

**Report of the
Lake Erie
Forage Task Group**

March 2000

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Presented to:

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

1.0 Charges to the Forage Task Group in 1998-1999

The Forage Task Group (FTG) addressed four major charges from the Lake Erie Committee (LEC) during the 1999-2000 work year:

- 1) Continue to describe the status and trends of forage fish species and invertebrates in 1998 for each basin of Lake Erie – Basin bullet statements (section **2.0**);
- 2) Continue the investigation and analyses regarding the utility of the interagency trawl assessment program (section **3.0**):
 - a) Support the use of SCANMAR equipment for interagency calibration of assessment trawl gear. Continue the development of an experimental design to facilitate forage assessment (section **3.1**),
 - b) Continue trawl catch simulations to select appropriate measures of central tendency expressing species' abundance (section **3.2**),
 - c) Complete statistical evaluation of species CPE indices and effects upon sampling from physical and environmental features (section **3.3**),
- 3) Conduct bioenergetics simulation to estimate consumption of smelt and other prey fish by predators in the central and eastern basins (section **4.0**);
- 4) Develop hydroacoustic programs to assess important forage fish stocks in the central and eastern basin. Plan should include sampling schedule, protocol, implementation costs, objectives, as well as agency staff and vessel requirements (section **5.0**);
- 5) Develop and implement an interagency lower-trophics monitoring program that produces annual indices of trophic conditions which can be included with the Forage Task Group's annual description of forage status (section **6.0**);
- 6) Lakewide round goby distribution (section **7.0**);
- 7) Protocol for data use (section **8.0**).

The bracketed numbers printed above in bold face, indicate the subsection where progress is reported for a particular charge in this document.

2.0 Forage Task Group Bullet Statements

Eastern basin

- Rainbow smelt, typically the most abundant forage species found in the offshore waters of eastern Lake Erie, was poorly represented in agency index trawl catches during 1999 fall assessments (Table 2.1). The 1999 year class of smelt was one of the weakest ever observed by OMNR and PFBC. In contrast, NYSDEC survey data indicate that young-of-the-year (YOY) smelt abundance increased in 1999, but remained below long-term average abundance. Independent agency trawl assessments and an interagency summer acoustic survey (see section 5.0) show that yearling-and-older (YAO) smelt abundance increased in 1999 from very low abundance in 1998. Size of Age 0 and 1 smelt decreased in 1999 (Figure 2.1).
- Round gobies continued an eastward expansion in Lake Erie during 1999. This exotic species was well established in Pennsylvania's waters of eastern Lake Erie in 1998 (Table 2.1). By 1999, the round goby had become the most abundant species captured in index trawl gear in that part of the lake (PFBC) and was encountered for the first time in OMNR and NYSDEC index trawl surveys. In areas sampled by index trawls east of Pennsylvania, the abundance of round gobies was relatively low and almost entirely YOY. In Pennsylvania waters, gobies were most dense at the shallow stations (18 meters), but they were also found in trawls at depths exceeding 30 meters.
- Spottail and emerald shiners experienced poor to below average YOY recruitment in 1999. YOY clupeid abundance increased in 1999 (Table 2.1). OMNR trawl catches indicate that the 1999 year class of alewife and gizzard shad were among the highest observed during the 1990's. Trout-perch ranked second in abundance, after smelt, in NYSDEC trawl catches during 1999, but exhibited low abundance elsewhere in the east basin.
- The 1999 year class of yellow perch was one of the poorest observed in the Long Point Bay area during the 90's. Yearling perch from the strong 1998 year class were well represented in the catch of all east basin agency trawl surveys in 1999.

Central basin

- Fall trawl survey indices of forage abundance differed between Ohio and Pennsylvania in 1999. In Pennsylvania, goby abundance continues to increase dramatically from 1998 (Table 2.2; 2.3). Trawl catches for other forage species in Pennsylvania waters are well below average values for the 1990's. In Ohio waters, round goby abundance has decreased from 1998 in both age-0 and age-1 and older size groups. Age-1 and older forage abundance increased from 1999, however, overall abundance of forage species declined from 1999. Age-0 alewife, gizzard shad, white perch and white bass increased from 1998. Age-0 forage was an even mix of benthic (white perch, and round goby) and pelagic species (rainbow smelt and emerald shiners). The age-1 and older size class was dominated by pelagic species (rainbow smelt and emerald shiners).
- Walleye diets in the fall have been primarily smelt, shiners, gizzard shad and round goby since 1997 (Figure 2.2). Round goby are increasing in occurrence in predator diets, making significant contributions to walleye, smallmouth, yellow perch and burbot diets (Figure 2.3).
- No trends in annual growth are evident for age-0 forage species in the central basin during the 1990's. However, there has been an increase in mean length of age-0 gizzard shad since 1995. In general, mean length of age-0 forage species in 1999 was higher than the average for the 1990's
- Lower trophic level sampling was conducted at four sites in the central basin. Two sites each are located off Wheatley, Ontario, and Fairport Harbor, Ohio. At this time, samples are still being processed from the Fairport sites and data will be included in future reports as analyses are completed. At the Wheatley sites, total phosphorus levels were comparable and chlorophyll a concentrations increased marginally over previous years (1993 and 1998). Preliminary zooplankton estimates suggest density and biomass has decreased in the west-central basin. The cladoceran fraction was relatively unchanged, while calanoid and cyclopoid copepods, and veliger larvae were considerably lower than in 1998.

3.0 Interagency Trawling Program

An ad-hoc task group, called the Interagency Index Trawl Group (ITG) was formed in 1992 to: 1) review the interagency index trawl program in western Lake Erie and recommend standardized trawling methods for measuring fish community indices, and; 2) lead in the calibration of agency index trawling gear using SCANMAR acoustical instrumentation. Upon their termination in March 1993, the ITG recommended that work on interagency trawling issues be continued by the FTG on two matters. Progress on these charges is reported below.

