Report of the
Lake Erie
Forage Task Group

March 1999

Members:

Don Einhouse	- New York Department of Environmental Conservation {Co-chairman}
Jeff Tyson	- Ohio Department of Natural Resources {Co-chairman}
Mike Bur	- United States Geological Service - Biological Resources Division
John Deller	- Ohio Department of Natural Resources
Bob Haas	- Michigan Department of Natural Resources
Chuck Murray	- Pennsylvania Fish and Boat Commission
Tim Johnson	- Ontario Ministry of Natural Resources
Les Sztramko	- Ontario Ministry of Natural Resources
Mike Thomas	- Michigan Department of Natural Resources
Betsy Trometer	- United States Fish and Wildlife Service
Lars Rudstam	- Cornell University
Larry Witzel	- Ontario Ministry of Natural Resources

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 1998-1999 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) Forage Task Group Initiatives (section **6.0**)
   a) Interagency coordination of lower trophic level assessment (section **6.1**).
   b) Lakewide round goby distribution (section **6.2**)

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

Central basin

- Round goby continue to expand in both range and abundance in the central basin. They are the most abundant forage species in both Pennsylvania and Ohio waters, except for young-of-the-year (YOY) smelt in Ohio (Table 2.2, 2.3). Young-of-the-year smelt abundance has increased from 1997 but is still low compared to historical levels. Yearling-and-older (YAO) smelt abundance was also low and reflects the poor 1997 year class. YAO smelt abundance in 1999 should continue to decline based on the small size of the 1997 and 1998 year classes. Emerald shiners have increased dramatically in Ohio trawl surveys. Gizzard shad have increased in the Ohio trawl survey and Ontario partnership gillnets. The forage fish base in the central basin is changing from one dominated by a primarily pelagic species (rainbow smelt) to a more diverse mix of benthic and pelagic species (round goby, smelt, emerald shiners, and gizzard shad.) The overall abundance of forage fish has increased compared to 1997, primarily from increases in abundance of emerald shiner and round goby.

- Predator diets are starting to reflect changes in the central basin forage fish base. In 1997, Ohio central basin walleye diets were primarily rainbow smelt (49%), gizzard shad (20%) and emerald shiner (18%). In 1998, emerald shiners comprised the bulk of walleye diets (40%), with gizzard shad and smelt comprising 20% each (Figure 2.3). Walleye diets in Ontario remained unchanged and were primarily clupeids and smelt. Round goby are increasing in occurrence in predator diets, making significant contributions to walleye, smallmouth bass, yellow perch and burbot diets (Figure 2.4).

- Growth of YOY forage species has increased from 1997, with mean lengths among the highest in the 1990's for most species. There are no long-term trends in YOY or YAO forage fish growth, however, YOY yellow perch and white perch have increased in size since 1996 and yearling-and-older smelt have decreased in size since 1995. Yearling yellow perch and white perch have increased in size in Ohio and yearling walleye have increased in size in Ontario and Ohio compared to 1997.

- Ontario and Ohio collected zooplankton samples in the central basin. The Ontario samples are the first collected by a Canadian agency in recent history. At this time, samples are still being processed and data will be included in future reports as analyses are completed.

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 three matters. Progress on these charges is reported below.

3.1 Calibration of Bottom Trawls (by M. Bur)

Use of SCANMAR acoustics equipment continues to be a thrust by MDNR, NYS DEC ODNR, OMNR, and PFBC for calibration of trawling gear. SCANMAR will be available during the greater part of the 1999 field season. Ohio Division of Wildlife will calibrate their trawling gear after the new research boat is delivered.

Demand for this type of gear on the Great Lakes has risen over the past few years. The SCANMAR equipment, which is owned by the Great Lakes Science Center, Ann Arbor, is being used in several research projects. Available time slots for the gear may be limited in the future. Information is being gathered to determine cost of purchasing SCANMAR or similar gear for future uses by Lake Erie agencies. SCANMAR equipment owned by Lake Erie fishery agencies would allow for greater availability for calibration of new trawls and use during assessment cruises.

3.2 Central Tendency Statistics (by B. Haas)

Resource management agencies on Lake Erie typically report the relative abundance of selected fish species from index trawls as an arithmetic mean or geometric mean catch per unit effort (catch per trawl hour). B. Haas has been leading a charge to determine the most appropriate statistic for describing relative abundance. He has written a computer program that simulates trawl catches of fish from populations of known size and distribution characteristics. The arithmetic mean, geometric mean, and median are generated from multiple trawl catch simulations. These statistics are then evaluated on the basis of how close they approximate the known (true) population size.

3.3 Summary of Species CPUE Statistics (by J. Tyson)

Interagency trawling in August has been conducted in Ohio, Michigan, and Ontario waters of the western basin of Lake Erie from 1987-1998. This interagency trawling series was developed to more precisely measure basin-wide fish community indices including growth and abundance of forage species. 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 are stratified into four depth strata (0-3 m, 3-6 m 6-9 m, and >9 m).

Historically, indices as computed from standard bottom trawling have been reported as relative indices, which cannot be combined across agencies; only compared on a qualitative basis. In 1992, the Interagency Trawling Group charged the Forage Task Group with development of standardized trawling procedures and calibration of agency trawls such that the indices could be combined and quantitatively analyzed. Preliminary calibration work was done in 1992 by several Lake Erie agencies using SCANMAR acoustic equipment to assess the dimensions of the bottom trawls being used. Subsequent work with SCANMAR has been 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 reports basin-wide estimates of forage abundance 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 /m^3 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/m^3) for each tow can be generated. Volumetric estimates of abundance and biomass were extrapolated by depth strata to the entire western basin of Lake Erie to obtain an absolute estimate of forage abundance and biomass by species. For reporting purposes, species have been pooled into three functional groups: clupeids (age-0 alewife and gizzard shad), soft-rayed fish (rainbow smelt, emerald and spottail shiners, silver chub, cyprinids, and round goby) and spiny-rayed fish (age-0 white perch, white bass, yellow perch, walleye, and freshwater drum).

Total forage abundance and biomass decreased in the western basin in 1998, relative to 1997. Both total abundance and biomass estimates were twice as high in 1997, due primarily to decreases in clupeid abundance. Spiny-rayed forage were the most abundant functional prey group in 1998, by both numbers and biomass (Figure 3.2, 3.5), in contrast to 1997, when clupeids were the most abundant forage. In 1998, clupeid abundance and biomass decreased to levels similar to those seen in 1995 (Figure 3.3, 3.6). Soft-rayed forage abundance in 1998 was similar to levels seen in 1997 (Figure 3.4), but soft-rayed biomass decreased substantially (Figure 3.7). Spiny-rayed forage fish abundance and biomass was similar to levels seen in 1997, and was much lower than the levels present during the late 1980s and early 1990s, when white perch

abundance was much higher. This decrease in abundance of age-0 spiny-rayed forage may translate into a reduced buffer from walleye predation for gizzard shad and shiners.

Spatial maps of forage distribution were constructed from site-specific catches (#/hectare) of broad prey categories from the August interagency trawls. Abundance contours were created using kriging, with a linear variogram model. Abundance of clupeids were generally higher in the eastern portions of the western basin (>100/hectare), with very high abundance of clupeids, particularly gizzard shad, in the Pelee island region and northward into Pigeon Bay (Figure 3.8a). In western portions of the basin, clupeid abundance was generally lower (<100 fish/hectare). High catches of soft-rayed forage occurred primarily in southwestern areas of the western basin (>500 fish/hectare) (Figure 3.8b). Catches in these areas were dominated primarily by cyprinids (silver chubs, unidentified cyprinids, emerald shiners) and troutperch. Eastern portions of the basin typically had lower soft-rayed forage abundance estimates (250 fish/hectare). The highest densities of spiny-rayed forage in 1998 were centered near the Lake Erie islands, similar to distributions seen in 1997 (Figure 3.8c). Age-0 white and yellow perch were the dominant spiny-rayed forage collected in the western basin trawls. Total forage abundance was generally 1000 fish/hectare across the basin in 1998 (Figure 3.8d).

4.0 Bioenergetics Modeling of Predator Consumption

(by L. Witzel, T. Johnson, A. Cook and D. Einhouse)

In March, 1996, the Lake Erie Forage Task Group was charged with measuring consumption of smelt by the major predators in the central and eastern basins of Lake Erie. Progress toward completing this assignment has recently slowed due to uncertainty of whether historical estimates of walleye abundance remain directly comparable to more recent retrospective calculations. As such, further work to address this charge has been deferred until a scheduled review of walleye population estimation techniques is completed later this year. Upon completion of this review, this bioenergetics assignment should be completed in a timely manner as much of the remaining framework for addressing this assignment is already in place.

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. These fisheries acoustic surveys have been conducted annually from 1993 to 1998. The 1993 to 1996 surveys were principally summertime efforts conducted only in eastern Lake Erie using the New York State Department of Environmental Conservation's 70-kHz single beam echosounder (Simrad EY-M, 7024 transducer). Since 1996, a new 120-khz split-beam system (Simrad EY-500) has been used. This equipment was jointly purchased by the Lake Erie Committee member agencies and the Great Lakes Fishery Commission. The 1998 survey work with this split-beam system included the ongoing July, eastern basin survey, a continuation of a western basin pilot survey, and also was expanded to spring (June) and fall (October) basinwide efforts in the eastern basin. The 1998 field data collection, including acoustic and mid-water trawl sampling, was conducted among four agencies (NYS DEC, OMNR, ODNR and PFBC) and four research vessels (Argo, Explorer, Erie Explorer, and Perca) in Lake Erie's Western and Eastern Basins. However, the acoustic survey results presented in this report are from the ongoing July eastern basin survey that has been in-place since 1993.

