Report of the
Lake Erie
Forage Task Group

March 2008

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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 2007-2008

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 Status and Trends of Forage Fish Species

2.1 Synopsis of 2008 Forage Status and Trends

General Patterns

- Overall forage abundance increased throughout the lake
- Recent resurgence of emerald shiners, which remain relatively abundant lake wide
- Round Goby increased in all areas in 2007, especially in the east
- Rainbow smelt abundance increased, although they remain well below the long term average
- Forage diversity is increasing
- Predator growth and condition remain good

Eastern Basin

- Moderate abundance of forage fish during 2007 was largely due to rainbow smelt and record high densities of round goby
- 2007 year class of rainbow smelt (age-0) was moderately strong in Ontario and Pennsylvania and record year class in New York; Yearling-and-older (YAO) smelt was below long-term average abundance in Ontario and New York, but well above average abundance in Pennsylvania
- Age-0 alewife and gizzard shad decreased in most regions
- Emerald shiners decreased from 2006 record abundance, except densities remained high in Pennsylvania
- Spottail shiner decreased in some regions, remain at low densities throughout basin
- Round goby, primarily age-0, increased to record numbers throughout basin
- Average length of age-0 and -1 smelt increased, remaining above long-term average
- Predator diets were diverse, dominated by fish species, primarily rainbow smelt and round goby
- Predator growth remains good; age-2 to -6 smallmouth bass were above average size both in Long Pt. Bay, ON, and in New York waters
- Age-1 walleye in 2007 were slightly below (11 mm) long-term average total length, while age-2 walleye remained very near long-term averages (NYS DEC).
- Lake trout size-at-age remain stable; among highest in the Great Lakes

Central Basin

- Overall increase in both age-0 and YAO forage abundance relative to 2006.
- Yellow perch, white perch and gizzard shad age-0 abundances increased and were generally above average
- Young-of-year rainbow smelt and round goby increased in the eastern areas of the basin
- Young-of-year emerald shiners decreased in all areas of the central basin
- Yearling-and-older rainbow smelt and round goby increased with the highest abundances in the eastern areas of the basin
- Yearling-and-older emerald shiner abundance increased, but only in the west and Pennsylvania areas of the basin
- General decline in size of most forage species from 2006, mean size is at or below long term averages. No long term trends in growth of forage species
- Predator diets dominated by emerald shiner, round goby and gizzard shad.

West Basin

- Age-0 gizzard shad catches down from 2006; both alewife and gizzard shad down well below long-term mean
- Age-0 smelt catches down from 2006; below long-term mean
- Age-0 emerald shiner down slightly from 2006 but well above long-term mean; YAO up from 2006 and near long-term mean
- Age-0 white perch and freshwater drum up from 2006, both well above long-term mean; round gobies up to second highest in time series
- Yellow perch and walleye recruitment up from 2006; yellow perch above long-term mean; white bass recruitment lowest in time series; smallmouth bass below long-term mean
- Predator size-at-age comparable to long term mean
- Fall walleye diets show reliance on gizzard shad and emerald shiners

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

Rainbow smelt have been the principal forage fish species of piscivores in the offshore waters of eastern Lake Erie. In 2007, smelt was the most abundant species captured in OMNR and NYS DEC fall index bottom trawl surveys (Table 2.2.1). In PFBC trawl surveys of eastern Lake Erie in 2007, above average numbers of smelt (primarily YAO) were exceeded by numbers of round goby (primarily age-0) and emerald shiner (primarily YAO). Young-of-the-year (age-0) rainbow smelt were observed in average to above average numbers in Ontario and Pennsylvania and record high numbers in New York. Yearling-and-older (YAO) smelt abundance was below average numbers in Ontario and New York waters and well above average numbers in Pennsylvania waters. Mean length of age-0 (66 mm FL) and age-1 (110 mm FL) smelt increased in 2007 with both age classes exceeding the long-term average for OMNR's trawl survey (Figure 2.2.1).

The contribution of non-smelt fish species to the forage fish community of eastern Lake Erie was dominated in 2007 by round gobies (primarily age-0) throughout all regions, YAO emerald shiner and age-0 white perch in Pennsylvania waters, and trout-perch in New York waters (Table 2.2.1). Record high catches of emerald shiners observed by Ontario and New York in 2006 were not sustained in these regions of eastern Lake Erie in 2007, but YAO emerald shiners in 2007 were caught in record high numbers in Pennsylvania. Spottail shiner abundance decreased in some regions and was unchanged in other areas, but overall their relative abundance basin wide remained below the long-term average for all of the agency surveys. Age-0 clupeid species appeared to decrease in most areas of the East Basin, except for above average numbers of age-0 gizzard shad in OMNR's offshore trawl survey (ON-DW).

Offshore-based east basin trawl surveys indicate the 2007 year class of yellow perch was relatively strong compared to historical levels. The 2007 perch year class was ranked second highest since 1992 by New York's trawl assessment and third highest since 1986 by Ontario's trawl survey (ON-DW). Noticeably higher numbers of age-0 yellow perch were observed in mid-water trawl samples during a hydroacoustic assessment of eastern Lake Erie in 2007 than in previous years.

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 were the most or second most numerically abundant species caught in agency index trawl gear across areas surveyed in eastern Lake Erie. By 2004, abundance of round goby peaked in Ontario and New York waters of eastern Lake Erie. A couple of years of lower densities followed in 2005 and 2006 and then in 2007, goby abundance primarily as age-0 cohort, rebounded to a new peak level (Table 2.2.1).

During 2007, 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 or are in the process of being incorporated in the Forage Task Group's LTLA database.

Rainbow smelt have remained the dominant prey of angler-caught walleye sampled each summer since 1993. Beginning in 2001 prey fish other than rainbow smelt made a small, but measurable, contribution to the walleye diet. Collections beginning in 2006, and continuing in 2007, were especially noteworthy because several other prey fish species contributed measurably to walleye diets. Increased prey species diversity coupled with lower smelt abundance is a consistent observation between independent walleye diet and east basin forage fish trawling programs in recent years. Round goby remain the largest component of the diet of adult smallmouth bass caught in NYS DEC gill net surveys since 2000. Fish species continue to comprise the majority of the diets of both lake trout and burbot caught in coldwater assessment gill nets in eastern Lake Erie, August 2007. However, the composition of the diet items continues to evolve. Smelt have been the dominant food item in lean-strain lake trout since coldwater surveys began in the early 1980's in Lake Erie, occurring in 85 – 95% of the stomachs. In 2006, a year of low YAO smelt abundance, round gobies were prominent in the diets of lean- and Klondike-strain lake trout, found in 53% and 68%, respectively of non-empty stomach samples. In 2007, smelt (YAO) abundance increased and this prey species was again the most frequently observed food item of both lean- (86%) and Klondike-strain (57%) lake trout. Burbot diets remained diverse with 9 different fish and invertebrate species found in stomach samples. Round gobies were once again the dominant prey item of burbot, occurring in 43% of the stomachs compared to 23% for smelt. Gobies have been the preferred prey item of burbot in four of the last five years.

Age-2 and age-3 smallmouth bass cohorts sampled in 2007 autumn gill net collections (NYS DEC) were both more than 20 mm longer than the average for the entire time series. Additionally, age-2 smallmouth bass in 2007 were the longest ever observed in the 27-year time series. Length-at-age trends from New York's juvenile walleye (age-1 and age-2) assessment were near long-term average sizes. Mean size-at-age (length and weight) of lake trout in 2007 were consistent with the recent 10-year average (1997 – 2006) and k condition coefficients remain high. Lake trout growth in Lake Erie continues to be among the highest in the Great Lakes.

2.3 Central Basin (by J. Deller and C. Murray)

In the central basin, overall forage abundance for age-0 and YAO increased from 2006 and was generally above a ten year mean. The increase in forage abundance was apparent in both East and West areas of the basin (Tables 2.3.1 and 2.3.2).

The overall increase in forage abundance was due to exceptionally large age-0 yellow perch, white perch, gizzard shad and round goby indices that increased to near record levels relative to the ten year time series. Yellow perch, white perch and gizzard shad indices were particularly high in the western areas of the basin, while round goby indices were skewed toward the eastern areas of the basin. Young-of-the-year rainbow smelt indices also increased in all areas of the central basin, but remain generally below the ten year mean. Young-of-the-year emerald shiner indices decreased in all areas of the basin compared to abundance indices from 2005 and 2006.

Yearling-and-older indices for yellow perch, rainbow smelt and round goby increased in all areas of the basin compared to 2006. Yearling yellow perch indices were at or slightly above the ten year mean in the East, but below the mean in the West, while rainbow smelt indices were above the mean only in the western areas of the basin. Round goby indices in the eastern areas of the basin were above the ten year mean and the second highest in the ten year time series. Although the round goby indices increased in the western areas of the basin, they were still below the ten year mean. Yearling-and-older emerald shiner indices increased only in the western Ohio and Pennsylvania waters of the basin. In the eastern Ohio waters, emerald shiner indices declined, in spite of larger than average age-0 cohorts in 2005 and 2006.

Diet data for the central basin is reported as % portion by dry weight. In 2007, walleye diets were consistently dominated by emerald shiners in May in all areas of the central basin (West 90%; East 81%). After May, the primary diet item in walleye stomachs changed to rainbow smelt in July (70%) and then to gizzard shad during August, September and into October (39%, 93% and 44% respectively). The change in diet composition for walleye is consistent with previous surveys. Walleye diets in the East portion of the basin continued to show a strong presence of emerald shiner throughout the summer and into the fall.

White bass diets, as usual, were variable throughout the season. In both the West and East portions of the central basin, chironomids represented a large part of the prey items in May (West 44%; East 26%) along with rainbow smelt in the West (30%) and emerald shiners in the East (50%). In June, chironomids remained the single largest contributing prey item in both portions of the basin (West 29%; East 60%). In July, white bass diets in the West were primarily rainbow smelt (38%), then emerald shiners (51%) in August and gizzard shad (50%) in September. In the East, samples were limited, but a similar trend was apparent, with diets consisting of smelt (33%) in August and emerald shiners (100%) in September. White bass diets in the fall gillnet survey continue to be primarily emerald shiners (West 66%; East 62%) in all areas of the basin. In 2005 2006 and again in 2007, rainbow smelt, usually a large component of predator diets, were almost absent from predator diets in the fall, further reflecting the below average rainbow smelt abundance.

Yellow perch diets consisted primarily of chironomids in May (West 80%; East 71%) with lower portions but still the single largest component of the diets from June through October. Round goby was a large part of the diets of yellow perch from August and October in the West (18% and 33% respectively) and July, August and October in the East (26%, 16% and 30% respectively). Additionally, the invasive bloody red shrimp, *Hemimysis anomala*, was found in the diets of five yellow perch caught in the central basin. Four of those were caught in the East off of Perry, OH and one in the West off Cleveland, OH.

During 2007, Lower Trophic Level Assessment samples were collected from May through October in the central basin. These data are being processed and completed files are incorporated in the Forage Task Group's LTLA database.

2.4 West Basin (by E. Weimer and M. Bur)

Western basin recruitment varied in 2007 compared to 2006. Increases were notable for age-0 freshwater drum (201.2/ ha, second highest index since 1987) and white perch (4704.3/ha, fifth highest in time series). Recruitment of age-0 yellow perch and walleye increased from 2006 (Figure 2.4.1), returning to levels above or near long-term means. Age-0 gizzard shad (255.6/ha) decreased from 2006, while alewife (0.22/ha) increased slightly (Figure 2.4.2); both remained well below long-term means. Recruitment of age-0 emerald shiners decreased slightly in 2007, while yearling-and-older (YAO) shiner production increased relative to 2006 (Figure 2.4.3). Age-0 white bass in 2007 were the lowest levels since 1987 (28.4/ha), while age-0 smallmouth bass decreased to 0.8/ha, just below the long-term mean. Numbers of all ages of round gobies (144.1/ha, second highest in time series) increased for the second year in a row. Lengths of age-0 walleye, yellow perch, white bass, and white perch slightly decreased in 2007 relative to 2006, while smallmouth bass lengths were up slightly.

Adult walleye diets remained dominated by gizzard shad (65%) and emerald shiner (23%), despite the relative low abundance of these species in trawls. White perch were present in walleye diets (1.5%). Yearling walleye relied on emerald shiners (71%) and gizzard shad (23%) in their diets. Yellow perch diets were dominated seasonally by zooplankton (*Daphnia* and *Bythotrephes*) and other invertebrates (*Hexagenia* and *Chironomidae*). Round gobies, emerald shiners, and trout-perch were notable fish components of yellow perch diets in fall samples.

Water temperatures were cooler in 2007 than in the previous year, with peak surface temperature (25.9°C) recorded on August 16. Spring warming rate (May 1 to May 31) was 0.31°C per day. Seasonally averaged basin wide Secchi depth decreased slightly from 2005, averaging 1.4

m [range 0.3m (July 2) to 4.3 m (June 25)]. Western basin bottom dissolved oxygen levels averaged 7.8 mg/l [range 4.5 (August 15) to 11.4 mg/l (May 23)], maintaining levels well above the previous year. Ecological indices useful in interpreting the state of the western basin resource are discussed in Section *5.0, Interagency Lower Trophic Level Monitoring*.

Table 2.2.1 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 2007 and 2006. 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 (00's Avg.) and two previous decades (90's Avg. and 80's Avg.). Pennsylvania (PA-fa) did not conduct a fall trawl survey in 2006.