3.1 Summary of Species CPUE Statistics (by J. Tyson, T. Johnson, M. Thomas)

Interagency trawling in August has been conducted in Ohio, Michigan, and Ontario waters of the western basin of Lake Erie from 1987-1999. This interagency trawling series was developed to measure basin-wide percid recruitment. Information collected during interagency trawling surveys includes species-specific length and abundance data. A total of 75-80 standardized tows per year are conducted by ODNR and OMNR in Lake Erie's western basin (Figure 3.1). Tows initially were stratified into four depth strata (0-3 m, 3-6 m, 6-9 m, and >9 m) in proportion to the area in each depth strata. However, due to low availability of trawlable areas in the 0-3 m depth strata in Ontario waters, the two shallow (0-6 m) and two deeper depth strata (>6 m) were lumped for analysis.

In 1992, the ITG recommended that the Forage Task Group review the interagency index trawling program and recommend standardized methods for measuring and reporting basin-wide fish community indices. These community indices included growth and abundance of forage fish species. Historically, indices computed from standard bottom trawls have been reported as relative abundance indices, which cannot be combined across agencies; only compared within an agency on a qualitative basis. In 1992, pursuant to the recommendations of ITG, the Forage Task Group began development of standardized trawling procedures and calibration of agency trawls such that the indices could be combined and quantitatively analyzed across agency/jurisdictional boundaries. Preliminary calibration work was done in 1992 by several Lake Erie agencies using SCANMAR acoustic equipment to calculate the dimensions of the bottom trawls while fishing. Subsequent work with SCANMAR was conducted in 1995 for both the OMNR and ODNR boats, and in 1997 for the ODNR boat. Net dimensions from the 1995 SCANMAR exercise were used for the OMNR boat, and dimensions from the 1997 SCANMAR exercise were used for the ODNR boat.

Currently, the Forage Task Group estimates basin-wide abundance of forage in the western basin using information from SCANMAR trials, total trawling distance, and catches from August interagency trawling. The estimate of volume sampled by each tow in conjunction with the species-specific abundance estimates of each tow allows for computation of a species-specific quantitative abundance estimate (in fish /m³ or hectare) for each tow (see western basin forage summary). Using the volumetric estimate of abundance in conjunction with the length/weight data from the interagency trawls, a species-specific biomass estimate (in g/m³) for each tow can be generated. Volumetric estimates of abundance and biomass were extrapolated by depth strata

5.0 Acoustic Survey Program

(by D. Einhouse, L. Witzel, C. Murray and L. Rudstam)

Introduction

Since 1993, the Forage Task Group has used a fisheries acoustic system as an additional tool to assess forage fish stocks in eastern Lake Erie. These fisheries acoustic surveys have been conducted annually from 1993 to 1999. The 1993 to 1996 surveys were principally summertime efforts using the New York State Department of Environmental Conservation's 70-kHz single beam echosounder (Simrad EY-M, 7024 transducer). Since 1997, acoustic surveys have used a modern 120-kHz split-beam system (Simrad EY-500) that was jointly purchased by the Lake Erie Committee member agencies and the Great Lakes Fishery Commission. The 1998 and 1999 surveys used this split-beam system for the ongoing July survey, in addition to replicate spring (June) and fall (October) basinwide acoustic assessments. However, only July acoustic survey results are presented in this report as the long-term abundance index of eastern basin pelagic forage fish that has been in-place since 1993. The 1999 field data collection for this July survey, including acoustic and mid-water trawl sampling, was coordinated among three agencies (NY, ONT, and PA) with three research vessels (Argo, Erie Explorer, and Perca) participating in various aspects of the data collection.

Methods

The 120 kHz split beam echo sounder was calibrated at the beginning of the July 1999 eastern basin survey and again during October. Acoustic signals were processed/analyzed using the EY500/EP500 analysis software (version 5.3, Simrad 1996). This software calculates total volume back scattering strength and single fish target strength (TS) simultaneously by applying 20 and 40 log R TVG functions. Fish densities within -3 dB TS bins were calculated by apportioning the volume backscattering strength to the proportion of single fish echoes within each target strength bin. The lower threshold for volume backscattering was set to -80 dB, and the single fish target strength threshold was set to -70 dB. From these split beam data, we selected a subset TS range of -55 dB to -43 dB as an index of yearling-and-older (YAO) pelagic forage fish ($\sim > 50$ mm). We believe this acoustic size range is also comparable to a length range for adult-sized forage fish, fully vulnerable to agency bottom trawling programs during summer. We used a -56 dB to -44 dB TS range from the earlier (1994-96) single beam surveys for contrasting pelagic forage fish abundance estimates across a 6-year time series. Rudstam et al. (1999) found the Simrad EY-M single beam system used prior to 1997 produced very similar, but not identical results, in describing target strength and fish density relative to the modern split beam acoustic systems. Although Rudstam's et al. (1999) study suggested single beam density estimates were 85 to 95% lower than those produced from our split beam system, we have not yet applied any scaling factor for comparing our 1993-96 single beam and 1997-99 split beam results.

the YOY smelt cohort.

The trawling and acoustic efforts together describe this smelt resource as consisting of two abundant groups (age-0 and age-1+) that vertically separate in the water column due to differing thermal preferences during summer stratification. As such, we ascribe thermocline and hypolimnion densities within the -55 to -43 dB range as our approximation of YAO smelt abundance in eastern Lake Erie. This definition of YAO rainbow smelt suggests 1999 abundance was considerably higher than 1998 (Table 5.2). Furthermore, a characteristic alternate year high and low abundance pattern since 1995 is also apparent in YAO rainbow smelt abundance through our brief time series (Figure 5.2).

