Status and Trends of the Lake Huron Prey Fish Community, 1976-2025[1, 2]

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Abstract

The U. S. Geological Survey-Great Lakes Science Center has monitored annual changes in the offshore (depth > 9m) prey fish community of Lake Huron since 1976. Assessment of prey fish populations in Lake Huron is based on a bottom trawl survey that targets demersal species (i.e., those predominantly or intermittently associated with the lake bottom) and an acoustic-midwater trawl survey that targets pelagic species and life stages. Prey fish abundance and species composition in 2025 was generally consistent with trends observed over the past decade. Overall status of main basin prey fish community was rated as 'fair.' Bloater (*Coregonus hoyi*) and Rainbow Smelt (*Osmerus mordax*) remain the first and second most abundant species in the main basin followed by Alewife (*Alosa pseudoharengus*), whose populations consist mainly of low numbers of age-0 individuals. Abundance of Rainbow Smelt is higher, and abundance of Bloater lower, in Georgian Bay and the North Channel than in the main basin, which suggests dynamics of these species vary by basin. Native sculpin communities consist primarily of Deepwater Sculpin (*Myoxocephalus thompsonii*) due to the reduced abundance and distribution of Slimy Sculpin (*Cottus cognatus*). In contrast, biomass of the exotic Round Goby (*Neogobius melanostomus*) in 2025 was the second highest observed in the bottom trawl time series. Evidence of strong Bloater and Rainbow Smelt year classes in 2025 and continued recovery by Cisco (*Coregonus artedi*) in the North Channel were interpreted as positive community trends, whereas growth and expansion of Round Goby populations and low species diversity of pelagic prey fish communities merit concern. Use of complementary surveys (bottom trawl, acoustics) remains important for evaluating prey fish status in Lake Huron, where prey fish community dynamics vary by basin and prey fish responses to changing environmental conditions depend on species and/or habitat.

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[1]Sampling and handling of fish during GLSC surveys are carried out in accordance with Guidelines for the Use of Fish in Research, a joint publication of the American Fisheries Society, the American Institute of Fishery Research Biologists, and the American Society of Ichthyologists and Herpetologists.

[2]The data release associated with this report, "Status and Trends of the Lake Huron Prey Fish Community Data Release, 1976-2025" (DOI 10.5066/P134KUDU), is open-access and available on the U.S. Geological Survey ScienceBase website (https://www.usgs.gov/tools/sciencebase).

Introduction

Monitoring of prey fish communities is a critical need of the Lake Huron fishery management community. Prey fish are the primary forage for sport fish that support valuable recreational and commercial fisheries (Riley and Ebener 2020), and, historically, prey species supported productive fisheries themselves (Berst and Spangler 1972). Prey fish also respond to perturbations at lower and upper trophic levels, so their status can serve as an important indicator of ecosystem health (Bunnell et al. 2014, Dobiesz et al. 2005).

The U. S. Geological Survey-Great Lakes Science Center (USGS-GLSC) began annual bottom trawl surveys of the Lake Huron prey fish community in 1973, and the first full survey covering Michigan waters of the lake was conducted in 1976. An integrated acoustics-midwater trawl survey (hereafter, "acoustics survey") was started in 2004 to better monitor pelagic species and life stages that were potentially underrepresented in the bottom trawl survey (Fabrizio et al. 1997). Data from these surveys are used to quantify relative abundance, species composition, and size/age structure of prey fish in "offshore" waters (depth > 9 m).

The purpose of this report is to describe the status and trends in the offshore prey fish community of Lake Huron from 1976 through 2025. Report objectives are to 1) characterize status of the main basin prey fish community in 2025 based on trends in species composition and diversity; 2) describe differences in prey fish abundance, species composition, and spatial variability by lake basin (main basin vs. North Channel and Georgian Bay); and 3) describe population status of individual prey fish species based on trends in relative abundance, and when possible, year class strength, and demographics (e.g., size or age structure).

Methods

Bottom Trawl Survey—Since 1976, USGS has monitored demersal prey fish using 12-m headrope (1973-1991) or 21-m headrope (1992-2025) bottom trawls towed at fixed transects at up to eleven depths (9, 18, 27, 36, 46, 55, 64, 73, 82, 91, and 110 m) near five ports (De Tour Village, Hammond Bay, Alpena, Au Sable Point, and Harbor Beach) in Michigan waters of Lake Huron (Figure 1). A sixth port, Goderich (Ontario), was added to the survey in 1998, but was not sampled in 2025 due to a lapse in federal appropriations. Bottom trawl surveys typically commence in early October and are completed by late October or early November, except for the 1992 and 1993 surveys, which occurred in September. Single 10-min. bottom trawl tows were conducted during daylight at each transect each year. Trawl catches were sorted by species, counted, and weighed. For Alewife *Alosa pseudoharengus*, Rainbow Smelt *Osmerus mordax*, and Bloater *Coregonus hoyi*, length thresholds determined from length-frequency data were used to apportion bottom trawl catches into age-0 fish (young-of-the-year, or YOY) and those age-1 year or older (yearling and older, or YAO) (Hondorp et al. 2022, Riley et al. 2008). Length thresholds used in 2025 were 120 mm, 90 mm, and 110 mm for Alewife, Rainbow Smelt, and Bloater, respectively. Thresholds were adjusted annually due to interannual variation in fish size distributions. Mean catch weighted by the area of the main basin occurring within 10-m depth strata was used to generate a main-basin estimate of prey fish abundance expressed in density (number/ha) or biomass (kg/ha). The bottom trawl survey was not conducted in 2000, and data from the 2008 survey were excluded because all three southern ports (Au Sable Point, Harbor Beach, Goderich) were not sampled. Additional details concerning survey design and data analysis are summarized in Riley et al. (2008) and Hondorp et al. (2022).

Acoustic-midwater trawl survey—The GLSC has monitored pelagic prey fish abundance annually since 2004 using a scientific echosounder system deployed along randomly-selected transects within five geographic regions: main-basin east, main-basin west, main-basin south, Georgian Bay, and the North Channel (Figure 1). The first transect location within a region was selected based on random latitude and longitude, with subsequent transects spaced equidistant (north to south, east to west for North Channel only) within the constraints of region boundaries (O'Brien et al. 2022). Final transect locations were selected by alternating shallow (10-50 m) and deep (>50 m) depths to achieve a spatially balanced survey design within each region. Acoustic surveys are typically conducted in September through early October. In all years, sampling was initiated one hour after sunset and ended no later than one hour before sunrise. Fish catches from midwater trawl tows conducted concurrently along each acoustic transect were used to identify the species composition of acoustic targets by depth strata. Information from acoustic surveys was combined with trawl data to produce region-specific fish abundance estimates expressed as density (number/ha) or biomass (kg/ha). Acoustic density was apportioned by age group (YOY vs. YAO) using length thresholds determined from age-length relationships for Alewife (100 mm), Rainbow Smelt (90 mm), and Bloater (100 mm) (O'Brien et al. 2022). Length thresholds differ between surveys because the acoustics survey begins 4-6 weeks earlier than the bottom trawl survey. No sampling occurred in Georgian Bay or the North Channel in 2006 and 2020. Additional details concerning survey design and data analysis are provided in O'Brien et al. (2022).

Data analysis— Status of the main basin prey fish community in 2025 (objective 1) was assessed based on relative importance of native species (estimated as the percent of total prey fish biomass comprised of native prey species) and species diversity as estimated by the Shannon Index (*H*):

$$H = -\sum_{i=1}^{s} p_i \ln(p_i)$$

where *p* is the proportion (by biomass) of species *i* in the community, and *s* is the total number of species sampled. Status was classified as 'Good,' 'Fair,' or 'Poor' based on indicator thresholds outlined in the 2022 State of the Great Lakes Report (Environment and Climate Change Canada and the U.S. Environmental Protection Agency 2022) and summarized in Table 1. If status categories for the two indicators did not agree, status was rated as 'Fair' if indicator categories were opposite (i.e., one 'Good,' and one 'Poor'), or the lower-rated status when indicators were in adjacent categories (e.g., Good' and 'Fair' = 'Fair'; 'Poor' and 'Fair' = 'Poor').

Table 1. Prey fish community status indicators and status category thresholds for each indicator.

		Status Category		
Indicator	**Measure**	Good	Fair	Poor
Native Species Importance	% Prey fish biomass comprised of native species	% Native ≥ 75	75 > % Native ≥ 25	% Native < 25
Species Diversity	Shannon Diversity (*H*)	$H \geq 0.75 \times H_{max}$	$0.75 \times H_{max} > H \geq 0.25 \times H_{max}$	$H < 0.25 \times H_{max}$

Trends in prey fish community status were assessed based on the slope of each indicator regressed against time (year) for two time periods: (1) the last 10 years of the survey (short-term trend), and (2) the entire time series (long-term trend). Indicator trends were classified as 'Improving' when slopes were positive and statistically significant ($P < 0.10$), and 'Deteriorating' for significant negative relationships. Otherwise, trends in the indicators were classified as 'Unchanging.' Condition of the main basin prey fish community was evaluated separately for each survey.

Spatial variability in prey fish abundance and species composition (objective 2) was quantified solely on fish biomass estimates from the acoustics survey, which unlike the bottom trawl survey samples all three lake basins.