	Trawl	**YOY**					**YAO**				
Species	**Survey**	**2007**	**2006**	**00's Avg.**	**90's Avg.**	**80's Avg.**	**2007**	**2006**	**00's Avg.**	**90's Avg.**	**80's Avg.**
Smelt	ON-DW	991.3	1256.0	1640.4	485.6	1382.9	232.8	136.2	242.5	404.7	969.0
	NY-Fa	2889.6	507.9	1452.3	1450.9	NA	176.9	162.9	542.0	581.6	NA
	PA-Fa	260.2	NA	153.5	550.8	7058.1	1006.3	NA	10.8	378.0	2408.6
Emerald	ON-DW	29.3	452.3	647.4	54.8	20.5	149.8	4200.3	1129.3	46.4	38.1
Shiner	ON-OB	76.9	64.8	100.1	119.4	152.3	56.3	318.4	65.9	49.9	133.5
	NY-Fa	150.9	778.5	248.2	112.4	NA	84.8	925.5	378.3	105.4	NA
	PA-Fa	81.7	NA	206.4	41.0	118.3	4713.1	NA	53.4	14.5	45.6
Spottail	ON-OB	12.3	12.5	190.8	696.6	249.0	0.0	6.5	12.5	52.3	21.3
Shiner	ON-IB	0.3	0.1	2.3	111.6	291.3	0.0	0.0	0.5	2.0	9.4
	NY-Fa	0.1	0.5	8.0	19.9	NA	0.0	4.1	8.2	4.0	NA
	PA-Fa	0.0	NA	0.0	4.0	2.0	0.0	NA	0.1	7.9	12.4
Alewife	ON-DW	1.0	78.6	31.6	234.1	21.4	NA	NA	NA	NA	NA
	ON-OB	25.5	459.4	73.3	61.0	51.5	NA	NA	NA	NA	NA
	NY-Fa	22.2	30.8	130.7	52.0	NA	NA	NA	NA	NA	NA
	PA-Fa	8.0	NA	0.5	7.7	16.6	NA	NA	NA	NA	NA
Gizzard	ON-DW	34.6	1.4	13.1	7.5	15.3	NA	NA	NA	NA	NA
Shad	ON-OB	12.3	19.0	5.9	9.6	24.1	NA	NA	NA	NA	NA
	NY-Fa	11.7	14.1	13.1	4.2	NA	NA	NA	NA	NA	NA
	PA-Fa	0.0	NA	0.1	0.9	74.3	NA	NA	NA	NA	NA
White	ON-DW	0.1	0.9	3.3	2.2	5.6	NA	NA	NA	NA	NA
Perch	ON-OB	0.4	0.8	2.8	14.2	28.7	NA	NA	NA	NA	NA
	NY-Fa	34.6	91.9	42.7	29.4	NA	NA	NA	NA	NA	NA
	PA-Fa	444.6	NA	210.0	101.1	NA	NA	NA	NA	NA	NA
Trout [a]	ON-DW	0.0	0.1	0.0	0.1	0.5	0.8	1.1	0.8	0.5	1.9
Perch	NY-Fa	561.2	519.4	881.9	410.0	NA	NA	NA	NA	NA	NA
	PA-Fa	46.2	NA	55.0	23.2	NA	110.6	NA	53.8	26.0	NA
Round [a]	ON-DW	973.2	93.3	127.1	0.2	0.0	NA	NA	NA	NA	NA
Goby	ON-OB	59.8	20.8	61.6	0.6	0.0	NA	NA	NA	NA	NA
	ON-IB	185.1	21.4	45.2	0.0	0.0	NA	NA	NA	NA	NA
	NY-Fa	1059.5	626.9	410.6	1.0	0.0	233.6	219.6	197.2	0.0	0.0
	PA-Fa	1092.3	NA	818.3	30.3	0.0	951.5	NA	351.0	5.6	0.0

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

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

Ontario Ministry of Natural Resources

All OMNR indices are reported as NPH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999. 00's average is for the period 2000 to 2006.

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

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.

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.

New York State Department of Environmental Conservation Trawl Survey

NY-Fa Trawling is conducted at 30 nearshore (15-30 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; 00's average is for the period 2000 to 2006.

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 NPH; 80's Avg. is for the period 1984 to 1989; 90's Avg. is for the period 1990 to 1999; 00's average is for the period 2000 to 2007.

Table 2.3.1 Relative abundance (arithmetic mean number per hectare) of selected age-0 species from fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1997-2007. Ohio West (OH West) is the area of the central basin from Huron, OH, to Fairport Harbor, OH. Ohio East (OH East) is the area of the central basin from Fairport Harbor, OH to the Pennsylvania state line.

	year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	mean
Yellow perch	OH West	11.6	67.7	73.2	21.2	109.1	5.8	140.7	8.1	70.2	9.9	176.5	63.1
	OH East	2.8	39.9	17.2	0.7	12.7	2.5	50	2.1	110.3	20.1	160.1	38.0
	PA	0.0	13.7	7.2	15.7	388.4	11.9	788.0	2.4	6.7	-	10.0	124.4
White perch	OH West	252.7	89.4	318.1	552.1	737.8	276.7	308.2	706.5	1376.3	419.4	1697.5	612.2
	OH East	2.4	53.8	36.3	3.1	73.2	6.4	43.6	119.5	1462.7	38.9	427.6	206.1
	PA	0.0	0.0	8.5	75.9	26.6	80.7	173.8	2.4	42.3	-	17.8	42.8
Rainbow smelt	OH West	225.5	267.3	70.1	147.3	2.2	259.4	2690.9	331	10.2	89.2	116.3	382.7
	OH East	523.9	1065.8	301.2	1151.5	0	236.2	1761.5	430.3	49.6	640.4	741.5	627.4
	PA	10.3	29.9	1.8	15.3	377.4	152.9	177.6	20.9	15.9	-	35.1	83.7
Round goby	OH West	46.9	129.1	91.1	20.9	43.1	35.7	21.5	24.7	36	17.9	30.4	45.2
	OH East	117	205.6	191	170.9	45.1	70.1	61.9	175	164.1	51.8	296.7	140.8
	PA	1.5	743.6	1114.4	781.1	1577.8	289.3	75.3	1011.3	204.0	-	227.8	602.6
Emerald shiner	OH West	154.6	4680.3	593.5	147.2	47.9	37.2	1089.2	6.7	530.3	550.5	51.3	717.2
	OH East	0.2	73	337.6	500.2	2.2	0.6	123.1	0.6	312.9	1254.5	67.8	243.0
	PA	0.0	5.8	0.0	0.0	8.5	38.1	81.8	0.0	17.8	-	0.8	15.3
Spottail shiner	OH West	13.8	1.9	5.3	0.4	5.6	1.5	0	0	0.1	0	2.9	2.9
	OH East	0.1	0.7	4.2	0	1.1	0.2	0.5	0	1.2	0.3	0.6	0.8
	PA	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.1
Alewife	OH West	8.8	9.4	40.7	59.1	48	56.4	0.1	0	0	4.1	0	20.6
	OH East	15.5	0.1	1.6	13	0	1.2	0	0	0	4	0	3.2
	PA	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	-	0.0	0.0
Gizzard shad	OH West	11.7	32	104.2	111.4	57	23.3	378	0.7	11.6	32.4	187.6	86.4
	OH East	7.9	42.9	9.8	29.1	1.7	13.3	21.4	0.1	17.4	31	7.8	16.6
	PA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	-	0.0	0.1
Trout-perch	OH West	0	0.4	6.8	0.9	1.9	1.3	1.9	18.8	0.1	0.2	1.8	3.1
	OH East	2.8	1.2	2.8	0.4	0	0.4	1.5	1.6	1.8	0.1	3.9	1.5
	PA	0.0	23.1	10.0	23.0	7.8	45.6	78.0	6.7	0.3	-	10.9	20.6

(-) The Pennsylvania Fish and Boat Commission was unable to sample in 2006.

Table 2.3.2 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 1997-2007. Ohio West (OH West) is the area of the central basin from Huron, OH, to Fairport Harbor, OH. Ohio East (OH East) is the area of the central basin from Fairport Harbor, OH to the Pennsylvania state line.

	year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	mean
Yellow	OH West	104.8	6.1	41.5	59.1	5.4	53.2	3	204.9	26.5	3.9	22.8	48.3
perch	OH East	36.1	4.3	38.8	19.8	0.6	34.9	1.3	44	131.2	14.1	33.1	32.6
	PA	14.7	2.5	7.9	3.9	41.3	37.5	75.6	18.3	1.9	-	27.4	23.1
White	OH West	42.3	5.3	33.6	87.4	20.5	88.1	26.9	77.9	32.4	39.5	27.5	43.8
perch	OH East	40.3	0.3	15.3	40	0.6	188.3	12.5	30.3	21.5	25.2	14.8	35.4
	PA	0.0	0.0	1.9	0.6	2.4	38.5	28.6	6.2	0.0	-	0.8	7.9
Rainbow	OH West	281.8	62.1	503.6	58.7	48	45.3	313.1	335	72.3	8	213.7	176.5
smelt	OH East	552.4	98.8	2056.5	190.2	4.4	320.9	105.8	1851.1	45.1	23.8	345.4	508.6
	PA	26.5	1.3	0.0	75.8	0.0	6.2	22.1	9.9	2.6	-	10.7	15.5
Round	OH West	162.1	170.2	78.9	27.9	52.2	37.2	25.3	29.1	70.4	19.3	24.8	63.4
Goby	OH East	343.8	82.9	114	175.3	128.2	58.7	135.6	160.2	222.7	88.5	208.6	156.2
	PA	0.0	113.1	55.3	126.5	55.2	238.3	59.1	767.0	206.7	-	361.1	198.2
Emerald	OH West	214.5	1762.2	518.8	111.6	100.4	220.9	346.6	1.5	220.6	153.1	394.4	367.7
shiner	OH East	0.4	12.5	496.9	886.7	1.1	144.2	74.6	0.2	534.6	506.4	27.4	244.1
	PA	7.4	0.0	0.0	0.0	0.0	107.4	217.5	0.0	123.0	-	769.5	122.5
Spottail	OH West	16.2	27.9	5.5	8.3	3.3	6.3	1.7	4.9	0.2	1.1	2.2	7.1
shiner	OH East	2	1.1	7.8	9.1	1.7	6.4	0.9	0.3	4.3	0.7	0.6	3.2
	PA	0.0	0.4	0.0	0.0	0.0	2.2	0.0	0.0	0.0	-	0.0	0.3
Alewife	OH West	0	0	0	0.6	0	2.7	0	0	0	0	0	0.3
	OH East	0	0.3	0	0.1	0	0.3	0	0	0	0	0.1	0.1
	PA	0.0	0.0	0.0	0.0	0.0	1.3	0.5	0.0	0.0	-	0.0	0.2
Gizzard	OH West	0.1	0.2	0.9	4.6	0.1	1.5	0	0.1	0.5	0.1	0	0.7
Shad	OH East	0.1	0.1	0.2	0.5	0	1.8	3.3	0.2	0.2	0.1	0	0.6
	PA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Trout-	OH West	15.9	15.1	10.9	16.4	3.1	25.7	12.8	13.8	39.2	3.5	6.1	14.8
perch	OH East	13.5	14.9	6.8	16.4	2.2	9.2	1.3	7.2	35.9	4.6	5.6	10.7
	PA	8.8	1.0	0.9	11.5	0.6	81.2	50.9	5.2	4.1	-	16.0	18.0

(-) The Pennsylvania Fish and Boat Commission was unable to sample in 2006.

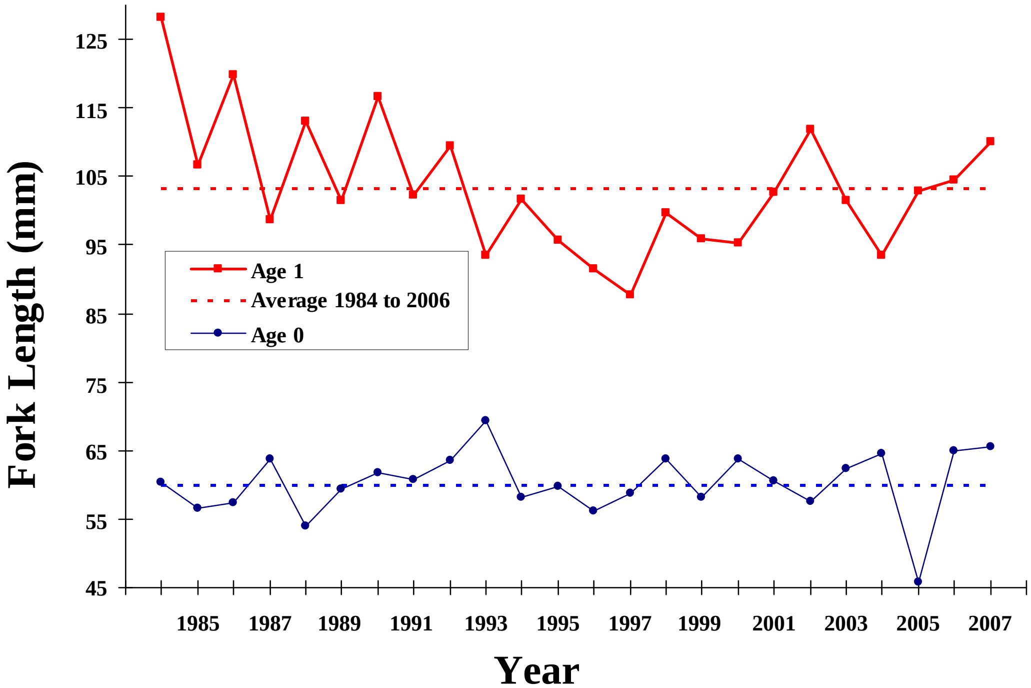

Figure 2.2.1 Mean fork length of age-0 and age-1 rainbow smelt from OMNR index trawl surveys in Long Point Bay, Lake Erie, October 1984-2007.

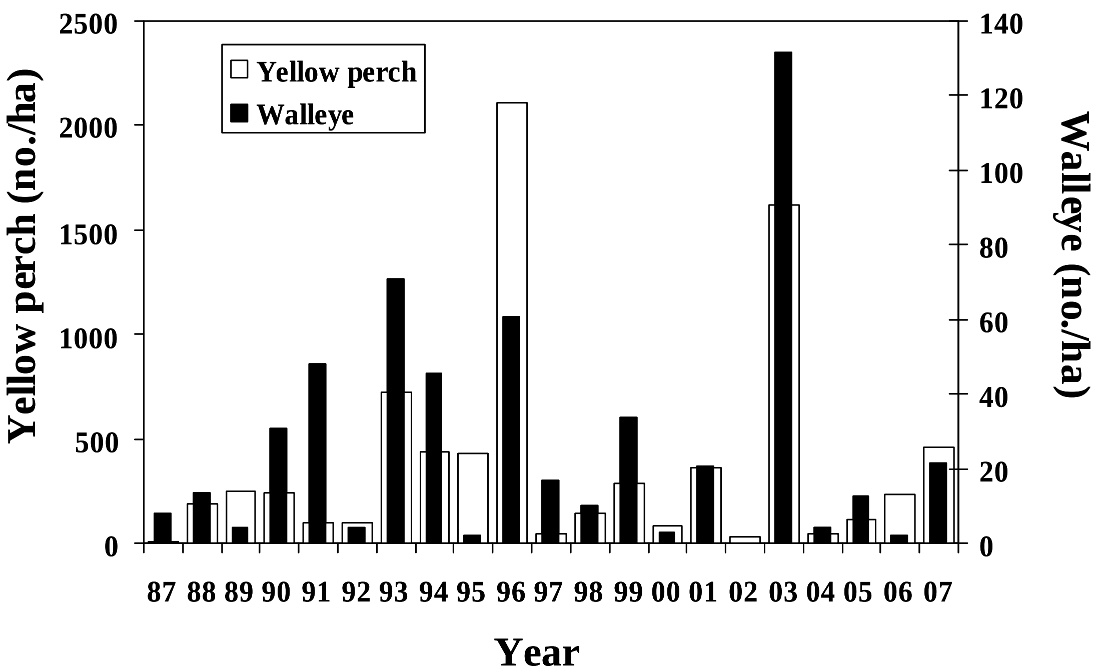

Figure 2.4.1 Density of age-0 yellow perch and walleye in the western basin of Lake Erie, August 1987-2007.

