emerging Aquatic Invasive Species in Lake Erie that exhibit the potential to directly impact economically important fisheries.

**Charge 1: Report on the results of the interagency lower trophic level monitoring program and status of trophic conditions as they relate to the Lake Erie Fish Community Goals and Objectives.**

(J. Markham)

In 1999, the Forage Task Group (FTG) initiated a Lower Trophic Level Assessment program (LTLA) within Lake Erie and Lake St. Clair (Figure 1.0.1). Nine key variables, as identified by a panel of lower trophic level experts, were measured to characterize ecosystem change. These variables included profiles of temperature, dissolved oxygen and light (Photosynthetically Active Radiation; PAR), water transparency (Secchi disc depth), nutrients (total phosphorus), chlorophyll *a*, phytoplankton, zooplankton, and benthos. The protocol called for each station to be visited every two weeks from May through September, totaling 12 sampling periods, with benthos collected on two dates, once in the spring and once in the fall. For this report, we will summarize the last 19 years of data for summer surface temperature, summer bottom dissolved oxygen, chlorophyll *a* concentrations, water transparency, total phosphorus and zooplankton. Stations were only included in the analysis if there were at least 3 years each containing 6 or more sampling dates. Stations included in this analysis are stations 3, 4, 5 and 6 from the west basin, stations 7, 8, 9, 10, 11, 12, 13 and 14 from the central basin, and stations 15, 16, 17, 18, 19, 20 and 25 from the east basin (Figure 1.0.1). Station 25 (located off Sturgeon Point in 19.5 meters of water) was added in 2009.

The fish community objectives (FCO) for the lower trophic level ecosystem in Lake Erie are to maintain mesotrophic conditions that favor percids in the west, central and nearshore waters of the east basin, and oligotrophic conditions that favor salmonids in the offshore waters of the east basin (Ryan et al. 2003). Associated with these trophic classes are target ranges for total phosphorus, water transparency, and chlorophyll *a* (Table 1.0.1). For mesotrophic conditions, the total phosphorus range is 9-18  $\mu\text{g/L}$ , summer (June-August) water transparency is 3-6 meters, and chlorophyll *a* concentrations between 2.5-5.0  $\mu\text{g/L}$  (Leach et al. 1977). For the offshore waters of the east basin, the target ranges for total phosphorus are  $< 9 \mu\text{g/L}$ , summer water transparency of  $> 6 \text{ m}$ , and chlorophyll *a* concentrations of  $< 2.5 \mu\text{g/L}$ .

A trophic state index (TSI) (Carlson 1977) was used to produce a metric which merges three independent variables to report a single broader measure of trophic conditions. This index uses algal biomass as the basis for trophic state classification, independently estimated using measures of chlorophyll *a*, water transparency, and total phosphorus. Each independent measure is combined and the average of the three indices reflects a trophic state value for that site and sampling event. The median value of the combined daily indices is used to determine an annual index for each basin. Because the number generated is only a relative measure of the trophic conditions and does not define trophic status, this index was calibrated to accepted Lake Erie ranges for values of total phosphorus, chlorophyll *a*, and transparency (from Leach et al. 1977) that have long been used to assess trophic conditions. In these terms, oligotrophic was determined to have a TSI  $< 36.5$ , mesotrophic between 36.5 and 45.5, eutrophic between 45.5 and 59.2, and hyper-eutrophic  $> 59.2$  (Table 1.0.2).

### **Mean Summer Surface Water Temperature**

Summer surface water temperature represents the temperature of the water at 0-1 m depth for offshore stations only. Mean summer surface temperatures across all years are warmest in the west basin (mean= $23.5^{\circ}\text{C}$ ), becoming progressively cooler in the central (mean =  $22.0^{\circ}\text{C}$ ) and east basins (mean =  $20.6^{\circ}\text{C}$ ) (Figure 1.0.2). A slightly increasing trend in summer surface water

temperature is evident for all basins. In 2017, the mean summer surface water temperature was at or near average in all three basins (west: 23.8° C; central: 22.0° C; east: 20.3° C).

### **Hypolimnetic Dissolved Oxygen**

Dissolved oxygen (DO) levels less than 2.0 mg/L are deemed stressful to fish and other aquatic biota (Craig 2012; Eby and Crowder 2002). Low DO can occur when the water column becomes stratified, which can begin in early June and continue through September in the central and east basins. In the west basin, shallow depths allow wind mixing to penetrate to the bottom, generally preventing thermal stratification. Consequently, there are only a few summer observations that detect low bottom DO concentrations in the time series (Figure 1.0.3). In 2017, there were no observations from the west basin stations of DO below the 2.0 mg/L threshold.

Low DO is more of an issue in the central basin, where it happens almost annually at the offshore stations (8, 10, 11 and 13) and occasionally at inshore stations. Dissolved oxygen of less than 2.0 mg/L has been observed as early as mid-June and can persist until late September when fall turnover remixes the water column. In 2017, bottom DO was below the 2.0 mg/L threshold in the central basin on six occasions (Station 10 on 8/8/17 (0.15 mg/L) and 8/21/17 (0.06 mg/L); Station 8 on 7/12/17 (1.58 mg/L) and 7/25/17 (0.10 mg/L); Station 11 on 8/10/17 (0.63 mg/L) and 8/24/17 (1.07 mg/L)) (Figure 1.0.3). There were also three other occasions where bottom DO was just above the 2.0 mg/L threshold.

DO is rarely limiting in the east basin due to greater water depths, a large hypolimnion and cooler water temperatures. The only occasion when DO was below the 2.0 mg/L threshold was on 14 July and 13 August, 2010 at Station 25 (Figure 1.0.3). In 2017, only one measure of DO concentration of less than 6.0 mg/L was recorded in the east basin.

### **Chlorophyll *a***

Chlorophyll *a* concentrations indicate biomass of the phytoplankton resource, ultimately representing production at the lowest level. In the west basin, mean chlorophyll *a* concentrations have mainly been above targeted levels in the 19-year time series, fitting into eutrophic status rather than the targeted mesotrophic status (Figure 1.0.4). Annual variability is also highest in the west basin. In 2017, the mean chlorophyll *a* concentration was 6.8 µg/L in the west basin, which was above the targeted mesotrophic range. In the central basin, chlorophyll *a* concentrations have been less variable and within the targeted mesotrophic range for the entire time series, and that trend continued in 2017 (3.9 µg/L) (Figure 1.0.4). In the east basin, chlorophyll *a* concentrations in the nearshore waters have been below the targeted mesotrophic level for the entire time series (Figure 1.0.4). This may be due to high levels of grazing by dreissenids (Nicholls and Hopkins 1993) in the nearshore east basin waters where biomass of quagga mussels (*Dreissena rostriformis bugensis*) remains high (Patterson et al. 2005). Conversely, chlorophyll *a* levels in the offshore waters of the east basin remain in, or slightly above, the targeted oligotrophic range. In 2016, the mean chlorophyll *a* concentrations were 2.5 µg/L in the nearshore waters of the east basin and 2.5 µg/L in the offshore waters, both of which were borderline between mesotrophic and oligotrophic. Chlorophyll *a* concentrations are most stable in the east basin.

### **Total Phosphorus**

Total phosphorus levels in the west basin have exceeded FCO targets since the beginning of the LTLA monitoring program, and in some years has been in the hyper-eutrophic range (Figure

1.0.5). In 2017, total phosphorus concentrations in the west basin increased slightly to 27.3 µg/L, which is the second lowest measure in the time series but still above targets. In the central basin, total phosphorus levels had exceeded FCO targets from 2006 through 2013, were borderline mesotrophic/eutrophic in 2014 and 2015, and have been increasing in recent years (Figure 1.0.5). Total phosphorus measures in the central basin in 2017 were 29.8 µg/L, which was higher than western basin measures for the second consecutive year. Similar to 2016, the value was heavily influenced by one exceptionally high value (210 µg/L) recorded on 21 September at Station 7 off the mouth of the Vermillion River. In the nearshore waters of the east basin, total phosphorus levels have remained stable and within the targeted mesotrophic range for nearly the entire time series (Figure 1.0.5). A gradual increasing trend was evident from 2006 through 2010, but a declining trend has been evident since 2010. Total phosphorus levels in the offshore waters of the east basin show a similar trend to nearshore waters, and had risen above the targeted oligotrophic range from 2008 through 2013 but have declined in more recent years. In 2017, mean total phosphorus concentrations in the east basin increased in both the nearshore (10.6 µg/L) and offshore (9.6 µg/L) waters, putting them within the targeted mesotrophic range in the nearshore waters and above the targeted oligotrophic range in the offshore waters.

## **Water Transparency**

Similar to other fish community ecosystem targets (i.e. chlorophyll *a*, total phosphorus), water transparency has been in the eutrophic range, which is below the FCO target in the west basin, for the entire time series (Figure 1.0.6). Mean summer transparency in the west basin was 2.9 m in 2017, which was the highest measure in the time series and borderline eutrophic/mesotrophic. In contrast, water transparency in the central basin has remained within the targeted mesotrophic range for the entire series with the exception of 2015 (2.9 m), which was slightly below the mesotrophic target range (Figure 1.0.6). In 2017, water transparency decreased to 4.2 m, which was once again the targeted mesotrophic range. In the nearshore water of the east basin, water transparency was in the oligotrophic range, which is above the FCO targets, from 1999 through 2006, sharply declined, and then steadily increased and generally remained within the FCO targets for the next ten years (Figure 1.0.6). In 2017, water transparency declined to 5.0 m in the nearshore waters of the east basin, which was within the targeted mesotrophic range. In the offshore waters of the east basin, water transparency was within the oligotrophic target from 1999 through 2007, decreased into the mesotrophic range in five of the next six years, then increased thereafter. In 2017, mean summer transparency was 6.2 m in the offshore waters, which was within the targeted oligotrophic range.

## **Trophic State Index (TSI) and Ecosystem Targets**

A box and whisker plot was used to describe the trophic state index (TSI) for each of the basins in Lake Erie (Figure 1.0.7). Median TSI values indicate that the west basin remained in a eutrophic status from the beginning of the entire time series until 2015, which was more favorable for a centrarchid (bass, sunfish) fish community. In recent years, overall measures of productivity have declined and are near or within the targeted mesotrophic status, which is more favorable for percid production (Walleye, Yellow Perch). In the central basin, median TSI values have generally remained within the targeted mesotrophic range for the entire time series. Trends in the nearshore waters of the east basin indicate median TSI values and ranges mostly below the targeted mesotrophic range in the early years of the time series, increasing into the targeted mesotrophic zone in the late-2000s, decreasing back into oligotrophic status through 2015, and increasing the

last two years. Similar trends are apparent in the offshore waters of the east basin. The TSI values for 2017 indicate borderline eutrophic/mesotrophic status in the west basin (46.4), mesotrophic status in the central basin (44.1), and borderline mesotrophic/oligotrophic status in both the nearshore (35.9) and offshore (36.8) waters of the eastern basin (Table 1.0.2). In general, the trophic status measures indicate that Lake Erie is in a favorable condition for percid production across the entire lake.

### **Zooplankton Biomass**

Zooplankton biomass varies among basins and years. In the west basin, the 2017 mean biomass was  $139.0 \text{ mg/m}^3$ , which was the fifth highest value in the time series and well above the long-term average of  $104.1 \text{ mg/m}^3$  (Figure 1.0.8). Cladocerans provide the bulk of the biomass of zooplankton in the west basin although increases in both calanoid and cyclopoid copepods have been observed in recent years. In the central basin, the 2017 mean zooplankton biomass was  $111.2 \text{ mg/m}^3$ , which was less than the average time-series biomass ( $130.4 \text{ mg/m}^3$ ). Calanoid copepods typically have been higher in biomass in the central basin compared to the west basin with cladocerans less numerous, but copepod biomass has been conspicuously low for the past four years. In the east basin, overall zooplankton biomass is traditionally lower compared to the central and west basins with cladocerans and calanoid copepods equally important (Figure 1.0.8). Looking at larger long-term trends, there appeared to be a gradient of high zooplankton biomass in the west and lower biomass in the east from 2000 to 2007. From 2009 through 2013, zooplankton biomass increased in the central and east basins, but shifted back to the west basin in 2015 with declines observed in the central and east basins. Cladocerans typically are more dominant in the west basin zooplankton community and decline to the east while calanoid and cyclopoid copepods tend to be higher in biomass in the central and east basins.

Table 1.0.1. Ranges of lower trophic indicators for each trophic class and trophic state index with the associated fish community (Leach et al. 1977; Ryder and Kerr 1978; Carlson 1977).

Trophic Status	Phosphorus (µg/L)	Chlorophyll a (µg/L)	Transparency (m)	Trophic State Index (TSI)	Harmonic Fish Community
Oligotrophic	<9	<2.5	>6	<36.5	Salmonids
Mesotrophic	9 - 18	2.5 - 5.0	3 - 6	36.5 – 45.5	Percids
Eutrophic	18 - 50	5.0 - 15	1 - 3	45.5 – 59.2	Centrarchids
Hyper-eutrophic	>50	>15	<1	>59.2	Cyprinids

Table 1.0.2. Trophic state index and current trophic status, by basin, from Lake Erie, 2017. The east basin is separated into nearshore and offshore.

Trophic Status	Trophic State Index (TSI)	Harmonic Fish Community		2017 TSI	2017 Trophic Status
Oligotrophic	<36.5	Salmonids	West	46.4	Eu/Mesotrophic
Mesotrophic	36.5 – 45.5	Percids	Central	44.1	Mesotrophic
Eutrophic	45.5 – 59.2	Centrarchids	East - Nearshore	35.9	Meso/Oligotrophic
Hyper-eutrophic	>59.2	Cyprinids	East - Offshore	36.8	Meso/Oligotrophic

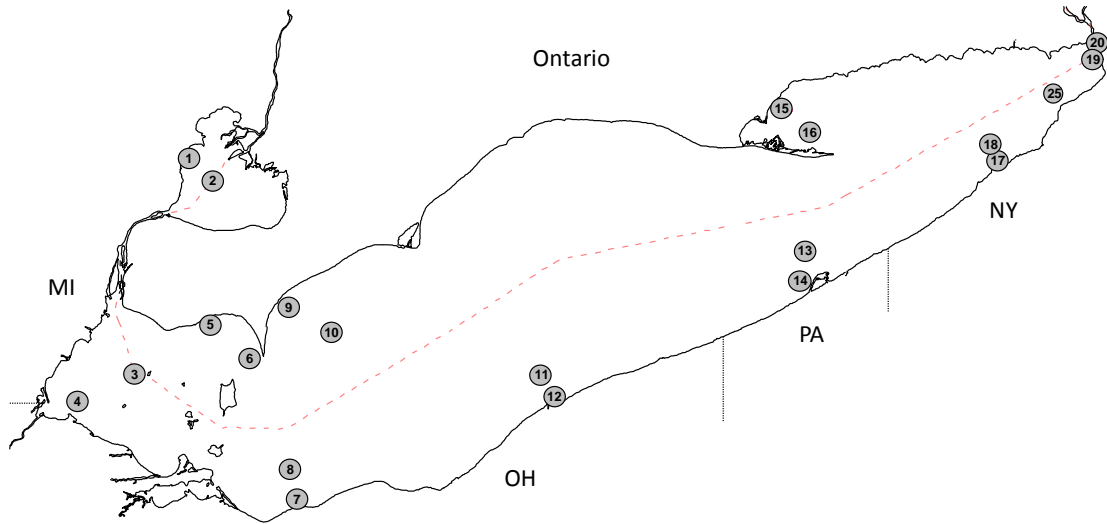


Figure 1.0.1. Lower trophic level sampling stations in Lake Erie and Lake St. Clair. Station 25 was added in 2009. Lake St. Clair stations were last sampled in 2005.

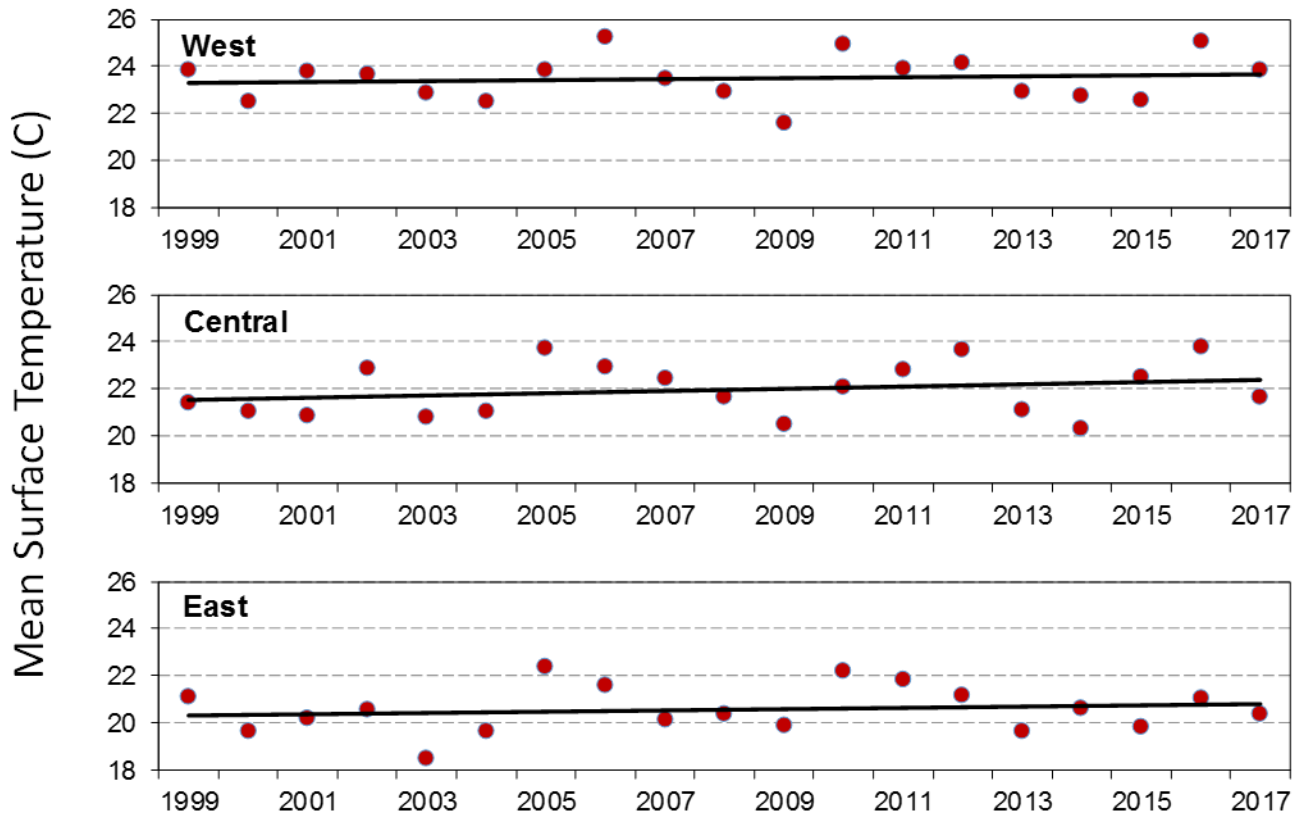


Figure 1.0.2. Mean summer (June-August) surface water temperature (°C) at offshore stations, weighted by month, by basin in Lake Erie, 1999-2017. Solid black lines represent time series trends. Data included in this analysis by basin and station: West – 3, 6; Central – 8, 10, 11, 13; East – 16, 18, 19, 25.



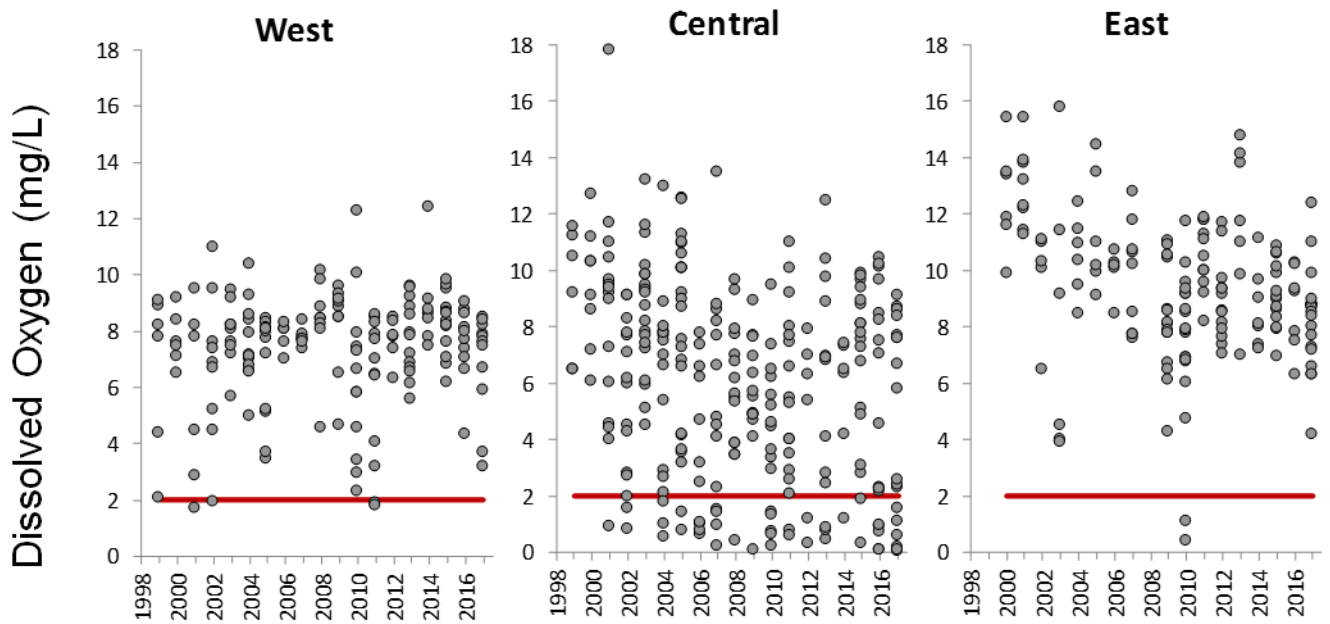


Figure 1.0.3. Summer (June-August) bottom dissolved oxygen (mg/L) concentrations for offshore sites by basin in Lake Erie, 1999-2017. The red horizontal line represents 2 mg/L, a level below which oxygen becomes limiting to the distribution of many temperate freshwater fishes. Data included in this analysis by basin and station: West – 3, 6; Central – 8, 10, 11, 13; East – 16, 18, 19, 25.

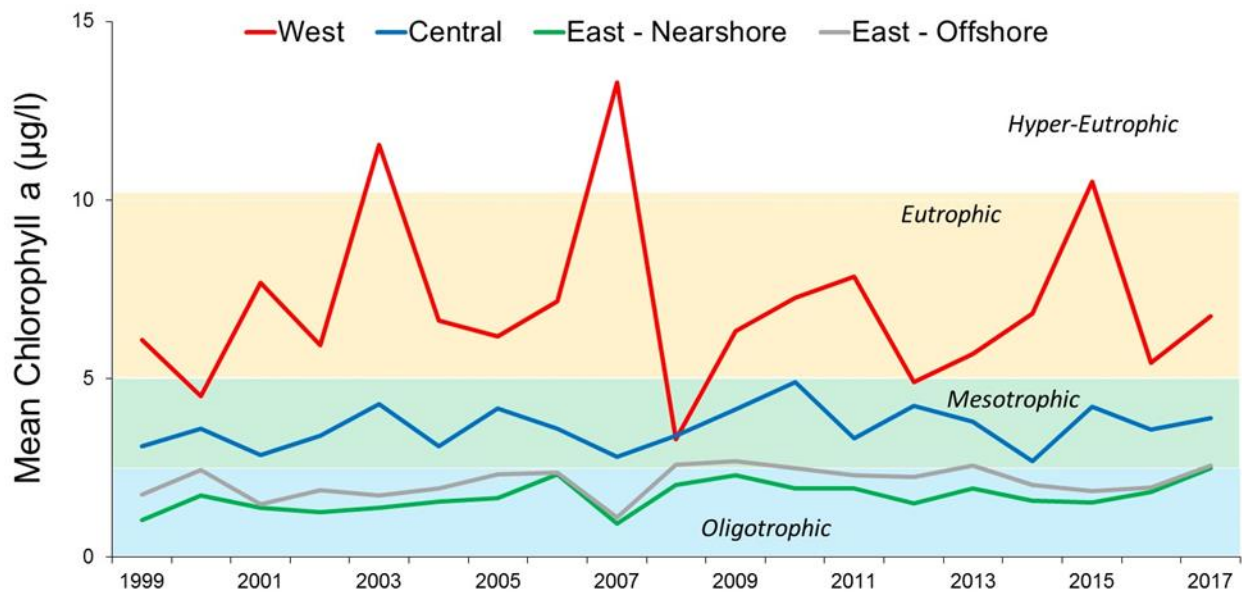


Figure 1.0.4. Mean chlorophyll *a* concentration ( $\mu\text{g/L}$ ), weighted by month, by basin in Lake Erie, 1999-2017. The east basin is separated into nearshore and offshore. Shaded areas represent trophic class ranges. For this analysis data from stations 3 through 20, and 25 were included.

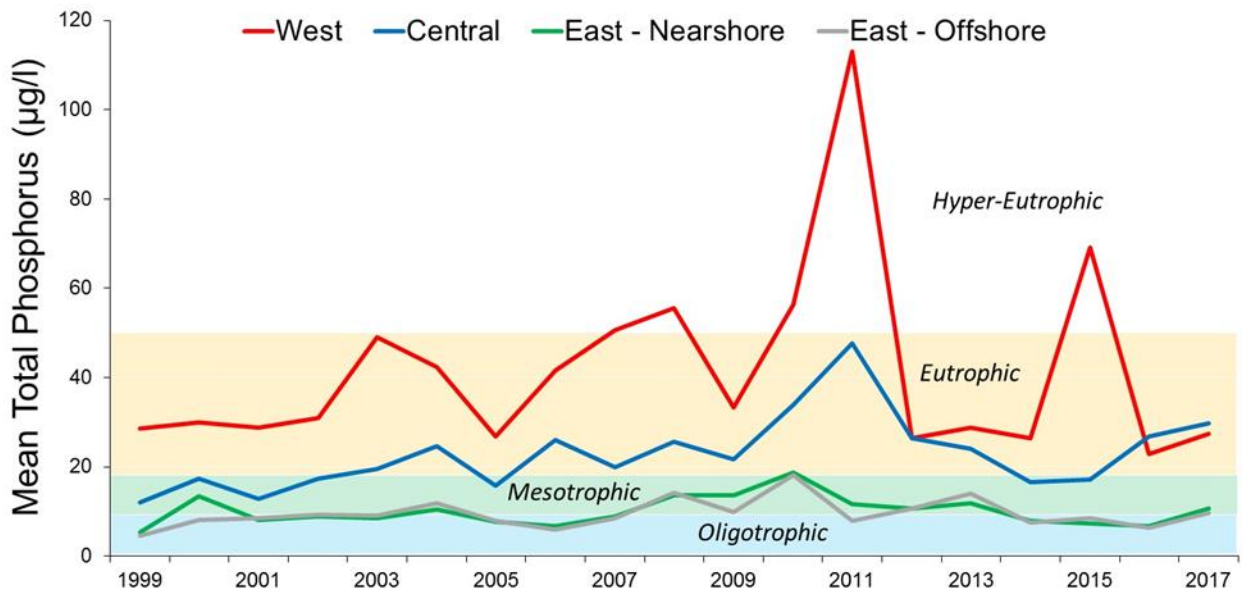


Figure 1.0.5. Mean total phosphorus ( $\mu\text{g/L}$ ), weighted by month, for offshore sites by basin in Lake Erie, 1999-2017. The east basin is separated into nearshore and offshore. Shaded areas represent the trophic class ranges. For this analysis data from stations 3 through 20, and 25 were included.