Status of individual prey fish species (objective 3) was determined from short- and long-term trends in biomass (all species), size/age structure (Bloater, Rainbow Smelt, and Alewife only), and year class strength (Bloater, Rainbow Smelt, and Alewife only). Relative year-class strength was calculated as the mean density (number/ha) of YOY-sized fish divided by the maximum observed density in the time series (index range: 0-1). When applicable, separate indices were calculated for both the bottom trawl and acoustics time series. Data from the acoustics survey also were used to describe current and long-term trends in the lake-wide distribution of dominant species (Bloater, Rainbow Smelt, Cisco *Coregonus artedi*, and Alewife).

Results and Discussion

Survey overview—The Lake Huron acoustic and bottom trawl surveys were completed during 4-25 September 2025 and 27 October - 8 November 2025, respectively. The bottom trawl survey was conducted aboard the R/V *Arcticus*, whereas the acoustic survey was conducted jointly by the GLSC (R/V *Sturgeon*) and U.S. Fish and Wildlife Service (M/V *Spencer F. Baird*). The lapse in FY2026 federal appropriations that occurred from 1 October through 12 November delayed the start of the bottom trawl survey, so only the five ports in Michigan waters were sampled, and, at De Tour Village (hereafter, "De Tour"), only tows at the 91-, 73-, and 64-m stations were completed before sampling was suspended due to inclement weather and unsafe working conditions. Twenty-five acoustic survey transects were sampled, and 41 midwater trawl tows were conducted in conjunction with acoustic data collection (Table 2, Figure 1). Over 81,000 fish representing 12 prey fish species were collected in bottom trawls in 2025, and over 8,000 fish representing 9 prey fish species were collected in midwater trawls (Table 2). Below we describe status and trends for the entire prey fish community and for the most common individual species. Appendix Tables A1 and A2 summarize biomass and density for all prey fish species sampled in 2025.

Table 2. Sampling effort and fish catch by survey, 2025.

	Survey	
Effort/catch metric	*Bottom Trawl*	*Acoustics-midwater trawl*
Number of ports or transects	5*	25**
Number of Trawls	34	41
Number of prey fish species (all species) sampled	12 (20)	9 (14)
Number of prey fish (all fish) sampled	81,225 (81,347)	22,776 (22,766)

*Number of ports (Goderich, Ontario, not sampled in 2025)
**Number of acoustic transects

Main Basin Status and Trends— Status of the main basin prey fish community in 2025 was considered 'Fair' (Table 3). Native species comprised less than 75% of the demersal prey fish community for the second consecutive year, resulting in a native species index rank of 'fair,' but species diversity of the demersal prey fish community has been rated as 'good' since 2022 (Table 3). Declines in the proportion of native species in the demersal fish community in recent years were due to declining biomass of Bloater, the most abundant and widespread native prey fish species, and large catches of Round Goby *Neogobius melanostomus* in bottom trawls in 2024 and 2025. The pelagic prey fish community as

Table 3. Status of the main basin prey fish community in 2025 by survey. "Max." is the maximum indicator value over the entire survey time series.

	Native Species Index				Species Diversity Index				
Survey	2025	2020-2024 mean ± SE	Max.	Status	2025	2020-2024 mean ± SE	Max.	Status	**Overall Status**
Bottom trawl	59	72 ± 6	90	Fair	1.36	1.12 ± 0.14	1.56	Good	**Fair**
Acoustics	81	90 ± 1	97	Good	0.51	0.51 ± 0.04	0.84	Fair	**Fair**

Table 4. Trends in main basin prey fish community indicators by survey and time period.

		Whole Time Series		2016-2025
Survey	Indicator	Years	Trend	Trend
Bottom Trawl	Native Species	1976-2025	improving	unchanging
	Species Diversity	1976-2025	unchanging	unchanging
Acoustics	Native Species	2005-2025	improving	unchanging*
	Species Diversity	2005-2025	unchanging	unchanging

*Year effect = -0.75, $P = 0.10$

assessed by the acoustics survey is overwhelmingly dominated by native species but has low diversity relative to the demersal prey fish community (Table 3). Low species diversity in the pelagic fish community reflects recent abundance declines in non-native planktivores such as Alewife and Rainbow Smelt in addition to the extirpation of several deepwater ciscoes that occurred before lakewide prey fish monitoring began in the early 1970s. Temporal trends in the percent native and species diversity indicators since 2016 were not significant (Table 4), which suggests that species composition of the main basin has remained relatively stable over the past decade. However, a weak declining trend in percent native species in the pelagic fish community was observed (Table 4). Over the past decade, Bloater, followed by Rainbow Smelt, have been the most abundant prey fish species in the main basin (Figures 2, 3). Over the whole time series, percent native species in the demersal and pelagic communities has increased, but diversity of both communities has remained unchanged (Table 4).

Prey fish abundance (biomass) was not considered as a factor in the evaluation of prey fish community status in the main basin because of long-term changes in lake trophic state that have the potential to affect fish production (Downing et al. 1990, Peters 1986). Mean prey fish biomass in the main basin estimated from the 2025 bottom trawl (12.5 kg/ha) survey was well below levels observed prior to basin-wide declines in prey fish biomass that occurred during the early 2000s (Figure 2). Offshore areas of Lake Huron have become increasingly oligotrophic in recent years (Barbiero et al. 2012), so the prey fish biomass that can be supported by current levels of primary production is probably lower than in the past. Prey fish population sizes that are in balance with lake productivity are consistent with Lake Huron fish community objectives (DesJardine et al. 1995). The most abundant demersal species sampled in the 2025 bottom trawl survey were Bloater, Rainbow Smelt, Alewife, and Round Goby (Figure 2). Among remaining species sampled in bottom trawls during 2025, Trout-Perch *Percopsis omiscomaycus* (4.8% of the catch by biomass), Deepwater Sculpin *Myoxocephalus thompsonii* (2.2%), and Ninespine Stickleback *Pungitius pungitius* (1.4%) were the most abundant. Mean prey fish biomass in the main basin estimated from the 2025-acoustics survey (9.6 kg/ha) was slightly above average value for the time series (7.3 kg/ha).

Community Trends by Basin—Abundance and species composition of the pelagic prey fish community determined from the 2025 acoustics survey varied by lake basin. Mean pelagic prey fish biomass in 2025 was higher in the North Channel (9.6 kg/ha) and main basin (9.6 kg/ha) than in Georgian Bay (6.8 kg/ha). Prey fish biomass increased in the main basin from 2024 to 2025 but decreased in the North Channel and Georgian Bay (Figure 3). Bloater was the single-most dominant species in the main basin, representing 81% of pelagic prey fish biomass but was less abundant in the in the North Channel and Georgian Bay, where Rainbow Smelt and Cisco were the most abundant pelagic prey species (Figure 3). Spatial variation in abundance of Bloater, Rainbow Smelt, and Cisco, suggests that population dynamics of pelagic prey species vary by lake basin.

Bloater—Bloater is the only remaining deepwater cisco species in Lake Huron and is not a favored prey of salmonid predators (Eshenroder et al. 2016, Roseman et al. 2014) so its abundance tends to fluctuate as a result of demographic factors rather than predation (Bunnell et al. 2006, Schaeffer 2004). Currently, Bloater abundance in the main basin is exhibiting a downward trend, which appears to have begun around 2020 (Figure 4). Since 2020, Bloater biomass in the main basin has declined by 34% based on acoustic estimates and by 48% based on bottom trawl estimates. However, Bloater year class strength in 2025 was the highest observed in the entire acoustics survey time series and the 4th highest in the bottom trawl time series (Figure 4), which suggests that bloater biomass will rebound in 2026. Age distribution of Bloater sampled in 2025 was not yet available as of the writing of this report, but age 2-5 individuals representing the 2019-2022 year classes comprised the majority of the population in 2024 (Figure 5). Bloater year class strength in 2024 was historically weak, so the YAO population in 2025 likely is dominated by age 3-5 individuals. The strong 2025 year class was evident in the bloater length-frequency distribution as the mode represented by individuals with total length less than 110 mm (Figure 5). Spatially, Bloater biomass in 2025 was highest in the northern main basin offshore of Hammond Bay and in the southeast main basin, both historical strongholds for Bloater in Lake Huron (Figure 6).

Rainbow Smelt—Trends in the abundance of Rainbow Smelt in the main basin varied by survey. Biomass of YAO Rainbow Smelt estimated from the bottom trawl survey has been declining since 2020, and the 2025 YAO biomass estimate was the lowest in the time series, whereas acoustic biomass fluctuated without trend during the period 2020-2025 (Figure 7). Bottom trawl sampling effort in 2025 was concentrated in areas where Rainbow Smelt biomass has historically been low, so low trawl biomass may reflect the spatial distribution of sampling effort in 2025. However, Rainbow Smelt year class strength in 2025 was the highest observed in the acoustics survey time series and 8th highest in the bottom trawl time series (Figure 7). Adult Rainbow Smelt are known to cannibalize younger age classes (Henderson and Nepszy 1989), so reduced predation pressure from a shrinking YAO population may have contributed to the strong 2025 year class, which is clearly evident in the 2025 Rainbow Smelt length-frequency distribution as the mode represented by individuals with total length less than 100 mm (Figure 8). Rainbow Smelt biomass historically is higher in the North Channel than elsewhere in Lake Huron, but in 2025, areas of high biomass also included northwestern Georgian Bay and the southeast main basin (Figure 9).