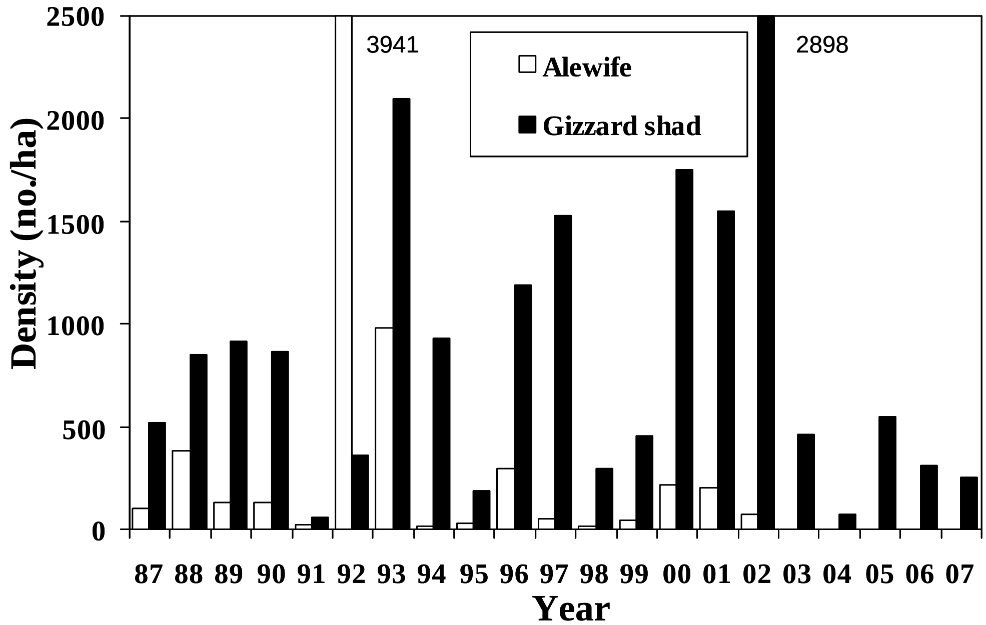

Figure 2.4.2 Density of age-0 alewife and gizzard shad in the western basin of Lake Erie, August 1987-2007.

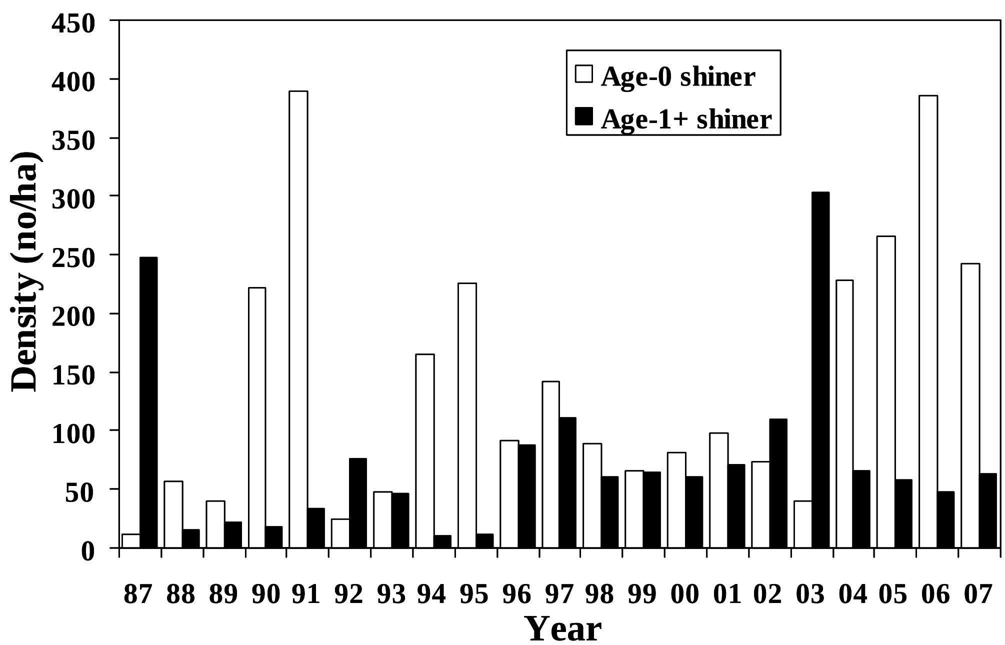

Figure 2.4.3 Density of age-0 and age-1+ shiners (*Notropis* spp.) in the western basin of Lake Erie, August 1987-2007.

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 continue the work on interagency trawling issues. Progress on these charges is reported below.

3.1 Trawl Calibration (by M. Bur, J. Tyson and S. Mackey)

In 2008, ODNR, Scudder Mackey, and USGS plan to conduct tests to estimate bottom trawl dimensions using three types of assessment gear (side-scan sonar, BioSonics, and Notus) simultaneously. These tests will be similar to those run in 2006 by the MDNR (Forage Task Group 2007). The first part of the test will consist of towing a bottom trawl with Notus acoustic mensuration sensors attached to each of the bottom trawl wings to determine trawl spread (width) and a sensor mounted on the headrope to measure vertical height. A second part of the testing will use a separate vessel with both side-scan and BioSonics sonar to measure both bottom trawl spread and height. The end outcome will be to ascertain if the independent measurements are similar. An additional test will be conducted with side-scan and BioSonics, but without the Notus sensors, to determine if the net spread and height are affected by the presence of the Notus sensors.

3.2 Summary of Species CPUE Statistics (by E. Weimer, J. Tyson and M. Bur)

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 2007 (Figure 3.2.1).

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 among agencies. In 1992, in response to the ITG recommendation, the FTG began the standardization and calibration of trawling procedures among 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. Results of the *Trawl Comparison Exercise* of 2003 have now been fully analyzed (see summary below), and Fishing Power Correction (FPC) factors have been applied to the vessels administering the western basin Interagency Trawling Program. All vessel CPUEs were standardized to the *R.V. Keenosay* using correction factors developed during the trawl comparison experiment in 2003 (Table 3.2.1). A manuscript describing justification, methods used, and results has been published in the *North American Journal of Fisheries Management* (Tyson et al. 2006). Information from this experiment will also be used in development of an additional interagency trawling program to examine temporal and spatial patterns in forage abundances in the western basin during June and September administered by ODNR and USGS – Lake Erie Biological Station.

Presently, the FTG estimates basin-wide abundance of forage fish in the western basin using information from SCANMAR trials, trawling effort 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 a FPC-adjusted, 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).

Total forage abundance increased in 2007, reaching its highest level since 2004 (Figure 3.2.2). Total forage biomass rebounded as well, reaching its highest level since 1990 (Figure 3.2.3). Increases in white perch recruitment in 2007 and the associated increase in the spiny-rayed group were responsible for much of this increase. Soft-rayed abundance decreased in 2007, and biomass decreased by nearly a third relative to 2006. Clupeids increased in abundance in 2007, and biomass responded with a 30% increase. Relative biomass of clupeid, soft-rayed, and spiny-rayed species was 6.7%, 2.7%, and 90.6%, and was different than the respective historic averages of 32.8%, 7.2%, and 60% (Figure 3.2.3). Walleye show a clear preference for clupeids and soft-rayed fishes over spiny-rayed prey (Knight and Vondracek 1993), and the long-term decreases in biomass of clupeid and soft-rayed fish may struggle to satisfy predatory demand in Lake Erie.

Mean length of age-0 fishes in 2007 varied when compared to 2006 (Figure 3.2.4). Length of age-0 for select species include: walleye (149.6 mm), yellow perch (67.6 mm), white bass (70.9 mm), white perch (55.7 mm), and smallmouth bass (83.3 mm). Long-term averages for the same species are: walleye (137.4 mm), yellow perch (66.5 mm), smallmouth bass (80.5 mm), white bass (67.5 mm), and white perch (57.4 mm). Decreases in age-0 walleye mean length likely reflects higher recruitment in 2007 than in 2006.

Spatial maps of forage distribution were constructed using FPC-corrected site-specific catches (#/ha) of the functional forage groups (Figure 3.2.5). Abundance contours were generated using kriging contouring techniques to interpolate abundance among trawl locations. Clupeid catches were highest in Pigeon Bay (northeast portion of the basin), with gizzard shad densities lowest along the south shore. Soft-rayed fish (predominantly trout-perch and round gobies) were most abundant along the south shore and extending into the outflow of the Detroit River. Spiny-rayed abundance was clustered across the basin, with pockets of high abundance along both the south shore and in Pigeon Bay. Relative abundance of the dominant species includes: age-0 white perch (75%), yellow perch (7%), gizzard shad (4%), and freshwater drum (3%). Total forage abundance averaged 5,817 fish/ha across the western basin, increasing 37% from 2006 to fall above the long-term average (4,673 fish/ha). Clupeid density was 180 fish/ha (average 987 fish/ha), soft-rayed fish density was 577 fish/ha (average 487 fish/ha), and spiny-rayed fish density was 5059 fish/ha (average 3,252 fish/ha).

3.3 Trawl Comparison Exercise (by J. Deller)

The Forage Task Group is looking into the possibility of continuing the trawl comparison exercise to include the boats and agencies of the central and eastern basins. We are currently in the planning stage, looking into feasibility and logistics needed to coordinate another trawl comparison exercise.   This would provide further improvement in coordination and integration of trawl surveys conducted throughout the basins of Lake Erie.

Table 3.2.1. Mean catch-per-unit-effort (CPUE) and fishing power correction factors (FPC) by vessel-species-age group combinations. All FPCs are calculated relative to the R.V. Keenosay.

Vessel	Species	Age group	Trawl Hauls	Mean CPUE (#/ha)	FPC	95% CI	Apply rule [a]
R.V. Explorer	Gizzard shad	Age 0	22	11.81	2.362	-1.26-5.99	Y
	Emerald shiner	Age 0+	50	67.76	1.494	0.23-2.76	Y
	Troutperch	Age 0+	51	113.20	0.704	0.49-0.91 z	Y
	White perch	Age 0	51	477.15	1.121	1.01-1.23 z	Y
	White bass	Age 0	50	11.73	3.203	0.81-5.60	Y
	Yellow perch	Age 0	51	1012.15	0.933	0.62-1.24	N
	Yellow perch	Age 1+	51	119.62	1.008	0.72-1.30	N
	Walleye	Age 0	51	113.70	1.561	1.25-1.87 z	Y
	Round goby	Age 0+	51	200.27	0.423	0.22-0.63 z	Y
	Freshwater drum	Age 1+	51	249.14	0.598	0.43-0.76 z	Y
R.V. Gibraltar	Gizzard shad	Age 0	29	14.22	1.216	-0.40-2.83	Y
	Emerald shiner	Age 0+	43	51.30	2.170	0.48-3.85	Y
	Troutperch	Age 0+	45	82.11	1.000	0.65-1.34	N
	White perch	Age 0	45	513.53	0.959	0.62-1.30	N
	White bass	Age 0	45	21.88	1.644	0.00-3.28	Y
	Yellow perch	Age 0	45	739.24	1.321	0.99-1.65	Y
	Yellow perch	Age 1+	45	94.56	1.185	0.79-1.58	Y
	Walleye	Age 0	45	119.17	1.520	1.17-1.87 z	Y
	Round goby	Age 0+	45	77.36	0.992	0.41-1.57	N
	Freshwater drum	Age 1+	45	105.21	1.505	1.10-1.91 z	Y
R.V. Grandon	Gizzard shad	Age 0	29	70.87	0.233	-0.06-0.53 z	Y
	Emerald shiner	Age 0+	34	205.43	0.656	-0.04-1.35	Y
	Troutperch	Age 0+	35	135.93	0.620	0.42-0.82 z	Y
	White perch	Age 0	36	771.40	0.699	0.44-0.96 z	Y
	White bass	Age 0	36	34.92	0.679	0.43-0.93 z	Y
	Yellow perch	Age 0	36	1231.63	0.829	0.58-1.08	Y
	Yellow perch	Age 1+	36	123.35	0.907	0.58-1.23	Y
	Walleye	Age 0	36	208.59	0.920	0.72-1.12	Y
	Round goby	Age 0+	36	161.78	0.501	0.08-0.92 z	Y
	Freshwater drum	Age 1+	36	58.82	2.352	1.51-3.19 z	Y
R.V. Musky II	Gizzard shad	Age 0	24	8.80	1.885	-1.50-5.26	Y
	Emerald shiner	Age 0+	47	32.29	3.073	0.36-5.79	Y
	Troutperch	Age 0+	50	62.35	1.277	0.94-1.62	Y
	White perch	Age 0	50	255.71	2.091	1.37-2.81 z	Y
	White bass	Age 0	46	8.35	4.411	0.90-7.92	Y
	Yellow perch	Age 0	50	934.03	1.012	0.77-1.26	N
	Yellow perch	Age 1+	50	34.94	3.452	1.23-5.67 z	Y
	Walleye	Age 0	50	63.70	2.785	2.24-3.33 z	Y
	Round goby	Age 0+	49	66.87	1.266	0.39-2.14	Y
	Freshwater drum	Age 1+	49	1.60	93.326	48.39-138.26 z	Y

z - Indicates statistically significant difference from 1.0 (α=0.05); [a] Y means decision rule indicated FPC application was warranted; , N means decision rule indicated FPC application was not warranted

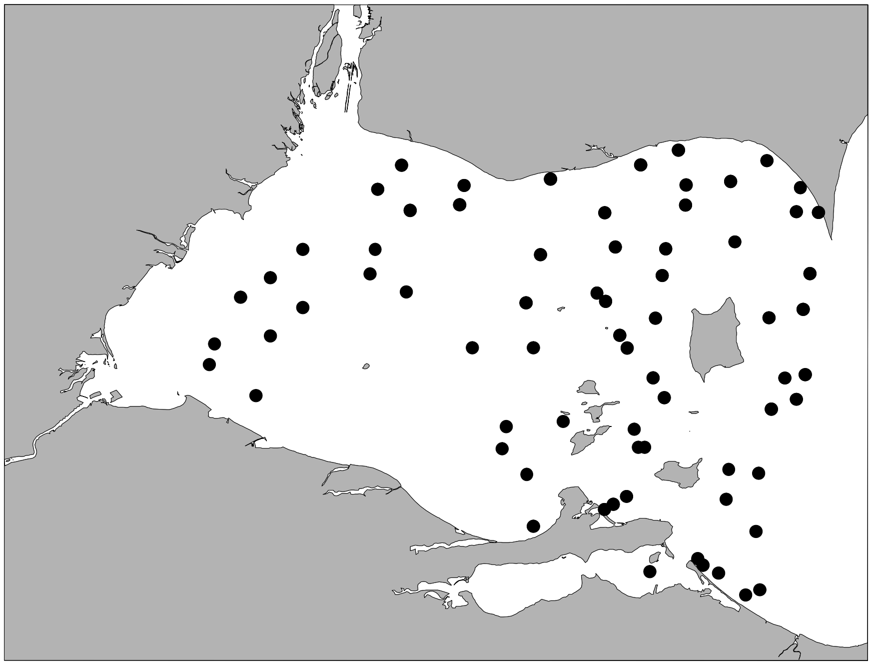

Figure 3.1 Trawl locations for the western basin interagency bottom trawl survey, August 2007.

