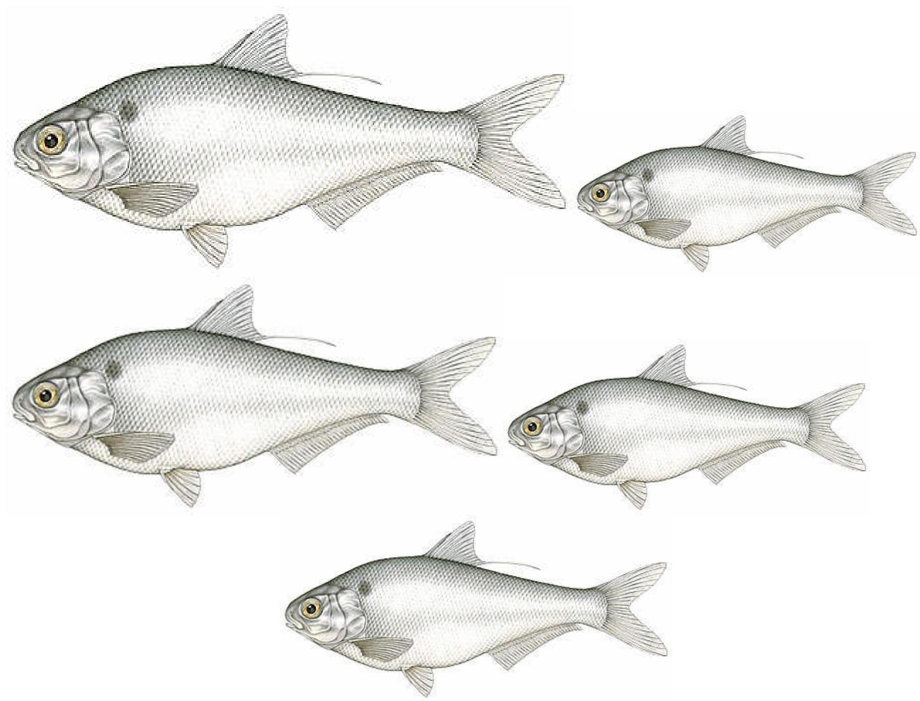
Report of the Lake Erie Forage Task Group

March 2005



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Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

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1.0 Charges to the Forage Task Group in 2004-2005

1. Continue to describe the status and trends of forage fish and invertebrates in each basin of Lake Erie.

2. Continue the development of an experimental design to facilitate forage fish assessment and standardized interagency reporting.

3. Continue hydroacoustic assessment of the pelagic forage fish community in eastern and central Lake Erie, incorporating new methods in survey design and analysis as necessary to refine these programs. Promote the development of an acoustic survey for western Lake Erie.

4. Continue the interagency lower-trophic food web monitoring program to produce annual indices of trophic conditions which will be included with the annual description of forage status.

5. Reassess the bioenergetics model’s status and its data needs.

2.0 Forage Task Group Bullet Statements

2.1 2005 Forage Task Group Synopsis

General Patterns

- Poor recruitment of most species lake wide; exceptions were round gobies and white perch
- Increase in yearling forage due to strong 2003 recruitment
- Predator diets remain dominated by rainbow smelt in east; clupeids and shiners were more important in other basins; round goby continue to increase in diets
- Predator size-at-age average for most species

Eastern Basin

- Age-0 smelt decreased; age-1+ smelt increased (highest in NYSDEC survey history).
- Age-0 forage (smelt, emerald & spottail shiners, alewife, gizzard shad) decreased; white bass, white perch and trout-perch also declined
- Round goby increased to record highs in some areas
- Predator diets remain dominated by smelt but round goby fraction continues to increase
- Size of age-0 smelt increased; decrease in length of age-1 smelt
- Predator growth remains good; age-2 to age-4 smallmouth bass and yellow perch size-at age is above average; age-1 to age-4 walleye size-at-age is slightly below average
- Age-1 walleye notably smaller than long-term average length (NYSDEC)
- lake trout size-at-age remain stable; among highest in the Great Lakes

Central Basin

- Decline in recruitment of all species except round gobies and white perch
- Increase in yearling-and-older (YAO) forage due to large 2003 cohorts of smelt, emerald shiner, yellow perch, and white perch
- Decrease in mean size of YOY and YAO of most species
- Shiners dominate walleye diets (45% by weight); smelt and gizzard shad also important prey

Western Basin

- Age-0 clupeid catches lowest in series (since 1987); no alewife captured in trawls and gizzard shad lowest in time series
- Age-0 white perch 4th highest; round gobies and trout-perch increased
- Percid recruitment down 30-fold relative to 2003; no age-0 smallmouth bass
- Predator size-at-age comparable to long term mean; age-1 walleye below average
- Predator diets show higher reliance on white perch than usual, although clupeids continue to dominate walleye diets

2.2 Eastern Basin (by L. Witzel, D. Einhouse, J. Markham and C. Murray)

Rainbow smelt are the principal forage fish species of piscivores in the offshore waters of eastern Lake Erie. Yearling-and-older (YAO) smelt (predominately age-1) have demonstrated a conspicuous alternate year cycle of increased abundance that forecasted a decrease in YAO smelt abundance in 2004, but the opposite was observed. In fact, NYSDEC trawls caught record high densities of YAO smelt during 2004 (2004 NPHa=2624, 1992-2003 Avg. NPHa=439) (Table 2.1). Strong recruitment of yearling smelt during 2004 was not unexpected based on record high catches (by OMNR) of this year class as YOY during 2003.

YOY smelt abundance decreased basin-wide in 2004. This decrease was less extreme in New York waters (Table 2.1); elsewhere, Age-0 smelt were well below long-term average densities. Mean length of Age-0 smelt increased and mean length of yearling smelt decreased in 2004 (Figure 2.1).

The contribution of non-smelt fish species to the forage fish community of eastern Lake Erie decreased during 2004 (Table 2.1). Fish species exhibiting the greatest decreased abundance were emerald shiner (except YAO in Ontario), trout-perch, white perch, alewife and gizzard shad. Only in Ontario waters did the large 2003 year class of emerald shiner show strong recruitment during 2004. Trout-perch were above average abundance in southern regions of eastern Lake Erie, but remained conspicuously sparse throughout the Long Point Bay area.

Round gobies emerged as a new species among the eastern basin forage fish community during the late 90's. Gobies continued to increase in density at a rapid rate and by 2001 became the most or second most numerically abundant species caught in agency index trawl gear across areas surveyed in eastern Lake Erie. In 2002, round goby population growth made an abrupt reversal in the southern regions of the basin. This anomaly was short-lived as goby densities resumed an upward trend throughout all survey areas since 2003 (Table 2.1). In 2004, round goby densities reached record high levels in Ontario and New York waters of eastern Lake Erie.

During 2004, NYS DEC and OMNR continued to participate in the eastern basin component of the lake-wide inter-agency Lower Trophic Level Assessment (LTLA) program coordinated through the Forage Task Group. These data have been incorporated in the Forage Task Group's LTLA database.

Examination of angler-caught adult walleye revealed that rainbow smelt have remained the dominant prey of walleye each summer of NYSDEC assessment since 1993. Beginning in 2001 prey fish other than rainbow smelt began to make a small, but measurable, contribution to the walleye diet. Round goby have remained the largest component of the diet of adult smallmouth bass caught in experimental gill net surveys (NYSDEC) since 2000. Fish species continue to comprise the majority of the diets of both lake trout and burbot caught in experimental gill net surveys in the eastern basin of Lake Erie, August 2004, and round gobies continued to be an increasingly important forage item. Smelt remain the dominant food item for lake trout, occurring in 77% of the lake trout stomach samples. However, occurrences of round gobies increased from 15.4% in 2003 to 20.8% in 2004. The occurrence of round gobies in lake trout diets has increased steadily since 2001. Burbot diets were more diverse with 8 different fish and invertebrate species found in stomach samples. Round gobies were the dominant prey item for the second straight year, occurring in 68% of the burbot stomachs. Similar to last year, smelt occurred in 19% of the burbot stomachs. Yellow perch, trout perch, alewife, whitefish, and *Morone* sp. were minor contributors to burbot diets.

Age-2 and age-3 smallmouth bass cohorts sampled in 2004 gill net collections remained longer than average for both New York's (24-year autumn survey) and Ontario's (18-year summer survey) data series. Age-1 walleye sampled in NYSDEC gill net program were notably smaller than long-term average lengths, but were also a very abundant cohort. Age-0 & age-1 juvenile yellow perch were longer than average for New York's length at age data series. Juvenile yellow perch were smaller than average in Ontario. Mean lengths-at-age and mean weights-at-age of lake trout remain consistent with the 5-year average (1999 – 2003). Lake trout growth in Lake Erie continues to be among the highest in the Great Lakes.

2.3 Central Basin (by J. Deller, T. Johnson, M. Bur and C. Murray)

In the central basin, overall forage abundance decreased from 2003, primarily due to low YOY recruitment for most forage species (Table 2.2). Although overall forage abundance declined, indices remained above the 10 year average. Abundance indices for age-1+ forage species were generally strong, as was expected, due to the strong 2003 cohorts (Table 2.3).

White perch and trout-perch YOY indices increased in the Ohio waters of the central basin, and the round goby index increased in the eastern half of the basin. YOY round goby decreased for the second consecutive year in the western half of the basin to its lowest abundance since 1997. Age-0 clupeid abundance declined dramatically to its lowest level recorded in both the 10-year Ohio trawl series and the 15-year OMNR-OCFA Partnership gillnet series. Alewives have been absent from the trawl surveys for the past two years and less than 6 alewife have been caught in each of the past 2 years in small mesh gillnets fished as part of the OMNR-OCFA Partnership index. Other age-0 pelagic forage species (smelt and emerald shiners) decreased to below average levels in 2004.

Yearling-and-older forage abundance increased over three fold from 2003 due to the large cohorts of smelt, white perch, yellow perch, and round goby produced in 2003. Round goby were the only YAO forage species that increased in all areas of the central basin from 2003, with the highest levels in the time series occurring in Pennsylvania. Round goby abundance in the rest of the basin has remained fairly stable since 1999. YAO rainbow smelt and yellow perch indices in Ohio trawl surveys were also at the highest levels in the ten year time series. YAO emerald shiner indices were at the lowest levels in the time series in all areas of the central basin, in spite of having a strong age-0 cohort in 2003.

In Ohio waters of the central basin, mean size of almost all age-0 and age-1+ forage species decreased from 2003 and were below the ten year average. There are no long term trends in growth of forage species, other than the general decrease in size from 2003 to 2004.

Adult walleye diets (percent dry weight) in the fall were dominated by emerald shiner (43%), gizzard shad (34%) in Management Unit 2, and emerald shiners 46% and smelt 43% in Management Unit 3 in the central basin. Round goby continue to be significant diet items in smallmouth bass (86%), yellow perch (48.7%).

2.4 Western Basin (by T. Johnson, J. Tyson, and M. Bur)

Recruitment of virtually all species declined in 2004, following the strong year-classes produced in 2003. The only notable exceptions were white perch (4,647/ ha, highest index since 1990), round gobies (168.3/ha, highest index), and trout-perch (495.7/ha, highest index). CPUE of age-0 yellow perch and walleye were down approximately 30-fold (Figure 2.2) as compared to

2003. Both gizzard shad (34.2/ha) and alewife (0 fish sampled) indices were the lowest in the time series (Figure 2.3). Recruitment indices for shiners (principally emerald and mimic shiners) were up in 2004, while yearling-and-older (YAO) shiner production was down markedly relative to 2003 (Figure 2.4). Age-0 white bass CPUE was the down 7-fold to 46.5/ha, while no age-0 smallmouth bass were sampled by either OMNR or ODW in the west basin in August.

Length of most species of age-0 fish also showed declines in 2004 relative to 2003 and the long-term average. Several factors may have contributed to slower growth including: cooler water temperatures, increased competition for prey resources, and size-selective predation by the large 2003 year classes of walleye and yellow perch. More intensive analyses of zooplankton data and predator diets in the coming months will aid in our interpretation of these and other hypotheses surrounding trends in growth. The large 2003 year classes of yellow perch and walleye continued to exhibit below average lengths-at-age. Lengths of age-2 and older yellow perch, walleye, and smallmouth bass were all marginally above average.

Walleye diets remained dominated by clupeids despite the near absence of these species in trawls. Incidence of white perch in piscivore diets was higher than reported in previous years, a likely consequence of their high numerical abundance. Round gobies and shiners were notable components of yellow perch and smallmouth bass diets, with mayflies being seasonally important to yellow perch in the early summer.