Alewife— Abundance of Alewife in Lake Huron has remained at historically low levels since the collapse of the adult population in 2003. Biomass of YAO Alewife has mostly been below detectable limits in both surveys since 2015, and recent Alewife year classes, including 2025, are consistently weaker than when adult populations were at their peak (Figure 10). Alewife catches in bottom trawls in 2025 consisted mainly of YOY (age-0) individuals with total length < 125 mm (Figure 11), which is typical of catches observed over the past decade. Age-0 Alewife are sampled in bottom trawls nearly every year, so small adult populations must still exist in Lake Huron, possibly in nearshore areas or shallow bays not sampled in either survey.

Sculpin— Slimy Sculpin *Cottus cognatus* and Deepwater Sculpin are native benthic species that are sampled only in the bottom trawl survey. Sculpin abundance in the main basin peaked in the late 1990s, decreased during the 2000s, and has remained relatively low since, although biomass of Deepwater Sculpin has increased slightly since 2021 (Figure 12). Sculpin communities in the main basin consist almost entirely of Deepwater Sculpin due to the low abundance of Slimy Sculpin (Figure 12). Slimy Sculpin have become exceptionally rare since 2010, with surveys failing to collect a single individual during the years 2007-2010, 2014, 2015, 2019, 2020, and 2025. De Tour is the only port where Slimy Sculpin have been sampled since 2014, suggesting their range also has contracted.

Round Goby—Round Goby is a non-native, bottom-dwelling fish species that was first captured in Lake Huron bottom trawls in 1997. Round Goby biomass in offshore waters of Lake Huron has increased sharply since 2021, with the first and second highest biomass in the time series occurring in 2024 (1.57 kg/ha) and 2025 (0.86 kg/ha), respectively (Figure 12). Round Goby is more common in nearshore (depth < 9-m) areas but may seasonally migrate offshore (Pennuto et al. 2021, Walsh et al. 2007), which might explain why they are sometimes caught in high numbers in the bottom trawl survey. Many sport fish that once fed on Alewife now feed on Round Goby, so why Round Goby were so much more abundant in offshore areas in 2024 and 2025 than in previous years is unclear. However, bottom trawls may not provide a robust estimate of Round Goby abundance because of the species' preference for rocky, untrawlable habitats.

Cisco—Cisco is a pelagic species that is sampled only during the acoustics survey. Cisco have been most consistently sampled in areas within and adjacent to Georgian Bay and the North Channel. In both basins, Cisco was rare until about 2015 when its biomass increased suddenly (Figure 13). Abundance in both systems leveled off in 2018, after which biomass in Georgian Bay declined again, whereas in the North Channel Cisco biomass reached record highs in 2022 and 2024 (Figure 13). Biomass of Cisco in 2025 was the highest observed since 2018 in Georgian Bay, and the third highest value in the entire time series in the North Channel, which suggests that Cisco, particularly North Channel populations, have sustained population increases first observed 2016.

Summary and Conclusions

1. Status of the main basin prey fish community in 2025 was considered 'Fair.' Positive trends include evidence of strong Bloater and Rainbow Smelt year classes and continued recovery by Cisco in the North Channel. Potentially concerning trends include the historically high abundance of exotic Round Goby in offshore areas of the main basin in 2024 and 2025 and continued low species diversity in pelagic prey fish communities.

2. Status of major prey fish stocks varied by species. Main basin stocks of Bloater have declined over the past several years, but the population remains comprised of multiple age classes, which is a desirable characteristic of longer-lived fish stocks. Evidence also suggests that the 2025 year-class was among the strongest on record. Rainbow Smelt remained the second-most abundant prey species across much of Lake Huron and produced a potentially record year class. Populations of Alewife, whose population collapsed in 2004, consist primarily of low numbers of age-0 individuals.

3. Status of benthic prey fish in the main basin in 2025 also varied by species. As in prior years, the native sculpin community in 2025 consisted primarily of Deepwater Sculpin because Slimy Sculpin has become exceedingly rare. In contrast, biomass of Round Goby, a non-native species

ecologically similar to sculpin, remained at near record highs in 2025.

4. Cisco, which are the target of a large reintroduction effort in Saginaw Bay, continued to show signs of recovery in the North Channel and Georgian Bay. Populations in the North Channel have sustained population increases first observed in 2016.

5. Use of complementary surveys (bottom trawl, acoustics) remains an important tool for evaluating prey fish status in Lake Huron, where prey fish community dynamics vary by basin and species responses to changing environmental conditions are non-uniform.

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Figures

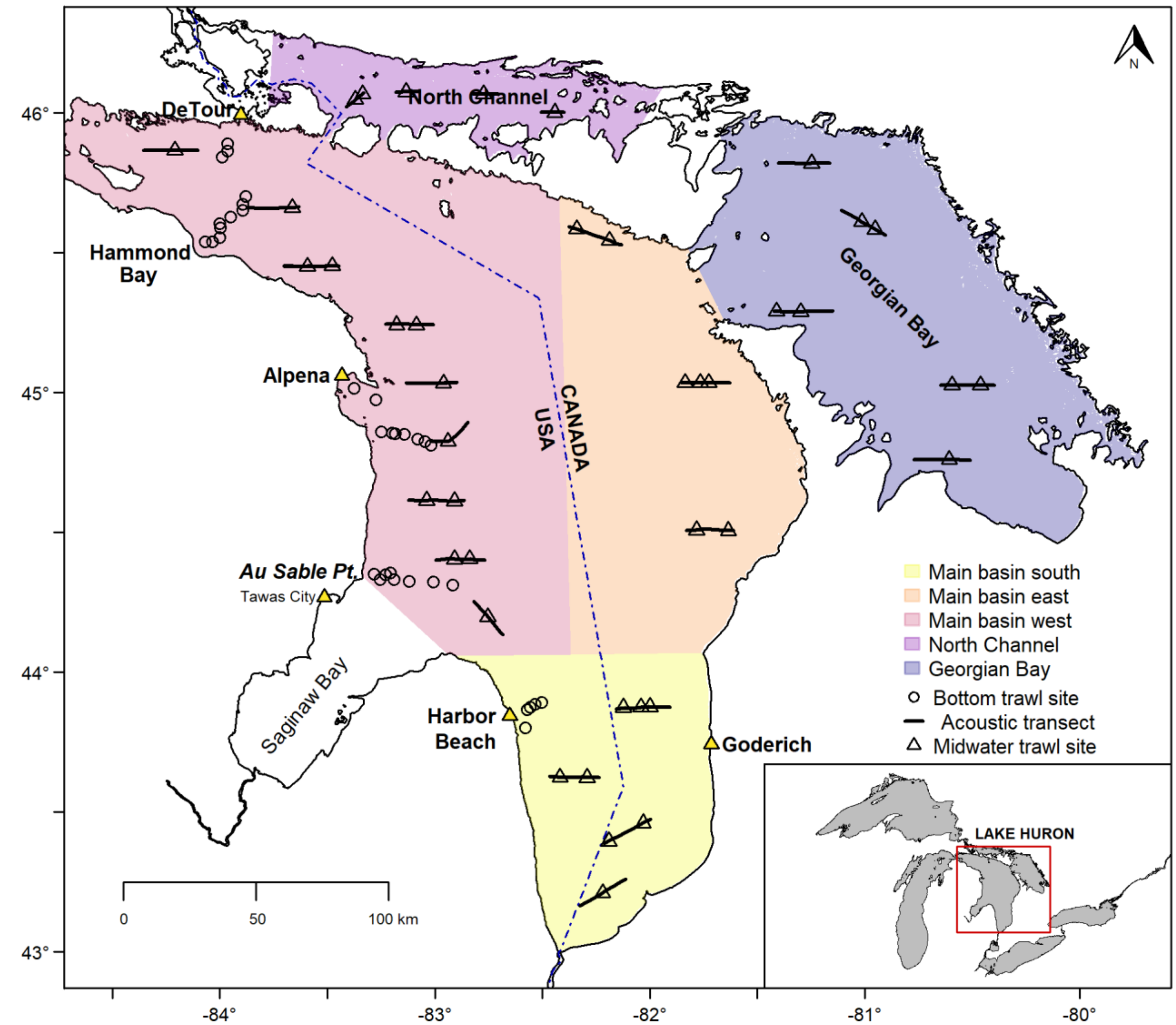

Figure 1. Location of bottom trawls, acoustic transects, and midwater trawls sampled in Lake Huron during 2025. Acoustic sampling strata (shaded areas) correspond to geographic regions: main-basin east, main-basin west, main-basin south, Georgian Bay, and North Channel. Saginaw Bay (unshaded) is not part of the standard bottom trawl or acoustics survey areas.

