Report of the Lake Erie Forage Task Group

March 2010

Members:

Eric Weimer	- Ohio Department of Natural Resources, (ODNR) {Chair}
Mike Bur	- United States Geological Service - Great Lakes Science Center (USGS)
John Deller	- Ohio Department of Natural Resources, (ODNR)
Bob Haas	- Michigan Department Natural Resources, (MDNR)
Tom MacDougall	- Ontario Ministry of Natural Resources, (OMNR)
Jim Markham	- New York Department of Environmental Conservation, (NYS DEC)
Chuck Murray	- Pennsylvania Fish and Boat Commission, (PFBC)
Elizabeth Trometer	- United States Fish and Wildlife Service, (USFWS)
Larry Witzel	- Ontario Ministry of Natural Resources, (OMNR)

Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Table of Contents

1.0 Charges to the Forage Task Group in 2009-2010

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 west-central Lake Erie, incorporating new methods in survey design and analysis as necessary to refine these programs.

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.

2.0 Status and Trends of Forage Fish Species

2.1 Synopsis of 2009 Forage Status and Trends

General Patterns

- Relative forage abundance moderate to high
- YAO smelt abundance at record levels in East and West basin surveys. YOY recruitment had dramatic west-east gradient (record in west to poor in east).
- Goby remain high in 2009
- Emerald shiners and gizzard shad generally increased in west
- Forage diversity increasing
- Predator growth and condition moderate
- *Hemimysis* use increasing in nearshore areas

Eastern Basin

- Moderate (Ontario) to high (New York) abundance of forage fish during 2009 was mostly attributable to especially abundant YAO rainbow smelt.
- 2009 smelt year class was weak throughout east basin particularly in New York waters where YOY numeric abundance was lowest observed in past 18 years.
- The YAO smelt trawl abundance measure in New York was the highest observed in 18 survey years.
- Age 0 clupeid species were below average abundance throughout basin. New York and Pennsylvania trawl assessments did not encounter any alewife in 2009.
- Emerald shiners remain at below average abundance except in Pennsylvania
- Spottail shiner remain at low densities throughout basin.
- Round goby densities decreased (Ontario and Pennsylvania) or remained about the same (New York) in 2009. In Ontario, goby densities decreased considerably in offshore areas and increased slightly near shore.
- Average length of Age 0 smelt (2009) was similar to previous years; however, age 1 smelt decreased to lowest size observed in Ontario since 1984.
- Predator diets were diverse, dominated by fish species, primarily rainbow smelt and round goby.
- Predator growth remains good; age-2 to age-6 smallmouth bass remain at or near record long length-at-age in Long Pt. Bay, ON, and age 2 and 3 bass in NY were well above long term mean lengths.
- Lake trout growth remains high and stable.

Central Basin

- Low to moderate forage fish abundance throughout the basin in 2009.
- Age-0 recruitment was very poor for most forage species throughout the basin.
- Very low forage abundance in eastern Ohio.
- Age-0 emerald shiner index was the highest on record in Pennsylvania waters.
- Yearling-and-older rainbow smelt increased throughout the basin.
- White perch age-1 abundance has increased since 2007 in Pennsylvania and eastern Ohio waters.
- Round goby abundance is below average in Pennsylvania and eastern Ohio and average in western Ohio.
- Mean size of forage species remains at or above average.
- Predator diets were predominantly rainbow smelt, gizzard shad and emerald shiners.

West Basin

- Age-0 gizzard shad catches increased dramatically from 2008 to the fifth highest level in time series (1988).
- Age-0 and YAO rainbow smelt catches highest in time series.
- Age-0 and YAO emerald shiner increased from 2008 and both above long-term mean.
- Age-0 white perch down from 2008, but remain slightly above the long-term mean.
- Round gobies decreased from 2008, but remain above the long-term mean (starting 1997).
- Yellow perch and walleye recruitment down from 2008; both below long-term mean; white bass recruitment up from 2008, and is above long-term mean; smallmouth bass decreased below long term mean.
- Size of Age-0 walleye, yellow perch, white bass, white perch, and smallmouth bass below or near long term means.
- Fall walleye diets show reliance on gizzard shad, rainbow smelt, 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 2009, yearling-and-older (YAO) smelt was the most abundant species age group captured in OMNR and NYSDEC fall index bottom trawl surveys (Table 2.2.1). YAO smelt abundance was high throughout eastern Lake Erie; 2009 agency trawl indices were in the order of two to five times greater than time series averages for the respective jurisdictions. Conversely, age-0 rainbow smelt were scarce in 2009. Young-of-the-year (YOY) rainbow smelt numeric indices were below long-term average across all regions of the east basin and record low densities were observed in New York. Mean length of age 0 (64 mm FL) smelt increased slightly, but age-1 (88 mm FL) smelt decreased to record small size in 2009 (Figure 2.2.1).

The contribution of non-smelt fish species to the forage fish community of eastern Lake Erie was dominated in 2009 by round gobies and emerald shiner in Ontario, by trout perch, round goby and emerald shiner in New York, and by emerald shiner, age-0 white perch, trout perch and round goby in Pennsylvania waters (Table 2.2.1). Emerald shiners have remained below average abundance throughout most regions of eastern Lake Erie following record high catches in 2006. An exception to this pattern occurred in the western end of the basin where near record high numbers of emerald shiners were captured in 2009 Pennsylvania trawl samples. Spottail shiner abundance remained low throughout all east basin regions in 2009. Age 0 clupeid species abundance was low across all regions of the east basin; zero age 0 alewife were captured during New York's and Pennsylvania's 2009 trawl assessment and only two YOY alewife were captured in Ontario's offshore trawl survey (ON-DW, Table 2.2.1). New York's and Ontario's trawl surveys indicate the 2009 year class of yellow perch was exceptionally weak compared to historical levels.

Round gobies emerged as a new species among the eastern basin forage fish community during the late 1990s. 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. Annual Goby abundance estimates during the current decade have been variable in an increasing trend with peak densities occurring about ever third year in 2001, 2004 and most recently in 2007. In 2009, goby densities either decreased (Ontario and Pennsylvania) or remained similar (New York) to 2008 estimates (Table 2.2.1).

During 2009, NYS DEC, OMNR and PFBC 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 and 2008, were especially noteworthy because several other prey fish species contributed measurably to walleye diets. Round goby remain the largest component of the diet of adult smallmouth bass caught in New York gill net surveys since 2000. Gobies were first observed in the summer diet of yellow perch in Long Point Bay in 1997 and have been the most common prey fish species found in perch stomachs since about 2002.

Fish species continue to comprise the majority of the diets of both lake trout and burbot caught in experimental gill net surveys during August in the east basin of Lake Erie. Smelt have been the dominant food item in Lean strain lake trout since coldwater surveys began in the early 1980s in

Lake Erie, occurring in 85 – 95% of the stomachs. However in 2006, a year of low YAO smelt abundance, round gobies became prominent in the diets of both Lean and Klondike strain lake trout, occurring in 53% and 68% respectively of stomach samples containing food. Since 2007, smelt once again were the most frequently observed food item of both Lean and Klondike strain lake trout. In 2009, smelt occurred in over 90% of Lean strain and over 80% of Klondike strain lake trout. Round gobies occurred more frequently in the diets of Klondike than Lean strain lake trout during all five years since 2005 that Klondike trout have been collected in coldwater assessment gear. Increased abundance of YAO smelt in the eastern basin of Lake Erie in 2009 was also evident in the diet of burbot. The occurrence of Smelt in burbot stomachs containing food increased to 60% and was coincident with a 30% decrease in occurrence of round gobies. This was the highest percentage of smelt and lowest percentage of round gobies in burbot diets since 2001. Despite their decline in 2009, round gobies continue to provide an important alternate food item for both burbot and lake trout in Lake Erie. For the first time ever, a stocked yearling lake trout was found in a burbot stomach in 2009.

Age-2 and age-3 smallmouth bass cohorts sampled in 2009 autumn gill net collections (New York) were well above the long-term average for this 29-year time series. Beginning in the late 1990s coincident with the arrival of round goby, several age classes of smallmouth bass in Long Point Bay, Ontario have exhibited a trend of increasing length-at-age. In 2009, length-at-age for each of age 2 to 6 bass cohorts remained at or near maximum values observed during the 24-year time series of OMNR's Long Point Bay gillnet survey. 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 2009 were consistent with the recent 10-year average (1998 – 2008) and k condition coefficients remain high. Klondike strain lake trout have significantly lower growth rates compared to Lean strain lake trout. Lake trout growth in Lake Erie continues to be stable and among the highest in the Great Lakes.

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

Overall forage abundance was low to moderate for 2009. Age-0 and YAO fall trawl indices generally decreased from 2008 and were below the ten year mean. Recruitment of age-0 forage species was very poor and well below average throughout the basin. Age-0 abundance was the lowest for the 10 year time series in eastern Ohio waters (Tables 2.3.1 and 2.3.2).

The only increase in YOY recruitment from 2008 in the eastern areas of the basin was for emerald shiners in Pennsylvania, where the index was the highest on record. In the western Ohio waters, only age-0 round goby and gizzard shad increased from 2008, but both indices were below the ten year mean.

Yearling and older forage decreased from 2008, but were generally above the ten year mean. The only YAO forage species that increased throughout the basin was rainbow smelt. Rainbow smelt were above average in PA and Western OH, but well below average in eastern OH. The only other YAO indices that increased from 2008 were emerald shiners in Pennsylvania waters and white perch in eastern Ohio waters, both indices were above the ten year mean.

Abundance indices for both YOY and YAO Round goby have decreased for the last two years in Pennsylvania and eastern Ohio and are well below the ten year mean. Western Ohio goby indices continue to fluctuate, with 2009 values of YOY above average and YAO below average.

Central basin diets of walleye and white bass from the fall gillnet survey in Ohio continue to be comprised of gizzard shad, rainbow smelt and emerald shiners. Walleye diets consisted of roughly equal amounts (mean percent dry weight) of gizzard shad and rainbow smelt (2010 ODW) across Ohio waters. There was a distinct shift in diet composition from east to west. Adult diets in the east were 70% rainbow smelt and 21% gizzard shad. Walleye diets in the west were 61% gizzard shad and 30% smelt. Emerald shiners and unidentifiable fish remains made up the rest of the walleye diets. White bass diets were primarily emerald shiners (50%) in both the east and west areas of Ohio. Rainbow smelt and gizzard shad comprised the remainder of the fall white bass diets. Similar to walleye diets, gizzard shad comprised a larger portion of white bass diets in the western areas of Ohio compared to the east. Round gobies continue to be an important component in the summer diet of white bass and yellow perch and are the primary food item of smallmouth bass during fall in Ohio waters. (2010 ODW).

Mean size at age of walleye and white bass are at or above average. Mean size of most forage species also remains at or above average for the ten year time series.

During 2009, Lower Trophic Level Assessment samples were collected from May through September 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, M. Bur and P. Kocovsky)

Overall, western basin recruitment and forage abundance improved in 2009, although not for all species. Both age-0 and yearling-and-older (YAO) rainbow smelt increased to the highest abundances since 1988 (1449/ha and 100.2/ha, respectively). Recruitment of age-0 yellow perch and walleye decreased from 2008 (Figure 2.4.1), remaining well below long-term means. Age-0 gizzard shad (1478.9/ha) increased dramatically to the fifth highest index since 1988, while alewife remain absent (Figure 2.4.2). Abundance of age-0 emerald shiners (109.2/ha) and YAO emerald shiners (168.7/ha) increased in 2009 (Figure 2.4.3). Age-0 white bass (250.7/ha) increased above long-term means in 2009, while age-0 smallmouth bass decreased below the long-term mean (0.2/ha). Numbers of all ages of round gobies (103.4/ha) decreased in 2009, but continue to remain above mean abundance since their discovery in 1997. Age-0 logperch and silver chubs, yearling yellow perch, and adult trout perch and logperch all increased. Age-0 white perch, trout perch, freshwater drum, and spottail shiners all decreased. Lengths of age-0 walleye, yellow perch, white bass, white perch, and smallmouth bass decreased in 2009 relative to 2008.

Adult walleye diets taken from fall gillnet catches were dominated by gizzard shad (70%), rainbow smelt (17%), and emerald shiner (9%) in the western basin. White perch were present in walleye diets (2%). Yearling walleye also relied on gizzard shad (59%), emerald shiners (22%), and rainbow smelt (19%). In 2009, the most frequently consumed diet items of yearling and older (YAO) yellow perch were benthic macroinvertebrates. Chironomidae dominated spring forage whereas *Hexagenia sp.* were the most consumed invertebrate during autumn. Trends indicate an increase in consumption of benthic macroinvertebrates from 2007 to 2009 for both spring and autumn. Autumn predation of fish by yellow perch has fallen since 2007.

Water temperatures were lower in 2009 than the previous year, with peak surface temperature (25.3°C) recorded on August 11. Spring warming rate (May 1 to May 31) was 0.16°C per day, similar to 2008. Seasonally averaged basin wide Secchi depth remained similar to 2008, averaging 1.7 m [range 0.3m (June 2) to 4.3 m (July 30)]. Western basin bottom dissolved oxygen levels averaged 8.5 mg/l [range 0.6 (August 25) to 10.3 mg/l (May 7)], maintaining levels slightly lower than the previous year.

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 for the most recent 10-year period. Indicies are reported as arithmetic mean number caught per hectare (NPH) for the age groups young-of-the-year (YOY), yearling-and-older (YAO), and all ages (ALL). 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. & 80's Avg.). Agency trawl surveys are described below. Pennsylvania FBC (PA-Fa) did not conduct a fall index trawl survey in 2006 and the 2008 survey was a reduced effort of four tows sampled in a single day.