Methods

The 120 kHz split beam echo sounder was calibrated at the beginning and end of the July 1998 eastern basin survey. 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 by TS bin are calculated by apportioning the volume backscattering distribution from single targets among the total volume backscattering strength. The lower threshold for volume backscattering was set to -80 dB, 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 (~ > 50 mm). We also selected this acoustic size range as perhaps 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 across a 5-year time series.

Data acquisition throughout the July 1998 effort generally occurred at a vessel speed of 6.0 knots with a transducer affixed to a towed body 1-m below the lake surface. This ongoing, transect survey is completed at night. Acoustic data are stratified vertically by thermal layer (epilimnion, thermocline, hypolimnion), and horizontally by the area encompassed within three depth contours (15 -25 m, 25 -35 m, and >35 m). The water column examined within these

eastern basin strata extended from 5-m below the surface to a backstep of 1-m above the detected bottom.

Mid-water trawling programs accompanied the summertime acoustic sampling efforts in eastern Lake Erie. This companion trawling activity was conducted aboard a second research vessel in 1998 using a mid-water trawl with fishing dimensions of 36 m^2. All trawl samples were counted by species and sub-samples of each collection were measured for total length.

Results and Discussion

The 1998 summer acoustic survey in eastern Lake Erie suggested a pattern of YAO pelagic fish abundance similar to efforts since 1993. Pelagic fish densities were concentrated near the thermocline, particularly in locations where the thermocline was in close proximity to the bottom. The lowest YAO pelagic fish densities occurred centrally over the deepest portion of the eastern basin (Figure 5.1). Accompanying nighttime mid-water trawl samples collected during this acoustic survey characterize the species composition of this pelagic fish community as dominated by rainbow smelt (Table 5.1). Although the 1998 epilimnion trawl samples consisted of only 32.7% YAO smelt, nearly all of the remaining catch (62.6%) in the epilimnion consisted of the YOY smelt cohort. We have found this smelt resource usually consists of two abundant groups (age-0 and age-1) that somewhat spatially separate in the water column due to differing thermal preferences during summer stratification. Our July 1998 survey suggests that YAO smelt experienced low abundance relative to the previous 4 years (Figure 5.2). Most of the YAO smelt in 1998 were distributed between the 25 and 35 m contours (Table 5.2). The YOY smelt cohort seemed particularly abundant in 1998. However, we only have a 2-year time series of acoustic data that encompasses the detection limits for YOY smelt during summer. As such, it remains difficult to assess the relative abundance of YOY smelt from acoustic data until a longer time series is developed.

More thorough examination of YOY and YAO smelt abundance and distribution from these extant data is planned in 1999 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, but not included in this report. The 1998 field season provided an opportunity to conduct fixed station acoustic sampling to provide a detailed description of 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 demand over this same time series (see Bioenergetics Charge).

Beyond the ongoing field sampling program, there have been several other significant initiatives in direct support of Lake Erie fisheries acoustics efforts conducted by the Forage Task Group that will aid these ongoing efforts. Firstly, there was FTG participation in a series of fisheries acoustics workshops developed specifically for Great Lakes applications. These workshops assembled technical experts in fisheries acoustics from throughout North America and Europe who discussed a variety of shared acoustic sampling issues. Also, beginning in 1998, support with specialized survey design and data analysis considerations for our Lake Erie efforts has been provided by Elizabeth Connors, a MS candidate at Cornell University's Biometrics Department, pursuing Lake Erie acoustic survey design and data analysis problems as her thesis topic. These initiatives should aid development of an effective long term fisheries acoustic sampling strategy for Lake Erie in the ensuing years.

Acknowledgments

The FTG is grateful to NYS DEC staff, Douglas Zeller, Richard Zimar, and Brian Beckwith 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 1998 field assistance of Sandra Parker (Cornell University) and Stacy Vega (ESF Syracuse) in conducting the basinwide surveys.

6.0 Forage Task Group Initiatives

6.1 Interagency Coordination of Lower Trophic Level Assessment (Tim Johnson)

The Lake Erie Forage Task Group (FTG) recognizes that changes in the environment and food web must be linked with the composition and productivity of the fish community to sustainably manage the fishery resources of Lake Erie. In September 1998, the Forage Task Group convened an expert workshop in Dunkirk, NY to design a lakewide survey to characterize long-term ecosystem change. The proposed survey calls for each of the member provincial, state and federal agencies to collect information on nine key parameters every two weeks between May and September at two stations (one inshore / one offshore) in the vicinity of their facility. Equipment and protocols will be standardized between agencies, with all information being catalogued in a common interagency database. Summary results would be reported annually in the FTG report. This program may be initiated as early as 1999, although funding to assist with the purchase of equipment, processing of samples and archiving of information continues to be sought from internal and external sources.

6.2 Lakewide Round Goby Distribution

The 1998 fall round goby (*Neogobius melanostomus*) populations in Lake Erie were estimated from bottom trawl surveys conducted by ODNR, OMNR, PFBC, and NYS DEC. Numbers in trawl hauls were converted to number per hectare based on area swept by the trawl. The inverse distance calculation method was used to interpolate goby abundance between trawl stations. The surface map, shown in Figure 6.1, shows high goby abundance along the south shore of the central and western basins, as well as Pennsylvania waters of the eastern basin. The absence of round goby on the north shore in the central basin is due to the lack of trawl data in that area. Round goby are still absent from NYS DEC and OMNR trawl surveys in the eastern basin, suggesting that either the east basin has not been heavily colonized at this time or there are gear limitations. However, round gobies have been reported from the Long Point Bay area and Buffalo harbor, in the eastern basin.

Round goby, first discovered in Lake St. Clair in 1990, continued to increase in abundance and expand their range during 1998. Lake St. Clair surveys showed that round goby made up 6% of trawl catches taken throughout the lake. Round goby collected in August trawls on Lake St. Clair averaged 77 mm total length (range 46 mm to 121 mm). Round goby became established in the central basin of Lake Erie in 1994, while it was not until 1996 that they were apparent in the western basin trawl surveys. In Lake Erie, similar to Lake St. Clair, goby continued to increase in abundance and range, covering all of the west and central basins where trawl surveys are conducted. In August central basin trawls, round goby ranged from 24 to 182 mm with a mean total length of 68 mm. We would expect western basin densities to approach densities found in the central basin in the near future.

In both lakes, zebra mussels (*Dreissena polymorpha*) made up the bulk of goby diets. A feeding study on the round goby during 1993 showed that zebra mussels were present in 96% of stomachs in the St. Clair River and 67% in Lake St. Clair. Round goby diets in the central basin of Lake Erie in 1996 were also comprised primarily of zebra mussels (87% for yearling and older, and 60% for young-of-the-year) (Carey Knight, ODNR, pers. comm.). In 1998, round goby diets were still primarily zebra mussels, but there was an increasing occurrence of Sphaeriidae (26%) and chironomids (26%) in October. Zebra mussels obviously provided a very significant portion of the gobies caloric intake. In 1997 and 1998 in Lake St. Clair, round goby were abundant near a known lake sturgeon spawning ground and were found to be actively feeding on sturgeon eggs. In the central basin, eggs were found in goby diets only in August and October, and based on the time of year, are presumed to be round goby eggs.

Predators in Lake St. Clair did not appear to utilize round goby at first but are now feeding on them extensively. In 1998 and early 1999, gobies were common in stomachs of angler-caught yellow perch, smallmouth bass, and walleye. Other predators, including channel catfish, largemouth bass, rock bass, bowfin, and *Necturus maculosus* captured in survey gear have had gobies in their stomachs. Similar to Lake St. Clair, predators in the central basin of Lake Erie did not initially utilize round goby as forage, but in recent years (1997 and 1998), round goby have become a more important prey item. The frequency of occurrence of round goby in predators was significant in walleye (5%), smallmouth bass (26%), burbot (14%), and yellow perch (19%) diets in 1998 (Figure 3.2-1). It is our opinion that round goby are providing

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 1998 and 1997. Indices are reported as geometric mean catch per trawling hour (GMCPTH) or number caught per hectare (NPH). Long-term averages are reported as the mean of the annual trawl indices for survey years during the present (90's Avg.) and previous (80's Avg.) decades. Agency trawl surveys are described below.

	Trawl	YOY				YAO			
Species	Survey	1998	1997	90s Avg.	80s Avg.	1998	1997	90s Avg.	80s Avg.
Smelt	ON-DW	797.9	102.7	688.4	2641.7	22.1	72.8	551.3	498.0
	NY-Fa	251.6	329.5	1743.4	---	27.8	1174.8	636.6	---
	PA-Fa	352.0	---	903.7	6902.1	0.5	---	633.5	1852.6
Emerald	ON-DW	5.9	0.1	10.7	16.8	0.5	0.3	14.2	40.8
Shiner	ON-OB	0.9	1.3	2.0	1.1	0.3	0.9	1.7	1.2
	NY-Fa	0.0	0.0	148.1	---	0.0	0.0	5.2	---
	Pa-Fa	16.8	---	5.6	47.8	0.0	---	12.4	20.1
Spottail	ON-OB	59.9	228.9	181.1	28.8	1.1	4.7	5.0	4.5
Shiner	ON-IB	11.6	3.8	7.1	16.2	0.2	0.1	0.2	1.3
	NY-Fa	0.1	2.0	26.3	---	0.0	1.7	5.2	---
	PA-Fa	27.0	---	4.0	1.6	0.5	---	2.1	7.6
Alewife	ON-DW	0.7	0.2	4.1	17.0	0.5	0.0	0.3	0.7
	ON-OB	0.0	0.3	1.2	2.6	0.0	0.0	0.0	0.1
	NY-Fa	0.0	32.8	69.3	---	---	---	---	---
	PA-Fa	0.0	---	3.3	16.2	0.0	---	2.1	18.0
Gizzard	ON-DW	2.1	0.0	0.5	14.0	0.1	0.0	0.2	0.2
Shad	ON-OB	0.8	0.4	1.4	5.1	0.0	0.1	0.2	0.6
	NY-Fa	0.1	1.6	4.4	---	---	---	---	---
	PA-Fa	0.0	---	0.7	41.6	0.0	---	0.7	0.4
White	ON-DW	0.4	0.0	1.3	3.9	0.0	0.1	1.1	3.2
Perch	ON-OB	0.3	1.7	4.0	4.4	0.0	0.5	0.2	0.7
	NY-Fa	0.0	0.1	39.1	---	---	---	---	---
	PA-Fa	61.1	---	56.4	848.6	0.0	---	8.2	32.8
Round	ON-DW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goby	ON-OB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NY-Fa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	PA-Fa	160.9	---	0.0	0.0	3.8	---	0.0	0.0

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 1990-1997.