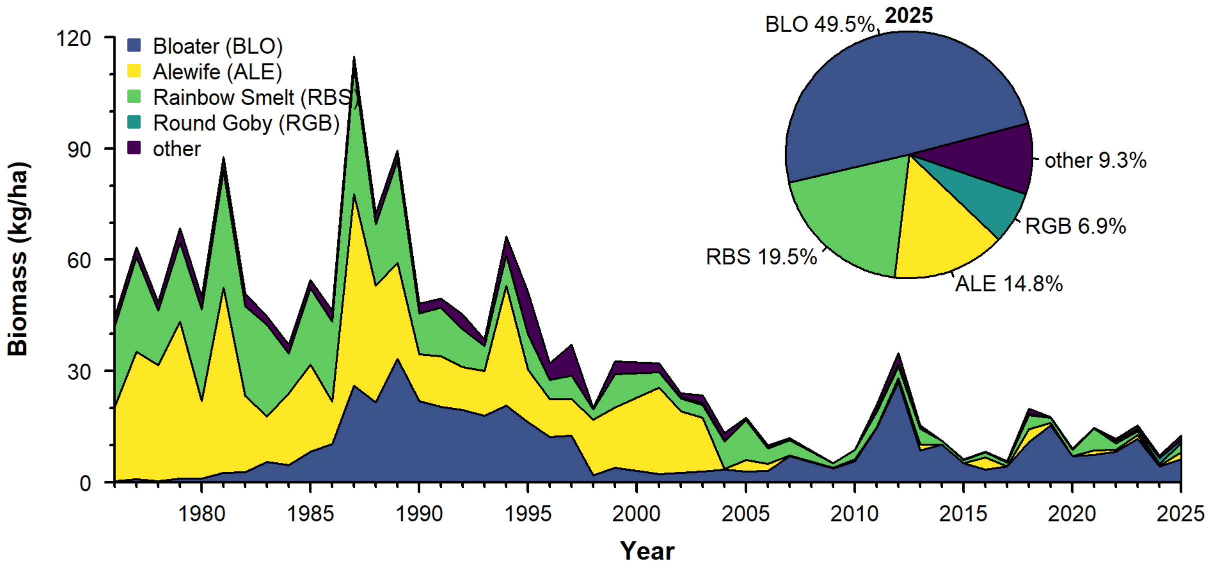

Figure 2. Biomass and species composition of prey fish sampled in bottom trawls in the main basin of Lake Huron, 1976-2025 (pie chart: species composition by biomass in 2025).

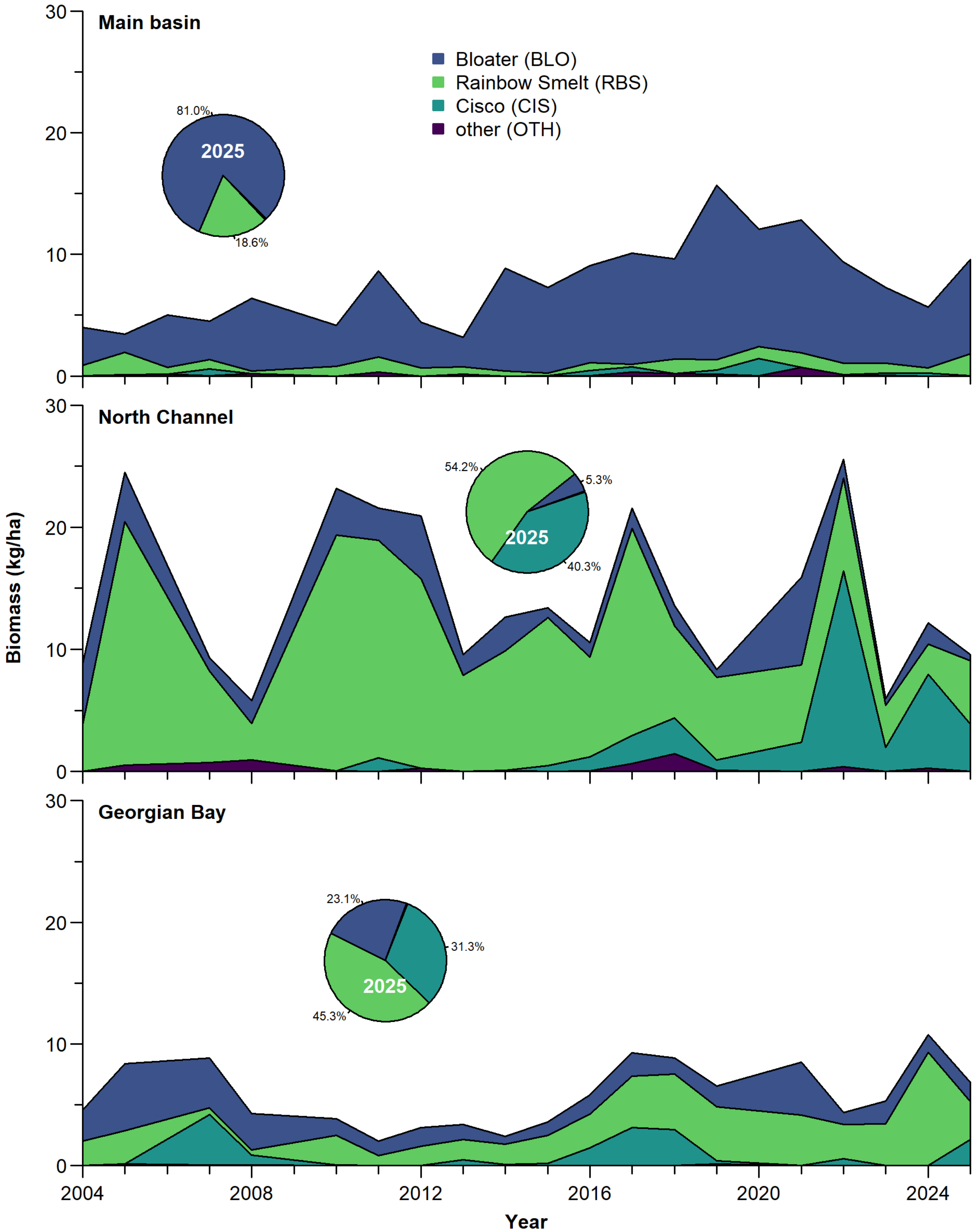

Figure 3. Acoustic prey fish biomass and species composition in Lake Huron by year (2004-2025) and lake basin. Pie charts denote species composition by biomass in 2025.

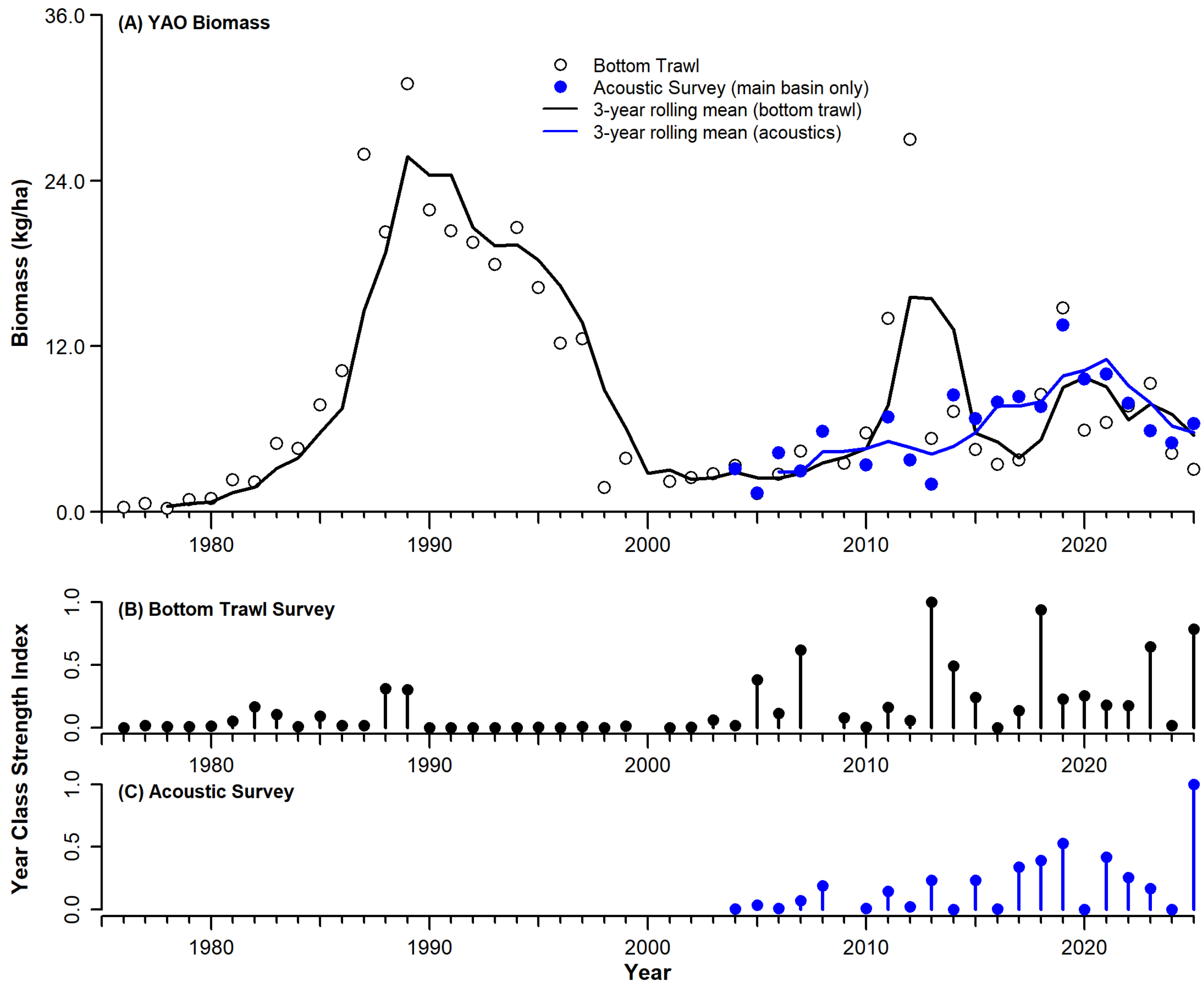

Figure 4. Biomass of yearling-and-older (YAO) Bloater *Coregonus hoyi* (A) and Bloater year-class strength (B, C) as estimated from annual USGS bottom trawl (1975-2025) and acoustics (2004-2025) surveys in the main basin of Lake Huron. Relative year-class strength was calculated as the mean annual density (number/ha) of YOY-sized fish divided by the maximum annual mean (index range: 0-1).

