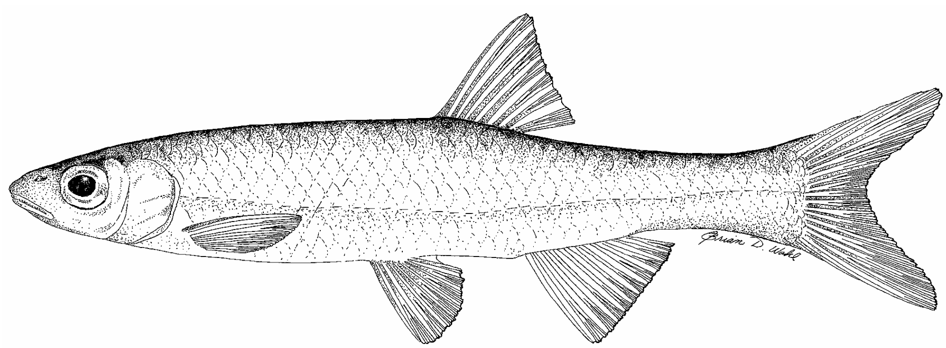
Report of the
Lake Erie
Forage Task Group

March 2006



Members:

Chuck Murray	- Pennsylvania Fish and Boat Commission, (PFBC) {Co-chair}
Bob Haas	- Michigan Department of Natural Resources, (MDNR) {Co-chair}
Mike Bur	- United States Geological Service - Biological Resources Division (USGS)
John Deller	- Ohio Department of Natural Resources, (ODNR)
Don Einhouse	- New York Department of Environmental Conservation, (NYSDEC)
Jim Francis	- Michigan Department Natural Resources, (MDNR)
Tim Johnson	- Ontario Ministry of Natural Resources, (OMNR)
Jim Markham	- New York Department of Environmental Conservation, (NYSDEC)
Tom MacDougall	- Ontario Ministry of Natural Resources, (OMNR)
Elizabeth Trometer	- United States Fish and Wildlife Service, (USFWS)
Jeff Tyson	- Ohio Department of Natural Resources, (ODNR)
Eric Weimer	- Ohio Department of Natural Resources, (ODNR)
Larry Witzel	- Ontario Ministry of Natural Resources, (OMNR)

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 2005-2006

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

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

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

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

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

2.0 Forage Task Group Bullet Statements

2.1 2006 Forage Task Group Synopsis

General Patterns

- Smelt abundance decreased lake wide to near record low abundance.
- Emerald shiner age-0 abundance increased to near record levels lake wide.
- Walleye diets dominated by rainbow smelt in east; clupeids and shiners were primary diet items in central and west basins; round goby continue to increase in diets
- Age-2 walleye size tended to be below long term averages

Eastern Basin

- Age-0 rainbow smelt decreased to near record low abundance in Ontario waters and remained about same in New York waters; age-1+ smelt abundance decreased basin wide
- Age-0 emerald and spottail shiners, alewife, gizzard shad, white bass, white perch and trout-perch increased
- Round goby decreased from a peak in 2004, but remained very abundant
- Predator diets remain dominated by smelt; gobies continue to increase in diets.
- Size of age-0 smelt decreased; size of age-1 smelt increased.
- Predator growth remains good; age-2 and -3 smallmouth bass were above average size; age-0 and age-1 yellow perch were below average size
- Age-2 walleye from the abundant 2003 year class were slightly smaller than long-term average length (NYSDEC)
- lake trout size-at-age remain stable; among highest in the Great Lakes

Central Basin

- Increase in most age-0 forage abundance indices from 2000; largest increase in white perch and emerald shiners indices
- Decrease in yearling-and-older (YAO) forage due to below average 2004 cohort
- Basin wide decrease in smelt and increase in emerald shiner abundances
- Increase in mean size of age-0 and YAO of most species. No long term trends in growth
- Walleye diets are primarily gizzard shad in west and emerald shiners in east

Western Basin

- Age-0 clupeid catches up from 2004; few alewife captured in trawls and gizzard shad up, but still below long-term mean
- Smelt catches third lowest in time series
- Age-0 emerald shiner 2nd highest in time series
- Age-0 white perch, round gobies, and adult trout-perch down from 2004, but still above long-term mean; age-0 trout-perch increased
- Percid recruitment up from 2004, but well below long-term mean; age-0 smallmouth bass above long-term mean
- Predator size-at-age comparable to long term mean; age-2 walleye below average
- Walleye diets show reliance on clupeids and shiners

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

Rainbow smelt are the principal forage fish species of piscivores in the offshore waters of eastern Lake Erie (Table 2.2.1). Relative abundance of yearling-and-older (YAO) smelt (predominately age-1) decreased basin wide in 2005, reaching near record low densities in Ontario, and marking a return to a pattern of alternate year shifts in abundance that has characterized the smelt population of eastern Lake Erie for many years.

Young-of-the-year (YOY) smelt abundance increased slightly in southern regions of the east basin, but was observed in record low numbers in Ontario (Table 2.2.1). Mean length of age-0 smelt in 2005 was the smallest observed in OMNR's 22-year time series (Figure 2.2.1). Mean length of age-1 smelt in 2005 increased to long-term average size (103 mm FL).

The contribution of non-smelt fish species to the forage fish community of eastern Lake Erie as depicted by agency index trawl survey catches in 2005 was not consistent among jurisdictional regions (Table 2.2.1). Fish species exhibiting the greatest change in abundance were emerald shiner (YOY increase, YAO decrease), age-0 white perch (increase), and round goby (decrease). Spottail shiner abundance increased in some regions in 2005, but their relative abundance basin wide remained below the long-term averages for all of the agency survey time series. Age-0 clupeid species appeared to be about the same or slightly more abundant in 2005 than last year, but were less abundant than the long-term average. Trout-perch were caught in near record high numbers in southern regions of eastern Lake Erie, but remained conspicuously sparse throughout Long Point Bay.

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. In 2005 goby densities decreased basin wide (Table 2.2.1).