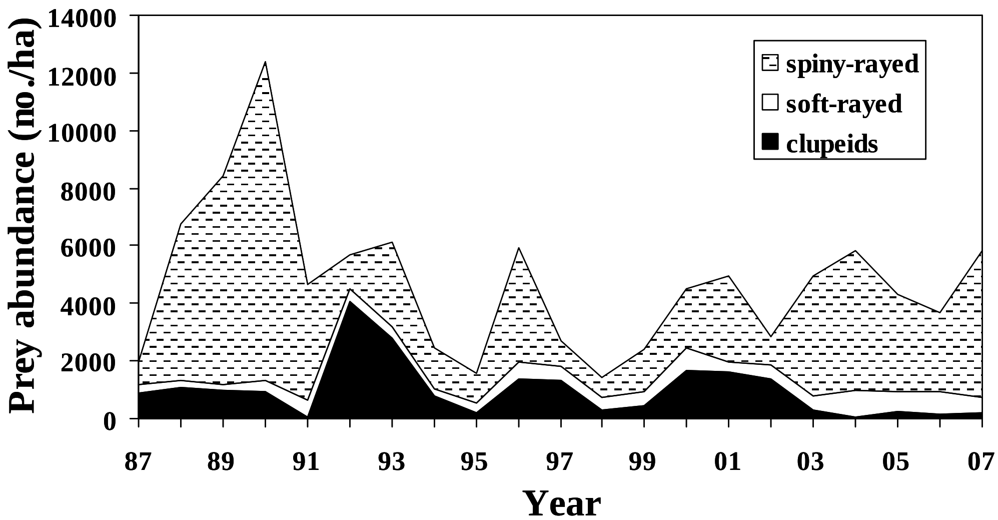

Figure 3.2.2 Mean density (no. / ha) of prey fish by functional group in western Lake Erie, August 1987-2007.

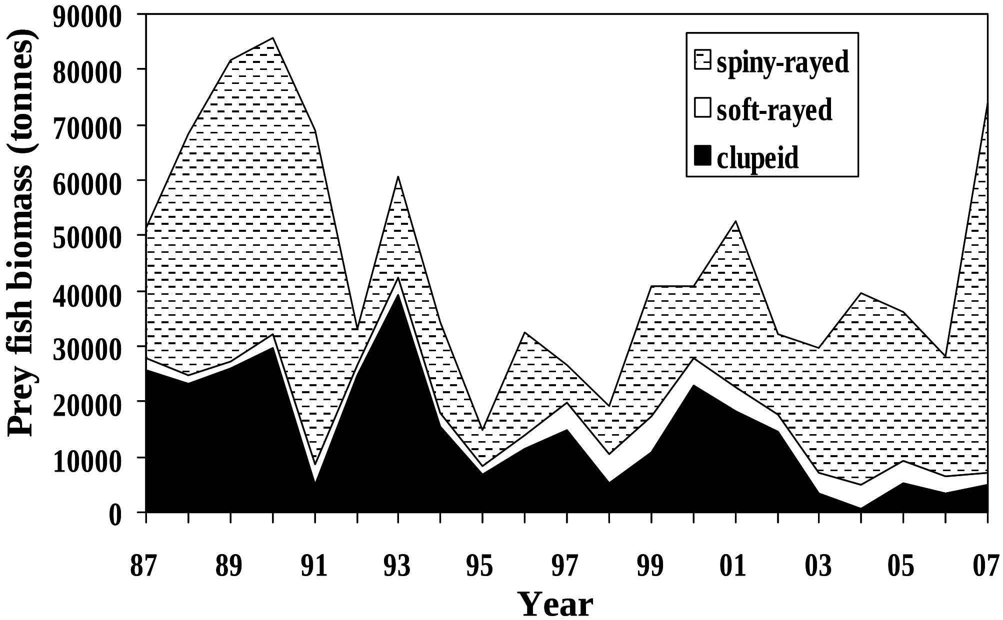

Figure 3.2.3 Mean biomass (tonnes) of prey fish by functional group in western Lake Erie, August 1987-2007.

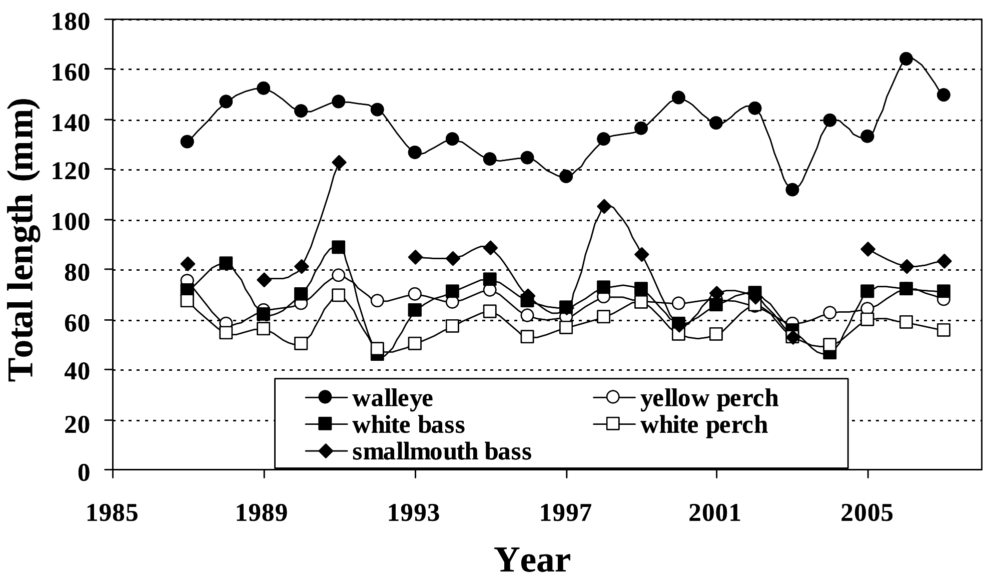

Figure 3.2.4 Mean total length (mm) of select age-0 fishes in western Lake Erie, August 1987- 2007.

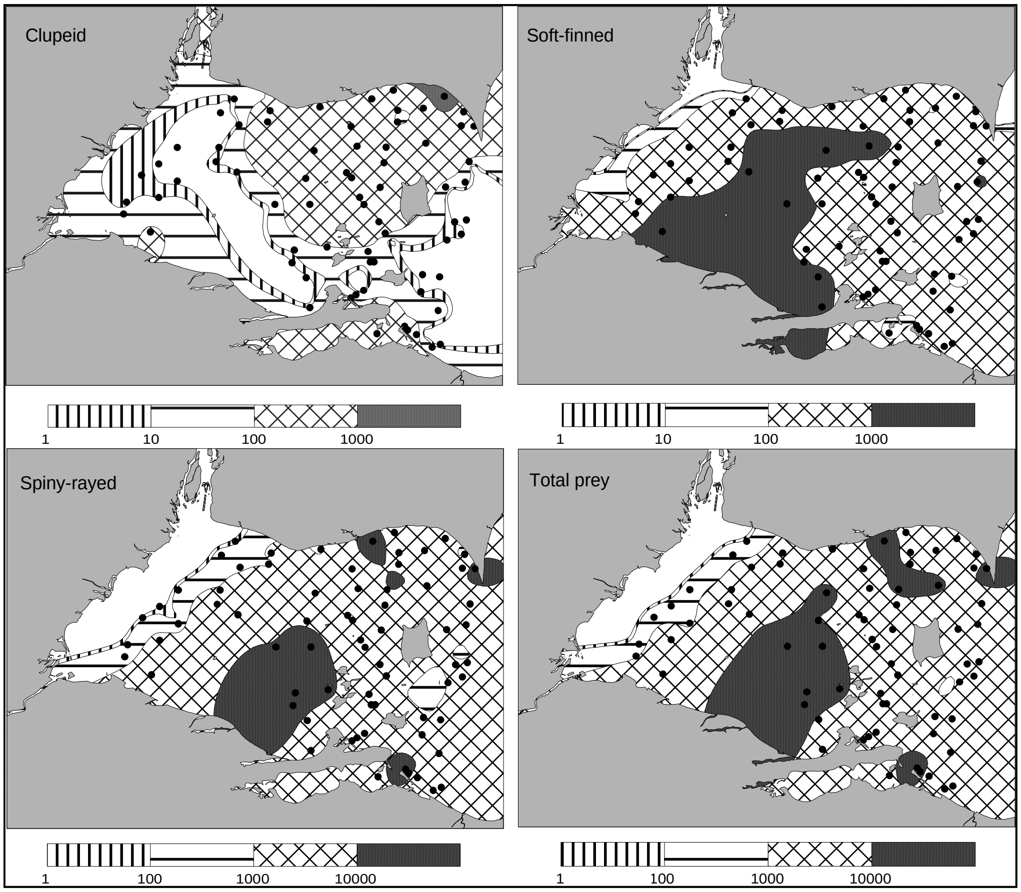

Figure 3.2.5 Spatial distribution of clupeids, soft-finned, spiny-rayed, and total forage abundance (individuals per hectare) in western Lake Erie, 2007. Black dots are locations for trawling and contour levels vary with the each functional fish group.

4.0 Hydroacoustic Survey Program

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

Introduction

In 1993 the Forage Task Group (FTG) introduced fisheries hydroacoustic technology as a principal tool for annual assessments of pelagic forage fish stocks in eastern Lake Erie. Surveys from 1993 to 1996 were largely summertime efforts with an outdated surplus 70-kHz single beam echosounder (Simrad EY-M, 7024 transducer). Beginning in 1997, ongoing summertime acoustic survey efforts used a 120-kHz split-beam system (Simrad EY-500, ES120-7G transducer) that was jointly purchased by the Lake Erie Committee (LEC) member agencies and the Great Lakes Fishery Commission (GLFC). A two-year New York Sea Grant research project coordinated by Dr's Edward Mills and Lars Rudstam from Cornell University allowed for an expanded survey effort during the 1998 and 1999 survey years that included seasonal coverage during spring (June), summer (July) and fall (October). 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. In 2005, a new 120-kHz split-beam system (Simrad EY60, ES120-7C transducer) was purchased for the Lake Erie acoustic program through another coordinated GLFC-LEC cost sharing arrangement.

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 (NYS DEC).

Beyond maintaining the standardized July survey effort, the FTG has been very actively pursuing initiatives to address survey design and analysis procedures to maintain an up-to-date and defensible scientific method for the Lake Erie fisheries acoustic assessment program. 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 NYS DEC jointly purchased a secondary site license for the Echoview software that functionally doubled the capacity for processing acoustic data. During 2005, eastern basin FTG members finalized efforts to upgrade the Lake Erie acoustic hardware system that resulted in the spring 2005 purchase of the aforementioned EY60 GPT/transducer. This echosounder has been used in all east basin acoustic surveys since 2006. Progress has also been ongoing in development and refinement of post-processing applications in Echoview, SAS (SAS 1992) and Excel that integrate data flow and analysis. These post-processing applications will facilitate Lake Erie's unique analytical procedures in a standard, semi-automated fashion across the extensive backlog of split-beam data. The completion of this comprehensive initiative is expected during 2008.

Two FTG members have continued to participate in a GLFC-sponsored Great Lakes Acoustic Study Group charged with preparing an array of standard operating procedures (SOP) for Great Lakes acoustic investigations. A draft SOP document titled "Standard Operating Procedures for Acoustics in the Great Lakes" has been prepared and recently distributed to the study group for review comments. This draft document is available to anyone by way of downloading from the Ohio DNR ftp site. A final version of the SOP document will eventually be available from the GLFC website at http://www.glfc.org/lakecom/lec/FTG.htm. In addition, these FTG investigators and affiliated external expert advisors 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). These same investigators/advisors have continued to seek peer review and an exchange of ideas with the scientific community to validate and improve the Lake Erie acoustic program through informal discussions and participation in fisheries/academic conferences at the Great Lakes regional level (e.g. IAGLR 2004, 2005, and 2006) and national (AFS 2003, CCFR 2003) and international forums (Swedish Acoustics Workshop 2004, ICES 2002, Fish Stock Assessment Conference, The Czech Republic, 2007).

Methods

A comprehensive description of survey procedures, and complete summary of results for the entire time series of the eastern basin Lake Erie acoustic survey are being pursued as separate reports expected to be released within a year. In general, standard survey procedures have been in-place for transect sampling of eastern Lake Erie since 1993. This midsummer, nighttime survey is typically implemented as a two vessel effort to collect acoustic signals of pelagic fish density and distribution, with accompanying mid-water trawling to characterize species composition.

In recent years, the usual contributions to this annual survey are acoustic data acquisition of fish densities and distribution by a scientific echosounder mounted on the OMNR's research vessel, *R/V Erie Explorer*, and accompanying mid-water trawl collections by the NYS DEC's *R/V Argo* to describe the fish species composition. The 2007 survey was completed without incident with the full compliment of acoustic transects (12 transects; 172 nautical miles), mid-water trawl collections (19 tows; 380 minutes) and temperature profiles (47 profiles) (Figure 4.1.1). Other new elements of the 2007 survey included trials conducted onboard the *R/V Erie Explorer* to examine noise levels relative to vessel speed, transducer location and sea state. Another new element of the 2007 survey was the collection of fixed station (stationary pinging) acoustic data at the ends of some transects to assess target strength (TS) variability of individual fish tracks. OMNR and NYS DEC participants both remained fully engaged in eastern basin data processing and analysis activities.

Results

Presentation of eastern basin acoustic survey results had been suspended while the principal investigators were immersed in other initiatives pertaining largely to data processing/analysis methods, software/hardware expansion/upgrades, and EY500-EY60 GPT calibration exercise (see introduction). New standard analysis procedures are being applied to the 1997 through 2007 data series and efforts are proceeding smoothly toward an objective of reporting the entire series of split-beam acoustic data each March as an element of the annual FTG report. A preview of 2003 east basin survey results was provided in the 2007 FTG Report (Forage Task Group, 2007). Those results, and all other previously reported analyses in past FTG reports, will be re-analyzed and reported in 2008 incorporating new standards recommended from the Great Lakes Acoustic Study Group SOP document and training workshop planned for 2008.