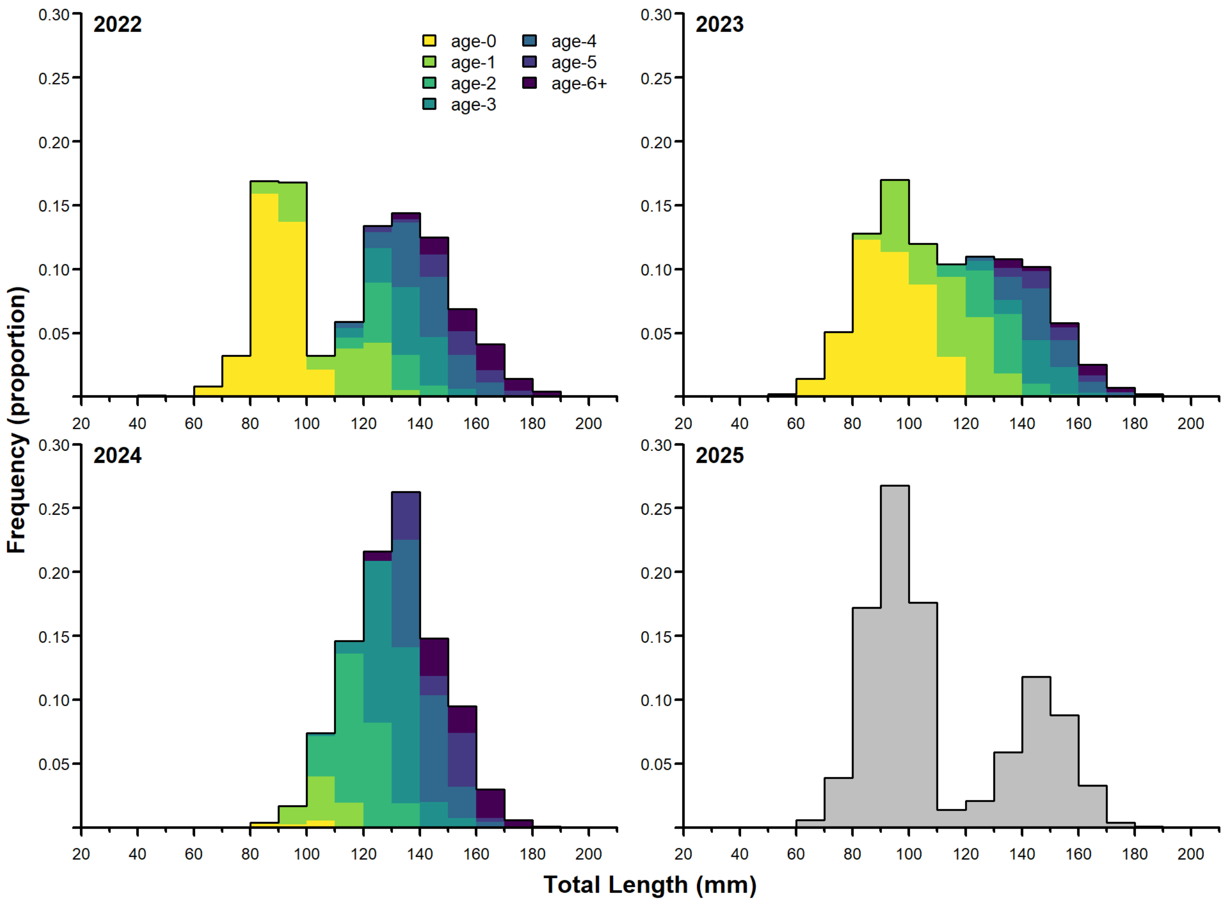

Figure 5. Length frequency and age composition of Bloater *Coregonus hoyi* sampled in bottom trawls conducted in the main basin of Lake Huron, 2022-2025. Ages were estimated from a subsample of up to 10 fish per 10-mm length bin for each port where Bloater were sampled and expanded to the total length frequency. Age composition of Bloater sampled in the 2025 survey was not yet available as of the writing of this report.

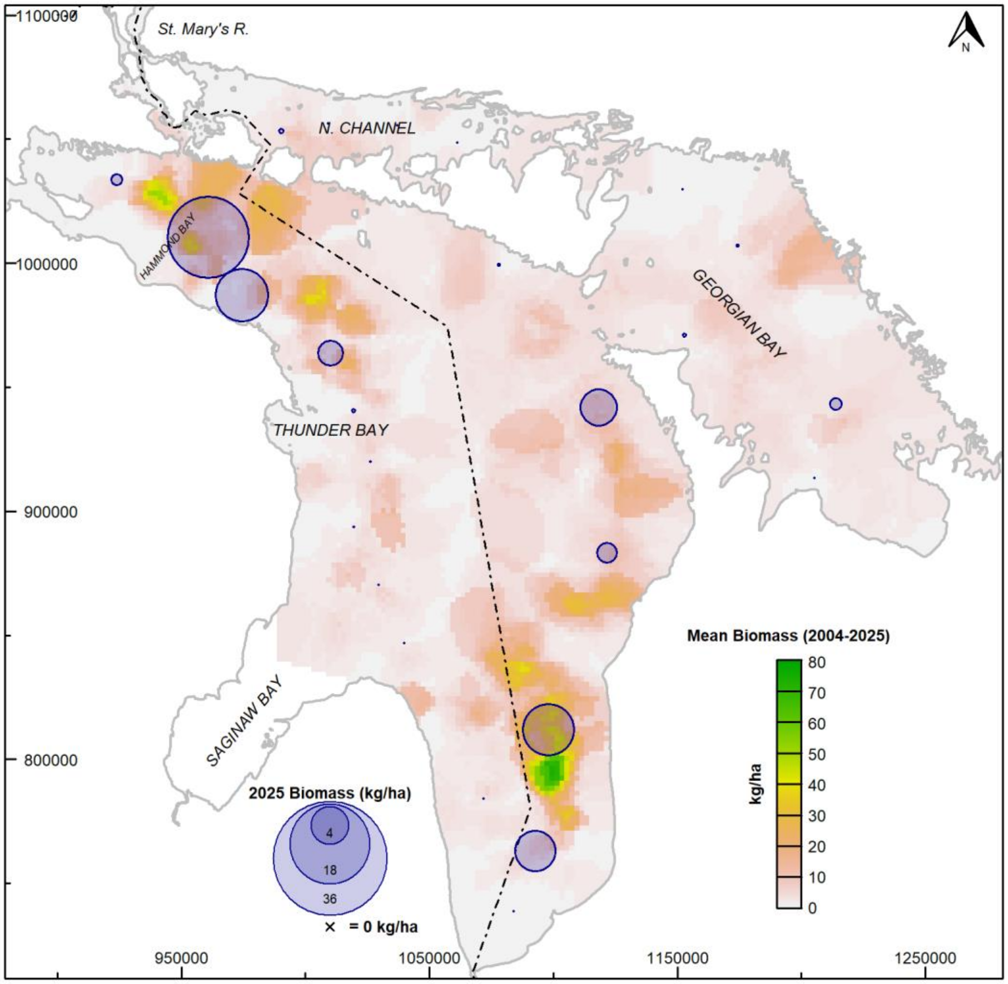

Figure 6. Distribution of Bloater *Coregonus hoyi* in Lake Huron for the most recent survey year, 2025 (bubbles), and mean distribution based on sampling during the period 2004-2025 (heat map). Bloater biomass was estimated solely from the acoustics-midwater trawl survey. Nearest-neighbor interpolation was used to extrapolate fish biomass from acoustic transects to the lake-wide scale.