Water temperatures were cooler in 2004 than in the previous 2 years, with peak temperature (23.83°C) recorded on July 9; surface temperatures were rarely observed above 23°C. Spring warming rate (May 1 to June 1) was 0.28°C per day. Seasonally averaged basin wide Secchi depth declined for the second consecutive year, averaging 1.92 m (range 0.5m (late July) to 4.5 m (early May). Preliminary results suggest total phosphorous concentration and chlorophyll a both declined in 2003, although wide seasonal variation continued to be observed especially in the vicinity of the Maumee River. Ecological indices useful in interpreting the state of the western basin resource are discussed in Section 5.0 (“Interagency lower trophic level monitoring”).

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 2003 and 2004. Indices are reported as arithmetic mean number caught per hectare (NPH) for the age groups young-of-year (YOY) and yearling-and-older (YAO). 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.

Species	Trawl Survey	YOY				YAO			
		2004	2003	90's Avg.	80's Avg.	2004	2003	90's Avg.	80's Avg.
Smelt	ON-DW	132.2	7058.1	485.6	1382.9	567.5	209.8	404.7	969.0
	NY-Fa	1146.1	1733.4	1450.9	NA	2624.1	282.1	581.6	NA
	PA-Fa	12.3	592.2	550.8	7058.1	12.3	32.4	378.0	2408.6
Emerald Shiner	ON-DW	20.3	3388.0	54.8	20.5	891.2	204.7	46.4	38.1
	ON-OB	405.2	160.3	119.4	152.3	60.0	21.3	49.9	133.5
	NY-Fa	7.8	229.7	112.4	NA	284.2	444.5	105.4	NA
	Pa-Fa	0.0	1163.4	41.0	118.3	0.0	157.6	14.5	45.6
Spottail Shiner	ON-OB	43.2	40.0	696.6	249.0	7.9	4.8	52.3	21.3
	ON-IB	1.9	0.3	111.6	291.3	0.0	0.6	2.0	9.4
	NY-Fa	0.1	13.2	19.9	NA	2.5	4.8	4.0	NA
	PA-Fa	0.0	0.0	4.0	2.0	0.0	0.0	7.9	12.4
Alewife	ON-DW	0.3	0.5	234.1	21.4	NA	NA	NA	NA
	ON-OB	3.2	8.9	61.0	51.5	NA	NA	NA	NA
	NY-Fa	4.4	3.9	52.0	NA	NA	NA	NA	NA
	PA-Fa	0.0	2.5	7.7	16.6	NA	NA	NA	NA
Gizzard Shad	ON-DW	0.2	68.6	7.5	15.3	NA	NA	NA	NA
	ON-OB	3.6	3.1	9.6	24.1	NA	NA	NA	NA
	NY-Fa	0.6	27.8	4.2	NA	NA	NA	NA	NA
	PA-Fa	0.0	0.0	0.9	74.3	NA	NA	NA	NA
White Perch	ON-DW	0.0	16.2	2.2	5.6	NA	NA	NA	NA
	ON-OB	0.1	8.6	14.2	28.7	NA	NA	NA	NA
	NY-Fa	1.0	37.7	29.4	NA	NA	NA	NA	NA
	PA-Fa	0.0	523.9	101.1	NA	NA	NA	NA	NA
Trout-perch	ON-DW	0.2	0.0	0.1	0.5	1.5	2.6	0.5	1.9
	NY-Fa	545.9	1392.6	410.0	NA	NA	NA	NA	NA
	PA-Fa	46.2	230.6	23.2	NA	114.1	26.0	26.0	NA
Round Goby [a]	ON-DW	323.8	158.8	0.2	NA	NA	NA	NA	NA
	ON-OB	69.1	61.6	0.6	NA	NA	NA	NA	NA
	ON-IB	66.9	20.4	0.0	NA	NA	NA	NA	NA
	NY-Fa	781.3	321.0	1.0	NA	313.2	292.4	0.0	NA
	PA-Fa	560.9	323.5	30.3	NA	366.6	63.8	5.6	NA

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

[a] Ontario(ON-) trawl indices for round goby and NYSDEC (NY-) trawl indices for trout perch reported as "all ages" under the heading for YOY.

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 NPH; 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 NPH; 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 NPH; 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; 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 fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1994-2004

	year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean
yellow	OH MU2	71.9	2.5	119.1	12.3	69.8	73.6	21.9	114.6	6.0	149.0	8.4	59.0
perch	OH MU3	16.1	12.4	128.4	2.6	38.1	21.0	1.3	13.6	2.5	47.5	1.9	25.9
	PA MU3	567.4	52.0	354.1	0.0	13.7	7.2	15.7	388.4	11.9	788.0	2.4	200.1
white	OH MU2	368.0	3.5	223.8	267.5	91.9	334.1	581.3	779.7	293.0	310.1	759.7	364.8
perch	OH MU3	157.4	69.5	539.9	2.3	57.5	37.1	4.9	57.6	5.9	61.8	108.0	100.2
	PA MU3	76.3	136.0	331.5	0.0	0.0	8.5	75.9	26.6	80.7	173.8	2.4	82.9
white bass	OH MU2	125.5	23.8	42.3	9.2	44.6	160.1	16.7	161.0	27.6	106.2	1.0	65.3
	OH MU3	105.9	15.8	101.4	20.1	41.7	84.0	24.5	18.0	11.2	90.2	0.3	46.6
	PA MU3	6.6	4.4	0.0	0.0	0.0	0.0	96.4	12.1	0.0	0.0	0.0	10.9
rainbow	OH MU2	2681.8	348.1	421.2	238.2	253.3	70.8	150.1	2.3	274.7	1753.9	352.1	595.1
smelt	OH MU3	640.1	1693.7	2944.5	477.2	953.8	282.4	1070.3	0.0	218.1	2914.1	388.9	1053.0
	PA MU3	952.9	106.7	5422.1	10.3	29.9	1.8	15.3	377.4	152.9	177.6	20.9	660.7
round	OH MU2	2.7	15.5	8.0	49.7	130.1	95.1	21.7	43.9	37.8	22.6	13.9	40.1
goby	OH MU3	2.9	51.8	44.5	106.4	186.7	178.2	158.2	39.6	64.7	57.5	173.9	96.8
	PA MU3			0.4	1.5	743.6	1114.4	781.1	1577.8	289.3	75.3	1011.3	621.6
emerald	OH MU2	20.6	8.9	15.6	160.7	4928.5	408.4	127.2	50.5	39.4	477.6	7.0	567.7
shiner	OH MU3	16.5	40.2	77.0	4.9	150.5	602.2	500.6	2.2	0.5	903.1	0.8	208.9
	PA MU3	0.0	53.6	3.5	0.0	5.8	0.0	0.0	8.5	38.1	81.8	0.0	17.4
spottail	OH MU2	2.6	0.3	13.8	14.6	1.4	5.6	0.4	5.9	1.6	0.0	0.0	4.2
shiner	OH MU3	9.5	2.0	24.9	0.1	2.7	3.9	0.0	0.7	0.2	0.5	0.0	4.0
	PA MU3	0.0	19.9	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	1.9
alewife	OH MU2	7.1	9.9	12.7	9.3	10.0	37.2	62.1	50.8	59.7	0.1	0.0	23.5
	OH MU3	14.2	11.2	6.3	14.1	0.1	9.2	12.4	0.0	1.1	0.0	0.0	6.2
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
gizzard	OH MU2	16.3	1.2	77.1	12.4	33.8	104.3	117.1	60.3	24.6	402.6	0.6	77.3
shad	OH MU3	11.2	1.5	181.5	7.2	34.8	17.0	27.6	1.8	12.3	20.4	0.3	28.7
	PA MU3	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
trout-perch	OH MU2	0.0	0.9	1.2	0.0	0.3	5.5	1.0	2.0	1.4	2.0	20.3	3.1
	OH MU3	0.0	13.4	35.4	2.6	1.3	4.8	0.4	0.0	0.3	1.4	1.4	5.5
	PA MU3	1.1	24.9	7.1	0.0	23.1	10.0	23.0	7.8	45.6	78.0	6.7	20.7

Table 2.3 Relative abundance (arithmetic mean number per hectare) of selected yearling-and-older species from fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1994-2004

	year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	mean
yellow	OH MU2	12.0	82.3	11.2	110.2	6.4	40.7	61.6	5.7	51.7	3.2	216.7	54.7
perch	OH MU3	3.4	27.3	3.9	34.0	3.7	40.0	19.3	0.4	38.3	1.2	45.2	19.7
	PA MU3	2.2	191.9	12.4	14.7	2.5	7.9	3.9	41.3	37.5	75.6	18.3	37.1
white	OH MU2	1.8	34.9	22.1	44.5	5.6	35.2	91.1	21.7	91.5	28.2	83.9	41.9
perch	OH MU3	0.0	9.4	4.3	37.1	0.2	14.6	38.6	0.4	176.3	12.0	27.0	29.1
	PA MU3	0.0	1.7	1.8	0.0	0.0	1.9	0.6	2.4	38.5	28.6	6.2	7.4
white bass	OH MU2	0.0	3.9	0.4	14.2	0.3	5.8	26.8	0.8	5.1	6.7	4.9	6.3
	OH MU3	0.0	3.3	0.2	13.0	0.3	2.0	10.8	1.8	5.8	0.9	6.8	4.1
	PA MU3	2.8	0.0	0.0	0.0	0.0	6.0	1.0	57.6	0.4	0.0	0.0	6.2
rainbow	OH MU2	230.0	242.7	90.9	322.6	71.0	146.2	65.6	55.6	45.3	29.4	320.5	147.2
smelt	OH MU3	19.4	174.4	136.2	380.6	58.2	2115.1	150.3	3.3	320.9	370.3	1360.2	462.6
	PA MU3	4.4	506.0	29.9	26.5	1.3	0.0	75.8	0.0	6.2	22.1	9.9	62.0
round	OH MU2	4.6	49.8	138.8	171.0	164.9	82.5	27.5	54.8	39.2	25.4	27.0	71.4
goby	OH MU3	0.6	22.1	76.0	313.4	118.6	106.7	164.5	88.4	54.3	127.1	148.8	111.0
	PA MU3			0.0	0.0	113.1	55.3	126.5	55.2	238.3	59.1	767.0	157.2
emerald	OH MU2	4.7	34.0	9.1	226.0	1862.1	515.8	109.2	106.3	233.9	54.9	1.5	287.0
shiner	OH MU3	4.7	37.2	25.6	2.1	22.8	502.6	830.5	0.7	133.2	432.0	0.4	181.1
	PA MU3	0.6	17.7	0.0	7.4	0.0	0.0	0.0	0.0	107.4	217.5	0.0	31.9
spottail	OH MU2	1.4	5.6	18.0	17.2	28.3	5.8	8.7	3.5	6.6	1.6	5.3	9.3
shiner	OH MU3	6.3	16.9	6.5	1.8	5.0	7.2	8.6	1.1	5.9	1.0	0.2	5.5
	PA MU3	0.0	17.7	0.0	0.0	0.4	0.0	0.0	0.0	2.2	0.0	0.0	1.8
alewife	OH MU2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	2.9	0.0	0.0	0.3
	OH MU3	0.0	0.3	0.0	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.0	0.1
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.5	0.0	0.2
gizzard	OH MU2	0.0	3.5	0.0	0.1	0.2	0.9	4.3	0.1	1.6	0.0	0.1	1.0
shad	OH MU3	0.0	1.2	0.1	0.1	0.1	0.3	1.2	0.0	1.7	3.0	0.2	0.7
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
trout-perch	OH MU2	2.0	5.4	5.4	16.5	15.1	9.2	17.2	3.2	27.2	12.2	14.0	11.6
	OH MU3	20.8	19.8	22.4	12.8	14.8	9.3	15.3	2.2	8.5	2.9	7.7	12.4
	PA MU3	7.2	53.1	0.0	8.8	1.0	0.9	11.5	0.6	81.2	50.9	5.2	20.0

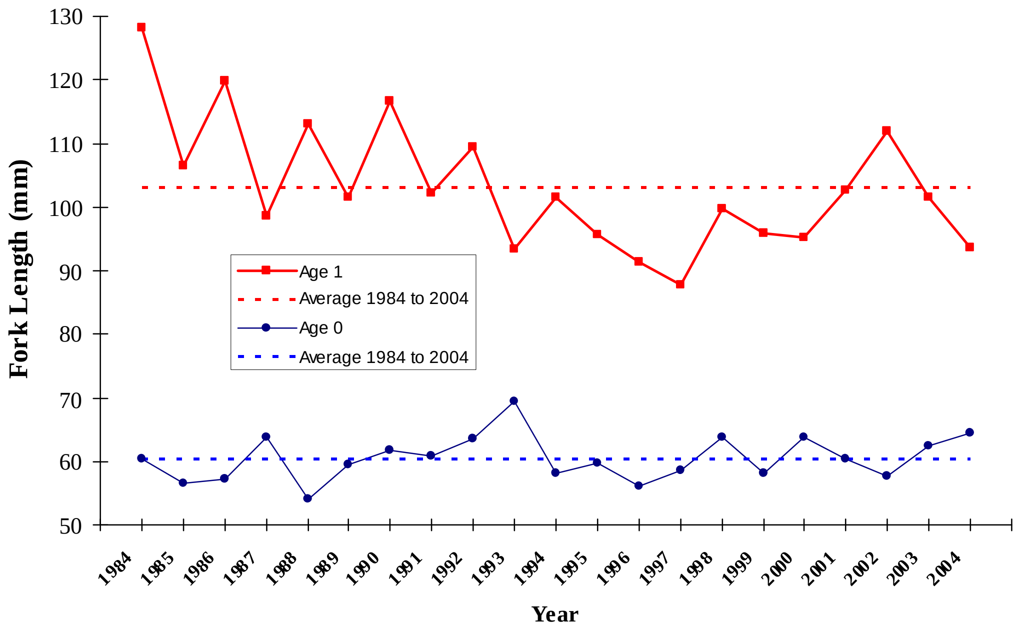

Figure 2.1 Mean fork length of Age 0 and 1 rainbow smelt from October OMNR index trawl survey in Long Point Bay, Lake Erie.