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 1990-1997.

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 1990-1997.

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 1992-1997.

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 1990-1996. Indices not reported from 1997 due to incomplete trawl sampling.

Table 2.2. Relative abundance (geometric mean catch per trawl hour) of selected young-of-the-year species from all trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1990-1998.

Species	Agency	Year								
		1990(a)	1991(a)	1992(a)	1993(a)	1994(a)	1995	1996	1997	1998
Alewife	OH	0.2	0.5	5.6	0.0	1.2	1.1	0.8	1.4	0.7
	PA	0.0	-	53.3	-	0.0	0.0	0.0	0.0	0.0
Gizzard Shad	OH	11.1	1.0	2.0	0.6	2.0	0.9	33.0	1.4	23.2
	PA	88.1	-	0.0	-	1.4	0.0	0.0	0.0	0.0
Goby	OH	0.0	0.0	0.0	0.0	1.6	5.5	11.1	47.4	210.0
	PA	0.0	-	0.0	-	0.0	0.0	0.0	4.0	439.6
Rainbow Smelt	OH	454.4	6.7	912.6	9.0	206.5	467.4	568.3	93.0	371.0
	PA	1918.2	-	8956.6	-	1100.5	240.9	9664.9	28.0	14.9
Trout-perch	OH	3.9	1.1	5.7	2.1	0.0	2.8	2.8	0.3	0.7
	PA	0.0	-	3.9	-	1.6	65.1	1.5	0.0	13.5
White Bass	OH	22.6	5.7	1.2	14.9	75.6	17.6	38.4	6.7	61.8
	PA	18.6	-	0.0	-	8.5	1.6	0.0	0.0	0.0
Emerald Shiner	OH	23.8	13.9	7.5	2.7	7.1	4.6	7.0	3.8	44.5
	PA	699.7	-	34.5	-	0.0	48.0	1.0	0.0	3.4
Spottail Shiner	OH	0.3	0.1	0.2	0.9	1.4	0.7	3.4	0.9	0.8
	PA	0.0	-	0.0	-	0.0	19.5	0.0	0.0	0.0
Yellow Perch	OH	9.1	2.0	11.7	9.8	12.1	5.3	86.1	2.0	49.1
	PA	22.2	-	97.5	-	253.4	125.5	490.8	0.0	3.0
White Perch	OH	1401.0	430.6	27.0	53.2	74.4	6.6	250.5	9.3	42.9
	PA	3607.9	-	998.8	-	109.4	101.4	287.0	0.0	0.0

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

Table 2.3. Relative abundance (geometric mean catch per trawl hour) of selected yearling-and-older species from all trawl surveys in the central basin, OH and Pennsylvania, Lake Erie, from 1990-1998.

		Year								
Species	**Agency**	**1990(a)**	**1991(a)**	**1992(a)**	**1993(a)**	**1994(a)**	**1995**	**1996**	**1997**	**1998**
Alewife	OH	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1
	PA	0.0	-	32.4	-	0.0	0.0	0.0	0.0	0.0
Gizzard Shad	OH	0.2	0.1	0.1	0.2	0.0	1.5	0.0	0.1	0.1
	PA	0.6	-	0.0	-	0.0	0.0	0.0	0.0	0.0
Goby	OH	0.0	0.0	0.0	0.0	0.9	2.5	48.4	81.8	219.4
	PA	0.0	-	0.0	-	0.0	0.0	0.0	0.0	4.0
Rainbow Smelt	OH	38.6	34.7	32.2	75.6	17.9	27.0	25.0	71.3	26.2
	PA	41.9	-	275.4	-	1.6	1049.0	44.2	0.0	0.0
Trout-perch	OH	4.4	2.2	2.9	4.4	2.1	6.3	7.5	5.3	7.1
	PA	148.0	-	3.5	-	4.8	135.0	0.0	0.0	0.0
White Bass	OH	0.1	0.0	0.4	0.0	0.0	2.5	0.2	11.7	0.3
	PA	3.3	-	0.5	4.5	0.0	0.0	0.0	0.0	0.0
Emerald Shiner	OH	18.4	22	4.1	4.4	2.0	4.5	8.1	4.3	18.4
	PA	1.4	-	560.1	-	0.6	21.0	0.0	0.0	0.0
Spottail Shiner	OH	0.6	0.4	0.4	0.2	1.5	2.2	1.6	1.6	1.6
	PA	19.7	-	0.0	-	0.0	40.5	0.0	0.0	0.0
Yellow Perch	OH	7.6	10.7	2.5	6.4	1.5	41.0	4.3	22.3	2.3
	PA	118.4	-	140.4	-	2.4	510.6	1.6	0.0	0.0
White Perch	OH	89.2	111.0	35.6	0.9	0.4	17.3	9.2	13.0	1.6
	PA	110.6	-	95.6	-	0.0	2.1	0.8	0.0	0.0

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

Table 2.4. Estimated abundance (#/hectare) of functional prey fish groups in Lake St. Clair, from Michigan DNR August trawls, 1996-1998.

Functional Prey	Year 1996	1997	1998
Clupeid	18.3	20.1	23.5
Soft-rayed	737.0	1711.0	160.0
Spiny-rayed	541.0	278.0	149.0

Table 5.1. Summary of nightime summer mid-water trawl catches to characterize species composition in offshore areas (>15 m contour) of the eastern basin of Lake Erie, 1993-1997.

YEAR	THERMAL STRATUM	TOWS	NUMBER OF YAO SMELT	NUMBER OF OTHER FISH	PERCENT YAO SMELT
1993	Epilimnion	1	75	11	87.2%
1993	Thermocline	2	108	5	95.6%
1993	Hypolimnion	3	369	4	98.9%
1995	Epilimnion	6	574	714	44.6%
1995	Thermocline	6	20,490	959	99.9%
1995	Hypolimnion	6	9,389	119	99.9%
1996	Epilimnion	3	2,220	207	91.5%
1996	Thermocline	2	3,740	4	99.9%
1996	Hypolimnion	1	104	2	98.1%
1997	Epilimnion	8	12,506	194	98.5%
1997	Thermocline	13	17,870	106	99.4%
1997	Hypolimnion	5	3,937	1	99.9%
1998	Epilimnion	6	84	173	32.7%
1998	Thermocline	3	1,373	87	94.0%
1998	Hypolimnion	1	2,807	2,899	96.8%

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, 1998. Confidence limits (95%) are the percent of the total abundance estimate.

JULY, 1998 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	61,368,005	36.5%
25-35 m	465,597,336	21.7%
35-65 m	175,751,815	18.0%
ALL	**702,717,156**	**14.7%**

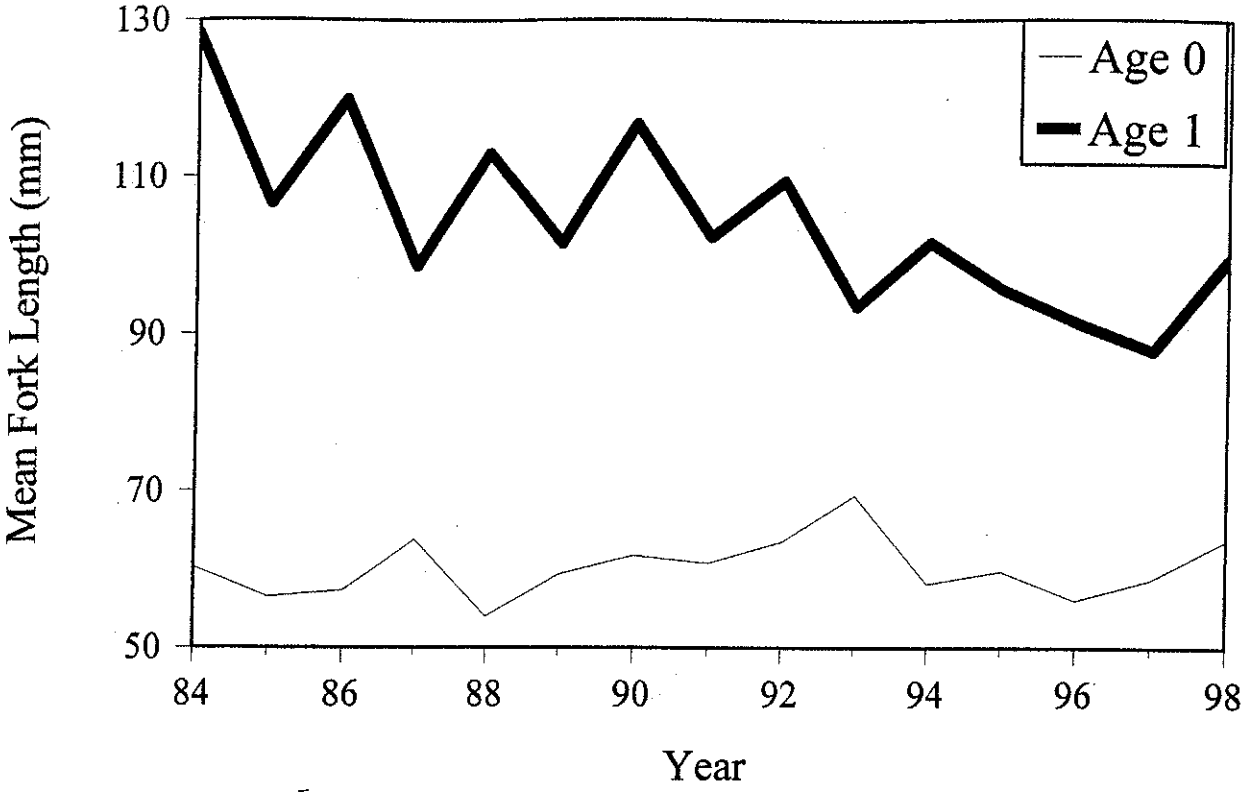


Figure 2.1. Mean fork length of age-0 and age-1 rainbow smelt from OMNR index trawl surveys in Long Point Bay, Lake Erie, October 1984-1998.