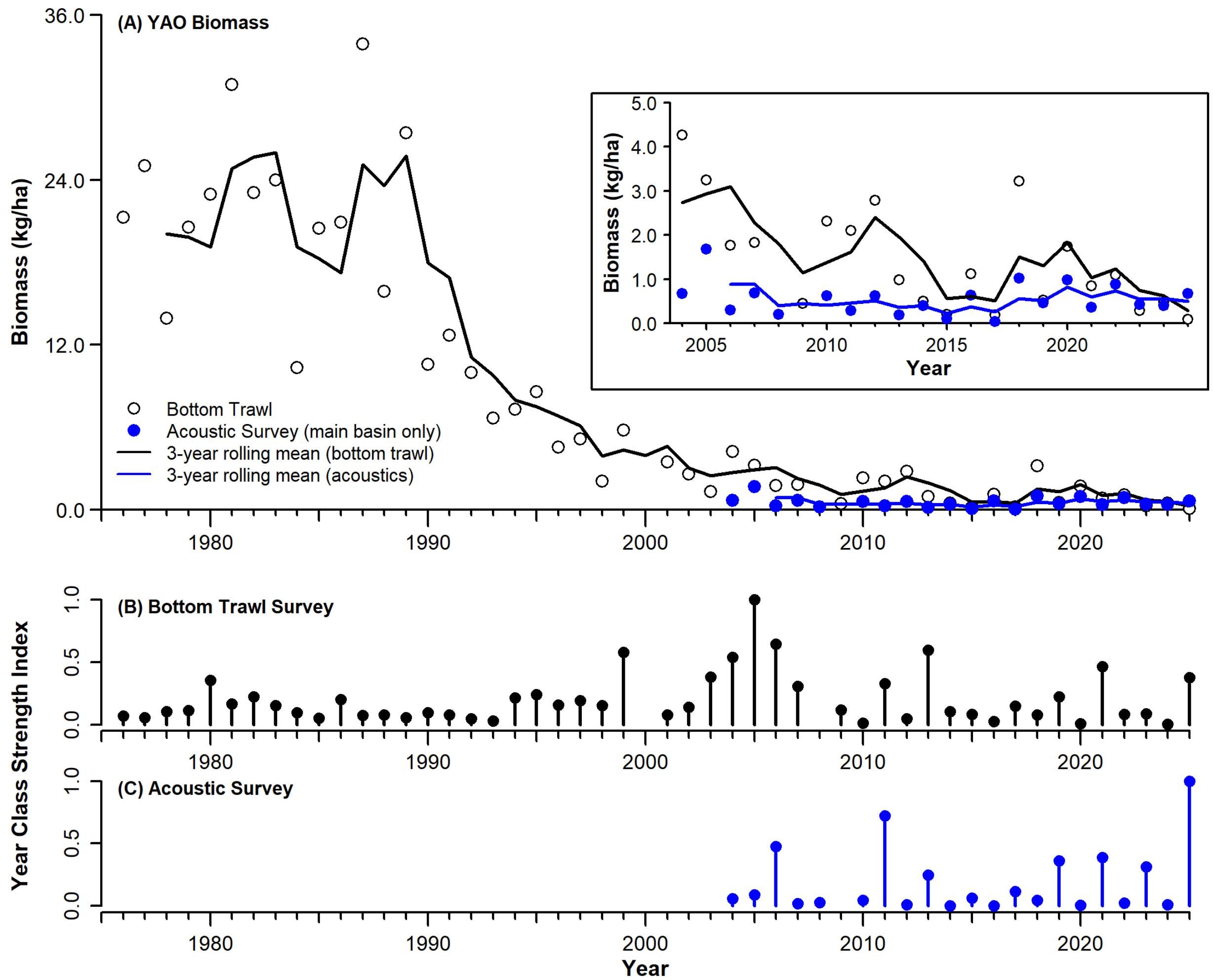

Figure 7. Biomass of yearling-and-older (YAO) Rainbow Smelt *Osmerus mordax* (A) and Rainbow Smelt year-class strength (B, C) as estimated from annual USGS bottom trawl (1976-2025) and acoustic (2004-2025) surveys in the main basin of Lake Huron. Inset: Biomass of yearling-and-older (YAO) Rainbow Smelt for the years 2004-2025. Relative year-class strength was calculated as the mean annual density (number/ha) of YOY-sized fish divided by the maximum annual mean (index range: 0-1).

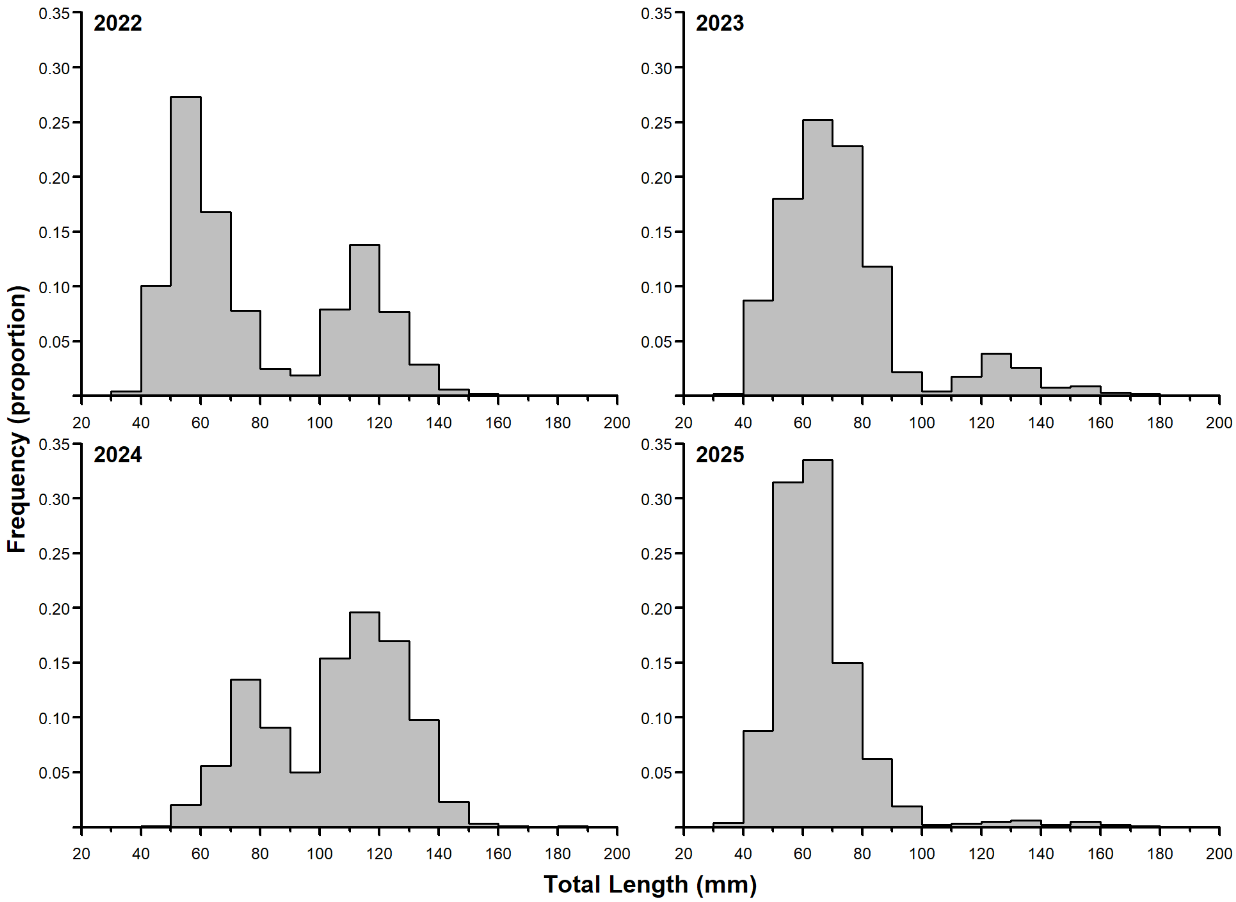

Figure 8. Length-frequency distribution for Rainbow Smelt *Osmerus mordax* sampled in bottom trawl surveys in the main basin of Lake Huron during 2022-2025.

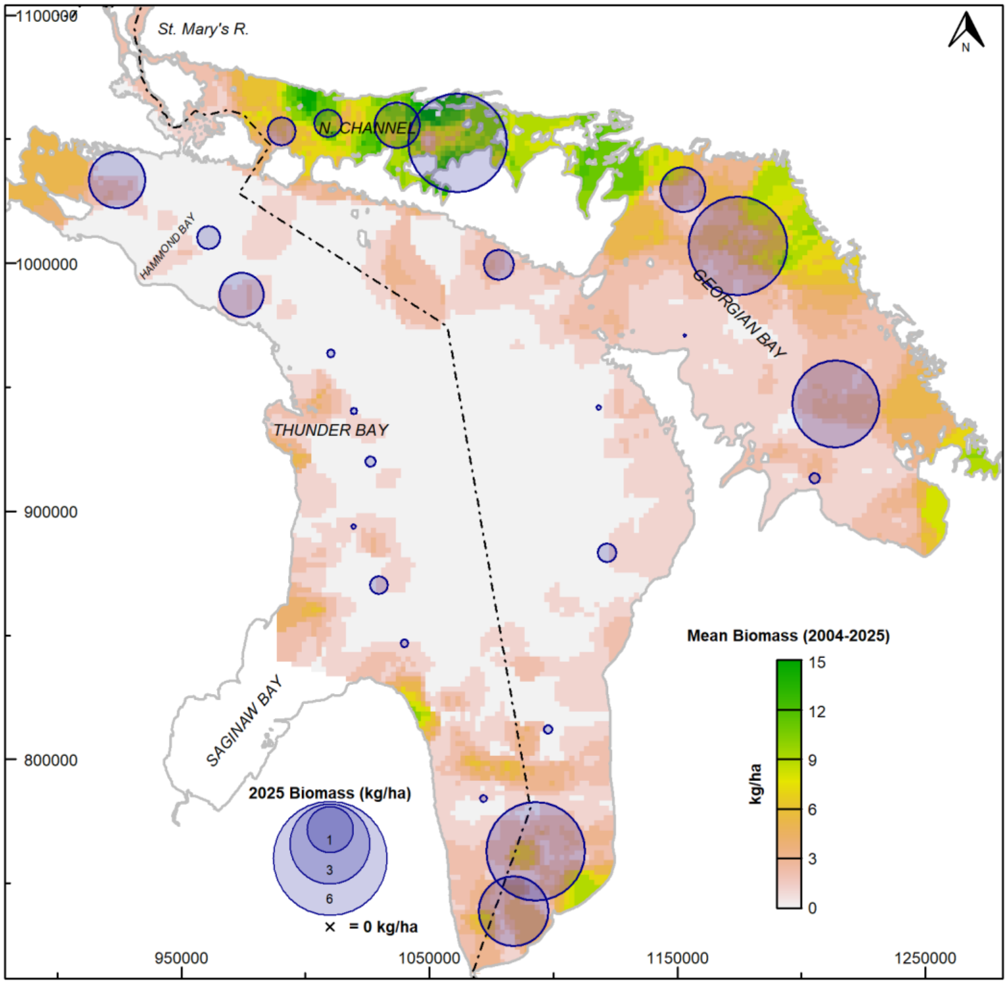

Figure 9. Distribution of Rainbow Smelt *Osmerus mordax* in Lake Huron for the most recent survey year, 2025 (bubbles), and mean distribution based on sampling during the period 2004-2025 (heat map). Rainbow Smelt biomass was estimated solely from the acoustics-midwater trawl survey. Nearest-neighbor interpolation was used to extrapolate fish biomass from acoustic transects to the lake-wide scale.