A more thorough examination of YOY and YAO smelt abundance and distribution from seven years of acoustic survey work is planned in 2000 to quantify absolute biomass and production in eastern Lake Erie. This effort will be assisted by a considerable amount of supplemental data collected in 1998 and 1999, but not included in this report. These last two field seasons provided an opportunity to conduct fixed station acoustic sampling and more closely examine target strength patterns of smelt cohorts. Additionally, three surveys distributed throughout the field season provided spring, summer and fall snapshots of changes in biomass and distribution. This information is expected to be particularly useful for understanding predator consumption demands over this same time series (see Section 4.0).

Acknowledgments

The FTG is grateful to OMNR research vessel captain Gordon Ives, PFBC research vessel captain Paul Atkinson, and NYS DEC staff, Douglas Zeller (research vessel captain), Richard Zimar, and Brian Beckwith (fish and wildlife technicians) for their annual contributions in field data collection and data processing in support of the eastern basin acoustic survey. We would also like to acknowledge the 1999 field assistance of graduate students Sandra Parker (Cornell University) and Stacy Vega (School of Environmental Science and Forestry at Syracuse) in conducting the basinwide surveys.

6.0 Interagency Lower Trophic Level Monitoring Program

(by Betsy Trometer and Tim Johnson)

Introduction and Methods

In 1999, the FTG agencies initiated the first year of the Lower Trophic Level Assessment program (LTLA) at most of the 20 sites within Lakes Erie and St. Clair (Figure 6.1). 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 (PAR), water transparency (Secchi), nutrients (total phosphorus), chlorophyll *a*, phytoplankton, zooplankton, and benthos. The protocol called for each site to be sampled once every two weeks from May through September, totaling 10 sampling dates, with benthos collected on three dates.

Table 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 in 1999 and 1998. Indices are reported as geometric mean catch per trawling hour (GMCPTH) or number caught per hectare (NPH) for age-0 (YOY) and age-1+ (YAO). Long-term averages are reported as the mean of the annual trawl indices for survey years during the two most recent decades (90's and 80's). Agency trawl surveys are described below.

Species	Trawl Survey	YOY				YAO			
		1999	1998	90s Avg.	80s Avg.	1999	1998	90s Avg.	80s Avg.
Smelt	ON-DW	11.2	797.9	631.6	2641.7	31.0	22.1	446.4	498.0
	NY-Fa	895.5	251.5	1450.9	NA	805.2	27.8	581.6	NA
	PA-Fa	35.6	641.5	664.1	NA	4.9	2.4	405.4	NA
Emerald Shiner	ON-DW	1.6	5.9	9.3	16.8	2.1	0.5	11.6	40.8
	ON-OB	0.3	0.9	1.7	1.1	0.0	0.3	1.4	1.2
	NY-Fa	10.8	0.0	112.4	NA	15.7	0.0	105.4	NA
	Pa-Fa	1.4	108.2	50.1	NA	0.0	0.0	15.7	NA
Spottail Shiner	ON-OB	39.1	59.9	154.8	28.8	4.3	1.1	4.5	4.5
	ON-IB	5.1	11.6	7.3	16.2	0.4	0.2	0.2	1.3
	NY-Fa	1.0	0.1	19.9	NA	1.0	0.0	4.0	NA
	PA-Fa	0.3	23.9	3.5	NA	0.0	2.0	4.4	NA
Alewife	ON-DW	16.4	0.7	5.0	17.0	NA	NA	NA	NA
	ON-OB	0.1	0.0	1.0	2.6	NA	NA	NA	NA
	NY-Fa	0.3	0.0	52.0	NA	NA	NA	NA	NA
	PA-Fa	0.0	0.7	9.6	NA	NA	NA	NA	NA
Gizzard Shad	ON-DW	11.0	2.1	1.7	14.0	NA	NA	NA	NA
	ON-OB	1.5	0.8	1.4	5.1	NA	NA	NA	NA
	NY-Fa	6.8	0.1	4.2	NA	NA	NA	NA	NA
	PA-Fa	0.0	0.0	1.2	NA	NA	NA	NA	NA
White Perch	ON-DW	0.3	0.4	1.1	3.9	NA	NA	NA	NA
	ON-OB	0.2	0.3	3.2	4.4	NA	NA	NA	NA
	NY-Fa	0.8	0.0	29.4	NA	NA	NA	NA	NA
	PA-Fa	2.4	281.4	87.2	NA	NA	NA	NA	NA
Round Goby	ON-DW	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	ON-OB	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NY-Fa	8.0	0.0	1.0	NA	0.1	0.0	0.0	NA
	PA-Fa	171.7	131.4	37.9	NA	0.0	55.6	6.9	NA

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

Ontario Ministry of Natural Resources

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. Indices are reported as GMCPTH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999.

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. Indices are reported as GMCPTH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1998

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. Indices are reported as GMCPTH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999.

New York State Department of Environmental Conservation Trawl Survey

NY-Fa Trawling is conducted at 30 nearshore (15-28 m) stations during October using a 10-m trawl with a 9.5-mm mesh cod end liner. Indices are reported as NPH; 90s Avg. is for the period from 1992-1999.

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. Indices are reported as GMCPTH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999, excluding 1993 and 1997.

Table 2.2. Relative abundance (arithmetic mean number per hectare) of selected young-of-the-year species from all trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1990-1999.