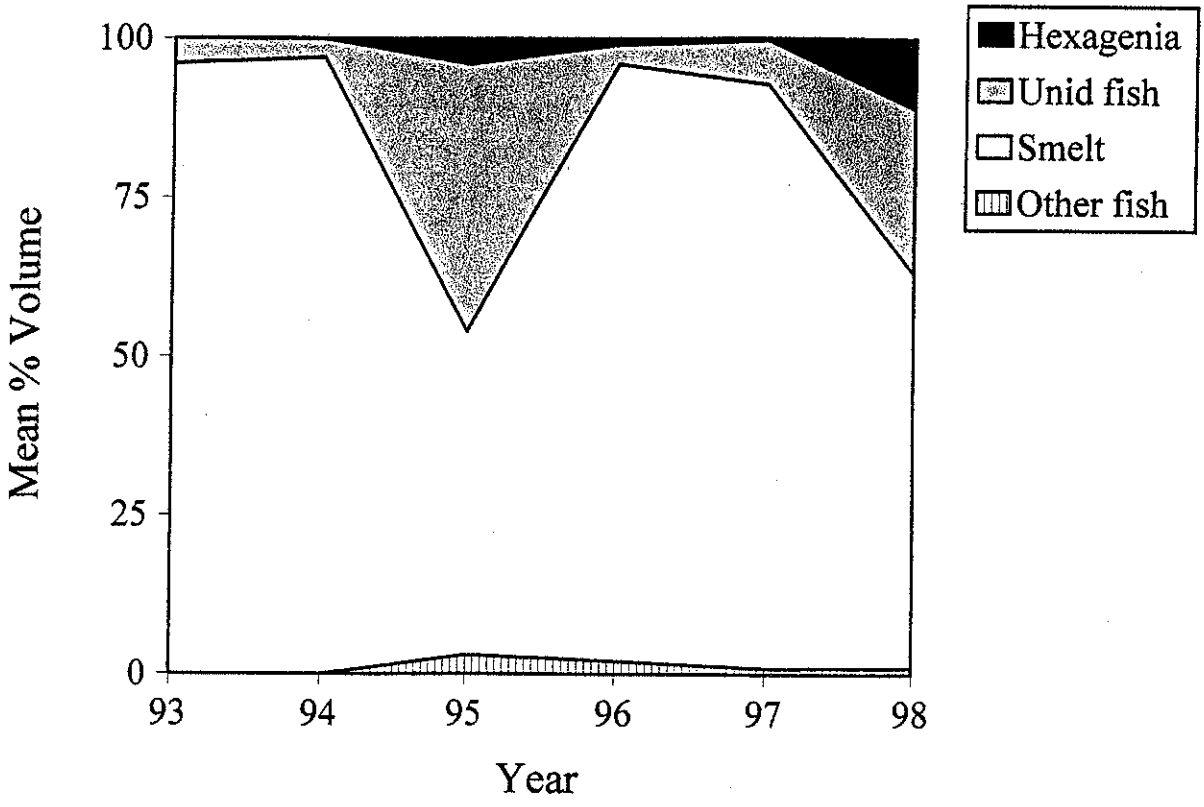


Figure 2.2. Food items identified from stomach contents of walleye collected, in the eastern basin of Lake Erie, 1993-1998 (NYSDEC summer sport fishery data).

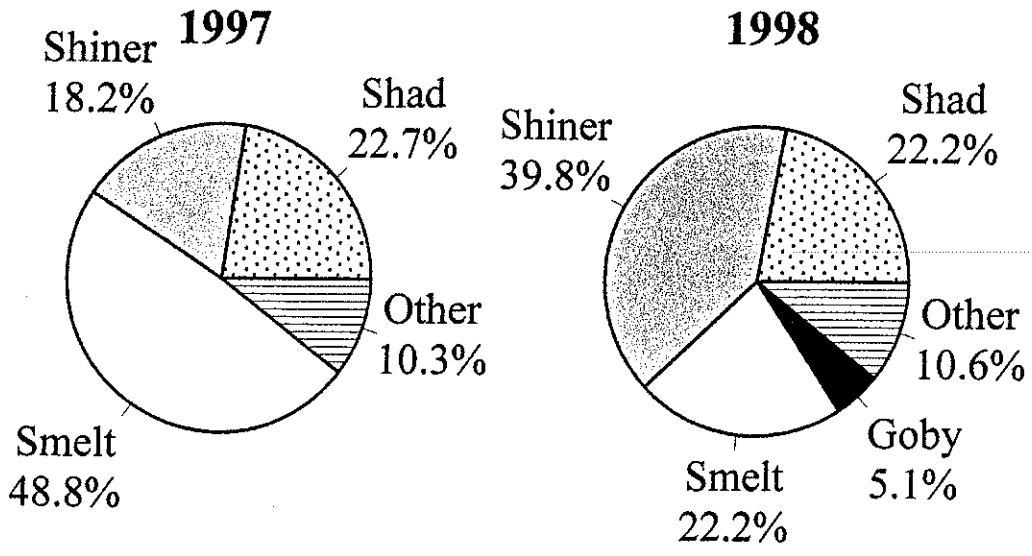


Figure 2.3 . Diet composition (mean percent by weight) of walleye from central basin sites in Lake Erie, during fall bottom trawl surveys, 1997 & 1998.

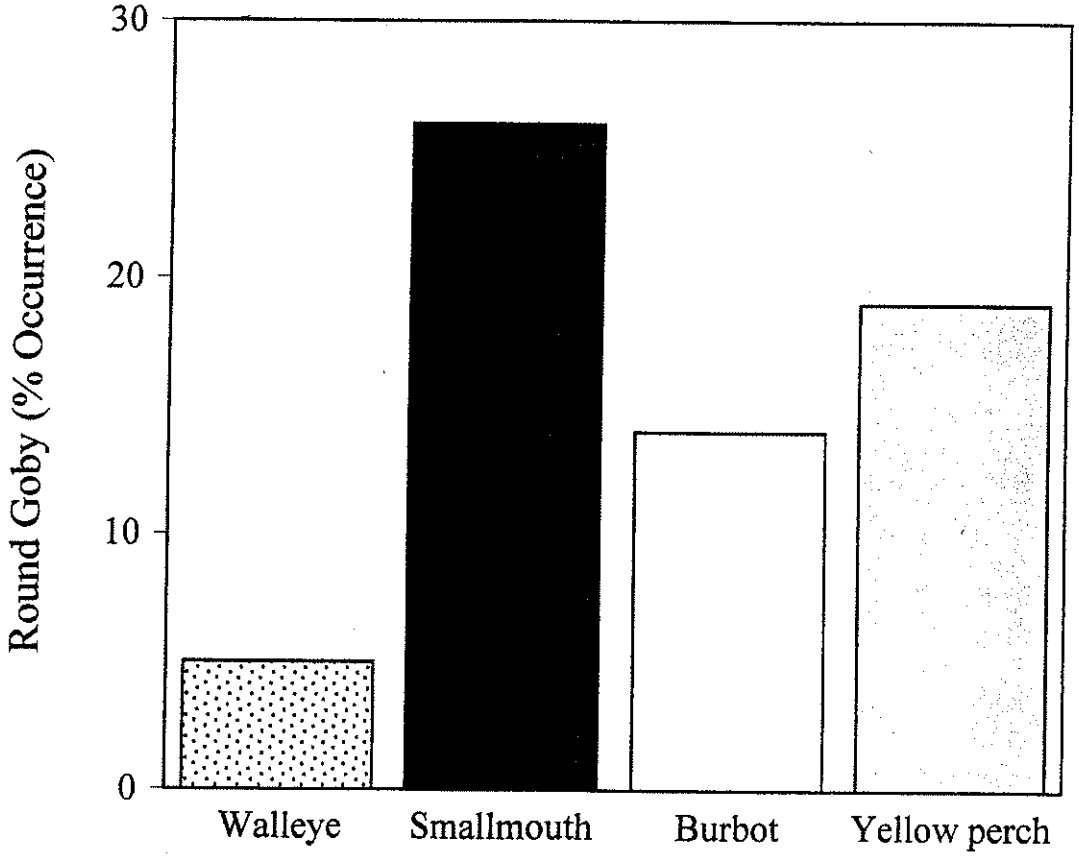


Figure 2.4. Contribution of round gobies to the diets (mean % occurrence) of selected Lake Erie predators in the central basin of Lake Erie, fall, 1998.