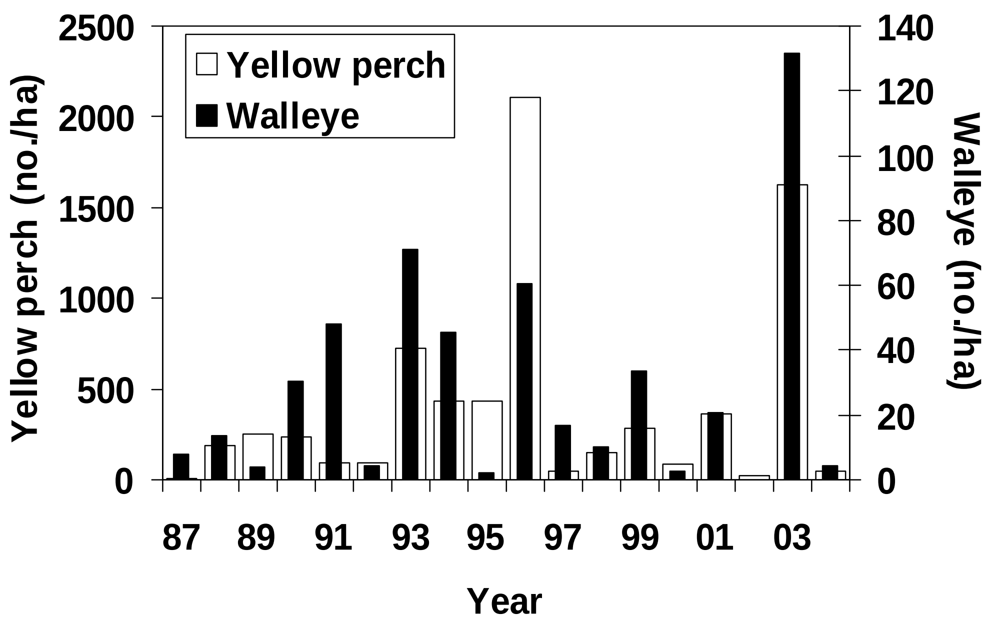

Figure 2.2 Density of age-0 yellow perch and walleye in the western basin of Lake Erie, August 1987-2004.

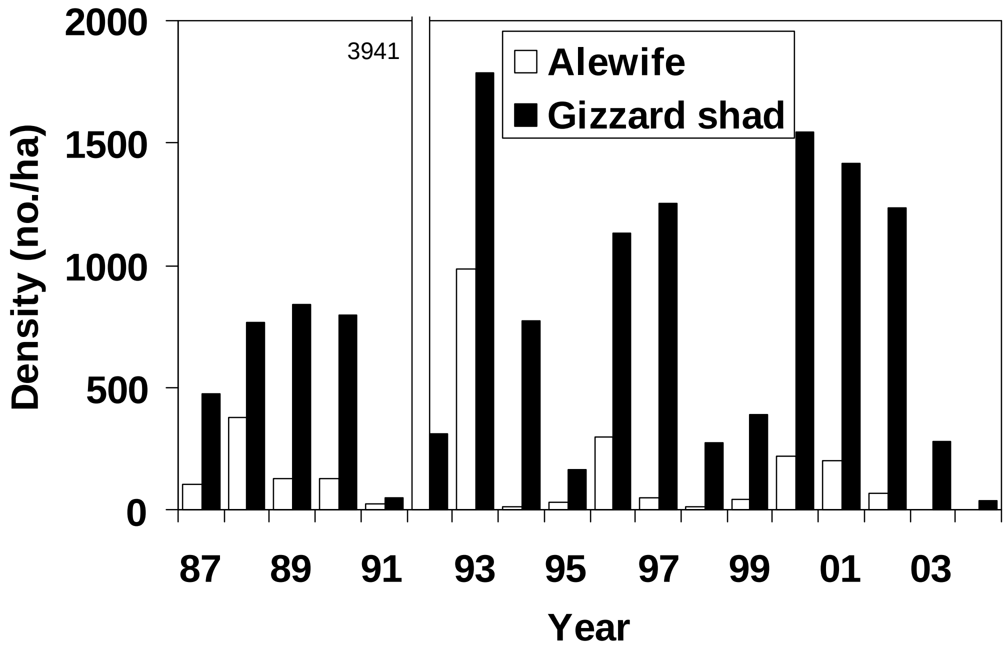

Figure 2.3 Density of age-0 alewife and gizzard shad in the western basin of Lake Erie, August 1987-2004.

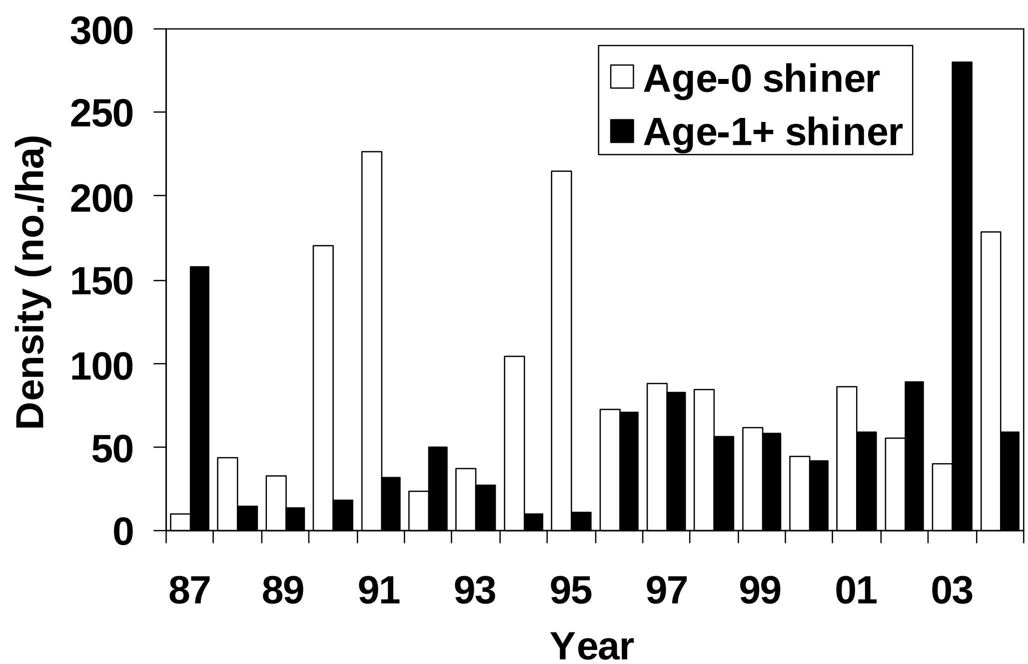

Figure 2.4 Density of age-0 and age-1+ shiners (*Notropis* spp.) in the western basin of Lake Erie, August 1987-2004.

3.0 Interagency Trawling Program

An ad-hoc Interagency Index Trawl Group (ITG) was formed in 1992 to first view the interagency index trawl program in western Lake Erie and recommend standardized trawling methods for assessing fish community indices; and second, to lead the agencies in calibration of index trawling gear using SCANMAR acoustical instrumentation. Before dissolving in March 1993, the ITG recommended the Forage Task Group (FTG) continue the work on interagency trawling issues. Progress on these charges is reported below.

3.1 Trawl Calibration (M. Bur)

Since the early 1990's Lake Erie agencies have had access to the USGS Great Lakes Science Center's Scanmar acoustic mensuration gear. The gear has been used to determine actual fishing dimensions of bottom and mid-water trawls, enabling precise determination of area and volume swept during indexing programs, and facilitating more direct comparison and integration of datasets among agencies. Without trawl mensuration, the FTG would not be able to provide density and biomass estimates by all agencies in the lake wide standard (per hectare). However, after 15 years of reliable service, the USGS-GLSC's Scanmar is no longer functional. Recent repairs in excess of $3K were paid by the USGS-GLSC but additional problems arose in 2004, that rendered the system inoperable and it was deemed irreparable. With changes in vessel fleet and trawl configuration, it is essential that the Lake Erie agencies find access to suitable trawl mensuration equipment. Some agencies have not updated their trawl measurements in over 10 years, and several agencies have never measured their midwater trawls now being used in the hydroacoustic programs. The FTG has therefore identified the purchase of acoustic mensuration gear as vitally important to the continued lake wide assessment of forage fish in Lake Erie.

3.2 Summary of Species CPUE Statistics (by T. Johnson, J. Tyson and J. Zhu)

Interagency trawling has been conducted in Ontario, Ohio and Michigan waters of the western basin of Lake Erie in August of each year since 1987. This interagency trawling program was developed to measure basin-wide recruitment of percids. More recently, the interpretation has been expanded to provide basin-wide community abundance indices, including forage fish abundance and growth. Information collected during the surveys includes length and abundance data on all species collected. A total of 62-90 standardized tows conforming to a depth-stratified (0-6m and >6m) random design are conducted annually by OMNR and ODNR throughout the western basin; results of 70 trawls were used in the analyses in 2004 (Figure 3.1).

In 1992, the ITG recommended that the FTG review its interagency trawling program and develop standardized methods for measuring and reporting basin-wide community indices. Historically, indices from bottom trawls had been reported as relative abundances, precluding the pooling of data between agencies. In 1992, in response to the ITG recommendation, the FTG began the standardization and calibration of trawling procedures between agencies so that the indices could be combined and quantitatively analyzed across jurisdictional boundaries. SCANMAR was employed by most Lake Erie agencies in 1992, by OMNR and ODNR in 1995, and by ODNR alone in 1997 to calculate actual fishing dimensions of the bottom trawls. In the western basin, net dimensions from the 1995 SCANMAR exercise are used for the OMNR vessel, while the 1997 results are applied to the ODNR vessel. In 2002, ODNR began interagency trawling with the new vessel *R.V Explorer II*, and SCANMAR was again employed to estimate the net dimensions in 2003.

The FTG recognizes the increasing interest in using information from this bottom trawling program to express abundance and distribution of the entire prey fish community of the western basin. Preliminary survey work by OMNR in 1999 demonstrated the potential to underestimate the abundance of pelagic fishes (principally clupeids and cyprinids) when relying solely on bottom trawls. The FTG will continue to recognize the strength of hydroacoustics to describe pelagic fish distribution and abundance, and has developed hydroacoustic programs for the east and central basins of Lake Erie. However, the shallow depths and complex bathymetry of the western basin provide challenges to implementing a hydroacoustic program in this basin, such that other pelagic sampling techniques are also being explored. The FTG has proposed a side-by-side comparison of available technologies (bottom trawl, mid-water trawl, conventional downward looking hydroacoustics, side-scan, and stationary upward looking sonar) in 2005 to estimate the abundance of all available fish species. These exercises are not intended to replace the bottom trawling program but rather estimate the biases in our current approach and explore alternative techniques that may supplement our current long-term program. Results of the *Trawl Comparison Exercise* of 2003 have now been fully analyzed (see summary below), and an evaluation of the effects of applying fishing power corrections to the long-term time series will be undertaken in 2005.

Presently, the FTG estimates basin-wide abundance of forage fish in the western basin using information from SCANMAR trials, total trawling distance, and catches from the August interagency trawling program. Species-specific abundance estimates (#/ha or $\#/m^3$) are combined with length-weight data to generate a species-specific biomass estimate for each tow. Arithmetic mean volumetric estimates of abundance and biomass are extrapolated by depth strata (0-6m, >6m) to the entire western basin to obtain an absolute estimate of forage fish abundance and biomass for each species. For reporting purposes, species have been pooled into three functional groups: clupeids (age-0 gizzard shad and alewife), soft-rayed fish (rainbow smelt, emerald and spottail shiners, other cyprinids, silver chub, trout-perch, and round gobies), and spiny-rayed fish (age-0 for each of white perch, white bass, yellow perch, walleye and freshwater drum). However, gear biases discussed above must be considered when interpreting basin-wide absolute estimates of fish abundance and biomass.