Species	Agency	Year										Mean
		1990 a	1991 a	1992 a	1993 a	1994 a	1995	1996	1997	1998	1999	
Alewife	OH	0.3	5.7	27.5	0.0	7.7	12.8	9.6	14.7	6.3	15.2	10.0
	PA	0.0	-	174.0	-	0.0	0.0	0.0	0.0	0.0	0.0	22.0
Gizzard	OH	29.9	2.6	8.2	2.1	10.7	1.4	103.1	11.6	33.7	48.8	25.2
Shad	PA	41.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Rainbow	OH	1004.5	13.1	641.2	19.9	1076.9	740.1	1359.6	431.2	606.2	213.4	610.6
Smelt	PA	1128.0	-	8205.0	-	953	107.0	5422.0	10.0	30.0	2.0	1982.0
Emerald Shiner	OH	246.0	126.8	105.7	4.8	28.2	20.0	38.9	78.3	2096.5	343.1	308.8
	PA	366.0	-	34.0	-	0.0	54.0	4.0	0.0	6.0	0.0	58.0
Spottail Shiner	OH	0.9	0.1	0.4	5.2	7.9	0.8	15.1	7.0	1.4	4.2	4.3
	PA	0.0	-	0.0	-	0.0	20.0	0.0	0.0	0.0	1.0	3.0
Trout-perch	OH	7.1	2.3	20.5	2.8	0.0	5.1	12.3	0.8	0.8	3.7	5.6
	PA	0.0	-	214.0	-	1.0	25.0	7.0	0.0	23.0	10.0	35.0
White Perch	OH	1348.4	1026.1	148.3	67.9	197.1	27.4	355.1	128.3	83.3	175.1	355.7
	PA	1528.0	-	887.0	-	76.0	136.0	332.0	0.0	0.0	8.0	371.0
White Bass	OH	47.8	12.7	0.5	38.5	147.3	20.5	65.3	15.7	41.7	108.4	49.8
	PA	17.0	-	0.0	-	7.0	4.0	0.0	0.0	0.0	0.0	3.0
Yellow perch	OH	28.0	4.9	28.5	10.8	40.0	5.3	121.8	7.7	69.4	42.4	35.9
	PA	9.0	-	125.0	-	567.0	52.0	354.0	0.0	14.0	7.0	141.0
Round Goby	OH	0.0	0.0	0.0	0.0	2.9	29.0	30.2	86.8	151.1	129.0	71.5
	PA	0	-	0	-	0	0	0	1	744	1114	232.0

a) Fairport values have been scaled to compare with trawl equipment used prior to 1995.

Table 2.3. Relative abundance (arithmetic mean number per hectare) of selected yearling-and-older species from all trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1990-1999.

Species	Agency	Year										Mean
		1990 a	1991 a	1992 a	1993 a	1994 a	1995	1996	1997	1998	1999	
Alewife	OH	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
	PA	0.0	-	61.0	-	0.0	0.0	0.0	0.0	0.0	0.0	8.0
Gizzard Shad	OH	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
	PA	1.0	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rainbow Smelt	OH	19.5	103.0	39.3	111.2	41.5	141.8	84.2	360.3	85.4	829.6	181.6
	PA	43.0	-	541.0	-	4	506.0	30.0	0.0	0.0	0.0	141.0
Emerald Shiner	OH	145.7	155.2	7.3	12.8	9.4	30.0	16.2	104.5	830.3	454.3	176.6
	PA	3.0	-	241.0	-	1.0	18.0	0.0	0.0	0.0	0.0	33.0
Spottail Shiner	OH	2.2	0.7	0.8	0.3	6.0	9.3	12.6	10.1	15.1	5.4	6.3
	PA	18.0	-	0.0	-	0.0	18.0	0.0	0.0	0.0	0.0	4.0
Trout-perch	OH	6.4	6.6	11.3	5.7	6.1	11.7	10.9	15.7	17.2	8.4	10.0
	PA	64.0	-	133.0	-	7.0	53.0	0.0	0.0	0.0	0.0	32.0
White Perch	OH	81.2	226.2	133.9	1.4	0.8	23.5	15.1	48.0	3.3	31.4	56.5
	PA	42.0	-	61.0	-	0.0	2.0	2.0	0.0	0.0	1.0	13.0
White Bass	OH	0.1	0.0	0.5	0.0	0.0	3.1	0.3	13.8	0.3	3.6	2.2
	PA	5.0	-	0.0	-	3.0	0.0	0.0	0.0	0.0	1.0	1.0
Yellow perch	OH	15.7	30.6	7.9	21.0	6.5	47.6	8.6	117.6	3.4	45.6	30.5
	PA	51.0	-	58.0	-	2.0	192.0	12.0	0.0	0.0	7.0	40.0
Round Goby	OH	0.0	0.0	0.0	0.0	3.0	78.6	133.6	268.8	175.7	98.6	126.4
	PA	0	-	0	-	0	0	0	0	33	0	4.0

a) Fairport values have been scaled to compare with trawl equipment used prior to 1995.

Table 5.2. Estimated minimum numeric abundance index of YAO smelt-sized fish (TS of -55 to -43 dB) in cold water habitat in the eastern basin of Lake Erie during July, 1999. Confidence limits (95%) are the percent of the total abundance estimate.

JULY, 1999 LARGE FORAGE FISH INDEX IN COLD WATER HABITAT OF EASTERN BASIN, LAKE ERIE (TARGET STRENGTH RANGE -55 to -43 dB)		
DEPTH CONTOUR	TOTAL NUMERIC ABUNDANCE	(95% Conf. Int. as percent of mean)
18-25 m	94,023,353	47.6%
25-35 m	573,222,127	22.3%
35-65 m	1,299,860,954	13.7%
ALL	1,967,106,433	6.9%

Table 6.1 Mean monthly zooplankton abundance (#/L) from interagency lower trophic level sample sites in the western (sites 3 & 4) and central (sites 11 & 12) basins of Lake Erie, 1999.