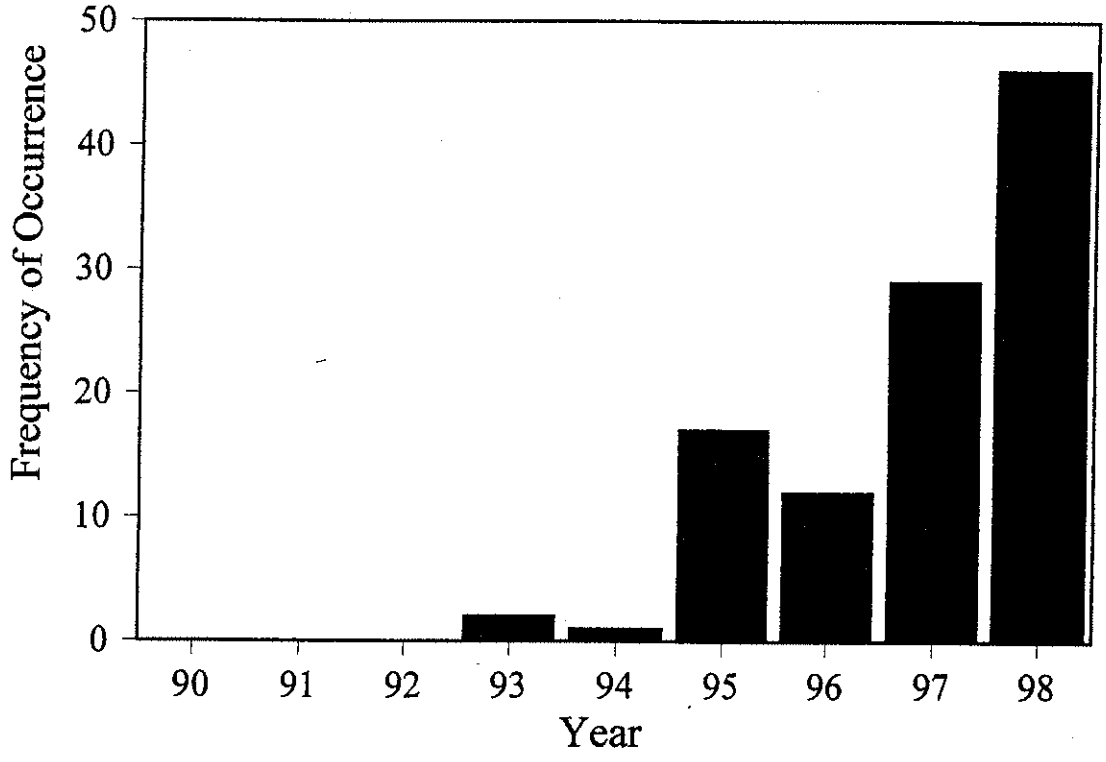


Figure 2.5. Percent *Hexagenia* in diets of yellow perch collected from Ohio waters of the western basin, Lake Erie, 1990-1998.

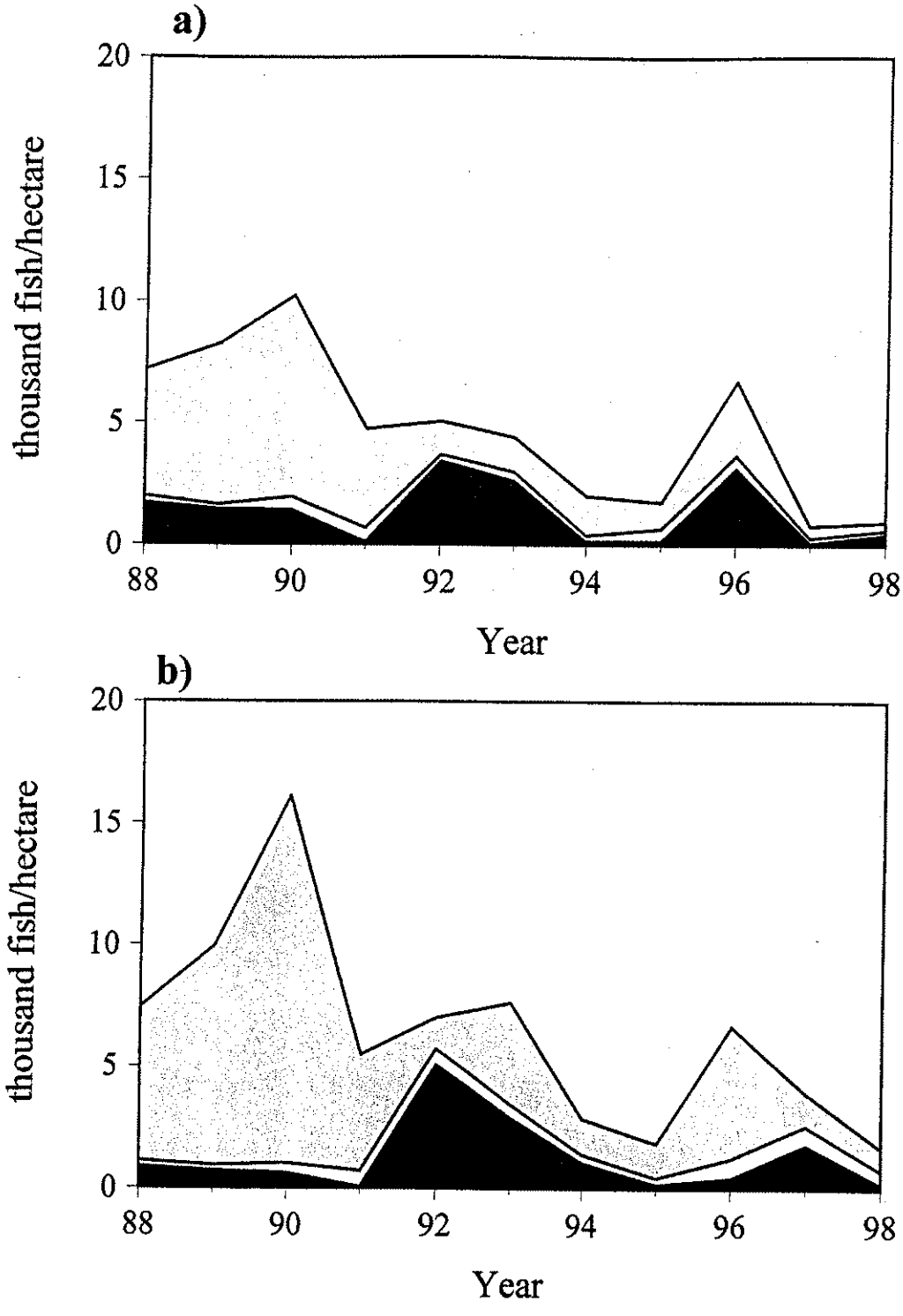


Figure 2.6. Mean abundance (#/hectare) of functional prey fish groups in Ontario (a) and Ohio (b) waters of the western basin, Lake Erie, August 1988-1998.

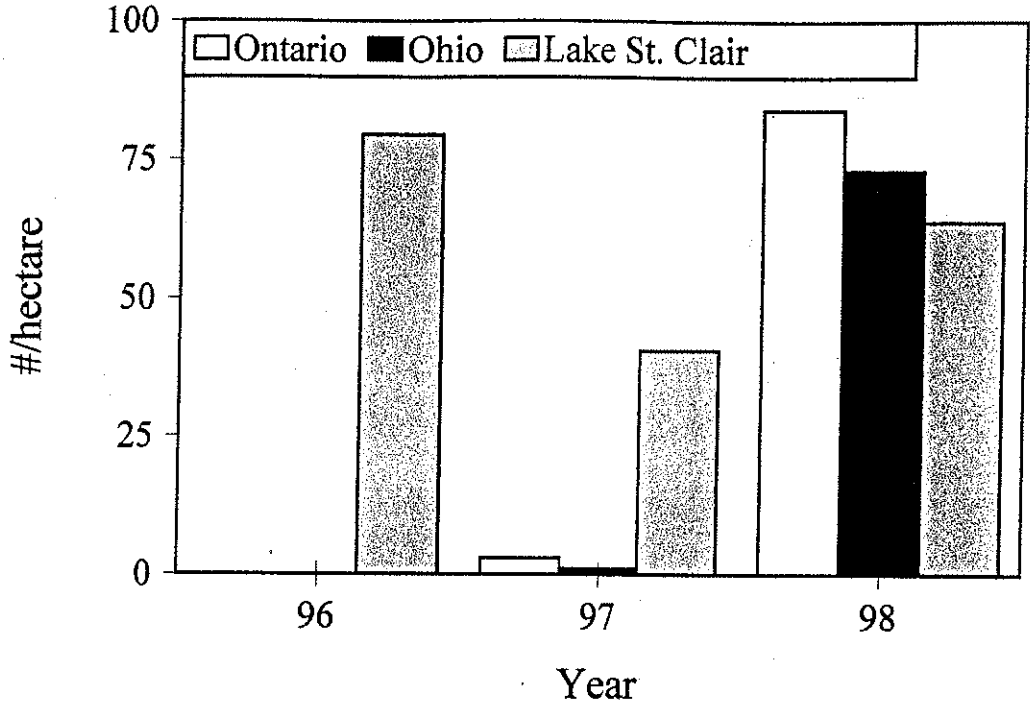


Figure 2.7. Abundance of round gobies in Lake St. Clair and the western basin of Lake Erie, August, 1996-1998.

