Status and Trends in the Lake Superior Fish Community, 2024

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Abstract

The U.S. Geological Survey has conducted annual fishery surveys across Lake Superior since 1978 that describe trends in fish species occurrence and relative abundance to inform fisheries management and ecosystem health. In 2024, the Lake Superior fish community was sampled with daytime bottom and surface trawls at 72 nearshore locations in June and 36 offshore locations in July. Nearshore bottom trawls collected 22,190 fish represented by 27 species or morphotypes. The number of species collected at each location ranged from 1 to 12, with a median of 5.5 species. Estimated fish biomass at individual locations ranged from <0.1 to 62.9 kg per ha with a lakewide mean of 3.7 kg per ha. Offshore bottom trawls collected 33,634 fish represented by 12 species or morphotypes. Estimated fish biomass at individual locations ranged from 0.6 to 25.8 kg per ha with a lakewide mean of 8.3 kg per ha, which was the second highest for the period-of-record. Lakewide average densities (fish per ha) of age-1 fish were 1 per ha for Bloater, 5 per ha for Cisco, 1 per ha for Lake Whitefish, 60 per ha for Rainbow Smelt, and 19 per ha for Kiyi. Surface trawling collected 5,177 larval *Coregonus* individuals which was the third fewest *Coregonus* larvae collected in a whole lake survey since the larval fish survey began in 2014. Nearshore mean larval *Coregonus* densities were 176 fish per ha in June 2024 and offshore densities were 7 fish per ha in July 2024. June and July surface water temperatures were near the warmest for the period-of-record.

Introduction

The U.S. Geological Survey, Great Lakes Science Center, Lake Superior Biological Station, based in Ashland, Wisconsin conducts annual daytime lakewide fish community bottom trawl surveys in nearshore (~15-80 m depths) and offshore (~90-300 m depths) waters. Both surveys provide data for assessing species occurrence and trends in relative abundance and biomass for principal fishes and estimates of year-class strength for age-1 Bloater, Cisco, Kiyi, Lake Whitefish, and Rainbow Smelt (scientific names are provided in Table 1). The number

of age-1 fish per ha has been used historically as a relative measure of year-class strength to predict future populations sizes for these important species.

The nearshore bottom trawl survey has been conducted annually since 1978 in USA waters, and since 1989 in USA and Canadian waters. The offshore bottom trawl survey has been conducted annually since 2011 in USA and Canadian waters. Surface trawling has occurred annually during the nearshore and offshore surveys since 2014. In 2020 only nearshore locations in the Apostle Islands (Management Unit WI-2), near Ashland, Wisconsin, were sampled and in 2021 only nearshore locations in USA waters were sampled due to COVID-related travel restrictions. Surface trawling has been conducted to collect larval *Coregonus* fishes, as measures of species occurrence and relative abundance, and to evaluate factors influencing survival to age-1. Larval *Coregonus* fishes have been identified using genomics since 2019. Genomic data for 2023 and 2024 are not yet available. In addition to fish collections, a whole water column zooplankton tow and an electronic water column sampler (SBE19plus profiler, SeaBird Inc., Bellevue, Washington) was deployed at each trawl location, which collects data on depth, temperature, beam transmission specific conductance, dissolved oxygen, pH, chlorophyll *a*, and photosynthetic active. Data for years prior to 2023 are publicly available (U.S. Geological Survey 2022, https://doi.org/10.5066/P9XVOLR1) and 2023-2024 data will be available in 2025.

Methods

Nearshore Bottom Trawl Fish Collections

Nearshore locations are fixed sites located around the perimeter of the lake and were established in the USA in 1978 and in Canada in 1989 (Figure 1). Locations are sampled with only slight annual variations due to commercial fishing operations, vessel crew manning, mechanical issues, and weather. In 2024, 72 of 78 planned locations were sampled during daylight hours from May 14 to June 15. Four locations, 85-Gay, 187-Big Sucker River, 457-Alona Bay, and 462-Dore Bay were not sampled due to insufficient time remaining in the day. The trawl was ripped at location 76-Mawikwe Point. Location 405-Black Bay South Demers Point was not sampled due to lightning. At each location sampled, a single bottom trawl tow was conducted along a cross-contour transect with a 12-m Yankee bottom trawl with a chain or rubber roller disk foot rope. The rubber roller disk foot rope trawl was fished at steeper rockier locations. The median start and end depths for bottom trawl tows were 15 (range 7-27 m) and 51 m (range 20-122 m), respectively. The median distance trawled was 1.5 km (range 0.5-4.0 km) at a speed of ~4.0 km per h. Specific location and

trawling data for each sampling location are provided in Appendix A. Bottom trawl fishing area was calculated based on a fixed trawl wing spread of 7.8 m and the distance the trawl was on the lake bottom as determined using a trawl mensuration system (Marport.com) and the Research Vessel Kiyi's global positioning system.

Offshore Bottom Trawl Fish Collections

Offshore locations were randomly selected in 2011 and have been sampled annually thereafter, except for 2020 and 2021, due to COVID restrictions. In 2024, 36 locations were sampled during daylight hours from July 9-24. A single bottom trawl tow was conducted at each location using a 12-m Yankee bottom trawl with a chain foot rope. All tows were made on-contour for 20 minutes. Station depths ranged from 82 to 294 m. The median trawl distance was 1.4 km (range 1.3-1.4 km) at a speed of ~4.0 km per h. Specific location and trawling data for each sampling location are provided in Appendix A. Bottom trawl fishing area was calculated based on a fixed trawl wing spread of 7.8 m and the distance the trawl was on the bottom as determined using a trawl mensuration system (Marport.com) and the Research Vessel Kiyi's global positioning system.

Surface Trawl Fish Collections

Surface trawling was conducted at all nearshore and offshore bottom trawl locations sampled in 2024 during daylight hours predominantly at the same time as bottom trawling (Figure 1, Appendix A). Fish were collected using a paired one-square-meter 500-micron mesh neuston net (model 9550, Sea-Gear Corporation, Melbourne, Florida). The bottom of the net frame was fished ~0.5 m below the lake surface, such that approximately half the net's height was submerged to reduce waves washing over the top of the net. The net was fished for 10 minutes at ~4.0 km per h for ~0.7 km as determined from the Research Vessel Kiyi's global positioning system.

Water Temperatures

Water column temperatures associated with each trawl sample were collected near the beginning and ending positions for nearshore locations and near the trawl ending position for offshore locations using an electronic water profiler, aka, bathythermograph (SBE19plus profiler, SeaBird Inc., Bellevue, Washington). The profiler was calibrated annually by the manufacturer and has a reported precision of 0.01 °C. Reported temperatures are the

average temperature within 3 m of the surface from the downcast profile from the surface to the bottom of the lake.

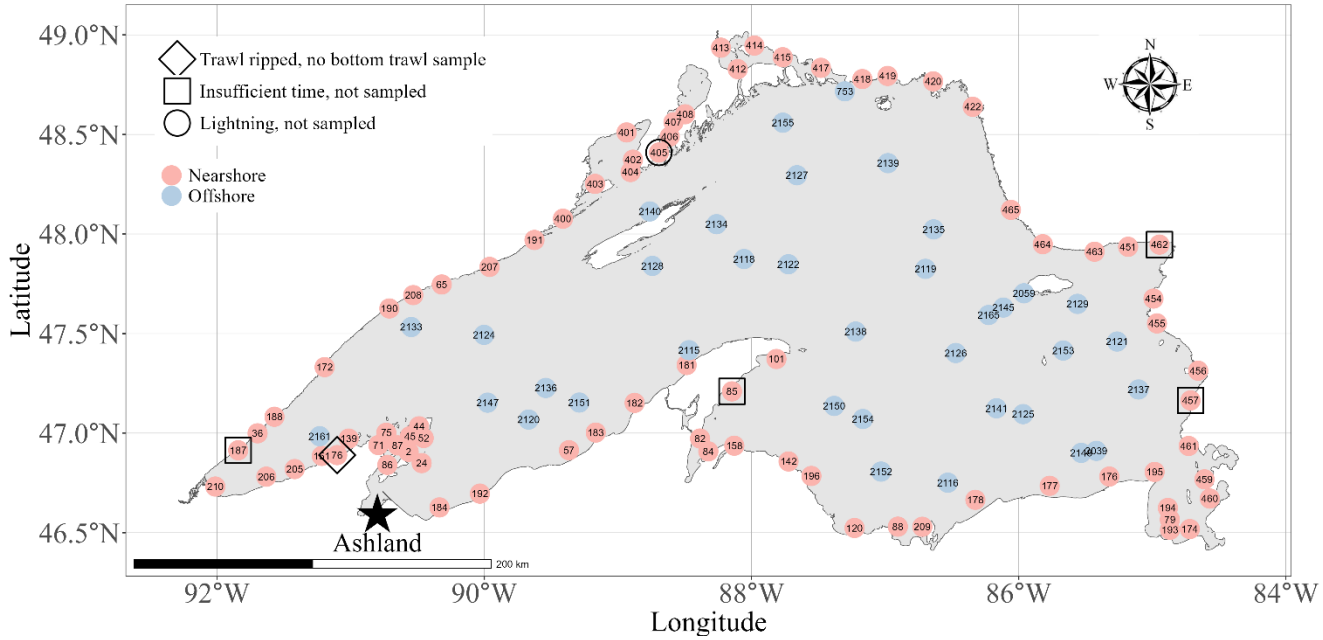

Figure 1. *Location of 78 nearshore (red) and 36 offshore (blue) planned sampling locations in 2024. These are long-term sampling locations traditionally sampled with bottom and surface trawls, a whole water column zooplankton tow, and an electronic water column sampler that collects data on depth, temperature, beam transmission, specific conductance, dissolved oxygen, pH, chlorophyll a, and photosynthetic active radiation each year. In 2024, bottom trawling for benthic and demersal fish occurred at 72 nearshore and 36 offshore locations. Surface trawling, zooplankton, and water column profiles were collected at 73 nearshore and 36 offshore locations. Four nearshore locations were not sampled for any attributes due insufficient time remaining in the day and one location was not sampled due to lightning. The bottom trawl was ripped at location 76, so no bottom trawl fish collections were made there, but the other traditional attributes were collected. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. Location numbers are unique identifiers that are sequentially added as new locations are sampled. Additional location and trawling data for each sampling location is provided in Appendix A.*