Discussion

A comprehensive analysis of our full series of acoustic survey findings has been planned for several years, but annual constraints on staff time have repeatedly postponed a complete analysis of acoustic data. However, at this time most of the hurdles related to specialized acoustic processing and analysis methodology have been resolved and the east basin investigators are now beginning efforts in 2008 to analyze and report on 15 years of acoustic survey results. Furthermore, upon completion of these new analyses, Forage Task Group acoustic survey investigators currently pursuing somewhat independent efforts in the eastern, central and western basins expect to eventually integrate their analysis and reporting efforts to produce a lake wide July snapshot of pelagic fish density and distribution for Lake Erie.

4.2 Central Basin Acoustic Survey (by P. Kocovsky and J. Deller)

The 2007 central basin acoustic survey was planned according to the protocol and sample design established at the hydroacoustic workshop held in Port Dover, Ontario in December 2003 (Forage Task Group 2005). This sample design, consisting of eight cross-basin transects, requires two acoustic survey vessels and two midwater trawling vessels. In 2007, acoustic sampling was limited to four cross basin transects due to the availability of only one acoustic vessel. As in past surveys, midwater trawling from separate vessels was conducted concurrent to acoustic data collection on each transect to ground truth species composition and aid in single target detection analysis if needed.

Methods

Hydroacoustics

Hydroacoustics data were collected aboard the USGS RV Musky II using a BioSonics DTX ® echosounder with 129-kHz transducer and BioSonics Visual Acquisition (release 5.1) software. Global Positioning Systems coordinates were collected using a Garmin ® GPSMAP 225 interfaced with the echosounder to obtain simultaneous latitude and longitude coordinates. The acoustic transducer was mounted on a stainless steel bracket bolted to the starboard hull roughly equidistant between the bow and stern. The transducer face was approximately 1 m below the water surface.

We sampled four transects corresponding to Loran-C TD-lines (Figure 4.2.1). Sampling began one half hour after sunset (around 2130) on either the north or south shore and continued to the opposite shore until the transect was completed. All sampling was conducted in waters 10 meters or deeper. Ending times varied from 0320 to 0400. Speed during data collection was approximately 6.8 knots. Transects 58100 and 57850 were sampled 7/9-7/10 and 7/10-7/11 2007, four days prior to the new moon. Rough seas (> 1.5-3 m wave height) forced work stoppage for transect 57850 at 0130. Transects 57600 and 57339 were sampled 7/17-7/18 and 7/18-7/19 2007, four days after the new moon. As with transect 57850, we were forced to stop data collection midway through transect 57339 owing to rough seas.

Hydroacoustics data were analyzed using EchoView ® version 4.2 software. Proportionate area backscattering coefficient and single targets identified using EchoView method 2 (recommended by Sonar Data, Inc., developer of EchoView software, for BioSonics data) were used to generate density estimates for 800-m cells in three water strata: epilimnion (3 m to 8 m depth), metalimnion (> 8 m to 14 m) and hypolimnion (> 14 m to 0.5 m above the bottom). These strata correspond with those sampled with trawls (see below). The area between the bottom and 0.5 m above the bottom was excluded from analyses because this is an acoustic "dead zone" in which targets cannot be identified owing to interference. The cell size of 800-m was chosen to match those used in the eastern basin in the interest of standardizing methods and analyses. Analyses from EchoView were used as raw data in SAS programs developed and maintained by L. Witzel, OMNR, and D. Einhouse, NYS DEC to screen cell outputs for quality and to generate final density estimates by cell and water stratum. Density estimates are derived using in situ target strength methodology.

Trawl

Midwater trawling was conducted during acoustics surveys to estimate species composition and age distribution of fishes within the three water strata. The ODNR's RV Grandon and OMNR's RV Keenosay trawled in OH and ON waters, respectively. At the beginning of acoustics data collection, the vessel on the same shore as the hydroacoustics vessel began trawling immediately after the hydroacoustics data acquisition began. The opposite shore vessel began trawling near the international border and moved shoreward throughout the night. Each trawling vessel sampled the three water strata in three sampling zones: near shore (near 10 m contour), mid-depth (near 15 m contour) and offshore (> 20 m contours). Total length and total catch were recorded from each trawl by species and life stage. Life stage classifications consisted of young-of-year (AGE-0) for all species and yearling-and-older (YAO) for forage species and age-2-or-older (2+) for predator species. Trawl data were pooled for each zone and species composition was determined for each water stratum.

Results

Within a transect, average acoustic density was always highest in the epilimnion and lowest in hypolimnion (Table 4.2.1). Epilimnion densities varied from 3 to 21 times hypolimnion densities. Viewed cell-by-cell, acoustic density was generally highest nearshore and lowest mid lake (Figure 4.2.2). Cell-by-cell density was also much higher in the epilimnion than the meta- or hypolimnion. Despite generally low density of fishes in the hypolimnion, there were a few cells that had higher densities in the hypolimnion than the metalimnion or epilimnion, for example between the 23- and 24-m contours along transect 57600 (Figure 4.2.3). Density was highest in ON nearshore waters when averaged across all three water strata (Figure 4.2.3).

Rainbow smelt was the most abundant species in all three water strata (Table 4.2.2). Emerald shiner was the second most abundant species. The majority of fish captured were Age-0, but YAO of several species and a few adult fish (age-2-and-older) were also captured. Young-of-year rainbow smelt and emerald shiner were the most common species in the epilimnion and metalimnion. Yearling-and-older emerald shiner were also primarily in epilimnion and metalimnion, but large proportions (in one case a majority) of YAO rainbow smelt were in the hypolimnion. Most adult predators were in the metalimnion and hypolimnion.

Discussion

This is the first year we have presented analyses from hydroacoustics work in the central basin of Lake Erie since the program began in 2000. In past years, problems with data analysis driven mostly by lack of fully functional software for analyzing hydroacoustics data prevented us from properly analyzing data. In 2007 ODNR purchased a copy of EchoView V.4.2, which solved the problem of having fully functional software, and we were able to produce analyses. We began our analyses with the 2007 data and will work backward through time analyzing data through 2004, after which we will produce a separate report summarizing work from 2004-2008. Extending analyses to include years prior to 2004 will require a different set of analytical procedures, because different acoustics gear was used prior to 2004.

In 2007 the Study Group on Fisheries Acoustics in the Great Lakes released a draft *Standard Operating Procedures for Acoustics in the Great Lakes* (Parker Stetter et al. 2007), which establishes a standard procedure for analyzing hydroacoustic data in the Great Lakes. We expect to use *Standard Operating Procedures for Acoustics in the Great Lakes* (hereafter SOP) for future analyses. In 2008 there will be a workshop at which individuals involved in hydroacoustics surveys will gather to collect and analyze hydroacoustics data sets following the SOP. We anticipate that discussion during the workshop will lead to revision of central basin sample design and analysis.

Last year was the second consecutive year in which less than the full set of transects was sampled. Lack of available research vessels for a second hydroacoustics platform prevented collecting data along all 8 transects. Poor weather also interfered with hydroacoustics data collection this year forcing us to abandon data collection on 2 of our 4 transects well before completion. Our ability to complete the full set of 8 transects was enhanced in late 2007 when ODNR received a new, 28-ft. Almar workboat that will be available as a hydroacoustics platform in 2008. Weather and budget permitting, the new boat may be available for hydroacoustics in 2008.

Future plans for hydroacoustics work includes potentially adding midwater trawling capability on the acoustics platforms to be able to conduct trawling and hydroacoustics data collection on the same work platform. This would enhance our ability to sample aggregations of fishes shortly after they are detected acoustically, which is currently not possible with the existing design. The USGS will begin mensuration of midwater trawling gear in summer 2008 in anticipation of launching a pilot examination of conducting midwater trawling and acoustics data collection aboard the Musky II in 2009.

4.3 West Basin Acoustic Survey (E. Weimer)

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 (Forage Task Group 2004). 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. As charged by the LEC, since 2004 a pilot western basin acoustic survey has been 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 for species composition was conducted during the 2004 pilot survey. Since 2005, companion midwater trawling was conducted during the acoustic survey. While currently unprocessed, the 2004 data will be used in conjunction with current survey data to develop a standardized acoustic sampling program for the west basin of Lake Erie that will complement the ongoing acoustic surveys in the central and eastern basins and facilitate an annual lake snapshot of pelagic forage fish abundance and biomass.

Methods

Three standard transects, extending through both Canadian and Ohio waters, were scheduled for survey during July 16-19, 2007 (Figure 4.3.1). 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. Due to equipment malfunction, survey dates were changed to July 24-25, and all transects were shortened to encompass only the Ohio waters of the lake. Transect 3 was surveyed on the 24th, and both Transects 1 and 2 were surveyed on the night of the 25th. Due to conflicts caused by rescheduling, mid-water trawling to determine community composition was not conducted in 2007.

Sampling was performed with a BioSonics DT-X surface unit loaned to us by the company while the new unit purchased by the ODNR was being serviced. This loaner unit was equipped with a single 6.8-degree, 201-kHz, split-beam transducer, a Garmin global positioning system, and a Panasonic CF-30 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.

The mobile survey, conducted aboard the ODNR's *RV Almar*, was initiated 0.5 h after sunset and completed before 0.5 h prior to sunrise. Transects were navigated with waypoints programmed in a Lowrance GPS, and speed was maintained at 8-9 kph, (roughly 5 mph) using the GPS. Data were collected with the transducer aimed down to sample from 3 m to near bottom. The transducer was mounted on a fixed pole located on the port side of the boat near mid-ship. The transducer was mounted 1 m below the surface. The transducer settings during the survey were 10 pings/second, a pulse length of 0.2 msec, and a minimum threshold of -60 dB. The sampling environment (water temperature) was set at the temperature 2 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 logged every 30 minutes. Latitude and longitude coordinates were written to the file as the data were collected to identify sample location. Data were analyzed using SonarData's Echoview 4 software.

Results

Mean western basin forage fish density and biomass estimates from down-viewing data were 33,624 fish per hectare and 52.8 kg per hectare, respectively, which was significantly higher than in 2006 (18,879 fish per hectare and 16.18 kg per hectare, $P<0.05$). Fish density (Figure 4.3.2) and biomass (Figure 4.3.3) in 2007 were highest in Transect 2; density and biomass in 2007 were significantly higher ($P<0.05$) than 2006 for Transects 2 and 3. The majority (76%) of forage fish in the survey was estimated to be 30-59 mm TL; 96% were between 30-109 mm. Dramatic increases in fish density and biomass in 2007 are likely due to strong year classes of white perch and yellow perch, although without collecting trawling data we cannot demonstrate causality.

Table 4.2.1 Mean acoustic density of fishes averaged across 800-m-long distance bins along four transects in the central basin of Lake Erie in July 2007. Transect numbers refer to Loran-C TD lines. Epilimnion (surface to < 8 m depth), metalimnion (8 to 14 m depth), and hypolimnion (> 14 m depth) correspond to sampling strata for trawl samples.

		Transect		
		58100	57600	57339
Latitude-longitude	Begin	41.96, -80.74	41.63, -81.54	42.15, -82.29
	End	42.63, -81.01	42.26, -81.83	41.92, -82.17
Time	Begin	2140	2140	2130
	End	0405	0320	0050
Number of 800-m cells		105	95	34
Mean Acoustic Density	Epilimnion	992 ± 121	3,117 ± 741	3,551 ± 1,367
± 95% confidence limit	Metalimnion	662 ± 79	799 ± 128	598 ± 143
	Hypolimnion	353 ± 63	535 ± 60	416 ± 70

Table 4.2.2. Species composition (expressed as % of catch within a water stratum) of midwater trawl samples by transect (57600 and 58100), species, life stage, and water stratum in the central basin of Lake Erie in July 2007. Transect numbers refer to Loran-C TD-lines along which trawls were conducted. Epi, Meta, and Hypo refer to the epilimnion (surface to < 8 m depth), metalimnion (8 to 14 m depth), and hypolimnion (> 14 m depth), respectively. Life stages are: young of year (age-0), yearling and older (YAO), and age 2 or older (2+).

			57600			58100	
Species	Life stage	Epi	Meta	Hypo	Epi	Meta	Hypo
Rainbow smelt	age-0	70.7	75.2	45.1	86.1	94.3	70.4
	YAO	0	0	53.6	0	0	29.1
Emerald shiner	age-0	12.2	20.9	0.2	0	0	0
	YAO	4.1	0.6	0	12.9	4.3	0
Trout-perch	age-0	0	0	0.2	0	0	0
White perch	age-0	11.4	0.3	0	0	0	0
White bass	age-0	1.6	0	0	0	0	0
Yellow perch	age-0	0	1.8	0.7	1.0	0	0
	2+	0	0.3	0.2	0	0	0
Walleye	2+	0	0	0	0	1.4	0.5
Freshwater drum	age-0	0	0.3	0	0	0	0
	2+	0	0.6	0	0	0	0

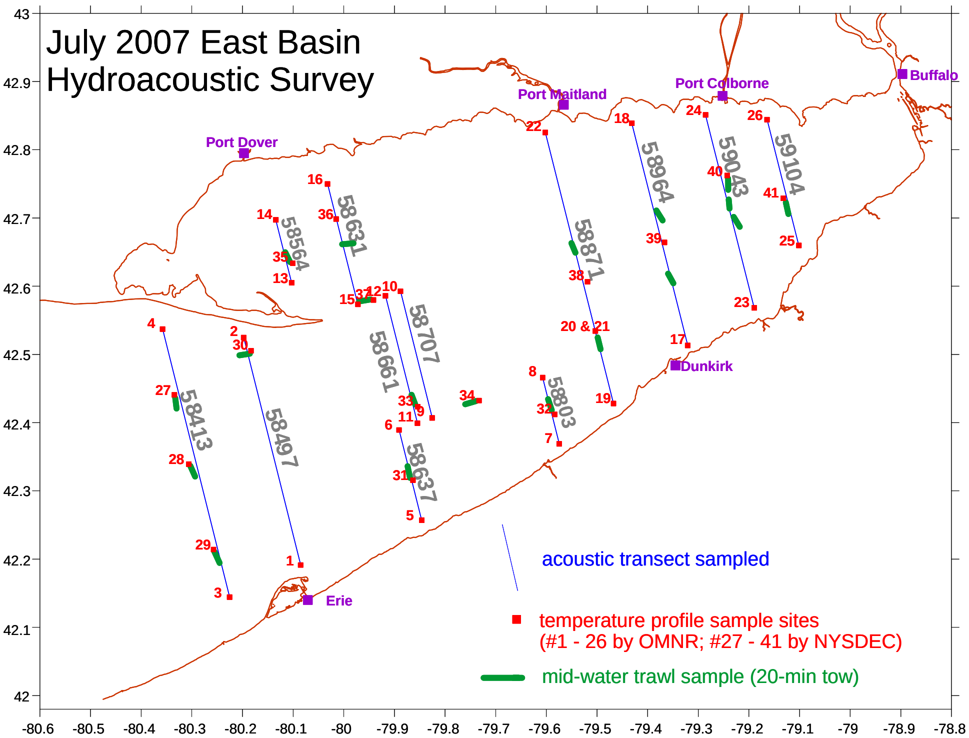

Figure 4.1.1 July 2007 eastern basin Lake Erie inter-agency acoustic survey transects, mid-water trawl and temperature profile sites sampled by the Ontario Ministry of Natural Resources (OMNR) research vessel, RV Erie Explorer and the New York State Department of Environmental Conservation (NYSDEC) research vessel, RV Argo.