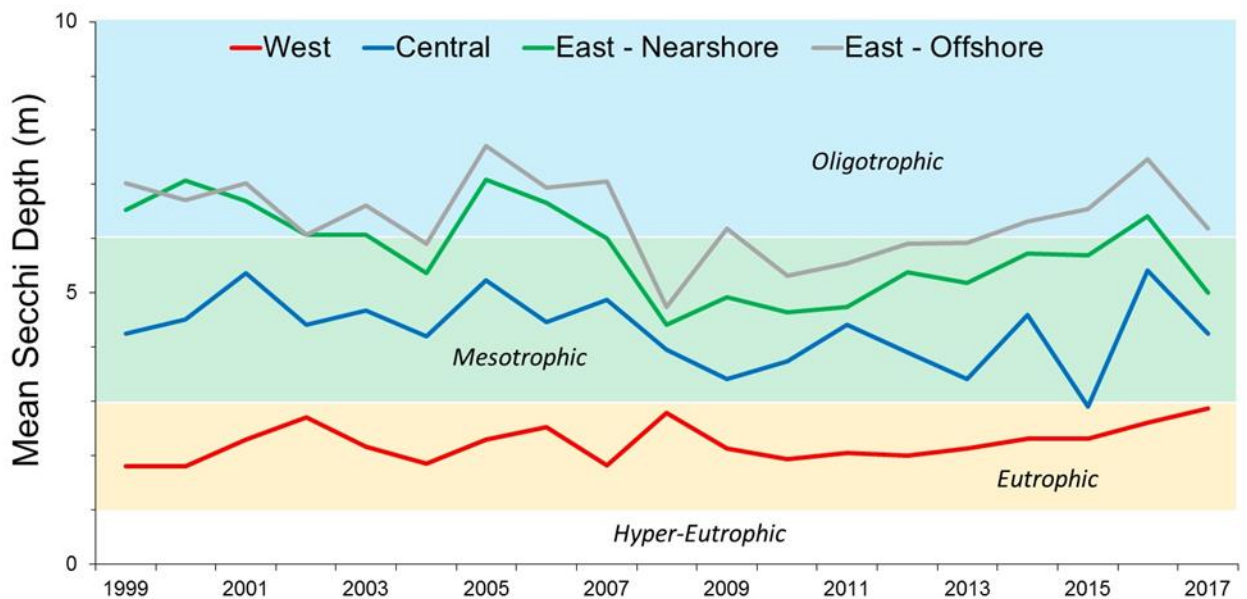


Figure 1.0.6. Mean summer (June-August) Secchi depth (m), weighted by month, by basin in Lake Erie, 1999-2016. The east basin is separated into inshore and offshore. Yellow shaded areas represent the targeted trophic class range. For this analysis data from stations 3 through 20, and 25 were included.

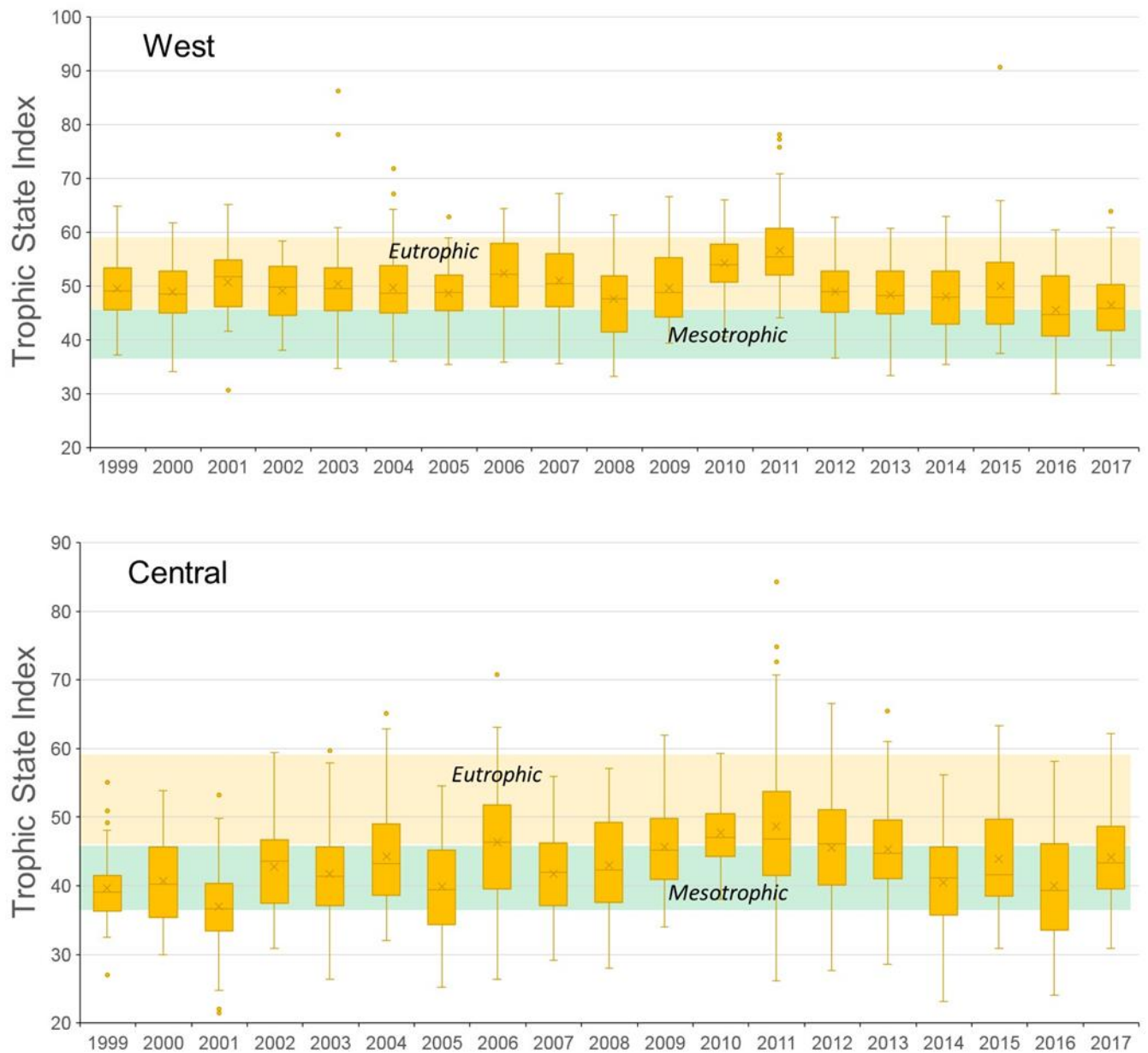


Figure 1.0.7. Box and whisker plot of trophic state indices (TSI) by basin in Lake Erie, 1999-2017. The east basin is separated into nearshore and offshore. Shaded areas represent trophic class ranges. Boxes indicate 25<sup>th</sup> and 75<sup>th</sup> quartiles of the values with the median value as the horizontal line. Vertical lines show the range of values with individual points representing outliers. All stations (3-20, 25) were included in this analysis.

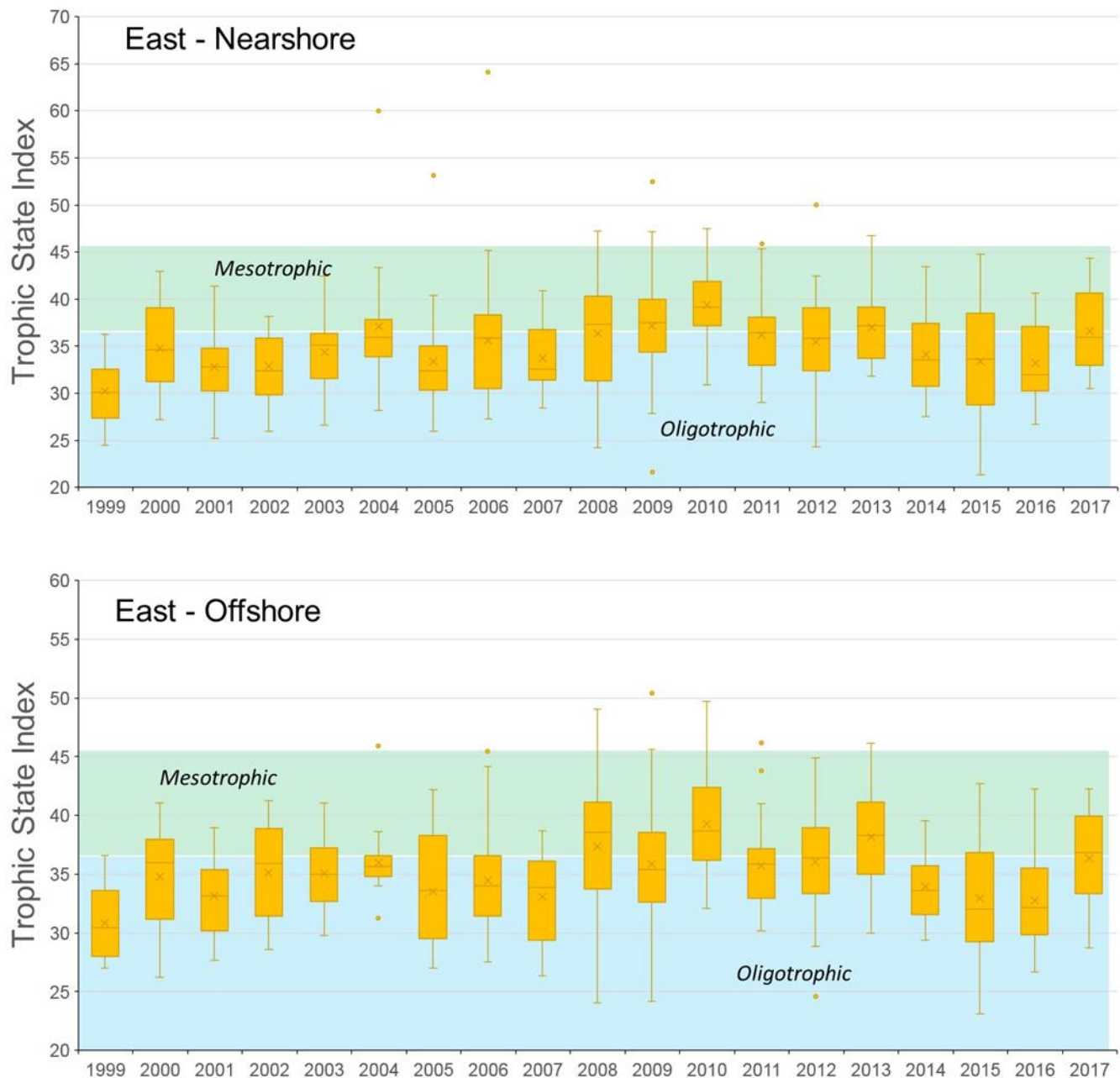


Figure 1.0.7. (Continued) Box and whisker plot of trophic state indices (TSI) by basin in Lake Erie, 1999-2017. The east basin is separated into nearshore and offshore. Shaded areas represent trophic class ranges. Boxes indicate 25<sup>th</sup> and 75<sup>th</sup> quartiles of the values with the median value as the horizontal line. Vertical lines show the range of values with individual points representing outliers. All stations (3-20, 25) were included in this analysis.

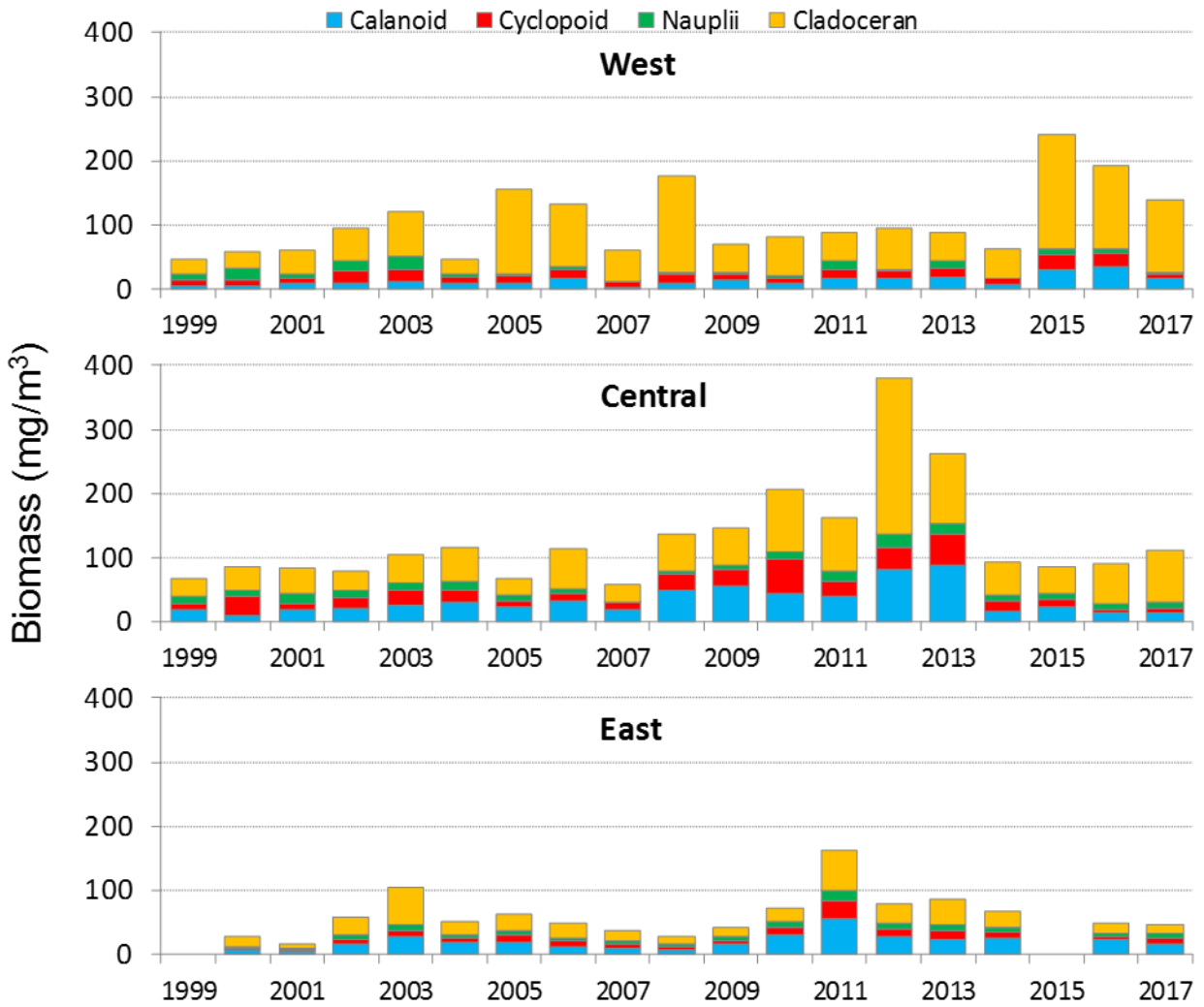


Figure 1.0.8. Mean zooplankton biomass ( $\text{mg}/\text{m}^3$ ) by major taxonomic group by basin, 1999 through 2017. There is no data for 1999 and 2015 in the east basin. West basin includes stations 3 through 6, central basin stations 7 through 14, and east basin stations 15 through 20. Data excludes rotifers and veligers. Harpacticoid zooplankton comprise a miniscule biomass for most years and are not included in the graph.

## **Charge 2: Describe the status and trends of forage fish in each basin of Lake Erie.**

### **2.1 Synopsis of 2017 Forage Status and Trends**

#### **Eastern Basin**

- Total forage fish abundance in 2017 decreased in Ontario and New York and increased in Pennsylvania
- Young-of-the-year (age-0) Rainbow Smelt density was above the long-term mean (10-year) in New York and Pennsylvania, but below long-term means in Ontario
- Yearling-and-older (age-1+) Rainbow Smelt density was below long-term means in all three east-basin jurisdictions
- Spiny-rayed fishes were down in Ontario and New York but up in Pennsylvania, with higher than average densities of White Perch
- Young-of-the-year Emerald Shiner were not detected in Ontario or Pennsylvania; catches in New York were up in 2017 compared to 2016 but still lower than the long-term mean
- Alewife densities increased in New York and Ontario, but were not detected in Pennsylvania
- Round Goby densities decreased in Pennsylvania and Ontario but increased in New York

#### **Central Basin**

- In Pennsylvania, overall forage abundance decreased slightly from 2016
- In 2017, overall forage abundance increased in Ohio waters due to large cohorts of age-0 Gizzard Shad, Alewife, and White Perch
- Young-of-the-year Yellow Perch abundance increased in Ohio indices, but was below long-term means in both Pennsylvania and Ohio
- Young-of-the-year Rainbow Smelt abundance increased in western Ohio, but decreased in eastern areas of the basin
- Yearling-and-older Rainbow Smelt indices were below long-term means in all central basin surveys
- Round Goby indices were above long-term means in Pennsylvania, but below long-term means in Ohio
- Gizzard Shad and Alewife indices in Ohio were some of the highest in the time series

## West Basin

- Forage abundance was above the long-term mean, ending a three-year decline
- Forage biomass declined from 2016
- Young-of-the-year Gizzard Shad density increased to long-term mean levels, rebounding from historic lows in 2016
- Young-of-the-year Rainbow Smelt density was near the long-term mean, also recovering from historic lows
- Young-of-the-year and age-1+ Emerald Shiner indices continue to be very low
- Young-of-the-year White Perch density was the highest since 2012
- Round Goby abundance was at long-term mean
- Young-of-the-year Walleye recruitment increased from 2016 but remained below the long-term mean
- Young-of-the-year Yellow Perch recruitment increased from 2016; remains above the long-term mean
- White Bass recruitment increased to above the long-term mean, the highest since 2009
- Yearling-and-older Spottail Shiners abundance was the lowest in the time series (since 1988)
- Young-of-the-year Walleye, White Bass and Smallmouth Bass were below long-term means; age-0 Yellow Perch and White Perch were near long-term means

## **2.2 Eastern Basin** (C. May, J. Markham and M. Hosack)

Forage fish abundance and distribution is determined primarily from long-term bottom trawl assessments conducted by the basin agencies (also see East Basin Hydroacoustic Survey, Section 3.1). In 2017, a total of 34 trawl tows were sampled across New York waters (NYSDEC; n=26 years), 102 trawl tows in nearshore and offshore Long Point Bay of Ontario (OMNRF; n=37 and 34 years) and 10 trawls in Pennsylvania waters of the East Basin (PFBC; n=28 years) (Figure 2.2.1).

In 2017, forage fish densities decreased in Ontario and New York and increased in Pennsylvania. Rainbow Smelt is the most abundant forage species in most years and jurisdictions and 2017 was no exception (Figure 2.2.2). However, this was primarily age-0 Rainbow Smelt. Very low densities of age-1+ Rainbow Smelt were caught in Ontario and Pennsylvania. Yearling-and-older catches were up from last year in New York but still low compared to the long-term mean. Alewife catches in New York were strong in 2017. Alewife numbers also increased in Ontario but were not caught in Pennsylvania. Spiny-rayed fishes were down in Ontario and New York but up in Pennsylvania, with higher than long-term mean densities of White Perch (Table 2.2.1). For soft-rayed fishes, age-0 Emerald Shiner was not detected in Ontario or Pennsylvania; catches in New York were up in 2017 compared to 2016 but still lower than average. Spottail Shiner density increased in Ontario but was very low in New York and not detected in Pennsylvania. Trout Perch remained low in all jurisdictions (Table 2.2.1). Round Goby, an important species in the eastern basin forage fish community since it appeared in the late 1990s, decreased in Pennsylvania and Ontario but increased in New York (Table 2.2.1).

## **2.3 Central Basin** (J. Deller and M. Hosack)

Routine bottom trawl surveys in the central basin began in Pennsylvania in 1982 and in Ohio in 1990 to assess age-0 percid and forage fish abundance and distributions. Trawl locations in Pennsylvania range from 13 to 24 m depth and Ohio trawl locations range from 5 to >20 m depth (Figure 2.3.1). Ohio West covers the area from Lorain to Fairport Harbor. Ohio East covers the area from Fairport Harbor to the Pennsylvania state line. The Pennsylvania survey covers the area from the Pennsylvania state line to Erie. In 2017, 62 trawl tows were completed in the central basin, 24 in Ohio East, 33 in Ohio West, and 5 in Pennsylvania. Currently there are no annual trawl surveys in Ontario. To address this gap, OMNRF and USGS are collaborating to develop a new survey. Preliminary trawls were conducted in 2016 and 2017. Future development, results and analysis of the new survey will be included in the Forage Task Group Report.

In 2017, overall forage abundance in Ohio waters increased from 2016 (Figure 2.3.2). The largest increases were in the clupeid and spiny-rayed forage groups (primarily age-0 White Perch). The Rainbow Smelt forage group decreased slightly from 2016. In Pennsylvania, overall forage abundance decreased from 2016 due to decreases in both Rainbow Smelt and spiny-rayed forage groups (Figure 2.3.3). All forage group density estimates were below the 25-year average in Pennsylvania and Ohio.

Trends in age-0 Rainbow Smelt abundance were not consistent across central basin surveys. Young-of-the-year Rainbow Smelt indices increased in Ohio West, but decreased in both Ohio East and Pennsylvania from 2016. Despite the observed decrease from 2016, the Pennsylvania index was above the long-term mean and was the third highest in the time series. Both Ohio indices were at the long-term mean. Yearling-and-older Rainbow Smelt indices increased in Ohio, but remained



low in Pennsylvania relative to 2016 (Table 2.3.2). All age-1+ indices for Rainbow Smelt in the central basin were below long-term means.

Densities of Round Goby have tended to be higher in eastern relative to western areas of the basin (Table 2.3.1; 2.3.2). In 2017, age-0 and age-1+ Round Goby abundance increased dramatically in Pennsylvania, and were well above the long-term mean. Ohio indices were mixed, with slight increases in age-0 densities in both areas, and age -1+ in the west. All Ohio indices were below the long-term mean.

In Ohio, age-0 Gizzard Shad and Alewife indices were some of the highest in the time series in 2017 (Table 2.3.1). The highest indices in Ohio were in the eastern areas of the basin. In Pennsylvania, Gizzard Shad and Alewife are not routinely captured in assessment surveys. Only Gizzard Shad were captured in 2017, and were below long-term means.

Since 2005, Yellow Perch cohorts in the central basin have tended to be strongest in the east relative to the west. In 2017, Yellow Perch age-0 indices in Ohio increased from 2016, but remain below long-term means. Ohio indices have been generally below long-term means since 2013. In contrast, the age-0 Pennsylvania index was the third highest in the time series and was above the long-term mean (Table 2.3.1). Yearling-and-older indices in both Ohio surveys decreased from 2016 and have been in decline since 2015 (Table 2.3.2). Both Ohio indices were below long-term means. In contrast to Ohio, the Pennsylvania age-1+ index increased from 2016 and was above the long-term mean, most likely due to the above average age-0 cohort from 2016.

Trends in White Perch age-0 and age-1+ indices across the central basin were mixed. Indices for age-0 White Perch increased in Ohio, but were below the long-term means (Table 2.3.1). In Pennsylvania, the age-0 White Perch index has been declining since 2015 and is below the long-term mean. Ohio indices decreased from 2016 and were below long-term means (Table 2.3.2). Pennsylvania's age 1+ index increased from 2016, but remains below the long-term mean.

## **2.4 West Basin (Z. Slagle and E. Weimer)**

### **History**

Interagency trawling has been conducted in Ontario and Ohio waters of the western basin of Lake Erie in August of each year since 1987, though missing effort data from 1987 has resulted in the use of data since 1988. This interagency trawling program was developed to measure basin-wide recruitment of percids, but has been expanded to provide basin-wide community abundance indices. In 1992, the Interagency Index Trawl Group (ITG) recommended that the Forage Task Group review its interagency trawling program and develop standardized methods for measuring and reporting basin-wide community indices. Historically, indices from bottom trawls had been reported as relative abundances, precluding the pooling of data among agencies. In 1992, in response to the ITG recommendation, the FTG began the standardization and calibration of trawling procedures among agencies so that the indices could be combined and quantitatively analyzed across jurisdictional boundaries. SCANMAR was employed by most Lake Erie agencies in 1992, by OMNRF and ODNR in 1995, and by ODNR alone in 1997 to calculate actual fishing dimensions of the bottom trawls. In the western basin, net dimensions from the 1995 SCANMAR exercise are used for the OMNRF vessel, while the 1997 results are applied to the ODNR vessel. In 2002, ODNR began interagency trawling with the new vessel R/V *Explorer II*, and SCANMAR was again employed to estimate the net dimensions in 2003. In 2003, a trawl comparison exercise among all western basin research vessels was conducted, and fishing power correction factors (Table 2.4.1) have been applied to the vessels administering the western basin Interagency Trawling Program (Tyson et al. 2006). Presently, the FTG estimates basin-wide abundance of forage fish in the

western basin using information from SCANMAR trials, trawling effort distance, and catches from the August interagency trawling program. Species-specific abundance estimates (number per hectare or number per m<sup>3</sup>) are combined with length-weight data to generate a species-specific biomass estimate for each tow. Arithmetic mean volumetric estimates of abundance and biomass are extrapolated by depth strata (0-6m, >6m) to the entire western basin to obtain a fishing power correction adjusted, absolute estimate of forage fish abundance and biomass for each species. For reporting purposes, species have been pooled into three functional groups: clupeids (age-0 Gizzard Shad and Alewife), soft-rayed fish (Rainbow Smelt, Emerald Shiner, Spottail Shiner, other cyprinids, Silver Chub, Trout-Perch, and Round Goby), and spiny-rayed fish (age-0 White Perch, White Bass, Yellow Perch, Walleye and Freshwater Drum).