Catch Processing

Fish collected in bottom trawls were sorted by species, counted, and weighed in aggregate to the nearest gram. Lake Trout were separated by morphotype (lean vs siscowet) and origin (hatchery vs wild). Total length was measured for a maximum of 50 individuals per species

per trawl. Lengths of these individuals were extrapolated to the entire catch when more than 50 individuals were collected. Abundance (fish per ha) and biomass (kg per ha) were estimated by dividing sample counts and aggregate weights by the area swept by each trawl tow (ha). For annual nearshore bottom trawl collections, biomass estimates are reported for all species combined, Sculpin species combined (Slimy, Spoonhead, and Deepwater Sculpin), and individually for Bloater, Cisco, Lake Whitefish, and Rainbow Smelt. A composite estimate is also reported for less-common species (Table 1). For offshore bottom trawl collections, biomass estimates are reported for all species combined and individually for Deepwater Sculpin, Kiyi, and siscowet Lake Trout. Age-1 year-class strength was estimated as the mean nearshore lakewide abundance (fish per ha) of age-1 fish determined by the following total length thresholds: Cisco ≤140 mm (Dryer and Beil, 1964), Bloater ≤130 mm (Dryer and Beil, 1968), Lake Whitefish ≤160 mm (Edsall 1960; Dryer 1964; Seider and Schram, 2009; Fera et al. 2015), Rainbow Smelt ≤100 mm (Luey and Adelman, 1984), and Kiyi ≤110 mm (Lepak et al. 2017). These age-size thresholds are approximate and are known to vary among years.

Larval fish collected in surface trawls were immediately removed from the nets and identified as *Coregonus*, Deepwater Sculpin, Rainbow Smelt, or Pacific Salmon based on morphological characters (Hinrichs 1979; Auer 1982). *Coregonus* larvae were counted and stored in 20 mL polyethylene scintillation vials with 90% ethanol. Presence of other larval species were noted and discarded. Larval fish densities were calculated based on the width of the sampling nets and the distance towed. Data are not reported for 2020 and 2021 as fewer locations were sampled due to COVID restrictions.

Data Analysis, Visualization, and Availability and USGS Disclaimer

All data manipulations, statistical analyses, and visualizations were performed in R version 4.0.5 (R Development Core Team 2023). Data visualizations were produced using ggplot2 (Wickham 2016). Data for years prior to 2023 are publicly available (U.S. Geological Survey 2022, https://doi.org/10.5066/P9XVOLR17) and 2023-2024 data will be available in 2025. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Results

Nearshore Fish Collections

A total of 22,190 fish from 27 species or morphotypes were collected across 72 nearshore locations (Table 1). The number of species collected at each location ranged from 1 to 12, with a median of 5.5 species. Estimated fish biomass at individual locations ranged from <0.1 to 62.9 kg per ha (Figure 2). The four locations with the highest biomass in 2024 were all in Wisconsin waters, 71 - Raspberry Point (62.9 kg per ha), 206 – Brule River (42.1 kg per ha, 151 - Bark Point (23.6 kg per ha), and 205 - Port Wing (14.8 kg per ha, Figure 2). Average lakewide fish biomass across all locations was 3.7 kg per ha, which was substantially less than the 18.2 kg per ha estimated in 2023 (Figure 3). Average lakewide biomass in 2024 was highest for Cisco (1.3 kg per ha), Rainbow Smelt (0.7 kg per ha), Lake Whitefish (0.5 kg per ha), and Bloater (0.4 kg per ha, Table 1). Other species collected in nearshore bottom trawl tows in 2024 (number collected) included Ninespine Stickleback (1115), Trout-perch (987), Slimy Sculpin (285), Pygmy Whitefish (186), Deepwater Sculpin (106), Alewife (101), lean Lake Trout (63), Spoonhead Sculpin (59), Kiyi (58), Longnose Sucker (45), siscowet Lake Trout (28), Ruffe (21), Threespine Stickleback (11), Burbot (11), hatchery Lake Trout (7), Spottail Shiner (6), White Sucker (4), Splake (2), and one each of Central Mudminnow, Round Whitefish, Johnny Darter, Yellow Perch, and Walleye. The 27 fish species or morphotypes collected in 2024 was higher than the 23 fishes typically collected during this survey (Table 2). This was likely a reflection of the warmer than normal water temperatures present during the nearshore survey at the depths sampled. These warmer water preferring fishes included Alewife, Threespine Stickleback, Spottail Shiner, White Sucker, Central Mudminnow, Johnny Darter, Yellow Perch, and Walleye.

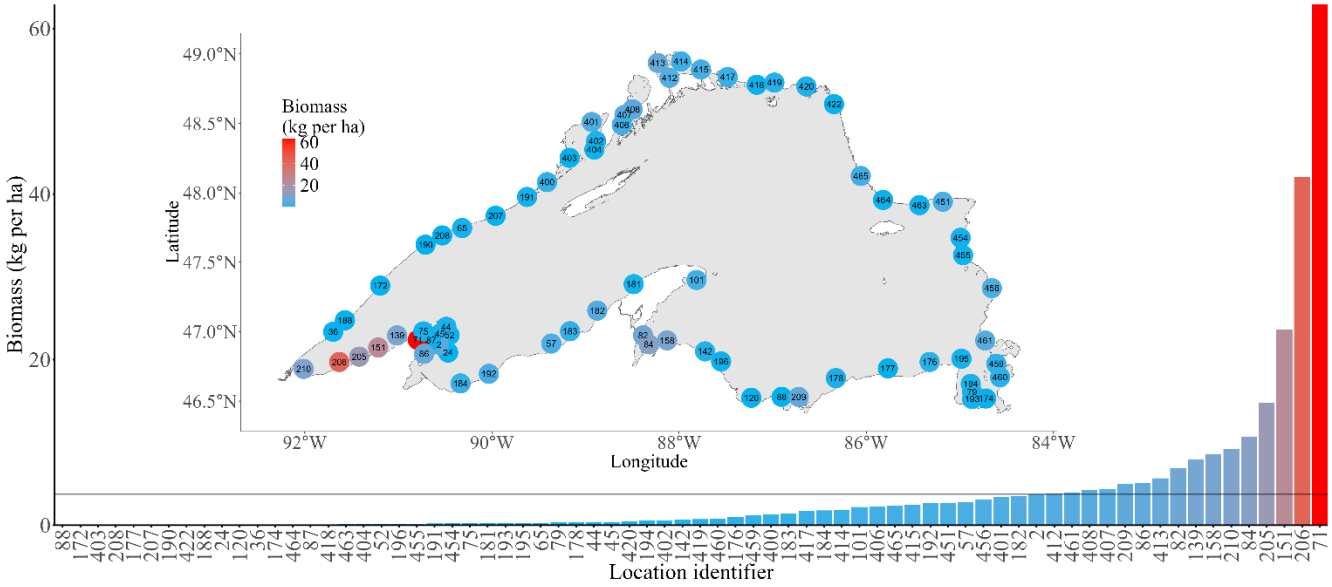

Figure 2. *Estimated total fish biomass (kg per ha) at 72 nearshore bottom trawling locations in nearshore USA and Canada waters of Lake Superior in 2024. Nearshore sampling locations were 7-122 m deep. The horizontal line is the 2024 average biomass across all locations (3.7 kg per ha). The inset figure shows sampling locations colored by their estimated biomass (kg per ha) in 2024. Colors within inset map correspond to colors in the histogram.*

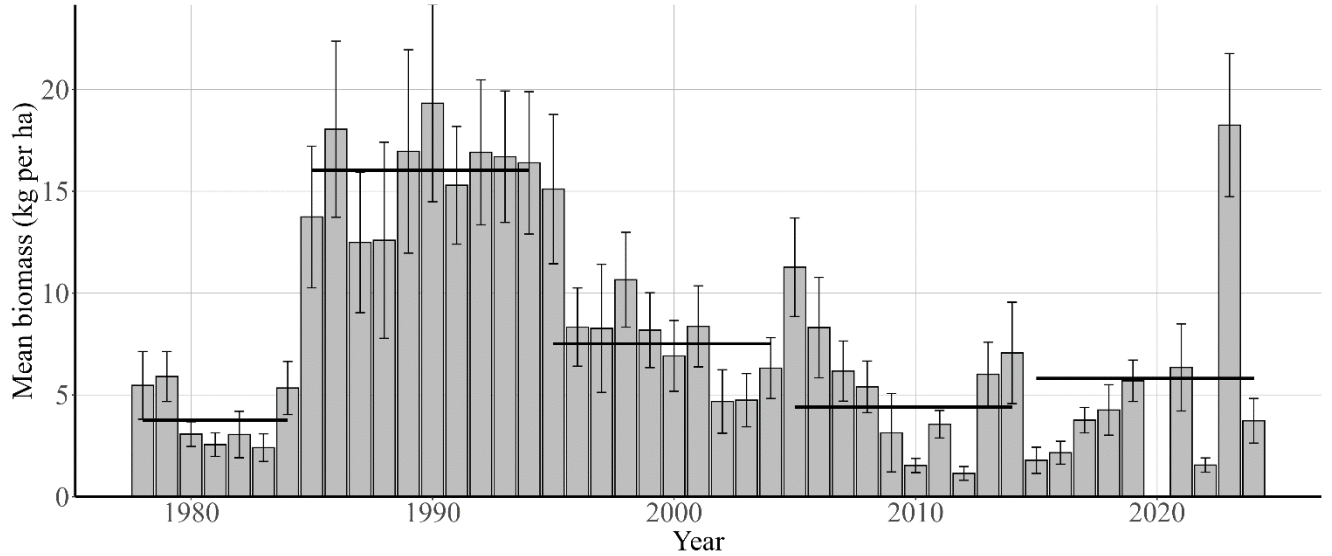

Figure 3. *Annual (mean ± standard error) total fish biomass estimates for all fish species collected in bottom trawl tows from 1978-2024 in nearshore USA and Canada waters of Lake Superior. Nearshore sampling locations were 7-122 m deep. Horizontal lines are 10-*

year averages across different periods. In 2020 sampling occurred outside the standard sampling window and only 11 locations were sampled in the Apostle Islands, north of Ashland, Wisconsin (Figure 1), so these data were excluded. From 1978-1988 and in 2021 only USA waters were sampled. The number of locations sampled in each year is presented in Table 2.