Total forage abundance and biomass increased in 2004, reaching its highest level since the mid 1990s (Figure 3.2 and 3.3). The exceptionally strong white perch year class in 2004, and associated increase in the spiny-rayed group was responsible for much of this increase. Soft-rayed abundance and biomass doubled relative to 2003 reflecting a large increase in trout-perch and round goby CPUE. Both clupeid species faced further declines in abundance, yielding the lowest clupeid index recorded since the survey began in 1987. Relative biomass of clupeid, soft-rayed, and spiny-rayed species was 1.2%, 17.8%, and 81.0%, markedly different than the historic averages of 40.1%, 10.3%, and 49.6% (Figure 3.3). Walleye show a clear preference for clupeids and soft-rayed fishes over spiny-rayed prey (Knight and Vondracek 1993), and the second consecutive year of poor clupeid production does not bode well for the strong 2003 walleye year class. Increased abundance of cyprinids and round gobies may offset some of the predatory demand, while high catches of trout perch will likely yield little benefit to piscivores, as trout-perch are rarely observed in the diets of predatory fish in Lake Erie.

Mean length of age-0 fishes was down in 2004 (Figure 3.4). Cooler water temperatures and lower planktonic prey abundance (preliminary findings of the lower trophic level monitoring), combined with increased competition for prey from the large white perch year class may have contributed to these declines in growth rates. Higher density of age-1 piscivores may have increased demand for forage, selectively removing the larger individuals of the recruiting species. Length of age-0 for select species include: walleye (140mm), yellow perch (62 mm), white bass (46 mm), and white perch (50 mm). No age-0 smallmouth bass were sampled in 2004. Long-term averages for the same species are: walleye (135 mm), yellow perch (67 mm), smallmouth bass (82 mm), white bass (68 mm), and white perch (58 mm).

Spatial maps of forage distribution were constructed using site-specific catches (#/ha) of the functional forage groups (Figure 3.5). Abundance contours were generated using kriging contouring techniques to interpolate abundance between trawl locations. Exceptionally low catches of clupeids were evident throughout the basin, although local maxima occurred in the central portion of the basin. Traditionally, clupeid catches are highest along the south shore, with gizzard shad densities loosely corresponding to the Maumee River plume. Soft-rayed fish (predominantly trout-perch and round gobies) were most abundant in the northwest portion of the basin, a pattern similar to that seen in previous years. Spiny-rayed abundance was distributed across the basin, although a local maxima in Pigeon Bay was driven by exceptionally high catches of age-0 white perch. Relative abundance of the dominant species includes: age-0 white perch (71.9%), trout-perch (7.7%), age-1 yellow perch (4.5%), and round goby (2.6%). Total forage abundance averaged 5,861 fish/ha across the western basin, increasing 18% from 2003 to remain above the long-term average (4,705 fish/ha). Clupeid density was only 34.2 fish/ha (average 1,182 fish/ha), soft-rayed fish density was 968 fish/ha (average 429 fish/ha), and spiny-rayed fish density was 4,847 fish/ha (average 3,090 fish/ha).

3.3 Trawl Comparison Exercise (by J. Tyson, T. Johnson, and M Bur)

One of the strengths of the interagency reporting format is that the distribution and abundance of fishes can be represented across the entire basin, irrespective of jurisdictional boundaries that have no influence on fish behavior. However, differences in trawl design, vessel operation, sample processing and interpretation of data can confound the pooling of the data. The SCANMAR exercise has provided a means to calibrate each agency trawl to its true fishing dimensions (height and width of trawl opening); but does not address other potential differences between agency trawling programs. Fishing Power Correction factors (FPCs) are generated to address systematic differences in agency trawling programs, providing a statistically defensible basis to combine the data. The procedures for conducting an FPC experiment were outlined at a workshop conducted in August 2000 by the Forage Task Group, in conjunction with the Ohio Chapter of the American Fisheries Society. The five Lake Erie research vessels that conduct trawling in the west and central basins of Lake Erie then implemented the trawl comparison experiment in September 2003.

A total of 232 side-by-side trawls were conducted in a 2.5 km^2 area over a three day period. During 2004, representatives of the agencies involved in the experiment committed time towards analysis and write-up of the catch-per-unit-effort data collected during the side-by-side trawl calibration experiment. We estimated FPCs for the 10 most commonly encountered species-age groups by each vessel during the experiment (Table 1). We then used an objective decision rule (Monro 1998) to determine whether to apply the FPCs. Of the five research vessels, the R.V. Grandon was the most efficient (highest CPUE), while the other 4 vessels exhibited catch rates more similar to one another. Most of the FPCs ranged from 0.50-3.0. For most vessel-species-age group combinations there was little evidence of systematic bias in the catch-per-unit effort data. However, the decision rule we used indicated that in most cases, application of the FPCs should be applied to reduce bias. With standardized estimates of catch-per-unit effort, the Lake Erie agencies will have the ability to directly compare and combine abundance time series. This is important for the recruitment estimation component of the walleye and yellow perch modeling exercises. With comparable data, the walleye recruitment index has better predictive capabilities than what is currently being used ($r^2 = 0.87$, $p<0.001$ for corrected data) (Figures 3.6 and 3.7). In 2005, both percid recruitment and forage abundance data collected during the interagency trawling exercise will be corrected for differences in catchability using the above developed FPCs. For additional information on the comparative trawling exercise, analytical techniques and results, see the companion manuscript entitled "**Fishing Power Correction Factor Estimates: An Application to Lake Erie Trawl Surveys".**

Table 3.1. Mean CPUEs and fishing power correction factors by vessel-species-age group combinations. All FPCs are calculated relative to the R.V. Keenosay.

Vessel	Species	Age group	Trawl Hauls	Mean CPUE (#/hectare)	FPC	95% CI	Decision rule *
R.V. Explorer	Gizzard shad	age-0	7	35.36	0.756	-1.94 - 3.45	Y
	Emerald shiner	age-0+	40	77.50	1.611	-0.36 - 3.58	Y
	Troutperch	age-0+	48	116.77	0.701	0.38 - 1.02	Y
	White perch	age-0	50	479.87	1.137	0.17 - 2.10	Y
	White bass	age-0	32	17.06	3.092	1.22 - 4.96 z	Y
	Yellow perch	age-0	51	1012.15	0.933	-0.45 - 2.32	N
	Yellow perch	age-1+	46	131.74	0.955	0.51 - 1.40	N
	Walleye	age-0	51	113.70	1.561	1.10 - 2.02 z	Y
	Round goby	age-0+	43	233.59	0.426	-0.06 - 0.91 z	Y
	Freshwater drum	age-1+	48	251.63	0.623	0.25 - 1.00	Y
R.V. Gibraltar	Gizzard shad	age-0	6	61.66	0.220	0.03 - 0.41 z	Y
	Emerald shiner	age-0+	38	60.55	2.070	0.01 - 4.14	Y
	Troutperch	age-0+	42	87.47	0.955	0.48 - 1.43	N
	White perch	age-0	43	514.01	0.991	-0.21 - 2.20	N
	White bass	age-0	34	26.89	1.641	0.07 - 3.21	Y
	Yellow perch	age-0	45	739.24	1.321	-0.01 - 2.64	Y
	Yellow perch	age-1+	40	103.87	1.145	0.52 - 1.77	Y
	Walleye	age-0	45	119.17	1.520	0.95 - 2.08	Y
	Round goby	age-0+	39	84.48	1.044	0.14 - 1.94	N
	Freshwater drum	age-1+	41	113.58	1.487	0.81 - 2.16	Y
R.V. Grandon	Gizzard shad	age-0	12	81.11	0.491	-1.19 - 2.18	Y
	Emerald shiner	age-0+	34	211.47	0.656	-1.06 - 2.37	Y
	Troutperch	age-0+	34	134.89	0.643	0.23 - 1.06	Y
	White perch	age-0	36	771.40	0.699	-0.51 - 1.91	Y
	White bass	age-0	32	38.16	0.649	0.39 - 0.91 z	Y
	Yellow perch	age-0	35	1266.82	0.806	-0.64 - 2.25	Y
	Yellow perch	age-1+	35	122.83	0.936	0.32 - 1.56	N
	Walleye	age-0	35	214.55	0.903	0.41 - 1.40	Y
	Round goby	age-0+	31	176.80	0.523	-0.55 - 1.60	Y
	Freshwater drum	age-1+	33	62.60	2.010	1.19 - 2.83 z	Y
R.V. Musky II	Gizzard shad	age-0	4	64.70	0.506	-0.25 - 1.27	Y
	Emerald shiner	age-0+	31	51.72	1.666	0.46 - 2.87	Y
	Troutperch	age-0+	42	73.63	1.127	0.76 - 1.49	Y
	White perch	age-0	50	233.42	2.336	0.86 - 3.81	Y
	White bass	age-0	22	15.17	4.196	0.95 - 7.44	Y
	Yellow perch	age-0	49	972.15	0.962	-0.04 - 1.98	N
	Yellow perch	age-1+	48	36.51	3.372	1.50 - 5.38 z	Y
	Walleye	age-0	51	63.70	2.738	2.18 - 3.39 z	Y
	Round goby	age-0+	38	86.52	1.223	-0.08 - 2.53	Y
	Freshwater drum	age-1+	16	4.99	33.687	26.32 - 41.05	Y

z - Indicates statistically significant difference from 1.0 ($\alpha=0.05$)

* Y means decision rule applied, N means decision rule not applied

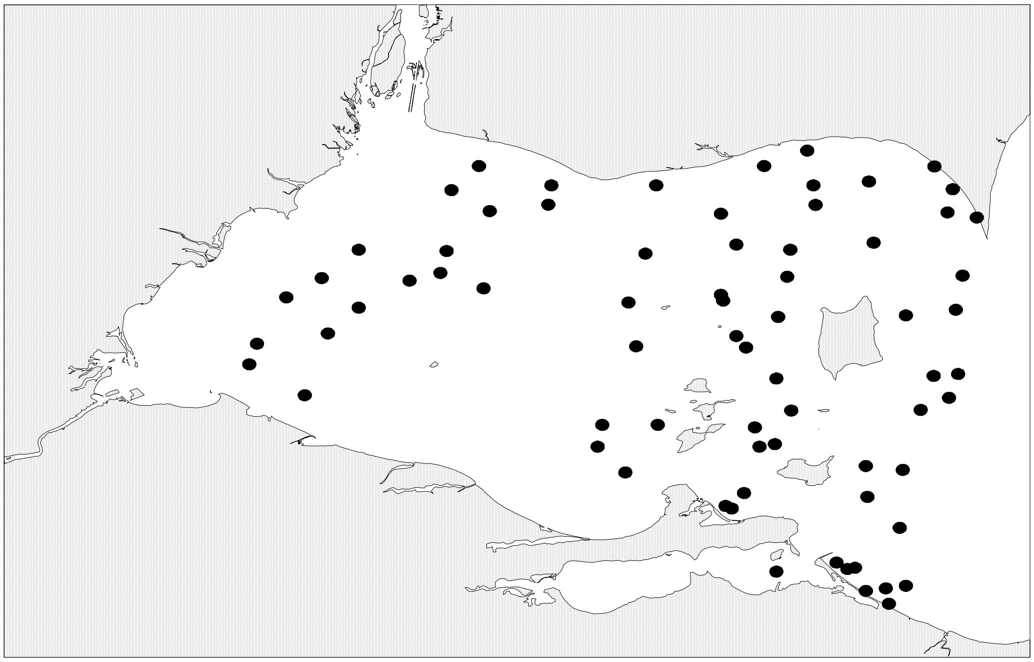

Figure 3.1 Trawl locations for the western basin interagency bottom trawl survey, August 2003.