2007 Central Basin Lake Erie hydroacoustic survey

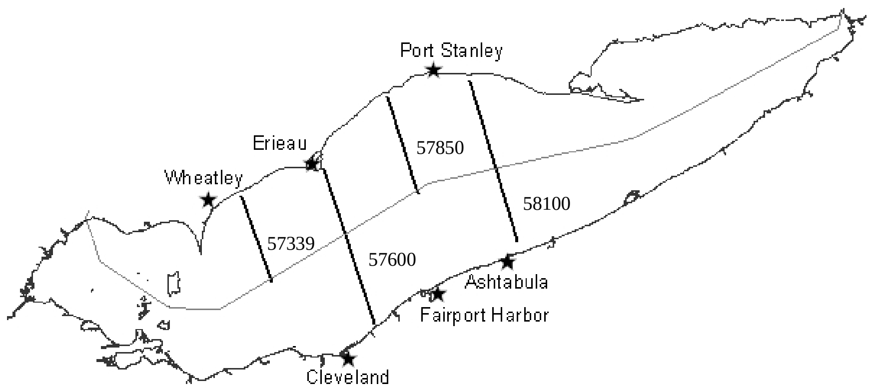

Figure 4.2.1 Central basin acoustic survey transects for July 9-11 (transects 58100 and 57850) and July 17-19, 2007 (transects 57600 and 57339). Transects were run along Loran-C TD lines. Acoustic data were collected aboard the *R/V Musky*. The *R/V Keenosay* and *R/V Grandon* conducted midwater trawling concurrent to acoustic data collection along each transect.

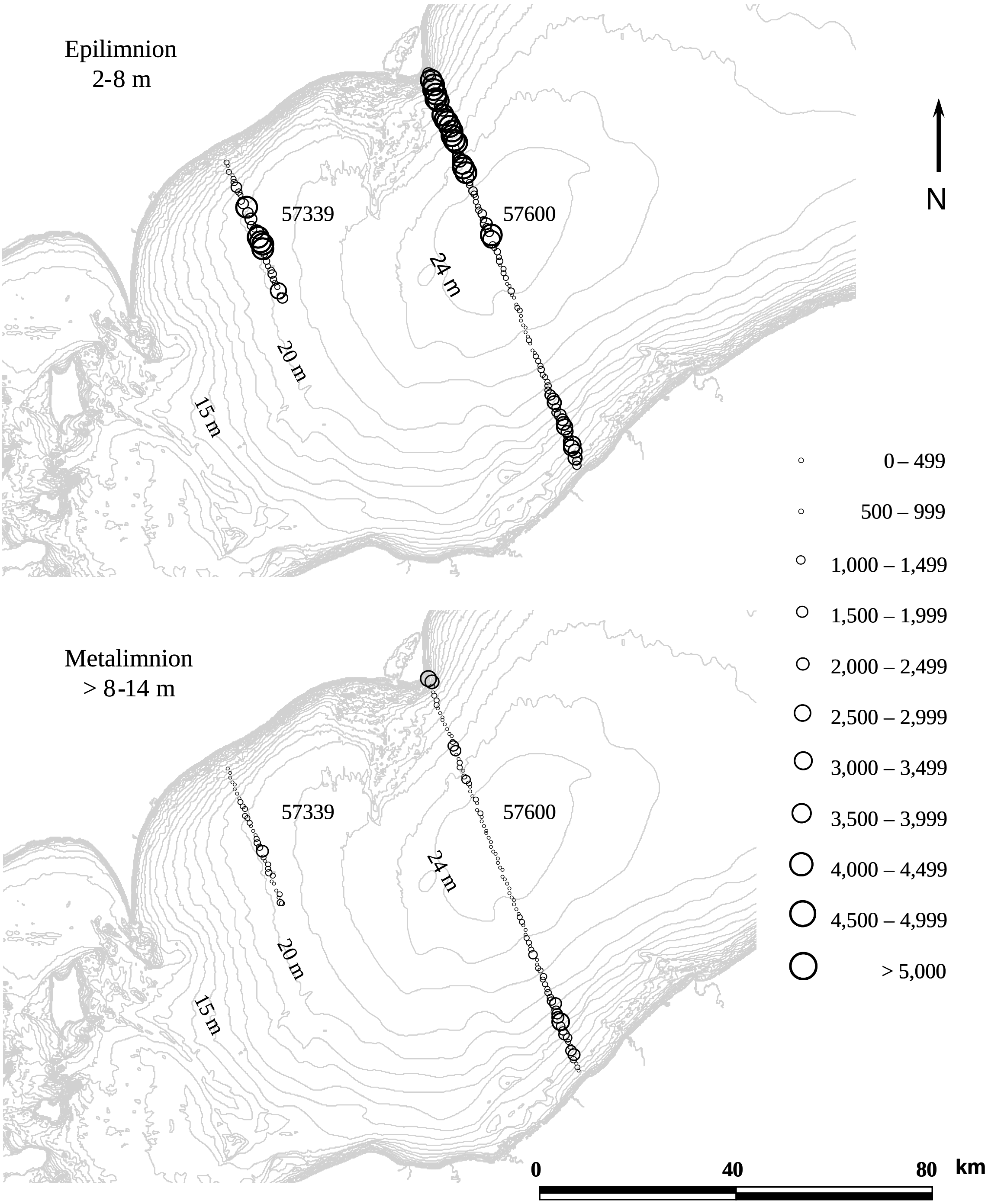

Figure 4.2.2. Graphical representation of fish density in the eipilimnion and metalimnion of the central basin of Lake Erie, 2007. Grey lines are 1-m bathymetric contours. Densities in the legend are fish per hectare. Five-digit numbers to the right of a transect are the transect number from Loran-C TD lines.

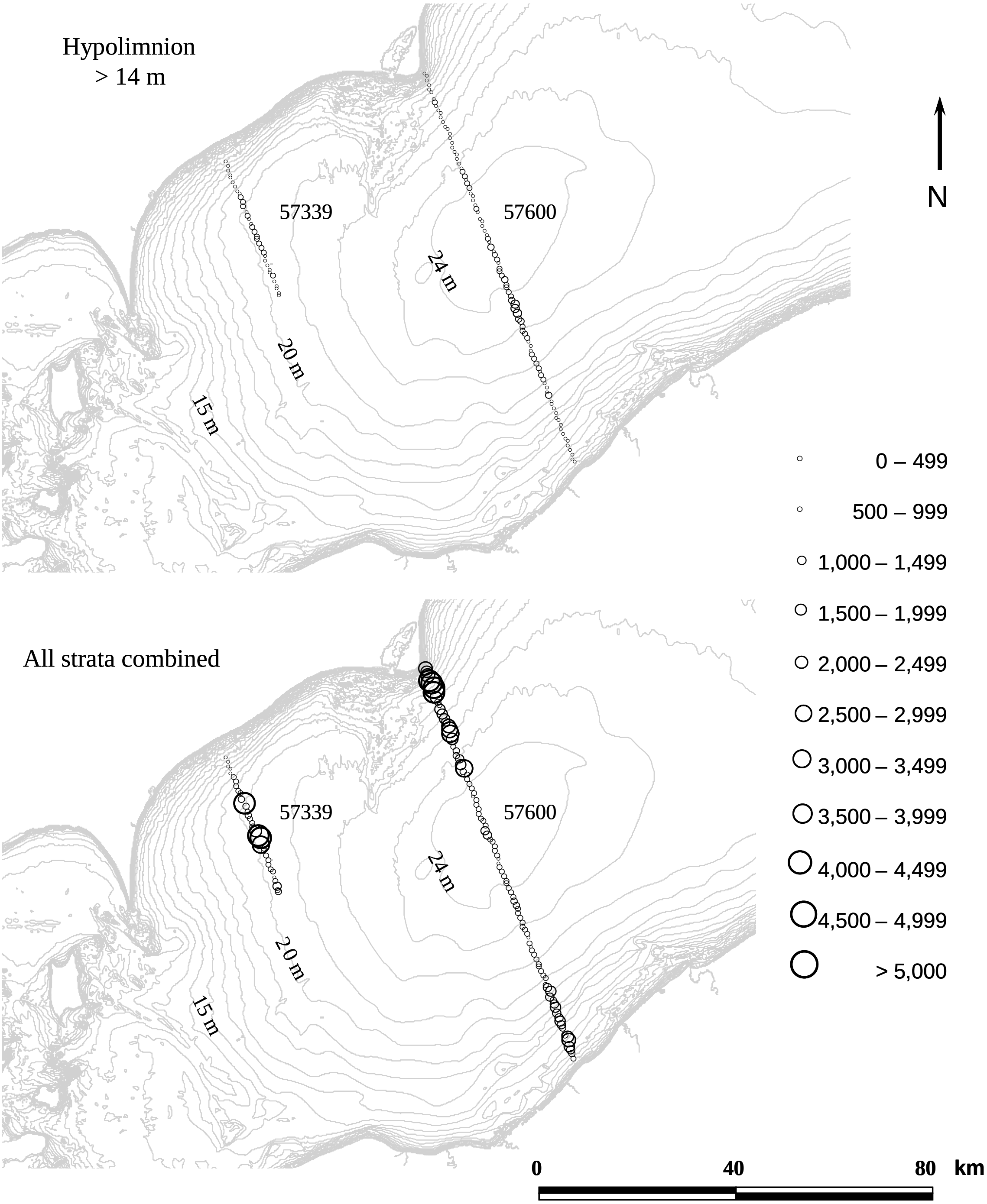

Figure 4.2.3. Graphical representation of fish density in the hypolimnion and all strata combined in the central basin of Lake Erie, 2007. Grey lines are 1-m bathymetric contours. Densities in the legend are fish per hectare. Five-digit numbers to the right of a transect are the transect number from Loran-C TD lines.

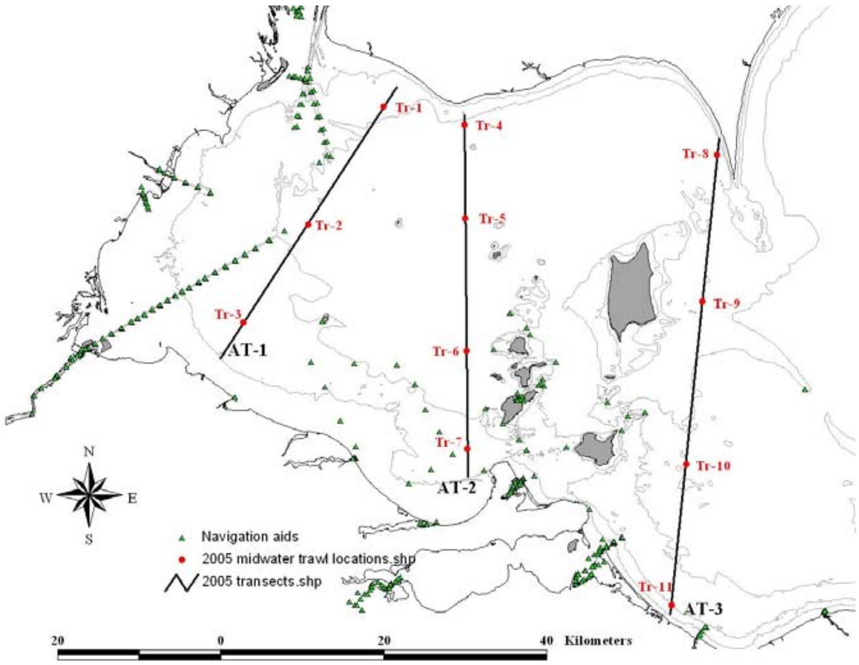

Figure 4.3.1. Three proposed acoustic survey transects and companion midwater trawling locations for the western basin July 24-25, 2007. Due to equipment malfunctions, only the southern transects were completed (Ohio waters).

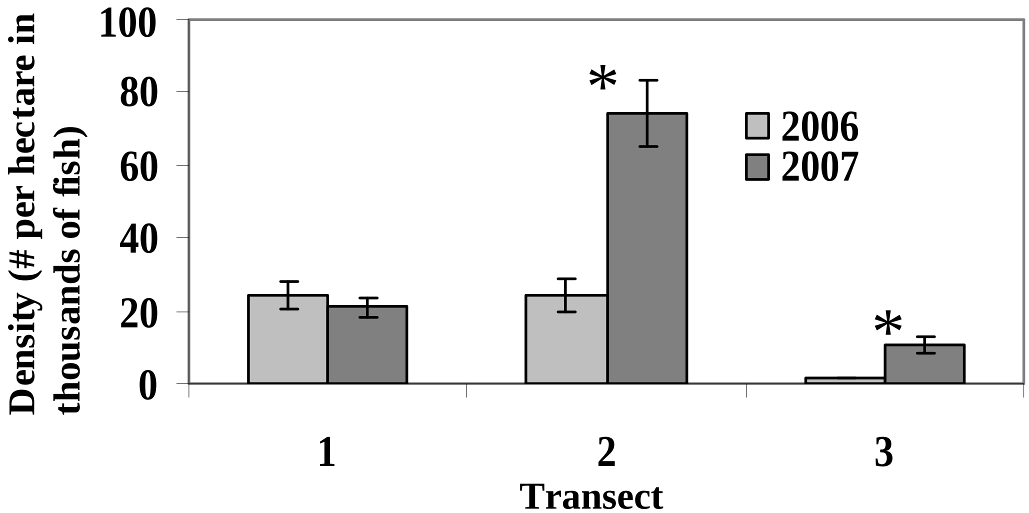

Figure 4.3.2 Estimated mean density (in thousands of fish/hectare) of western basin forage fish from down-viewing hydroacoustic survey data collected July, 2006 and 2007, along three transects. Error bars are standard errors; significant annual differences are designated by an *.