	Age	Trawl	Year										Long-term Average by decade		
Species	**Group**	**Survey**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**2000's**	**1990's**	**1980's**
Smelt	**YOY**	ON-DW	148.2	1293.0	991.3	1256.0	0.9	132.2	7058.1	142.5	2633.3	259.9	1391.5	485.6	1382.9
	YOY	NY-Fa	64.9	2128.9	2889.6	507.9	1259.6	1146.1	1733.4	1606.6	2727.7	1184.7	1524.9	1450.9	NA
	YOY	PA-Fa	47.7	15.1	260.2	NA	47.9	12.3	592.2	98.0	34.6	136.1	138.2	550.8	7058.1
	YAO	ON-DW	1654.3	77.3	232.8	136.2	7.6	567.5	209.8	5.9	741.5	29.1	366.2	404.7	969.0
	YAO	NY-Fa	3016.6	546.5	176.9	162.9	395.2	2624.1	282.1	117.0	138.3	74.4	753.4	581.6	NA
	YAO	PA-Fa	407.2	1.8	1006.3	NA	0.0	12.3	32.4	6.5	13.9	0.0	164.5	378.0	2408.6
Emerald	**YOY**	ON-DW	54.8	16.0	29.3	452.3	645.7	20.3	3388.0	9.5	12.7	3.3	463.2	54.8	20.5
Shiner	**YOY**	ON-OB	1.3	1.6	76.9	64.8	1.1	405.2	160.3	20.0	28.6	20.7	78.1	119.4	152.3
	YOY	NY-Fa	48.5	3.7	150.9	778.5	291.4	7.8	229.7	19.5	366.7	43.6	194.0	112.4	NA
	YOY	PA-Fa	1063.0	0.0	81.7	NA	0.5	0.0	1163.4	74.4	0.0	0.0	264.8	41.0	118.3
	YAO	ON-DW	40.1	95.2	149.8	4200.3	139.0	891.2	204.7	247.8	1503.7	718.4	819.0	46.4	38.1
	YAO	ON-OB	3.0	5.1	56.3	318.4	0.1	60.0	21.3	19.3	21.8	20.6	52.6	49.9	133.5
	YAO	NY-Fa	156.4	18.2	84.8	925.5	151.4	284.2	444.5	466.4	333.8	42.6	290.8	105.4	NA
	YAO	PA-Fa	1360.3	0.0	4713.1	NA	52.5	0.0	157.6	105.6	4.6	0.0	710.4	14.5	45.6
Spottail	**YOY**	ON-OB	2.8	23.9	12.3	12.5	58.7	43.2	40.0	12.6	50.4	1118.2	137.5	696.6	249.0
Shiner	**YOY**	ON-IB	0.0	0.0	0.3	0.1	1.0	1.9	0.3	0.0	10.7	2.3	1.7	111.6	291.3
	YOY	NY-Fa	0.1	0.3	0.1	0.5	0.5	0.1	13.2	1.0	40.6	0.1	5.6	19.9	NA
	YOY	PA-Fa	1.1	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.0	2.0
	YAO	ON-OB	2.0	4.7	0.0	6.5	3.2	7.9	4.8	12.1	8.4	44.8	10.3	52.3	21.3
	YAO	ON-IB	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	2.0	0.4	0.4	2.0	9.4
	YAO	NY-Fa	5.1	1.5	0.0	4.1	4.3	2.5	4.8	34.2	7.5	0.1	6.4	4.0	NA
	YAO	PA-Fa	0.0	0.0	0.0	NA	0.0	0.0	0.0	0.8	0.0	0.0	0.1	7.9	12.4
Alewife	**YOY**	ON-DW	0.1	2.3	1.0	78.6	0.1	0.3	0.5	35.3	81.1	25.6	22.5	234.1	21.4
	YOY	ON-OB	1.1	11.4	25.5	459.4	11.0	3.2	8.9	13.0	0.3	17.4	55.1	61.0	51.5
	YOY	NY-Fa	0.0	5.6	22.2	30.8	27.7	4.4	3.9	617.6	16.2	214.5	94.3	52.0	NA
	YOY	PA-Fa	0.0	0.0	8.0	NA	0.0	0.0	2.5	0.8	0.0	0.0	1.3	7.7	16.6
Gizzard	**YOY**	ON-DW	0.4	86.5	34.6	1.4	1.7	0.2	68.6	3.2	16.0	0.3	21.3	7.5	15.3
Shad	**YOY**	ON-OB	1.1	2.6	12.3	19.0	1.9	3.6	3.1	1.5	6.3	5.8	5.7	9.6	24.1
	YOY	NY-Fa	5.3	10.8	11.7	14.1	3.7	0.6	27.8	5.5	39.7	0.1	11.9	4.2	NA
	YOY	PA-Fa	0.0	0.0	0.0	NA	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.9	74.3
White	**YOY**	ON-DW	0.6	5.4	0.1	0.9	0.1	0.0	16.2	0.0	6.1	0.0	2.9	2.2	5.6
Perch	**YOY**	ON-OB	0.0	1.3	0.4	0.8	0.4	0.1	8.6	0.0	3.9	5.9	2.1	14.2	28.7
	YOY	NY-Fa	20.2	431.5	34.6	91.9	99.8	1.0	37.7	6.2	19.3	0.7	74.3	29.4	NA
	YOY	PA-Fa	598.5	0.7	444.6	NA	51.2	0.0	523.9	0.0	677.4	7.8	256.0	101.1	NA
Trout	**All**	ON-DW	0.1	0.1	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.5
Perch	**All**	NY-Fa	517.0	996.4	561.2	519.4	1317.3	545.9	1392.6	886.0	1015.3	496.7	826.0	410.0	NA
	All	PA-Fa	558.8	0.6	156.9	NA	198.5	160.3	256.6	0.0	27.6	9.7	152.1	50.9	NA
Round	**All**	ON-DW	43.6	452.6	973.2	93.3	66.9	323.8	158.8	127.0	69.0	50.8	235.9	0.0	0.0
Goby	**All**	ON-OB	52.1	44.2	59.8	20.8	28.0	69.1	61.6	97.2	129.9	24.4	58.7	0.1	0.0
	All	ON-IB	164.0	137.9	185.1	21.4	21.0	66.9	20.4	46.6	122.6	17.4	80.3	0.0	0.0
	All	NY-Fa	502.6	466.8	1293.2	846.5	707.0	1094.5	613.4	135.9	575.4	282.3	651.7	35.9	0.0
	All	PA-Fa	350.1	441.6	2043.8	NA	887.8	927.5	387.3	43.9	3419.1	1350.6	1094.6	30.3	0.0

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

Ontario Ministry of Natural Resources Trawl Surveys

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; 80's Avg. is for the period 1984 to 1989; 90's Avg. is for the period 1990 to 1999; 00's Avg. is for the period 2000 to 2009.

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; 80's Avg. is for the period 1984 to 1989; 90's Avg. is for the period 1990 to 1999; 00's Avg. is for the period 2000 to 2009.

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; 80's Avg. is for the period 1984 to 1989; 90's Avg. is for the period 1990 to 1999; 00's Avg. is for the period 2000 to 2009.

New York State Department of Environment Conservation Trawl Survey

NY-Fa Trawling is conducted at approximately 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; 90's Avg. is for the period 1992 to 1999; 00's Avg. is for the period 2000 to 2009.

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 Avg. is for the period 2000 to 2009.

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 1999-2009. 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 Ohio-Pennsylvania state line. PA is the area of the central basin from the Ohio-Pennsylvania state line to Presque Isle, PA.

	year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	mean
Yellow perch	OH West	74	22	115	6	149	9	38	10	167	37	1	65
	OH East	21	1	14	3	48	2	156	19	178	53	1	49
	PA	7	16	388	12	788	2	-	-	10	863	14	233
White perch	OH West	334	581	780	293	310	760	1003	440	1381	545	506	643
	OH East	37	5	58	6	62	108	2035	46	1096	92	35	354
	PA	8	76	27	81	174	2	-	-	18	199	146	81
Rainbow	OH West	71	150	2	275	1754	352	11	94	98	635	294	344
smelt	OH East	282	1070	0	218	2914	389	44	571	702	3998	0	1019
	PA	2	15	377	153	178	21	-	-	35	552	23	151
Round goby	OH West	95	22	44	38	23	14	37	19	27	17	26	34
	OH East	178	158	40	65	58	174	148	46	273	26	1	117
	PA	1114	781	1578	289	75	1011	-	-	228	227	72	597
Emerald	OH West	408	127	51	39	478	7	567	587	53	36	6	235
shiner	OH East	599	501	2	1	903	1	280	1115	64	20	2	349
	PA	0	0	8	38	82	0	-	-	1	0	303	48
Spottail	OH West	6	0	6	2	0	0	0	0	3	4	1	2
shiner	OH East	4	0	1	0	1	0	1	0	1	0	0	1
	PA	1	0	0	0	0	0	-	-	0	0	0	0
Alewife	OH West	37	62	51	60	0	0	0	4	0	0	0	21
	OH East	9	12	0	1	0	0	0	4	0	0	0	3
	PA	0	0	0	0	0	0	-	-	0	0	0	0
Gizzard	OH West	104	117	60	25	403	1	12	33	195	36	51	99
shad	OH East	17	28	2	12	20	0	16	31	16	63	4	20
	PA	0	0	0	0	0	0	-	-	0	0	0	0
Trout-perch	OH West	6	1	2	1	2	20	0	0	1	0	0	3
	OH East	5	0	0	0	1	1	2	0	5	0	0	2
	PA	10	23	8	46	78	7	-	-	11	126	28	37

- The Pennsylvania Fish and Boat Commission was unable to sample in 2005 and 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 1999-2009. 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. PA is the area of the central basin from the Ohio-Pennsylvania state line to Presque Isle, PA.

	year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	mean
Yellow perch	OH West	41	62	6	52	3	217	18	4	20	57	21	48
	OH East	40	19	0	38	1	45	132	13	37	26	139	35
	PA	8	4	41	37	76	18	-	-	27	76	121	45
White perch	OH West	35	91	22	92	28	84	34	32	27	77	42	52
	OH East	15	39	0	176	12	27	20	39	17	37	282	38
	PA	2	1	2	39	29	6	-	-	1	4	63	16
Rainbow	OH West	146	66	56	45	29	321	90	9	40	10	419	81
smelt	OH East	2,115	150	3	321	370	1,360	31	17	532	65	109	497
	PA	0	76	0	6	22	10	-	-	11	4	408	60
Round goby	OH West	83	28	55	39	25	27	34	20	26	58	58	39
	OH East	107	165	88	54	127	149	263	79	186	168	19	139
	PA	55	127	55	238	59	767	-	-	361	327	76	229
Emerald	OH West	516	109	106	234	55	2	234	163	419	495	100	233
shiner	OH East	503	831	1	133	432	0	480	451	28	1,159	168	402
	PA	0	0	0	107	218	0	-	-	769	28	171	144
Spottail	OH West	6	9	4	7	2	5	0	1	2	2	3	4
shiner	OH East	7	9	1	6	1	0	4	1	1	3	0	3
	PA	0	0	0	2	0	0	-	-	0	0	0	0
Trout-perch	OH West	9	17	3	27	12	14	14	3	6	5	1	11
	OH East	9	15	2	9	3	8	76	5	7	8	2	14
	PA	1	12	1	81	51	5	-	-	16	62	127	39

- The Pennsylvania Fish and Boat Commission was unable to sample in 2005 and 2006.

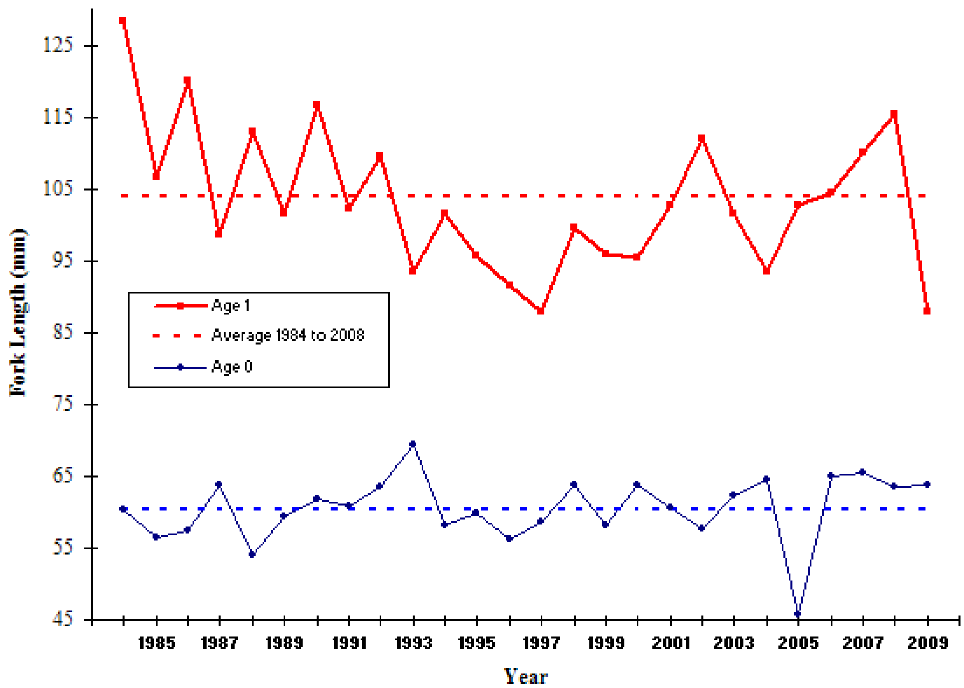

Figure 2.2.1 Mean fork length of age 0 and 1 rainbow smelt from OMNR index trawl surveys in Long Point Bay, Lake Erie, October 1984 to 2009.

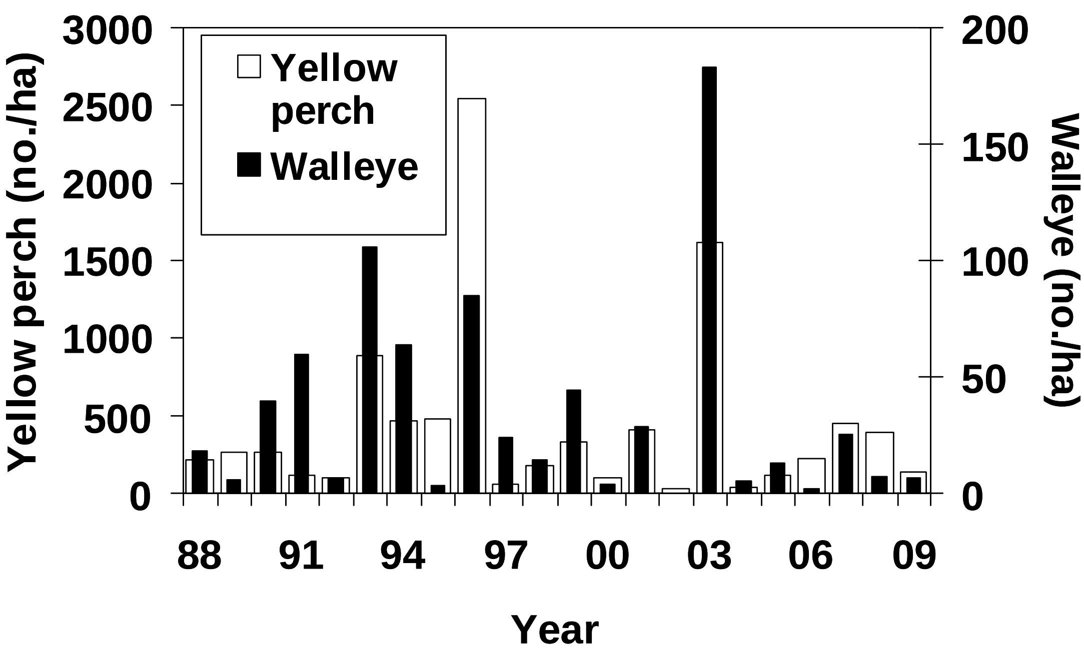

Figure 2.4.1. Density of age-0 yellow perch and walleye in the western basin of Lake Erie, August 1988-2009.