During 2005, 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 (FTG). 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 began to make a small, but measurable, contribution to the walleye diet. Within a year or two of colonization, round goby has emerged as the single largest component of the diet of adult smallmouth bass (NY index gill nets). Fish species continue to comprise the majority of the diets of both lake trout and burbot caught in index gill nets during August. Smelt remain the dominant food item of lake trout, occurring in 85% of stomach samples. Round gobies were the next most common forage item consumed by lake trout, occurring in 19% of stomach samples. Burbot were one of the most diverse feeders among large predators with 10 different fish and invertebrate species found in their stomach samples. Round gobies, the most dominant prey item in burbot over the past two years, declined in occurrence to 36% while smelt increased to 59%.

Age-2 and age-3 smallmouth bass cohorts sampled in 2005 autumn gill net collections remained longer than average for New York's 25-year data series. Age-2 walleye sampled in this survey gear were only slight smaller (4%) than long-term average lengths, and were an exceptionally abundant cohort. Juvenile yellow perch (age-0 & age-1) were both below long-term averages for New York's length at age data series. Mean lengths-at-age and mean weights-at-age of lake trout remain consistent with the 5-year average (2000 – 2004) 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 increased from 2004 primarily due to basin wide increases in YOY white perch and YOY and YAO emerald shiners (Tables 2.3.1 and 2.3.2). Most YOY indices increased, while YAO indices decreased from 2004. Both the YOY and YAO abundance indices are at the 10 year average.

Young-of-the-year indices increased to almost twice what was seen in 2004. The increase was driven by white perch and emerald shiners in Ohio waters of the Central basin. White perch in particular have increased each year since 2002. Round goby indices continue to oscillate, decreasing in eastern areas and increasing in western areas of the basin. Rainbow smelt have decreased for the second year in a row to some of the lowest values in the time series. Clupeid abundance continues to be well below the long term average in spite of an increase in gizzard shad from 2004.

Yearling-and-older forage abundance decreased from 2004 due to the generally poor cohort strength of 2004. Emerald shiners were the only YAO forage species that increased in abundance basin wide from 2004. In Pennsylvania waters, round goby abundance has oscillated since becoming established in 1998 but has generally increased over the time series. In the eastern areas of Ohio, round goby indices have increased over the last three years to the second highest abundance in the time series, while indices in the western areas of the basin have remained stable over the same time period. Yearling-and-older smelt abundance decreased dramatically from 2004. The decrease is probably due to a large post spawning die-off that occurred in the Central basin in May and June of 2005 and poor recruitment from the 2004 cohort

In Ohio waters of the central basin, mean size of almost all age-0 and age-1+ forage species increased from 2004. Mean size of age-0 smelt has decreased over the last three years and is the smallest in the time series. Other than age-0 smelt, there are no long term trends in growth of forage species.

Similar to previous years, there was a distinct east to west trend in walleye diets. In the east, walleye diets were primarily emerald shiners (70%) and gizzard shad (16%). In the west, walleye consumed gizzard shad (67%) and emerald shiners (27%). In 2005, rainbow smelt, usually a large component of predator diets, were almost absent from predator diets in the fall, further supporting the low abundance indices in the central basin. Round goby continue to be important diet items in smallmouth bass, white bass and yellow perch.

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

Recruitment of virtually all species improved in 2005, following the weak year-classes produced in 2004. The only notable exceptions were rainbow smelt (0.7/ ha, third lowest index since 1990), white perch (3399.8/ha, still above long-term mean), and round goby (41.7/ha). CPUE of age-0 yellow perch and walleye were up from 2004 (Figure 2.4.1), although still well below long-term means. Both gizzard shad (550.4/ha) and alewife (1.2/ha) indices were improved from 2004 (Figure 2.4.2). Recruitment indices for shiners were down slightly in 2005, although emerald shiner recruitment was up. Yearling-and-older shiner production was down markedly relative to 2004 (Figure 2.4.3). Age-0 white bass CPUE was up to 185.8/ha, while age-0 smallmouth bass increased to 2/ha, the third highest index in the series.

Length of most species of age-0 fish also showed increases in 2005 relative to 2004, closer to long-term averages. Several factors may have contributed to improved growth including: warmer water temperatures, decreased competition for prey resources, and size-selective predation by the large 2003 year classes of walleye and yellow perch. More intensive analyses of zooplankton data and predator diets in the coming months will aid in our interpretation of these and other hypotheses surrounding trends in growth. The large 2003 year classes of yellow perch and walleye continued to exhibit below average lengths-at-age.

Walleye diets remained dominated by clupeids (72.2%) and emerald shiner (20.2%), despite the relative low absence of these species in trawls. White perch were present in walleye diets (4.9%), as were yellow perch (2.6%). Round gobies and shiners were notable components of yellow perch and smallmouth bass diets, with mayflies being seasonally important to yellow perch in the early summer.

Water temperatures were warmer in 2005 than in the previous year, with peak surface temperature (26.3°C) recorded on August 10. Spring warming rate (May 4 to June 2) was 0.28°C per day. Seasonally averaged basin wide Secchi depth increased slightly from 2004, averaging 2.04 m [range 0.45m (early May) to 5.2 m (mid July)]. Western basin bottom dissolved oxygen levels averaged 7.6 mg/l [range 0.38 (August 10) to 12.5 mg/l (May 4)]. 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 2003 and 2004. Indices are reported as arithmetic mean number caught per hectare (NPH) for the age groups young-of-year (YOY) and yearling-and-older (YAO). Long-term averages are reported as the mean of the annual trawl indices for survey years during the present (90's Avg.) and previous (80's Avg.) decades. Agency trawl surveys are described below.