5.0 Interagency Lower Trophic Level Monitoring Program (by E. Trometer)

In 1999, the FTG initiated a Lower Trophic Level Assessment program (LTLA) within Lake Erie and Lake St. Clair (Figure 5.1.1). 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 2007 marks the ninth year, of a ten year commitment, for the lower trophic level monitoring program. For this report, we will summarize the last nine years of data for five variables for which there is sufficient data. These variables are epilimnetic temperature, hypolimnetic or bottom dissolved oxygen, grazing pressure (chlorophyll *a* and total phosphorous) and planktivory index. Stations were only included in the analysis if there were at least 3 years each containing 6 or more sampling dates. Stations included in this analysis are stations 3, 4, 5, and 6, from the western basin, stations7,8, 9, 10, 11, 12, 13 and 14 from the central basin, and stations 15, 16, 17, 18, 19 and 20 from the eastern basin (Figure 5.1.1).

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 coolest in the eastern basin (Figure 5.1.2). Temperatures in 2007 were around average in the west basin, slightly above average in the central basin and slightly below average in the east basin.

Hypolimnetic Dissolved Oxygen

Figure 5.1.3 illustrates the mean hypolimnetic dissolved oxygen (DO) concentration (i.e. below the thermocline) for each basin of Lake Erie by year during periods when the water column was stratified. Stratification can begin in early June and continue through September in the central and eastern basins. DO less than 4 mg/L is deemed stressful to fish and other aquatic biota. Hypolimnetic DO is rarely limiting in the eastern basin due to greater water depths and cooler temperatures. In the western basin, shallow depths allow wind mixing to penetrate to the bottom, generally preventing thermal stratification. As a result, few observations exist to describe hypolimnetic DO, and when low oxygen occurs it is usually right at the water/sediment interface. Low oxygen in the central basin has resurfaced as an issue in the central basin. Typically, DO < 4 mg/L was first observed in mid July and persisted until late September when fall turnover remixes the water column. Average hypolimnetic DO was lower in the central basin in 2007 than in 2006, with about half of the observations being stressful to aquatic life in each year.

Grazing Pressure

Mazumder (1994) developed equations relating chlorophyll *a* with total phosphorus 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 waters where they reside (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 phosphorus concentration, chlorophyll *a* (a measure of phytoplankton standing crop) 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 the three basins of Lake Erie (Figure 5.1.4), we see that grazing pressure is lowest in the western basin (more chlorophyll than predicted) and highest in the eastern basin. Annual grazing pressure is the most variable in the western basin. Note that the chlorophyll *a* levels in the west basin are highest and most variable. In 2006, observed chlorophyll *a* was slightly higher than predicted in all basins and increased from 2005. In 2007, observed chlorophyll *a* was much higher than predicted in the west basin and slightly lower than predicted in the central basin. Also in 2007, observed chlorophyll *a* was higher in the west basin than in 2006, but lower in the central and east basins.

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 5.1.5 reflects this planktivory index for the zooplankton communities of the three basins of Lake Erie. Zooplankton predation is deemed high, as the average size of the community is often less than this critical 0.57 mm size. Predation was high in 2000 in the western and eastern basins but not exceptionally higher in the central basin relative to other years. Planktivory was lowest in 2001 and 2003 in the central and eastern basin and in 2005 an 2006 in the western basin. Zooplankton size increased noticeably in the western basin in 2005 and 2006, but had high variability (data included only 2 stations for these years vs. 4 stations in the previous years). In the east basin zooplankton size has increased since 2004, indicating a decrease in planktivory in the last two years.

Distribution of New Zooplankters

For this review only data from stations 3, 4, 5, 6, 9, 10, 11, 12, 15, 16, 17, 18, 19, and 20 are included. *Bythotrephes longimanus* was first collected in Lake Erie in October 1985 (Bur et al. 1986). It is consistently present at central and eastern basin stations, but is very rare at western basin stations.

Cercopagis pengoi was first collected in Lake Ontario in 1998, and by 2001 was collected in western basin of Lake Erie (Therriault et al. 2002). They first appeared in this sampling effort at station 5 in July 2001 and station 9 in September 2001. In subsequent years it has also been found at stations 5, 6, 9, 10, 15, 16, 18 and 19. Except for the year 2002, *Cercopagis* is seen less frequently around the lake than *Bythotrephes.*

The first record of *Daphnia lumholtzi* in the Great Lakes was in the western basin of Lake Erie in August 1999 (Muzinic 2000). It was first identified in this sampling effort in August 2001 at stations 5 and 6, and at station 9 by September 2001. It was collected at stations 5 and 6 in 2002, and at stations 5, 6 and 9 in 2004. Data is not available for these stations from 2005 through 2007.

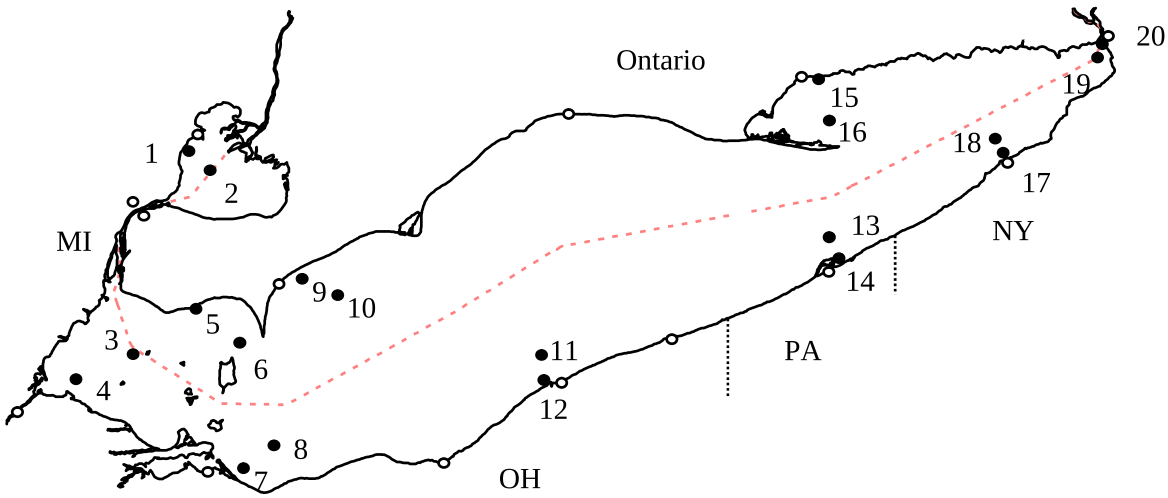

Figure 5.1.1. Lower trophic level sampling stations in Lakes Erie and St. Clair.

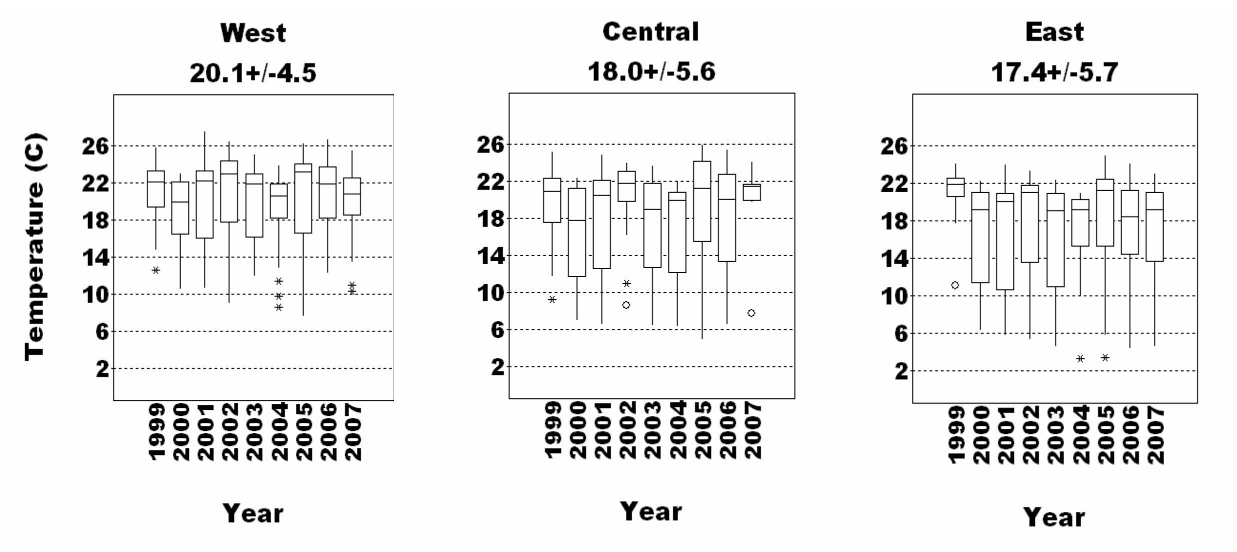

Figure 5.1.2. Epilimnetic water temperature (C) at offshore stations by basin in Lake Erie, 1999-2007. Box plots represent median, 25th, and 75th quartile. Long-term average water temperature is 20.1 C in the western basin, 18.01 C in the central basin and 17.5 C in the eastern basin. For this analysis only data from stations 3, 6, 8, 10, 11, 13, 16, and 18 were included.

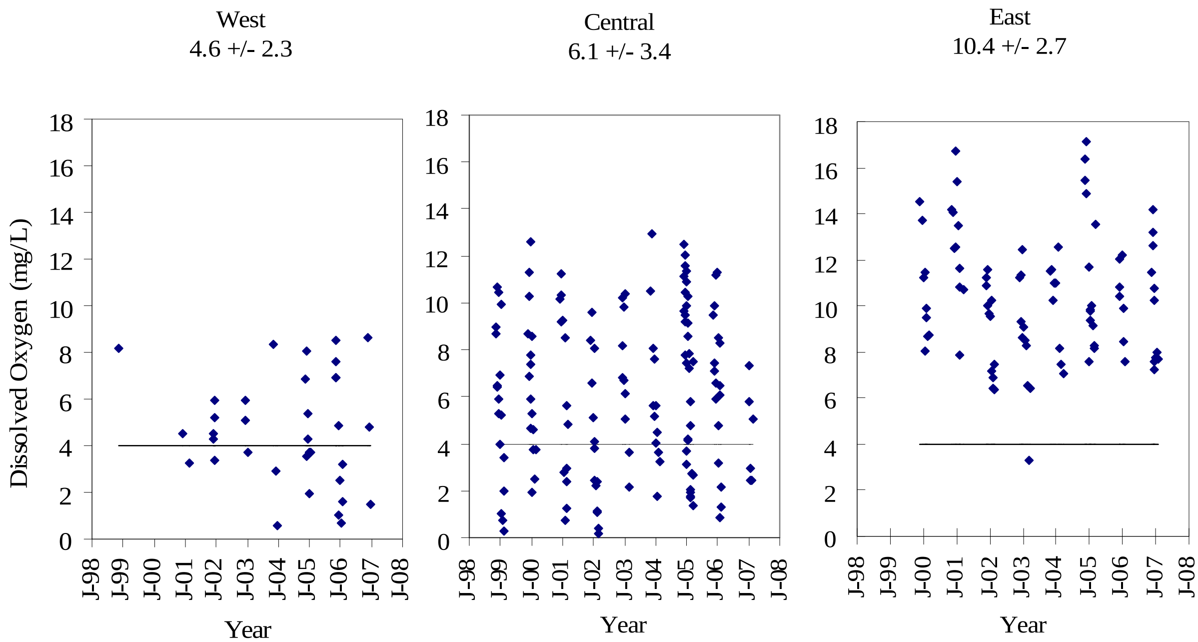

Figure 5.1.3. Mean hypolimnetic dissolved oxygen (mg/L) for each basin of Lake Erie, 1999-2007. Data are presented only when water column is stratified. The horizontal line represents 4 mg/L, a level below which oxygen becomes limiting to the distribution of many temperate freshwater fishes. Long-term average hypolimnetic dissolved oxygen is shown above each graph. For this analysis only data from stations 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 were included.

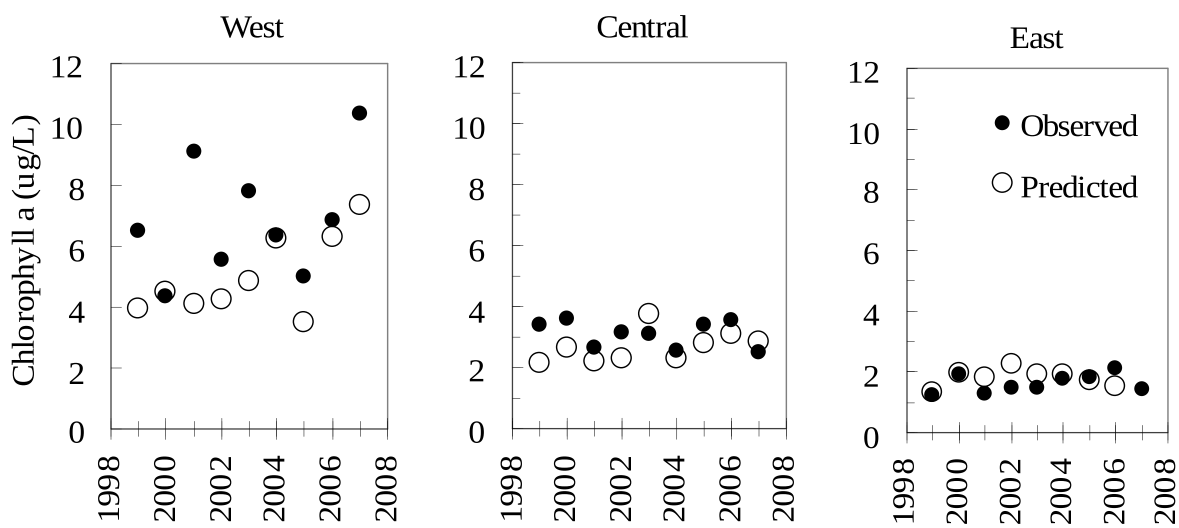

Figure 5.1.4. Observed and predicted chlorophyll *a* concentration (ug/L) in each basin of Lake Erie, 1999-2007. Chlorophyll *a* is predicted from equations presented in Mazumder 1994 for even-linked systems (those where grazing limits phytoplankton standing crop). For this analysis data from stations 3 through 20 were included.