Nearshore Fishes Year-Class Strength

The number of age-1 fish per ha has been used historically as a measure of year-class strength of Lake Superior ciscoes and Rainbow Smelt. In 2024, age-1 Bloater were caught at 10 of 72 locations (Figure 4) and the average lakewide age-1 abundance was 1.2 per ha (Figure 5). Age-1 Cisco were caught at 23 of 72 locations (Figure 4) and the average lakewide age-1 abundance was 4.6 per ha (Figure 5). Age-1 Lake Whitefish were caught at 13 of 72 locations (Figure 4) and the average age-1 abundance was 0.9 per ha (Figure 5, Table 3). Age-1 Rainbow Smelt were caught at 69 of 72 locations (Figure 4) and the average lakewide age-1 abundance was 59.6 per ha which was in the lower 15% of all years (range = 5-615 age-1 Rainbow Smelt per ha, Table 3).

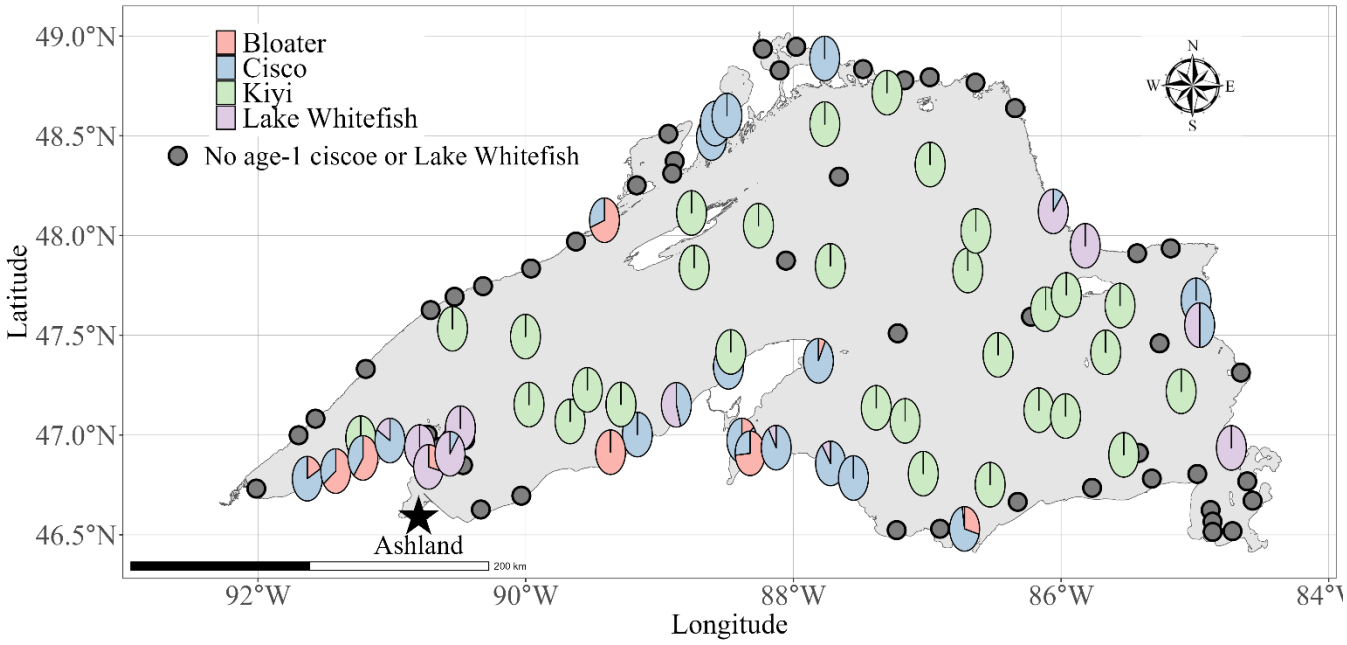

Figure 4. *Proportional abundance of age-1 Bloater, Cisco, Kiyi, and Lake Whitefish collected in near- and off-shore surveys in USA and Canada waters of Lake Superior in 2024. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. Gray solid points indicate no age-1 Bloater, Cisco, Kiyi, or Lake Whitefish were*

collected at that location. The location of individual stations by identification number is shown in Figure 1.

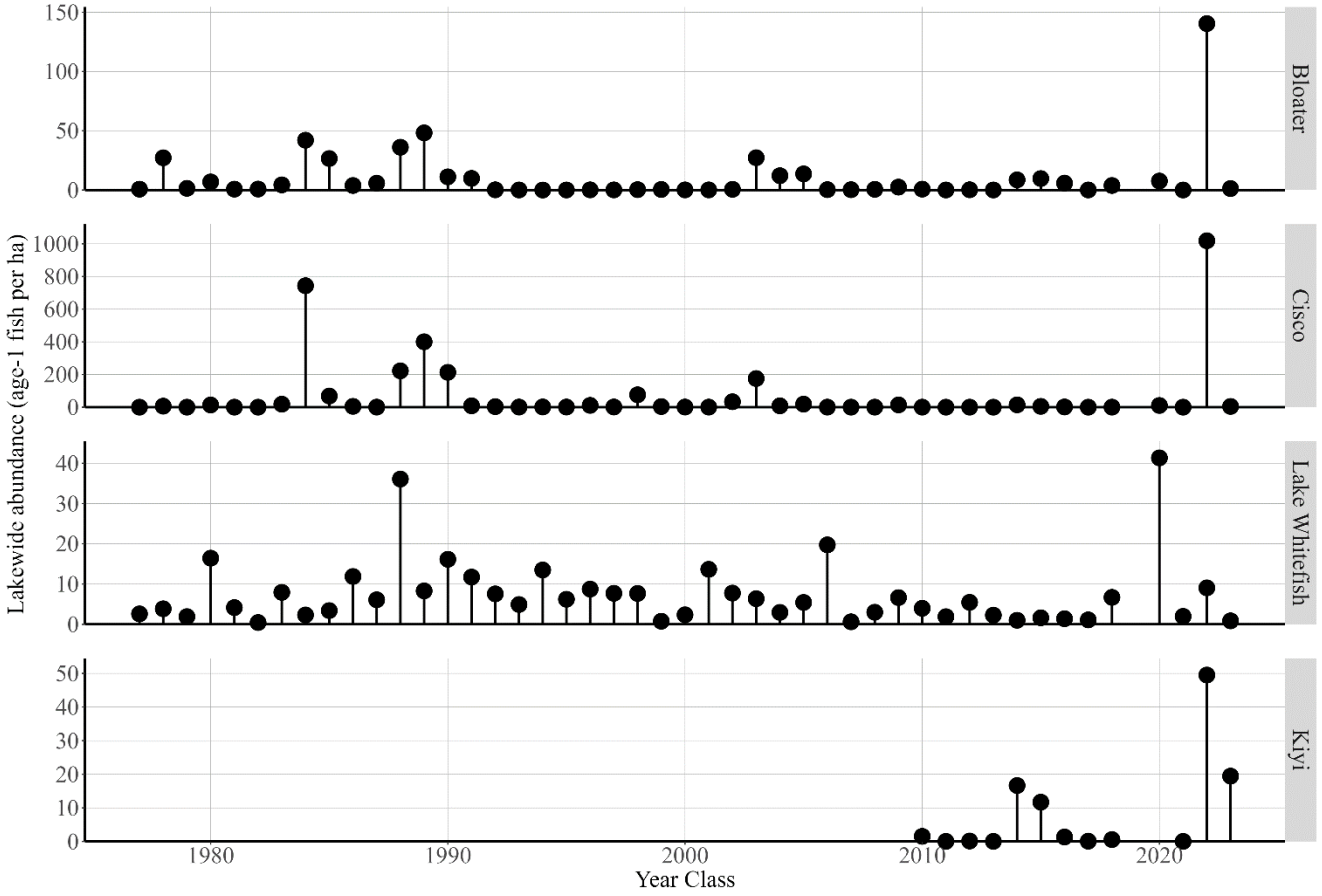

Figure 5. *Annual mean age-1 nearshore Bloater, Cisco, and Lake Whitefish and offshore Kiyi abundance estimates (age-1 fish per ha) collected in bottom trawl tows from 1978-2024 in nearshore surveys and 2011-2024 in offshore surveys in USA and Canada waters of Lake Superior. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. In 2020 sampling occurred outside the standard sampling window and only 11 locations were sampled in the Apostle Islands, north of Ashland, Wisconsin (Figure 1), so data for the 2019 year-class were excluded for nearshore Bloater, Cisco, and Lake Whitefish. Similarly, no data were available for the 2019 and 2020 Kiyi year-classes. From 1978-1988 and in 2021 only USA waters were sampled. The number of locations sampled in each year is presented in Table 3.*

Annual Offshore Fish Collections

Thirty-six offshore locations were sampled in 2024 from which 33,634 fish from 12 species or morphotypes were collected (Table 1). Estimated fish biomass at individual locations ranged from 0.6 to 25.8 kg per ha (Figure 6). Individual locations with the highest biomass in 2024 were all located east of the Keweenaw Peninsula and at depths near the lakewide mean depth of 147 m. These locations were 2137, a 185 m deep location east of Caribou Island, Ontario, locations 2154 and 2125, two 170 m deep locations near Stannard Rock, Michigan and south of Caribou Island, Ontario, and location 2129, a 185 m deep location near Michipicoten Island, Ontario (Figure 6). The lakewide offshore mean biomass was 8.3 kg per ha, which was the second highest for the period of record and 23% higher than the long-term (2011-2024) annual average of 6.4 kg per ha.