Basin	Month	Cyclopoids	Calanoids	Nauplii	Cladoceran	Rotifer	Veliger	Total Zooplankton
west	May	9.13	3.86	38.42	21.28	6.67	12.74	92.10
	June	5.27	1.68	31.22	19.39	34.22	225.43	317.22
	July	2.65	1.56	21.94	16.32	150.42	268.49	461.39
	Aug.	9.05	0.55	21.29	9.92	74.91	121.82	237.54
	Sept.	6.75	4.54	27.27	7.94	51.79	1.11	99.40
central	June	9.40	4.59	0	26.50	347.60	1.14	389.24
	July	13.06	13.59	0	12.77	117.07	13.53	170.02

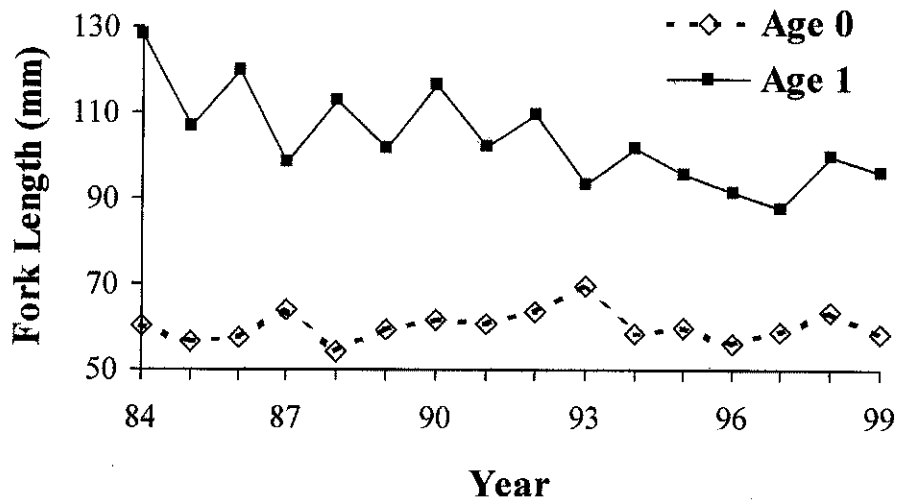


Figure 2.1. Mean fork length (mm) of age-0 and age-1 rainbow smelt from OMNR index trawl surveys in Long Point Bay, Lake Erie, 1984-1999.

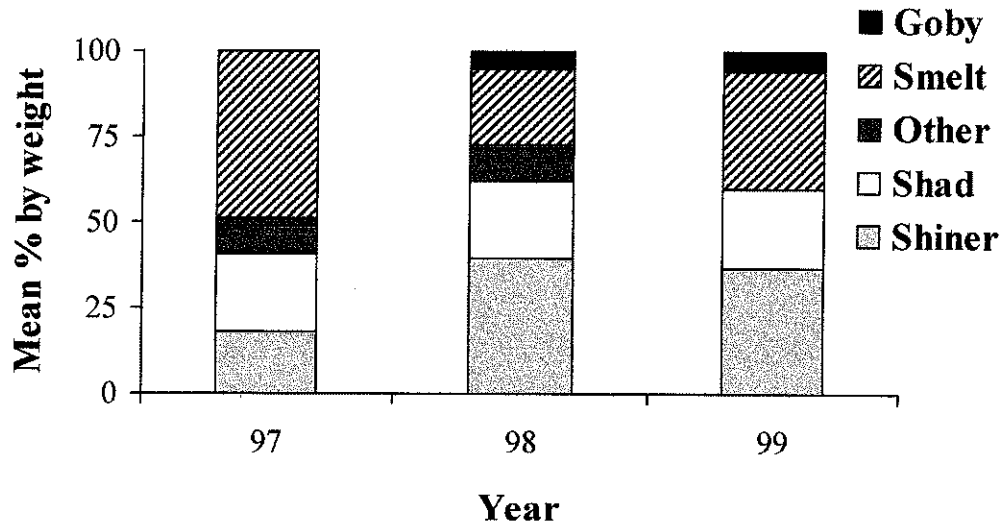


Figure 2.2. Diet composition (mean % by weight) of adult walleye from fall bottom trawl surveys in the central basin, Lake Erie, 1997-1999.

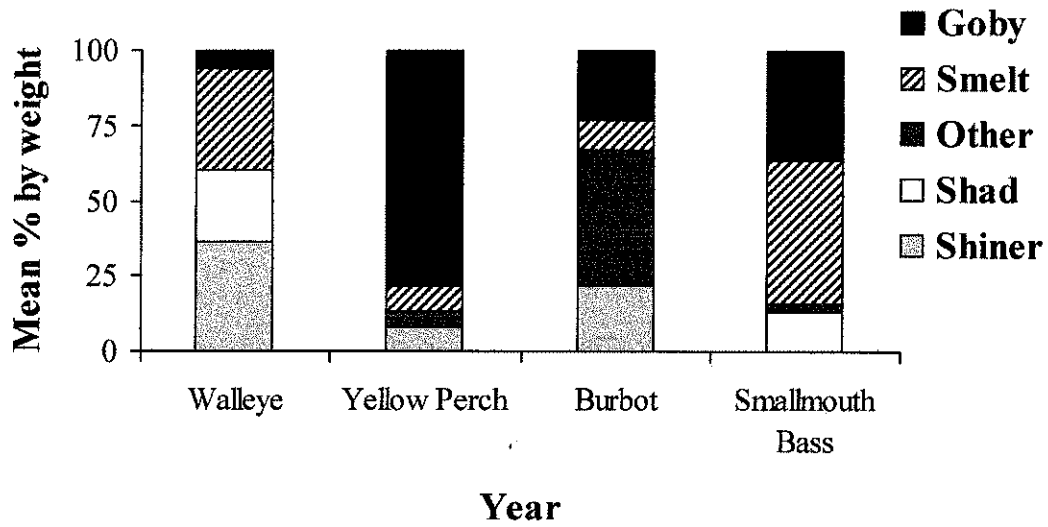


Figure 2.3. Diet composition (mean % by weight) for selected species from fall bottom trawl surveys in the central basin, Lake Erie, 1999.