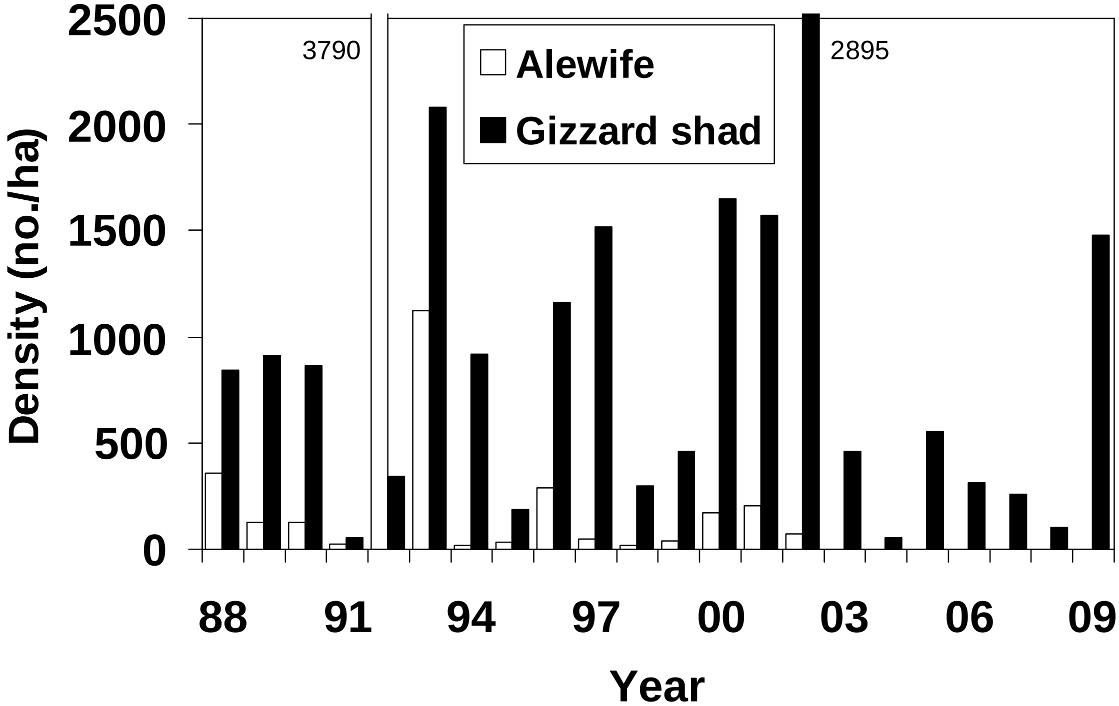

Figure 2.4.2. Density of age-0 alewife and gizzard shad in the western basin of Lake Erie, August 1988-2009.

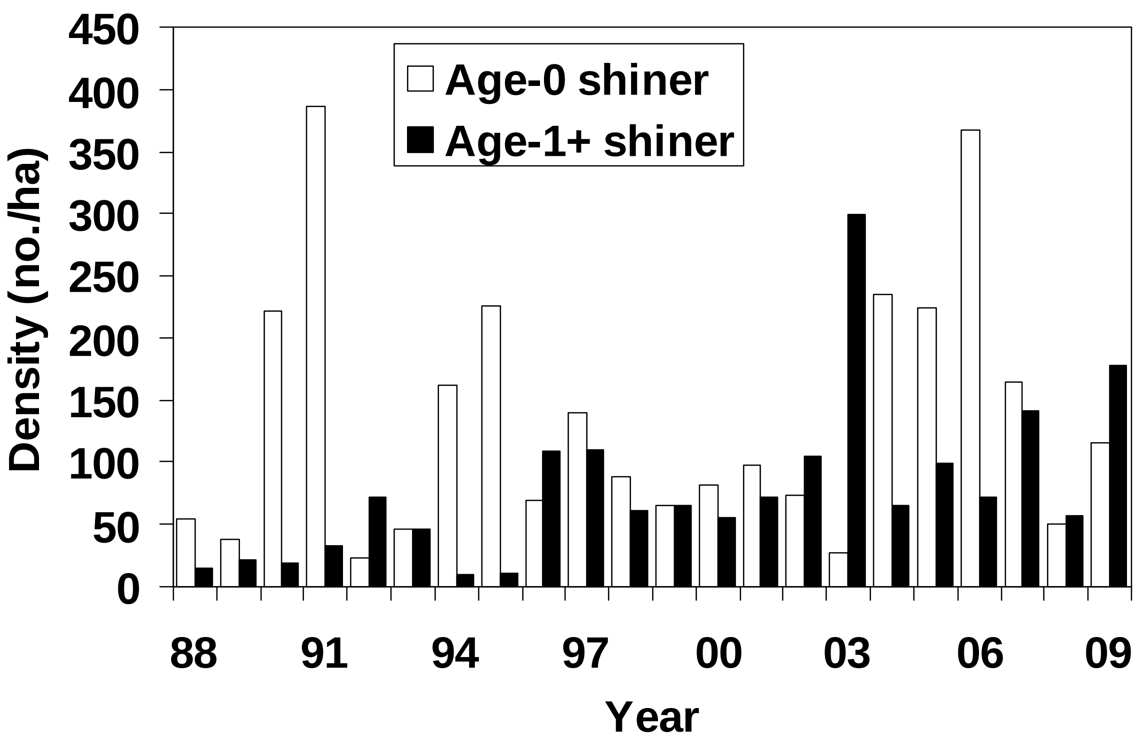

Figure 2.4.3. Density of age-0 and age-1+ shiners (*Notropis* spp.) in the western basin of Lake Erie, August 1988-2009.

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 Summary of Species CPUE Statistics (by E. Weimer, M. Bur and P. Kocovsky)

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, though missing effort data from 1987 has resulted in the use of only data since 1988. 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 67 trawls were used in the analyses in 2009 (Figure 3.1.1).

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, 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 3.1.1). 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 62% in 2009, reaching a level similar to 2007 (Figure 3.1.2). Clupeid and soft-rayed fish increases (up 1479% and 535%, respectively) were responsible for this trend; spiny-rayed fish decreased 9% compared to 2008. Because of the composition of the forage fish community in 2009, total forage biomass increased, but to levels similar to 2005 (Figure 3.1.3). Relative biomass of clupeid, soft-rayed, and spiny-rayed species was 28%, 13%, and 59%, and, similar to the respective historic averages of 31%, 8%, and 61%. Walleye show a clear preference for clupeids and soft-rayed fishes over spiny-rayed prey (Knight and Vondracek 1993), and increases in biomass of clupeid and soft-rayed fish may help satisfy predatory demand in Lake Erie.

Mean length of age-0 fishes in 2009 declined compared to 2008 (Figure 3.1.4). Length of age-0 for select species include: walleye (127 mm), yellow perch (69 mm), white bass (56 mm), white perch (56mm), and smallmouth bass (53 mm). These lengths are below or near long-term averages (137 mm, 67 mm, 67 mm, 57 mm, and 79 mm, respectively).

Spatial maps of forage distribution were constructed using FPC-corrected site-specific catches (#/ha) of the functional forage groups (Figure 3.1.5). Abundance contours were generated using kriging contouring techniques to interpolate abundance among trawl locations. Clupeid catches were highest along the south shore from Little Cedar Point to Cedar Point, extending out around the western basin reefs to Middle Sister Island, and in Pigeon Bay along the north shore. Soft-rayed fish (predominantly rainbow smelt) were most abundant at the mouth of the Detroit River and around Kelleys Island and the Bass Islands. Spiny-rayed abundance was highest in the center of the basin, from the south shore and extending northeast of East Sister Island. Relative abundance of the dominant species includes: age-0 white perch (44%), age-0 gizzard shad (21%), and age-0 rainbow smelt (20%). Total forage abundance averaged 7,101 fish/ha across the western basin, increasing 62% from 2008, above the long-term average (5,344 fish/ha). Clupeid density was 1,479 fish/ha (average 1,156 fish/ha), soft-rayed fish density was 2,092 fish/ha (average 591 fish/ha), and spiny-rayed fish density was 3,531 fish/ha (average 3,597 fish/ha).

3.3 Trawl Comparison Exercise (by J. Deller)

The Forage Task Group is considering continuation of the trawl comparison exercise to include the boats and agencies of the central and eastern basins. This would provide further improvement in coordination and integration of trawl surveys conducted throughout Lake Erie. We are currently trying to coordinate agency sampling schedules and working through travel restrictions. We are planning on conducting the exercise during the summer of 2011 or 2012.

Table 3.1.1. 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

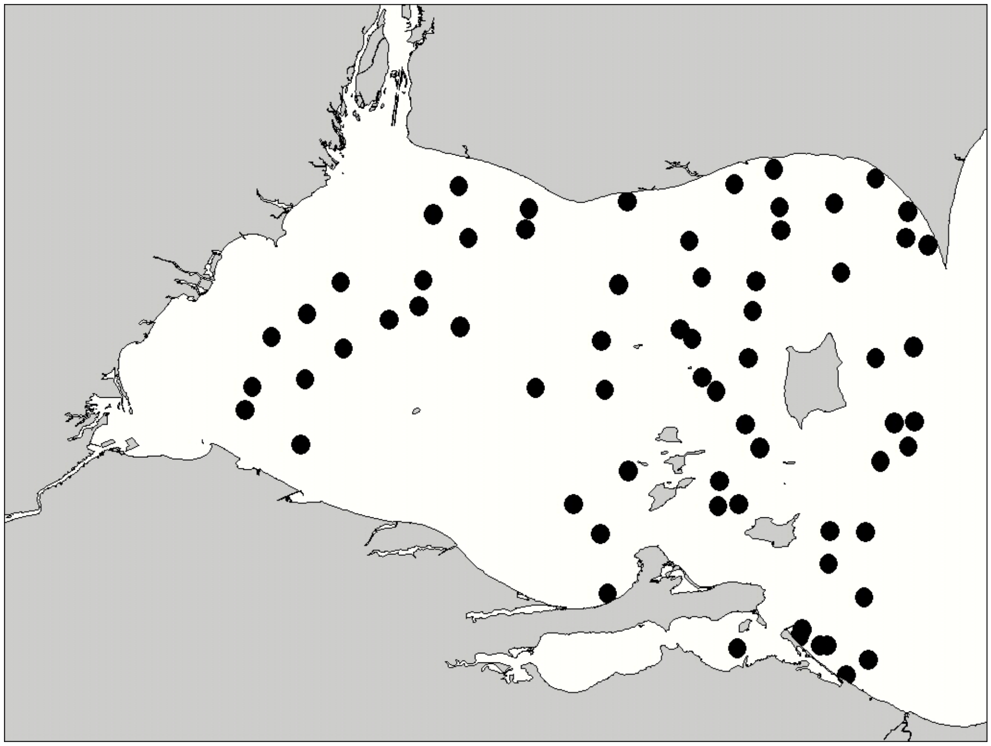

Figure 3.1.1. Trawl locations for the western basin interagency bottom trawl survey, August 2009.

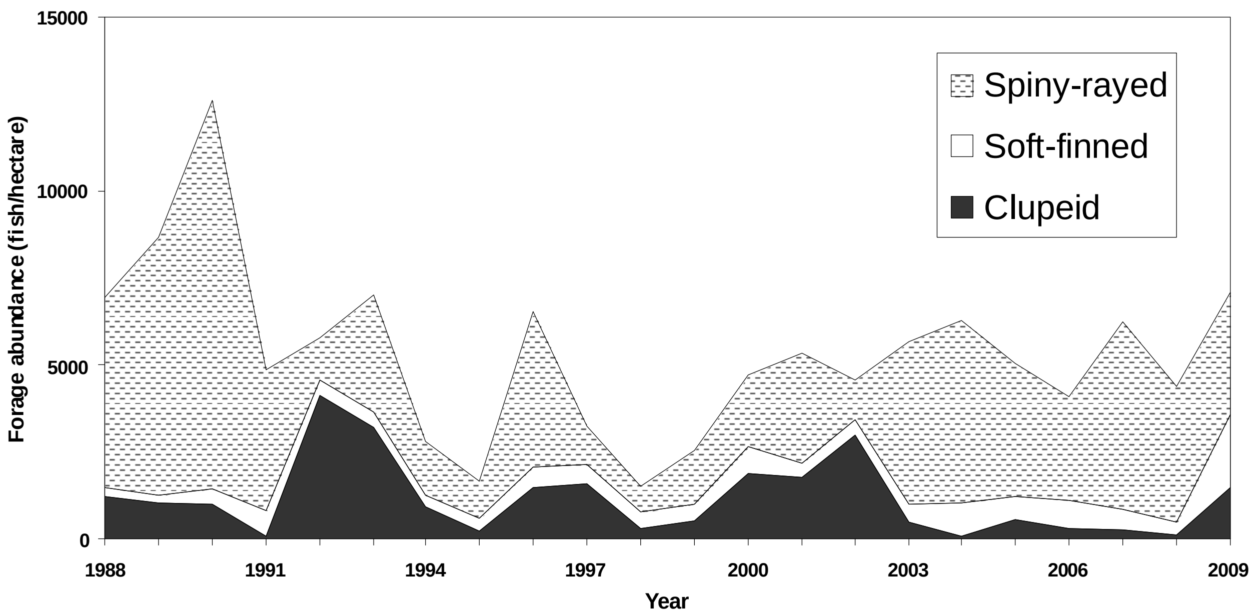

Figure 3.1.2. Mean density (no. / ha) of prey fish by functional group in western Lake Erie, August 1988-2009.