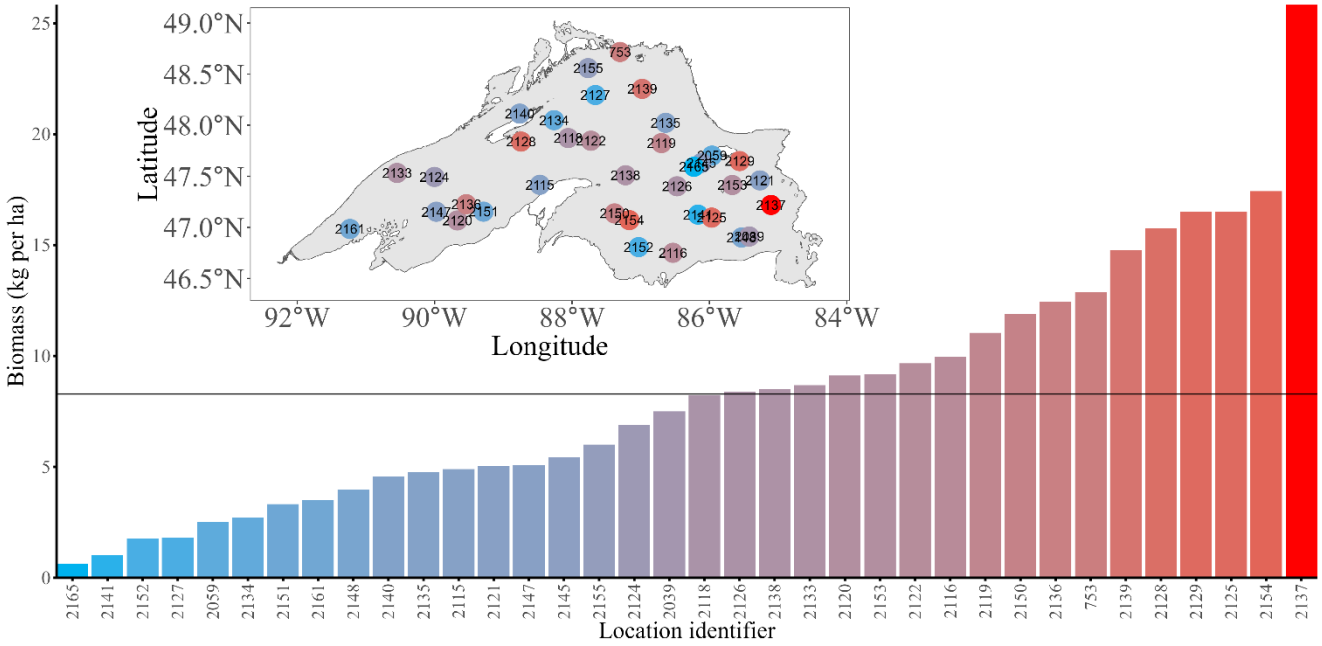

Figure 6. *Estimated biomass (kg per ha) at individual offshore locations in USA and Canada waters of Lake Superior in 2024. The horizontal line is the 2024 lakewide offshore average biomass (8.3 kg per ha). Locations were 82-294 m deep. The inset figure shows sampling locations colored by their estimated biomass (kg per ha) in 2024. Colors within inset map correspond to colors in the histogram.*

Deepwater Sculpin, Kiyi, and siscowet Lake Trout made up 99% of the total number of individuals and biomass collected in offshore waters (Table 1). Other fish collected in much lower abundances were Slimy Sculpin (35), Bloater (21), Spoonhead Sculpin (9), Cisco (8),

Burbot (6), Rainbow Smelt (6), Pygmy Whitefish (3), and one lean Lake Trout and Ninespine Stickleback (Table 1). Deepwater Sculpin offshore biomass averaged 3.8 kg per ha in 2024, which was the highest for the period of record and 45% higher than the long-term average of 2 kg per ha (Figure 7). Kiyi offshore biomass averaged 1.2 kg per ha in 2024 which was similar to the long-term average (Figure 8). Siscowet Lake Trout biomass averaged 3.2 kg per ha in 2024, which was the highest estimate since 2019 and similar to the long-term average of 2.8 kg per ha (Figure 7).

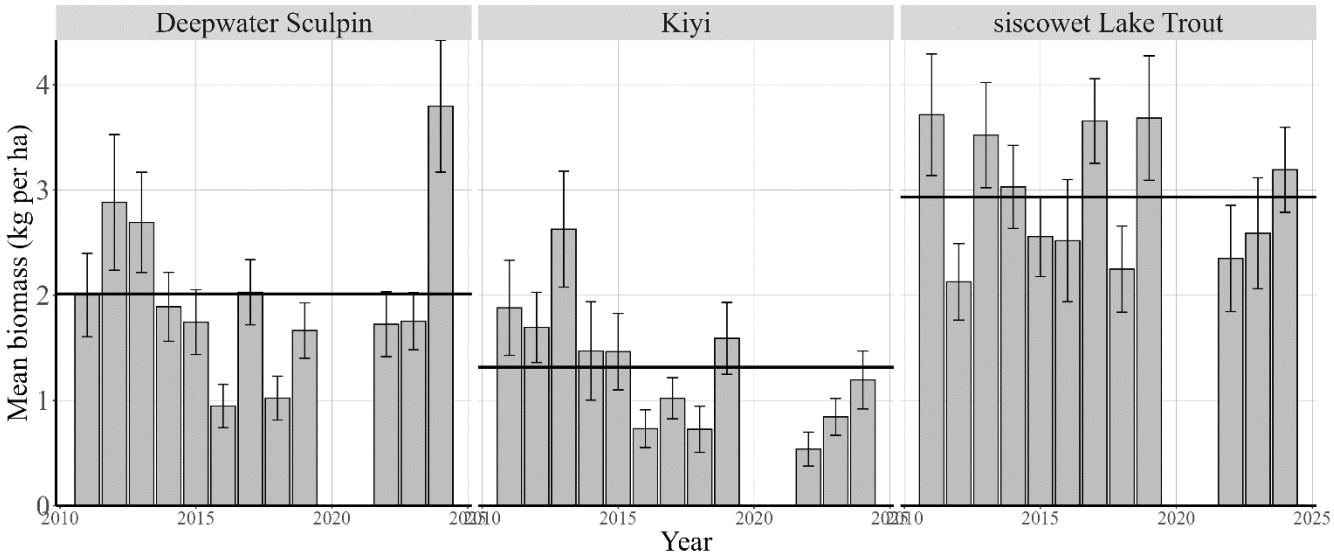

Figure 7. *Annual offshore biomass estimates (mean lakewide kg per ha ± standard error) for Deepwater Sculpin, Kiyi and siscowet Lake Trout in USA and Canada waters of Lake Superior from 2011-2024. Locations were 82-294 m deep. Annual offshore sampling locations were not sampled in 2020 and 2021 due to COVID-related travel restrictions. Scientific names are presented in Table 1.*

Kiyi Year-class Strength

Age-1 Kiyi (i.e., ≤110 mm), were caught at 30 of 36 locations (Figure 4) and the averaged 19 per ha (Figure 5, Table 3), which was the second highest estimate for the period-of-record (2011-2024, Figure 5, Table 3). The relatively high 2024 estimate for the 2023 year-class may be due to 1) high survival to age-1 in 2023 or 2) slow growth, such that most of the small (≤110 mm) Kiyi collected in 2024 were members of the 2022 year-class rather than the 2023 year-class. The past has shown that Bloater, Cisco, and Kiyi survival to age-1 is synchronized, in other words, a high survival year for one of these ciscoe species is high for all three species (Figure 5). Larval sampling, see below, and age-1 data for Bloater and Cisco (Figure

5) suggests larval ciscoe survival was near zero in 2023, which led to near zero age-1 Bloater and Cisco collected in 2024 (Figure 5). This likely supports the hypothesis that small Kiyi collected in 2024 were slow growing members of the 2022 year-class. The length frequency distribution of Kiyi collected in our offshore survey since 2011 also supports the slower growth hypothesis (Figure 8). Kiyi year-classes had moderate survival to age-1 in 2009, 2014, 2015, and 2016 and high survival in 2022 (Figure 5). Growth of successful year-classes can be observed in subsequent years, with several ≤110 mm fish likely spilling over into the next year (Figure 8). For instance, Kiyi ≤110 mm, collected in 2010 and 2017, and identified as members of the 2010 and 2016 year-classes, were probably members of the 2009 and 2014-15 year-classes. Future aging of a subset of Kiyi collected from this survey could resolve this dilemma, but growth each year varies.

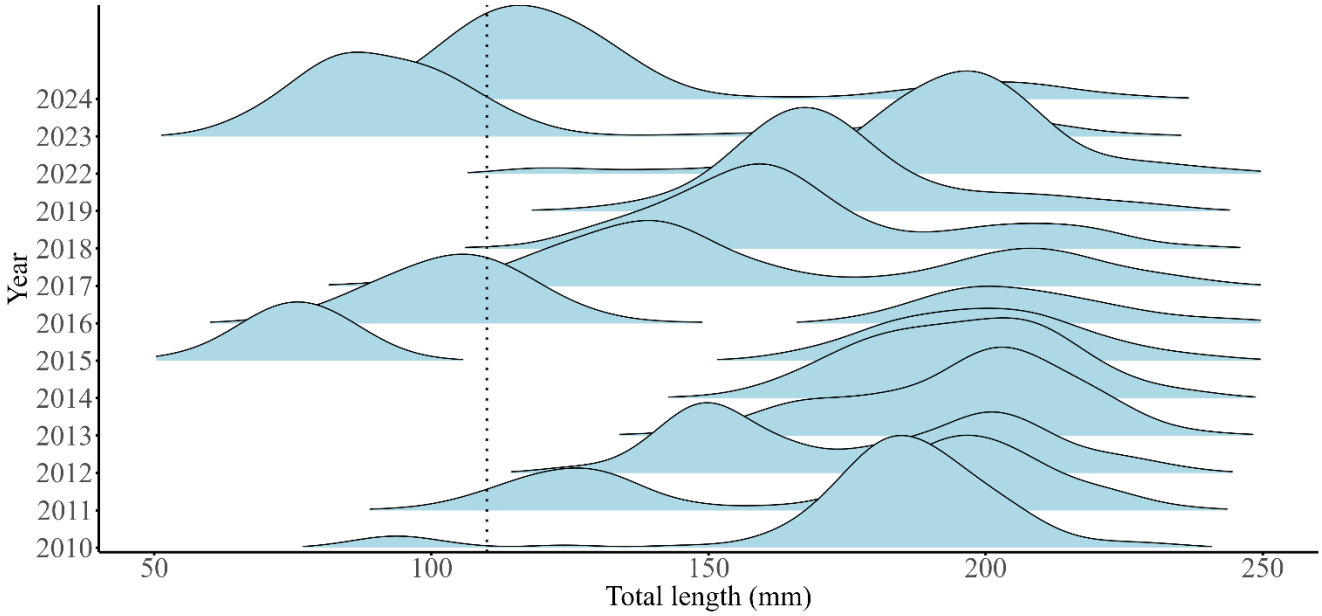

Figure 8. *Length frequency distributions of Lake Superior Kiyi from the 2009-2023 year-classes collected the following July at age-1. The vertical dotted line at 110 mm is the total length cut-off for age-1 fish from Lepak et al. (2017). Collections occurred at the same offshore assessment locations, ~80-310 m deep (Figure 1), in July 2011-2024. In 2010 Kiyi were collected from a mix of nearshore and offshore July collections. No Kiyi collections occurred in July 2020 and 2021, the 2019 and 2020 year-classes, so no data are shown for these year-classes.*