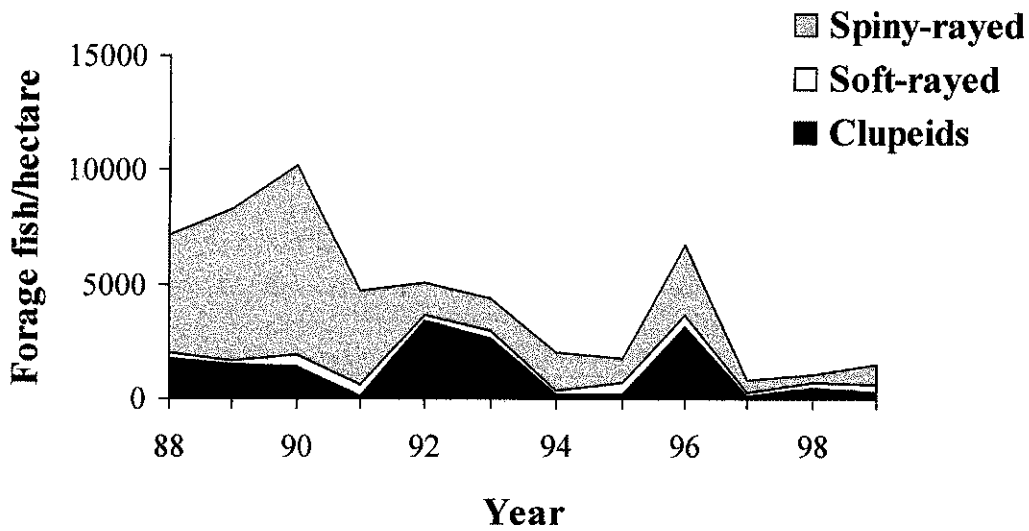


Figure 2.4. Mean abundance (#/hectare) of functional prey fish groups in Ontario waters of the western basin, Lake Erie, 1988-1999.

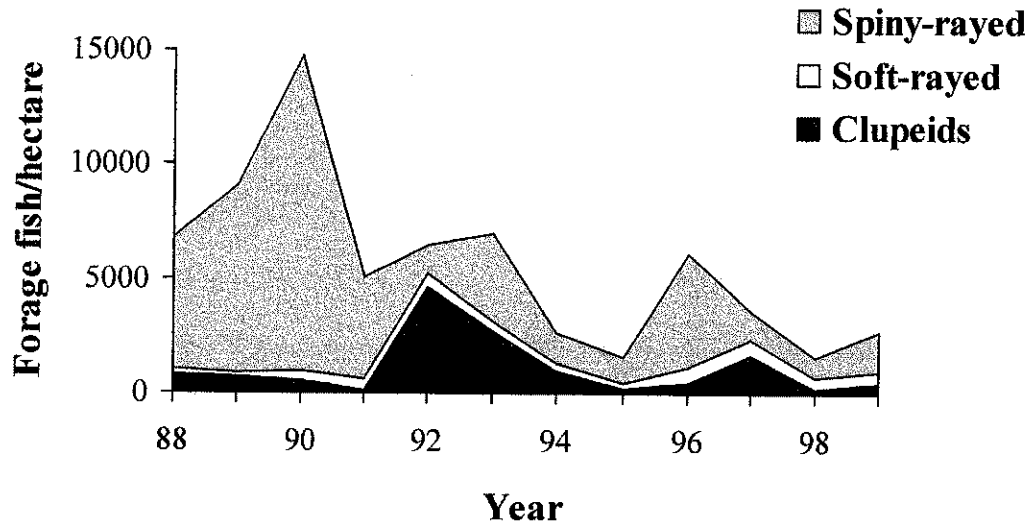


Figure 2.5. Mean abundance (#/hectare) of functional prey fish groups in Ohio waters of the western basin, Lake Erie, 1988-1999.

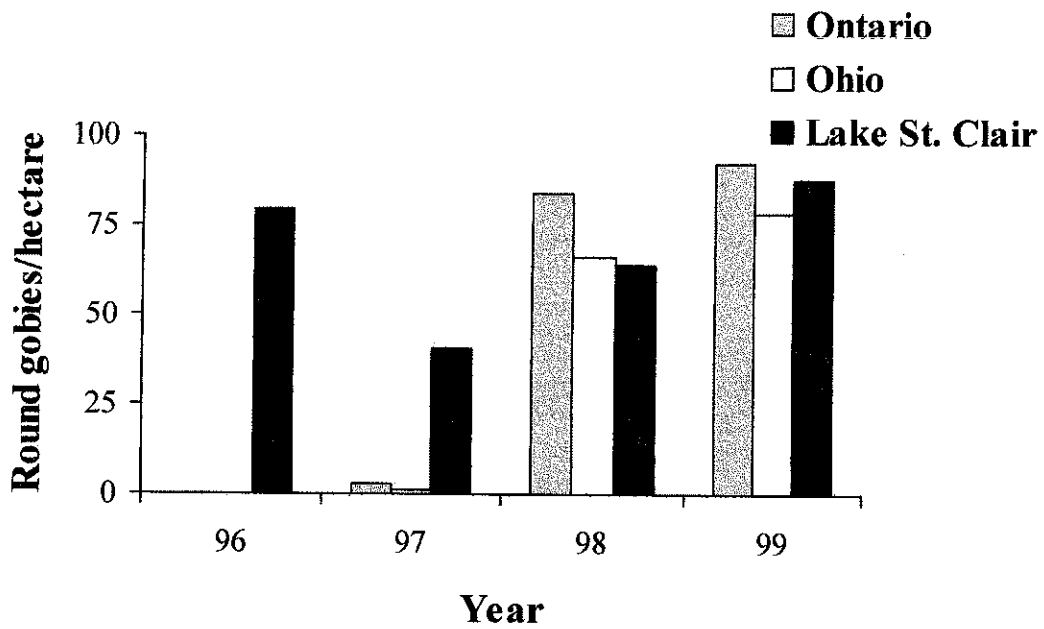


Figure 2.6. Mean abundance (#/hectare) of functional prey fish groups in Ohio waters of the western basin, Lake Erie, 1988-1999.