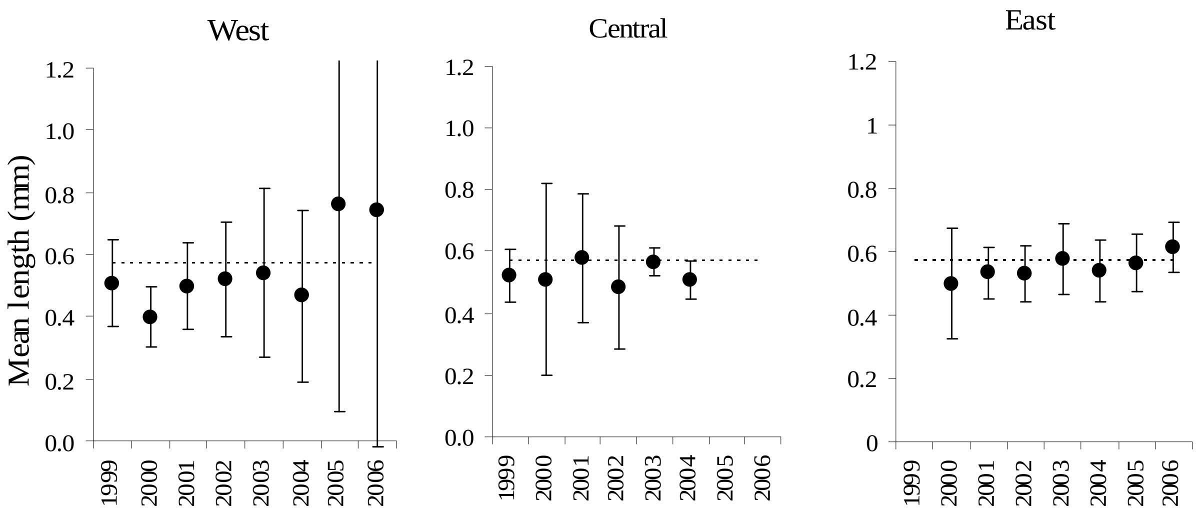

Figure 5.1.5. Mean length of the zooplankton community (± SD) sampled with a 63µm plankton net hauled through the epilimnion of each basin of Lake Erie, 1999-2006. The horizontal dashed line depicts 0.57 mm; if the mean size of the zooplankton community is less than 0.57mm, predation by fish is considered to be intense (Mills et al. 1987, Johannsson et al. 1999). For this analysis only data from stations 3, 4, 5, 6, 9, 10, 11, 12, 15, 16, 17, 18, 19, and 20 were included.

6.0 Lakewide Round Goby Distribution (by B. Haas)

Round goby (*Apollonia 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 and have become established in all areas of Lake Erie (Figure 6.0.1). In 2007, round goby abundance indices have increased in all areas of Lake Erie. The largest increase in abundance occurred in the east basin, where round goby indices have reached record levels. Please refer to previous Forage Task Group reports for information on the yearly spread and distribution of round goby in Lake Erie prior to 2006.

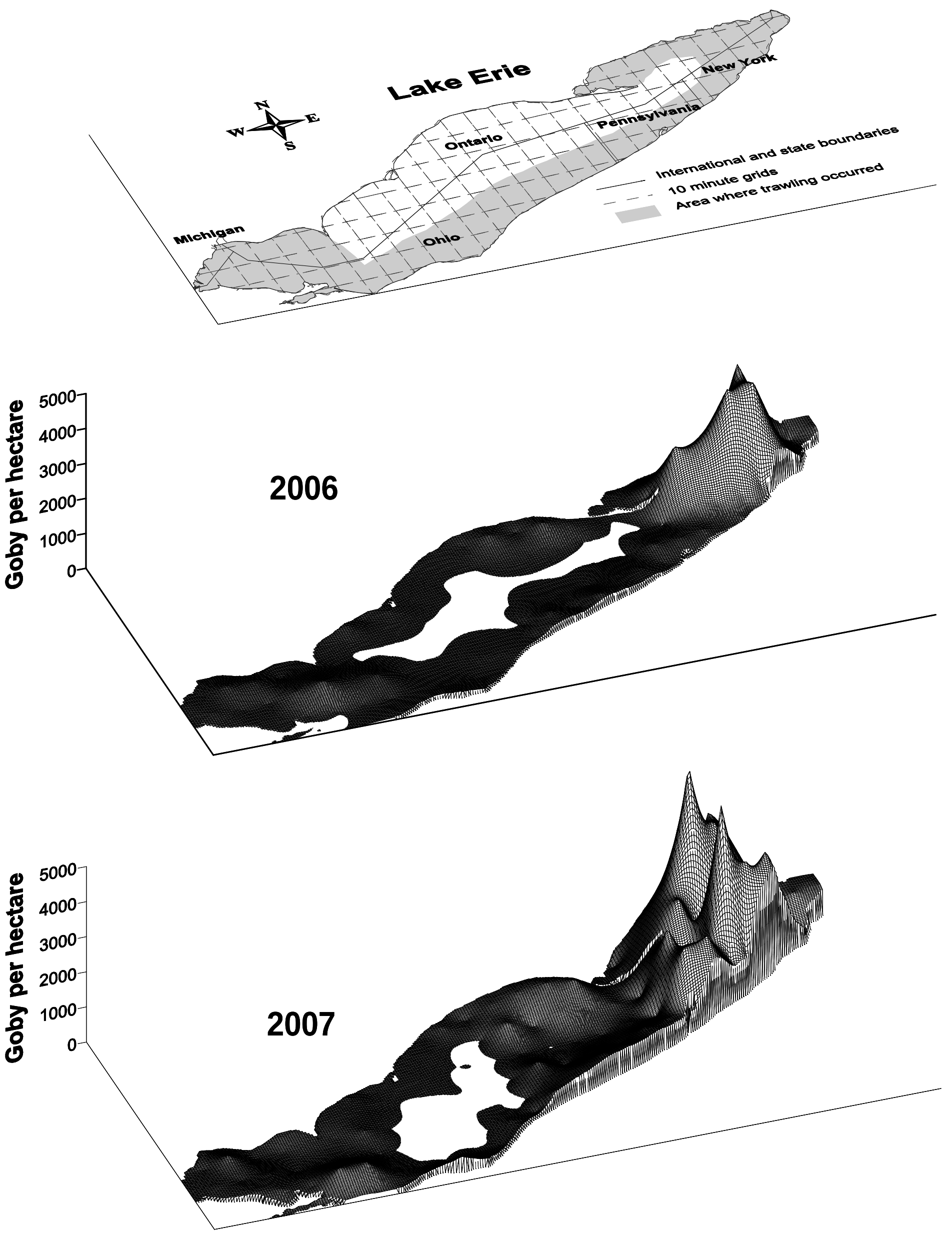

Figure 6.0.1 Two dimensional base map (upper) and three dimensional maps of round goby distribution in Lake Erie as density per hectare 2006 and 2007 estimated from bottom trawl catches. The base map shows state and provincial boundaries, the ten minute grid system used for trawl data summarization, and the area of the lake sampled with bottom trawls (shaded gray). The goby distribution maps were extrapolated from individual bottom trawl catches averaged within 10 minute grids using SURFER© software and a kriging algorithm.

7.0 Status of Bioenergetics Model of Predator Consumption

(J. Markham)

Estimates of annual consumption by walleye were last completed by the bioenergetics sub-group in 2001. Data limitations describing critical population parameters prevented the use of other key lake predators such as lake trout, burbot, and steelhead in the analysis. Results of this analysis can be found in the 2002 Forage Task Group Report (FTG 2002).

Since 2001, members of the Coldwater Task Group (CWTG) have been addressing some of the data limitations that were preventing annual consumption estimates of key coldwater predators. Recent data gains in previous gaps include:

- The CWTG has updated and revised the lake trout population model that estimates the adult population of lake trout in Lake Erie. Model estimates of the lake trout population, one of the limiting parameters in 2001, should allow estimates of prey consumption by lake trout in Eastern Lake Erie.
- Ageing and length-at-age relationships were recently developed from burbot collected in jurisdictional coldwater assessment surveys (Stapanian et al. 2007). Mortality of the burbot population was also estimated (Stapanian and Madenjian 2007).
- A lakewide steelhead diet study involving all inter-jurisdictional agencies was completed in 2004 (Clapsadl et al. 2006). Additional diet information has been gathered by the Ohio Division of Wildlife in 2002, 2003, 2005, and 2007 (Kayle 2007). These studies show that steelhead consume a wide variety of different fish and invertebrate species but that emerald shiners and smelt provide the majority of their diets' biomass.
- Estimates of steelhead growth, longevity, and migration patterns were made from data collected in the lakewide steelhead diet study. Catch-at-age data from the 2004 interagency study was used to generate catch curves to obtain annual estimates of total mortality, and these rates were used with stocking numbers and estimates of natural reproduction to build an initial population model (Kayle 2007). Model runs using variable stocking survival estimates the age-1 and older steelhead population between 0.3-2.8 million fish.

Despite these gains, there is still critical information lacking that will prevent the complete analysis of lakewide predatory demand. Although Kayle (2007) developed an initial model that estimates the abundance of the Lake Erie steelhead population, additional work is needed to estimate the total contribution of wild steelhead, fishery catch rates, and overall mortality to develop a more comprehensive model that would provide more meaningful results for a bioenergetics exercise. There is a proposed plan to tag steelhead through the Great Lakes Mass Marking Initiative (GLMMI), and results of this tagging are expected to provide most of the critical information that would be needed to further development of the model. However, the GLMMI is still only in its planning stage and years away from fruition. Research on the contribution of specific steelhead stocks to the summertime fishery is being conducted by Bowling Green University and should also provide information to improve the population model. Estimates of burbot population size also remain unknown. Suggestions have been made to use the relationship of lake trout and burbot CPUE's in the coldwater netting program and apply them to the lake trout population model to estimate the burbot population, but these have not been pursued.

In order to fully estimate lakewide predatory demand, all major predators need to be included in the bioenergetics analysis. As of now, an update of the model could account for walleye and lake trout but would not include burbot or steelhead. Predatory demand by lake trout is not expected to be high given that its current population estimates are only 50% of early-1990's population estimates (CWTG 2008). However, steelhead and burbot populations remain high and estimates of total prey consumption cannot be fully understood without including these fish in the analysis.

8.0 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.

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Literature Cited

Bur, M.T., M. Klarer, and K.A. Krieger. 1986. First records of a European cladoceran, *Bythotrephes cederstroemi*, in Lakes Erie and Huron. Journal of Great Lakes Research 12(2):144-146.

Clapsadl, M., J.L. Markham, K.A. Kayle, C. Murray, and B. Locke. 2005. An analysis of the diet of steelhead trout in Lake Erie to provide resource managers with a basic understanding of their role in lakewide predator/prey dynamics. Final Report for Project #30181-3-J225. Great Lakes Fisheries Commission, Ann Arbor, Michigan. 24 pp.

Coldwater Task Group. 2008. Report of the Lake Erie Coldwater Task Group, March 2008. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Conners, M. E., 1999. Use of Adaptive Cluster Sampling Designs for Hydroacoustic Fish Surveys. MS Thesis, Cornell University, Ithaca, New York, August, 1999.

Conners, M. E. and S. J. Schwager. 2002. The use of adaptive cluster sampling for hydroacoustic surveys. ICES Journal of Marine Science 59:1314-1325

Einhouse, D. W. and L. D. Witzel, 2003. A new signal processing system for Inter-agency fisheries acoustic surveys in Lake Erie. Great Lakes Fishery Commission Completion Report, December, 2003.

Forage Task Group. 2007. Report of the Lake Erie Forage Task Group, March 2007. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery commission. Ann Arbor, Michigan, USA.

Forage Task Group. 2005. Report of the Lake Erie Forage Task Group, March 2005. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery commission. Ann Arbor, Michigan, USA.

Forage Task Group. 2004. Report of the Lake Erie Forage Task Group, March 2004. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery commission. Ann Arbor, Michigan, USA.

Forage Task Group. 2002. Report of the Lake Erie Forage Task Group, March 2002. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery commission. Ann Arbor, Michigan, USA.

Johannsson, O.E., C. Dumitru, and D. Graham. 1999. Estimation of zooplankton mean length for use in a index of fish community structure and its application to Lake Erie. J. Great Lakes Res. 25: 179-186.

Kayle, K. A. 2007. Summer diets and population dynamics of steelhead in Lake Erie. Final report: State Project FFDR06. Federal Aid in Sport Fish Restoration Project F-69-P. Ohio Department of Natural Resources, Division of Wildlife. Fairport Harbor Fisheries Research Unit. 56 pp.

Knight, R.L. and B. Vondracek. 1993. Changes in prey fish populations in western Lake Erie, 1969-1988, as related to walleye, *Stizostedion vitreum*, predation. Can. J. Fish. Aquat. Sci. 50: 1289-1298.

Mazumder, A. 1994. Patterns in algal biomass in dominant odd- vs. even-linked lake ecosystems. Ecology 75: 1141-1149.

Mills, E.L., D.M. Green, and A. Schiavone. 1987. Use of zooplankton size to assess the community structures of fish populations in freshwater lakes. N. Am. J. Fish. Manage. 7: 369-278.

Muzinic, C.J. 2000. First record of *Daphnia lumholtzi* Sars in the Great Lakes. Journal of Great Lakes Research 26(3):352-354.

Nicholls, K.H. and G.J. Hopkins. 1993. Recent changes in Lake Erie (north shore) phytoplankton: cumulative impacts of phosphorus loading reductions and the zebra mussel introduction. J. Great Lakes Res. 19: 637-647.

Parker Stetter, S. L., L. G. Rudstam, P. J. Sullivan, and D. M. Warner. 2007. Standard Operating Procedures for Acoustic in the Great Lakes. School of Aquatic and Fishery Sciences, University of Washington, and Study Group on Fisheries Acoustics in the Great Lakes, Great Lakes Fishery Commission. Version 1.0.

Rudstam, L.G., S. Hansson, T. Lindem, and D.W. Einhouse. 1999. Comparison of target strength distributions and fish densities obtained with split and single beam echo sounders. Fisheries Research 42:207-214.

Rudstam, S. L., S. L. Parker, D. W. Einhouse, L. D. Witzel, D. M. Warner, J. L. Stritzel, D. L. Parrish, and P. J. Sullivan. 2003. Application of in situ target –strength estimations in lakes: examples from rainbow-smelt surveys in Lakes Erie and Champlain. ICES Journal of Marine Science, 60: 500-507.

Stapanian, M.A., C.P. Madenjian, and J. Tost. 2007. Regional differences in size-at-age in the recovering burbot population in Lake Erie. Journal of Great Lakes Research – in press.

Stapanian, M.A. and C.P. Madenjian. 2007. Evidence that lake trout served as a buffer against sea lamprey predation on burbot in Lake Erie. North American Journal of Fisheries Management 27:238-245.

Therriault, T.W., I. A. Grigorovich, D.D. Kane, E.M. Haas, D.A. Culver, and H.J. MacIsaac. 2002. Range expansion of the exotic zooplankter *Cercopagis pengoi* (Ostroumov) into western Lake Erie and Muskegon Lake. Journal of Great Lakes Research 28(4):698-701.

Tyson, J. T., T. B. Johnson, C. T. Knight, M. T. Bur. 2006. Intercalibration of Research Survey Vessels on Lake Erie. North American Journal of Fisheries Management 26:559-570.