Hypoxic conditions have been observed during previous years of interagency bottom trawl assessment in the west basin. Due to concerns about the potential effects of hypoxia on the distribution of juvenile percids and other species, representatives from task groups, the Standing Technical Committee, researchers from the Quantitative Fisheries Center at Michigan State University and Ohio State University (OSU) developed an interim policy for the assignment of bottom trawl status. Informed by literature (Eby and Crowder 2002; Craig and Crowder 2005) and field study (ODNR /OSU/USGS) concerning fish avoidance of hypoxic waters, an interim policy was agreed upon whereby bottom trawls that occurred in waters with dissolved oxygen less than or equal to 2 mg per liter would be excluded from analyses. The policy has been applied retroactively from 2009. Currently, there is no consensus among task groups on the best way to handle this sort of variability in the estimation of year-class strength in Lake Erie. In part, this situation is hampered by a lack of understanding of how fish distribution changes in response to low dissolved oxygen. This interim policy will be revisited in the future following an improved understanding of the relationship between dissolved oxygen and the distribution of fish species and life stages in Lake Erie (Kraus et al. 2015).

## 2017 Results

In 2017, hypolimnetic dissolved oxygen levels were below the 2 mg per liter threshold at one site during the August trawling survey (located offshore in the Sandusky sub-basin). In total, data from 72 sites were used in 2017 (Figure 2.4.1).

Total forage abundance rebounded from a three-year decline (2014-2016) in 2017, increasing to above the 10-year and overall means (Figure 2.4.2). Spiny-rayed species increased 35% compared to 2016, while soft-rayed species increased by 93%. Clupeid abundance increased 18-fold from historic lows in 2016. Total forage abundance averaged 5,769 fish/ha across the western basin, increasing 58% from 2016, and residing above the long-term mean (5,194 fish/ha). Clupeid density was 815 fish/ha (average 1,100 fish/ha), soft-rayed fish density was 262 fish/ha (mean 518 fish/ha), and spiny-rayed fish density was 4,692 fish/ha (mean 3,576 fish/ha). Relative abundance of the dominant species includes: age-0 White Perch (68%), Gizzard Shad (14%), and age-0 Yellow Perch (9%). Total forage biomass in 2017 declined 185% relative to 2016 (Figure 2.4.3). Relative biomass of clupeid, soft-rayed, and spiny-rayed species in 2017 was 26%, 2%, and 72%, respectively, and differed from their respective historic averages of 28%, 7%, and 65%. Spatial maps of forage distribution were constructed using FPC-corrected site-specific catches (number per hectare) of the functional forage groups (Figure 2.4.4). Abundance contours were generated using kriging techniques to interpolate abundance among trawl locations. Clupeid catches were highest in Sandusky Bay and off Catawba Island in the South Passage. Soft-rayed fish were most abundant in the waters east and south of Pelee Island. Spiny-rayed abundance was densest in northern Maumee Bay and off Catawba Island in the South Passage.

Recruitment of individual species is highly variable in the western basin. Young-of-the-year Yellow Perch (494/ha; Figure 2.4.5) increased relative to 2016 and was above the long-term mean (407/ha); age-0 Walleye abundance (23/ha; Figure 2.4.5) also increased but was below the long-term mean (31/ha). Young-of-the-year White Perch (3,907/ha) climbed above the 2016 index, above the long-term mean and was the highest since 2012. Young-of-the-year White Bass (248/ha) increased to above the long-term mean and was the highest since 2009. Young-of-the-year Rainbow Smelt (105/ha) rebounded to the long term mean after disappearing in 2016; Age-1+ Rainbow Smelt density (1.3/ha) was the greatest since 2009. Young-of-the-year Gizzard Shad (815/ha) increased relative to 2016 to just below the long-term mean (883/ha), while age-0 Alewife was again almost non-existent (Figure 2.4.6). Densities of age-0 (2.5/ha) and age-1+ Emerald Shiner (0.3/ha) were very low, but up from 2016, which was lowest in the time series (Figure 2.4.7). Age-1+ Spottail Shiner density was the lowest of the time series (0.4/ha).

### **Summary of Michigan Lake Erie Forage Trawls** (J. Hessenauer)

Michigan initiated a trawling program to assess the forage and age-0 sportfish community in Michigan waters of Lake Erie in August of 2014. This assessment samples eight two-minute index grids for one five or ten minute tow, typically sampling an area of approximately 0.2-0.4 ha depending on tow time. The otter trawl has a 33 foot head rope and 3/8 inch terminal mesh and is deployed with a single warp and 150 foot bridle. Captured fish are passed through a 1.25 inch screen to grade out forage and age-0 sized sportfish. In 2017 all eight sites (Figure 2.4.8; Table 2.4.2) were sampled between August 7<sup>th</sup> and August 9<sup>th</sup>.

The 2017 survey had the highest density of total forage sized and age-0 sport fish (3,315.4/ha) across the four-year time series of the survey (Table 2.4.3). An abundance of forage-sized Gizzard Shad (730.9/ha), White Bass (101.8/ha) and White Perch (1,896/ha) relative to other years in the survey drove this trend (Table 2.4.3). We also observed the highest density of age-0 Walleye (16.6/ha) over the four-year time series. The catch of Spottail Shiner declined to their lowest density (2.2/ha) over the four-year time series. Abundance of age-0 Yellow Perch (331.6/ha) declined in 2017 relative to 2016, but were slightly higher than the four-year average.

Since this was only the fourth trawl survey in the time series, it is difficult to put the catch rates that we observed during 2017 into broader context for Michigan waters of Lake Erie. Michigan plans to continue forage trawling at these sites annually to contribute to lake wide estimates of forage and age-0 sportfish abundance.

**Table 2.2.1** Indices of relative abundance of selected forage fish species in Eastern Lake Erie from bottom trawl surveys conducted by Ontario, New York, and Pennsylvania for the most recent 10-year period. Indices are reported as arithmetic mean number caught per hectare (NPH) for the age groups young-of-the-year (YOY), yearling-and-older (YAO), and all ages (ALL). Long-term averages are reported as the mean of the annual trawl indices for the most recent 10-year period (2008-2017) and for the two most recent completed decades. Agency trawl surveys are described below. Pennsylvania FBC (PA-Fa) did not conduct a fall index trawl survey in 2006, 2010, 2011, 2013, and 2014 and the 2008 survey was a reduced effort of four tows sampled in a single day.

Species	Age Group	Trawl Survey	Year										10-Yr & Long-term Avg. by decade		
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	10-Yr	2000's	1990's
Rainbow Smelt	YOY	ON-DW	1293.0	148.2	326.9	509.2	1657.7	217.9	1001.6	3245.2	538.3	372.3	931.0	1391.5	431.7
	YOY	NY-Fa	2184.5	73.4	1453.6	1621.7	424.4	755.2	5520.2	2930.7	2901.3	3225.3	2109.0	1566.1	1468.0
	YOY	PA-Fa	15.1	47.7	NA	NA	560.2	NA	NA	129.1	166.9	872.3	298.6	112.5	421.1
	YAO	ON-DW	77.3	1654.3	222.7	277.1	367.8	165.3	4.6	411.0	20.2	0.1	320.0	360.7	358.6
	YAO	NY-Fa	560.8	3088.6	1023.8	656.8	22.7	45.8	24.8	590.1	5.8	67.5	608.7	772.6	583.3
	YAO	PA-Fa	1.8	407.2	NA	NA	22.3	NA	NA	39.6	0.0	0.5	78.6	179.5	1108.8
Emerald Shiner	YOY	ON-DW	16.0	54.8	117.6	70.3	438.3	58.7	2.9	346.7	2.0	0	110.7	463.2	52.3
	YOY	NY-Fa	3.8	49.7	64.6	3006.7	96.8	130.9	526.3	137.6	6.1	51.6	407.4	188.3	115.1
	YOY	PA-Fa	0.0	1063.0	NA	NA	14.8	NA	NA	68.2	0.0	0	191.0	203.4	39.9
	YAO	ON-DW	95.2	40.1	30.7	201.1	119.2	188.6	2.5	6.5	28.2	0.4	71.2	819.0	37.7
	YAO	NY-Fa	18.6	160.4	21.1	1874.0	96.2	67.1	822.8	24.8	22.2	4.5	311.2	309.3	108.1
	YAO	PA-Fa	0.0	1360.3	NA	NA	86.9	NA	NA	146.9	0.0	0	265.7	694.7	10.3
Spottail Shiner	YOY	ON-OB	37.8	3.7	3.0	2.5	19.1	8.1	5.0	5.8	4.1	38.2	12.8	119.3	815.9
	YOY	ON-IB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.5	113.9
	YOY	NY-Fa	0.3	0.1	6.7	0.7	1.8	0.0	0.1	0.0	0.1	0.4	1.0	6.3	20.4
	YOY	PA-Fa	0.0	1.1	NA	NA	0.0	NA	NA	0.0	0.0	0	0.2	0.1	3.6
	YAO	ON-OB	7.5	3.3	2.1	0.5	1.6	3.0	0.2	1.5	0.0	2.8	2.3	10.8	74.6
	YAO	ON-IB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0	0.0	0.1	2.0
	YAO	NY-Fa	1.5	5.2	10.7	29.7	2.1	0.3	0.2	0.0	9.3	0.8	6.0	6.8	4.0
	YAO	PA-Fa	0.0	0.0	NA	NA	0.1	NA	NA	0.0	0.0	0	0.0	0.0	5.7
Alewife	YOY	ON-DW	2.3	0.1	0.9	2.1	707.3	17.7	0.0	0.7	0.8	36.1	76.8	22.5	231.2
	YOY	ON-OB	11.9	1.9	0.0	6.8	6.0	26.1	0.0	3.4	0.0	28.3	8.5	82.1	88.5
	YOY	NY-Fa	5.7	0.0	15.8	12.7	188.6	223.9	0.0	5.6	0.8	297.7	75.1	96.7	53.4
	YOY	PA-Fa	0.0	0.0	NA	NA	4.6	NA	NA	0.0	0.0	0	0.8	1.1	2.2
Gizzard Shad	YOY	ON-DW	86.5	0.4	13.3	18.9	47.6	0.0	0.0	0.4	1.9	1.9	17.1	21.3	7.5
	YOY	ON-OB	4.0	0.0	3.8	3.4	20.0	0.3	0.4	10.1	0.0	4.1	4.6	7.6	13.4
	YOY	NY-Fa	11.1	5.4	42.0	15.4	4.9	3.9	0.6	3.3	1.9	3.8	9.2	12.2	4.4
	YOY	PA-Fa	0.0	0.0	NA	NA	1.0	NA	NA	41.5	0.0	0	7.1	0.0	0.3
White Perch	YOY	ON-DW	5.4	0.6	1.6	0.0	0.8	0.0	0.0	0.5	96.1	0.3	10.5	2.9	1.8
	YOY	ON-OB	2.1	0.0	0.0	0.0	0.9	0.0	0.0	0.2	0.0	0.7	0.4	2.8	17.6
	YOY	NY-Fa	442.8	20.7	161.3	37.5	18.7	4.5	36.1	17.3	79.3	44.2	86.2	76.2	30.1
	YOY	PA-Fa	0.7	598.5	NA	NA	380.0	NA	NA	287.9	2.3	150.4	236.6	231.0	71.5
Trout Perch	All	ON-DW	0.8	0.8	0.3	0.0	0.0	0.0	0.0	0.1	0.2	0	0.2	0.9	0.6
	All	NY-Fa	1022.4	530.1	473.7	671.4	347.8	152.7	64.9	33.1	26.1	8.6	333.1	846.7	417.5
	All	PA-Fa	0.6	558.8	NA	NA	52.2	NA	NA	2.1	0.2	4.2	103.0	137.3	64.6
Round Goby	All	ON-DW	452.6	43.6	9.7	125.4	129.0	14.5	0.5	67.2	300.9	137.9	128.1	235.9	0.0
	All	ON-OB	63.4	91.2	67.6	103.3	68.0	76.3	98.5	359.1	54.0	93.5	107.5	86.9	0.1
	All	ON-IB	211.8	280.5	135.1	114.6	80.2	49.6	95.4	151.6	160.8	28.2	130.8	120.0	0.1
	All	NY-Fa	478.96	515.73	177.81	170.15	184.89	86.06	140.33	441.58	104.9	146.9	244.7	671.5	1.0
	All	PA-Fa	441.6	350.1	NA	NA	32.1	NA	NA	47.2	85.6	30.1	164.4	1074.9	42.0

"NA" denotes that reporting of indices was Not Applicable or that data were Not Available.

Indices are reported as NPH; Unless otherwise noted, 90's Avg. is for the period 1990 to 1999; 00's Avg. is for the period 2000 to 2009.

**Ontario Ministry of Natural Resources Trawl Surveys**

ON-DW Trawling is conducted weekly during October at 4 fixed stations in the offshore waters of Outer Long Point Bay using a 10-m trawl with 13-mm mesh cod end liner.

ON-OB Trawling is conducted weekly during September and October at 3 fixed stations in the nearshore waters of Outer Long Point Bay using a 6.1-m trawl with a 13-mm mesh cod end liner.

ON-IB Trawling is conducted weekly during September and October at 4 fixed stations in Inner Long Point Bay using a 6.1-m trawl with a 13-mm mesh cod end liner.

**New York State Department of Environment Conservation Trawl Survey**

NY-Fa Trawling is conducted at approximately 30 nearshore (15-30 m) stations during October using a 10-m trawl with a 9.5-mm mesh cod end liner. 90's Avg. is for the period 1992 to 1999.

**Pennsylvania Fish and Boat Commission Trawl Survey**

PA-Fa Trawling is conducted at nearshore (< 22 m) and offshore (> 22 m) stations during October using a 10-m trawl with a 6.4-mm mesh cod end liner.

Table 2.3.1 Relative abundance (arithmetic mean number per hectare) of selected age-0 species from fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 2007-2017. Ohio West (OH West) is the area from Huron, OH, to Fairport Harbor, OH. Ohio East (OH East) is the area from Fairport Harbor, OH to the Ohio-Pennsylvania state line. PA is the area from the Ohio-Pennsylvania state line to Presque Isle, PA.

Species	Survey	Year										Mean	
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		2017
Yellow	OH West	151.0	32.1	1.6	41.1	10.3	69.2	8.9	37.7	19.6	0.5	19.0	37.2
Perch	OH East	177.8	52.8	0.5	96.3	15.1	134.4	8.9	49.1	18.6	1.6	39.1	55.5
	PA	10.0	863.4	14.2	-	-	481.6	28.0	-	107.0	332.9	92.9	262.5
White	OH West	1096.2	470.6	379.0	254.8	346.6	1709.6	174.7	135.0	371.0	15.3	200.8	495.3
Perch	OH East	1095.9	91.6	34.6	190.3	72.1	661.9	200.1	99.4	338.8	5.4	44.4	279.0
	PA	17.4	199.0	146.3	-	-	380.1	2.2	-	758.6	165.5	149.3	238.5
Rainbow	OH West	78.4	765.8	267.8	776.2	29.8	84.4	126.0	747.8	447.0	219.4	347.1	354.3
Smelt	OH East	702.4	3997.7	0.3	421.6	247.3	319.1	12.8	1709.5	236.4	1383.4	898.7	903.1
	PA	34.8	552.2	23.1	-	-	10.4	132.8	-	148.1	506.4	319.4	201.1
Round	OH West	26.8	19.1	24.5	28.4	100.8	18.2	17.5	6.3	56.8	14.5	27.3	31.3
Goby	OH East	273.1	26.3	1.0	41.8	256.0	53.9	45.8	86.2	66.8	29.9	31.1	88.1
	PA	224.0	227.1	72.0	-	-	3.3	11.7	-	124.1	47.2	210.3	101.3
Emerald	OH West	36.3	25.1	7.5	8.8	361.7	951.3	2218.5	1369.3	3.5	0.0	0.0	498.2
Shiner	OH East	63.7	20.2	1.7	234.9	103.7	2188.5	306.2	650.1	13.2	0.0	0.0	358.2
	PA	0.8	0.0	304.6	-	-	0.0	31.6	-	57.7	2.2	0.0	56.7
Spottail	OH West	2.1	3.4	0.4	0.0	0.6	0.0	0.0	2.5	0.0	0.0	0.0	0.9
Shiner	OH East	0.5	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.4	0.0	0.0	0.1
	PA	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0
Alewife	OH West	0.0	0.0	0.0	0.0	0.0	0.0	52.1	0.0	0.0	0.0	30.3	5.2
	OH East	0.0	0.0	0.0	0.0	0.0	0.1	36.1	0.0	0.0	0.0	223.6	3.6
	PA	0.0	0.0	0.0	-	-	2.8	5.0	-	0.0	4.0	0.0	1.7
Gizzard	OH West	183.8	34.3	52.6	2.6	675.8	98.7	304.2	33.8	568.0	12.0	201.6	196.6
Shad	OH East	15.5	63.1	3.9	8.5	4.2	28.7	39.5	7.3	455.6	1.2	214.8	62.8
	PA	0.0	0.0	0.0	-	-	0.0	0.0	-	8.7	0.0	0.5	1.2
Trout-perch	OH West	0.9	0.3	0.5	0.7	1.3	0.0	0.1	0.3	0.4	0.0	0.0	0.5
	OH East	5.4	0.1	0.2	1.4	2.2	0.2	0.0	0.6	1.2	0.0	0.2	1.1
	PA	10.8	126.1	28.2	-	-	0.0	0.0	-	2.2	4.6	4.2	24.6

- The Pennsylvania Fish and Boat Commission was unable to sample in 2006, 2010, 2011 and 2014.

Table 2.3.2 Relative abundance (arithmetic mean number per hectare) of selected age-1+ species from fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 2007-2017. Ohio West (OH West) is the area from Huron, OH, to Fairport Harbor, OH. Ohio East (OH East) is the area from Fairport Harbor, OH to the Pennsylvania state line. PA is the area from the Ohio-Pennsylvania state line to Presque Isle, PA.

Species	Survey	Year											Mean
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Yellow Perch	OH West	20.7	55.0	20.2	11.9	6.3	7.4	34.9	15.4	41.3	5.0	3.7	21.8
	OH East	37.0	26.4	139.4	12.4	55.5	23.3	109.5	24.2	30.2	8.7	7.6	46.7
	PA	27.4	76.4	121.8	-	-	117.7	73.7	-	59.0	61.2	114.1	76.7
White Perch	OH West	24.0	81.7	45.8	32.6	25.9	45.8	195.9	5.8	1.7	47.5	29.9	50.7
	OH East	16.8	36.6	282.3	44.8	49.8	7.7	546.9	4.4	1.4	55.4	17.6	104.6
	PA	0.8	4.2	62.6	-	-	7.8	18.4	-	78.9	4.0	19.6	25.3
Rainbow Smelt	OH West	41.3	7.4	368.8	9.0	15.6	9.1	8.1	34.9	340.8	0.5	53.8	83.6
	OH East	371.0	48.7	98.2	49.8	186.0	95.4	200.7	6.2	295.4	17.1	35.7	136.9
	PA	10.8	3.5	406.5	-	-	20.5	25.1	-	69.7	5.0	0.9	77.3
Round Goby	OH West	26.9	64.8	60.4	44.0	68.6	11.8	24.3	6.9	35.8	3.7	19.6	34.7
	OH East	185.6	167.8	19.3	36.0	118.1	27.0	46.3	89.1	72.4	16.1	14.3	77.8
	PA	356.8	326.6	76.0	-	-	72.9	8.6	-	50.3	12.7	183.9	129.1
Emerald Shiner	OH West	300.0	601.2	127.7	51.5	138.2	998.8	298.0	55.8	0.9	1.3	0.0	257.3
	OH East	27.8	1159.4	167.8	375.1	149.7	433.2	8.4	333.5	1.8	0.0	0.0	265.7
	PA	793.2	28.0	172.5	-	-	8.9	17.2	-	179.5	6.4	0.0	172.3
Spottail Shiner	OH West	1.6	2.4	1.9	0.0	20.7	0.0	0.5	1.7	0.0	0.0	0.0	2.9
	OH East	0.6	2.9	0.0	0.0	3.1	3.0	2.9	0.0	0.0	0.0	0.0	1.3
	PA	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	0.0	0.0	0.0
Trout-perch	OH West	4.2	3.3	0.9	0.7	3.3	1.6	3.3	0.6	0.7	0.0	0.4	1.9
	OH East	6.7	8.4	1.5	5.0	7.9	11.7	1.0	0.4	3.0	0.1	0.3	4.6
	PA	15.8	61.7	127.5	-	-	30.4	9.3	-	8.3	2.4	5.2	36.5

- The Pennsylvania Fish and Boat Commission was unable to sample in 2006, 2010, 2011 and 2014.

Table 2.4.1. Mean catch-per-unit-effort (CPUE) and fishing power correction factors (FPC) by vessel-species-age group combinations. All FPCs are calculated relative to the R.V. Keenosay.

Vessel	Species	Age group	Trawl Hauls	Mean CPUE (#/ha)	FPC	95% CI	Apply rule <sup>a</sup>
R.V. Explorer	Gizzard shad	Age 0	22	11.8	2.362	-1.26-5.99	Y
	Emerald shiner	Age 0+	50	67.8	1.494	0.23-2.76	Y
	Troutperch	Age 0+	51	113.2	0.704	0.49-0.91 z	Y
	White perch	Age 0	51	477.2	1.121	1.01-1.23 z	Y
	White bass	Age 0	50	11.7	3.203	0.81-5.60	Y
	Yellow perch	Age 0	51	1012.2	0.933	0.62-1.24	N
	Yellow perch	Age 1+	51	119.6	1.008	0.72-1.30	N
	Walleye	Age 0	51	113.7	1.561	1.25-1.87 z	Y
	Round goby	Age 0+	51	200.3	0.423	0.22-0.63 z	Y
	Freshwater drum	Age 1+	51	249.1	0.598	0.43-0.76 z	Y
R.V. Gibraltar	Gizzard shad	Age 0	29	14.2	1.216	-0.40-2.83	Y
	Emerald shiner	Age 0+	43	51.3	2.170	0.48-3.85	Y
	Troutperch	Age 0+	45	82.1	1.000	0.65-1.34	N
	White perch	Age 0	45	513.5	0.959	0.62-1.30	N
	White bass	Age 0	45	21.9	1.644	0.00-3.28	Y
	Yellow perch	Age 0	45	739.2	1.321	0.99-1.65	Y
	Yellow perch	Age 1+	45	94.6	1.185	0.79-1.58	Y
	Walleye	Age 0	45	119.2	1.520	1.17-1.87 z	Y
	Round goby	Age 0+	45	77.4	0.992	0.41-1.57	N
	Freshwater drum	Age 1+	45	105.2	1.505	1.10-1.91 z	Y
R.V. Grandon	Gizzard shad	Age 0	29	70.9	0.233	-0.06-0.53 z	Y
	Emerald shiner	Age 0+	34	205.4	0.656	-0.04-1.35	Y
	Troutperch	Age 0+	35	135.9	0.620	0.42-0.82 z	Y
	White perch	Age 0	36	771.4	0.699	0.44-0.96 z	Y
	White bass	Age 0	36	34.9	0.679	0.43-0.93 z	Y
	Yellow perch	Age 0	36	1231.6	0.829	0.58-1.08	Y
	Yellow perch	Age 1+	36	123.4	0.907	0.58-1.23	Y
	Walleye	Age 0	36	208.6	0.920	0.72-1.12	Y
	Round goby	Age 0+	36	161.8	0.501	0.08-0.92 z	Y
	Freshwater drum	Age 1+	36	58.8	2.352	1.51-3.19 z	Y
R.V. Musky II	Gizzard shad	Age 0	24	8.8	1.885	-1.50-5.26	Y
	Emerald shiner	Age 0+	47	32.3	3.073	0.36-5.79	Y
	Troutperch	Age 0+	50	62.4	1.277	0.94-1.62	Y
	White perch	Age 0	50	255.7	2.091	1.37-2.81 z	Y
	White bass	Age 0	46	8.4	4.411	0.90-7.92	Y
	Yellow perch	Age 0	50	934.0	1.012	0.77-1.26	N
	Yellow perch	Age 1+	50	34.9	3.452	1.23-5.67 z	Y
	Walleye	Age 0	50	63.7	2.785	2.24-3.33 z	Y
	Round goby	Age 0+	49	66.9	1.266	0.39-2.14	Y
	Freshwater drum	Age 1+	49	1.6	93.326	48.39-138.26 z	Y

z - Indicates statistically significant difference from 1.0 ( $\alpha=0.05$ ); <sup>a</sup> Y means decision rule indicated FPC application was warranted; , N means decision rule indicated FPC application was not warranted

Table 2.4.2 2017 Michigan forage trawl sampling dates, locations, and site conditions.

Date	2min Grid	Start_Lat	St_Long	End_Lat	End_Long	Stime (24hr)	Towtime (min)	Start Depth (m)	End Depth (m)	Temp (oC)	Secchi (m)	Area (ha)
08/07/2017	3	41.95855	-83.15	41.96113	-83.1487	13:44	5	7.6	7.3	24.80	2.13	0.27
08/08/2017	895	41.9309333	-83.2076	41.92628	-83.2032	9:35	10	8.2	8.5	24.00	2.64	0.40
08/08/2017	877	41.9109167	-83.2613	41.90612	-83.2573	10:46	10	7.3	7.0	25.00	0.00	0.40
08/08/2017	885	41.8994	-83.2458	41.9046	-83.2427	13:06	10	7.0	7.3	25.30	0.65	0.40
08/09/2017	859	41.8188667	-83.3768	41.8247	-83.3768	9:07	10	5.8	5.2	24.00	1.90	0.53
08/09/2017	872	41.8274167	-83.3269	41.83155	-83.3216	10:08	10	6.7	6.7	24.70	1.71	0.40
08/09/2017	886	41.8642167	-83.2437	41.8672	-83.2384	11:36	10	8.2	8.2	25.30	1.39	0.40
08/09/2017	855	41.7730333	-83.4193	41.77863	-83.4182	13:43	10	4.3	4.6	25.30	1.46	0.40



Table 2.4.3. Average density (number of fish per ha) of forage sized and age-0 sportfish captured during the Michigan trawl survey. Forage sized and age-0 individuals are graded through a 1.25 inch screen.