Surface Trawl Fish Collections

A total of 5,177 larval *Coregonus* individuals were collected at 73 of 109 locations sampled lakewide in June-July 2024. This was the third fewest *Coregonus* larvae collected in a whole lake survey since the survey began in 2014 (range 3,863-21,208 fish). In 2024, nearshore mean larval *Coregonus* densities were 176 fish per ha in June and offshore densities were 7 fish per ha in July (Figure 9). Average lakewide 2024 larval *Coregonus* densities were the second lowest estimate in June (range 40-851 fish per ha) and the lowest estimate in July (range 7-441 per ha) as compared to all previous years (2014-2024). These low 2024 larval *Coregonus* density estimates were a stark contrast to those observed in 2022 when survival through July was the highest for the period-of-record for this survey, which in turn, led to high survival of *Coregonus* species to age-1 and suggests that survival of the 2024 ciscoe year-classes to age-1 will likely be near zero.

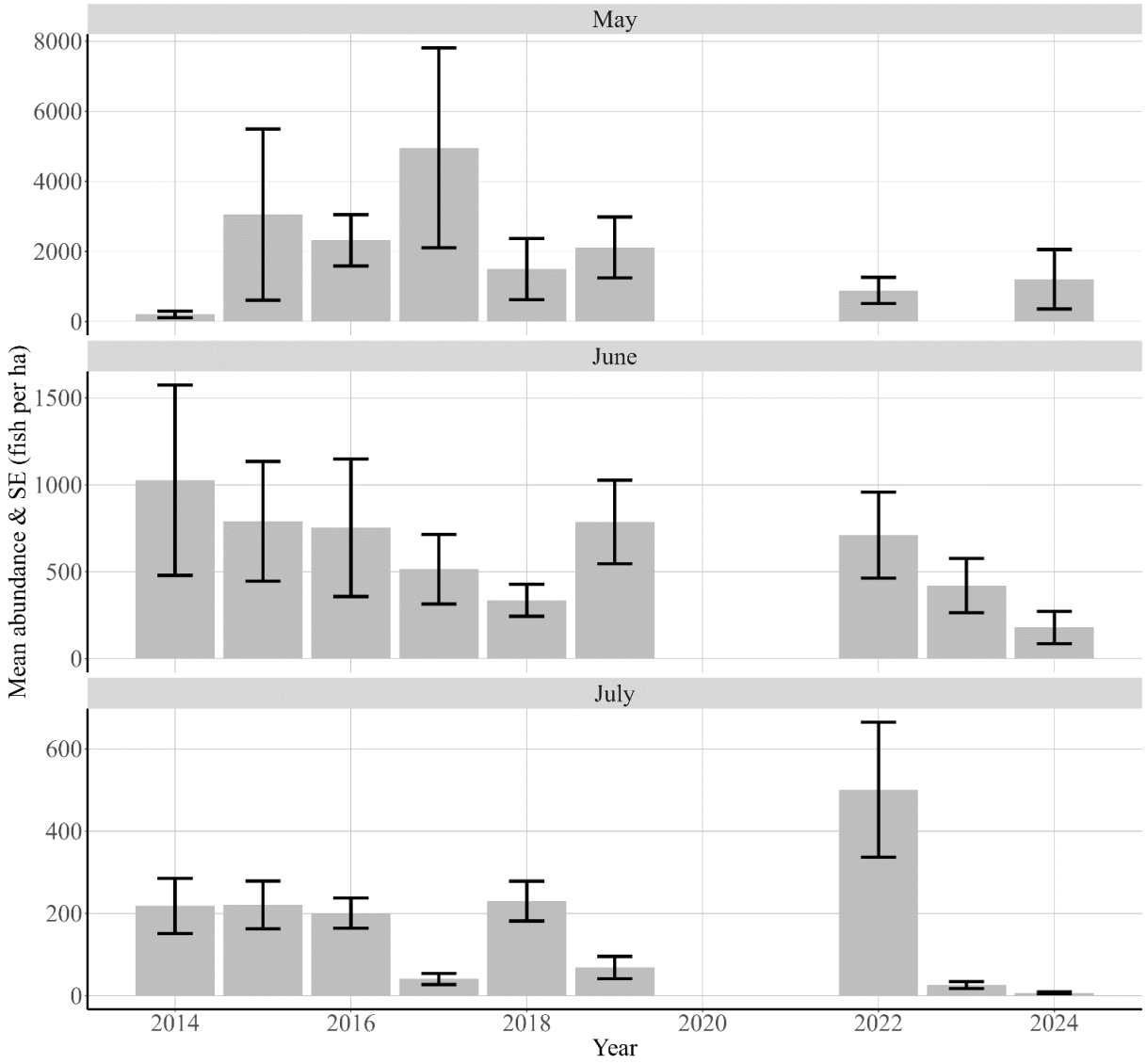

Figure 9. *Monthly mean larval Coregonus abundance estimates (fish per ha ± standard error) for nearshore collections in May and June, and for offshore collections in July from USA and Canada waters of Lake Superior from 2014-2024, sans 2020 and 2021, due to COVID-related travel restrictions. Sampling locations were from the nearshore survey in May and June and from the offshore survey in July. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. Sampling locations are shown in Figure 1. Note different y-axis scales.*

Water Temperatures

Surface water temperatures in June and July were among the warmest recorded during these two surveys. June surface water temperatures at nearshore locations (Figure 1) were ~3°C

above average and offshore surface temperatures in July were ~5 °C above average (Figure 10).

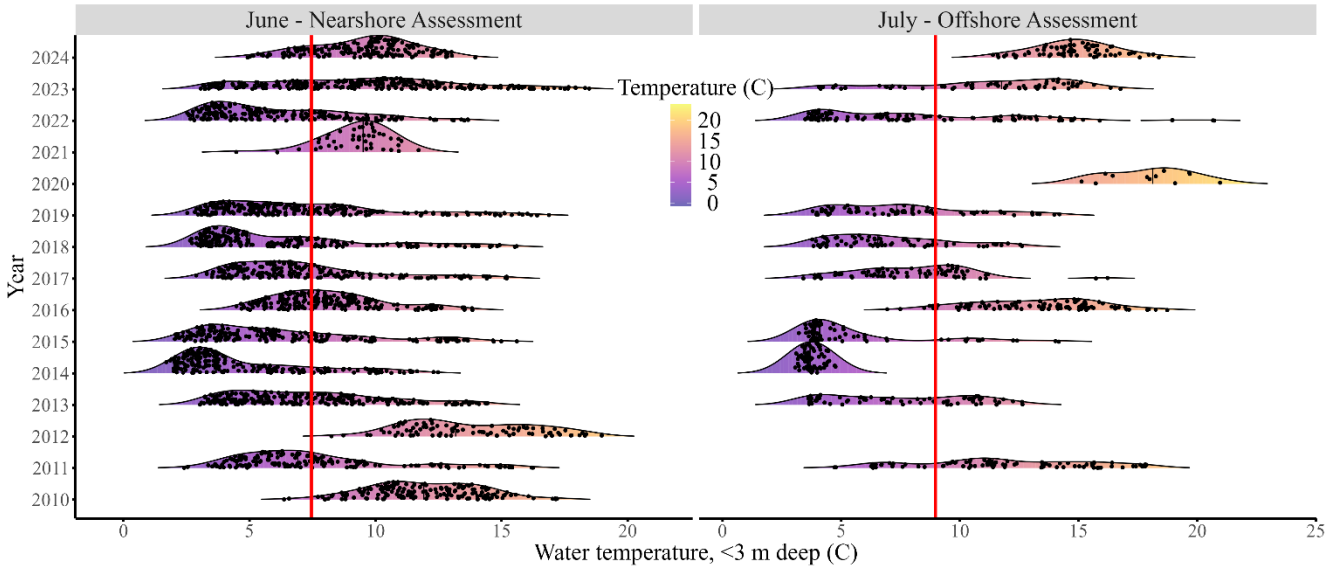

Figure 10. *Lake Superior near-surface (<3 m deep) June and July water temperatures from 2010-2024. No nearshore water temperatures were collected in 2020 and no offshore water temperatures were collected in 2021 due to COVID travel restrictions. The vertical red lines are the mean temperature for that month and habitat from 2010 to 2024. Individual points are individual sampling locations. Individual sampling locations were sampled within a few days of each other each year.*

Summary

Over the 47-year history of the U.S. Geological Survey's Lake Superior nearshore fish community surveys, total estimated biomass of benthic and demersal fish has largely been influenced by the survival of Bloater, Cisco, and Lake Whitefish populations to age-1+. In 2024, nearshore fish biomass estimates were lower than expected based on the high survival of the 2022 ciscoe year-classes that resulted in near record biomass estimates in 2023. The low biomass estimates for nearshore fishes is potentially due to warm nearshore water temperatures in May and June, which may have driven fish to greater depths than what was sampled at our traditional nearshore locations. Offshore fish biomass estimates in 2024 were higher than average for Deepwater Sculpin and siscowet Lake Trout and similar to the long-term average for Kiyi. The status of the 2022 ciscoe year-classes was evaluated by a lakewide survey using acoustics deployed from SailDrones® and a mid-water trawl survey conducted

in September-October 2024 by the U.S. Geological Survey Lake Superior Biological Station. The results of this work are expected to be available by summer 2025.