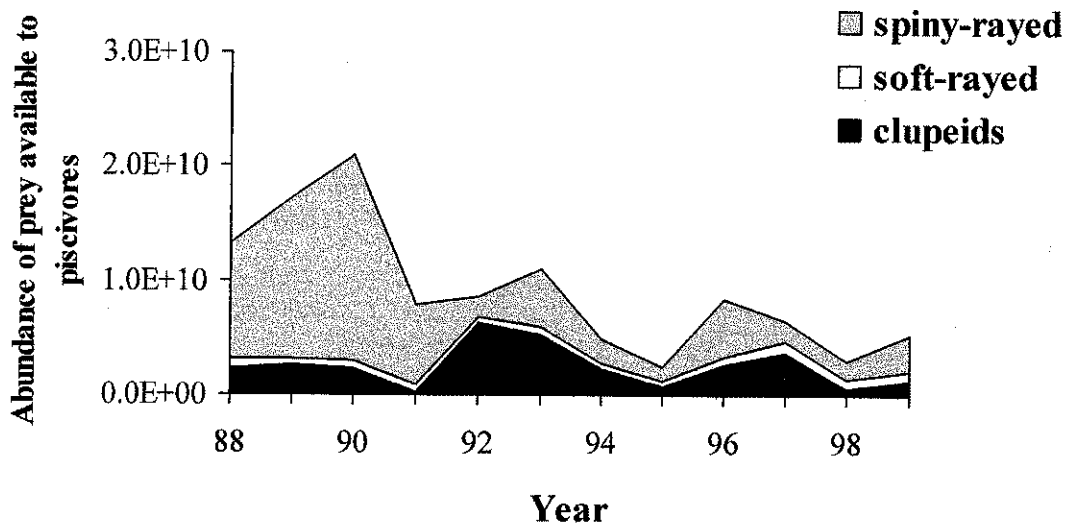


Figure 3.2. Estimated absolute abundance of prey fish by functional category in waters of the western basin, Lake Erie, 1988-1999.

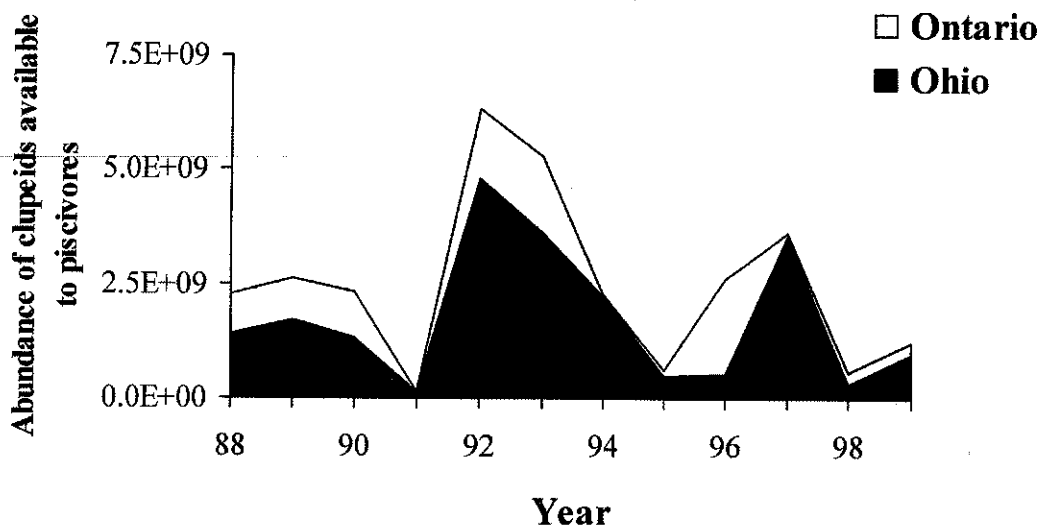


Figure 3.3. Estimated absolute abundance of clupeids in Ohio and Ontario waters of the western basin, Lake Erie, 1988-1999.

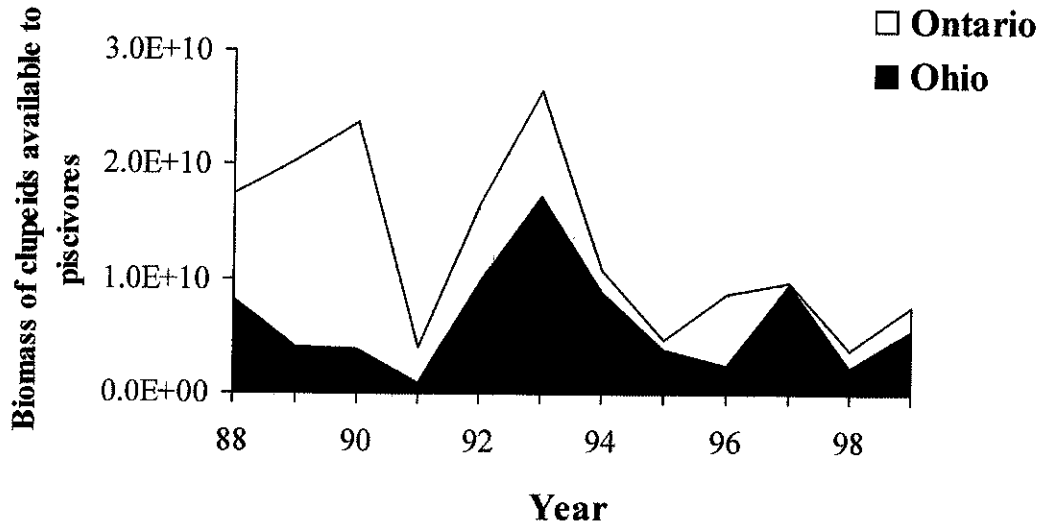


Figure 3.6. Estimated absolute biomass of clupeids in Ohio and Ontario waters of the western basin, Lake Erie, 1988-1999.