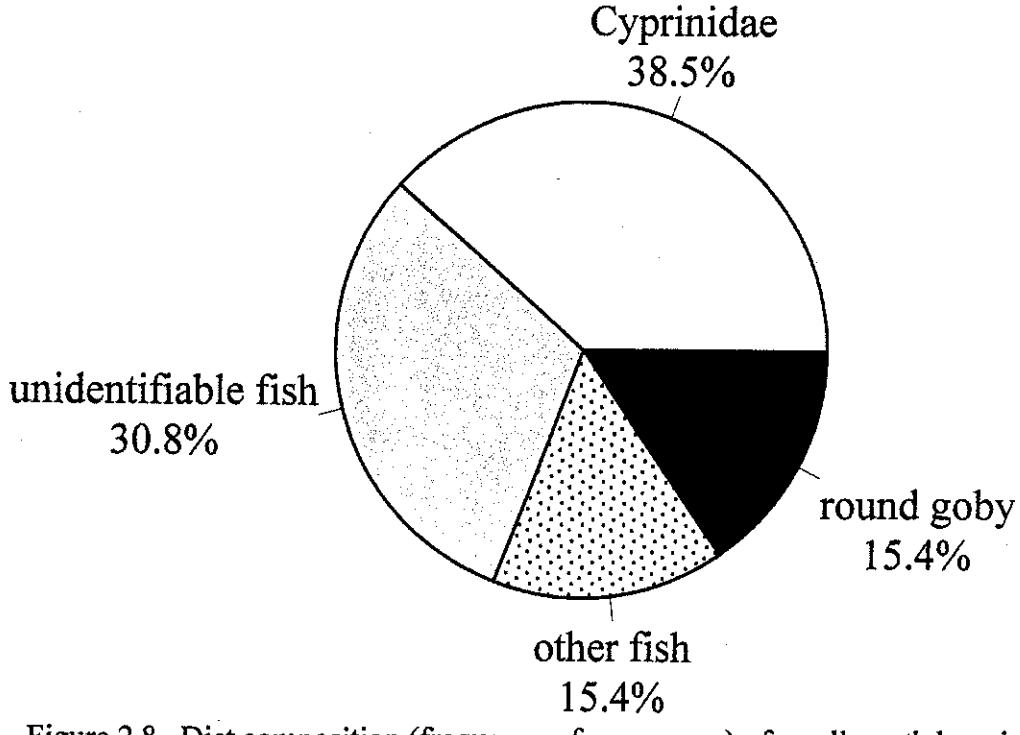


Figure 2.8. Diet composition (frequency of occurrence) of smallmouth bass in Ontario waters of the western basin of Lake Erie, fall, 1998. Data are from OMNR partnership gill net collections.

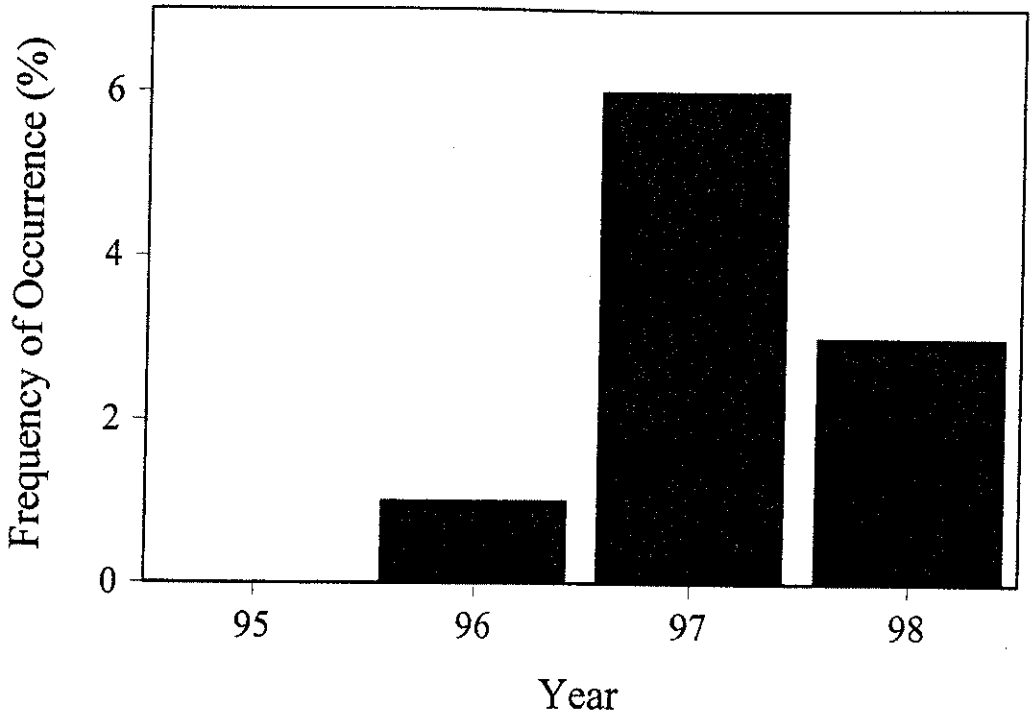


Figure 2.9. Percent of round gobies in diets of yellow perch collected from Ohio waters of the western basin of Lake Erie, 1995-1998.

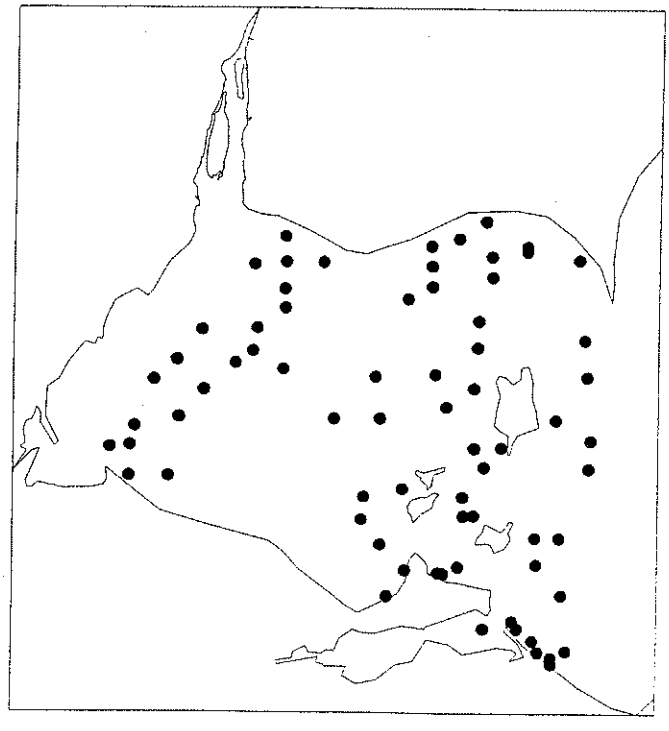


Figure 3.1. Trawl locations for western basin interagency trawling survey, August 1998.

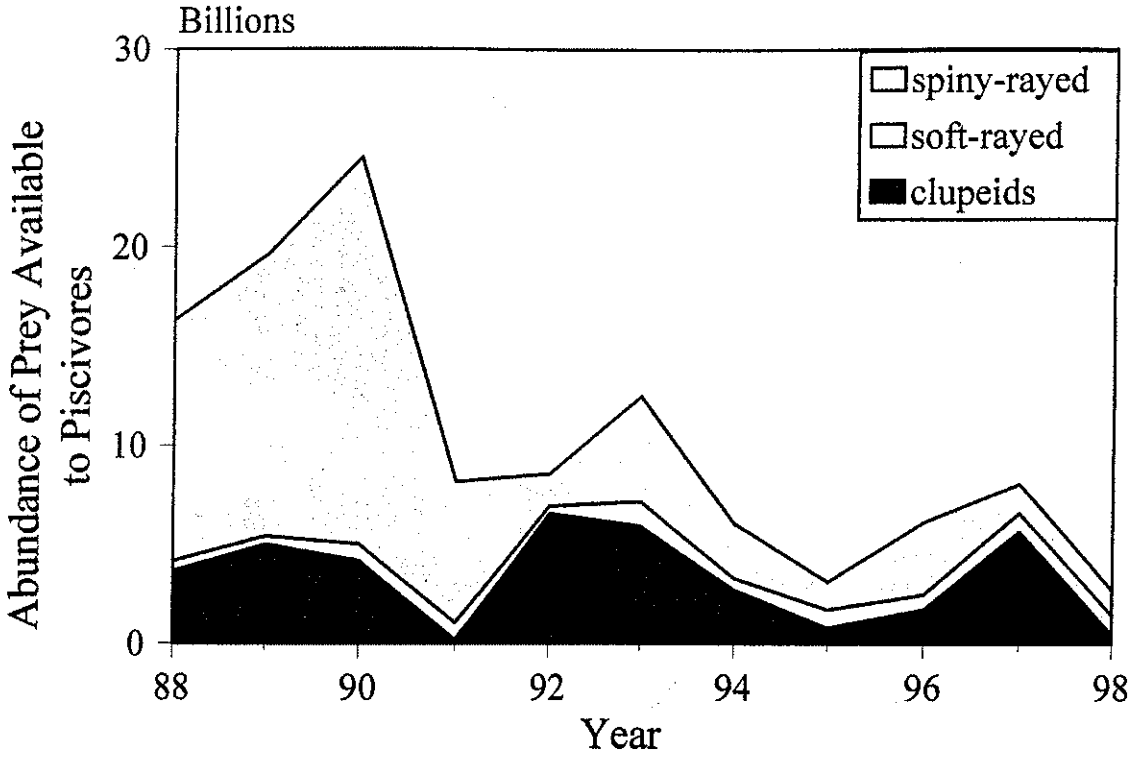


Figure 3.2. Estimated absolute abundance of prey fish groups in Ontario and Ohio waters of the western basin, Lake Erie, generated from August trawls (1988-1998).