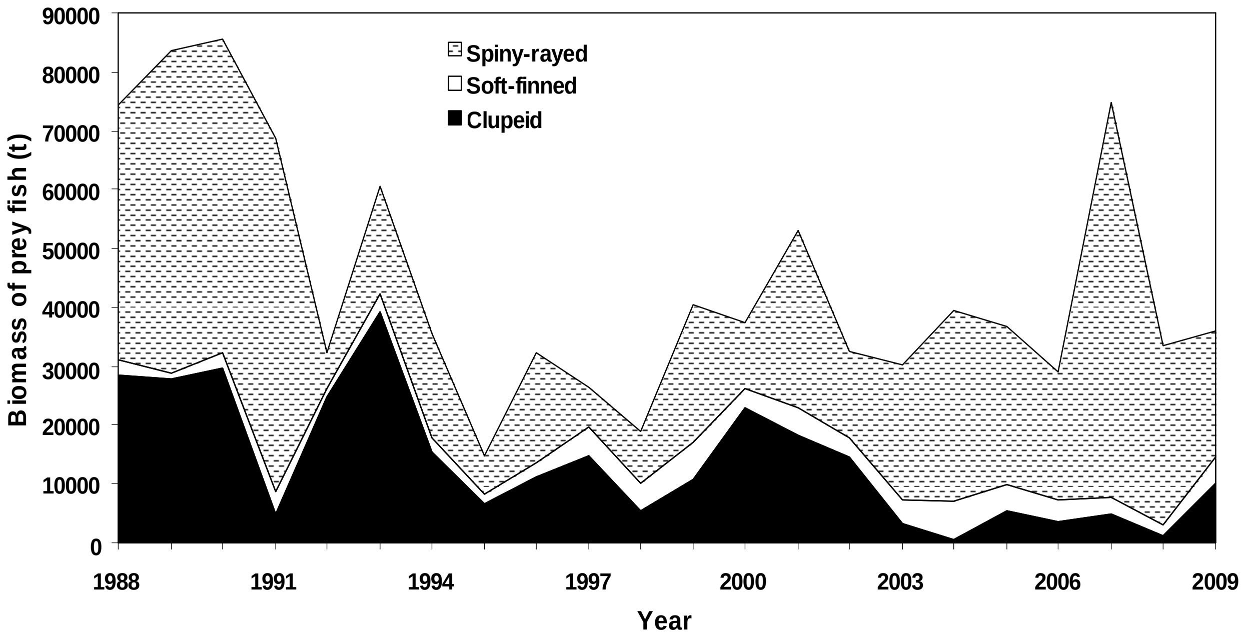

Figure 3.1.3. Mean biomass (tonnes) of prey fish by functional group in western Lake Erie, August 1988-2009.

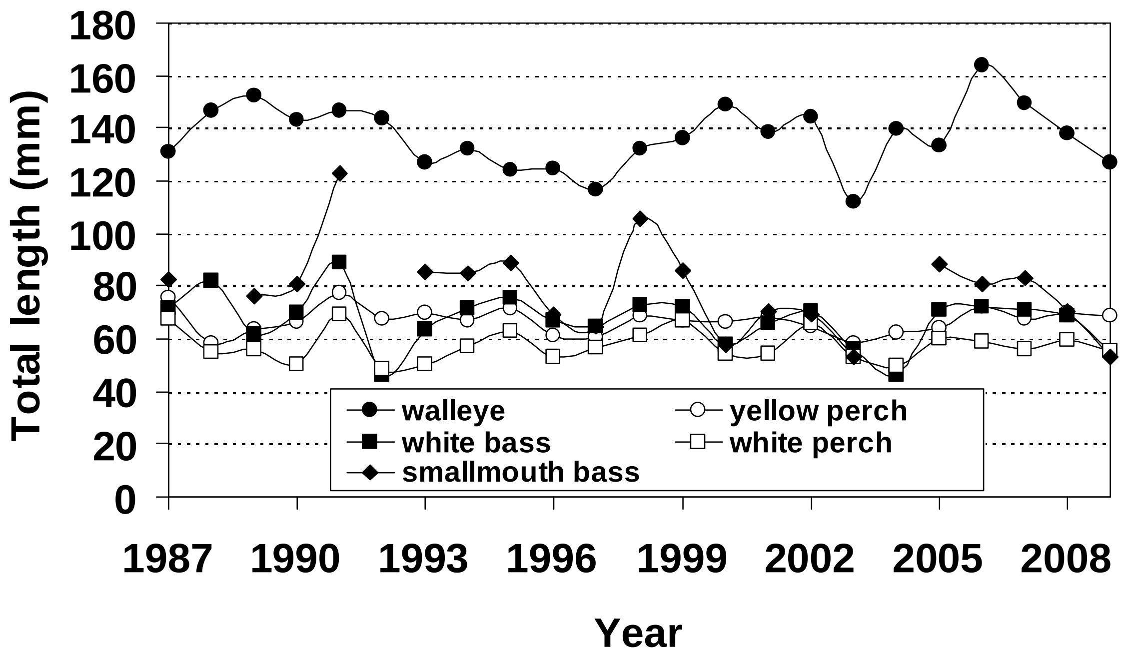

Figure 3.1.4. Mean total length (mm) of select age-0 fishes in western Lake Erie, August 1987- 2009.

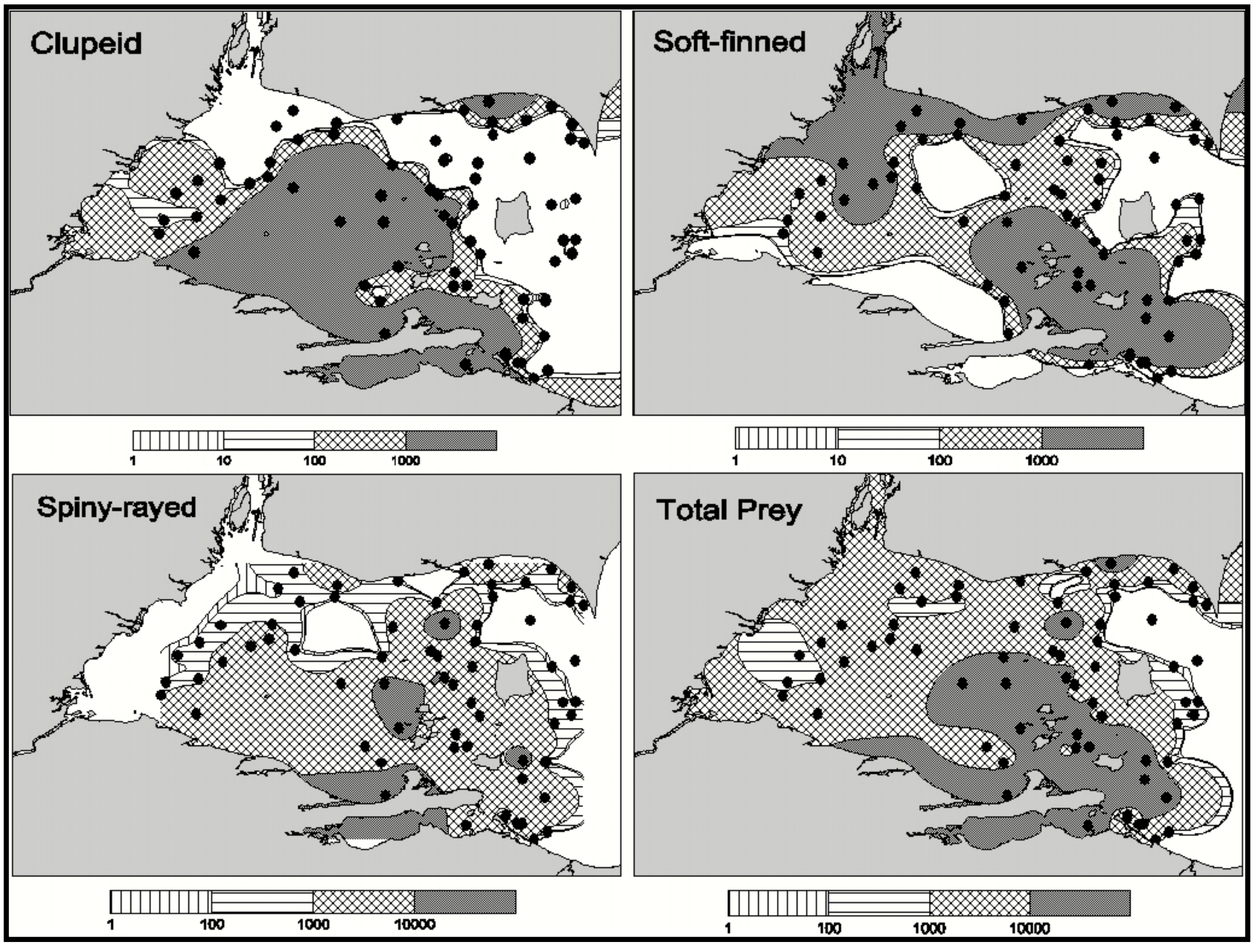

Figure 3.1.5 Spatial distribution of clupeids, soft-finned, spiny-rayed, and total forage abundance (individuals per hectare) in western Lake Erie, 2009. Black dots are locations for trawling and contour levels vary with the each functional fish group.

4.0 Hydroacoustic Survey Program

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

Introduction

Beginning in 1993, a midsummer East Basin fisheries acoustic survey was implemented to provide a more comprehensive evaluation of the distribution and abundance of rainbow smelt. This initiative has been pursued under the auspices of the Lake Erie Committee's Forage Task Group (FTG), and is a collaboration of neighboring East Basin Lake Erie jurisdictions and Cornell University's Warmwater Fisheries Unit through coordinated management efforts facilitated by the Great Lakes Fishery Commission (GLFC).

Some of the more recent progress in the development of an acoustic survey program was achieved when Lake Erie's FTG was successful in being awarded a grant to purchase a modern signal processing and data management system for inter-agency fisheries acoustic surveys on Lake Erie (Einhouse and Witzel 2003). The new data processing system (Echoview) arrived in 2002. In 2003, Lake Erie representatives from New York State Department of Environmental Conservation and the Ontario Ministry of Natural Resources also attended a training workshop to attain proficiency in this new software. The newly trained biologists then hosted a second workshop to introduce this signal processing system to the Lake Erie FTG. During 2005 FTG members upgraded the Lake Erie acoustic hardware system through the purchase of a Simrad EY60 GPT/transducer. In 2008 and 2009, several members of Lake Erie's FTG participated in an ongoing series of workshops, devoted to the development of Standard Operating Procedures (SOP) for hydroacoustic surveys in the Great Lakes region (Parker-Stetter et al 2009, Rudstam et al. 2009). Completion of the 2008 workshop represented a benchmark event toward implementation of the SOP's in Lake Erie basin acoustic surveys, and specifically for the East Basin, then proceeding to re-processing an acoustic data series beginning in 1997 and applying new standards. A primary focus of the 2009 workshop was to compare present-day acoustic methods used in various acoustic assessments across the Great Lakes with results from following the SOP and further publications by the principal investigators within this study group are anticipated in the next year or two. Additional GLFC funds were recently awarded to the Great Lake Acoustic Study Group to convene a workshop during fall 2010 that will begin the development of standard protocols for conducting acoustic assessment-based ground-truth trawling operations.

Survey Methods

A thorough description of survey methodology as well as a thorough description of the entire series of acoustic survey results for the eastern basin Lake Erie is being pursued as a separate report expected to be available during 2010. In general, standard survey procedures have been in-place for offshore transect sampling of eastern Lake Erie since 1993. This midsummer, mobile nighttime survey is implemented as an interagency program involving multiple vessels to collect acoustic signals of pelagic fish density and distribution, with an accompanying mid-water trawling effort to characterize fish species composition.

The 2009 Survey

In recent years, the east basin survey has been accomplished as a two-agency endeavour. Acoustic data acquisition to determine fish densities and distribution were measured with a scientific echosounder, a Simrad EY60 120 kHz split-beam GPT, mounted aboard the Ontario Ministry of Natural Resources (OMNR) research vessel, *R/V Erie Explorer*. Companion mid-water trawl collections to obtain representative samples of the pelagic forage fish community for apportioning of acoustic targets was completed by the New York State DEC's research vessel, *R/V Argo*. Acoustic data acquisition for the 2009 survey was completed during five consecutive nights from July 20 to 25th (Figure 4.1.1). A full compliment of twelve acoustic transects were sampled totaling 177 nautical miles. Approximately 900,000 KB of raw acoustic data were recorded including some 36,000 KB of stationary sampling at the ends of some transects to assess target strength (TS) variability of individual fish tracks. In total, 18 mid-water trawl samples were collected on nine transects and 38 water temperature-depth profiles sampled across all transects in 2009. OMNR and NYS DEC participants both remained fully engaged in eastern basin data processing and analysis activities.

Acoustic Series Results

Procedures for the east basin acoustic survey have now been completed largely through the support of GLFC sponsored project "Study group on fisheries acoustics in the Great Lakes". At this time the principal investigators for Lake Erie's east basin survey are incorporating the new SOP for each survey year, and then re-computing fish densities based on these new standards. Among these standard data processing elements is the use of the N_v index, a type of data quality control filter for examining estimates of fish abundance in densely concentrated areas to diminish possible bias associated with extrapolating abundance based on mean in-situ target strength (Rudstam et al. 2003). Additionally, a standard objective method has now been developed to ascribe passive noise thresholds for each survey transect. A complete description of our data collection and processing methods will be forthcoming in a separate document with accompanying results for the entire split-beam time series of this acoustic survey (since 1997).

We expect to resume analysis of acoustic results for years 1997, 1998, and 2004 through 2009 during spring 2010. The entire 1997 to 2009 data series is expected to be thoroughly reported in a separate document with an accompanying description of survey methods and data processing procedures. Upon completion of this overview document, subsequent results will be updated annually in Lake Erie's FTG Report.

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 continuing efforts started 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 2009 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). In past surveys, this sample design consisted of eight cross-basin transects, requiring two acoustic survey vessels and two midwater trawling vessels. In 2009, two changes were made to the sample design to address issues that developed during analysis of 2008 data. The first change was to include midwater trawling aboard the *R/V Musky II* (United States Geological Survey; USGS) and *R/V Grandon* (ODNR-DOW) while collecting acoustic data. This would allow for a direct comparison of target strength to fish length from the trawl data and analysis of spatial aspects of fish distributions changing during the period between trawling with one vessel and acoustic data collection by a second vessel. The second change to the survey involved alternating the pulse widths between 0.2ms (experimental) to 0.4ms (standard) during data collection on one transect. Shorter pulse width may improve single target strengths (TS) that would allow for the use of *in-situ* TS in areas of high fish concentrations, such as the YOY smelt densities found in 2008.

Hydroacoustics

In 2009, the *R/V Musky II* and *R/V Grandon* were the acoustic vessels. Acoustic transects corresponding to Loran-C TD lines were sampled from 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 or weather conditions forced cancellation of data collection. All sampling was conducted in waters 10 meters or deeper. Hydroacoustics data were collected using BioSonics DTX ® echosounders and BioSonics Visual Acquisition (release 5.1) software. The *R/V Musky II* collected acoustic data with a 120-kHz transducer and the *R/V Grandon* used a 70 kHz transducer. Transducers on both vessels were mounted to the starboard hull by brackets roughly equidistant between the bow and stern, approximately 1 m below the water surface. Global Positioning Systems coordinates were collected using a Garmin ® GPSMAP 225 on the *R/V Musky II* and a Lowrance iFinder on the *R/V Grandon* interfaced with the echosounder to obtain simultaneous latitude and longitude coordinates. Echosounders on both acoustic vessels were set according to collection parameters in the Great Lakes SOP (Parker-Stetter et al. 2009) for all transects except the western most transect, on which pulse duration was set at either 0.2 ms or 0.4 ms, alternating every 30 minutes. This was done to test whether the shorter pulse duration produced less biased *in-situ* target strength estimates (see below). A coin flip determined starting pulse duration (0.2 ms).