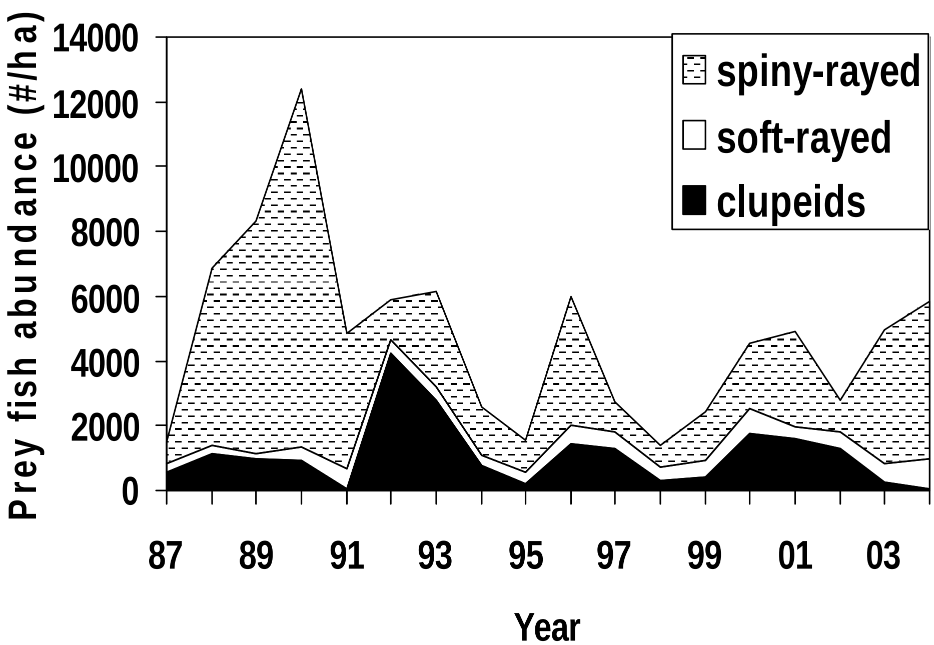

Figure 3.2 Mean density (no. / ha) of prey fish by functional group in western Lake Erie, August 1987-2004.

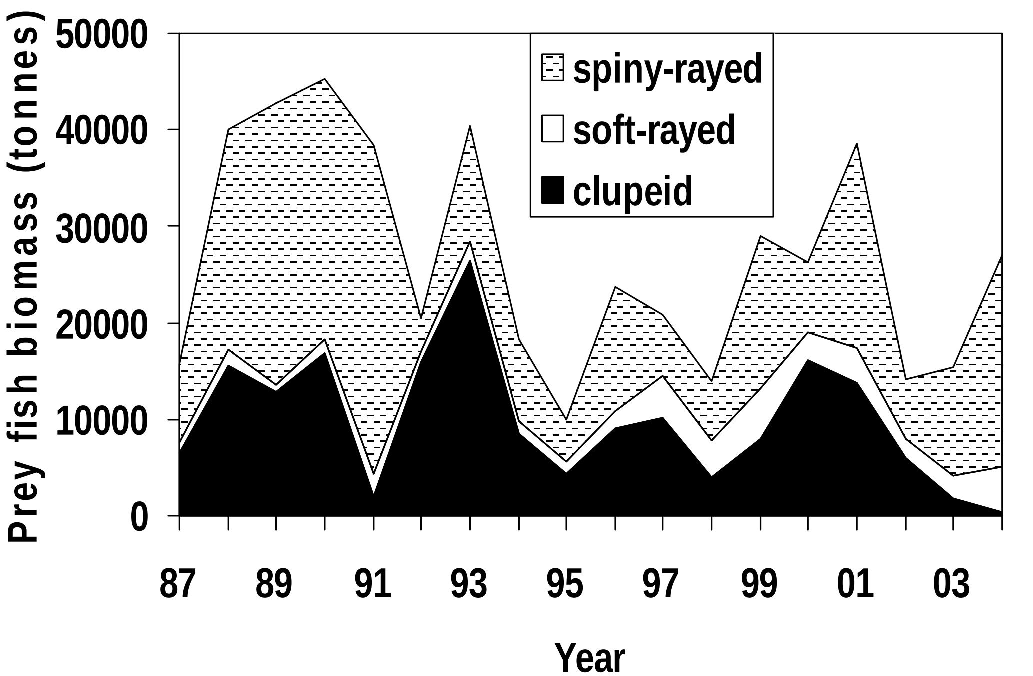

Figure 3.3 Mean biomass (tonnes) of prey fish by functional group in western Lake Erie, August 1987-2004.

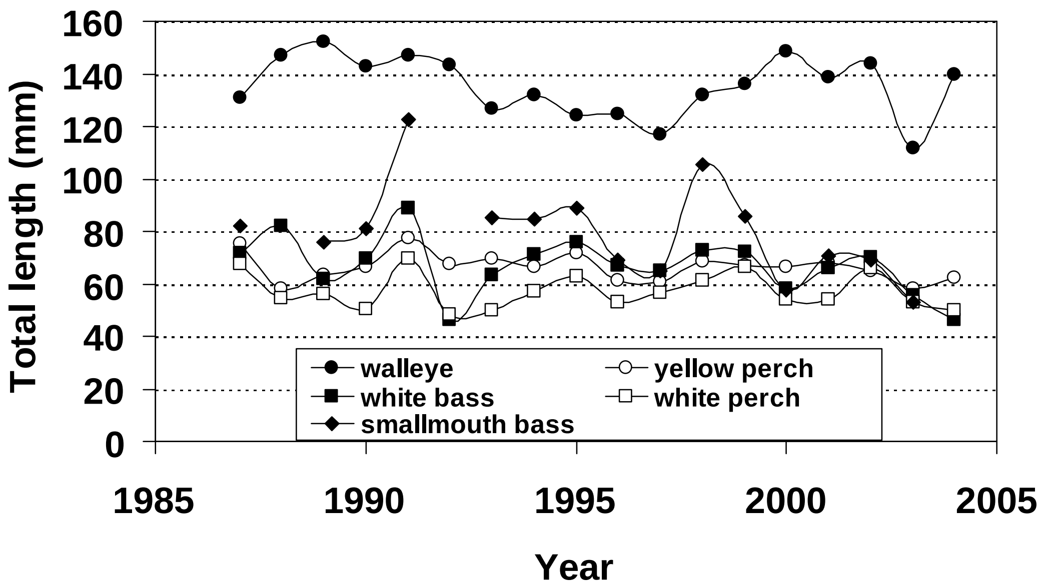

Figure 3.4 Mean total length (mm) of select age-0 fishes in western Lake Erie, August 1987- 2004.

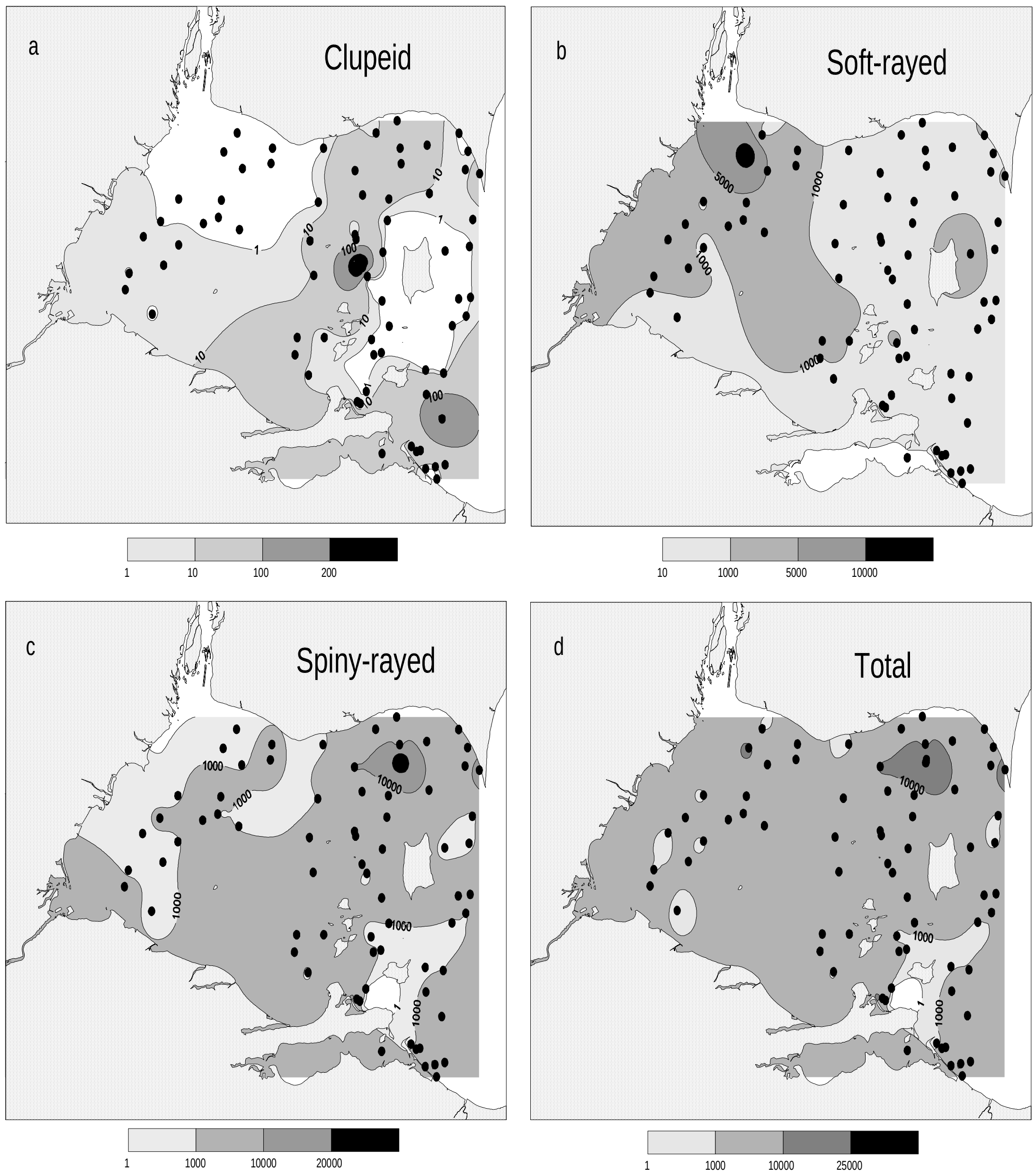

Figure 3.5 Spatial distribution of clupeids, soft-rayed forage, spiny-rayed forage, and total forage in western Lake Erie, August 2004. Contour levels vary for each functional group.

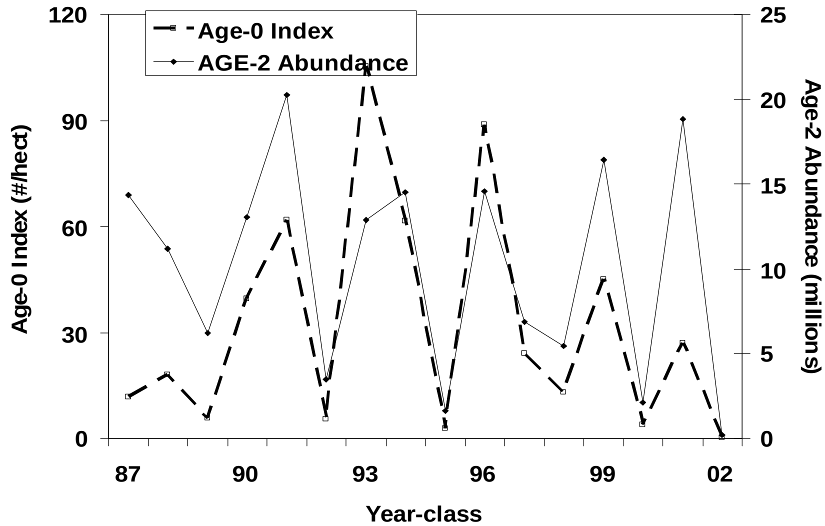

Figure 3.6 Combined age-0 walleye abundance index (#/hectare) and age-2 abundance for the same year class as estimated from ADMB, 1987-2002.

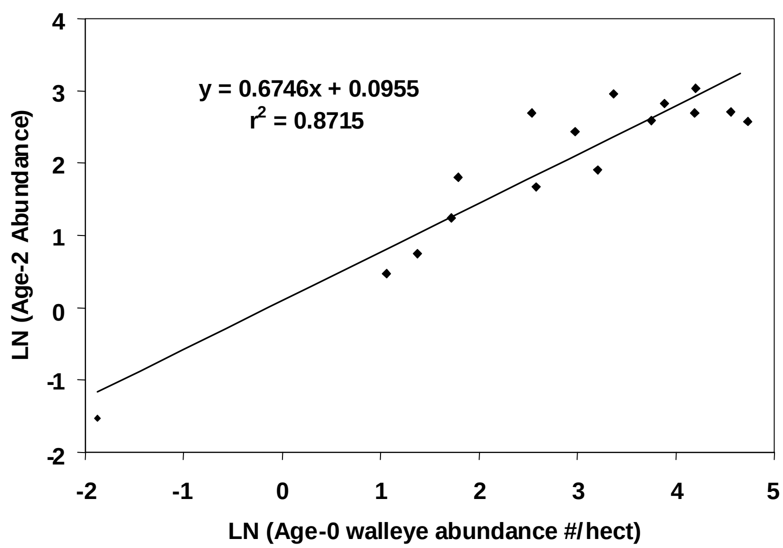

Figure 3.7. Regression of age-2 walleye abundance on combined age-0 walleye abundance. Data were log transformed to linearize.