Common Name	2014	2015	2016	2017
BROOK SILVERSIDE			8.1	
EMERALD SHINER	2.1			
FRESHWATER DRUM	29.4	6.9	6.3	
GIZZARD SHAD	55.4	2.7	11.4	730.9
LOGPERCH	1.9	14.8	3.1	4.4
MIMIC SHINER	5.3	617.9	170.6	120.2
RAINBOW SMELT	0.3	2.7		2.2
ROCK BASS			0.2	
ROUND GOBY	43.4	135.8	19.2	41.4
SILVER CHUB		11.3	0.6	3.4
SMALLMOUTH BASS	5.4	0.3	1.9	
SPOTTAIL SHINER	54.2	18.8	26.6	2.2
TROUT-PERCH	25.6	16.8	68.8	62.1
TUBENOSE GOBY			1.9	2.2
WALLEYE	0.6	4.8	3	16.6
WHITE BASS	1.2	7	8.4	101.8
WHITE PERCH	715.5	783.2	448.5	1896.4
WHITE SUCKER	0.3			
YELLOW PERCH	129.5	335.8	424.4	331.6
GRAND TOTAL	1070.1	1958.8	1203	3315.4

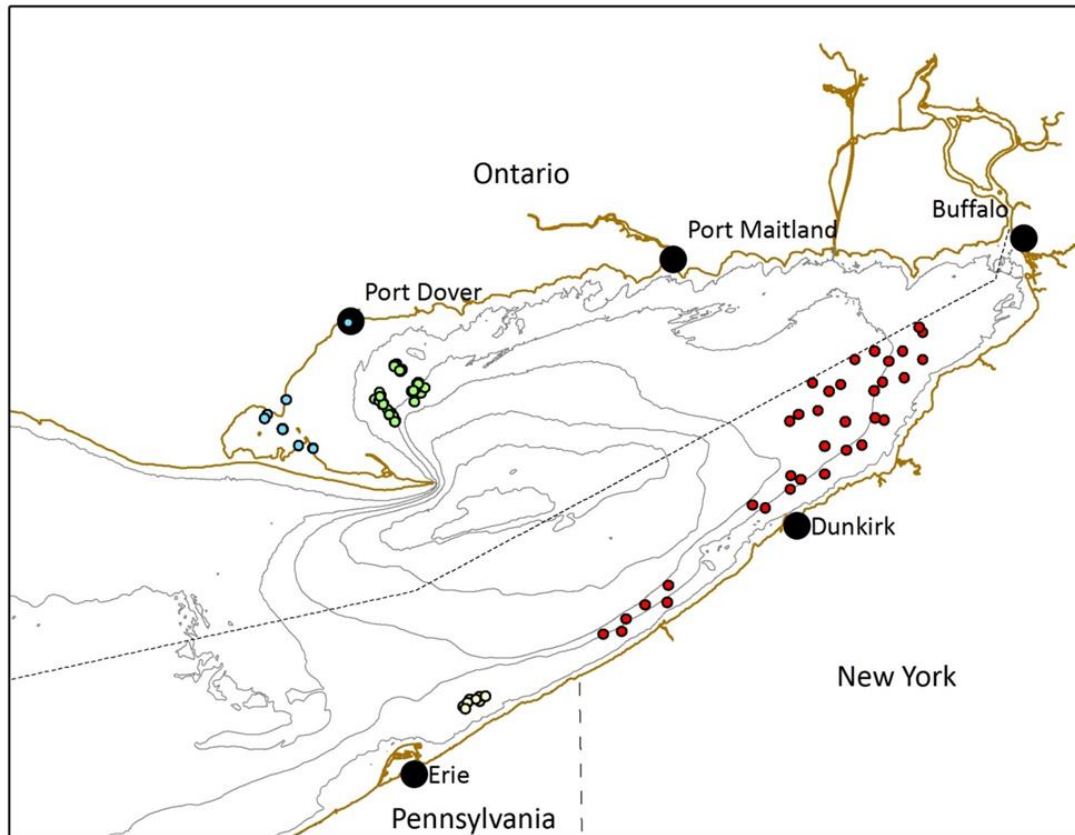


Figure 2.2.1 Locations sampled with standard index bottom trawls by Ontario (OMNRF), New York (NYSDEC) and Pennsylvania (PFBC) to assess forage fish abundance in eastern Lake Erie during 2017.

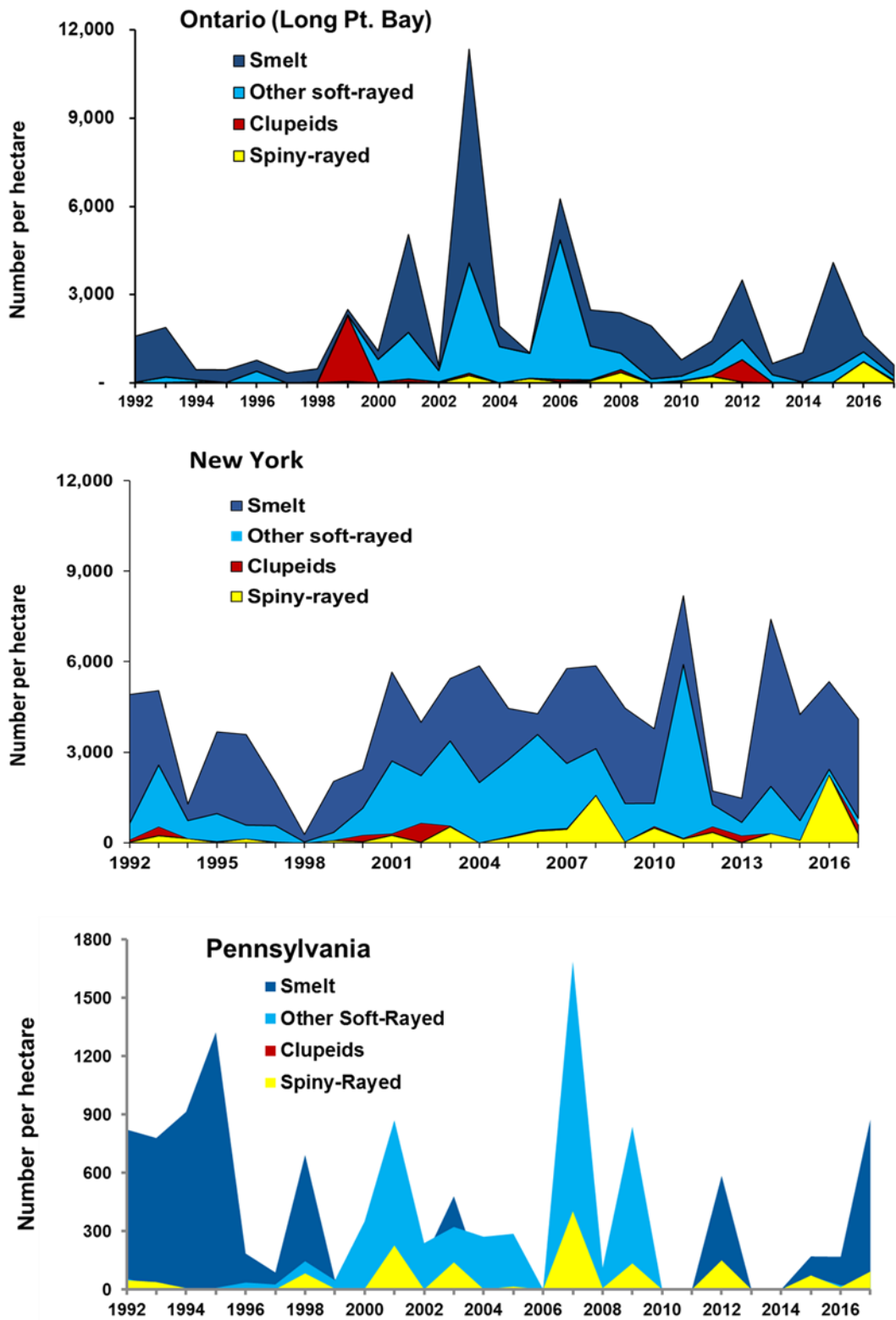


Figure 2.2.2 Mean density of prey fish (number per hectare) by functional group in the Ontario, New York and Pennsylvania waters of the eastern basin, Lake Erie, 1992-2017. Note that the y-axis values are lower for Pennsylvania.

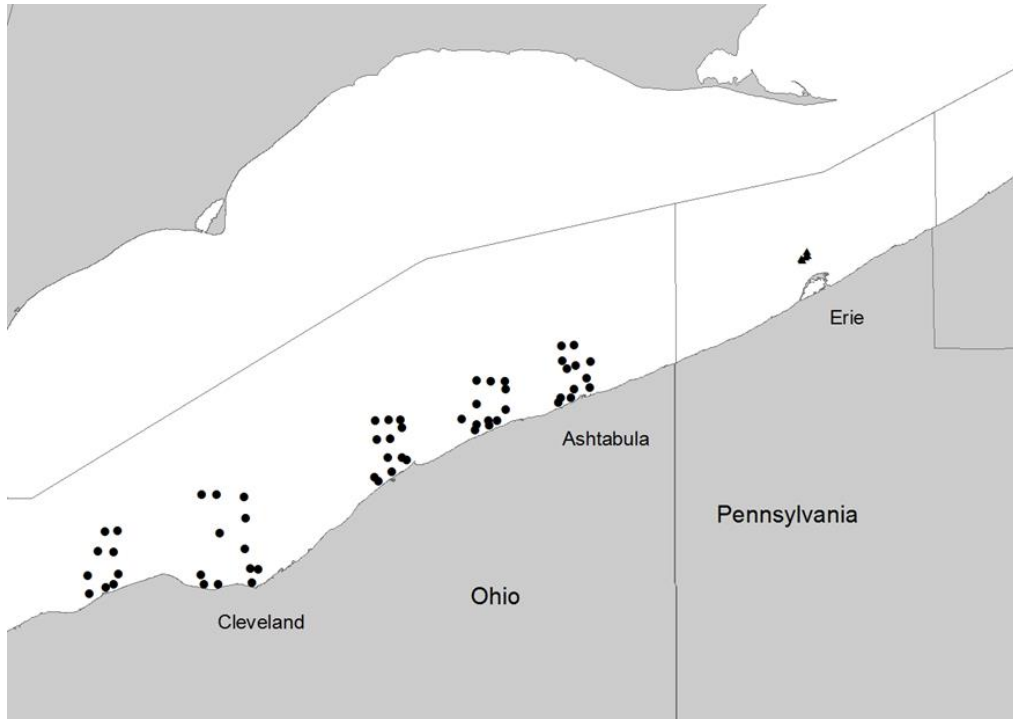


Figure 2.3.1 Locations sampled with index bottom trawls by Ohio (ODNR) and Pennsylvania (PFBC) to assess forage fish abundance in central Lake Erie during 2017.

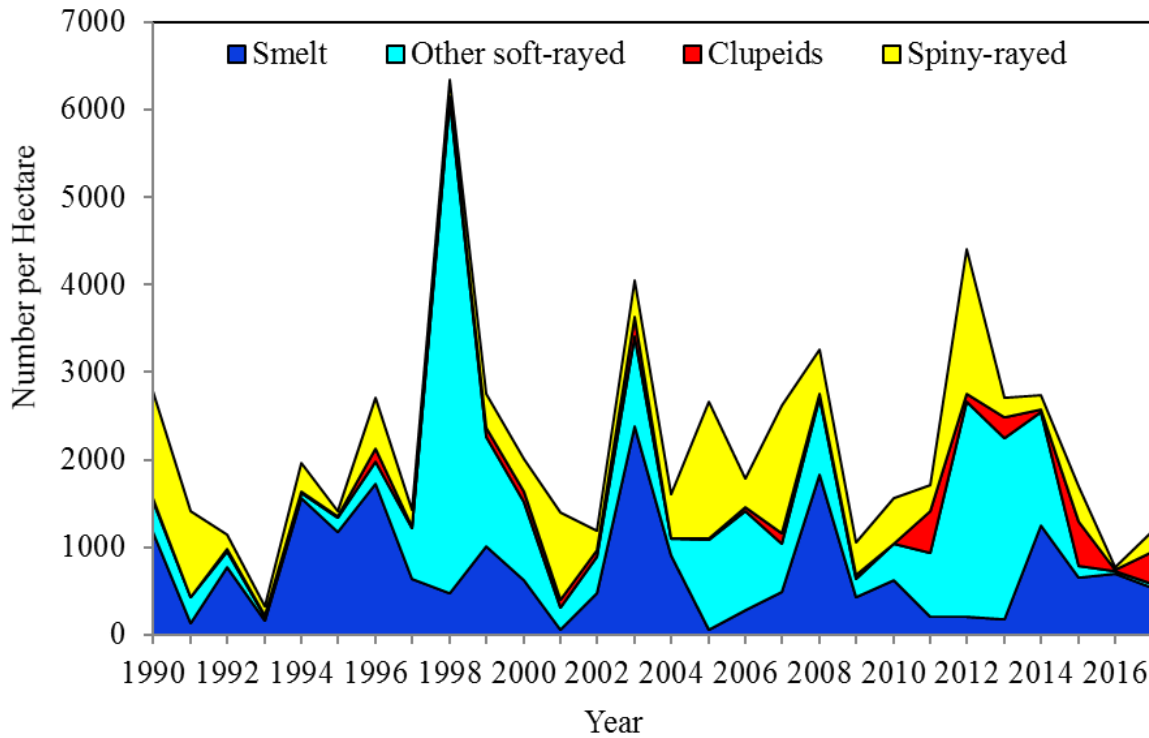


Figure 2.3.2 Mean density of prey fish (number per hectare) by functional group in the Ohio waters of the central basin, Lake Erie, 1990-2017.

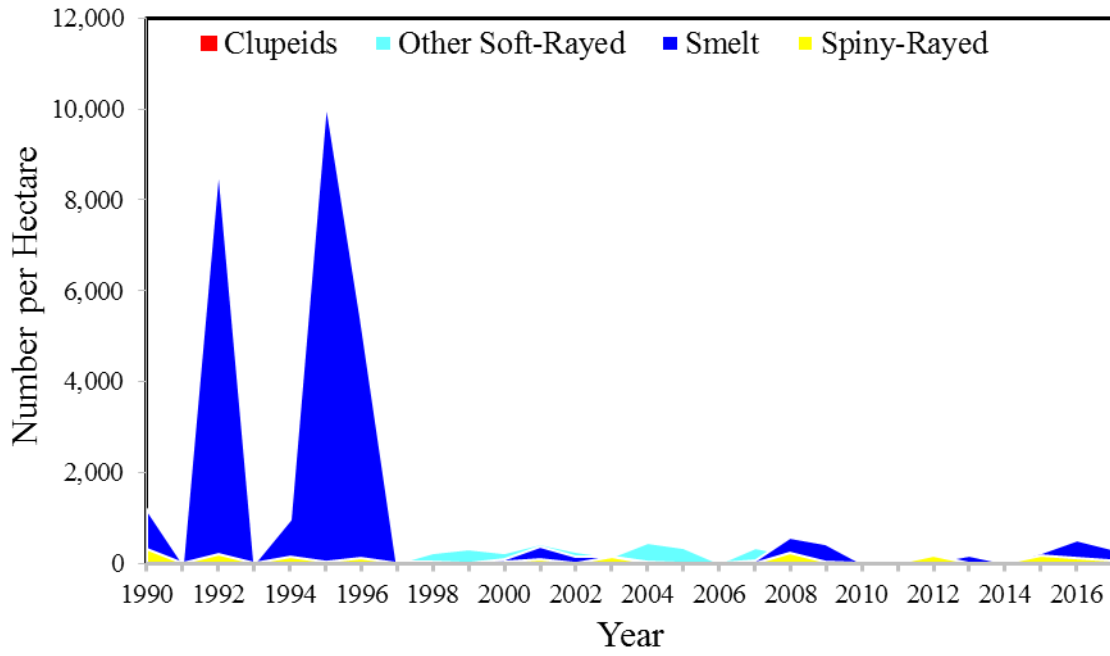


Figure 2.3.3 Mean density of prey fish (number per hectare) by functional group in the Pennsylvania waters of the central basin, Lake Erie, 1990-2017.

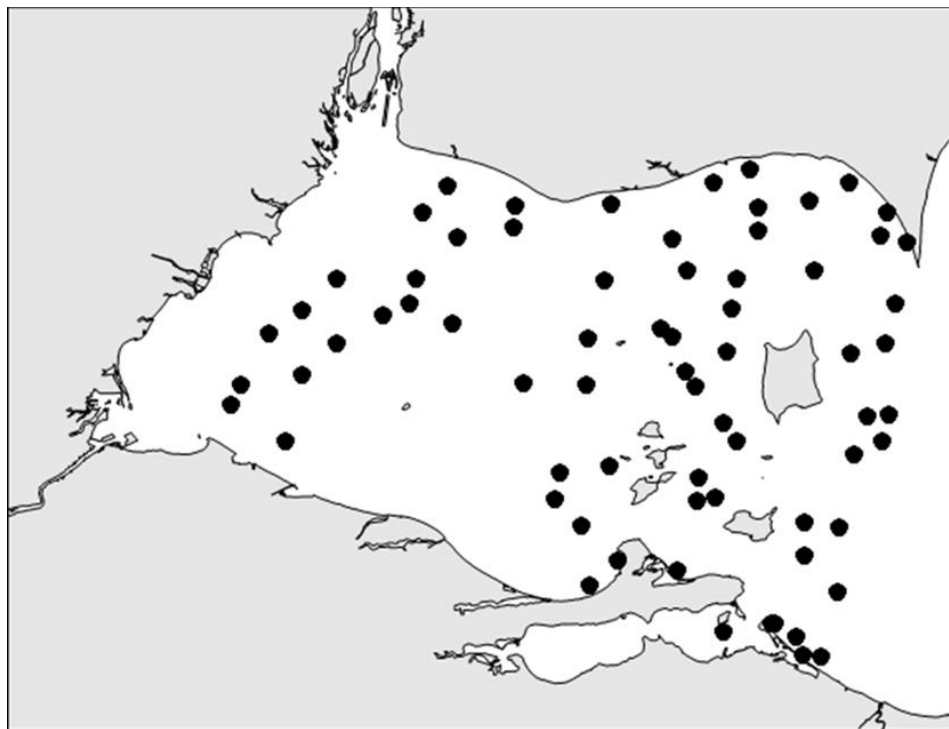


Figure 2.4.1. Trawl locations for the western basin interagency (OMNRF and ODNR) bottom trawl survey, August 2017

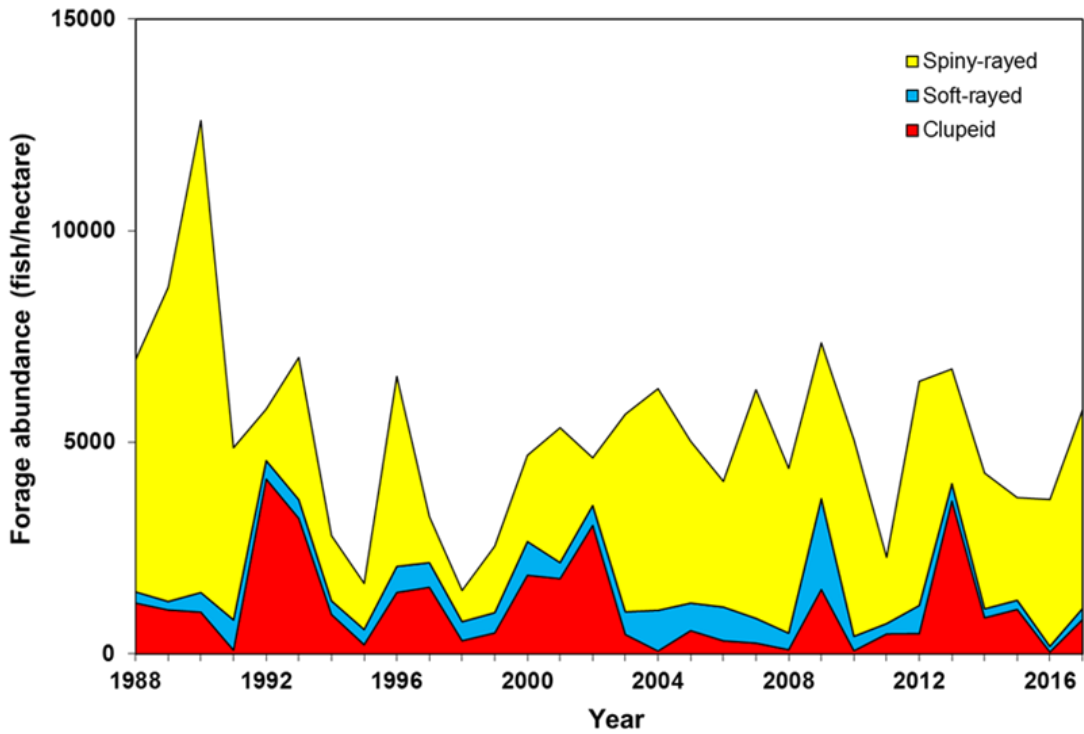


Figure 2.4.2. Mean density (number per hectare) of prey fish by functional group in western Lake Erie, August 1988-2017.

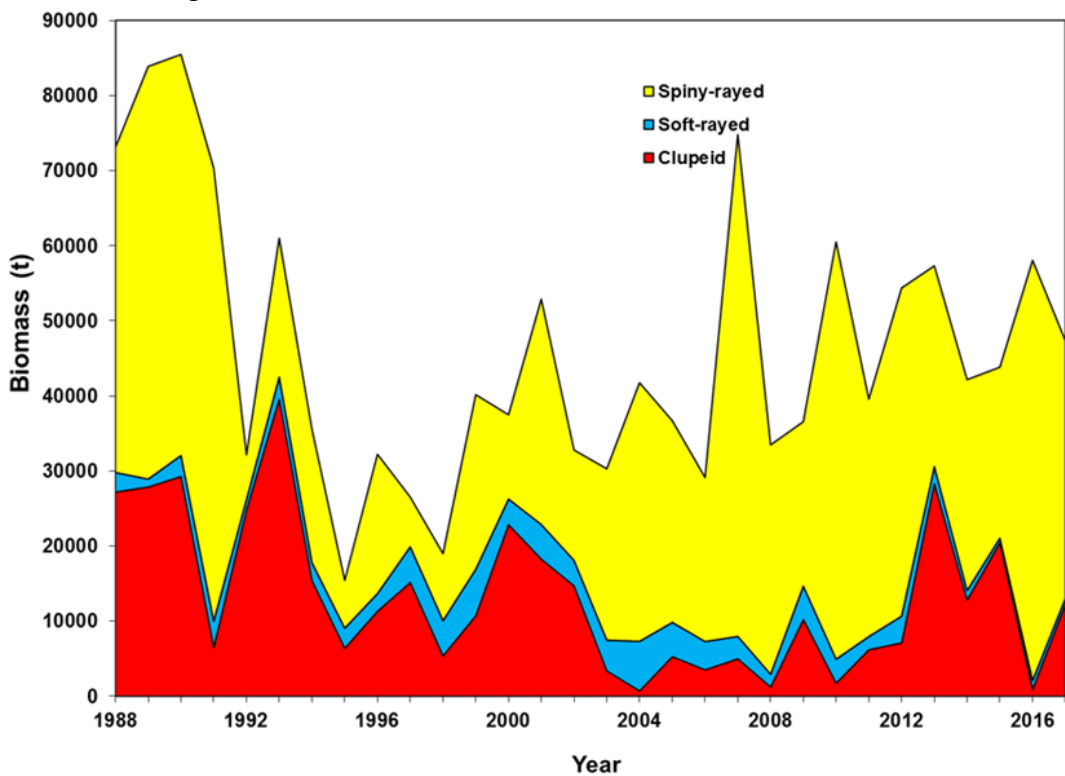


Figure 2.4.3. Mean biomass (tonnes) of prey fish by functional group in western Lake Erie, August 1988-2017.

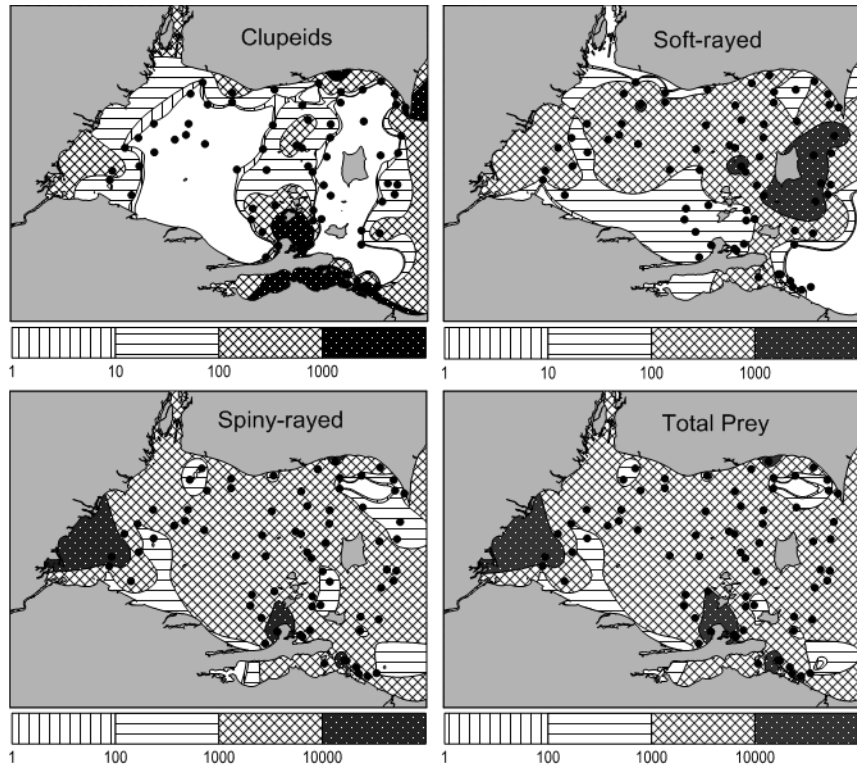


Figure 2.4.4. Spatial distribution of clupeids, soft-rayed, spiny-rayed, and total forage abundance (number per hectare) in western Lake Erie, 2017. Black dots are trawl sites, white areas are estimates of zero abundance, and contour levels vary with each functional fish group.