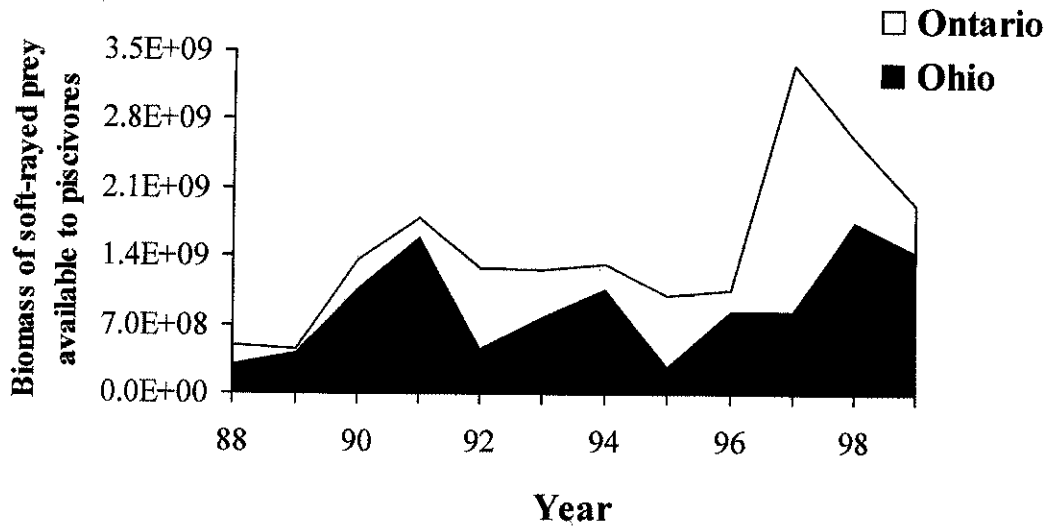


Figure 3.7. Estimated absolute biomass of soft-rayed prey in Ohio and Ontario waters of the western basin, Lake Erie, 1988-1999.

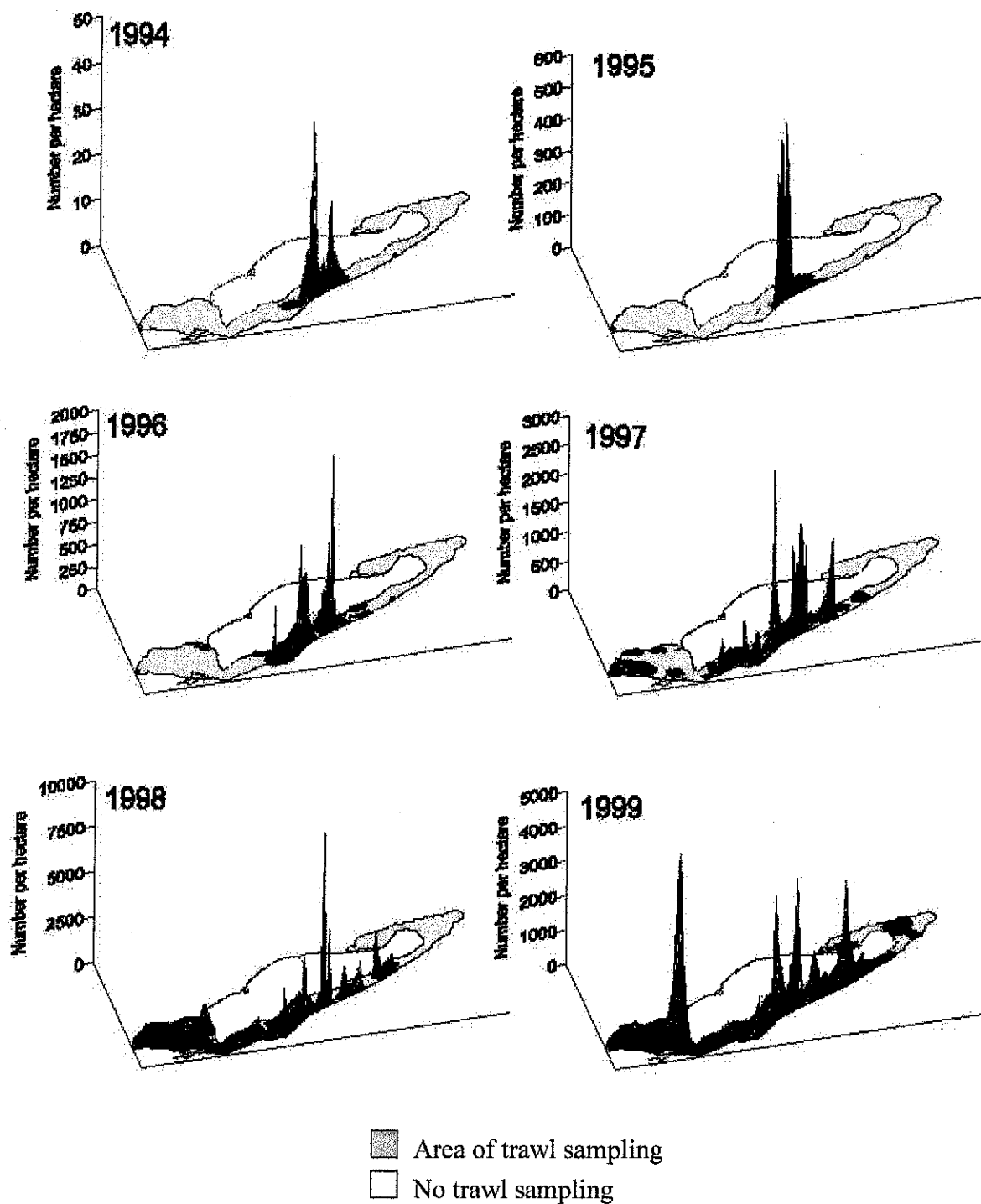


Figure 7.1 Goby distribution and abundance from agency bottom trawls in Lake Erie, 1994-1999