4.0 Acoustic Survey Program

4.1 East Basin Acoustic Survey (by L. Witzel, and D. Einhouse)

Introduction

Since 1993, the Forage Task Group (FTG) has used a fisheries acoustic system as an additional tool to assess pelagic forage fish stocks in eastern Lake Erie. Surveys from 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 1996, ongoing summertime acoustic survey efforts used a modern 120-kHz split-beam system (Simrad EY-500) that was jointly purchased by the Lake Erie Committee (LEC) member agencies and the Great Lakes Fishery Commission (GLFC). The 1998 and 1999 survey years included broader seasonal coverage during spring (June), summer (July) and fall (October) assessment efforts. After 1999, only the July acoustic survey was continued as a standard, long-term measure of pelagic forage fish density and distribution in eastern Lake Erie. Throughout this acoustic monitoring program data collection has been coordinated among FTG member agencies with several research vessels (Argo, Erie Explorer, Keenosay, Musky II, and Perca) participating in various aspects of the data collection and calibration. Recent year's surveys and ongoing data analysis has been principally coordinated between the Ontario Ministry of Natural Resources (OMNR) and New York State Department of Environmental Conservation (NYSDEC).

Beyond maintaining the long-term summertime eastern basin survey program, the FTG has been actively pursuing initiatives to address survey design and analysis procedures to maintain an up-to-date and defensible scientific method for ongoing surveys. Through a GLFC grant (Einhouse and Witzel 2003) Lake Erie's FTG acquired a site license for SonarData's Echoview acoustic signal processing software. This grant also supported accompanying software training for selected members of the FTG. Subsequently, the newly trained individuals led a workshop to introduce Echoview software to other biologists connected with fisheries acoustic surveys on Lake Erie. In December 2004 OMNR and NYSDEC jointly purchased a secondary site license for the Echoview software that functionally doubled the capacity for processing acoustic data. Also during 2004, eastern basin FTG members initiated efforts to upgrade the Lake Erie acoustic echosounder system. This initiative is ongoing and is expected to result in the purchase of a new hydroacoustic echosounder through a partnership cost-sharing arrangement among Lake Erie Committee (LEC) member agencies and the GLFC in the spring of 2005. Significant progress was made this winter to prepare the extensive backlog of split-beam acoustic data from July East Basin surveys since 1997 for standardized echo-integration and post-processing using Echoview and other software. Survey results are anticipated to be available for reporting by late 2005.

Two FTG members remain ongoing participants in a GLFC-sponsored Great Lakes Acoustic Study Group charged with preparing an array of standard operating procedures for Great Lakes acoustic investigations. In addition, Lake Erie acoustic surveys have contributed to four recent publications advancing our approach to survey design (Conners 1999, Conners and Schwager 2002), abundance estimation (Rudstam et al. 2003), and comparing density estimates through a time series that employed different acoustic systems (Rudstam et al. 1999). Finally, the FTG members continue to build post-processing applications in SAS software (SAS 1992) for implementing these new analytical procedures.

Methods

The 2004 summertime east basin acoustic survey effort was completed from July 12 to 29, 2004 (Figure 4.1). Poor weather and engine problems with the Erie Explorer delayed completion of the acoustic data acquisition component of the survey beyond the normal one-week period. This component of the survey was completed in five non-consecutive nights, between the hours of 9:30 PM and 5:30 AM at an approximate vessel speed of 5.8 knots with a transducer affixed to the hull of the survey vessel (*RV Erie Explorer*). In all, 12 transects, spanning a total distance of 177 nm, were surveyed during this period. The companion mid-water trawling component of this survey was conducted aboard the *RV Argo* from July 12 to 20, 2004 using a mid-water trawl with fishing dimensions of 36 m^2 and 20 tows were collected throughout the basin. Collectively, the two survey vessels obtained 40 temperature profiles of the water column at the ends and intermediate points along acoustic transects.

Results

Presentation of eastern basin acoustic survey results has been suspended while the principal investigators remain immersed in other initiatives pertaining to survey design, data processing/analysis methods, and software/hardware expansion/upgrades (see Introduction). New standard analysis procedures will be applied to the time series beginning from 1997 and efforts are currently underway or planned during the next few months to analyze the multi-year back-log of acoustic data and facilitate resumption of an annual FTG reporting cycle in March 2006.

Discussion

A thorough reporting of acoustic survey results was planned for several years but annual constraints on staff time had repeatedly postponed undertaking this more comprehensive analysis of the entire time series of split-beam acoustic data. Additional major hurtles have now been addressed during this past year with; 1) the acquisition of a secondary Echoview site license, which will greatly expand our capacity to process data and accelerate our collective experience with this powerful software, 2) significant progress in pre-analysis data management procedures (eg. identify and exclude acoustic noise, establish Echoview file and variable properties, surface and bottom back-step exclusion lines) through dedicated temporarily assignment of a NYSDEC technical staff member, 3) continued developments in the automation of post-processing data management and analysis steps using SAS, and 4) further refinements on standardized methodology for estimating fish densities and expressing estimate precision. Prospects for completing and reporting this initiative during 2005 now appears much improved.

4.2 Central Basin Acoustic Survey (by J. Deller, M. Bur, T. Johnson)

In December 2003 the FTG held a hydroacoustic workshop in Port Dover, Ontario. As a result of preliminary analysis and discussion at the workshop, a new experimental design was suggested for the central basin acoustic survey, scheduled for July of 2004 (Trometer et. al. 2004). The new survey design required an additional vessel and sounding unit, and would increase the number of transects from three in previous surveys to eight in 2004 (Figure 4.2). This would more than double the spatial extent of the acoustic survey. As in past surveys, midwater trawling from separate vessels would be conducted to ground truth the species composition recorded with the acoustic sounders. With the increase in the number of transects and to reduce steaming times, it was decided that trawls would occur on only half of each transect, alternating north and south of the international border. Four vessels participated in the 2004 survey: trawling was conducted aboard the R/V Grandon (ODNR-DOW) and the R/V Keenosay (OMNR), and the R/V Musky (USGS) and the R/V Bowfin (USGS) collected acoustic data. The central basin hydroacoustic survey occurred during the week of July 19-23. Four of the eight proposed transects were completed due to weather and mechanical problems with one sounding unit. The four completed transects totaled over 157 nautical miles and covered the area of the central basin east of Cleveland and Erieau to the Pennsylvania state line (Figure 4.3). Acoustic data were collected with two 120 kHz split beam sounding units, a Simrad EY-500 and a Biosonics DT 5000. Ping rates, acoustic vessel speed and other methods were kept consistent with past surveys to provide as much continuity as possible between survey years. A total of 37 midwater trawls were completed in conjunction with the acoustic transects. Eight species of fish, including both forage and predators, were caught in the trawls. Forage species tended to segregate by depth with emerald shiners concentrated in the epilimnion (upper 10m of the water column) and rainbow smelt densities increasing with increasing depth, reaching a peak near the thermocline. The thermocline ranged from 17 to 19 meters in both Ontario and Ohio waters.

We now have four years of acoustic data from the central basin, ranging from one to four cross basin transects. Analysis and interpretation of results is occurring in conjunction with the east basin acoustic survey in order to provide uniformity in post processing procedures, forage density and biomass estimates, and precision between the two surveys. Results from the previous years central basin acoustic surveys will be processed upon completion of the 2004 data, adhering to the same post-processing procedures and algorithms to ensure internal consistency across the years. We hope to include the entire time series in the 2006 Forage Task Group report.

4.3 West Basin Acoustic Survey

Introduction

A standardized inter-agency fishery acoustics program has been used to assess forage community abundance and distribution in the eastern basin of Lake Erie since 1993. The acoustic survey was expanded to the central basin in 2000 (Trometer et. al. 2004). The survey of the eastern and central basins is typically conducted in late summer. In 1997, a pilot program was conducted by

Sandusky Fisheries Research Unit staff adjacent to Sheldon's Marsh in July to assess the feasibility of using acoustic technology in the shallow waters of the western basin. The pilot study showed much promise and results indicated an offshore to nearshore gradient in forage-sized fish abundance. In 2004, as charged by the LEC, a pilot western basin acoustic survey was initiated to explore the utility of using down-looking and side-looking sonar for assessing pelagic forage fish abundance in the west basin. Multiplexing two different transducers, one looking down and one looking sideways has been used in other shallow-water systems to effectively sample more of the water column. No companion trawling data for species composition was conducted during this pilot survey. The data from the 2004 survey will be used to develop a standardized acoustic sampling program for 2005 in the west basin of Lake Erie that will complement the ongoing acoustic surveys in the central and eastern basins.

Methods

Fishery acoustic sampling was conducted on the nights of July 28-29 and July 29-30, 2004, to assess the large-scale spatial distribution and density of pelagic forage fishes in western Lake Erie. The large-scale approach consisted of five transects in Ohio waters of western Lake Erie (Table 4.1, Figure 4.4). The two eastern-most transects were sampled the first night and three western transects the second night. All transects were linear. The distribution of transects was based upon previous work and was designed to capture the range and extent of variability seen in habitat types and likely forage fish densities. Acoustic sampling transects overlapped with existing bottom trawl sampling stations which were sampled the week prior to acoustic sampling.

Sampling during the west basin pilot acoustic program was performed with a BioSonics DT-X surface unit. This unit was equipped with two 6-degree 200-kHz split-beam transducers, a JRC global positioning system, and a Panasonic CF-28 laptop computer. The acoustic system was calibrated to US Navy standards at the Biosonics, Inc. Laboratory in Seattle, Washington prior to sampling and also calibrated before each survey with a tungsten carbide reference sphere of known acoustic size.

Mobile surveys initiated 0.5 h after sunset and completed before 30 minutes prior to sunrise. Transects were navigated with waypoints programmed in a Garmin GPS, and speed was maintained at 8-9 kph, (roughly 5 mph) using the GPS. Data were collected by multiplexing the transducers, with one transducer aimed down to sample from 3 m to near bottom and a second transducer aimed to the side to sample from near surface to approximately 3 m depth. Each transducer was mounted on a fixed pole located on opposite sides of the boat near the stern. The down-looking transducer was mounted 1 m below the surface and the side-looking transducer was mounted 1.5 m below the surface. Both transducers sampled at 4 pings/second with a pulse length of 0.4 msec and minimum threshold of -70 dB. The sampling environment (water temperature) was set at the temperature 3 m deep on the evening of sampling. Data were written to file and named by the date and time the file was collected. Files were automatically collected every 10 minutes. A total of 80 km worth of acoustic transect data were collected during the two nights of sampling. Latitude and longitude coordinates were written to the file as the data were collected to identify sample location. Surface and bottom water temperature and dissolved oxygen were measured at the start and end points of each transect.

Post-Processing

Data will be analyzed to provide estimates of forage-sized fish biomass, density, and spatial distribution using Biosonics and Echoview software. Spatial maps will be derived using ArcView GIS software and sample size and power analysis, will be run to develop sampling strata and sample sizes for the 2005 west basin acoustics survey.

Lake Erie's fisheries acoustic applications and needs are expanding. An annual survey in Lake Erie's Central Basin is now firmly established and acoustic data collection for a Western Basin pilot survey has been completed. The ongoing eastern basin survey has a time series that now spans 12 years. The effective administering of these surveys will require the continued support of Lake Erie Committee member agencies. This support was exemplified through recent united efforts to modernize and expand hydroacoustic software/hardware resources on Lake Erie. Inter-agency acoustic monitoring programs will continue to require periodic equipment upgrades, extension and perhaps expansion of site licenses, and ongoing training of personnel to remain as a functional fish stock assessment tool for Lake Erie.