Species	Trawl Survey	YOY 2005	YOY 2004	YOY 90's Avg.	YOY 80's Avg.	YAO 2005	YAO 2004	YAO 90's Avg.	YAO 80's Avg.
Smelt	ON-DW	0.9	132.2	485.6	1382.9	7.6	567.5	404.7	969.0
	NY-Fa	1259.6	1146.1	1450.9	NA	395.2	2624.1	581.6	NA
	PA-Fa	47.9	12.3	550.8	7058.1	0.0	12.3	378.0	2408.6
Emerald Shiner	ON-DW	645.7	20.3	54.8	20.5	139.0	891.2	46.4	38.1
	ON-OB	1.1	405.2	119.4	152.3	0.1	60.0	49.9	133.5
	NY-Fa	291.4	7.8	112.4	NA	151.4	284.2	105.4	NA
	Pa-Fa	0.5	0.0	41.0	118.3	52.5	0.0	14.5	45.6
Spottail Shiner	ON-OB	58.7	43.2	696.6	249.0	3.2	7.9	52.3	21.3
	ON-IB	1.0	1.9	111.6	291.3	0.0	0.0	2.0	9.4
	NY-Fa	0.5	0.1	19.9	NA	4.3	2.5	4.0	NA
	PA-Fa	0.0	0.0	4.0	2.0	0.0	0.0	7.9	12.4
Alewife	ON-DW	0.1	0.3	234.1	21.4	NA	NA	NA	NA
	ON-OB	11.0	3.2	61.0	51.5	NA	NA	NA	NA
	NY-Fa	27.7	4.4	52.0	NA	NA	NA	NA	NA
	PA-Fa	0.0	0.0	7.7	16.6	NA	NA	NA	NA
Gizzard Shad	ON-DW	1.7	0.2	7.5	15.3	NA	NA	NA	NA
	ON-OB	1.9	3.6	9.6	24.1	NA	NA	NA	NA
	NY-Fa	3.7	0.6	4.2	NA	NA	NA	NA	NA
	PA-Fa	0.0	0.0	0.9	74.3	NA	NA	NA	NA
White Perch	ON-DW	0.1	0.0	2.2	5.6	NA	NA	NA	NA
	ON-OB	0.4	0.1	14.2	28.7	NA	NA	NA	NA
	NY-Fa	99.8	1.0	29.4	NA	NA	NA	NA	NA
	PA-Fa	51.2	0.0	101.1	NA	NA	NA	NA	NA
Trout-perch	ON-DW	0.0	0.2	0.1	0.5	0.0	1.5	0.5	1.9
	NY-Fa	1317.3	545.9	410.0	NA	NA	NA	NA	NA
	PA-Fa	27.4	46.2	23.2	NA	171.2	114.1	26.0	NA
Round Goby a	ON-DW	66.9	323.8	0.2	0.0	NA	NA	NA	NA
	ON-OB	28.0	69.1	0.6	0.0	NA	NA	NA	NA
	ON-IB	21.0	66.9	0.0	0.0	NA	NA	NA	NA
	NY-Fa	438.4	781.3	1.0	0.0	268.5	313.2	0.0	0.0
	PA-Fa	497.7	560.9	30.3	0.0	390.2	366.6	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 NYSDEC (NY-) trawl indices for trout perch reported as "all ages" under the heading for YOY.

Ontario Ministry of Natural Resources

ON-DW — Trawling is conducted weekly during October at 4 fixed stations in the offshore waters of Outer Long Point Bay using a 10-m trawl with 13-mm mesh cod end liner. Indices are reported as NPH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999.

ON-OB — Trawling is conducted weekly during September and October at 3 fixed stations in the nearshore waters of Outer Long Point Bay using a 6.1-m trawl with a 13-mm mesh cod end liner. Indices are reported as NPH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1998

ON-IB — Trawling is conducted weekly during September and October at 4 fixed stations in Inner Long Point Bay using a 6.1-m trawl with a 13-mm mesh cod end liner. Indices are reported as NPH; 80s Avg. is for period from 1984-1989; 90s Avg. is for period from 1990-1999.

New York State Department of Environmental Conservation Trawl Survey

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

Pennsylvania Fish and Boat Commission Trawl Survey

PA-Fa — Trawling is conducted at nearshore (<22 m) and offshore (>22 m) stations during October using a 10-m trawl with a 6.4-mm mesh cod end liner. ndices are reported as NPH; 80's Avg. is for the period 1984 to 1989; 90's Avg. is for the period 1990 to 1999.

Table 2.3.1 Relative abundance (arithmetic mean number per hectare) of selected young-of-the-year species from fall trawl surveys in the central basin, Ohio and Pennsylvania, Lake Erie, from 1995-2005.

	year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	mean
Yellow perch	OH MU2	2.5	119.1	12.3	69.8	73.6	21.9	114.6	6.0	149.0	8.7	37.7	55.9
	OH MU3	12.4	128.4	2.6	38.1	21.0	1.3	13.6	2.5	47.5	1.9	156.2	38.7
	PA MU3	52.0	354.1	0.0	13.7	7.2	15.7	388.4	11.9	788.0	2.4	6.7	149.1
White perch	OH MU2	3.5	223.8	267.5	91.9	334.1	581.3	779.7	293.0	310.1	759.7	1002.5	422.4
	OH MU3	69.5	539.9	2.3	52.3	37.1	4.9	57.6	5.9	61.8	108.0	2034.5	270.3
	PA MU3	136.0	331.5	0.0	0.0	8.5	75.9	26.6	80.7	173.8	2.4	42.3	79.8
White bass	OH MU2	23.8	42.3	9.2	44.6	160.1	16.7	161.0	27.6	106.2	1.0	77.6	60.9
	OH MU3	15.8	101.4	20.1	41.7	84.0	24.5	18.0	11.2	90.2	0.3	58.2	42.3
	PA MU3	4.4	0.0	0.0	0.0	0.0	96.4	12.1	0.0	0.0	0.0	1.9	10.4
Rainbow smelt	OH MU2	348.1	421.2	238.2	253.3	70.8	150.1	2.3	274.7	1753.9	352.1	10.7	352.3
	OH MU3	1693.7	2944.5	477.2	953.8	282.4	1070.3	0.0	218.1	2914.1	388.9	44.4	998.8
	PA MU3	106.7	5,422.1	10.3	29.9	1.8	15.3	377.4	152.9	177.6	20.9	15.9	575.5
Round goby	OH MU2	15.5	8.0	49.7	130.1	95.1	21.7	43.9	37.8	22.6	13.9	37.2	43.2
	OH MU3	51.8	44.5	106.4	186.7	178.2	158.2	39.6	64.7	57.5	173.9	148.1	110.0
	PA MU3		0.4	1.5	743.6	1,114.4	781.1	1,577.8	289.3	75.3	1,011.3	204.0	579.9
Emerald shiner	OH MU2	8.9	15.6	160.7	4928.5	408.4	127.2	50.5	39.4	477.6	7.0	567.1	617.4
	OH MU3	40.2	77.0	4.9	150.5	599.4	500.6	2.2	0.5	903.1	0.8	279.8	232.6
	PA MU3	53.6	3.5	0.0	5.8	0.0	0.0	8.5	38.1	81.8	0.0	17.8	19.0
Spottail shiner	OH MU2	0.3	13.8	14.6	1.4	5.6	0.4	5.9	1.6	0.0	0.0	0.2	4.0
	OH MU3	2.0	24.9	0.1	2.7	3.9	0.0	0.7	0.2	0.5	0.0	1.1	3.3
	PA MU3	19.9	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Alewife	OH MU2	9.9	12.7	9.3	10.0	37.2	62.1	50.8	59.7	0.1	0.0	0.0	22.9
	OH MU3	11.2	6.3	14.1	0.1	9.2	12.4	0.0	1.1	0.0	0.0	0.0	4.9
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Gizzard shad	OH MU2	1.2	77.1	12.4	33.8	104.3	117.1	60.3	24.6	402.6	0.6	12.3	76.9
	OH MU3	1.5	181.5	7.2	34.8	17.0	27.6	1.8	12.3	20.4	0.3	15.7	29.1
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.1
Trout-perch	OH MU2	0.9	1.2	0.0	0.3	5.5	1.0	2.0	1.4	2.0	20.3	0.1	3.1
	OH MU3	13.4	35.4	2.6	1.3	4.8	0.4	0.0	0.3	1.4	1.4	1.6	5.7
	PA MU3	24.9	7.1	0.0	23.1	10.0	23.0	7.8	45.6	78.0	6.7	0.3	20.6