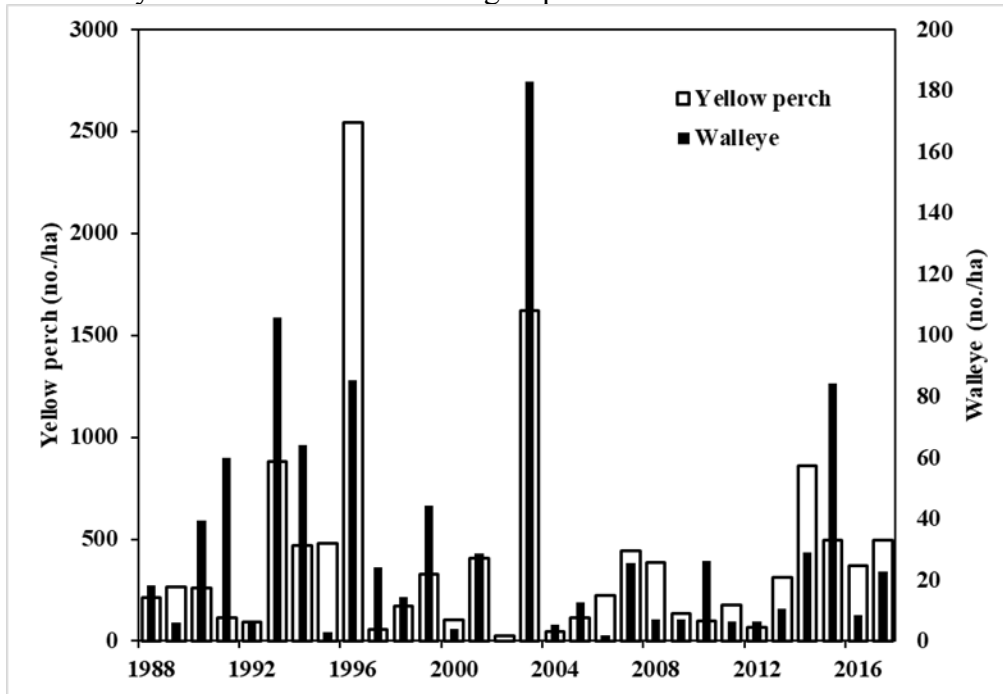


Figure 2.4.5. Density of age-0 Yellow Perch and Walleye in the western basin of Lake Erie, August 1988-2017.

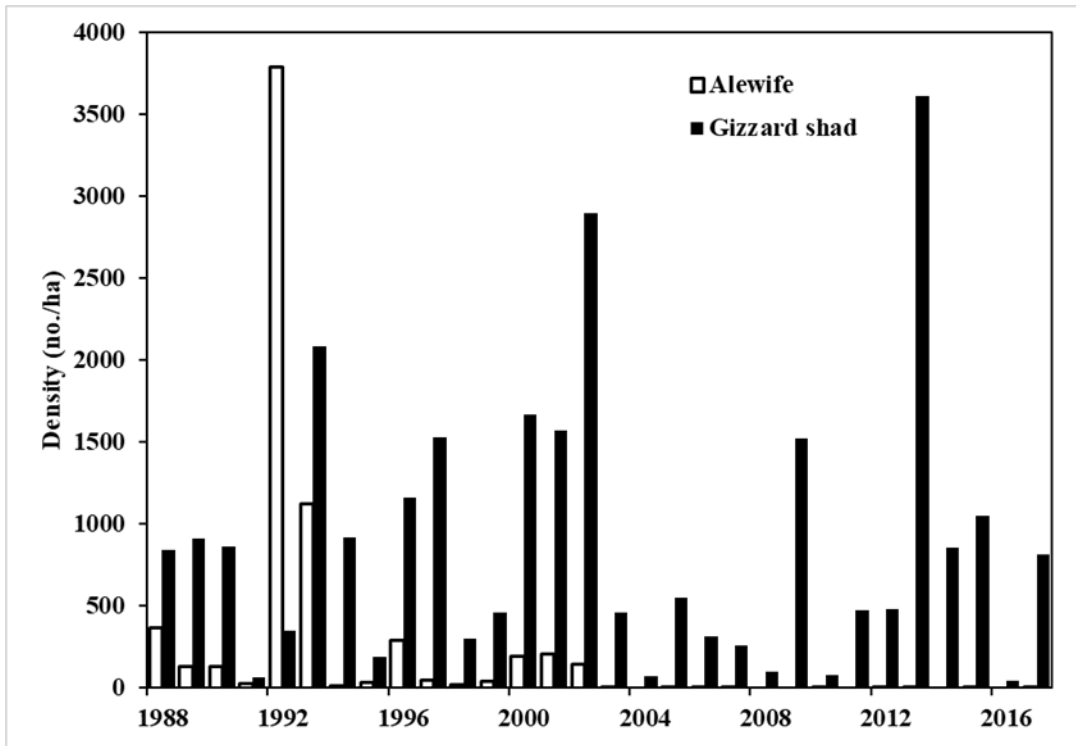


Figure 2.4.6. Density of age-0 Alewife and Gizzard Shad in the western basin of Lake Erie, August 1988-2017.

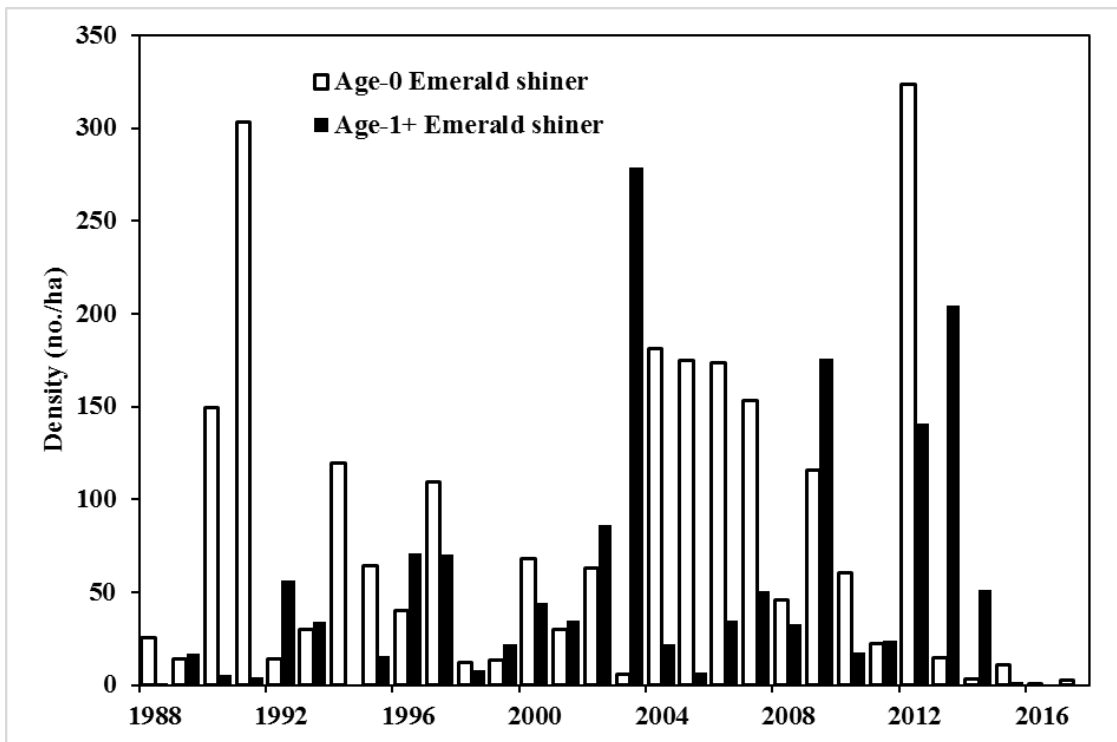


Figure 2.4.7. Density of age-0 and age-1+ shiners (*Notropis* spp.) in the western basin of Lake Erie, August 1988-2017.



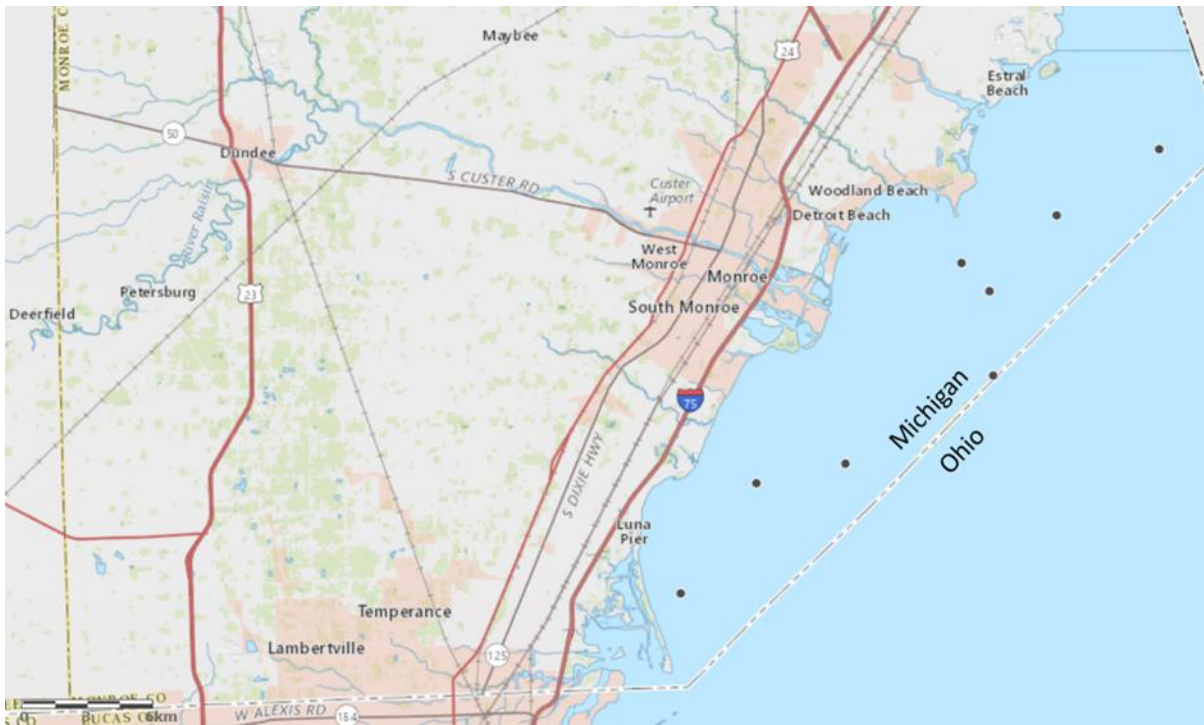


Figure 2.4.8. Map of Michigan waters of Lake Erie. The start of each trawl is indicated by a black dot.

**Charge 3: Continue hydroacoustic assessment of the pelagic forage fish community in Lake Erie, incorporating new methods in survey design and analysis while following the GLFC's Great Lakes Hydroacoustic Standard Operating Procedures where possible/feasible.**

### **3.1 East Basin Hydroacoustic Survey (C .May)**

A fisheries hydroacoustic survey has been conducted in the East Basin since 1993 to provide estimates of the distribution and abundance of Rainbow Smelt. The current hydroacoustic data acquisition system consists of a Simrad EY60 surface unit with a 120 kHz 7-degree split-beam general purpose transducer mounted on a fixed pole in a down facing orientation approximately 1 m below the water surface on the OMNRF research vessel, R/V *Erie Explorer*. The 2014 edition of this report details the history, design and analytical methods of the hydroacoustic survey (Forage Task Group 2014). Companion mid-water trawls have been completed by NYSDEC in the past but due to vessel issues, those data have not been collected since 2007.

#### **Results**

All 12 transects were completed July 17, 19-21 and 24-25, with a basin-wide average density of 3,201 fish/ha, representing a moderate density of forage fish in the east basin since 2007 (Figure 3.1.1). The largest density of forage fish the size of age-1+ Rainbow Smelt occurred between Long Point and Erie (Figure 3.1.2).

### **3.2 Central Basin Hydroacoustic Survey (P. Kočovský and J. Deller)**

The Ontario Ministry of Natural Resources (OMNR), Ohio Department of Natural Resources (ODNR), and the U.S. Geological Survey (USGS) have collaborated to conduct joint hydroacoustic and midwater trawl surveys in central Lake Erie since 2004. The 2017 central basin hydroacoustic survey was planned according to the protocol and sample design established at the hydroacoustic workshop held in Port Dover, Ontario in December 2003 (Forage Task Group 2005). That survey design calls for eight cross-basin transects on which both hydroacoustic and trawl data are collected. Beginning in 2008, all hydroacoustic data were collected and analyzed following recommendations in the Standard Operating Procedures for Fisheries Acoustics Surveys in the Great Lakes (GLSOP; Parker-Stetter et al. 2009). The primary purpose of the central basin hydroacoustic survey is to estimate densities of Rainbow Smelt and Emerald Shiner, which are the primary pelagic forage species in the central basin.

#### **Hydroacoustics**

Hydroacoustic data were collected from the USGS R/V *Muskie* and the ODNR-DOW R/V *Grandon*. Acoustic transects corresponding to Loran-C TD lines were sampled from one half hour after sunset (approximately 2130) to no later than one half hour before sunrise (approximately 0530), depending on the length of the transect and vessel speed. The prescribed starting and ending points for the survey are the 10 m depth contour lines.

Hydroacoustic data, from both vessels, were collected with BioSonics DTX® echosounders and BioSonics Visual Acquisition (release 6.0) software. Data from the R/V *Muskie* were collected

using a 120 kHz, 7.4 degree, split-beam transducer mounted inside a through hull transducer tube at a depth of 1.5 m below the water surface. Data from the R/V *Grandon* were collected with a 122 kHz, 7.6 degree, split-beam transducer mounted to the starboard hull on a movable bracket, roughly equidistant between the bow and stern, with the transducer 1.3 meters below the surface.

Sound was transmitted at four pulses per second with each pulse lasting 0.4 milliseconds. Global Positioning Systems (GPS) coordinates from the R/V *Muskie* were collected using a Garmin ® GPSMAP 76Cx, and from the R/V *Grandon*, with a Garmin 17HVS. Both vessels interfaced GPS coordinates with the echosounders to obtain simultaneous latitude and longitude coordinates. Temperature readings from just above the thermocline were used to calculate speed of sound in water because the largest proportion of fish occurred nearest this depth in the water column. Selecting the temperature nearest the thermocline, where fish were densest, results in the least cumulative error in depth of fish targets. Prior to data collection, a standard tungsten-carbide calibration sphere, specific to 120-kHz transducers, was used to calculate a calibration offset for calculating target strengths. Background noise was estimated by integrating beneath the first bottom echo at several locations for each transect, then averaging within a transect. The average noise within a transect was subtracted from total backscatter.

Analysis of hydroacoustic data was conducted following guidelines established in the Standard Operating Procedures for Fisheries Acoustics Surveys in the Great Lakes (Parker-Stetter et al. 2009) using Echoview ® version 7.1 software. Proportionate area backscattering coefficient was scaled by mean target strength calculated from single targets identified using Single Target Detection Method 2 (Parker-Stetter et al. 2009) to generate density estimates for distance intervals. Distance intervals for each transect were 500 m. Two depth strata, epilimnetic and hypolimnetic, were established by examining distributions of single target strength by depth. Settings for pulse length determination level, minimum and maximum normalized pulse length, maximum beam compensation, and maximum standard deviation of major and minor axes followed Parker-Stetter et al. (2009). Minimum target strength threshold was -74 dB. This value permitted inclusion of all targets at least -68 dB within the half-power (6 dB) beam angle. We used -68 dB as the lowest target of interest based on distribution of *in situ* target strength and theoretical values for Rainbow Smelt of the lengths captured in midwater trawls (Horppila et al. 1996, Rudstam et al. 2003). The  $N_v$  statistic, a measure of the probability of observing more than one fish within the sampling volume (Sawada et al. 1993), which will result in overlapping echoes, was calculated for each interval-by-depth stratum cell to monitor the quality of *in situ* single target data. If  $N_v$  for an interval-by-depth stratum cell was greater than 0.1, the mean TS of the entire stratum within a transect where  $N_v$  values were less than 0.1 was used (Rudstam et al. 2009). Density estimates for fish species were calculated by multiplying acoustic density estimates within each cell by proportions calculated from trawls. For each cell we used proportions of each species and age group from the trawl sample from the same water stratum and from a similar total depth that was nearest the cell.

## **Trawling**

The R/V *Keenosay* conducted up to nine 20-minute trawls on transects in Ontario waters concurrent with and on the same transect as the R/V *Muskie* acoustic data collection. The R/V *Grandon* conducted up to three 20-minute midwater trawls in Ohio waters concurrent with acoustic data collection on the remaining transects. Whenever possible, trawl effort was distributed above and below the thermocline to adequately assess species composition throughout the water column. The catch was sorted by species and age group, and relative proportions of each species and age

group were calculated for each trawl. Age group was determined based on age-length keys and length distributions. Age group classifications consisted of young-of-year (age-0) for all species, yearling-and-older (age-1+) for forage species, and age-2-and-older (age 2+) for predator species. Total lengths were measured from a subsample of individuals from each species and age group. Temperature and dissolved oxygen profiles were recorded at each trawl location.

## Results

Seven cross-lake transects were sampled between 17 July and 21 July 2017 with hydroacoustics and midwater trawls (Figure 3.2.1). The remaining transect was not completed due to weather and vessel commitments to other projects.

Forty-Five midwater trawls were completed during the survey. Midwater trawl catch on the east transects (58100, 57975, 57850) were comprised primarily of age-0 Rainbow Smelt (Table 3.2.1). Young-of-the-year Rainbow Smelt were also a large component of midwater trawls on the west transects (57725, 57600, 57475, 57350), however there were a few instances where age-0 Gizzard Shad or age-0 *Morone* species (White Perch, White Bass) were the primary catch. The highest catch of age-1+ Rainbow Smelt occurred on transect 57600, in the middle portion of the basin, in trawls that were run 10 m or deeper. Yearling-and-older Rainbow Smelt were encountered in most of the remaining transects, however, their proportion in the midwater trawl catch remained low relative to other species and age groups. Young-or-the-year Yellow Perch composed sizable portions of midwater trawl catches on all transects. Emerald Shiner was caught on the four western most transects in very low numbers. The highest catch of Emerald Shiner occurred on Transect 57475 (11 individuals) and 57350 (24 individuals). Other species caught in midwater trawls included Freshwater Drum, Walleye, Rainbow Trout, Burbot, Alewife and Round Goby.

Acoustic target strength (TS) distributions showed differences in TS across depth strata. Highest acoustic densities occurred in the upper depth layers relative to the lower layer in all but one transect (Table 3.2.2). Higher densities of age-0 Rainbow Smelt were encountered in the lower layer (below the thermocline) compared to the upper layer in transect 57850. Age group composition for Rainbow Smelt in the trawl catch did not separate by depth on most transects. Only on the western most transect, 57350, were the age groups roughly separated by depth. On the remaining transects, both Rainbow Smelt age groups were generally mixed above and below the thermocline. Young-of-the-year Yellow Perch were primarily located in the lower layer of the water column on all transects. Young-of-the-year Gizzard Shad, White Perch and White Bass densities were higher in the upper layer on all transects, relative to the lower layer, and densities for these three species tended to be higher in the west transects relative to transects in the east.

Spatial distribution across transects varied by species and age group. The highest densities of age-0 Yellow Perch were found on the southern portions of most transects throughout the basin (Figure 3.2.2). Young-of-the-year Rainbow Smelt densities tended to be higher in the eastern transects compared to the west, and uniformly distributed from north to south across the basin (Figure 3.2.3). Yearling-and-older Rainbow Smelt densities were concentrated off Erieau, Ontario on transects 57600 and 57725 (Figure 3.2.4).

Hydroacoustic density estimates for Emerald Shiner have been generally declining since 2011, and have been caught in very low numbers since 2015 (Figure 3.2.5). In 2017 only 47 Emerald Shiner were captured in 45 midwater trawls. Young-of-the-year Rainbow Smelt densities decreased from 2016, but were similar to densities encountered from 2011 through 2013. Yearling-and-older Rainbow Smelt decreased from 2016, but were similar to densities encountered from 2012 through 2014.

Temperature and dissolved oxygen profiles collected concurrently with midwater trawls found one area of low oxygen at the south end of transect 57475 off Cleveland, OH (Figure 3.2.6). At this location, dissolved oxygen levels 1.5 m above the bottom dropped below 3 mg/L, a concentration which is known to influence fish behavior (Vanderploeg 2009). Based on target distributions from whole-transect echograms, the thermocline depth tended to be deeper on the south end of transects compared to the north end (Figure 3.2.6; 3.2.7). Temperature and dissolved oxygen profiles collected by the R/V *Keenosay* and R/V *Grandon* during the acoustic survey support the thermocline patterns on the echograms.

## Discussion

In 2017 there was a high proportion of age-0 Gizzard Shad, White Bass, and White Perch caught in midwater trawls relative to previous years. The high proportion of these “other” species is most likely due to the timing of the 2017 hydroacoustic survey and the low densities of Rainbow Smelt. Central basin hydroacoustic surveys are scheduled based on the timing of the new moon in July and are usually run during the days before and after the peak of the phase to take advantage of darker nighttime periods (Parker-Stetter et al. 2009). The new moon in 2017 peaked July 26, which resulted in the survey being run later in the month relative to previous years. Typically, when hydroacoustic surveys are run later in July, age-0 Gizzard Shad, Emerald Shiner, White Bass, and White Perch will have grown enough to be recruited to midwater trawls and hydroacoustic sonar. Young-or-the-year Gizzard Shad, or the combination of age-0 Gizzard Shad, White Bass and White Perch were the highest proportion of the catch in eight midwater trawls, all on western transects (57725-57350). While Rainbow Smelt were caught in rather high proportions on all transects, they were consistently highest on the eastern transects (58100-58750). In addition, densities of both age groups of Rainbow Smelt were much lower in 2017 relative to the previous two years. In most years, there is a strict pattern of Rainbow Smelt age groups separating around the thermocline, with age-0 fish in the upper layer, and age-1+ fish in the lower layer. However, the partition between age groups of Rainbow Smelt was not as obvious as in the past as both age groups were frequently encountered in both layers (above and below the thermocline).

A late July hydroacoustic survey would normally include catches of age-0 Emerald Shiner in addition to the normal contribution from age-1+ Emerald Shiner. This was not the case in 2017. Only 15 age-0 and 32 age-1+ Emerald Shiner were captured in midwater trawls. While this is an increase from 2016 (catch of 3 age-1+), Emerald Shiner abundance remains at extremely low levels for both age groups.

In contrast to the recruitment of age-0 Gizzard Shad, White Bass, and White Perch, age-0 Yellow Perch are routinely caught during hydroacoustic surveys regardless of the timing of the new moon phase in July. While the overall proportion of age-0 Yellow Perch was relatively small in individual trawls (usually < 10%), they were caught on all transects, at or below the thermocline, with the highest densities generally occurring on the southern ends of transects. In 2016, the highest densities for age-0 Yellow Perch occurred above the thermocline, in the central and western transects.

Hydroacoustics has been used to assess forage fish in central Lake Erie for approximately 13 years. The current design of hydroacoustic data collection in central Lake Erie includes 8 north- to-south-oriented, cross-lake transects between the 10-m depth contours. Ideally two hydroacoustic vessels each collect data along 4 transects, paired with two additional vessels using midwater trawls to collect fish specimens to identify fish species and relative abundances. The stated objective of the survey is to produce a basin-wide snapshot of abundance of pelagic species, primarily Rainbow

Smelt and Emerald Shiner. A detailed history of the survey can be found in the March 2017 Forage Task Group Report to the Lake Erie Committee (Forage Task Group 2017).

In June of 2017 we initiated analysis of the design and conduct of the central basin hydroacoustics program to address the questions discussed in previous reports to the Lake Erie Committee (Forage Task Group 2017). The principal objective is to better define what are relevant sampling strata for key forage species based on the last 10 years of trawl data from the R/V *Keenosay*, R/V *Musky II*, and R/V *Grandon*. Preliminary analyses have shown some basin wide trends in species location. We are proceeding with more rigorous analysis to try to quantify habitat boundaries (e. g. nearshore vs. offshore habitat). Results of the analysis will be discussed at future Forage Task Group meetings, and recommendations to improve the central basin survey will be presented to the Lake Erie Committee.

### 3.3 West Basin Acoustic Survey (G. Steinhart)

Since 2004, the Ohio Department of Natural Resources Division of Wildlife has been conducting a hydroacoustic forage fish survey in the western basin of Lake Erie. This survey consists of three, cross-basin transects surveyed between one-half hour after sunset and one-half hour before sunrise. No trawling has been conducted in conjunction with acoustic data collection since 2006.

#### Methods

Three fixed cross basin transects were successfully sampled in 2017. Surveying began on 17 July 2017, but within 30 min the new Lake Erie BioSonics DTX surface unit failed. After borrowing a DTX surface unit from the University of Toledo, all transect were sampled: transect 2 on 18-19 July, transect 1 on 19-20 July, and transect 3 on 20-21 July. All transects were surveyed using a single, downward-facing, 6.1-degree, 201-kHz split-beam transducer, a Garmin global positioning system, and a Panasonic CF-30 laptop computer. BioSonics will repair or replace our DTX surface unit for future surveys.

The acoustic system was calibrated after the survey with a tungsten carbide reference sphere of known acoustic size. The mobile survey, conducted aboard the ODNR's R/V *Almar*, was initiated approximately 0.5 h after sunset and completed by 0.5 h prior to sunrise. Transects were navigated with waypoints programmed in a Lowrance GPS, and speed was maintained at 8-9 km/h. The transducer was mounted to a BioSonics towfish at 1-m below the surface starboard side of the boat. Data were collected using BioSonics Visual Acquisition 6 software. Collection settings during the survey were 10 pings/second, a pulse length of 0.2 msec, and a minimum threshold of -70 dB. The sampling environment (water temperature) was set at the temperature 2-m deep on the evening of sampling. Data were written to a file and named by the date and time the file was collected. Files were automatically collected every 30 minutes. Latitude and longitude coordinates were written to the file as the data were collected to identify sample location.

Data were analyzed using the Myriax software Echoview 4.5 using a modified process developed by the Ohio Division of Wildlife Inland Fisheries Research Unit. Target strength range was estimated using Love's dorsal aspect equation (Love 1971):

$$\text{Total length} = 10 \left( \frac{\text{Target Strength} + 26.1}{19.1} \right) * 1000$$

Biomass estimates were based on average target length as determined by the above equation.

## Results

In 2017, three cross-basin transects (approximately 140 km in total) were surveyed July 18-21. Forage fish densities were marginally highest on the middle transect (9,007 fish/ha) and lowest on the eastern transect (1,626 fish/ha). Forage fish were slightly more abundant on the southern end of the western and eastern transects (Figure 3.3.1). Western basin forage fish density (4,726 fish/ha) was the lowest since 2008-2011 and less than half of 2016 densities (10,907 fish/ha). Biomass (8.26 kg/ha); however, was slightly higher than 2016 (6.73 kg/ha), although still less than half the long-term mean (18.6 kg/ha; Figure 3.3.2).

Table 3.2.1. Percent composition of fish captured in trawl samples collected by the R/V *Keenosay*, and R/V *Grandon* in the central basin Lake Erie in July 2017.