Table 4.1 July 2004 west basin acoustic survey start points, end points, transect lengths and estimated time required to sample transects

	Transect 1	**Transect 2**	**Transect 3**	**Transect 4**	**Transect 5**
Start	N41.58 W82.53	N41.51 W82.71	N41.58 W82.87	N41.770 W82.97	N41.82 W83.19
End	N41.43 W82.61	N41.58 W82.53	N41.71 W82.87	N41.86 W83.10	N41.68 W83.28
Distance	18 km	17 km	15 km	15 km	15 km
Est. time	1.75 hrs	1.75 hrs	1.50 hrs	1.50 hrs	1.50 hrs

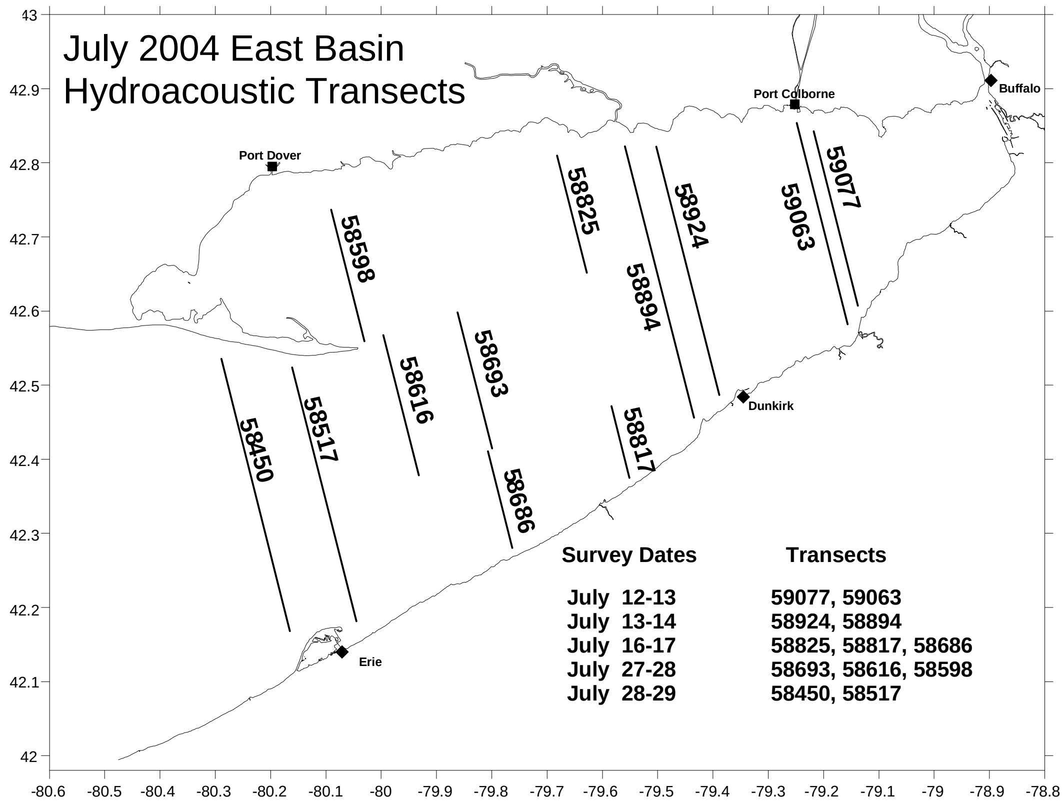

Figure 4.1 Transects sampled during the eastern basin fisheries acoustic survey

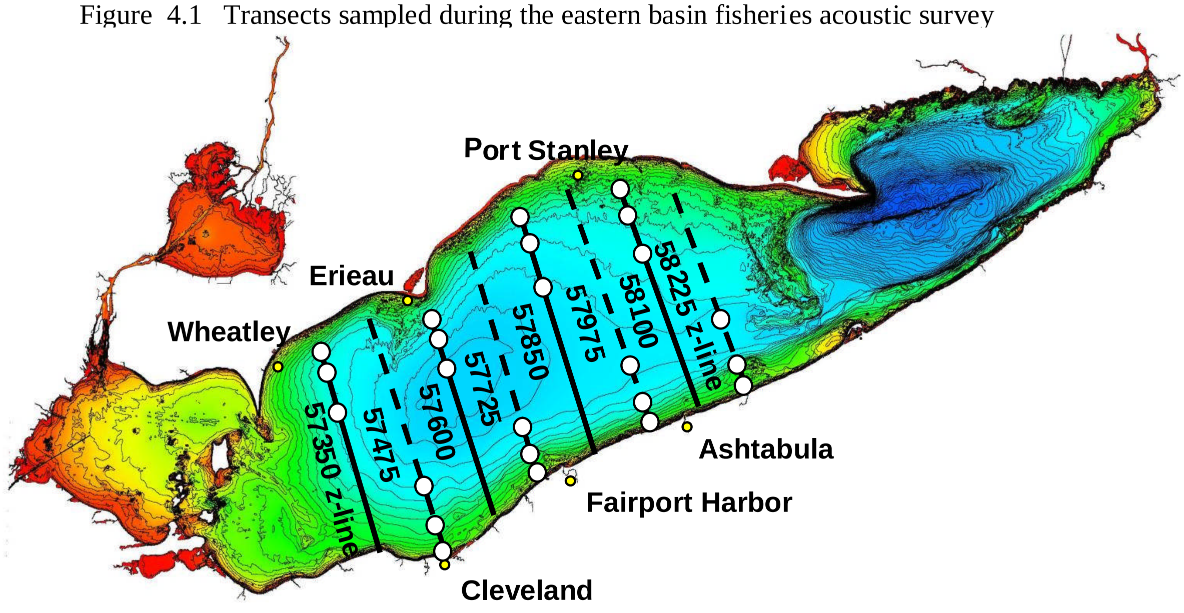

Figure 4.2. Eight proposed central basin acoustic survey transects scheduled for July 19-23, 2004. Transects run along Loran-C TD lines. Dashed line indicates acoustic data are to be collected aboard the R/V Bowfin, with trawling done aboard the R/V Grandon. Solid line indicates acoustic data are to be collected aboard the R/V Musky, with trawling aboard the R/V Keenosay. Circles indicate approximate trawling locations.

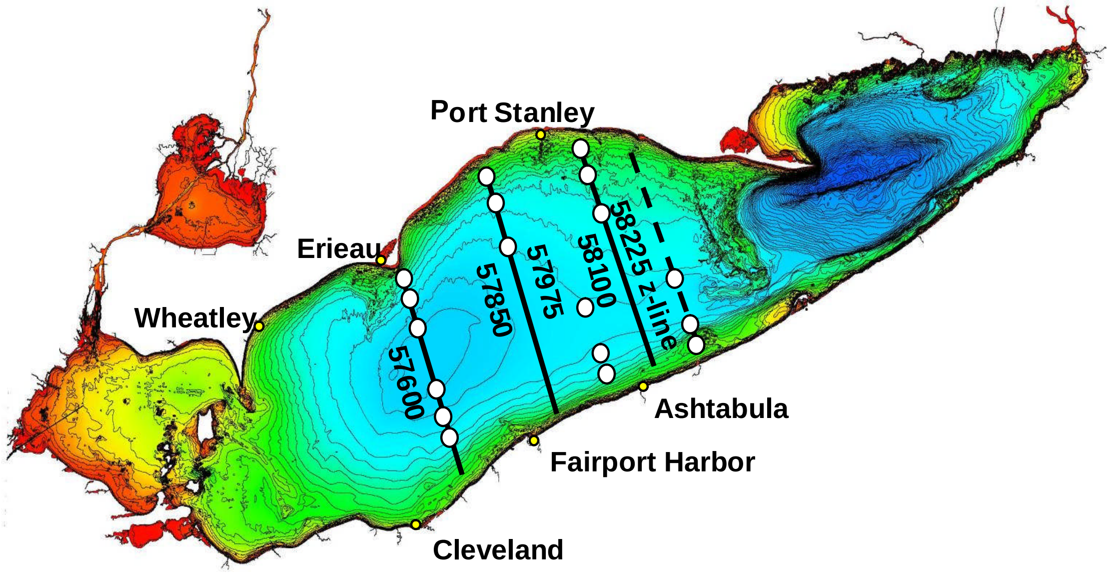

Figure 4.3. Four completed central basin acoustic survey transects for July 19-23, 2004. Transects were run along Loran-C TD lines. Dashed line indicates acoustic data are collected aboard the R/V Bowfin, with trawling done aboard the R/V Grandon. Solid line indicates acoustic data are collected aboard the R/V Musky, with trawling done aboard the R/V Keenosay. Circles indicate approximate trawling locations.

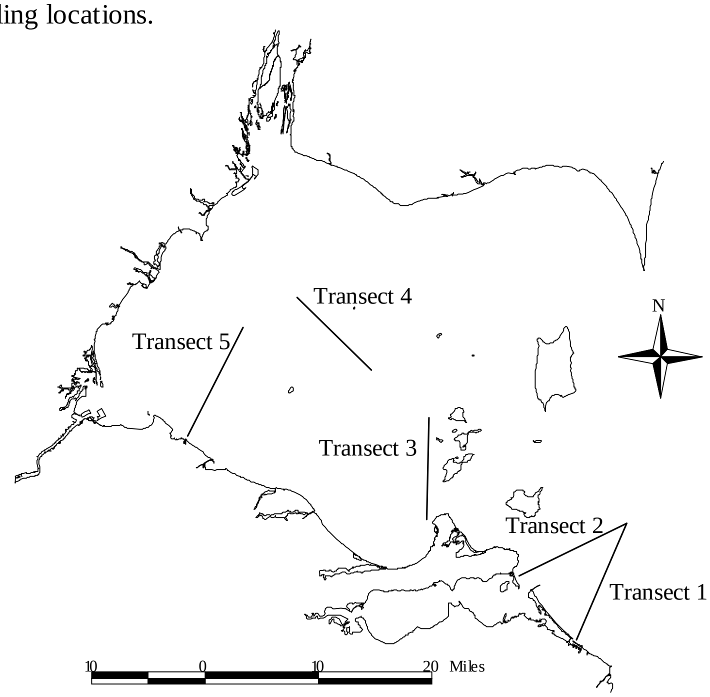

Figure 4.4. West basin acoustic survey transects, July 2004

5.0 Interagency Lower Trophic Level Monitoring Program

(by T. Johnson and B. Trometer)

In 1999, the FTG initiated a Lower Trophic Level Monitoring Program within Lake Erie and Lake St. Clair (Figure 5.1). 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 station to be visited every two weeks from May through September, totaling 12 sampling periods, with benthos collected on two dates, once in the spring and once in the fall. The year 2004 marks the sixth year of this monitoring program. For this report, we have generated 4 indices which provide a useful description of the state of the Lake Erie ecosystem. These indices include mean epilimnetic water temperature, mean hypolimnetic dissolved oxygen, observed and predicted chlorophyll a (an index of grazing pressure), and mean zooplankton size (an index of predation pressure by zooplanktivores). At the time this report was printed, insufficient results on total phosphorous had been returned from the lab to generate the 2004 grazing index, and zooplankton results remain lagged 1 year due to tedious analytical processing requirements. Stations included in this analysis are 1 and 2 from Lake St. Clair, stations 3, 4, 5, 6, 7 and 8 from the western basin, stations 9, 10, 11, 12, 13 and 14 from the central basin, and stations 15, 16, 17, 18, 19 and 20 from the eastern basin.

Epilimnetic Temperature

Mean epilimnetic water temperature represents the average temperature of the water column when not stratified, or the upper (warm) layer when thermal stratification exists. This index, calculated for offshore stations only, should provide a good index of relative system production and growth rate potential for fishes, assuming prey resources are not limiting. As expected, temperatures were warmest in the western basin, and were coolest in the eastern basin (Figure 5.2). Relative to previous years, temperatures were cooler in 2004, and showed less variation across the year.

Hypolimnetic Dissolved Oxygen

Oxygen is a critical environmental parameter that influences the distribution and survival of all aquatic organisms. Water remains well saturated with oxygen as long as the water remains in contact with the atmosphere, and processes that consume oxygen (primarily decomposition and respiration) do not exceed the rate of replenishment (photosynthesis by algae or rooted aquatic macrophytes, and atmospheric exchange). Lake Erie has a well documented history of low oxygen in its central basin, due to a very thin hypolimnion (deep water layer) relative to a large sediment area. Figure 5.3 illustrates the dissolved oxygen concentration for each basin of Lake Erie during periods when the water column is stratified (and hypolimnetic oxygen can become limiting). As expected, hypolimnetic dissolved oxygen is highest in the east basin (a very large and deep hypolimnion and cooler temperatures regulate oxygen depletion rates). The western basin rarely stratifies due to its shallow depth, and therefore few cases occur where hypolimnetic waters form and persist to generate low oxygen conditions. Conversely, many observations are available each year for the central basin, where a characteristic seasonal decline in hypolimnetic oxygen concentration is evident (over the course of the summer, oxygen concentration in the hypolimnion is reduced due to oxygen consuming processes). The horizontal line depicts 4 mg/L, a level below which oxygen becomes limiting to the distribution and survival of many temperate fishes and other biota (i.e. mayflies, *Hexagenia*). In 2004, the western basin never stratified, and our surveys recorded no cases where the average hypolimnetic oxygen concentration was below 4 mg/L.