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 1995-2005.

	year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	mean
Yellow perch	OH MU2	82.3	11.2	110.2	6.3	40.7	61.6	5.7	51.7	3.2	216.5	18.4	55.3
	OH MU3	27.3	3.9	34.0	3.7	40.0	19.3	0.4	38.3	1.2	45.2	132.3	31.4
	PA MU3	191.9	12.4	14.7	2.5	7.9	3.9	41.3	37.5	75.6	18.3	1.9	37.1
White perch	OH MU2	34.9	22.1	44.5	5.6	35.2	91.1	21.7	91.5	28.2	83.9	34.1	44.8
	OH MU3	9.4	4.3	37.1	0.2	14.6	38.6	0.4	176.2	12.0	27.0	20.1	30.9
	PA MU3	1.7	1.8	0.0	0.0	1.9	0.6	2.4	38.5	28.6	6.2	0.0	7.4
White bass	OH MU2	3.9	0.4	14.2	0.3	5.8	26.8	0.8	5.1	6.7	4.9	0.4	6.3
	OH MU3	3.3	0.2	13.0	0.3	2.0	10.8	1.8	5.8	0.9	6.8	0.1	4.1
	PA MU3	0.0	0.0	0.0	0.0	6.0	1.0	57.6	0.4	0.0	0.0	1.6	6.1
Rainbow	OH MU2	242.7	90.9	322.6	71.0	146.2	65.6	55.6	45.3	29.4	320.5	89.8	134.5
smelt	OH MU3	174.4	136.2	380.6	58.2	2115.1	150.3	3.3	320.9	370.3	1360.2	30.8	463.7
	PA MU3	506.0	29.9	26.5	1.3	0.0	75.8	0.0	6.2	22.1	9.9	2.6	61.9
Round	OH MU2	49.8	138.8	171.0	164.9	82.5	27.5	54.8	39.2	25.4	27.0	33.6	74.0
Goby	OH MU3	22.1	76.0	313.4	118.6	106.7	164.5	88.4	54.3	127.1	148.8	263.0	134.8
	PA MU3		0.0	0.0	113.1	55.3	126.5	55.2	238.3	59.1	767.0	206.7	162.1
Emerald	OH MU2	34.0	9.1	226.0	1862.1	515.8	109.2	106.3	233.9	54.9	1.5	233.6	307.9
shiner	OH MU3	37.2	25.6	2.1	22.8	502.6	830.5	0.7	133.2	432.0	0.4	479.6	224.2
	PA MU3	17.7	0.0	7.4	0.0	0.0	0.0	0.0	107.4	217.5	0.0	123.0	43.0
Spottail	OH MU2	5.6	18.0	17.2	28.3	5.8	8.7	3.5	6.6	1.6	5.3	0.3	9.2
shiner	OH MU3	16.9	6.5	1.8	5.0	7.2	8.6	1.1	5.9	1.0	0.2	3.8	5.3
	PA MU3	17.7	0.0	0.0	0.4	0.0	0.0	0.0	2.2	0.0	0.0	0.0	1.8
Alewife	OH MU2	0.0	0.0	0.0	0.0	0.0	0.6	0.0	2.9	0.0	0.0	0.0	0.3
	OH MU3	0.3	0.0	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.1
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.5	0.0	0.0	0.2
Shad	OH MU2	3.5	0.0	0.1	0.2	0.9	4.3	0.1	1.6	0.0	0.1	0.5	1.0
	OH MU3	1.2	0.1	0.1	0.1	0.3	1.2	0.0	1.7	3.0	0.2	0.2	0.7
	PA MU3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trout-perch	OH MU2	5.4	5.4	16.5	15.1	9.2	17.2	3.2	27.2	12.2	14.0	13.5	12.6
	OH MU3	19.8	22.4	12.8	14.8	9.3	15.3	2.2	8.5	2.9	7.7	76.2	17.4
	PA MU3	53.1	0.0	8.8	1.0	0.9	11.5	0.6	81.2	50.9	5.2	4.1	19.8