Transect	Trawl ID	Depth	Layer	Latitude	Longitude	Yellow Perch Age-0	Rainbow Smelt Age-0	Rainbow Smelt Age-1+	Other species <sup>1</sup> all ages
58100	1009	5	1	42.606	-80.9993	1%	98%	0%	1%
58100	1004	7	1	42.3725	-80.8895	3%	93%	0%	4%
58100	1008	8	1	42.62767	-81.0075	0%	92%	7%	1%
58100	1007	10	1	42.54333	-80.9747	1%	98%	0%	1%
58100	1006	12	1	42.53083	-80.9687	1%	97%	1%	1%
58100	1005	14	2	42.54617	-80.9787	2%	74%	23%	1%
58100	1003	17	2	42.37933	-80.9118	4%	95%	2%	0%
58100	1002	18	2	42.38567	-80.8948	7%	89%	3%	1%
58100	1001	19	2	42.38467	-80.9147	7%	79%	13%	1%
57975	732	9.4	1	42.06322	-81.03712	0%	91%	0%	9%
57975	731	13.4	2	42.13179	-81.07015	12%	68%	0%	20%
57975	730	14	2	42.20864	-81.10788	21%	70%	0%	9%
57850	2002	5	1	42.54483	-81.4593	0%	97%	1%	2%
57850	2005	5	1	42.49067	-81.437	0%	86%	0%	14%
57850	2009	5	1	42.318	-81.3672	5%	89%	0%	7%
57850	2001	8	1	42.56217	-81.4697	2%	80%	15%	3%
57850	2004	10	1	42.47	-81.4302	1%	97%	0%	2%
57850	2008	10	1	42.34367	-81.3733	2%	96%	0%	3%
57850	2003	13	2	42.47567	-81.4307	2%	95%	2%	1%
57850	2007	17	2	42.32383	-81.367	6%	92%	0%	1%
57850	2006	20	2	42.33733	-81.3732	5%	92%	3%	1%
57725	738	7.3	1	41.91404	-81.43828	5%	47%	0%	47%
57725	737	10.7	1	41.96127	-81.46101	0%	32%	0%	68%
57725	736	14.3	2	42.03272	-81.49248	9%	49%	41%	1%
57600	3004	5	1	42.0405	-81.7452	0%	18%	0%	82%
57600	3007	5	1	42.21217	-81.8073	1%	71%	1%	27%
57600	3009	5	1	42.23917	-81.818	0%	59%	40%	1%
57600	3006	8	1	42.23017	-81.8158	3%	89%	5%	4%
57600	3008	10	1	42.2555	-81.8272	0%	3%	97%	0%
57600	3005	12	1	42.21217	-81.807	2%	39%	43%	16%
57600	3003	14	2	42.05833	-81.7447	0%	44%	3%	54%
57600	3002	17	2	42.04933	-81.73	12%	43%	26%	19%
57600	3001	20	2	42.066	-81.739	2%	2%	94%	2%
57475	735	7.3	1	41.66515	-81.80894	4%	79%	0%	17%
57475	733	9.1	1	41.79473	-81.87192	0%	0%	0%	100%
57475	734	14.6	2	41.73499	-81.84303	10%	4%	0%	85%
57350	4007	5	1	42.05983	-82.22	1%	31%	0%	68%
57350	4009	5	1	42.13133	-82.2617	0%	95%	3%	2%
57350	4004	6	1	41.94017	-82.1648	0%	22%	0%	78%
57350	4006	7	1	42.0715	-82.2348	2%	93%	3%	2%
57350	4008	7	1	42.14667	-82.2643	0%	70%	28%	1%
57350	4003	9	1	41.921	-82.155	1%	13%	1%	85%
57350	4005	9	1	42.055	-82.2245	3%	90%	3%	4%
57350	4002	12	1	41.89233	-82.1413	4%	82%	1%	13%
57350	4001	15	2	41.908	-82.15	26%	37%	30%	7%

<sup>1</sup> Other species (age, N captured): Gizzard Shad YOY (770), White Bass YOY (221), Clupeidae (7), Cyprinidae (31), Moronidae (168), Alewife (11), Emerald Shiner (47), Freshwater Drum YAO (23), Gizzard Shad YAO (1), Round Goby (1), Rainbow Trout (2), Walleye Adult (53), White Bass YAO (10), White Perch YOY (119), White Perch YAO (30), Yellow Perch YAO (1), Burbot YOY (1).



Table 3.2.2. Density (number per hectare) of key species by age class and depth layer for hydroacoustic transects in central basin Lake Erie, July 2017. Transect numbers refer to Loran-TD lines. Depth layers were determined by differences in acoustic target strength (TS) across depth strata within each transect. Species were applied from midwater trawl catch by nearest distance within depth layer.

Age	Species	57350		57475		57600		57725		57850		57975		58100	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Age-0	Rainbow Smelt	2479	941	104	54	124	708	2122	767	4728	5147	7537	380	9136	6159
Age-1+	Rainbow Smelt	50	731	35	34	581	875	1527	620	29	28	2	1	100	434
Age-0	Yellow Perch	86	739	25	62	21	292	18	132	89	600	44	89	79	460
Age-0	Gizzard Shad	1206	876	3286	233	4306	858	1944	0	71	13	66	0	2	3
Age-0	White Bass	277	113	826	9	407	145	135	2	156	1	82	0	9	0
Age-0	White Perch	392	110	1068	25	913	84	17	6	50	0	223	0	165	0
	All others	502	83	1301	14	541	155	337	9	61	518	237	49	249	426

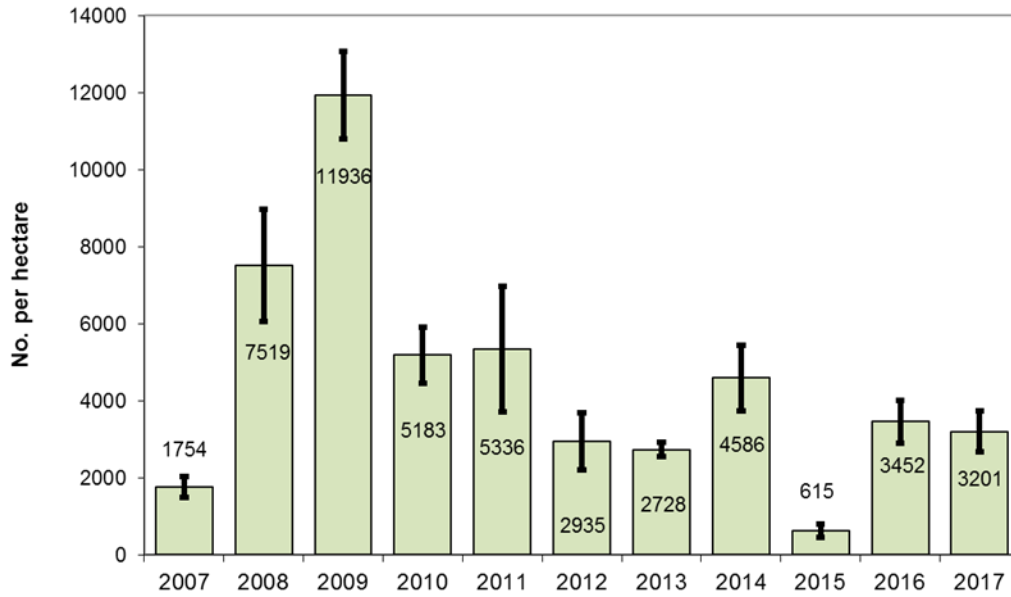


Figure 3.1.1. Mean density (fish per hectare) estimates of pelagic forage fish in cold-water habitat (all species, age-1+ Rainbow Smelt-sized) during the July east basin, Lake Erie hydroacoustic survey, 2007-2017.

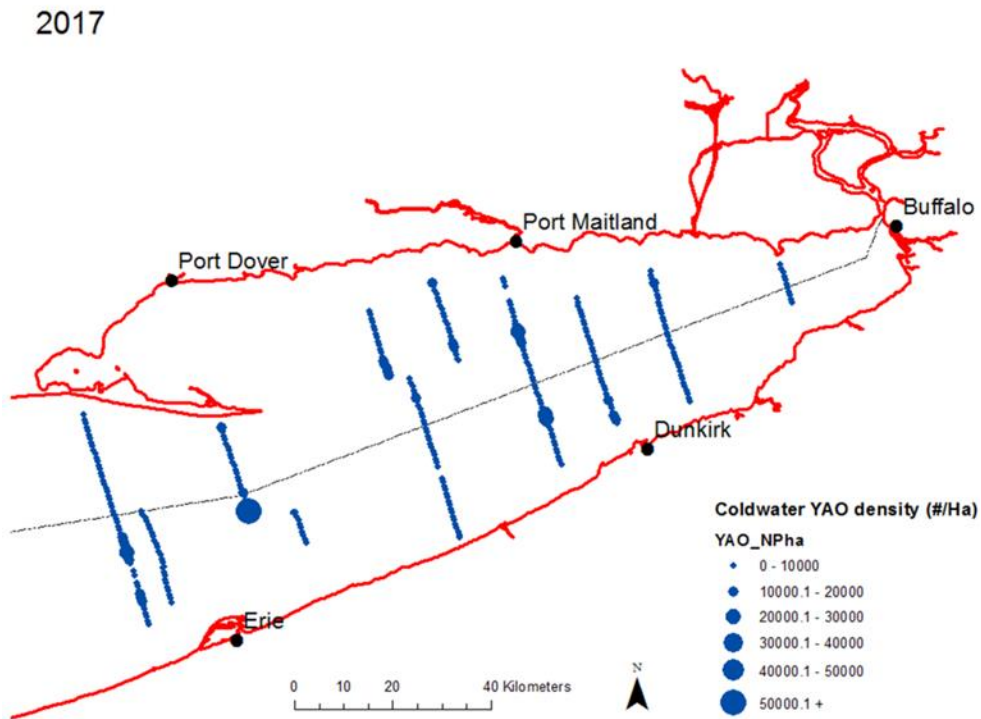


Figure 3.1.2. Density estimates of age-1+ Rainbow Smelt (fish per hectare) per 800 m interval along hydroacoustic transects in the eastern basin, Lake Erie in 2017.

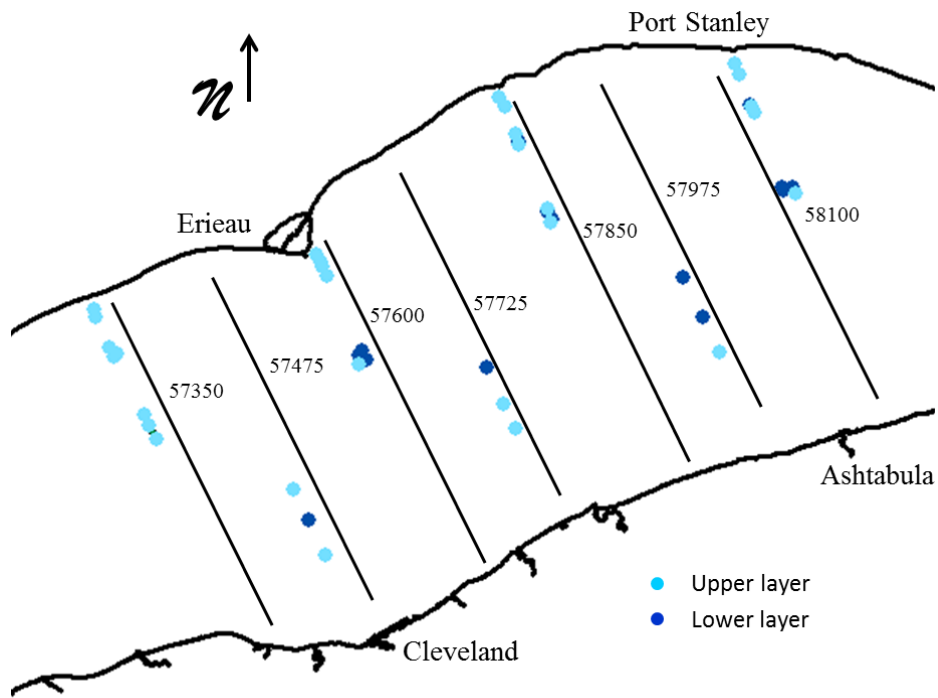


Figure 3.2.1 Hydroacoustic transects (solid lines) and midwater trawling stations (●) in the central basin, Lake Erie, July 17-21, 2017. Transect numbers are Loran-TD lines.

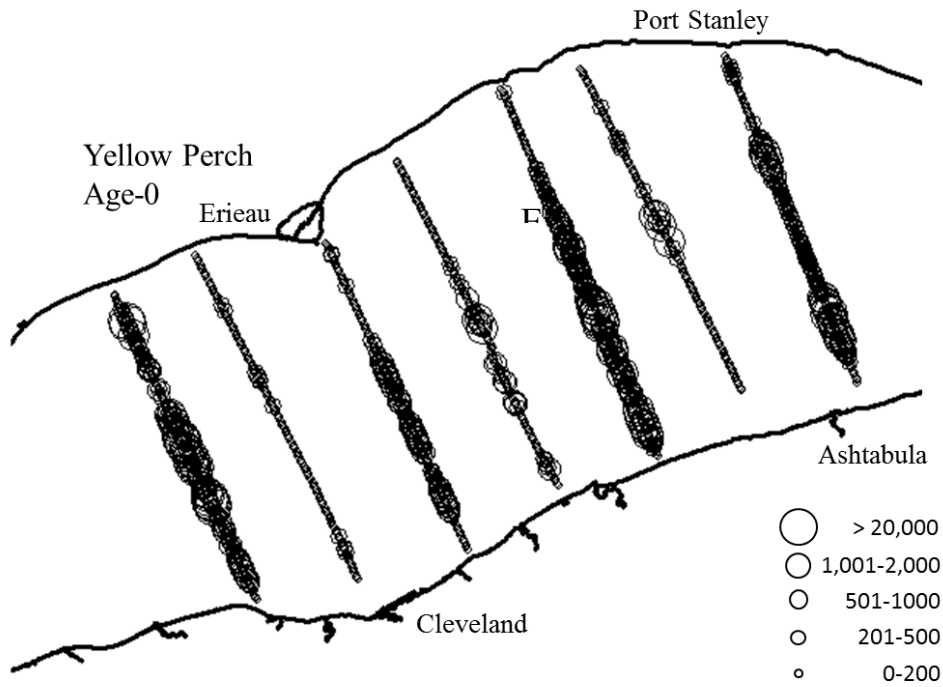


Figure 3.2.2. Density estimates of age-0 Yellow Perch (number per hectare) per distance interval along hydroacoustic transects in the central basin, Lake Erie. Distance intervals were 500 m segments to ensure adequate numbers of single targets for *in-situ* analysis. Transects are Loran-TD lines sampled in 2017.

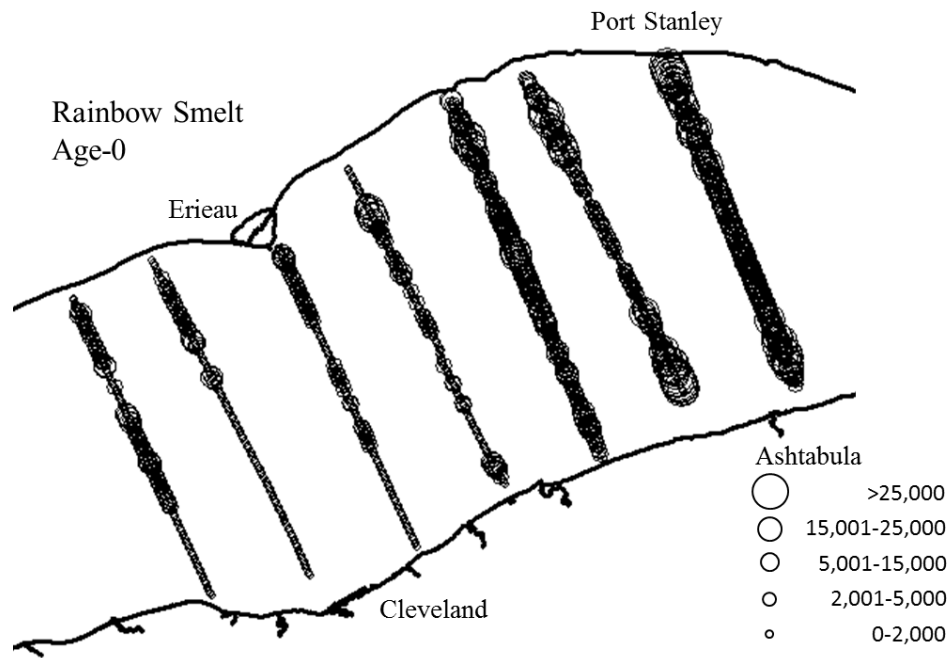


Figure 3.2.3. Density estimates of age-0 Rainbow Smelt (number per hectare) per distance interval along hydroacoustic transects in the central basin, Lake Erie. Distance intervals were 500 m segments to ensure adequate numbers of single targets for *in-situ* analysis. Transects are Loran-TD lines sampled in 2017.

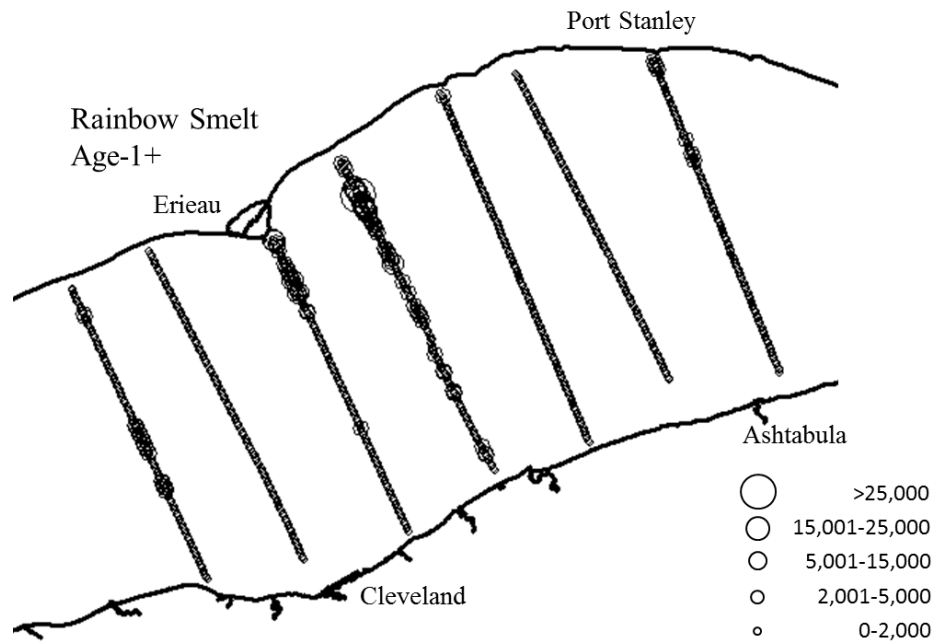


Figure 3.2.4. Density estimates of age-1+ Rainbow Smelt (number per hectare) per distance interval along hydroacoustic transects in the central basin, Lake Erie. Distance intervals were 500 m segments to ensure adequate numbers of single targets for *in-situ* analysis. Transects are Loran-TD lines sampled in 2017.

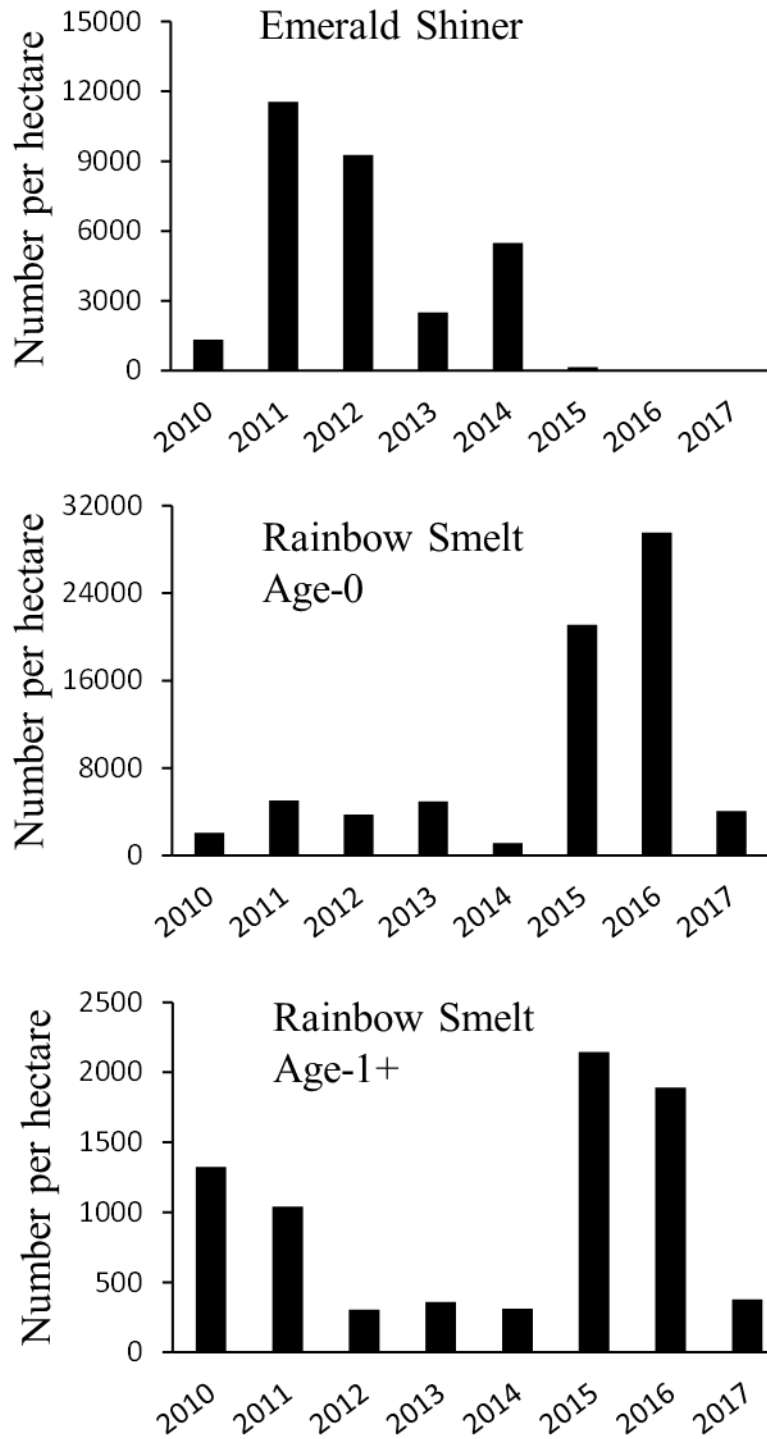


Figure 3.2.5. Mean density (number per hectare) estimates of pelagic forage fish during the July central basin, Lake Erie hydroacoustic survey, 2010-2017.

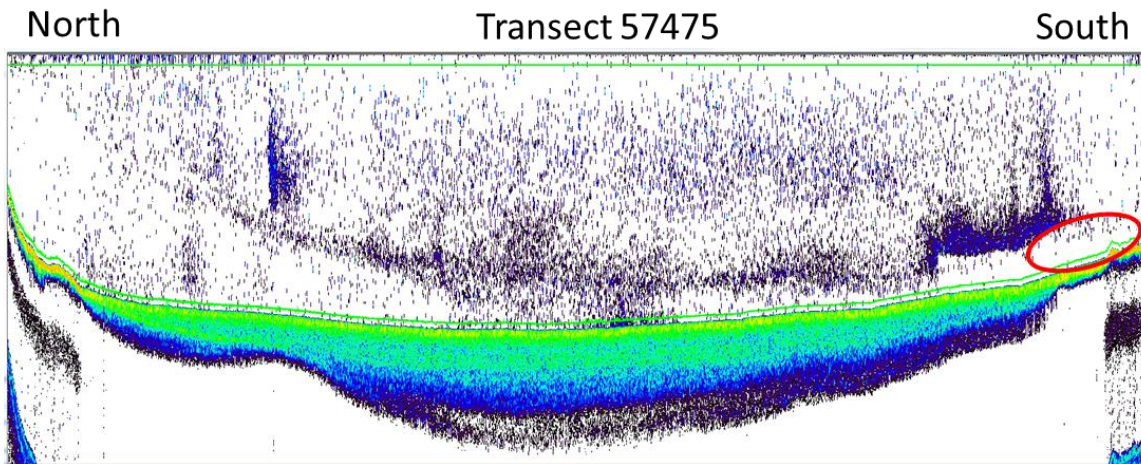
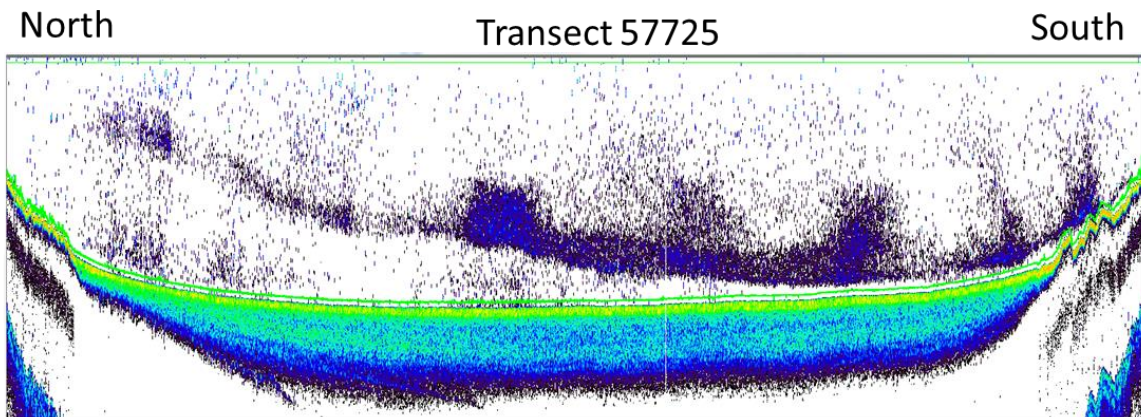
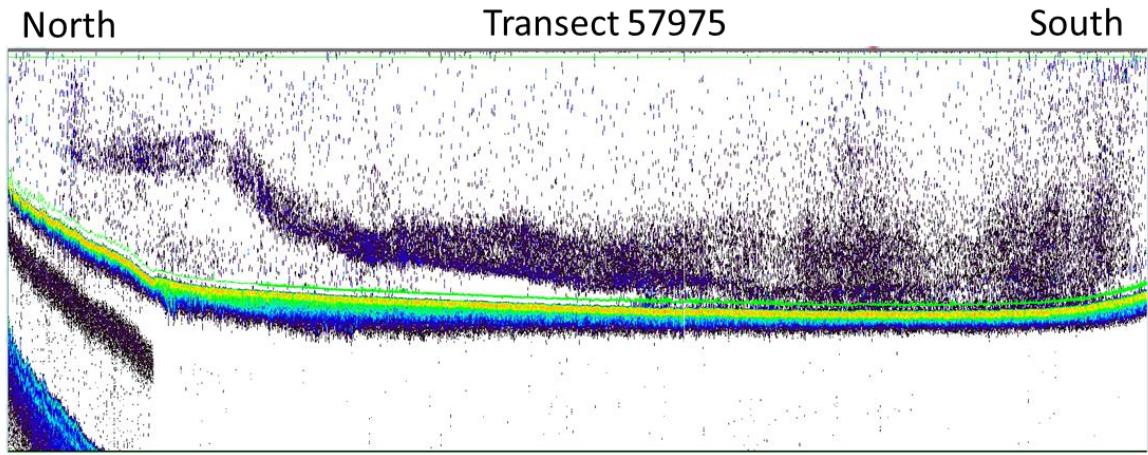


Figure 3.2.6. Echogram files generated from Echoview<sup>®</sup> software version 6.1 that show total back scattering ( $S_v$ ) along transects run by the R/V *Grandon* in the central basin, 2017. Top panel is eastern transect, bottom panel is western transect. Red circle indicates oxygen levels measured at less than 3 mg/L.