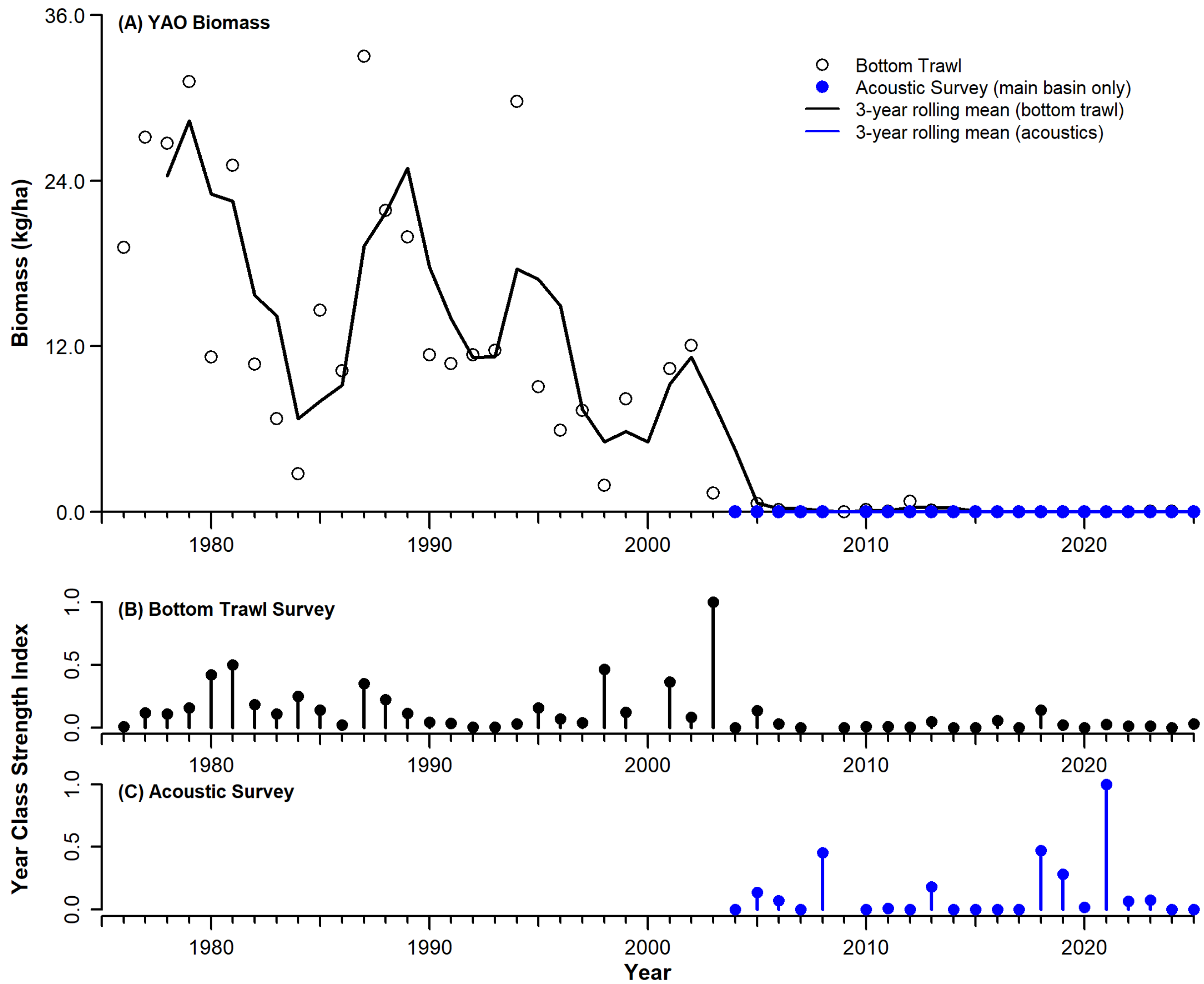

Figure 10. Biomass of yearling-and-older (YAO) Alewife *Alosa pseudoharengus* (A) and Alewife year-class strength (B, C) as estimated from annual USGS bottom trawl (1976-2025) and acoustic (2004-2025) surveys in the main basin of Lake Huron. Relative year-class strength was calculated as the mean annual density (number/ha) of YOY-sized fish divided by the maximum annual mean (index range: 0-1).

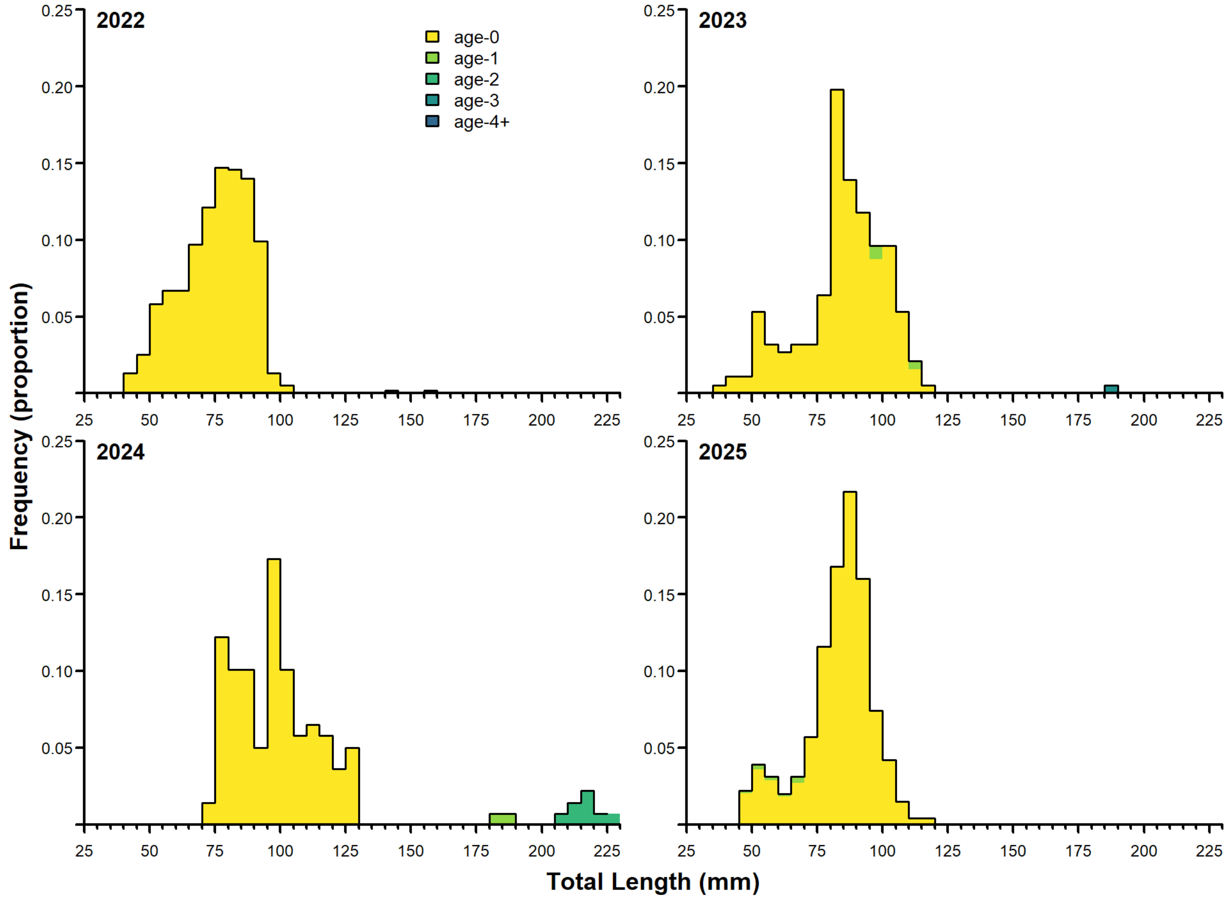

Figure 11. Length frequency and age composition of Alewife *Alosa pseudoharengus* sampled in bottom trawls conducted in the main basin of Lake Huron, 2022-2025. Ages were estimated from a subsample of up to 7 fish per 5-mm length bin for each port where Alewife were sampled and expanded to the total length frequency.