Grazing Pressure

Mazumder (1994) developed equations relating chlorophyll a with total phosphorous under varied trophic and grazing conditions. Central to his food-chain definitions was the degree to which phytoplankton was grazed by large herbivorous zooplankton. Dreissenid mussels may be the dominant source of grazing in infected waters (Nichols and Hopkins 1993). Heavily grazed systems were defined as 'even-linked', while those where grazers are controlled are functionally 'odd-linked'. For a given total phosphorous concentration, chlorophyll a is predicted to be higher in 'odd-linked' systems because less algae will be removed by the grazers. When this index was applied to our data collected from Lake St. Clair and the three basins of Lake Erie (Figure 5.4), we see that grazing is intense in Lake St. Clair (much less chlorophyll a is available than is predicted). Grazing pressure is substantially lower in Lake Erie, being highest at the nearshore stations of the eastern basin. Grazing pressure has increased marginally in each basin since 2001, and all basins continue to best be predicted by the even-linked equations (heavy grazing).

Planktivory Index

Fish are size-selective predators, removing larger prey with a resultant decrease in the overall size of the prey community that reflects feeding intensity (Mills et al. 1987). Johannsson et al. 1999 estimated that a mean zooplankton length of 0.57 mm sampled with a 63-µm net reflects a high level of predation by fish. Figure 5.5 reflects this planktivory index for the zooplankton communities of the three basins of Lake Erie. Predation is deemed high, as the average size of the community is often less than this critical 0.57 mm size. Predation is more intense in the central and western basins than in the east basin, and was higher in 2002 (the last year for which data are presently available) when compared to previous years. In the eastern basin, the index suggests predation may have been lower in 2002 (than in 2000 or 2001) which may reflect lower smelt density in that year.

Collaboration and access to the Lake Erie Lower Trophic Level Database

The partner agencies of the Lake Erie Committee actively seek and would welcome collaborators interested in using data or samples collected as part of the lake wide program. Presently, basic limnological variables (temperature, oxygen, Secchi) are uploaded to the database at regular intervals (minimal time lags). Chlorophyll a and total phosphorous samples are analyzed at outside labs, and are typically not available until the early spring of the year following collection. Zooplankton and benthos data are processed by external contracts, with an approximate 2 year lag from time of collection to entry in the database. Both zooplankton and benthos samples are archived after enumeration for reference purposes. Phytoplankton samples (250 ml composite water sample stored in Lugol's solution) are simply archived, as we do not have the resources to process these. The Forage Task Group, with continued support from Nick Preston (our database developer), are working to find more efficient ways to upload, maintain, and retrieve data stored in the database. We are currently pursuing web-hosting options, which would enable near real-time access to data from all agencies.

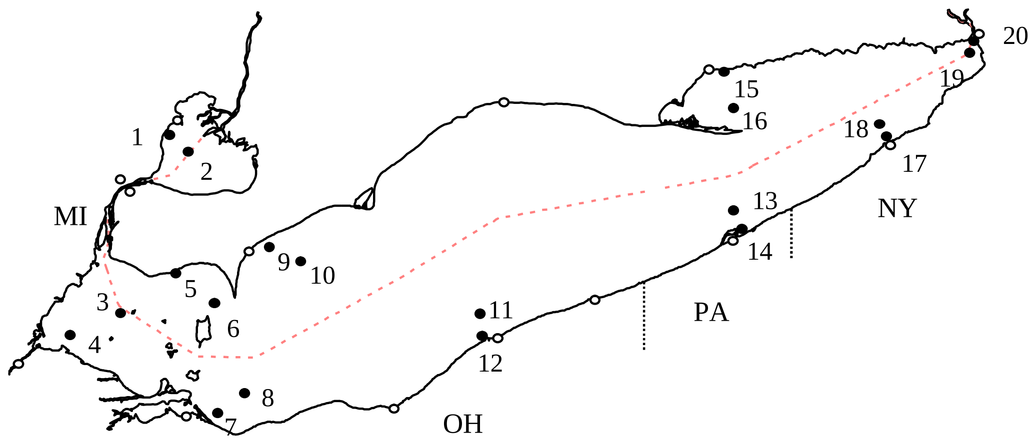

Figure 5.1 Lower trophic level sampling stations in Lakes Erie and St.Clair.

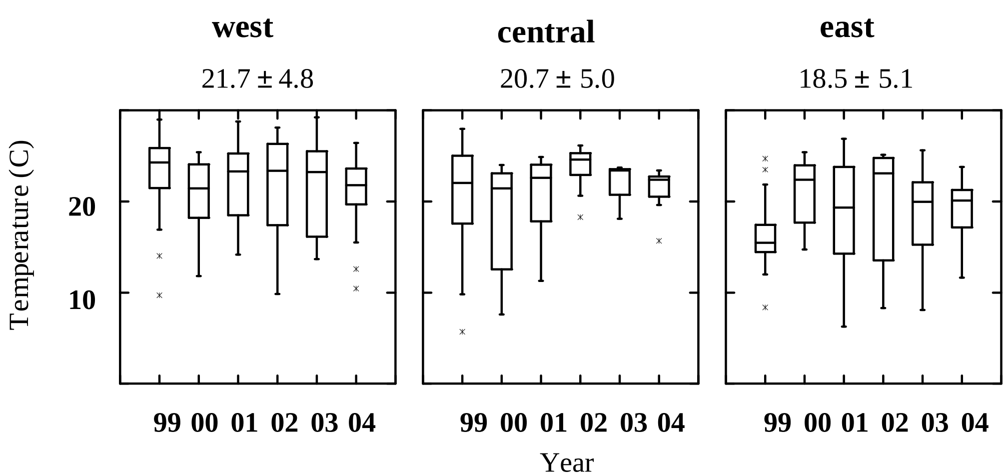

Figure 5.2 Epilimnetic water temperature (°C) at offshore stations by basin in Lake Erie, 1999-2004. Long-term average water temperature is provided above each plot. Box plots represent median, 25th and 75th quartile.

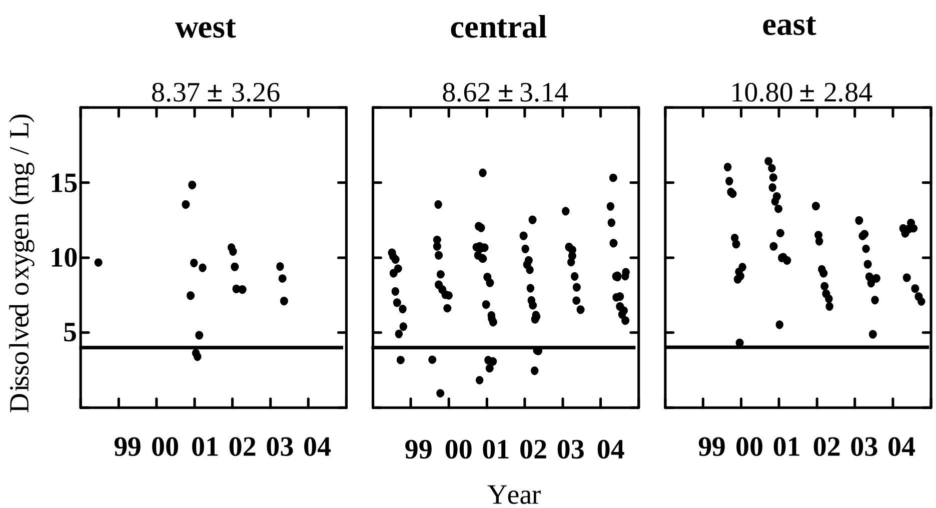

Figure 5.3 Mean hypolimetic dissolved oxygen (mg/L) for each basin of Lake Erie, 1999-2004. Data are presented only when water column is stratified. The horizontal line represents 4 mg/L, a level below which oxygen becomes limiting to the distribution of many temperate freshwater fishes. Long-term average hypolimnetic dissolved oxygen is provided above each plot.

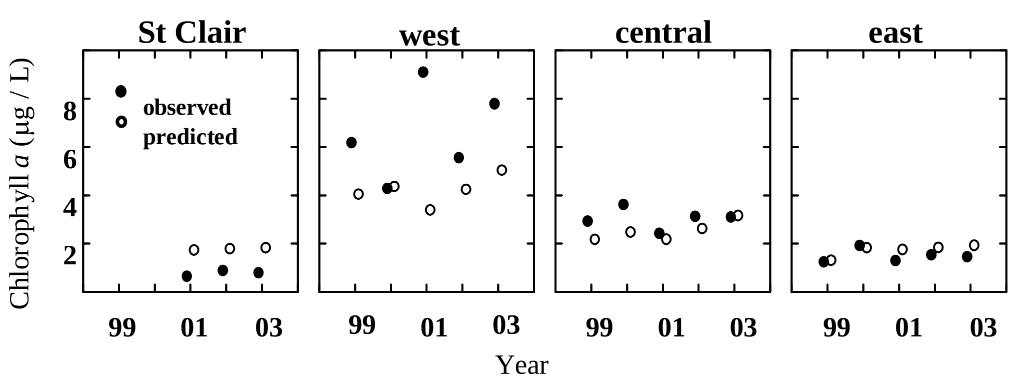

Figure 5.4 Observed and predicted chlorophyll a concentration (µg/L) in each basin of Lake Erie and Lake St. Clair, 1999-2003. Chlorophyll a is predicted from equations presented in Mazumder 1994 for even-linked systems (those where grazing limits phytoplankton standing crop).

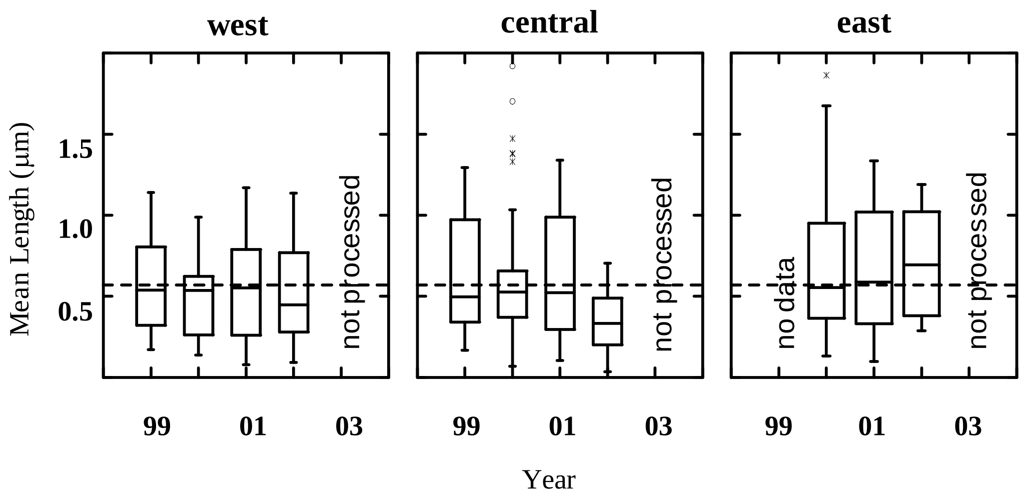

Figure 5.5 Median length of the zooplankton community (µm) sampled with a 63 µm plankton net hauled through the epilimnion of each basin of Lake Erie, 1999-2004. The horizontal line depicts 0.57mm; if the median size of the zooplankton community is less than 0.57mm, predation by fish is considered to be intense (Mills et al. 1987; Johannsson et al. 1999).

6.0 Lakewide Round Goby Distribution (by B. Haas and J. Tyson)

Round goby (*Neogobius melanostomus*), were first discovered in the St. Clair River in 1990, and became established in the central basin of Lake Erie in 1994. In the past, the Forage Task Group has provided annual maps chronicling the spread of round goby throughout Lake Erie. Round goby are present in all bottom trawling surveys. Thus, in this and future reports, round goby will be treated as a regular forage species and abundance information will be reported in section 2.0. Please refer to Forage Task Group reports from 1999 through 2003 for information on the spread and distribution of round goby in Lake Erie.

7.0 Protocol for Use of Forage Task Group Data and Reports

- The Forage Task Group (FTG) has standardized methods, equipment, and protocols as much as possible; however, data are not identical across agencies, management units, or basins. The data are based on surveys that have limitations due to gear, depth, time and weather constraints that vary from year to year. Any results, conclusions, or abundance information must be treated with respect to these limitations. Caution should be exercised by outside researchers not familiar with each agency's collection and analysis methods to avoid misinterpretation.

- The FTG strongly encourages outside researchers to contact and involve the FTG in the use of any specific data contained in this report. Coordination with the FTG can only enhance the final output or publication and benefit all parties involved.

- Any data intended for publication should be reviewed by the FTG and written permission obtained from the agency responsible for the data collection.

Acknowledgments

The FTG is grateful to Dr. Lars Rudstam (Cornell University) and Dr. Dave Warner (USGS) for their continued support of hydroacoustic surveys, section 4.0, and Dr. Jeffery Zhu (University of Windsor) for his efforts on the summary of species statistics, section 3.2 .

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