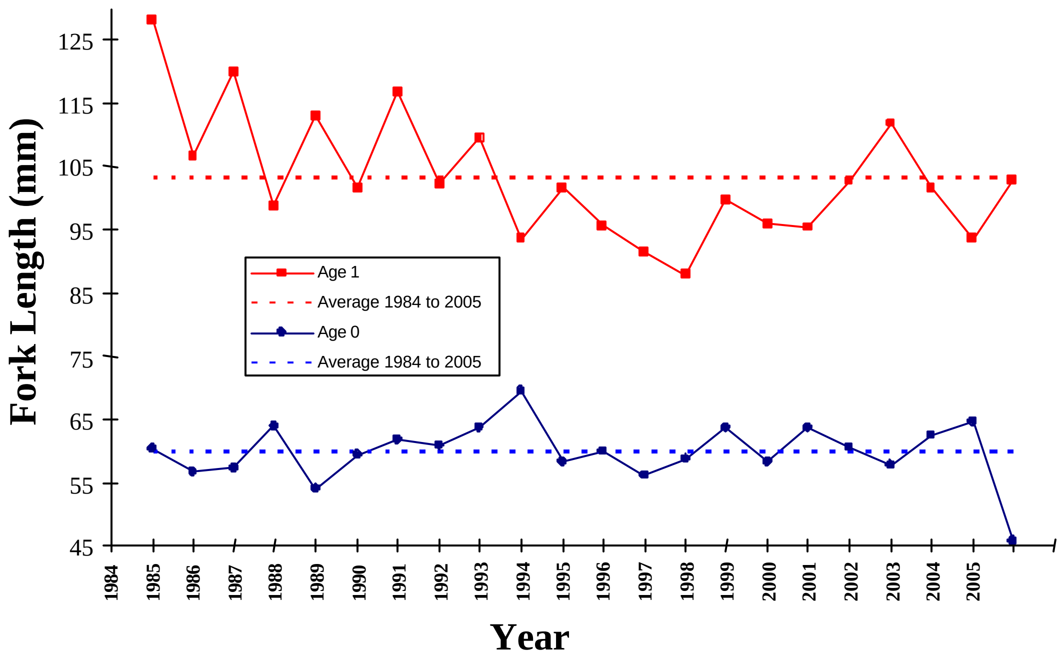

Figure 2.2.1 Mean fork length of age-0 and age-1 rainbow smelt from OMNR index trawl surveys in Long Point Bay, Lake Erie, October 1984-2005.

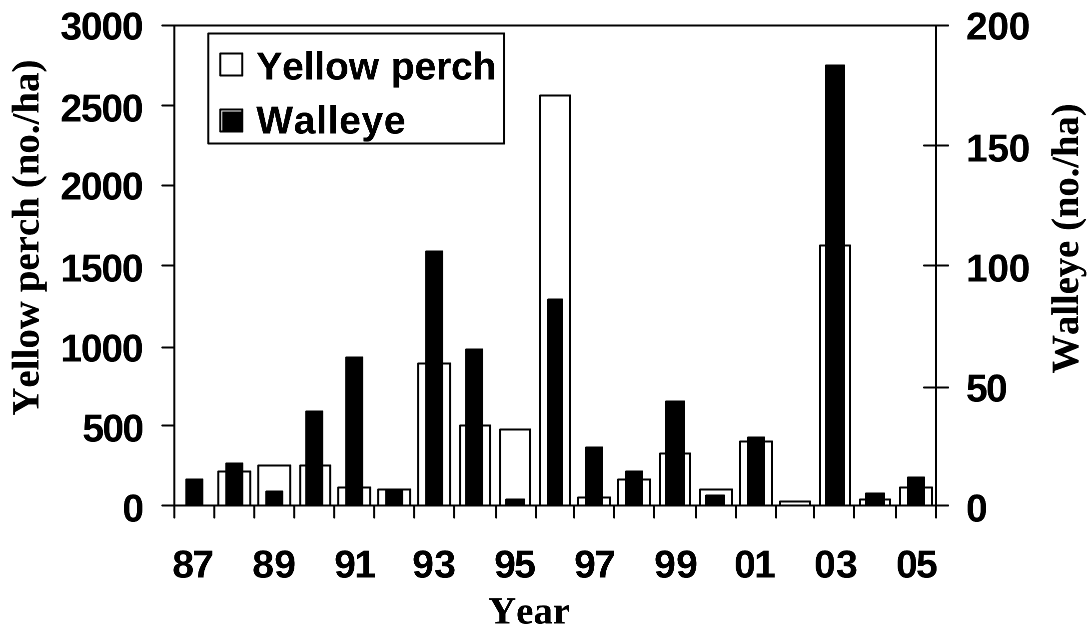

Figure 2.4.1 Density of age-0 yellow perch and walleye in the western basin of Lake Erie, August 1987-2005.

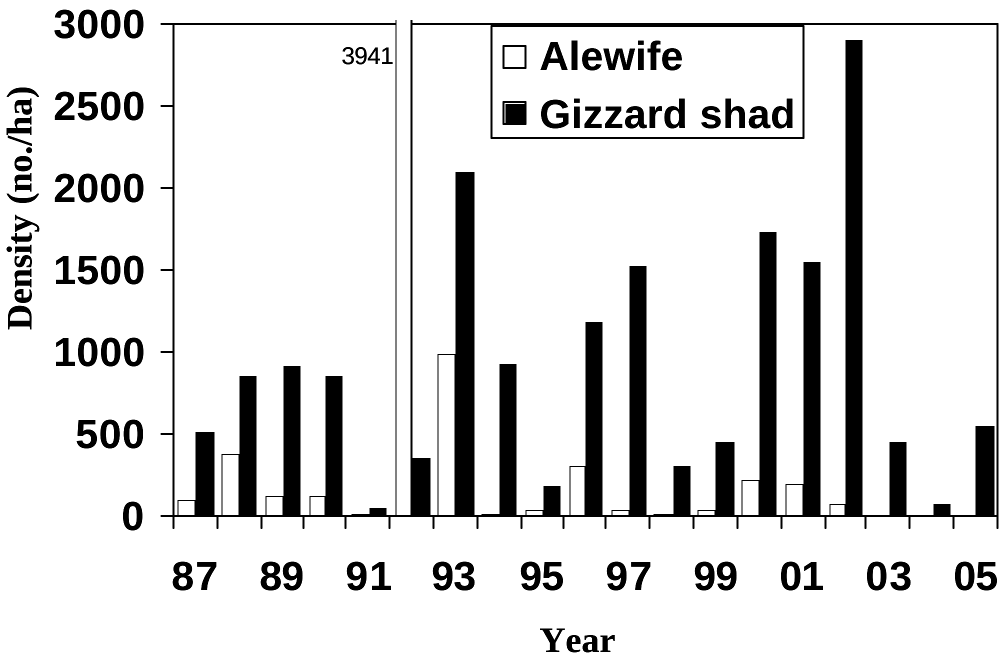

Figure 2.4.2 Density of age-0 alewife and gizzard shad in the western basin of Lake Erie, August 1987-2005.