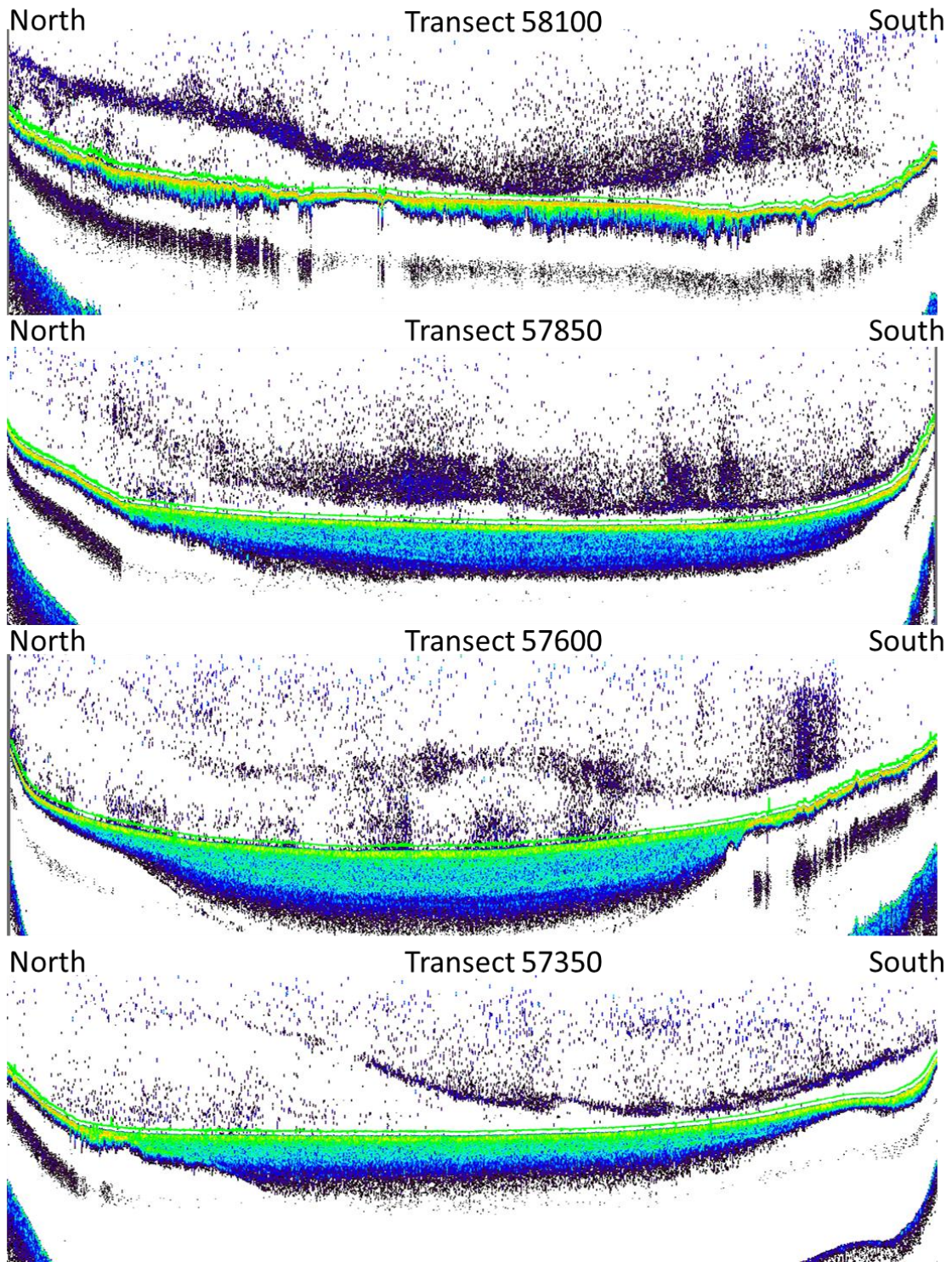


Figure 3.2.7. Echogram files generated from Echoview<sup>®</sup> software version 6.1 that show total back scattering ( $S_v$ ) along transects run by the R/V *Muskie* in the central basin, 2017. Top panel is eastern transect, bottom panel is western transect.

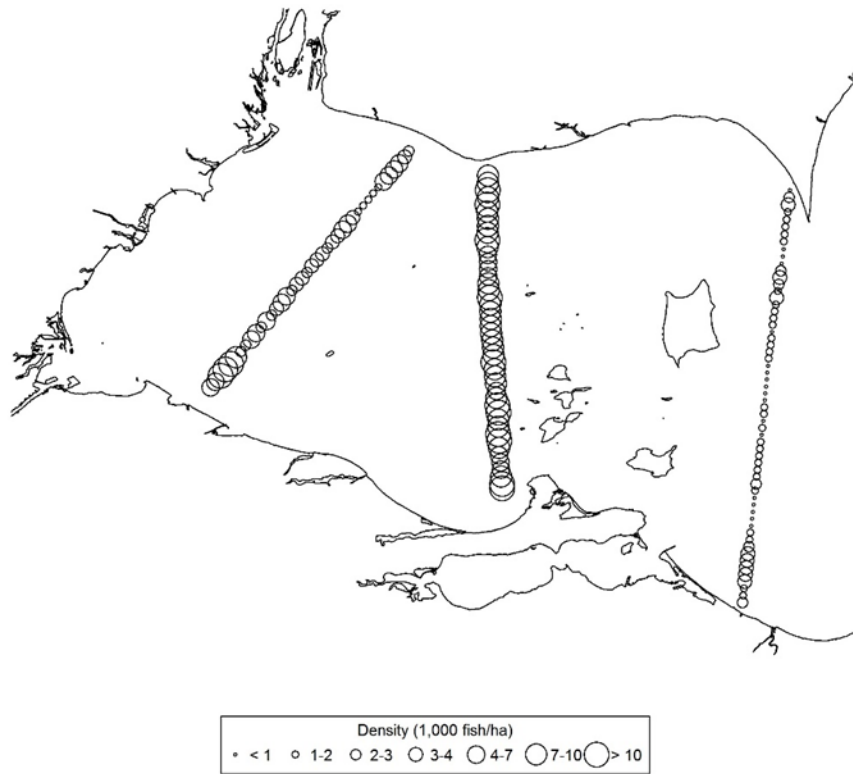


Figure 3.3.1. Acoustic survey transects and associated density (number per hectare) for the western basin of Lake Erie, 2017.

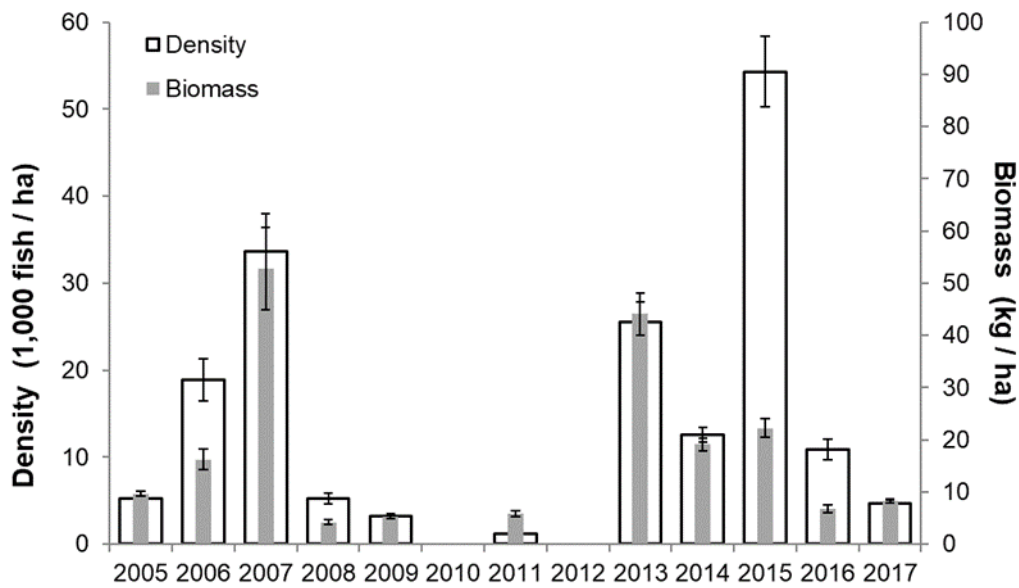


Figure 3.3.2. Mean density (number per hectare) and biomass (kilograms per hectare) estimates from the western basin acoustic survey, 2005-2017. Estimates are for acoustic targets between -60dB and -38dB. Error bars are standard errors.



## **Charge 4: Report on the use of forage fish and new invasive species in the diets of selected commercially or recreationally important Lake Erie predator fishes.**

### **4.1 Eastern Basin (C. May and J. Markham)**

Beginning in 1993, annual, summertime (June-August) visits were made to fish cleaning stations by the NYSDEC to gather stomach content information from angler-caught Walleye in the New York waters of Lake Erie. The number of Walleye stomachs examined annually ranged from 409 in 2000 to 34 in 2004. The percent of non-empty stomachs ranged from 57% in 1995 to 20% in 2016. During 2017, 227 Walleye stomachs were examined, of which 63 (28%) contained food remains. Round Goby was the dominant diet item by volume for angler-caught adult Walleye for the first time in the series; Rainbow Smelt have dominated Walleye diets in every previous year (Figure 4.1.1). The contribution by volume of identifiable species included five fish species: Round Goby (37%), Gizzard Shad (24%), Rainbow Smelt (13%), Moronidae Sp. (10%), and Emerald Shiner (1%). Also of note was the presence of Mayfly nymphs (*Hexagenia* spp.) for the first time since 2002. The prey items found in Walleye diets from summer index gillnets in Long Point Bay (34 non-empty stomachs examined) during 2017 were Rainbow Smelt (occurred in 91% of stomachs), Round Goby (6%) and Clupeids (6%).

Round Goby has been a dominant component in the diets of Yellow Perch and Smallmouth Bass caught in gillnets in Long Point Bay since 2000. In Long Point Bay in 2017, Round Goby occurred in 68% of non-empty Yellow Perch (n=237) and 78% Smallmouth Bass (n=32) stomachs (Figure 4.1.2).

Rainbow Smelt has been the dominant food item in lean strain Lake Trout since coldwater netting surveys began in the early 1980s in Lake Erie, occurring in 85-95% of the stomachs. However, Round Goby has become a more common prey item since they invaded the eastern basin of Lake Erie in the early 2000s, especially during years of low Smelt abundance. Klondike strain Lake Trout have typically shown a higher incidence of Round Goby in stomach contents compared to lean strain Lake Trout. During 2017, 341 lean strain Lake Trout and 6 Klondike strain Lake Trout stomachs were examined, of which 178 (52%) lean and 4 (67%) Klondike Lake Trout contained food remains. Rainbow Smelt remained the dominant forage species in lean strain Lake Trout, occurring in 88% of the non-empty stomach samples (Figure 4.1.3). Round Goby were the next most abundant diet item, occurring in 9% of the stomach samples. In Klondike strain Lake Trout, Rainbow Smelt was the only prey item found (Figure 4.1.4). Six Yellow Perch (3%) and one Gizzard Shad (<1%) were the only other identifiable fish species found in 2017, and these were in lean strain Lake Trout. One lean strain fish also contained Dreissenids in its stomach, possibly consumed while foraging for benthic fish species.

Round Goby has increased in the diet of Burbot since this invasive species first appeared in Lake Erie's eastern basin in 1999, replacing Rainbow Smelt as the main prey item in Burbot diets in 10 of the last 14 years (Figure 4.1.5). In 2017, Round Goby (43%) and Rainbow Smelt (39%) were the most common fish species found in non-empty Burbot stomachs (n=28). Yellow Perch (18%) and Gizzard Shad (11%) were the only other identifiable fish species found in 2017 samples. In general, Burbot appear to have a more diverse diet than Lake Trout over this time series.

### **Growth**

Mean length of age-2 and age-3 Smallmouth Bass sampled in autumn gill nets (New York) have remained stable over ten years and are among the highest in the 37-year time series. Beginning in the late 1990's, roughly coincident with the arrival of Round Goby, Smallmouth Bass in Long Point Bay, Ontario,

exhibited a trend of increasing length-at-age (Figure 4.1.6). Following a peak in size-at-age for the older age classes in 2008, there was a moderate decreasing trend in size-at-age of Smallmouth Bass. However, size increased in 2017.

Walleye length at age-1 and age-2 from gill net surveys targeting juveniles in New York has remained relatively stable for the past decade with both age-1 and age-2 Walleye currently at or near the long-term average. In general, age-0 and age-1 Yellow Perch have exhibited stable growth rates over the past ten years. Length-at-age of age-1 to age-6 Yellow Perch were above the time-series average (1986-2017) in Ontario's Long Point Bay gillnet assessments in 2017, with the exception of age-3 fish, which were smaller than the long-term mean. Mean size-at-age (length and weight) of Lake Trout in 2017 were consistent with the recent 10-year average (2007 – 2016) and condition coefficients (K) remain high. Klondike strain Lake Trout have significantly lower growth rates compared to lean strain Lake Trout. Lake Trout growth in Lake Erie continues to be stable and among the highest in the Great Lakes.

## 4.2 Central Basin (J. Deller)

Diets of adult Walleye are collected from the central basin fall gill net survey in Ohio waters. In 2017, 205 non-empty stomachs were examined and analyzed for diet composition. Gizzard shad comprised 65.5% (by dry weight) of Walleye diets, followed by Rainbow Smelt (10.0%) (Figure 4.2.1). Emerald Shiner normally contribute up to 30% of Walleye diets. Emerald Shiner was not present in Walleye diets examined in 2016. In 2017, Emerald Shiner comprised 14.4% of Walleye diets, with the remaining diet items being Round Goby (4.4%) and unidentifiable fish remains (3.7%).

Round Goby continue to comprise large portions of Smallmouth Bass and Yellow Perch diets in the central basin. In 2016, Round Goby accounted for 85.7% of Smallmouth Bass diets by dry weight (Figure 4.2.2). This was the second highest consumption rate by Smallmouth Bass in a 7-year time series. In 2017, Round Goby comprised over 27.5% of Adult Yellow Perch diets in the fall.

## Growth

Growth rates of most age-0 predator and forage species in 2017 were below the long-term mean (10 years, 2006-2016). Rainbow Smelt and Round Goby were the only species that were at or above long-term means. Mean length at age for Walleye from age-3 through age-8 was above long-term means. Mean length of White Bass and Yellow Perch are generally at or above long-term means through age-6, with no apparent trends in length-at-age for either species.

## 4.3 Western Basin (D. Panos, H. Bontrager, P. Kočovský and E. Weimer)

In 2017, adult Walleye diets (by frequency of occurrence) taken from ODNR fall gill net catches consisted of Gizzard Shad (63%), Round Goby (10%), Invertebrates (10%), Yellow Perch (2%), and unidentifiable fish remains (15%) in the western basin. Yearling Walleye relied on Gizzard Shad (63%), Emerald Shiner (5%), and unidentifiable fish remains (32%). All age-0 Walleye diets from the fall gill net survey in 2017 were empty.

Stomachs were collected by USGS from age-1+ Yellow Perch captured in bottom trawls from 42 sites throughout the western basin in June and September 2017. Fish were dissected in the field immediately after capture. Stomach contents were placed in Whirl-Pak bags and frozen at -70°, then transferred to -20° after flash freezing. Contents were processed in the lab. Prey items were identified to the lowest taxonomic level possibly by coarse visual inspection (i.e., no effort was made to use taxonomic keys to identify species of *Hexagenia*), dried in a Heratherm drying oven at -60° until a constant mass was achieved, then weighed to the

nearest 0.001 g. Frequency of occurrence was measured as percent of non-empty stomachs. Fifty-Six Yellow Perch stomachs were collected in June and 62 Yellow Perch stomachs in September. In June 12% of Yellow Perch stomachs were empty. In September 18% were empty. Analyses below are based on stomachs containing food.

The most common taxon consumed by Yellow Perch in June was zooplankton (64%; Figure 4.3.1). This frequency increased to 68% in September. Specifically, the most common zooplankton consumed in June were Daphniidae (60%), Leptodoridae (48%), Calanoida (20%), and Bythotrephes sp. (16%). The only other zooplankton found was Sididae (4%, specifically *Diaphanosoma*). In September, the zooplankton with the highest frequency of occurrence was Daphniidae (46%). This was followed by Leptodoridae (32%), Bosminidae (27%), and Calanoida (23%). Less common September zooplankton included Cercopagididae (9%), Sididae (9%), Chydoridae (5%) and Cyclopoida (5%).

In June, 56% of non-empty Yellow Perch stomachs contained benthic macroinvertebrates (Figure 4.3.1). This frequency dropped to 27% in September. In June, the most common benthic macroinvertebrate was Ephemerae (specifically *Hexagenia* spp.; 32%). This was followed by Trichoptera (16%) and Chironomidae (16%). Less common benthic invertebrates in June included Nematoda (8%), Dreissenidae (8%), Ostracoda (4%), Hirudinea (4%), Amphipoda (4%), and unidentified invertebrates (4%). In September, the most common September benthic macroinvertebrate was Ephemerae (27.3%, *Hexagenia* spp.). The only other September benthic macroinvertebrate taxon was Amphipoda (4%). There were no Trichoptera, Chironomidae, Nematoda, Dreissenidae, Ostracoda, or Hirudinea found in Yellow Perch stomachs from September.

Fish prey occurrence decreased slightly from June (16%) to the September (14%; Figure 4.3.1). In June, the only identifiable fish prey was Round Goby, having a frequency of occurrence of 4% in June. Unidentified fish had an occurrence of 12% and 13% in June and September, respectively.

Based on mean percent dry weights, benthic macroinvertebrates (50%) and zooplankton (46%) contributed the most to Yellow Perch diets in June (Figure 4.3.2). The highest contributing benthic macroinvertebrates were Ephemerae (23%), Chironomidae (15%), and Dreissenidae (7%). All other macroinvertebrates contributed less than 3%. The zooplankton taxa Daphniidae and Leptodoridae contributed 32% and 13%, respectively. All other zooplankton taxa combined were less than 2% of the average individual's diets. Fish prey composed only 4% of an individual's diet (Round Goby was 0.3% and unidentified fish prey was 4%).

The largest contributor to diets in September was zooplankton (68%), followed by benthic macroinvertebrates (21%) and unidentified fish prey (11%). The two main zooplankton contributors were Daphniae (28%) and Leptodoridae (27%; Figure 4.3.2). Taxa of lesser importance were Bosminidae (5%), Cercopagididae (5%), and Cyclopoida (2%). All other zooplankton contributed less than 2% each to the total dry weight of items consumed in September.

## **Growth**

Overall, mean length of age-0 sport fish in 2017 decreased compared to 2016 (Figure 4.3.3). Lengths of select age-0 species in 2017 include Walleye (126 mm), Yellow Perch (68 mm), White Bass (58 mm), White Perch (56 mm), and Smallmouth Bass (66 mm). Walleye, White Bass, and Smallmouth Bass were below long term averages (138mm, 66mm, and 78mm respectively); Yellow Perch and White Perch were near long-term averages (67 mm and 58 mm respectively).

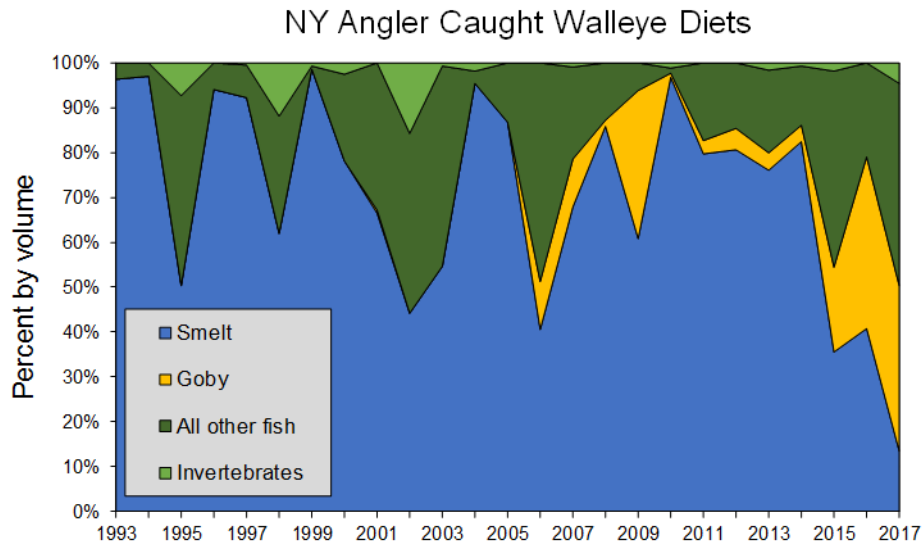


Figure 4.1.1. The percent contribution (by volume) of identifiable prey in stomachs of adult Walleye caught by summertime anglers in New York’s portion of Lake Erie, 1993-2017.

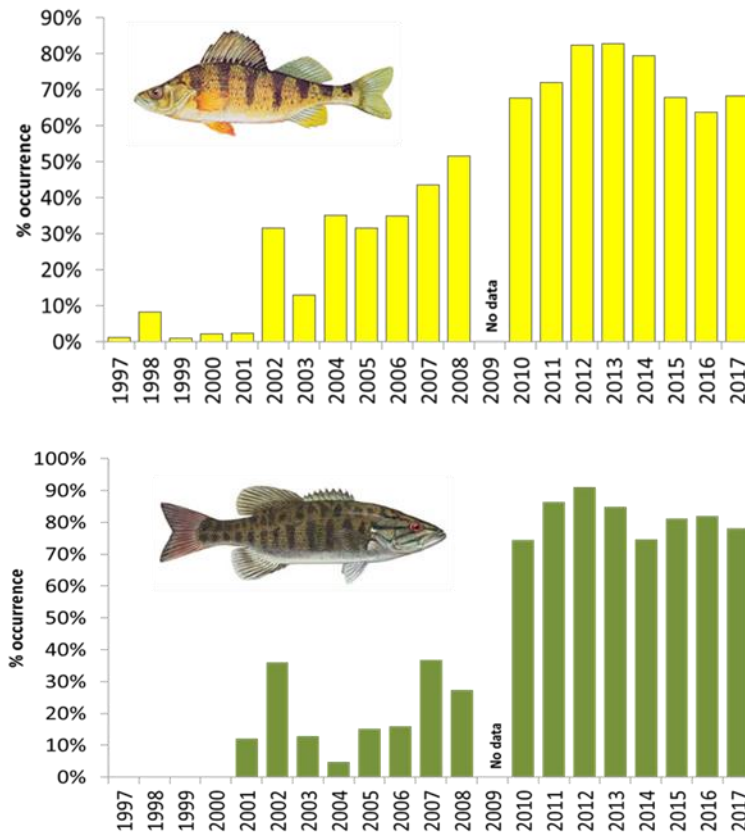


Figure 4.1.2. Percent occurrence of Round Goby in non-empty stomachs of adult Yellow Perch (top figure) and Smallmouth Bass (bottom figure) from OMNRF summer index gill nets set in summer months, Long Point Bay 1997-2017.

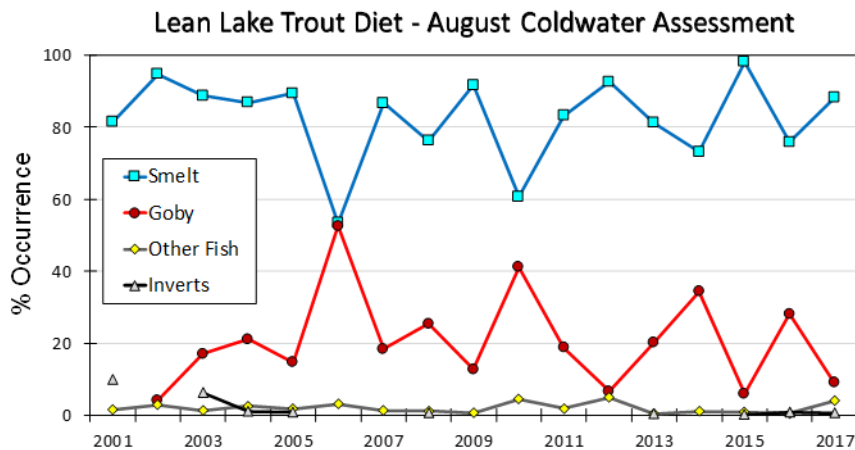


Figure 4.1.3. Percent occurrence of diet items from non-empty stomachs of Lean strain Lake Trout collected in eastern basin gill net assessments, August, 2001-2017.

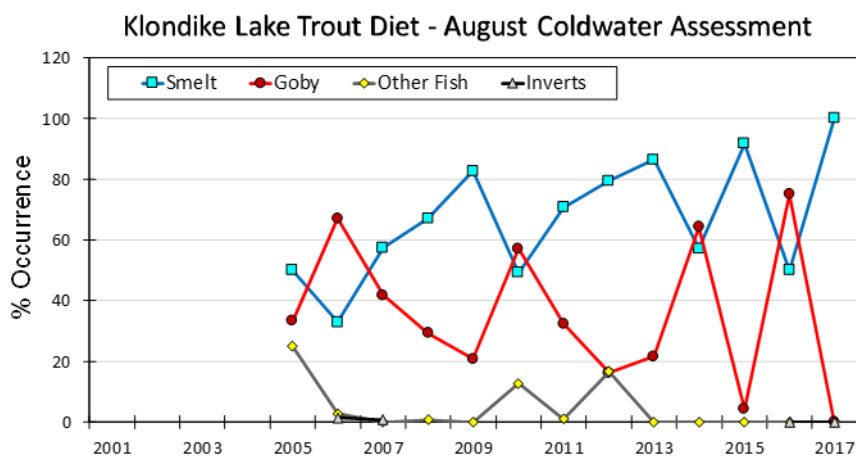


Figure 4.1.4. Percent occurrence of diet items from non-empty stomachs of Klondike strain Lake Trout collected in eastern basin gill net assessments, August, 2001-2017.