The combination of near- and offshore bottom and surface trawl surveys provides a lakewide assessment of the status and trends of the Lake Superior fish community susceptible to these trawls, particularly larval and age-1 *Coregonus* species, Rainbow Smelt, and offshore Deepwater Sculpin, Kiyi, and siscowet Lake Trout. We plan to continue these surveys in the future and adapt them as needed to address emerging issues.

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Table 1. *Summary of 2024 nearshore and offshore fish collections from USA and Canada waters of Lake Superior. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. Shown are the 27 species or morphotypes collected, the number of locations the species or morphotype was collected at, the number of individuals collected, and the average estimated abundance (fish per ha) and biomass (kg per ha) from 72 nearshore and 36 offshore locations in Lake Superior in 2024. Sampling locations are shown in Figure 1.*

		Nearshore				Offshore			
Common name	Scientific name	Collection locations	Individuals collected	Number per ha	Kg per ha	Collection locations	Individuals collected	Number per ha	Kg per ha
Alewife	*Alosa pseudoharengus*	4	101	0.8	0.0	0	0	0.0	0.0
Rainbow Smelt	*Osmerus mordax*	72	11988	138.4	0.7	4	6	0.2	0.0
Central Mudminnow	*Umbra limi*	1	1	0.0	0.0	0	0	0.0	0.0
Burbot	*Lota lota*	8	11	0.1	0.1	5	6	0.2	0.1
Threespine Stickleback	*Gasterosteus aculeatus*	2	11	0.2	0.0	0	0	0.0	0.0
Ninespine Stickleback	*Pungitius pungitius*	55	1115	12.7	0.0	1	1	0.0	0.0
Trout-Perch	*Percopsis omiscomaycus*	43	987	12.2	0.0	0	0	0.0	0.0
Cisco	*Coregonus artedii*	32	5142	45.1	1.3	5	8	0.2	0.0
Lake Whitefish	*Coregonus clupeaformis*	22	373	3.9	0.5	0	0	0.0	0.0
Bloater	*Coregonus hoyi*	20	1587	13.1	0.4	8	21	0.5	0.0
Kiyi	*Coregonus kiyi*	7	58	0.4	0.0	33	2840	74.5	1.2
Pygmy Whitefish	*Prosopium coulteri*	17	186	2.6	0.0	1	3	0.1	0.0
Round Whitefish	*Prosopium cylindraceum*	1	1	0.0	0.0	0	0	0.0	0.0
hatchery Lake Trout	*Salvelinus namaycush*	1	7	0.1	0.0	0	0	0.0	0.0
siscowet Lake Trout	*Salvelinus namaycush siscowet*	7	28	0.2	0.1	34	243	6.4	3.2
Splake	*Salvelinus namaycush x Salvelinus fontinalis*	1	2	0.0	0.0	0	0	0.0	0.0
lean Lake Trout	*Salvelinus namaycush*	20	63	0.5	0.1	1	1	0.0	0.0
Longnose Sucker	*Catostomus catostomus*	11	45	0.6	0.4	0	0	0.0	0.0
White Sucker	*Catostomus commersoni*	2	4	0.1	0.0	0	0	0.0	0.0
Spottail Shiner	*Notropis hudsonius*	1	6	0.1	0.0	0	0	0.0	0.0
Johnny Darter	*Etheostoma nigrum*	1	1	0.0	0.0	0	0	0.0	0.0
Yellow Perch	*Perca flavescens*	1	1	0.0	0.0	0	0	0.0	0.0
Walleye	*Sander vitreus*	1	1	0.0	0.0	0	0	0.0	0.0
Ruffe	*Gymnocephalus cernuus*	5	21	0.2	0.0	0	0	0.0	0.0
Slimy Sculpin	*Cottus cognatus*	37	285	2.7	0.0	8	35	0.9	0.0
Spoonhead Sculpin	*Cottus ricei*	14	59	0.7	0.0	7	9	0.2	0.0
Deepwater Sculpin	*Myoxocephalus thompsoni*	13	106	0.7	0.0	36	30461	804.0	3.8

Table 2. *Annual lakewide bottom trawl biomass (kg per ha) estimates for all species and for a few common prey fishes collected in the nearshore bottom trawl survey in USA and Canada waters of Lake Superior, 1978-2024. Nearshore sampling locations were 17-122 m deep. Sculpin includes Slimy, Spoonhead, and Deepwater Sculpin. Mean and median total biomass includes all species. Other species includes Ninespine Stickleback, Trout-perch, Kiyi, Shortjaw Cisco, Pygmy Whitefish, Round Whitefish, Longnose Sucker, and lean, siscowet, and hatchery Lake Trout. Scientific names are presented in Table 1. Zero fish locations are the number of locations where no fish were collected.*

Year	Sampling locations	Zero fish locations	Total species	Mean Species per location	Mean total biomass	Median total biomass	Bloater	Cisco	Lake Whitefish	Rainbow Smelt	Sculpins	Other fishes
1978	43	0	17	5.81	5.47	0.74	0.12	0.01	0.7	3.72	0.12	0.8
1979	49	0	17	6.98	5.91	2.25	0.4	0.06	1.27	2	0.18	2
1980	48	0	16	6.54	3.08	1.11	0.27	0.26	0.57	0.81	0.16	1
1981	48	2	19	6.19	2.56	0.39	0.41	0.36	0.67	0.2	0.16	0.77
1982	32	0	18	6.03	3.06	0.29	0.43	0.35	0.85	0.25	0.03	1.16
1983	50	0	19	6.12	2.41	0.54	0.42	0.16	0.2	0.9	0.05	0.68
1984	53	0	21	7.25	5.34	1.43	1.5	0.59	1.23	0.72	0.05	1.24
1985	53	0	19	7.98	13.74	3.52	2.28	6.45	1.94	1.2	0.07	1.8
1986	53	2	19	7.74	18.05	3.53	3.22	8.25	2.61	2.68	0.06	1.21
1987	53	0	16	7.06	12.49	1.21	2.31	5.34	1.93	1.74	0.06	1.1
1988	53	0	19	6.21	12.59	0.82	5.15	2.93	2.26	1.13	0.04	1.08
1989	76	0	21	7.49	16.96	3.23	1.57	5.95	5.43	2.03	0.07	1.9
1990	81	0	22	7.9	19.32	5.04	4.09	9.08	2.29	1.88	0.08	1.9
1991	84	1	22	7.85	15.3	3.32	0.74	9.02	2.63	1.12	0.09	1.69
1992	85	0	24	7.53	16.91	3.21	7.26	3.06	3.59	0.94	0.07	1.99
1993	87	1	23	7.75	16.7	5.12	3.62	4.51	3.56	2.06	0.08	2.86
1994	87	0	23	7.32	16.4	3.59	0.42	6.52	5.33	1.84	0.08	2.22
1995	87	0	27	7.6	15.11	2.54	0.54	3.42	5.8	2.1	0.09	3.16
1996	87	0	26	7.41	8.33	2.35	2.79	0.93	1.5	1.23	0.1	1.78
1997	85	1	30	6.91	8.27	2.06	0.81	1.34	2.73	1.3	0.05	2.04
1998	87	0	22	6.98	10.66	1.66	3.86	1.06	2.2	1.43	0.06	2.05
1999	83	5	23	5.1	8.18	1.39	2.62	2.28	1.07	0.93	0.03	1.25
2000	85	4	25	5.55	6.92	1.12	0.94	2.42	1.6	0.83	0.04	1.09
2001	83	1	32	7.24	8.37	1.7	1.19	1.15	2.78	1.52	0.04	1.68
2002	84	2	26	6.21	4.68	0.53	0.57	1.48	1.69	0.18	0.02	0.74
2003	86	8	26	5.4	4.75	0.98	0.88	0.64	1.84	0.31	0.02	1.06
2004	75	1	25	7.64	6.32	1.87	1.15	1.8	1.88	0.32	0.03	1.14
2005	52	0	27	7	11.27	4.39	1.65	2.23	4.37	1	0.01	2.02
2006	55	2	24	6.49	8.31	1.57	1.79	2.25	1.7	0.95	0.02	1.59
2007	56	0	31	6.21	6.17	0.97	0.9	0.27	1.86	1.77	0.02	1.34

2008	59	3	23	6.39	5.4	1.57	0.17	0.38	2.37	0.94	0.02	1.52
2009	64	6	20	4.02	3.14	0.14	1.18	0.3	0.15	0.38	0.02	1.12
2010	76	11	24	4.01	1.54	0.13	0.23	0.31	0.27	0.22	0.05	0.46
2011	82	6	21	5.63	3.56	1.28	0.56	0.41	0.94	0.62	0.05	0.98
2012	72	16	25	4.22	1.15	0.31	0.35	0.02	0.15	0.16	0.03	0.44
2013	79	3	27	5.53	6.01	1.17	0.49	0.52	2.98	0.53	0.02	1.47
2014	73	3	28	5.36	7.06	1.86	0.5	0.35	4.31	0.43	0.02	1.46
2015	76	4	21	4.34	1.79	0.19	0.4	0.23	0.54	0.22	0.02	0.38
2016	76	5	23	4.75	2.16	0.23	0.38	0.22	0.53	0.44	0.02	0.59
2017	76	4	27	5.53	3.77	1.81	0.49	0.16	1.11	0.94	0.01	1.05
2018	77	10	24	4.55	4.26	0.28	0.13	0.36	1.52	1.24	0.02	1
2019	76	8	25	5.59	5.7	1.38	0.68	0.14	2.48	0.96	0.02	1.42
2020	11	1	17	6.36	10.55	3.35	6.23	0.95	2.27	0.34	0.01	0.75
2021	45	6	23	5.69	6.35	0.79	1.45	0.32	3.22	0.5	0.02	0.84
2022	71	1	25	4.55	1.56	0.52	0.21	0.05	0.39	0.29	0.01	0.62
2023	57	0	25	8.72	18.25	6.77	1.14	10.53	2.41	2.35	0.1	1.73
2024	72	0	27	5.54	3.73	0.7	0.37	1.27	0.53	0.74	0.02	0.8
Mean	67.70	2.49	23.06	6.30	8.08	1.81	1.47	2.14	2.01	1.07	0.05	1.34
Median	75.00	1.00	23.00	6.21	6.32	1.39	0.81	0.93	1.86	0.94	0.04	1.21