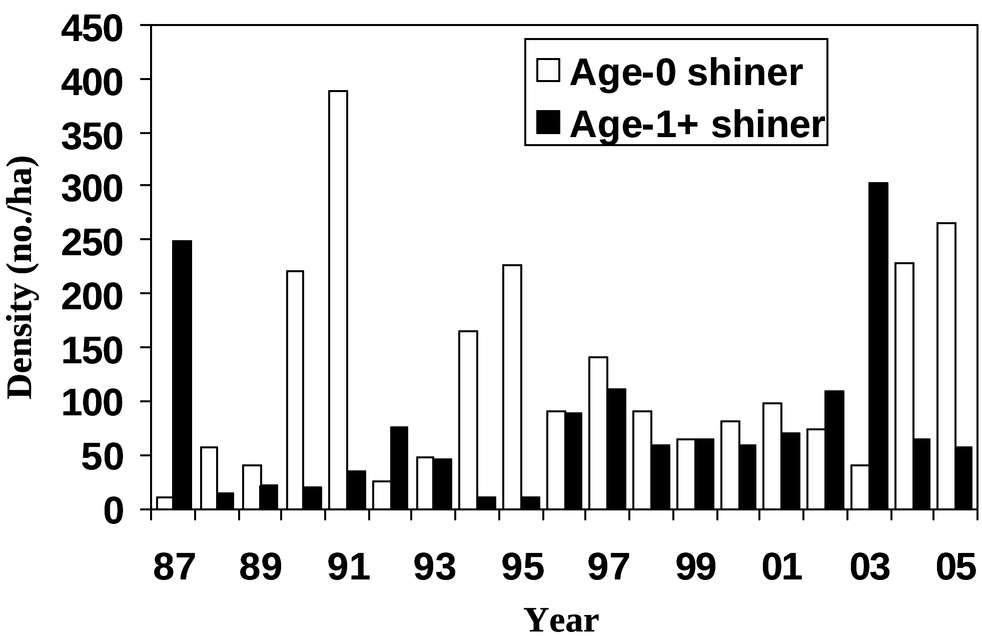

Figure 2.4.3 Density of age-0 and age-1+ shiners (*Notropis* spp.) in the western basin of Lake Erie, August 1987-2005.

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. Deller and D. Einhouse)

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

In 2001 the FTG started to compile information on current net mensuration systems. The white paper that was compiled identified several manufactures and references for product endorsements that provided very positive feedback on each systems use under field conditions. Current net mensuration systems are designed for commercial marine fisheries, where the trawl equipment is much larger than what is used for agency trawl surveys in Lake Erie. Thus, one question that consistently arises is the possible effect of the relatively large sensor size and weight on the small trawls used in management surveys.

New York State Department of Environmental Conservation purchased Netmind, manufactured by Northstar Technical, for use on Lake Ontario and Lake Erie trawl surveys. They have been using the Netmind system on midwater and bottom trawl surveys since 2004. It is now a standard component of every trawl sample and is useful in validating fishing dimensions. Additionally, they have found the system is beneficial for targeting specific depth strata for midwater trawl samples collected to support the hydroacoustic survey.

Bottom trawl equipment and protocols for NYDEC surveys had been standardized prior to initial efforts at net mensuration using the Scanmar equipment owned by USGS in the early 1990's. The net dimensions measured by the Netmind system appear to be different from what was measured with the Scanmar equipment, even though net design has not changed. The average wing spread is over 1m wider with the Netmind system compared to the Scanmar (Figure 3.1.1). The change in net dimensions could result from several factors; new technology may have better, more accurate measures; the size of new sensors or sensor placement may affect fishing dimensions; or are the new net dimensions a measure of the individual variability among replicate trawl construction. If the current measurements are true, not sensor induced, it would decrease the current trawl survey estimates of catch per hectare relative to previous years and require more frequent assessment of net dimensions to maintain the precision of trawl surveys over time.

The Michigan Department of Natural Resources has successfully measured trawl dimensions with side-scan sonar and a Biosonics 5000 DT acoustic sounder (Figure 3.1.2 and 3.1.3). The side-scan sonar gives an aerial representation of the shape of a trawl much like a photograph. Trawl dimensions can then be measured with post processing software. The head rope height off the bottom is measured with the Biosonics plant analysis software. By combining the two acoustic methods, it is possible to accurately measure trawl dimensions without the possible affects from sensor size or placement. Experiments conducted by MDNR found the side-scan and Biosonics measures of net dimensions were almost identical to the dimensions measured by the Scanmar equipment. By utilizing these techniques developed by the MDNR, the FTG is proposing to more fully evaluate the possible affect of Netmind sensors on net dimensions during 2006. If independent validation by side scanning sonar determines there is no influence on trawl fishing dimensions attributable to measurement sensors, then one shared trawl mensuration system among Lake Erie agencies satisfies the FTG's assessment need for maintaining survey standards. If not, each trawling program would either need to routinely employ a mensuration system as an element of trawl surveys, or otherwise intermittently validate trawl fishing dimensions using side scanning sonar. The FTG will provide a recommendation to the LEC based on the outcome these 2006 experiments.