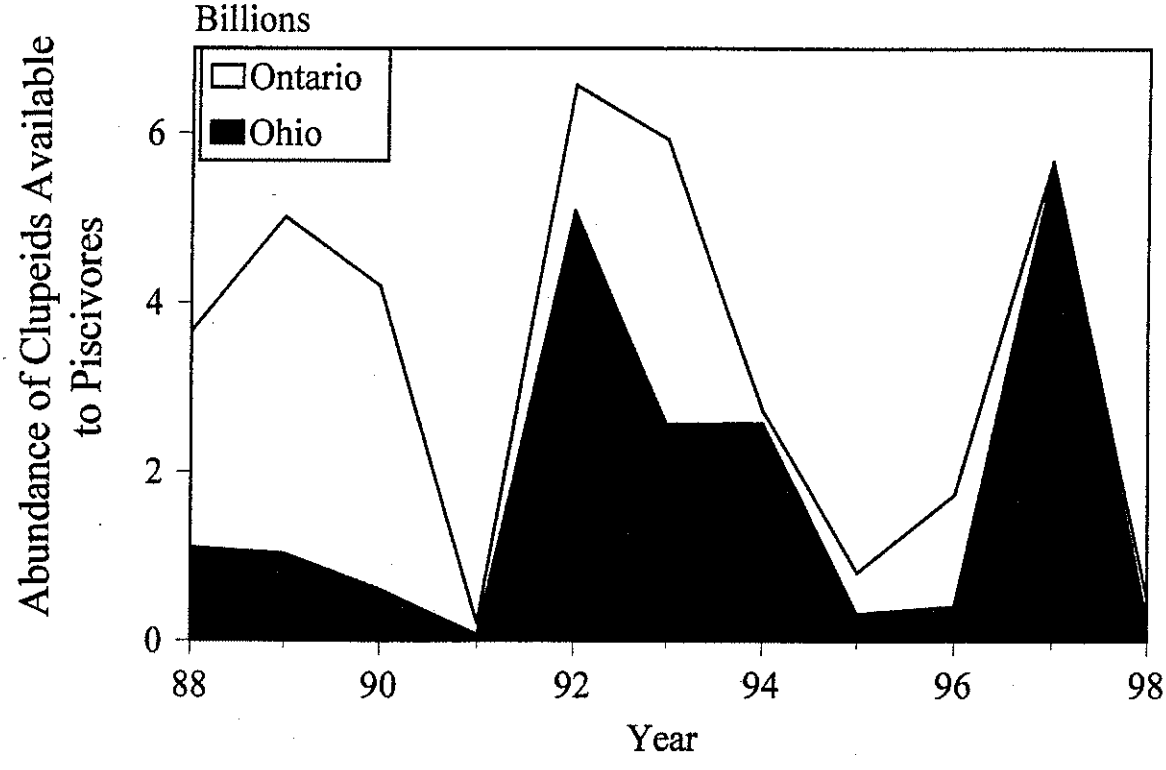


Figure 3.3. Estimated absolute abundance of clupeids in Ontario (□) and Ohio (■) waters of the western basin, Lake Erie, generated from August trawls (1988-1997).

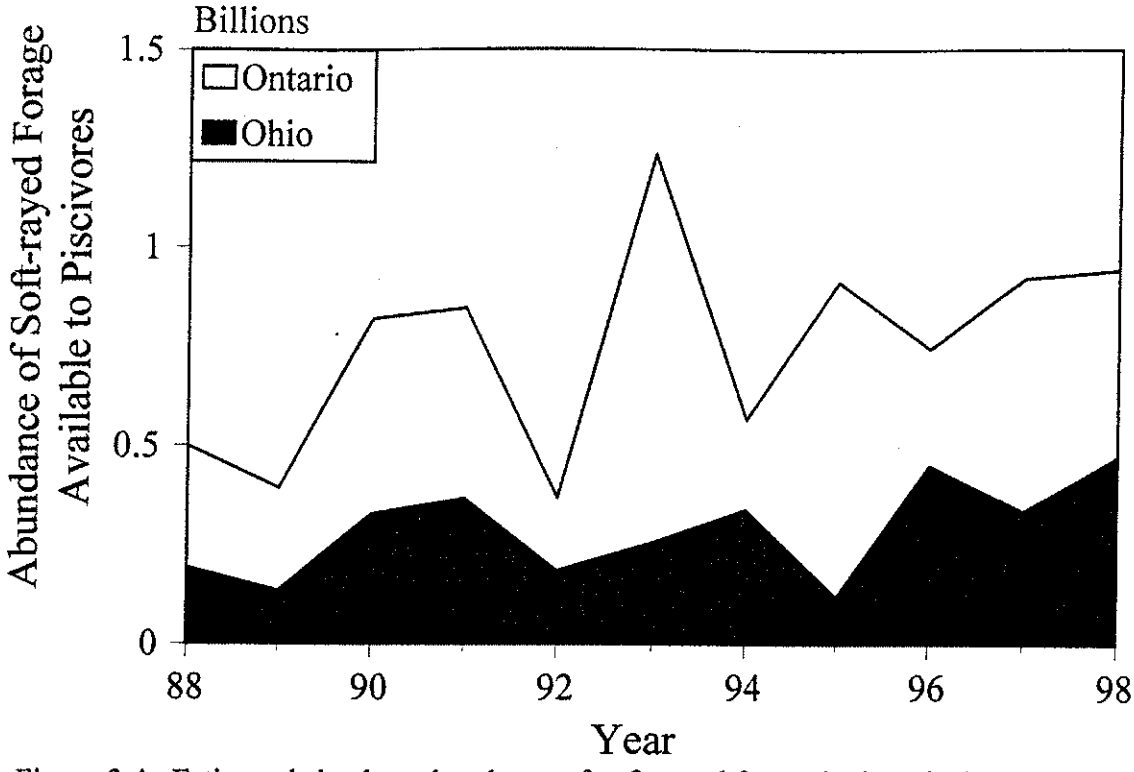


Figure 3.4. Estimated absolute abundance of soft-rayed forage in Ontario (□) and Ohio (■) waters of the western basin, Lake Erie, generated from August trawls (1988-1997).

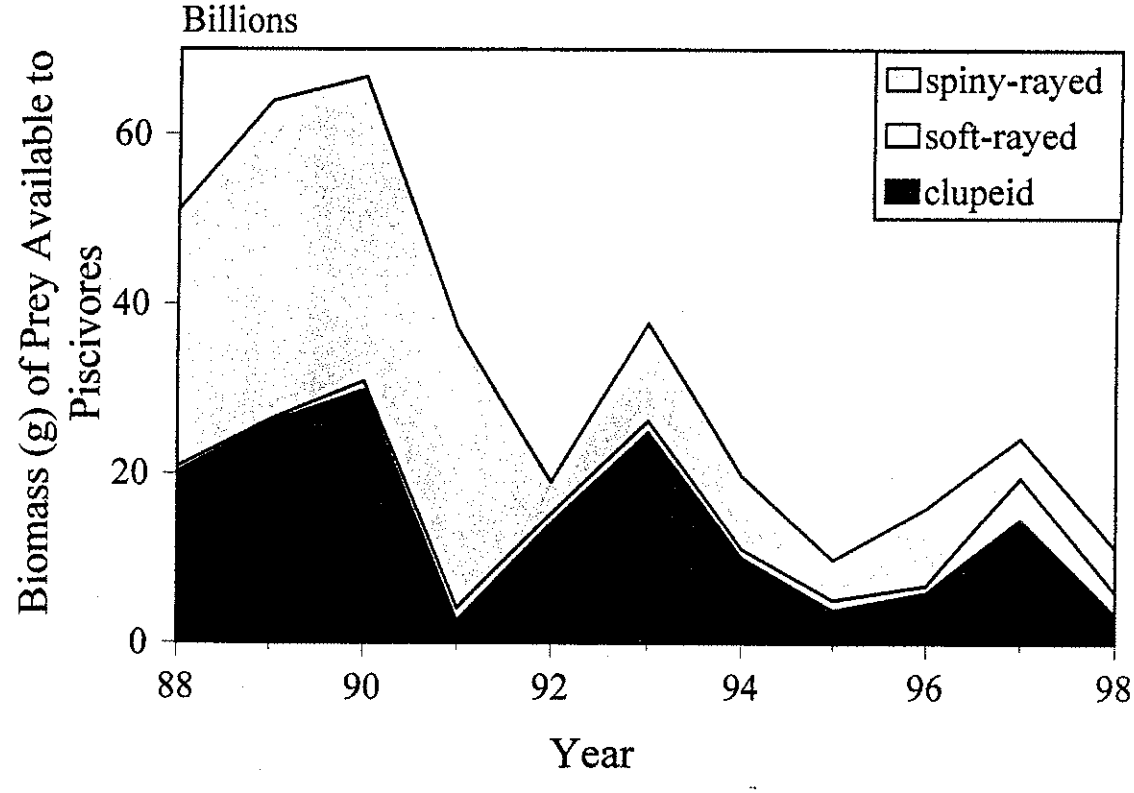


Figure 3.5. Estimated absolute biomass (g) of prey fish groups in Ontario and Ohio waters of the western basin, Lake Erie, generated from August trawls (1988-1997).