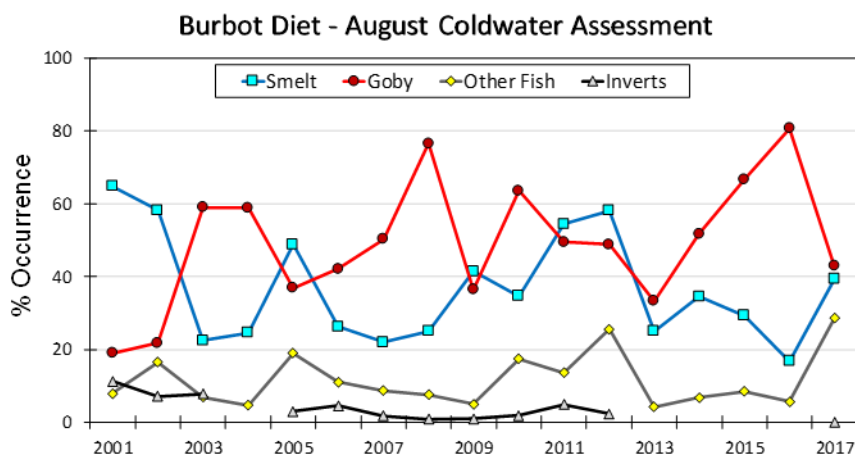


Figure 4.1.5. Percent occurrence of diet items from non-empty stomachs of Burbot collected in eastern basin gill net assessments, August, 2001-2017.

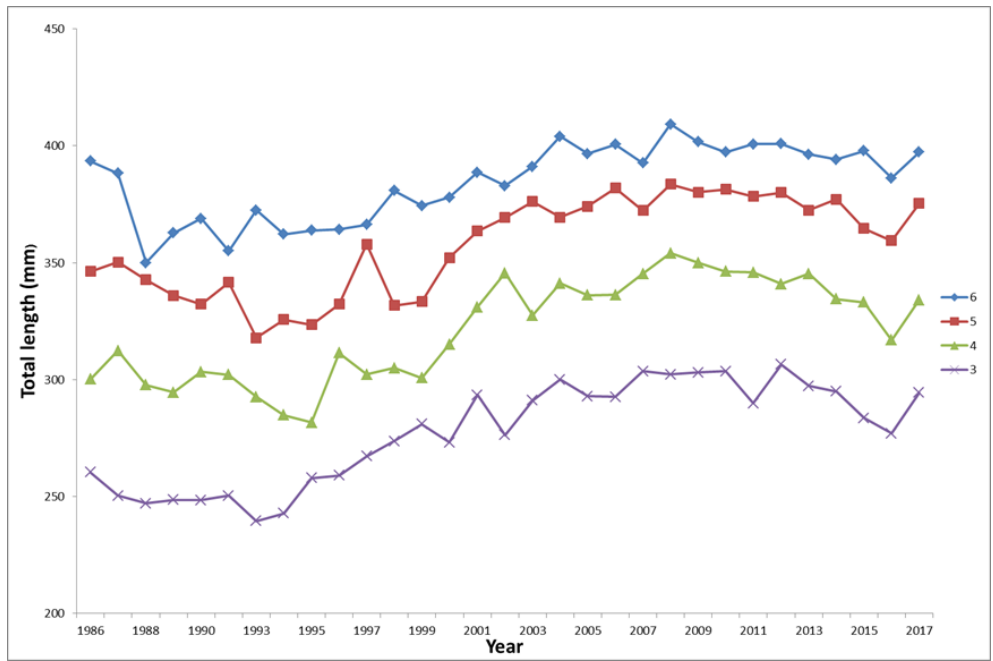


Figure 4.1.6. Smallmouth Bass mean total length (mm) at ages 3 to 6 captured in OMNRF index gill nets set during summer months in Long Point Bay, Lake Erie, 1986-2017. Males and females are combined. Smallmouth Bass ages were not available for 1992 samples.

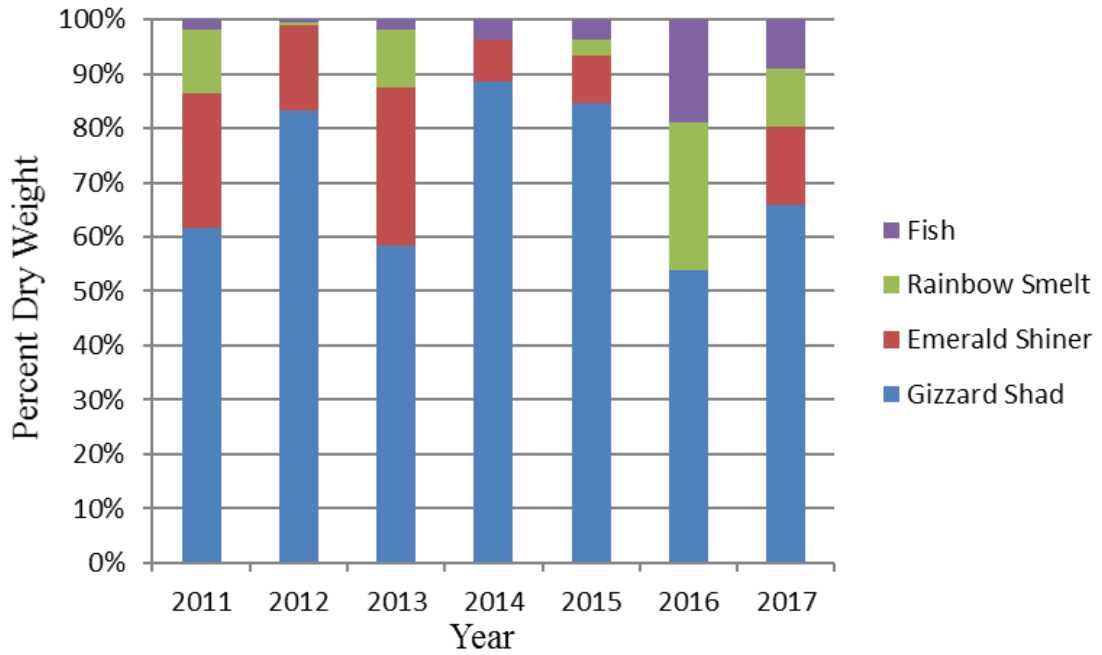


Figure 4.2.1. Adult Walleye diet composition (Percent dry weight) from non-empty stomachs collected in gill nets from central basin, Ohio waters of Lake Erie, 2011 - 2017.

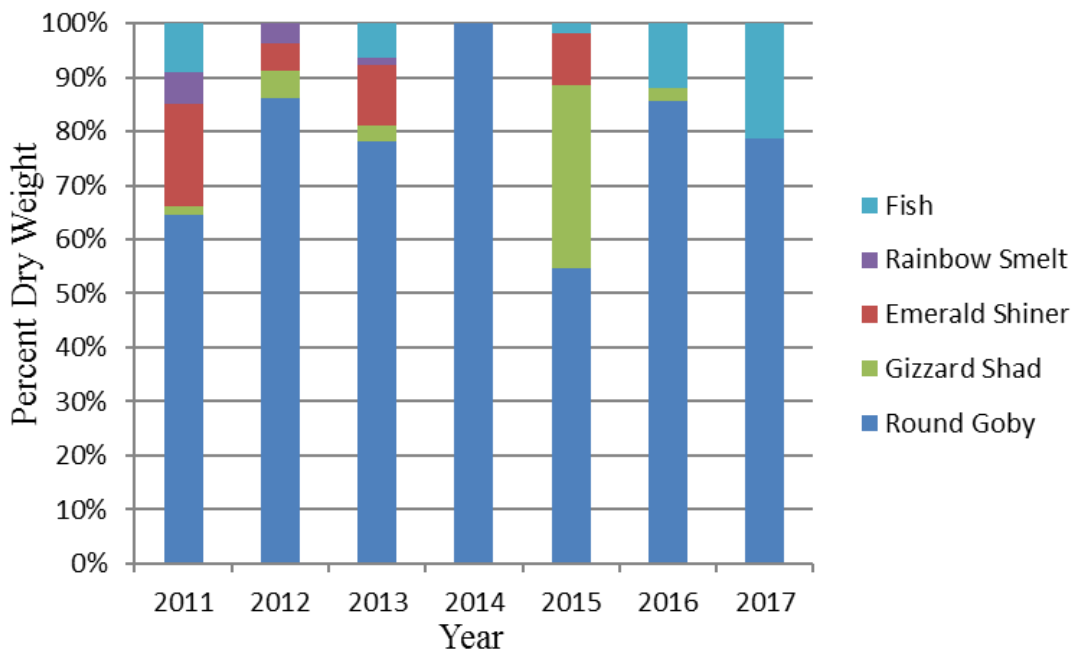


Figure 4.2.2. Adult Smallmouth Bass diet composition (Percent dry weight) from non-empty stomachs collected in gill nets from central basin, Ohio waters of Lake Erie, 2011 - 2017.

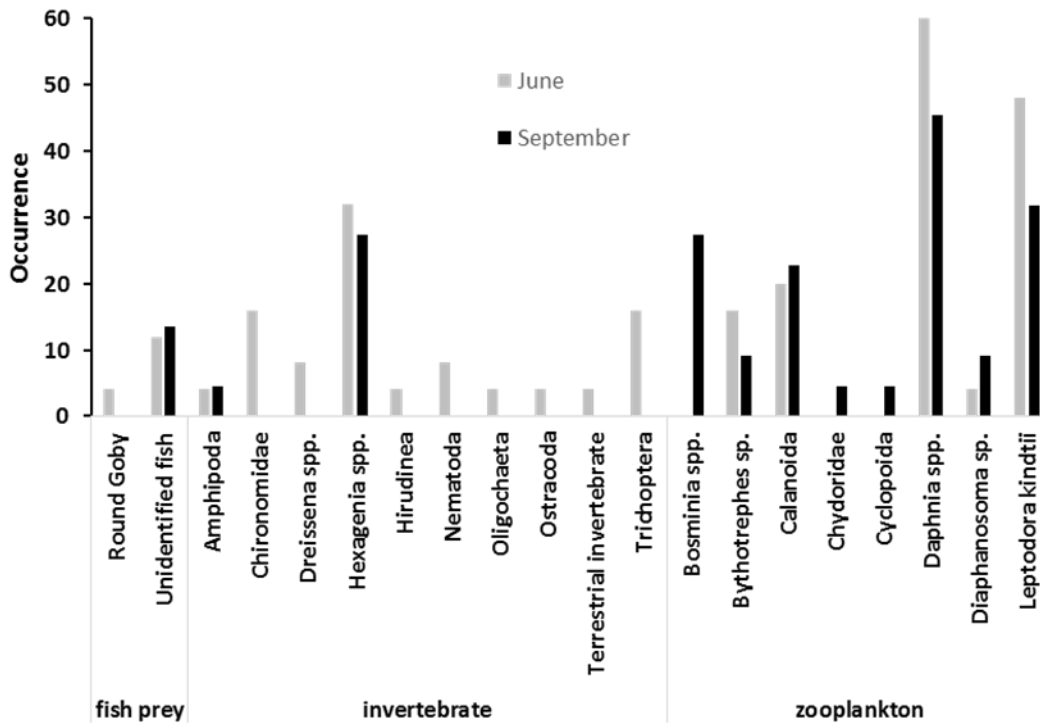


Figure 4.3.1. Frequency of occurrence of prey taxa in diets of Yellow Perch from western Lake Erie, in June and September 2017.

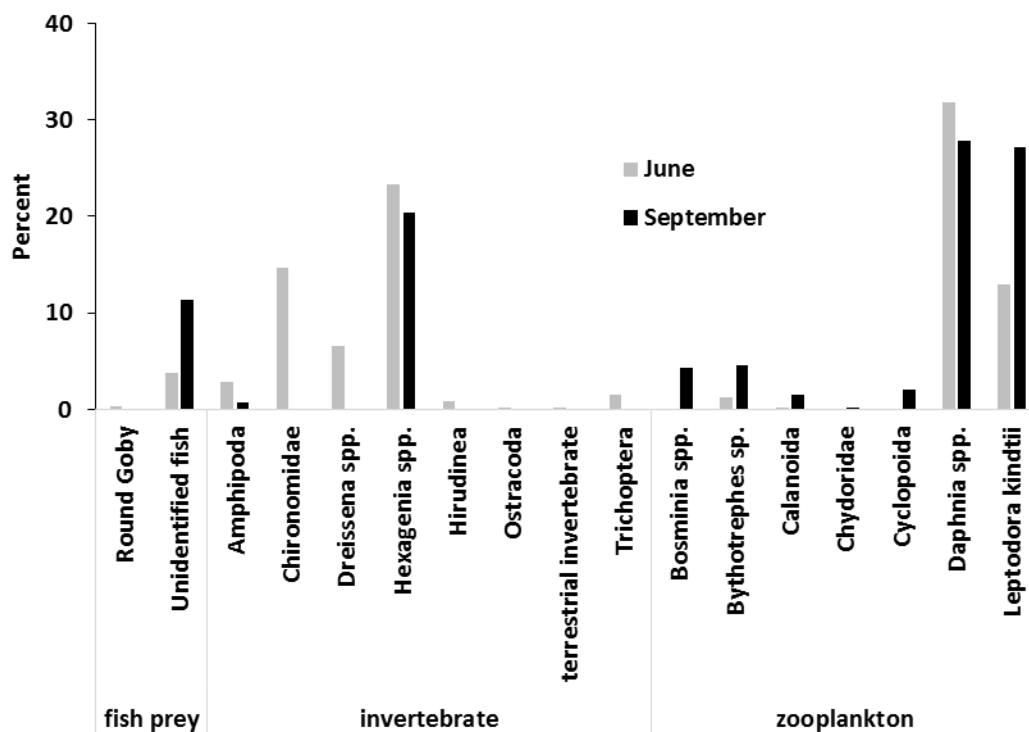


Figure 4.3.2. Percent composition of Yellow Perch diets (% dry weight) in western Lake Erie in June and September 2017.

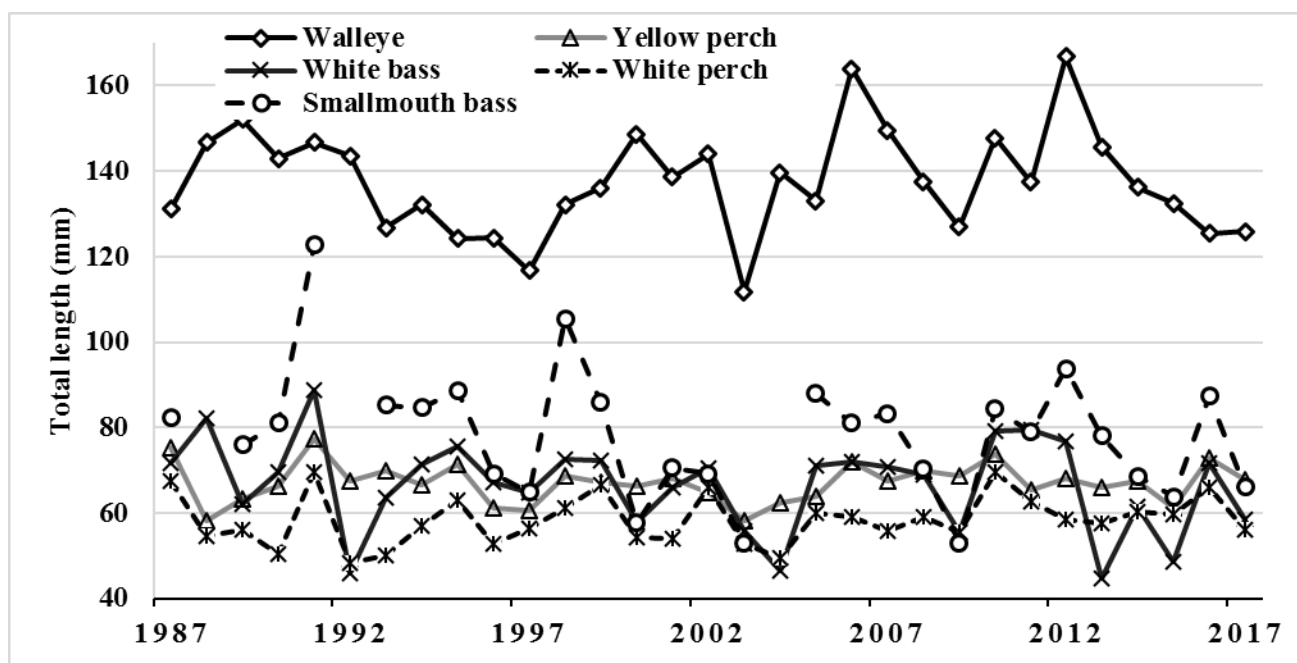


Figure 4.3.3. Mean total length (mm) of select age-0 fishes in western Lake Erie, August 1987-2017.



## **Charge 5: Develop and maintain a database to track Aquatic Invasive Species in Lake Erie**

(P. Kočovský)

In 2016, the Lake Erie Committee added a new charge to “Develop and maintain a database to track Aquatic Invasive Species (AIS) in Lake Erie.” This charge was developed in recognition of the need for a systematic, centralized, lake-wide effort to track records of new, non-native species that might become invasive. The recognized need to better track status of the most recent invaders of management interest, such as Grass Carp, was the impetus for creating this new charge. Placing this charge with the Forage Task Group took advantage of the FTG’s existing reporting structure, which includes sampling data from all agencies in all basins of Lake Erie, which has been a primary past source for detecting new invasive species, (e.g., Round Goby, White Perch).

Our first efforts to fulfill this charge included adopting the USFWS service list of injurious freshwater species (<https://www.fws.gov/injuriouswildlife/11-freshwater-species.html>) as the primary species to track and developing a relational database to track instances of new invasive species. All species on the USFWS list are believed to be absent from Canadian and US waters, with the exception of Prussian Carp, which are abundant and spreading in rivers in southern Alberta (Elgin et al. 2014, Docherty 2016). We also include Bighead Carp, Silver Carp, and Black Carp as species that are currently absent but potentially damaging to Lake Erie, Grass Carp, which have been reproducing in Lake Erie since at least 2011 (Chapman et al. 2013; Embke et al. 2016), and Rudd, which have reproducing populations in Ontario and New York waters connected to Lake Erie. We are also preparing a secondary list of “candidate species,” and we will include other non-native species not on the injurious species or candidate lists as they are reported. This report includes only species reported to member agencies and may not be complete.

### ***Reported non-native species***

One Rudd (*Scardinius erythrophthalmus*) was captured 14 June by electrofishing during sampling as part of a University of Toledo Master’s research project. The fish was 375 mm and 1050 g and was deposited in the Ohio State museum (specimen number OSUM 117463). Rudd have been captured in and are believed to be reproducing in the upper Niagara River, and they have been captured elsewhere in the Lake Erie Basin (see Forage Task Group 2017) including western Lake Erie. The capture in 2017 does not represent a range expansion.

Forty-two Grass Carp were captured in Lake Erie or its tributaries in 2017 (Figure 5.1.1). Seven diploid and nine triploid fish were captured in Michigan waters, all in commercial seines. Two diploid females were captured in North Maumee Bay in late July. All other fish were captured near cooling water effluent ponds near Monroe, Michigan. Twenty-six Grass Carp were captured in Ohio waters between early March and late August. Fifteen were captured by a commercial seine fisherman in the lower Sandusky River. Two were captured in commercial trap nets, one near Maumee Bay, the other on the east side of Catawba Island. The remaining eight were captured during a multi-agency effort to capture Grass Carp on the lower Sandusky River on 29-30 August. All fish were either diploid or of unknown ploidy. No Grass Carp were reported from New York, Ontario, or Pennsylvania waters of Lake Erie. Pennsylvania remains the only jurisdiction from which Grass Carp have not been reported in Lake Erie.

There are no apparent trends in number of total Grass Carp or number of diploid or triploid Grass Carp in Michigan waters between 2012 and 2017. In Ohio waters there is a trend of increasing overall numbers, with a decrease in triploid and an increase in diploid Grass Carp.

One new non-native species was reported by FTG member agencies in 2017. On 20 March 2017 a private citizen delivered to New York State Department of Environmental Conservation a Clown Knifefish

(*Chitala ornata*) that he found in Van Buren Bay in New York waters of eastern Lake Erie. Clown Knifefish is a freshwater species native to the Ganges-Brahmaputra and Mahanadi river basins in southeast Asia (Nico et al. 2017). Wyman-Grothem (2017) rated this species as highly invasive based on the existence of an established population in Florida and ecological effects elsewhere, but climate match is low for the Great Lakes and most of conterminous US.

Annual fish community surveys (electrofishing, gill nets, trawls, seines, and trap nets) provide extensive spatial coverage on Lake Erie (Figure 5.1.2). There were no Bighead or Silver carp captured in assessment surveys in 2017. In addition, neither species was reported from commercial or recreational fisheries.

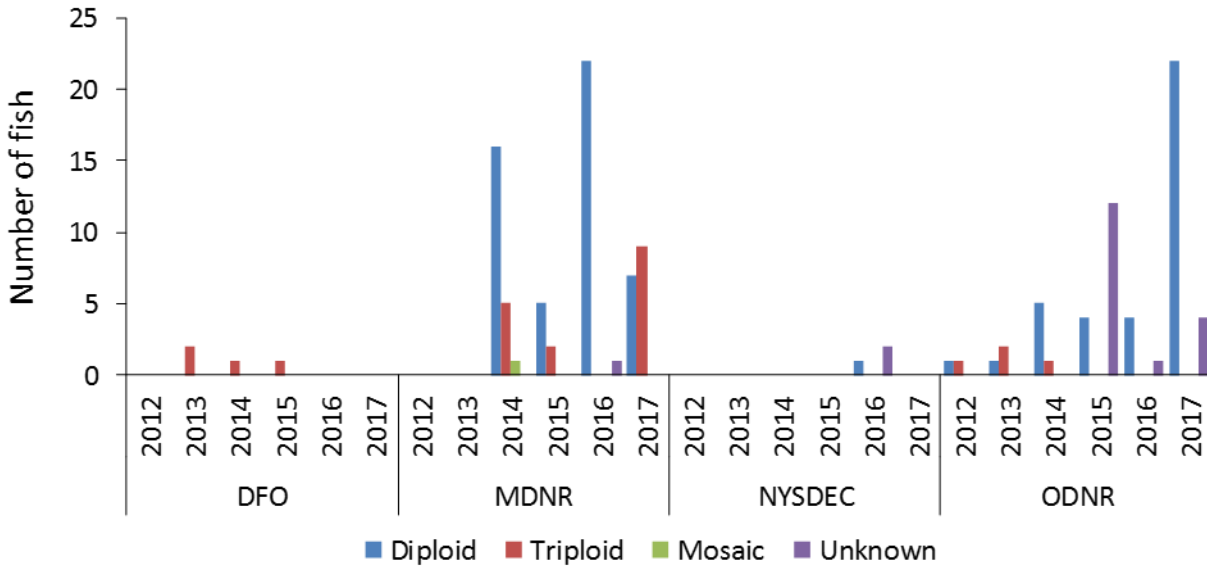


Figure 5.1.1 Numbers of Grass Carp captured in Lake Erie or its tributaries by jurisdiction, year, and reproductive status.

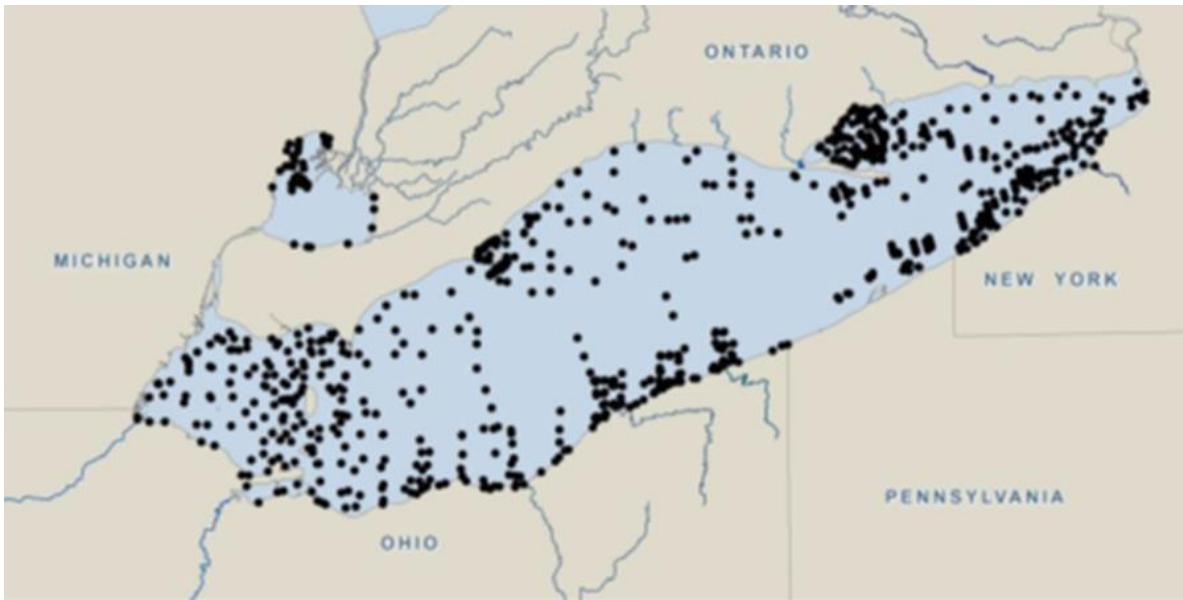


Figure 5.1.2 Annual agency assessment locations in Lake Erie. Standard survey assessment gears include electrofishing, gill nets, trawls, seines, and trap nets. Sampling is conducted by MDNR, NYSDEC, ODNR, OMNRF, PFBC and USGS.

## **Protocol for Use of Forage Task Group Data and Reports**

- The Forage Task Group (FTG) has standardized methods, equipment, and protocols as much as possible; however, data are not identical across agencies, management units, or basins. The data are based on surveys that have limitations due to gear, depth, time and weather constraints that vary from year to year. Any results, conclusions, or abundance information must be treated with respect to these limitations. Caution should be exercised by outside researchers not familiar with each agency's collection and analysis methods to avoid misinterpretation.
- The FTG strongly encourages outside researchers to contact and involve the FTG in the use of any specific data contained in this report. Coordination with the FTG can only enhance the final output or publication and benefit all parties involved.
- Any data intended for publication should be reviewed by the FTG and written permission obtained from the agency responsible for the data collection.

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