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

Interagency trawling has been conducted in Ontario, Ohio and Michigan waters of the western basin of Lake Erie in August of each year since 1987. This interagency trawling program was developed to measure basin-wide recruitment of percids. More recently, the interpretation has been expanded to provide basin-wide community abundance indices, including forage fish abundance and growth. Information collected during the surveys includes length and abundance data on all species collected. A total of 62-90 standardized tows conforming to a depth-stratified (0-6m and >6m) random design are conducted annually by OMNR and ODNR throughout the western basin; results of 70 trawls were used in the analyses in 2005 (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 between agencies. In 1992, in response to the ITG recommendation, the FTG began the standardization and calibration of trawling procedures between agencies so that the indices could be combined and quantitatively analyzed across jurisdictional boundaries. SCANMAR was employed by most Lake Erie agencies in 1992, by OMNR and ODNR in 1995, and by ODNR alone in 1997 to calculate actual fishing dimensions of the bottom trawls. In the western basin, net dimensions from the 1995 SCANMAR exercise are used for the OMNR vessel, while the 1997 results are applied to the ODNR vessel. In 2002, ODNR began interagency trawling with the new vessel *R.V Explorer II*, and SCANMAR was again employed to estimate the net dimensions in 2003.

The FTG recognizes the increasing interest in using information from this bottom trawling program to express abundance and distribution of the entire prey fish community of the western basin. Preliminary survey work by OMNR in 1999 demonstrated the potential to underestimate the abundance of pelagic fishes (principally clupeids and cyprinids) when relying solely on bottom trawls. The FTG will continue to recognize the strength of hydroacoustics to describe pelagic fish distribution and abundance, and has developed hydroacoustic programs for the east and central basins of Lake Erie. However, the shallow depths and complex bathymetry of the western basin provide challenges to implementing a hydroacoustic program in this basin, such that other pelagic sampling techniques are also being explored. Results of the *Trawl Comparison Exercise* of 2003 have now been fully analyzed (see summary below), and Fishing Power Correction 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 draft manuscript describing justification, methods used, and results has been submitted to the *North American Journal of Fisheries Management* and is currently in review. Information from this experiment will also be used in development of an additional interagency trawling program in the western basin during June and September administered by ODNR and USGS – Lake Erie Biological Station. Indices from these coordinated trawling surveys will be reported on in the 2007 FTG report.

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

Total forage abundance decreased in 2005, while biomass increased, reaching its highest level since 2002 (Figure 3.2.2 and 3.2.3). The exceptionally strong white perch year class in 2004 and associated increase in the spiny-rayed group was responsible for much of this increase. Soft-rayed abundance decreased slightly in 2005, and biomass almost doubled relative to 2004. Clupeid species increased in abundance 8 times the 2004 levels, and biomass increased 9 times, yielding the highest clupeid index recorded since 2002. Relative biomass of clupeid, soft-rayed, and spiny-rayed species was 23%, 9%, and 68%, different than the historic averages of 42.5%, 6.4%, and 51.1% (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 increase in clupeid production bodes well for the strong 2003 walleye year class. Increased biomass of soft-rayed fish may provide additional resources to further offset predatory demand in Lake Erie.

Mean length of age-0 fishes generally improved in 2005 (Figure 3.2.4). Warmer water temperatures and decreased competition for prey from the large 2004 white perch year class may have contributed to improved growth rates. Reduced density of age-1 piscivores as compared to 2004 may have reduced demand for forage. Length of age-0 for select species include: walleye (133 mm), yellow perch (64 mm), white bass (71 mm), white perch (60 mm), and smallmouth bass (88 mm). Long-term averages for the same species are: walleye (135 mm), yellow perch (66 mm), smallmouth bass (80 mm), white bass (67 mm), and white perch (57 mm). Decreases in age-0 walleye mean length likely reflects higher recruitment in 2005 than in 2004.

Spatial maps of forage distribution were constructed using site-specific catches (#/ha) of the functional forage groups (Figure 3.2.5). Abundance contours were generated using kriging contouring techniques to interpolate abundance between trawl locations. Clupeid catches were highest along the south shore, with gizzard shad densities loosely corresponding to the Maumee River plume. Soft-rayed fish (predominantly trout-perch and round gobies) were most abundant in the northwest portion of the basin, a pattern similar to previous years. Spiny-rayed abundance was distributed across the basin. Relative abundance of the dominant species includes: age-0 white perch (68%), gizzard shad (11%), white bass (3.7%), and emerald shiner (3.5%). Total forage abundance averaged 5,001 fish/ha across the western basin, decreasing 19% from 2004 to fall slightly below the long-term average (5,161 fish/ha). Clupeid density was 551.7 fish/ha (average 1,269 fish/ha), soft-rayed fish density was 614 fish/ha (average 497 fish/ha), and spiny-rayed fish density was 3,824 fish/ha (average 3,389 fish/ha).

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

In 1993, subsequent to the dissolution of the Interagency Index Trawling Group, the Lake Erie Committee charged the Forage Task Group (FTG) with development of an experimental trawling program that would facilitate forage fish assessment and utilize standardized indices for interagency reporting. Since then, the FTG has pursued the development of standardized trawling survey indices to estimate both percid and forage abundance estimates in each of the three basins of Lake Erie. Standardized catch-per-unit-effort (CPUE) data is essential for producing abundance estimates from demersal trawl surveys, particularly when trends of abundance are monitored over time, or when data are used in statistical catch-age models for estimating recruitment.

Historically, CPUE data was reported independently by agencies as mean catch-per-trawl-hour (CPTH), despite standardized equipment and survey protocols in some of the trawling surveys (e.g. western basin's Interagency Trawling Program). The FTG felt that combining catch-per-trawl-hour (CPTH) across agencies was invalid because the potential to introduce significant bias into the data. Additionally, the FTG felt it was unnecessary to represent the data as CPTH, because agencies routinely sample only for ten minutes, therefore multiplying the data by 6 to expand to CPTH may amplify the bias. In particular, representing the Interagency Trawling Data as CPTH is unnecessary because all tows are standardized to ten minutes. Sources of biases in the combined data identified by the FTG as potentially important included 1) bias associated with different net fishing dimensions and 2) bias associated with other factors that affect "trawl catchability" (e.g. fish behavior relative to vessel noise etc.).