Table 3. *Annual estimated age-1 densities (fish per ha) and sites collected at for nearshore Bloater, Cisco, Lake Whitefish, and Rainbow Smelt and offshore Kiyi in USA and Canada waters of Lake Superior. Nearshore sampling locations were 7-122 m deep and offshore locations were 82-294 m deep. Age-1 fish were defined by species-specific lengths: Cisco ≤140 mm, Bloater <130 mm, Kiyi ≤110 mm, Lake Whitefish ≤160 mm, and Rainbow Smelt ≤100 mm. Scientific names are presented in Table 1. Offshore sampling for Kiyi began in 2011.*

		Sampling locations	Bloater		Cisco		Kiyi		Lake Whitefish		Rainbow Smelt	
Sampling year	Year-class	nearshore / offshore	Density	Locations	Density	Locations	Density	Locations	Density	Locations	Density	Locations
1978	1977	43 / -	0.72	12	0.02	1	-	-	2.6	10	83.85	40
1979	1978	49 / -	27.18	42	6.3	2	-	-	3.86	14	216.06	49
1980	1979	48 / -	1.44	19	0.09	3	-	-	1.91	14	89.18	46
1981	1980	48 / -	6.85	16	13.47	27	-	-	16.43	10	105.9	45
1982	1981	32 / -	0.75	11	0.16	5	-	-	4.16	10	63.81	31
1983	1982	50 / -	0.81	18	0.05	3	-	-	0.45	8	96.77	49
1984	1983	53 / -	4.35	26	18.48	23	-	-	7.93	13	211.03	51
1985	1984	53 / -	42.02	31	743.43	40	-	-	2.32	10	145.1	50
1986	1985	53 / -	26.57	25	68.32	30	-	-	3.41	12	137.11	49
1987	1986	53 / -	3.82	24	5.1	26	-	-	11.88	14	252.95	53
1988	1987	53 / -	5.76	13	0.44	4	-	-	6.09	14	149	53
1989	1988	76 / -	36.07	31	222.37	46	-	-	36.08	22	260.68	76
1990	1989	81 / -	48.23	32	400.22	70	-	-	8.3	21	250.74	78
1991	1990	84 / -	11.13	33	213.27	65	-	-	16.15	23	150.12	83
1992	1991	85 / -	9.81	31	8.33	39	-	-	11.73	22	158.81	81
1993	1992	87 / -	0.18	4	3.32	37	-	-	7.56	22	152.38	84
1994	1993	87 / -	0.06	5	0.75	10	-	-	4.92	23	192.62	84
1995	1994	87 / -	0	0	1.43	31	-	-	13.5	31	386.15	86
1996	1995	87 / -	0.05	4	0.91	21	-	-	6.22	32	159.81	86
1997	1996	85 / -	0.15	7	11.08	29	-	-	8.75	21	242.7	81
1998	1997	87 / -	0.12	7	1.18	20	-	-	7.7	24	141.15	84
1999	1998	83 / -	0.34	3	75.83	41	-	-	7.68	15	180.88	72
2000	1999	85 / -	0.48	13	3.85	24	-	-	0.77	10	58.39	77
2001	2000	83 / -	0.12	6	0.84	16	-	-	2.37	22	257.37	76
2002	2001	84 / -	0.12	6	0.53	8	-	-	13.66	18	56.79	73
2003	2002	86 / -	0.59	5	33.23	39	-	-	7.75	21	77.88	71
2004	2003	75 / -	27.26	36	175.35	47	-	-	6.36	23	70.28	71
2005	2004	51 / -	12.07	23	8.19	21	-	-	2.97	16	110.39	52
2006	2005	55 / -	13.61	19	18.58	22	-	-	5.43	15	249.53	49
2007	2006	54 / -	0.32	6	0.41	10	-	-	19.74	13	366.45	53
2008	2007	58 / -	0.28	7	0.2	10	-	-	0.63	13	279.75	54

2009	2008	63 / -	0.59	7	0.27	9	-	-	3	7	71.55	52
2010	2009	62 / -	2.46	12	14.03	19	-	-	6.64	10	45.37	53
2011	2010	82 / 35	0.76	8	0.3	11	1.52	17	3.98	17	73.98	69
2012	2011	72 / 34	0.06	2	0.03	1	0.03	1	1.9	9	10.9	36
2013	2012	79 / 35	0.22	9	0.17	9	0.13	5	5.46	24	142.9	70
2014	2013	73 / 30	0.06	6	0.01	1	0.03	1	2.27	12	68.46	67
2015	2014	76 / 33	8.57	25	14.31	25	16.65	19	1	11	30.66	70
2016	2015	76 / 35	9.68	26	4.99	22	11.7	22	1.62	11	83.04	67
2017	2016	76 / 36	5.81	16	1.37	17	1.33	17	1.39	15	146.95	70
2018	2017	77 / 35	0.07	4	0.01	1	0.08	3	1.1	8	161.39	64
2019	2018	76 / 35	3.82	17	0.31	11	0.56	11	6.7	14	137.07	68
2020	2019	11 / -	0.89	5	0.14	1	-	-	12.45	3	5.14	9
2021	2020	45 / -	7.59	12	10.58	13	-	-	41.33	16	140.45	37
2022	2021	71 / 35	0.04	5	0.06	4	0.03	1	1.98	8	77.83	64
2023	2022	57 / 31	140.39	38	1018.73	43	49.52	24	9.06	17	615.46	56
2024	2023	72 / 36	1.24	10	4.62	23	19.45	30	0.86	13	59.62	69
Mean		67 / 32	9.86	15.26	66.08	20.85	8.42	12.58	7.45	15.55	153.71	61.87
Median		73 / 35	0.89	12.00	3.32	20.00	0.95	14.00	5.46	14.00	141.15	67.00

Community, 2024

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Appendix A. Lake Superior fish community survey locations from the United States (USA) and Canada and trawling data for locations sampled in 2024. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Survey	Date	Time	Location identifier	Management Unit	Country	Mid-Latitude, north	Mid-Longitude, west	Begin depth, m	End depth, m	Surface temperature, °C	Bottom temperature, °C	Bottom trawl distance, km
Nearshore	05/14/2024	1110	52	WI2	USA	46.976	-90.453	19	68	5.4	4.4	1.44
Nearshore	05/14/2024	1252	44	WI2	USA	47.034	-90.488	10	49	5.7	4.8	1.34
Nearshore	05/14/2024	1417	45	WI2	USA	46.985	-90.556	9	58	5.5	4.8	1.06
Nearshore	05/15/2024	1004	24	WI2	USA	46.850	-90.468	16	57	4.3	3.9	1.20
Nearshore	05/15/2024	1141	2	WI2	USA	46.906	-90.566	14	88	5.6	4.7	2.53
Nearshore	05/15/2024	1356	87	WI2	USA	46.939	-90.649	7	54	6.2	5.0	1.18
Nearshore	05/16/2024	1120	71	WI2	USA	46.940	-90.792	8	35	7.7	5.5	1.17
Nearshore	05/16/2024	1301	75	WI2	USA	47.002	-90.733	25	44	6.3	4.6	0.75
Nearshore	05/16/2024	1502	86	WI2	USA	46.841	-90.725	14	49	7.0	5.0	1.39
Nearshore	05/17/2024	1231	190	MN2	USA	47.626	-90.710	20	48	3.7	3.4	1.41
Nearshore	05/17/2024	1447	208	MN3	USA	47.693	-90.531	9	69	3.6	3.4	0.99
Nearshore	05/17/2024	1700	65	MN3	USA	47.746	-90.319	11	65	3.8	3.6	0.85
Nearshore	05/18/2024	1138	172	MN2	USA	47.332	-91.195	15	29	4.3	3.7	0.45
Nearshore	05/18/2024	1454	188	MN1	USA	47.082	-91.571	19	26	4.6	3.9	0.59
Nearshore	05/18/2024	1636	36	MN1	USA	46.999	-91.697	20	33	4.1	3.8	0.64
Nearshore	05/19/2024	752	210	WI1	USA	46.732	-92.013	15	22	8.8	7.3	1.92
Nearshore	05/19/2024	1119	206	WI1	USA	46.781	-91.632	23	46	6.2	5.0	2.37
Nearshore	05/19/2024	1343	205	WI1	USA	46.820	-91.419	22	51	5.8	4.9	2.38
Nearshore	05/20/2024	1056	151	WI1	USA	46.886	-91.216	11	67	6.0	4.8	1.71
Nearshore	05/20/2024	1445	139	WI2	USA	46.973	-91.014	23	48	6.6	4.7	2.00
Nearshore	05/31/2024	1039	184	MI2	USA	46.627	-90.335	17	37	10.1	6.4	2.75