Trawling

The R/V Keenosay, (Ontario Ministry of Natural Resources; OMNR), *R/V Musky II* and *R/V Grandon* all provided midwater trawling concurrent to the acoustic data collection. The *R/V Musky II* and *R/V Grandon* conducted four 10-minute trawls per transect, while the *R/V Keenosay* conducted up to eight 20-minute trawls per transect in Ontario waters. In order to maximize the number of midwater trawls, the *R/V Keenosay* and *R/V Musky II* trawled the same transect each night, while the *R/V Grandon* trawled the alternate transect. Whenever possible, trawl vessels attempted to distribute trawl effort above and below the thermocline to adequately assess species composition in each depth stratum. Total length and total catch were recorded from each trawl by species and age group. Age group classifications consisted of young-of-year (age-0) for all species and yearling-and-older (age-1+) for forage species and age-2-or-older (2+) for predator species.

Analysis

Acoustic transects were stratified along each transect into two depth layers for analysis: epilimnion (above the thermocline) and hypolimnion (below the thermocline). These layers were chosen based on temperature and dissolved oxygen profiles and acoustic target size distributions along each transect. Analysis of hydroacoustic data were conducted following the guidelines established in the GL-SOP (Parker-Stetter et al. 2009). Hydroacoustics data were analyzed using EchoView ® version 4.4 software. Proportionate area backscattering coefficient and single targets identified using Single Target Detection Method 2 single target detection algorithm (recommended by Sonar Data, Inc., developer of EchoView software, for BioSonics data) were used to generate density estimates for 500 to 1000m intervals in each water stratum. For some data collected on the *R/V Musky II* data were partitioned into 6-minute strata owing to failure of GPS data collection. *In-situ* TS data were used to determine single target numbers and sizes for converting volume backscattering strength (Sv) into fish density estimates (fish per hectare) for each interval and depth stratum. The Nv statistic, a measure of the relationship between the number of single targets and Sv, was calculated for each interval-by-depth stratum cell to monitor the quality of using *in-situ* data to calculate TS (Sawada et al. 1993). If Nv for an interval-by-depth stratum cell was >0.1, the mean TS of the entire stratum within a transect where Nv values were <0.1 was used (Rudstam et al. 2009). Occasionally, using the mean TS value for the transect produced worse Nv values than either *in-situ* TS or TS values derived from trawl data. In these cases, *in-situ* TS was retained.

Results

Four complete transects and two partial transects were sampled from 13 through 21 July (Figure 4.2.1). Equipment malfunction and rough seas prevented sampling all eight complete transects. Thermal profiles identified a thermocline between 14 and 18 m depth, with the thermocline generally shallower in nearshore areas and in the western portion of the central basin. Dissolved oxygen remained sufficiently high throughout most of the hypolimnion to sustain fish.

Hypolimnetic acoustic densities were 1.2 to 4 times that of epilimnetic densities except on the western-most transect where densities were similar (Figure 4.2.3). On the western-most transect varying pulse length between 0.2 ms and 0.4 ms resulted in eight 30-minute periods of collecting data at 0.2 ms and eight 30-minute periods collecting at 0.4 ms. Acoustic densities for the 0.2 ms pulse length setting were 1.2% higher and 4.0% for the epilimnion and the hypolimnion, respectively. There was no apparent improvement in ability to discern individual targets using shorter pulse duration as evidenced by high percentage (over 30% for some transects) of high Nv values for both pulse duration levels. A more complete analysis of the differences will be presented elsewhere.

Trawl samples

Trawl samples throughout the water column were dominated by age-1 rainbow smelt (Table 4.2.1). Yearling-and-older emerald shiners and YOY rainbow smelt were captured in small numbers in epilimntic samples. Age-2 and older rainbow smelt, white perch, white bass, yellow perch, walleye, and freshwater drum and a 177-mm sea lamprey comprised the remainder of fish captured in trawls.

Discussion

Both acoustic sampling and trawling confirmed very high densities of age-1 rainbow smelt. This resulted in very high total volume of return echoes (Sv). We encountered the same problem in 2008 owing to high densities of age-0 rainbow smelt. High fish densities cause problems for scaling Sv to estimate fish densities using mean *in-situ* single target strength (TS) values. High densities make it difficult to discern single targets from return echoes, which can lead to biased *in-situ* TS estimates, further leading to biased estimated acoustic densities. Anticipating this problem based on our experience with 2008 sampling we attempted to compensate partially by using a shorter pulse duration, which theoretically should improve detection of single targets in dense fish layers (Parker-Stetter et al. 2009). Preliminary analyses suggest this attempt was not entirely successful. When *in-situ* TS estimates are biased one can rely on published regression equations relating TS to fish length, using lengths of fish captured in trawls to solve for TS, then using those TS values to scale Sv to estimate fish density. Although we have data to do so we have not taken that approach with this year's analysis, because it, too, has liabilities. For example, three published equations for rainbow smelt (Rudstam et al. 2003, Argyle 1992, Horppila et al. 1996) produce widely different estimates of TS for a given fish length, which results in density estimates that differ by over 50% (P. Kocovsky and J. Deller, unpublished data). We will continue to pursue improvements in data collection and analysis to develop increased capability to use *in-situ* TS estimates. We are also assembling data to produce a central basin TS-fish length regression equation.

Estimated acoustic fish densities were higher for transects sampled by the *R/V Grandon* than those sampled by the *R/V Musky II*. Data from all transects were analyzed following the Great Lakes SOP (Parker-Stetter et al. 2009); thus, differences in methods for analyzing data are ruled out as causing differences in estimated densities. That transducers with different frequencies were used also does not suffice to explain differences in estimated densities as past work has shown no appreciable difference in fish density owing to transducer frequency (Guillard 2004, Godlewska et al. 2009). It is possible that the observed differences reflect actual densities as there was a general pattern of decreasing densities from east to west. Another possible explanation for the observed differences in estimated acoustic density by vessel is problems with high-gain circuitry in the transducer used on the *R/V Musky II* (D. Warner, USGS Great Lakes Science Center, personal communication), which may have produced flawed data. The problem with the high-gain circuitry was discovered after acoustic data collection in central Lake Erie, and it is not known if the problems existed during our survey. A procedure has been developed to adjust the flawed data, but we have not yet examined whether adjusting the data will account for the observed differences.

4.3 West Basin Acoustic Survey (E. Weimer)

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 (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 sonar for assessing pelagic forage fish abundance in the west basin. These data have been 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

Equipment failures again plagued the western basin survey in 2009. Of the three proposed transects (limited to Ohio waters due to recent changes in border crossing rules), only the eastern transect was completed. A small portion of the western transect was completed prior to loss of function with the Lake Erie BioSonics DT-X surface unit, and data from this transect was unusable during analysis. Unlike previous years, the Inland Fisheries Research (IFRE) BioSonics DT-X surface unit was not available for emergency use, and the survey remained incomplete. The equipment was sent to the manufacturer for a diagnostic check up in August, and was returned in January, 2010. Extensive testing is planned for the summer of 2010 to ensure the equipment is fully functional prior to the 2010 hydroacoustic survey.

In 2009, 1.47 GB of acoustic data were collected across 29 km of Lake Erie's western basin using a single, downward-facing, 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 before the 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 by 0.5 h prior to sunrise. Transects were navigated with waypoints programmed in a Lowrance GPS, and speed was maintained at 8-9 kph using the GPS. The transducer was mounted on a fixed pole located on the port side of the boat amidships. The transducer was mounted 1 m below the surface. Data were collected using BioSonics Visual Acquisition 5.0.4 software. Collection settings during the survey were 10 pings/second, a pulse length of 0.2 msec, and a minimum threshold of -70 dB. The sampling environment (water temperature) was set at the temperature measured at 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 the Myriax software Echoview 4.5 using a modified process developed by the Ohio Division of Wildlife Inland Fisheries Research Unit. Target length was estimated using Love's dorsal aspect equation (Love 1971):

$$\text{Total length} = 10 \wedge ((\text{Target Strength} + 26.1)/19.1) * 1000$$

Biomass estimates were based on average target length as determined by the above equation.

Results

Mean forage fish density and biomass estimated from the single eastern transect in the west basin survey during 2009 were 3,205 fish per hectare and 5.3 kg per hectare, respectively, which is similar to the 2006 and 2008 survey estimates (Figure 4.3.1). Fish densities were higher offshore than inshore (Figure 4.3.2). The majority (79%) of forage fish in the survey was estimated to be 20-59 mm TL; 93% were between 20-109 mm.

Table 4.2.1. Species composition of age-0 (YOY) and yearling-and-older (YAO) fishes captured in trawl samples collected by the *R/V Keenosay*, *R/V Musky II*, and *R/V Grandon* in central Lake Erie in July, 2009.

		Loran-C TD transect					
Epilimnion	Life stage	58100	57975	57850	57725	57600	57339
Rainbow smelt	YOY	1%	2%	2%	4%	77%	2%
Rainbow smelt	YAO	98%	93%	97%	95%	1%	71%
Emerald shiner	YAO	1%	3%	1%	0%	21%	27%
Other	YAO	0%	2%	0%	1%	0%	1%
Hypolimnion							
Rainbow smelt	YOY	0%	0%	0%	0%	-	1%
Rainbow smelt	YAO	99%	86%	99%	100%	-	97%
Emerald shiner	YAO	0%	0%	0%	0%	-	3%
Other	YAO	1%	14%	0%	0%	-	0%

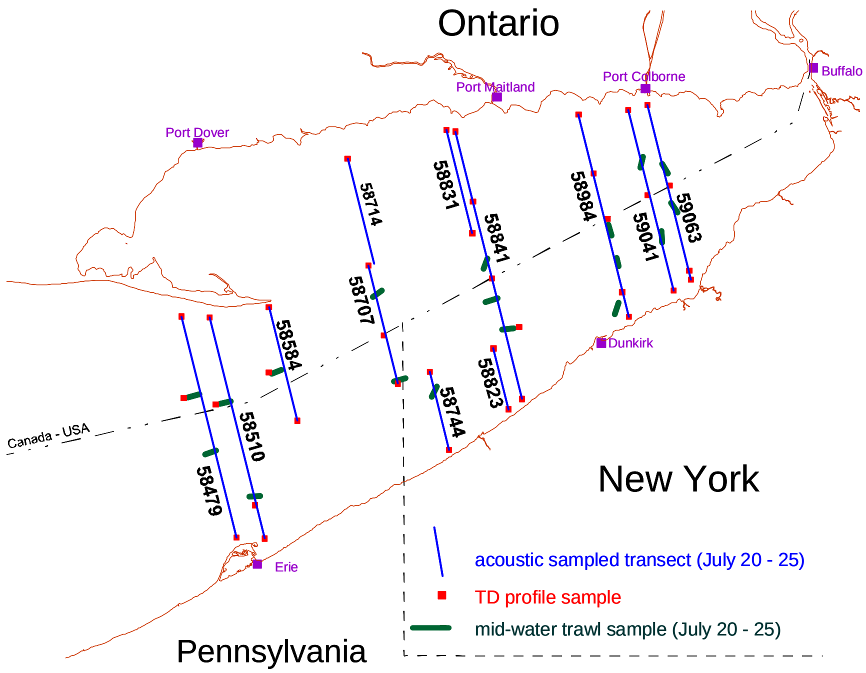

Figure 4.1.1. July 2009 eastern basin Lake Erie inter-agency acoustic survey transects, mid-water trawl and temperature profile sites visited by the Ontario Ministry of Natural Resources (OMNR) research vessel, *R/V Erie Explorer* and the New York State Department of Environmental Conservation vessel, *R/V Argo***.**

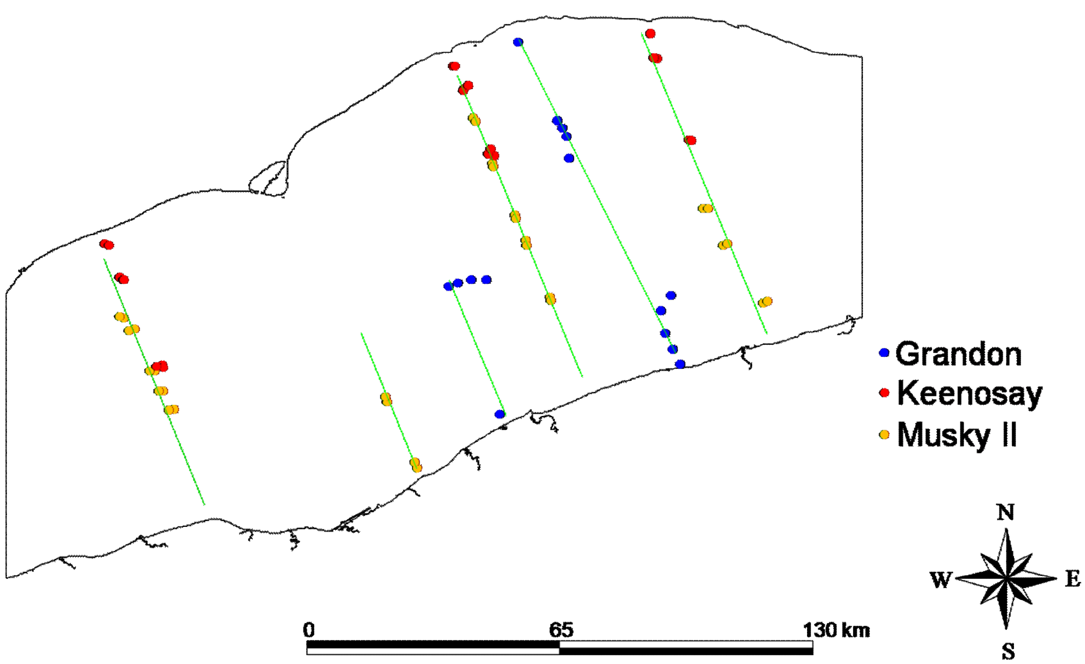

Figure 4.2.1 Acoustic transect lines and midwater trawl locations in the central basin, Lake Erie, 2009. The solid lines indicate acoustic transects, colored dots indicate trawl locations of each respective vessel