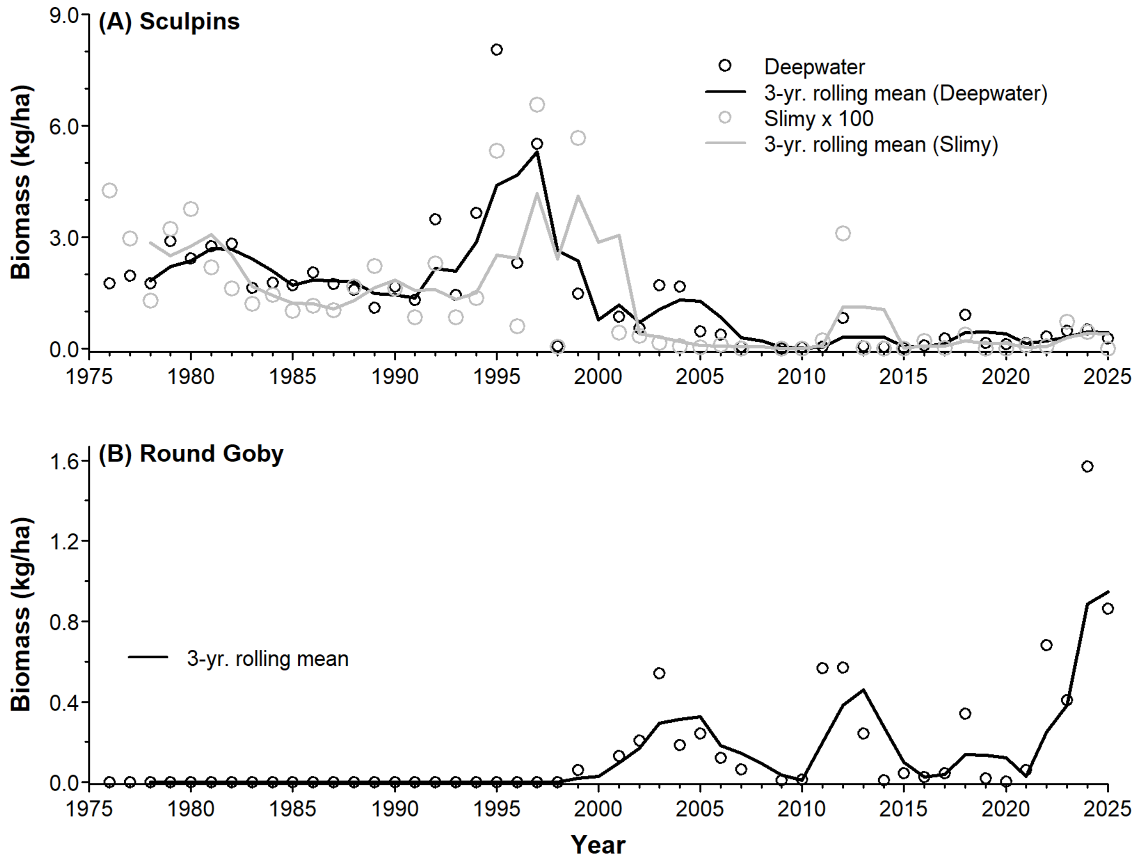

Figure 12. Biomass of sculpins—Slimy Sculpin *Cottus cognatus* and Deepwater Sculpin *Myoxocephalus thompsonii* (A)—and Round Goby *Neogobius melanostomus* (B) as estimated from annual U.S. Geological Survey bottom trawl surveys in the main basin of Lake Huron, 1976-2025. Slimy Sculpin biomass was multiplied by 100 to facilitate comparison of abundance trends between sculpin species.

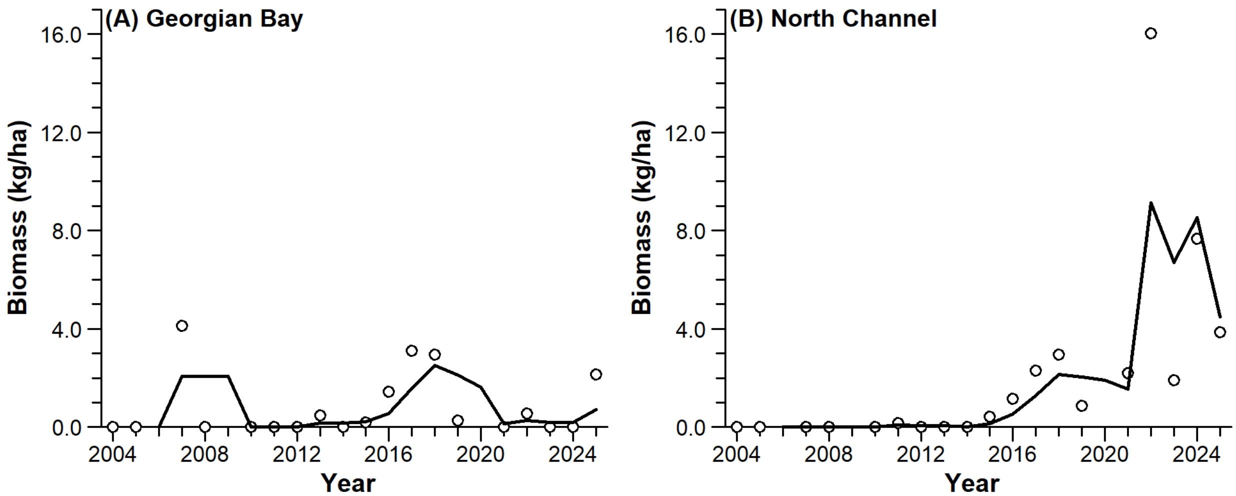

Figure 13. Biomass of Cisco *Coregonus artedi* in Georgian Bay (A) and the North Channel (B) as estimated from annual U.S. Geological Survey acoustics surveys in Lake Huron, 2004-2025. Lines represent 3-year rolling means.

Appendix

Table A1. Mean (±SE) prey fish biomass (g/ha) from the Bottom Trawl Survey (main basin) and Acoustics Survey (lake-wide) in Lake Huron by species in 2025. Biomass estimates for Alewife, Rainbow Smelt, Bloater, and Cisco are stratified by age class (YOY = young-of-year; YAO = yearling and older).

			Survey	
Common Name	**Scientific Name**	**Age Class**	*Bottom Trawl*	*Acoustics*
Alewife	*Alosa Pseudoharengus*	YOY	1856.2 ± 1767.9	0.8 ± 0.4
		YAO	—	—
Bloater	*Coregonus hoyi*	YOY	3124.1 ± 793.2	1034.1 ± 416.8
		YAO	3081.1 ± 1016.2	5048.8 ± 1627.0
Cisco	*Coregonus artedi*	YOY	—	—
		YAO	—	653.7 ± 440.1
Deepwater Sculpin	*Myoxocephalus thompsonii*		275.1 ± 56.8	—
Emerald Shiner	*Notropis atherinoides*		—	14.3 ± 6.0
Gizzard Shad	*Dorosoma cepedianum*		1.7 ± 1.3	—
Ninespine Stickleback	*Pungitius pungitius*		170.6 ± 103	11.5 ± 5.5
Rainbow Smelt	*Osmerus mordax*	YOY	2358.3 ± 731	995.4 ± 358.3
		YAO	92.6 ± 53.1	1244.3 ± 341.7
Round Goby	*Neogobius melanostomus*		863.0 ± 276.4	—
Spottail Shiner	*Notropis hudsonius*		6.5 ± 4.1	—
Threespine Stickleback	*Gasterosteus aculeatus*		0.9 ± 0.7	8.9 ± 4.8
Trout-perch	*Percopsis omiscomaycus*		599.8 ± 482.8	—
White Perch	*Morone americana*		3.1 ± 2.4	—
Yellow Perch	*Perca flavescens*		111.3 ± 40.5	—

Table A2. Mean (±SE) prey fish density (number/ha) from the Bottom Trawl Survey (main basin) and Acoustics Survey (lake-wide) in Lake Huron by species in 2025. Density estimates for Alewife, Rainbow Smelt, Bloater, and Cisco are stratified by age class (YOY = young-of-year; YAO = yearling and older).

			Survey	
Common Name	**Scientific Name**	**Age Class**	*Bottom Trawl*	*Acoustics*
Alewife	*Alosa Pseudoharengus*	YOY	353 ± 333	1 ± 0
		YAO	—	—
Bloater	*Coregonus hoyi*	YOY	546 ± 123	962 ± 381
		YAO	144 ± 47	209 ± 53
Cisco	*Coregonus artedi*	YOY	—	—
		YAO	—	1 ± 1
Deepwater Sculpin	*Myoxocephalus thompsonii*		51 ± 11	—
Emerald Shiner	*Notropis atherinoides*		—	24 ± 11
Gizzard Shad	*Dorosoma cepedianum*		< 1	—
Ninespine Stickleback	*Pungitius pungitius*		90 ± 53	8 ± 4
Rainbow Smelt	*Osmerus mordax*	YOY	2090 ± 773	1924 ± 657
Rainbow Smelt		YAO	7 ± 4	188 ± 52
Round Goby	*Neogobius melanostomus*		235 ± 82	—
Spottail Shiner	*Notropis hudsonius*		2 ± 1	—
Threespine Stickleback	*Gasterosteus aculeatus*		< 1	14 ± 7
Trout-perch	*Percopsis omiscomaycus*		146 ± 121	—
White Perch	*Morone americana*		< 1	—
Yellow Perch	*Perca flavescens*		33 ± 12	—