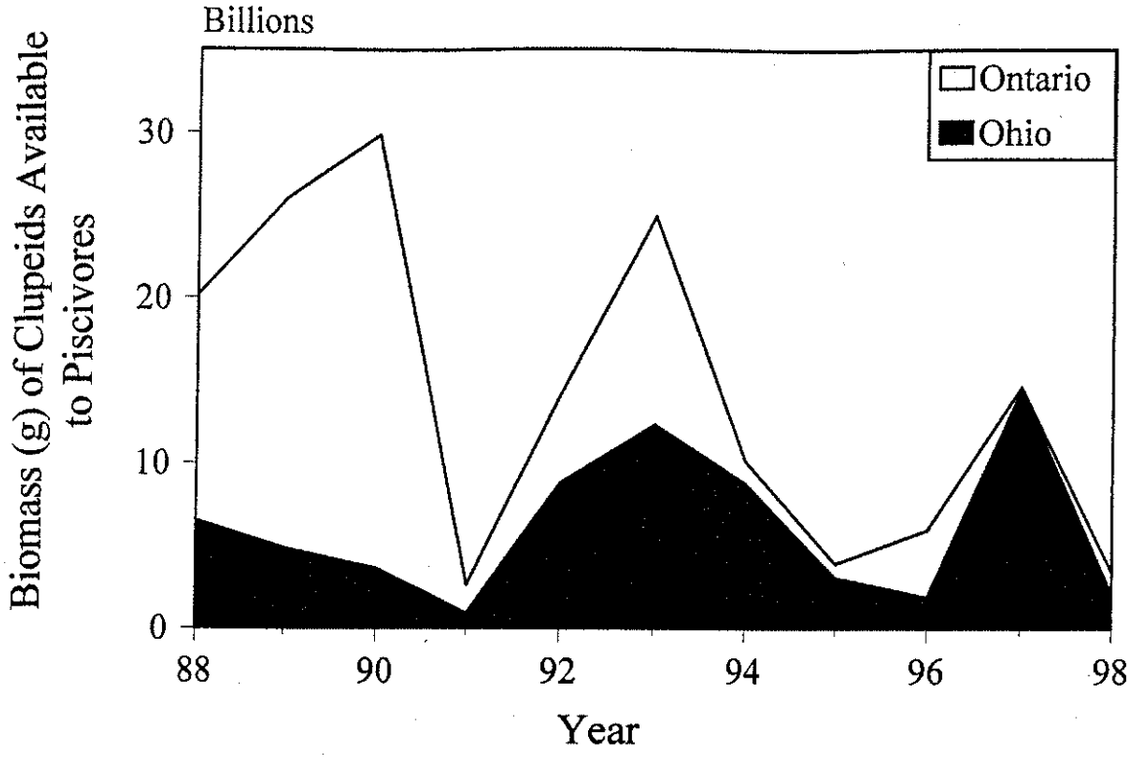


Figure 3.6. Estimated absolute biomass (g) of clupeids in Ontario (□) and Ohio (■) waters of the western basin, Lake Erie, generated from August trawls (1988-1997).

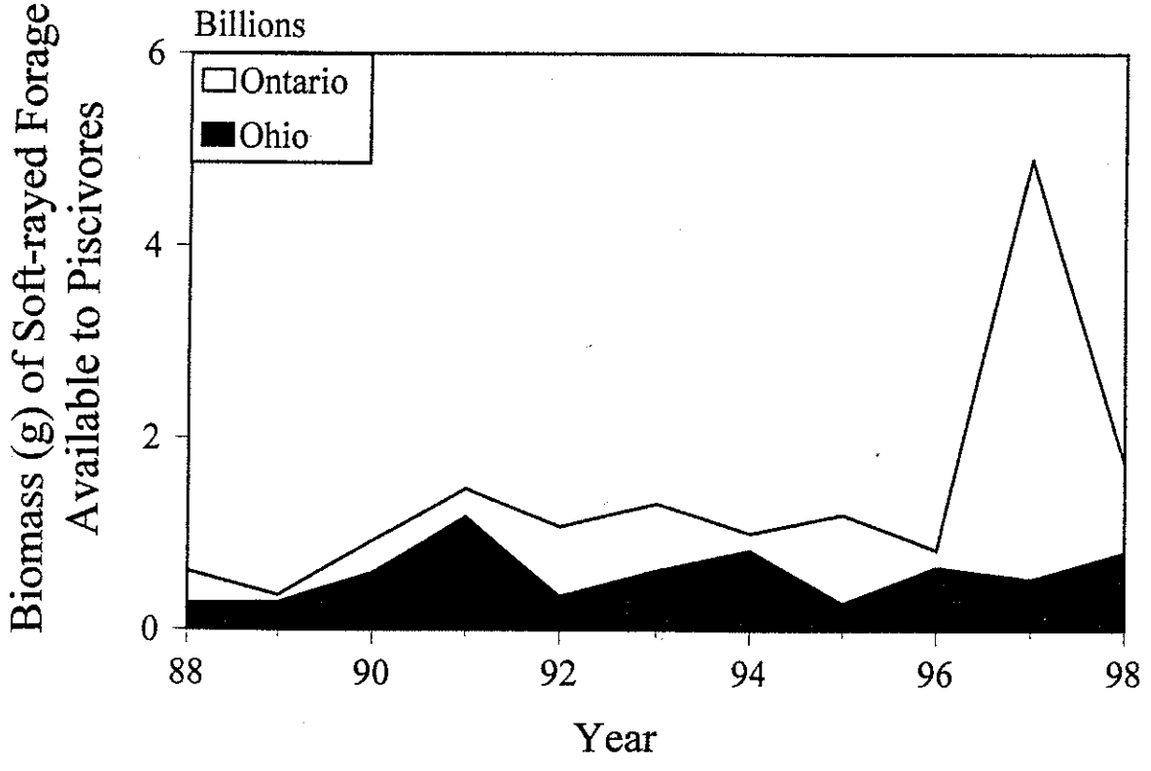


Figure 3.7. Estimated absolute biomass (g) of soft-rayed forage in Ontario (□) and Ohio (■) waters of the western basin, Lake Erie, generated from August trawls (1988-1997).

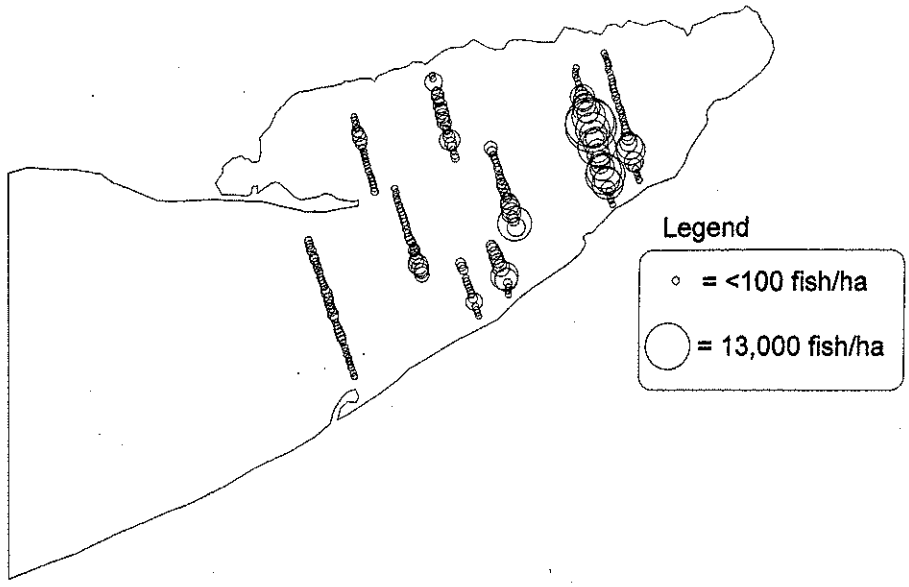
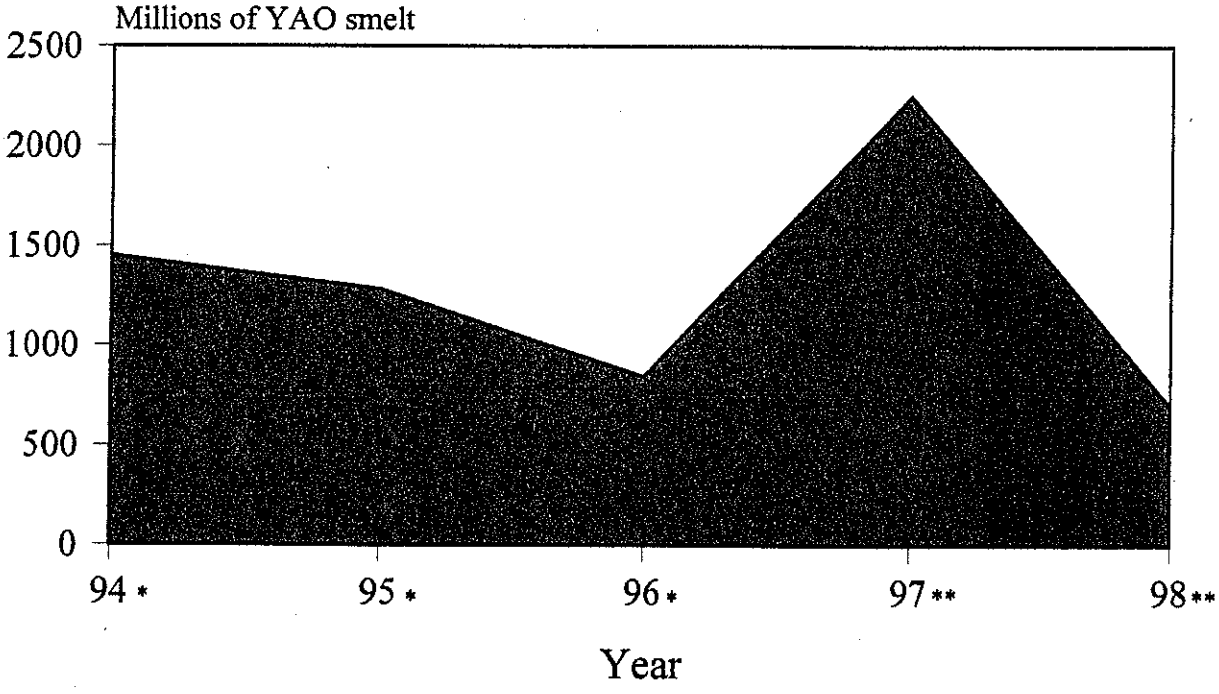


Figure 5.1. Sampling locations and relative density of pelagic, adult forage-sized fish during July 1998 fisheries acoustic survey.



* - 1993 to 1996 data was extrapolated from 70 kHz single beam echosounder for a target strength range of -56 to -44 dB,

** - 1997 and 1998 data was extrapolated from 120 kHz split beam echosounder for target strength range from -55 to -43 dB

Figure 5.2. July, 1998 eastern basin index of yearling-and-older pelagic forage fish estimate obtained from annual summer acoustic surveys.