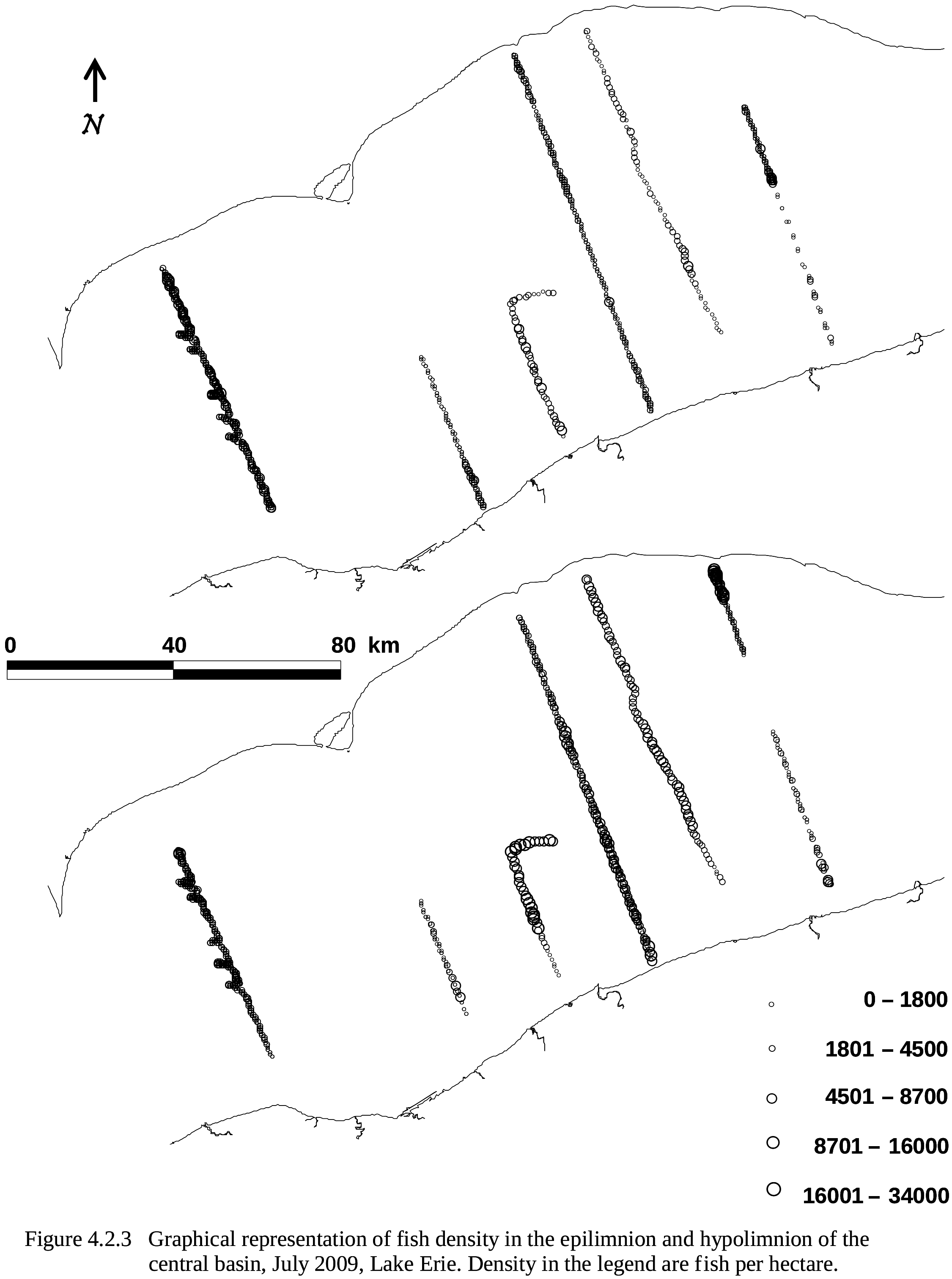

Figure 4.2.3 Graphical representation of fish density in the epilimnion and hypolimnion of the central basin, July 2009, Lake Erie. Density in the legend are fish per hectare.

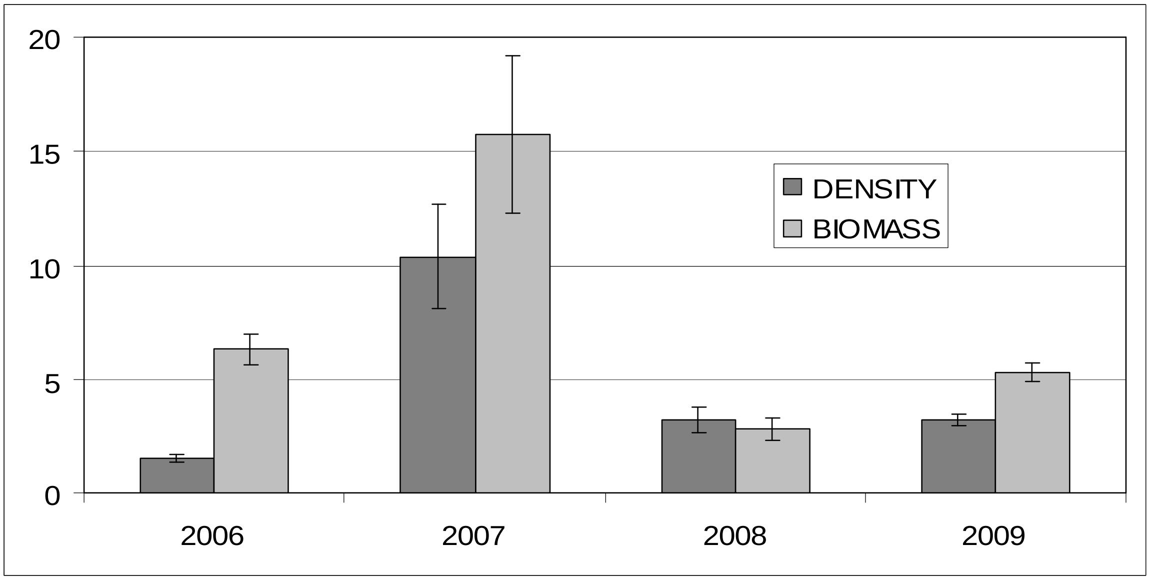

Figure 4.3.1. Estimated mean density (in thousands of fish/hectare) and biomass (kg/hectare) of western basin forage fish from down-viewing hydroacoustic survey data collected July, 2006-09, along one transect. Error bars represent the standard error of the mean.

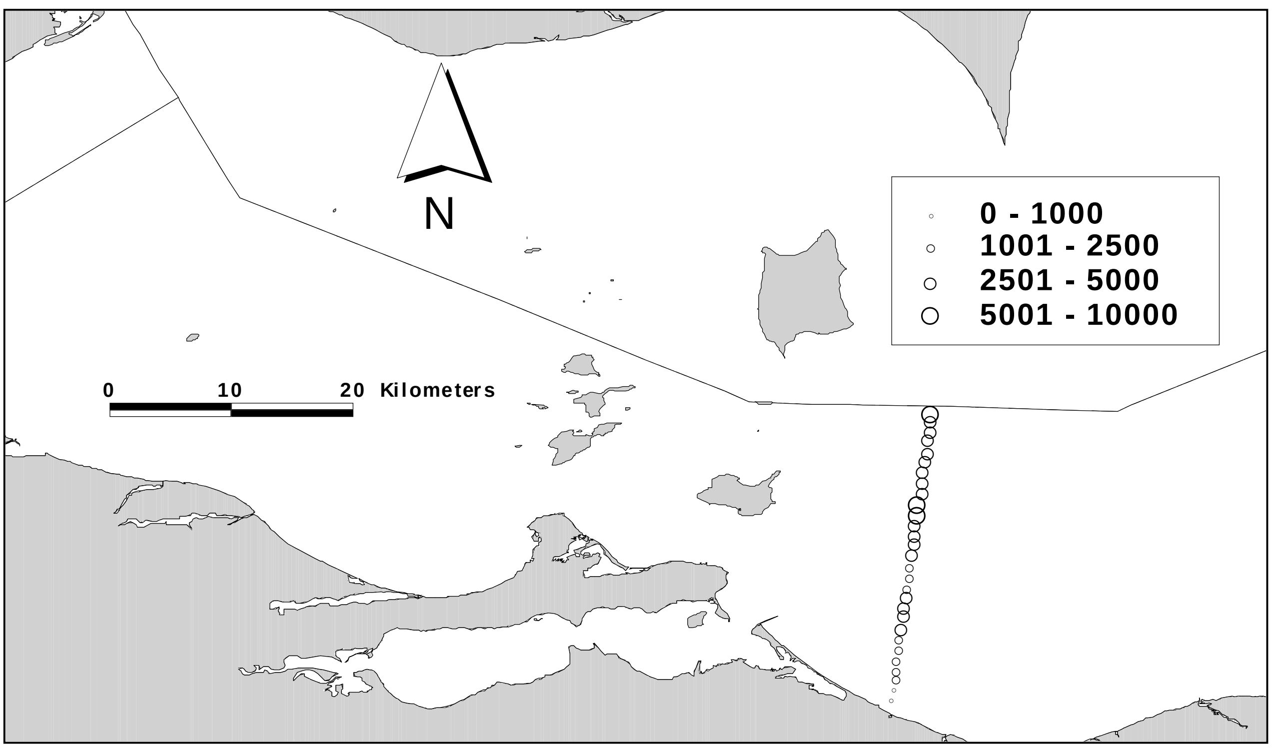

Figure 4.3.2. Spatial abundance of forage fish along one western basin hydroacoustic transect, July 2009. The proposed survey in 2009 was limited to U.S. waters only due to new passport requirements. Equipment failure ended the survey after only one transect. Legend densities are in fish per hectare.

5.0 Interagency Lower Trophic Level Monitoring Program, 1999-2009

(by B. Trometer, and J. Markham)

In 1999, the FTG initiated a Lower Trophic Level Assessment program (LTLA) within Lake Erie and Lake St. Clair (Figure 5.0.1). 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. For this report, we will summarize the last 11 years of data for epilimnetic temperature, hypolimnetic or bottom dissolved oxygen, grazing pressure (chlorophyll *a* and total phosphorous), the last 10 years for zooplankton data, and the last 2 years for Secchi and total phosphorus. 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, 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 (Figure 5.1). A new eastern basin offshore station was added in 2009. Station 25 is located off Sturgeon Point in 19.5 meters of water.

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. Temperatures were warmest in the western basin and coolest in the eastern basin (Figure 5.0.2). In 2009, the mean epilimnetic temperature was slightly lower than the long term average in all three basins (west 19.8 C, central 17.4 C, and east 16.7 C).

Hypolimnetic Dissolved Oxygen

Figure 5.0.3 illustrates the mean hypolimnetic dissolved oxygen (DO) concentration (i.e. below the thermocline) for dates when the water column is stratified at each station in each basin of Lake Erie by year. 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. 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 is an issue in the central basin. It happens almost annually at the offshore stations (10, 11 and 13) and inshore station 9. Dissolved oxygen of less than 4 mg/L has been first observed as early as mid July and has persisted until late September or early October when fall turnover remixes the water column. For 2009, data is from stations 9, 10, 11 and 12. Mean hypolimnetic DO was below 4 mg/L at station 10 on the two sampling dates in September and at station 11 on one sampling date in September.

Hypolimnetic DO is rarely limiting in the eastern basin due to greater water depths, a large hypolimnion and cooler water temperatures.

Lake Erie Fish Community Ecosystem Targets

The first fish community objective for Lake Erie is to maintain mesotrophic conditions that favor a dominance of cool-water organisms in the western, central and nearshore waters of the eastern basin (Ryan et al. 2003). For mesotrophic conditions, phosphorus should range from 10 to 20 μg/L and summer water transparency measured using a Secchi disk should range from 3 to 5 meters. Offshore waters of the eastern basin should be oligotrophic with phosphorus levels of 5 to 10 μg/L and Secchi depths greater than 6 meters. For 2008 and 2009, the phosphorus levels in the western basin far exceeded mesotrophic conditions in both years, although the offshore total phosphorus was only slightly above the range in 2009 (Figure 5.0.4). The phosphorus levels in the central basin were slightly above or meeting the mesotrophic range for both years. The phosphorus levels in the eastern basin generally meet the mesotrophic/oligotrophic conditions.

Transparency was below the 3 to 5 meter target in western basin and within target range in the central basin and nearshore eastern basin for both 2008 and 2009 (Figure 5.0.4). Transparency was below the greater than 6 meter target in offshore eastern basin.

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 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 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 5.0.5), we see that grazing pressure is lowest in the western basin (more chlorophyll observed than predicted) and highest in the eastern basin. Note that the chlorophyll *a* levels in the west basin are highest and most variable.

In 2008, predicted Chlorophyll *a* was higher than observed in all three basins indicating high grazing pressure throughout the lake especially in the western basin (Figure 5.0.5). In 2009, predicted Chlorophyll *a* was lower than observed in all basins indicating low grazing pressure throughout the lake, but especially in the western and central basins.

Zooplanktivory 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 or less sampled with a 63-µm net reflects a high level of predation by fish. In general, zooplankton predation is deemed high in Lake Erie, as the average size of the community is more often less than this critical 0.57 mm size (Figure 5.0.6).

For 1999-2004, zooplankton mean length was less than 0.57 mm, indicating zooplanktivory was generally high throughout the lake during this time period. Zooplanktivory does not vary much in the eastern basin, as the mean zooplankton size varies only slightly ranging from 0.51 to 0.62 mm. In 2005, zooplanktivory was high in the central basin and low in the western basin. In 2006, zooplanktivory was low throughout the lake. In 2007, zooplanktivory was high in the western and central basins. In 2008, zooplanktivory was low in the central basin (0.65 mm) and slightly high in the western basin (0.56 mm).

Distribution of New Zooplankters

For this review data from stations 3, 4, 5, 6, 9, 10, 11, 12, 15, 16, 17, 18, 19, and 20 were 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. Densities ranged from 0.01 to 1082/m^3 and were generally higher from July through September.

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, 17, 18 and 19. Except for the year 2002, *Cercopagis* is seen less frequently around the lake than *Bythotrephes*. Densities ranged from 0.03 to 876/m^3.

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, 8 and 9 in 2004. Data is not available for these stations from 2005 through 2008. In 2007 it was found at station 18, first record for the eastern basin. Densities were relatively low ranging from 0.13 to 64/m^3.