Nearshore	05/31/2024	1316	192	MI2	USA	46.696	-90.033	14	38	8.5	6.4	2.08
Nearshore	05/31/2024	1720	57	MI2	USA	46.914	-89.366	18	46	10.5	6.1	4.03
Nearshore	06/01/2024	830	183	MI2	USA	47.003	-89.166	13	47	10.2	6.5	3.65
Nearshore	06/01/2024	1145	182	MI3	USA	47.152	-88.875	24	50	10.3	5.8	3.52
Nearshore	06/01/2024	1529	181	MI3	USA	47.342	-88.485	19	68	10.0	6.1	1.25
Nearshore	06/02/2024	1020	82	MI4	USA	46.973	-88.385	14	63	9.7	6.0	2.37
Nearshore	06/02/2024	1203	84	MI4	USA	46.909	-88.323	16	122	10.2	6.0	3.73
Nearshore	06/02/2024	1701	101	MI4	USA	47.372	-87.813	18	54	9.6	5.2	1.82
Nearshore	06/03/2024	912	158	MI4	USA	46.937	-88.128	9	36	11.2	7.9	1.52
Nearshore	06/03/2024	1205	142	MI5	USA	46.858	-87.722	17	66	7.4	5.0	1.58
Nearshore	06/03/2024	1404	196	MI5	USA	46.785	-87.551	26	72	8.2	4.4	1.90
Nearshore	06/04/2024	802	120	MI5	USA	46.524	-87.228	22	56	9.1	4.9	3.82
Nearshore	06/04/2024	1054	88	MI6	USA	46.530	-86.904	27	78	10.2	4.3	3.38
Nearshore	06/04/2024	1307	209	MI6	USA	46.530	-86.721	22	86	11.5	4.6	1.33
Nearshore	06/04/2024	1559	178	MI6	USA	46.665	-86.324	25	87	10.1	4.9	3.09
Nearshore	06/05/2024	818	177	MI7	USA	46.736	-85.768	18	60	10.7	6.0	3.47
Nearshore	06/05/2024	1157	176	MI7	USA	46.782	-85.322	19	48	10.3	5.6	1.74
Nearshore	06/05/2024	1423	195	MI8	USA	46.805	-84.982	9	64	9.9	5.0	2.11
Nearshore	06/06/2024	1057	194	MI8	USA	46.624	-84.883	25	88	11.1	4.9	2.82
Nearshore	06/06/2024	1303	79	MI8	USA	46.566	-84.868	21	75	10.1	5.4	2.94
Nearshore	06/06/2024	1453	193	MI8	USA	46.515	-84.867	11	59	8.4	5.3	2.35
Nearshore	06/06/2024	1651	174	MI8	USA	46.518	-84.719	25	47	9.8	4.5	1.46
Nearshore	06/08/2024	1132	460	ONT12	Canada	46.671	-84.569	13	49	12.6	7.0	2.22
Nearshore	06/08/2024	1319	459	ONT11	Canada	46.768	-84.609	15	66	12.3	5.1	2.62
Nearshore	06/08/2024	1557	461	ONT11	Canada	46.936	-84.728	12	69	9.3	4.3	2.21
Nearshore	06/09/2024	759	456	ONT11	Canada	47.313	-84.657	20	80	9.8	6.7	2.02
Nearshore	06/09/2024	1114	455	ONT11	Canada	47.551	-84.965	16	100	10.7	6.2	1.95
Nearshore	06/09/2024	1359	454	ONT9	Canada	47.676	-84.991	9	78	10.1	7.0	1.07
Nearshore	06/09/2024	1649	451	ONT9	Canada	47.936	-85.181	10	64	7.9	4.7	2.72
Nearshore	06/10/2024	935	463	ONT9	Canada	47.911	-85.432	16	75	7.2	5.4	1.78
Nearshore	06/10/2024	1214	464	ONT9	Canada	47.949	-85.820	11	76	5.4	4.4	1.50
Nearshore	06/10/2024	1523	465	ONT7	Canada	48.121	-86.058	12	94	5.8	4.8	1.33
Nearshore	06/11/2024	810	422	ONT7	Canada	48.639	-86.344	24	45	7.0	4.9	0.62

Nearshore	06/11/2024	1022	420	ONT7	Canada	48.766	-86.640	12	42	7.9	6.0	1.42
Nearshore	06/11/2024	1300	419	ONT7	Canada	48.794	-86.981	26	42	6.2	4.8	0.59
Nearshore	06/11/2024	1450	418	ONT4	Canada	48.778	-87.170	18	34	8.1	5.5	0.72
Nearshore	06/11/2024	1706	417	ONT4	Canada	48.834	-87.480	8	58	6.9	5.5	0.90
Nearshore	06/12/2024	847	415	ONT4	Canada	48.888	-87.766	15	38	10.6	8.0	0.98
Nearshore	06/12/2024	1041	414	ONT4	Canada	48.946	-87.978	10	23	10.3	8.6	1.17
Nearshore	06/12/2024	1238	413	ONT4	Canada	48.935	-88.228	15	25	12.3	11.9	0.82
Nearshore	06/12/2024	1424	412	ONT4	Canada	48.828	-88.103	8	47	13.0	11.3	1.42
Nearshore	06/13/2024	1022	408	ONT3	Canada	48.601	-88.496	12	20	12.8	12.4	0.77
Nearshore	06/13/2024	1132	407	ONT3	Canada	48.561	-88.584	10	28	12.4	9.0	1.06
Nearshore	06/13/2024	1252	406	ONT3	Canada	48.489	-88.612	12	34	11.8	7.5	1.25
Nearshore	06/14/2024	848	401	ONT1	Canada	48.510	-88.934	15	43	10.7	8.0	1.07
Nearshore	06/14/2024	1022	402	ONT1	Canada	48.373	-88.887	10	42	11.1	6.0	2.11
Nearshore	06/14/2024	1224	404	ONT2	Canada	48.311	-88.905	15	55	7.7	5.4	1.02
Nearshore	06/15/2024	837	403	ONT1	Canada	48.252	-89.170	16	36	10.2	7.4	0.66
Nearshore	06/15/2024	1054	400	ONT2	Canada	48.077	-89.411	8	54	9.5	5.4	2.18
Nearshore	06/15/2024	1327	191	MN3	USA	47.970	-89.625	20	48	8.4	5.7	1.79
Nearshore	06/15/2024	1612	207	MN3	USA	47.835	-89.960	15	40	7.0	4.9	0.51
Offshore	07/09/2024	1125	2161	WI1	USA	46.985	-91.232	125	127	17.1	3.9	1.28
Offshore	07/09/2024	1640	2133	MN3	USA	47.533	-90.547	170	172	16.1	3.8	1.36
Offshore	07/10/2024	921	2124	MN3	USA	47.494	-90.002	143	144	13.3	3.9	1.33
Offshore	07/10/2024	1221	2147	MI2	USA	47.153	-89.975	160	159	14.7	3.8	1.36
Offshore	07/10/2024	1502	2120	MI2	USA	47.068	-89.669	192	195	14.0	3.7	1.31
Offshore	07/11/2024	941	2136	MI2	USA	47.227	-89.539	187	190	13.7	3.7	1.38
Offshore	07/11/2024	1159	2151	MI2	USA	47.154	-89.288	132	132	14.6	4.0	1.38
Offshore	07/12/2024	1010	2115	MI3	USA	47.416	-88.468	186	198	15.4	3.8	1.38
Offshore	07/12/2024	1418	2128	MI1	USA	47.840	-88.741	224	228	15.4	3.7	1.38
Offshore	07/12/2024	1758	2134	MI1	USA	48.049	-88.261	236	236	14.9	3.7	1.34
Offshore	07/13/2024	953	2118	MI1	USA	47.874	-88.055	232	230	13.6	3.7	1.38
Offshore	07/13/2024	1229	2122	MI3	USA	47.848	-87.724	210	222	12.0	3.7	1.38
Offshore	07/13/2024	1640	2138	MI4	USA	47.510	-87.221	272	283	14.7	3.6	1.34
Offshore	07/14/2024	849	2150	MI5	USA	47.137	-87.381	124	123	17.9	4.0	1.36
Offshore	07/14/2024	1100	2154	MI5	USA	47.071	-87.166	174	166	16.0	3.8	1.34

Offshore	07/14/2024	1343	2152	MI5	USA	46.807	-87.030	138	136	18.3	3.8	1.38
Offshore	07/15/2024	1000	2116	MI6	USA	46.751	-86.530	160	158	16.4	3.9	1.36
Offshore	07/15/2024	1348	2141	MI6	USA	47.125	-86.166	139	135	15.2	3.9	1.38
Offshore	07/15/2024	1557	2125	MI7	USA	47.096	-85.967	174	175	16.6	3.9	1.36
Offshore	07/16/2024	939	2148	MI7	USA	46.901	-85.532	144	148	16.0	3.9	1.36
Offshore	07/16/2024	1117	2039	MI7	USA	46.911	-85.419	84	88	15.6	4.2	1.36
Offshore	07/18/2024	1421	2137	ONT10	Canada	47.219	-85.103	178	197	15.7	3.7	1.28
Offshore	07/18/2024	1726	2121	ONT10	Canada	47.460	-85.264	255	263	16.9	3.7	1.31
Offshore	07/19/2024	818	2059	ONT10	Canada	47.702	-85.961	82	104	15.0	4.8	1.33
Offshore	07/19/2024	1113	2153	ONT10	Canada	47.415	-85.667	144	140	14.9	3.8	1.36
Offshore	07/19/2024	1351	2129	ONT10	Canada	47.649	-85.560	187	184	15.9	3.8	1.34
Offshore	07/20/2024	850	2145	ONT10	Canada	47.631	-86.115	140	139	11.7	3.9	1.34
Offshore	07/20/2024	1023	2165	ONT10	Canada	47.593	-86.225	122	123	12.7	3.8	1.34
Offshore	07/20/2024	1314	2126	MI6	USA	47.402	-86.471	277	294	12.3	3.7	1.33
Offshore	07/21/2024	1406	2119	ONT8	Canada	47.825	-86.697	250	251	14.0	3.7	1.36
Offshore	07/22/2024	1000	2135	ONT8	Canada	48.023	-86.636	137	134	14.9	3.9	1.34
Offshore	07/22/2024	1333	2139	ONT8	Canada	48.356	-86.978	169	177	14.8	3.8	1.38
Offshore	07/22/2024	1705	753	ONT4	Canada	48.716	-87.300	155	156	16.3	3.9	1.38
Offshore	07/23/2024	908	2155	ONT6	Canada	48.559	-87.765	142	139	14.6	3.8	1.36
Offshore	07/23/2024	1153	2127	ONT6	Canada	48.295	-87.660	208	213	13.0	3.7	1.28
Offshore	07/24/2024	947	2140	MI1	USA	48.113	-88.761	131	143	14.0	3.8	1.33