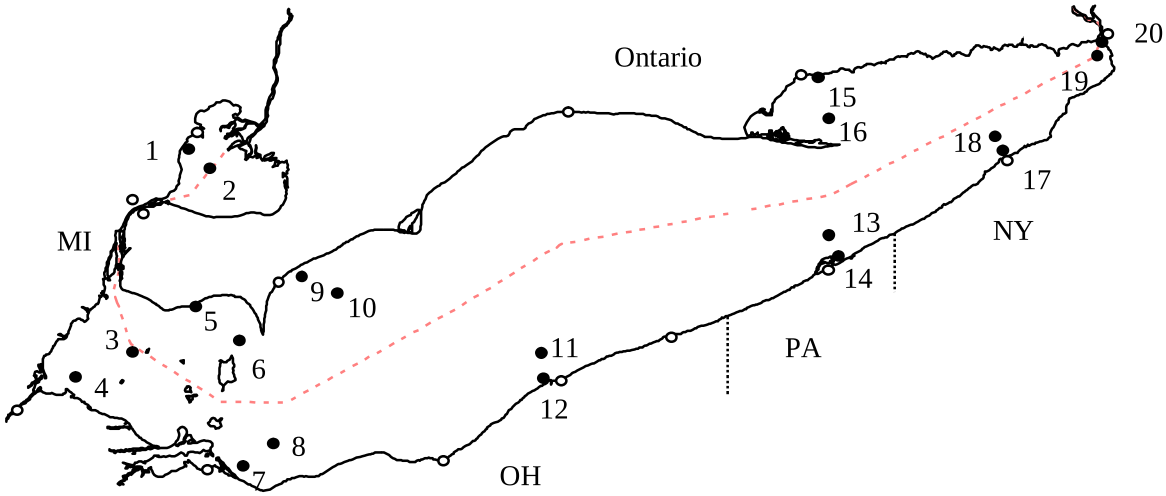

Figure 5.0.1. Lower trophic level sampling stations in Lakes Erie and St. Clair.

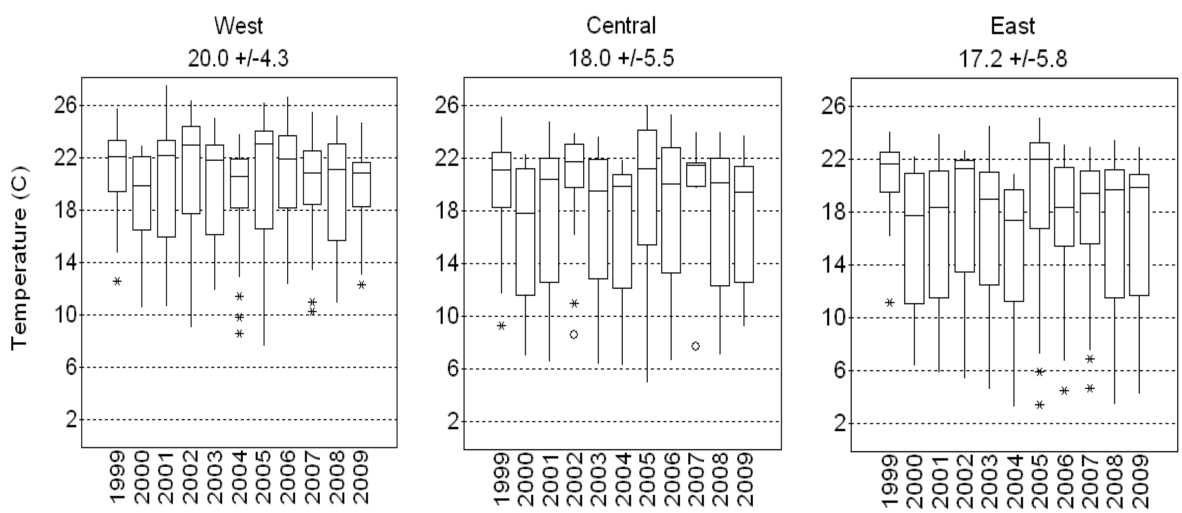

Figure 5.0.2. Epilimnetic water temperature (C) at offshore stations by basin in Lake Erie, May-Sept, 1999-2008. Box plots represent median, 25th, and 75th quartile. Long-term average water temperature is 20.0 C in the western basin, 18.0 C in the central basin and 17.2 C in the eastern basin. For this analysis only data from stations 3, 6, 8, 10, 11, 13, 16, and 18 were included.

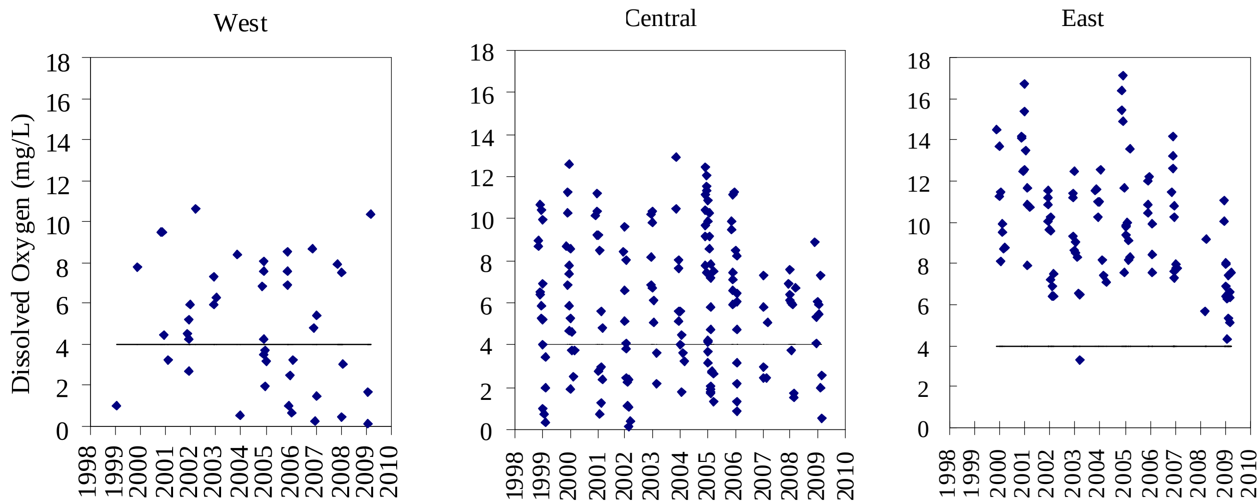

Figure 5.0.3. Mean hypolimnetic dissolved oxygen (mg/L) in each basin of Lake Erie, 1999-2007. The mean is an average of all hypolimnion DO measurements by date and is calculated only for dates when the water column was stratified (typically from June to September). The horizontal line represents 4 mg/L, 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, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18 and 25 were included. Stations 7, 14, 19 and 20 rarely stratified.

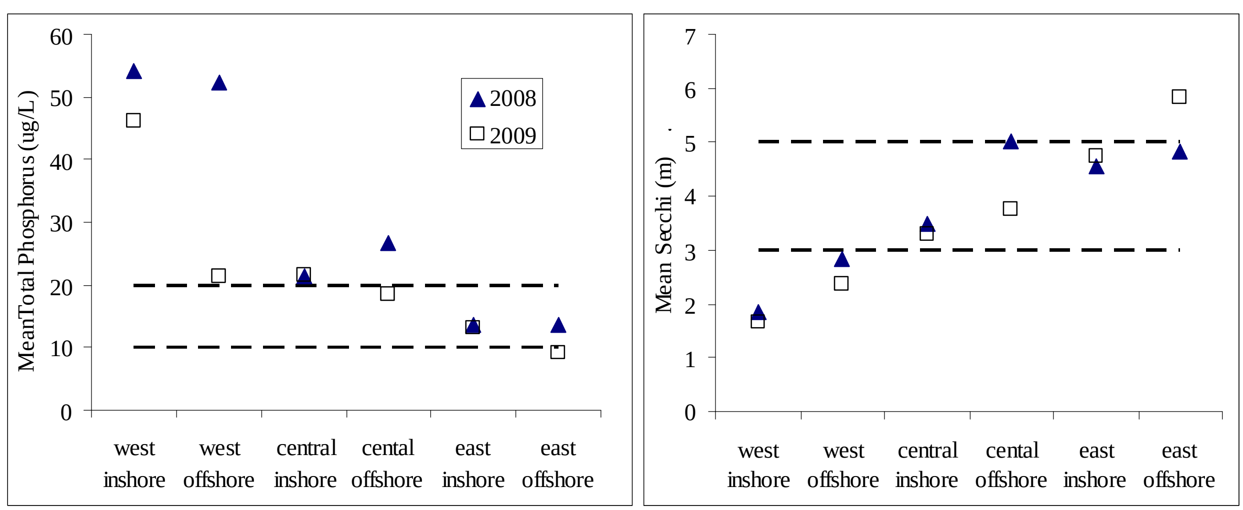

Figure 5.0.4 Mean total phosphorus and Secchi depth by basin and location for 2008 and 2009. West inshore includes stations 4, 5, and 7; west offshore includes stations 3, 6, and 8; central inshore includes stations 9, 12, and 14; central offshore includes stations 10, 11, and 13; east inshore includes 15, 17, 19, and 20; and east offshore includes 16, 18 and 25.

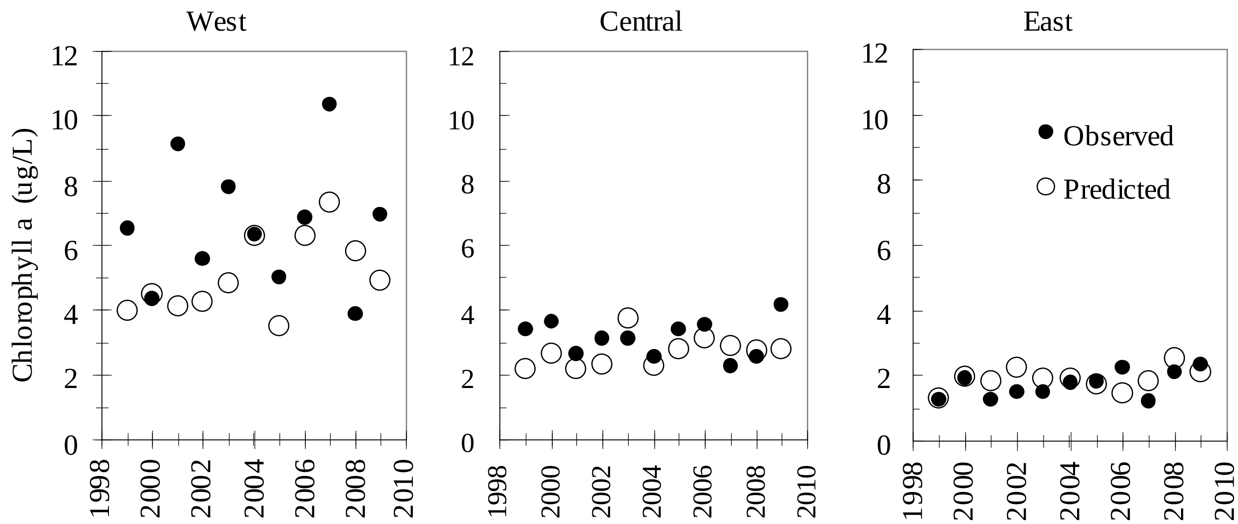

Figure 5.0.5. Observed and predicted chlorophyll *a* concentration (ug/L) in each basin of Lake Erie, 1999-2007. Chlorophyll *a* is predicted from equations presented in Mazumder 1994 for even-linked systems (those where grazing limits phytoplankton standing crop). For this analysis data from stations 3 through 20, and station 25 were included.

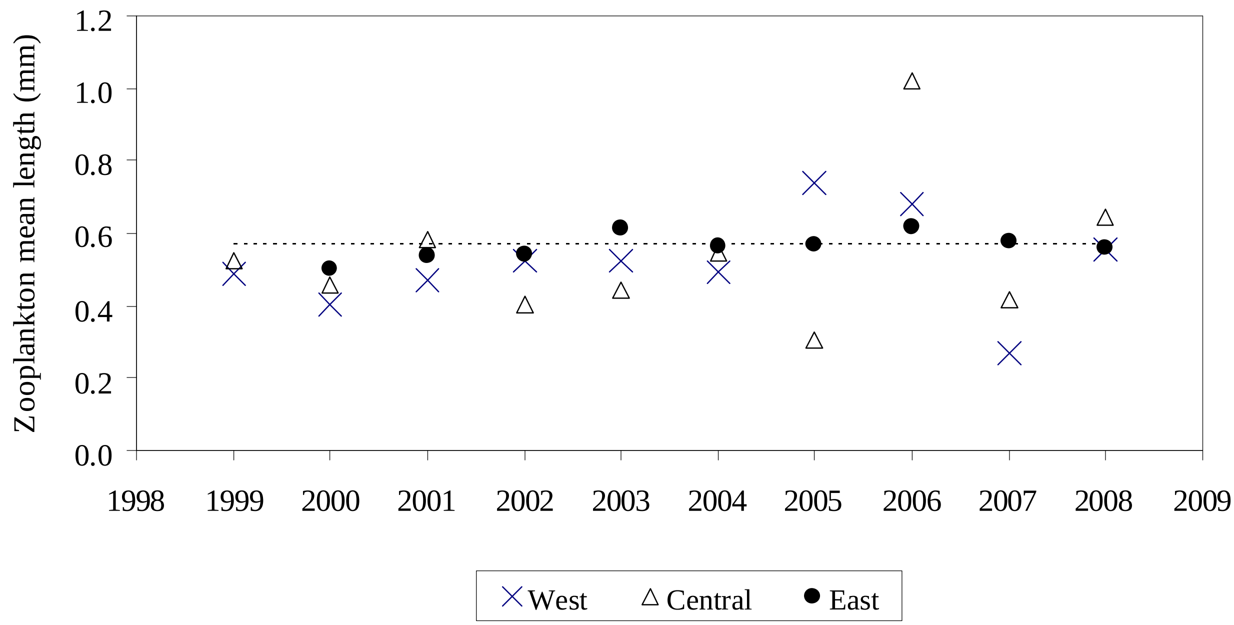

Figure 5.0.6. Mean length of the zooplankton community sampled with a 63 µm plankton net hauled through the epilimnion of each basin of Lake Erie, 1999-2006. The horizontal dashed line depicts 0.57 mm; if the mean size of the zooplankton community is 0.57mm or less, predation by fish is considered to 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 (*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 and have become established in all areas of Lake Erie (Figure 6.0.1). In 2009, round goby abundance indices have generally decreased from 2008 and are at or below long term means. 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.

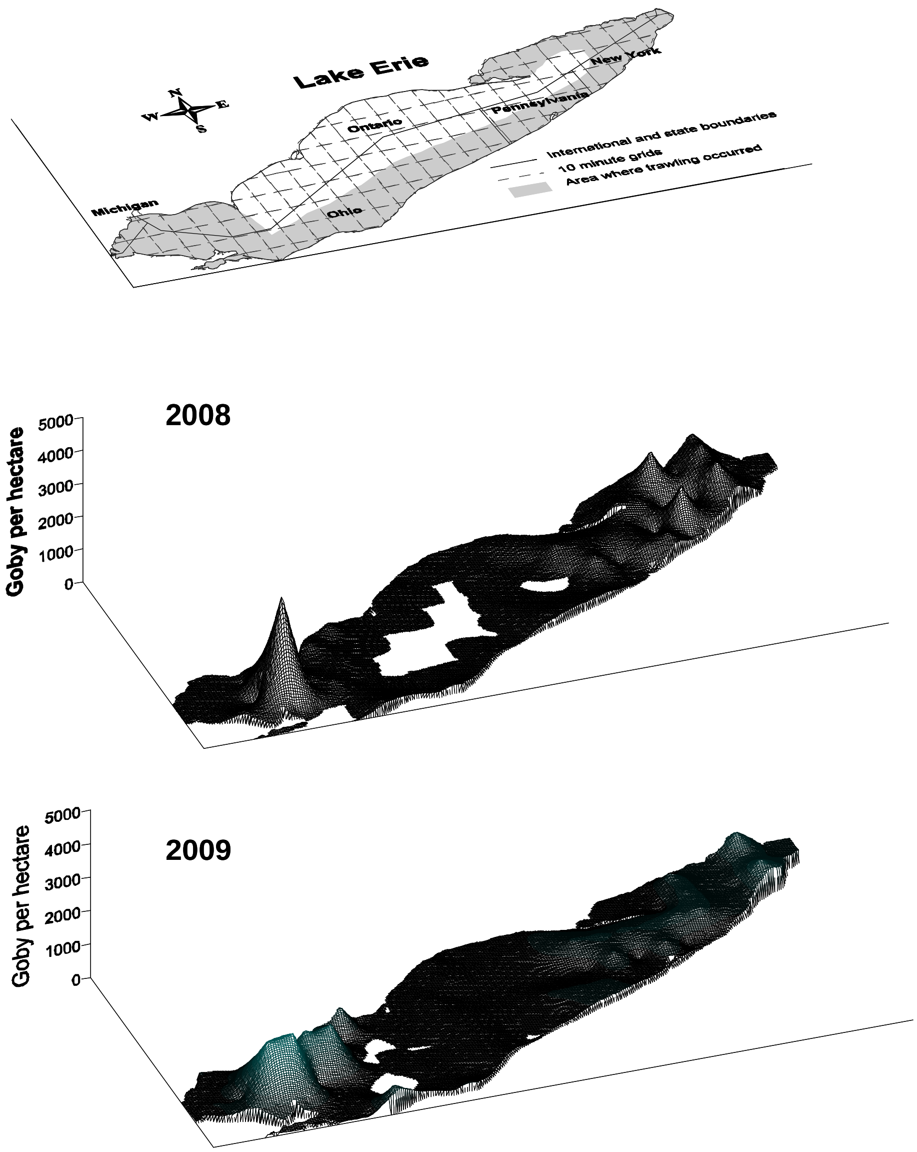

Figure 6.0.1 Two dimensional base map (upper) and three dimensional maps of round goby distribution in Lake Erie as density per hectare 2008 and 2009 estimated from bottom trawl catches. The base map shows state and provincial boundaries, the ten minute grid system used for trawl data summarization, 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 *Hemimysis anomala* Distribution (by T. MacDougal, J. Markham, and J. Deller)

Hemimysis anomala, commonly called the bloody-red shrimp, is a small shrimp-like mysid crustacean native to European waters, primarily the Black Sea, the Azov Sea, and the Caspian Sea. It was first detected in the Great Lakes in 2006, likely as a result of introduction via ballast water from oceangoing ships. Confirmed observations of *H. anomala* from disparate geographic locations in 2006 (near Muskegon, MI, along the northeast shoreline of Lake Erie and in Lake Ontario near Oswego, New York) suggest that this species is established and broadly distributed within the Great Lakes (NOAA- GLERL; Hemimysis fact sheet, February 2007).

Observations of Hemimysis in fish diets continue to increase in Lake Erie. To date, they have been observed in the stomachs of white perch, rock bass, and yellow perch. Hemimysis have been observed annually in white perch since 2006 and in rock bass since 2007. They have only been observed in the stomachs of yellow perch (5 fish from ODNR surveys of Ohio waters) in 2007. Evidence from the Long Point Bay area of the north shore, eastern basin, suggests that their use as a food source by white perch, at least in that part of the lake, has steadily increased from 3% to 14% between 2006 and 2009 (Figure 7.0.1)

The spatial extent of Hemimysis in fish diets has also increased over time. Hemimysis in the stomach of a white perch taken from the western basin, east of Pelee Island in 2009 (USGS surveys) is the first observation from offshore waters and suggests that the islands of the western basin likely also harbor this mysid . An observation of a free swimming individual bloody red shrimp captured during a trawl survey (USFWS ruffe survey) extends the known range eastward on the Ohio shoreline (Figure 7.0.2).

Outside of fish diets, *H. anomala* can be difficult to locate because the species is nocturnal, preferring to hide in rocky cracks and crevices near the bottom along the shoreline during daylight. It sometimes exhibits swarming behavior, especially in late summer, forming small dense reddish-tinged clouds containing thousands of individuals concentrated in one location and visible just below the waters surface in a shallow zone (NOAA- GLERL; Hemimysis fact sheet, February 2007).

In 2007, one free-swimming individual was detected in waters associated with the NRG Steam Station in Dunkirk, NY and underwater video of the lakebed near Hoover Point, Ontario revealed multiple swarms of what appear to be *H. anomala* in 7m depths associated with rocky areas. In November 2008, lake trout egg traps captured 58 individuals on Brocton Shoal, a historic lake trout spawning area just west of Dunkirk. These samples were collected at depths of 13.7-18.9m. *Hemimysis* were also collected in egg traps in this same area during 2009 but in lesser numbers. Targeted sampling for *H. anomala*, conducted by the Canadian Department of Fisheries and Oceans (GLLFAS), along the north shore during 2007 and 2008, regularly found *Hemimysis* in large numbers in all three lake basins (K. Bowen, Dept. of Fisheries and Oceans, GLLFAS, pers. comm.). There is no doubt that the species is now well established in Lake Erie. It may be notable that, in the eastern basin diet analysis, Hemimysis were observed in white perch captured in the rocky north shore shoal areas but not white perch captured in the sandier regions of Long Point Bay

The impact of this species on Lake Erie and the other Great Lakes is unknown, but based on its history of invasion across Europe, significant impacts are possible. If integrated into the current lake ecosystem, this species has the potential to alter foodwebs by serving as both a food source and as a consumer of zooplankton resources. In its native waters, its main prey item is zooplankton, primarily cladocerans, rotifers, and ostracods. It has the ability to reduce zooplankton biomass were it is abundant. Due to its lipid content, *H. anomala* is considered a high-energy food source and has the potential to increase the growth of planktivores (Rebekah M. Kipp and Anthony Ricciardi. 2006. GLANSIS).

The Forage Task Group will continue to monitor and document the progression of this species and determine its impact on the Lake Erie ecosystem.

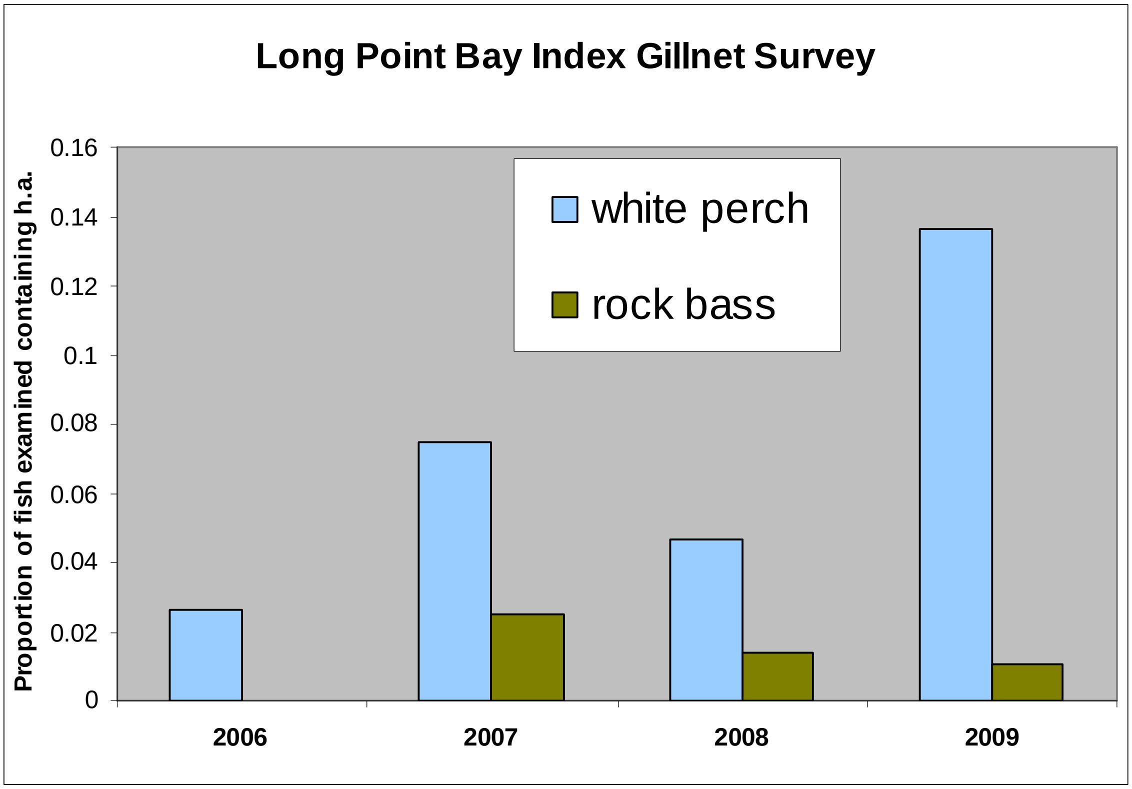

Figure 7.0.1 Proportion of stomachs containing Hemimysis anomala from white perch and rock bass taken from Long Point Bay, 2006-2009.

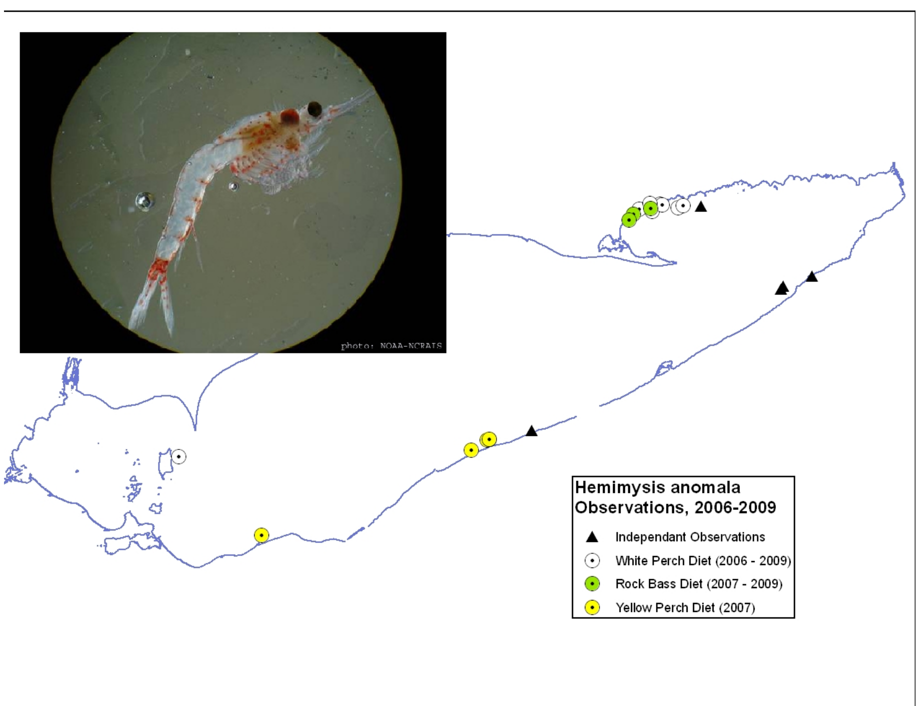

Figure 7.0.2 Spatial extent of Hemimysis observations in Lake Erie, 2006 to 2009.

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.

Acknowledgments

The FTG is grateful to Dr. Patrick Kocovsky (USGS) and Jeff Tyson (ODOW) for input on trawl CPUE statistical summaries, section 3.1; Dr. Lars Rudstam (Cornell University), Dr. Dave Warner (USGS) and Dr. Patrick Kocovsky (USGS) for their continued support of hydroacoustic surveys, section 4.0; Dr. Alicia Perez-Fuentetaja (SUNY-Buffalo) for lower trophic collections, section 5.0; and Sherr Vue (Ohio State University) and Andy Cook (OMNR) for contributions to multiple sections of this report.

Literature Cited

Argyle, R. L. 1992. Acoustics as a tool for the assessment of Great Lakes forage fishes. Fisheries Research 14:179-196.

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.

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. 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.

Godlewska, M., Colon M., Doroszczyk L., Długoszewski B., Verges C., Guillard J. 2009. Hydroacoustic measurements at two frequencies: 70 and 120 kHz – consequences for fish stock estimation. Fish Res. Special Issue, 96:11-16.

Guillard, J., Lebourges-Dhaussy, A., and Brehmer, P. 2004. Simultaneous Sv and TS measurements on Young-of-the-Year (YOY) freshwater fish using three frequencies. ICES Journal of Marine Science, 61: 267-273.

Horpilla J., T. Malined, and H. Peltonen. 1996. Density and habitat shifts of a roach (*Rutilus rutilus*) stock assessed within one season with cohort analysis, depletion methods, and echosounding. Fisheries Research 28:151-161.

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.

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.

Love, R.H. 1971. Measurements of fish TS: a review. Fishery Bulletin 69:703-715.

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.

Ohio Division of Wildlife (ODW). 2010. Ohio Lake Erie Fisheries, 2009. Annual status report. Federal Aid in Fish Restoration Project F-69-P. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Units, Fairport and Sandusky.

Parker-Stetter, S.L., Rudstam, L.G., Sullivan, P.J., and Warner, D.M. 2009. Standard operating procedures for fisheries acoustic surveys in the Great Lakes. Great Lakes Fish. Comm. Spec. Pub. 09-01.

Rebekah M. Kipp and Anthony Ricciardi. 2006. GLANSIS.

Rudstam, L.G., Parker-Stetter, S.L., Sullivan, P.J., and Warner, D.M. 2009. Towards a standard operating procedure for fishery acoustic surveys in the Laurentian Great Lakes, North America. – ICES Journal of Marine Science, 66: 000-000

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.

Ryan, P.A., R. Knight, R. MacGregor, G. Towns, R. Hoopes, and W. Culligan. 2003. Fish-community goals and objectives for Lake Erie. Great Lakes Fish. Comm. Spec. Publ. 03-02. 56 p.

Sawada, K., Furusawa, M., and Williamson, N.J. 1993. Conditions for the precise measurement of fish target strength *in situ*. Journal of the Marine Acoustical Society of Japan, 20: 73-79.

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.