To address the first component of bias (differences in net fishing dimension), the FTG pursued the use of SCANMAR net mensuration equipment to estimate the fishing dimensions of each of the agency trawls. Each agency estimated their net fishing dimensions at various times in 1992, 1995, and 1997. These estimates were then combined with information on distance towed to correct abundance estimates for differences in area swept. In 1999 the FTG adopted an areal index of abundance (#/hectare) as a standard of choice, primarily because this index appeared to correct for significant bias in the data (Figure 3.3.1) For example, despite standardized equipment and protocols, the R.V. Keenosay trawls a 15-20% greater area per standard ten minute tow than does the R.V. Explorer (Figure 3.3.1). Some agencies (NYSDEC) have expanded the use of net mensuration equipment to include measurements on every trawl that is fished during standard trawl assessments.

To address the second potential source of bias (other factors that affect "trawl catchability") the FTG sponsored a workshop in 2000 to develop an approach to estimating trawl catchability, generally accomplished by conducting a comparative trawling experiment. The FTG/LEC agencies brought in an expert from NOAA/NMFS to assist with development of this comparative trawling experiment. In 2003, five research vessels from four different agencies participated in the comparative trawling experiment which was a product of the workshop. From this comparative trawling experiment a series of Fishing Power Correction factors (FPCs) were generated that accounted for bias associated with "trawl catchability" (Figures 3.3.2 and 3.3.3).

Bias in the index trawling data is a component of the overall error variance and has a direct impact on accuracy of the estimate. Application of the FPCs, along with representation of the data aerially, allows for appropriate combination and comparison of data from different survey vessels and minimizes the error associated with bias in the data. The FTG is confident that abundance indices from these surveys are much more robust and comparable because of the elimination of significant bias, relative to representing the data as mean CPTH.

Currently YOY abundance estimates used by the Walleye and Yellow Perch Task Groups are calculated as CPTH from various agencys' summer and fall trawl surveys. This results in multiple independent abundance indices that often show divergent trends due to the biases associated with CPTH calculations and patchy distribution of YOY fish populations. The ability to combine trawl surveys across jurisdictional boundaries greatly reduces the divergence of independent surveys. The FTG recommends the application of FPC's and an aerial representation of trawl survey data to reconcile these biases.

By incorporating the trawl standardization work done by the FTG to the current trawl surveys, the Walleye and Yellow Perch Task Groups can combine independent surveys and significantly reduce the known bias of trawl data used in the population models. As the standardized trawl estimates become established in the population models, the FTG recommends expanding the trawl comparison exercise to include the central and eastern basin agencies so that single abundance estimates can be developed for each basin.

Table 3.2.1. Mean CPUEs and fishing power correction factors by vessel-species-age group combinations. All FPCs are calculated relative to the R.V. Keenosay.

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

z - Indicates statistically significant difference from 1.0 (a=0.05)

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

NYDEC Bottom Trawl Fishing Dimensions for Lake Erie

- later-1990's USGS-SCAMNAR measured dimensions ascribed to NY's standard bottom trawl for FTG measures.
  - **Average Wing Spread = 4.32 meters**
- 2004-05 NYS DEC-NETMIND updated dimensions ascribed to NY's standard bottom trawl for FTG measures.
  - **Average Wing Spread = 5.39 meters**
  - **Min = 4.9 meters**
  - **Max = 5.7 meters**
  - **N = 30**

Figure 3.1.1 Wing spread dimensions from NYDEC standard bottom trawl using both USGS-Scanmar and NYSDEC-Netmind trawl mensuration equipment.

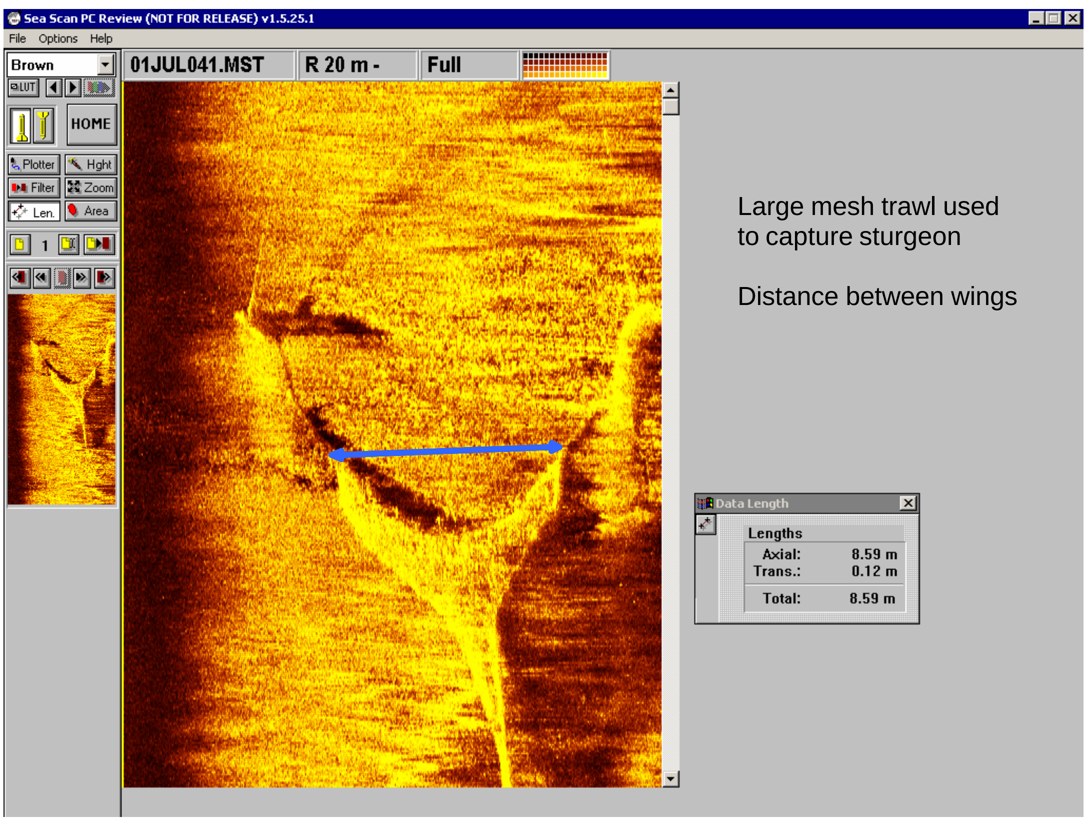

Figure 3.1.2 Side-scan sonar view of MDNR large mesh sturgeon trawl to measure wing spread.

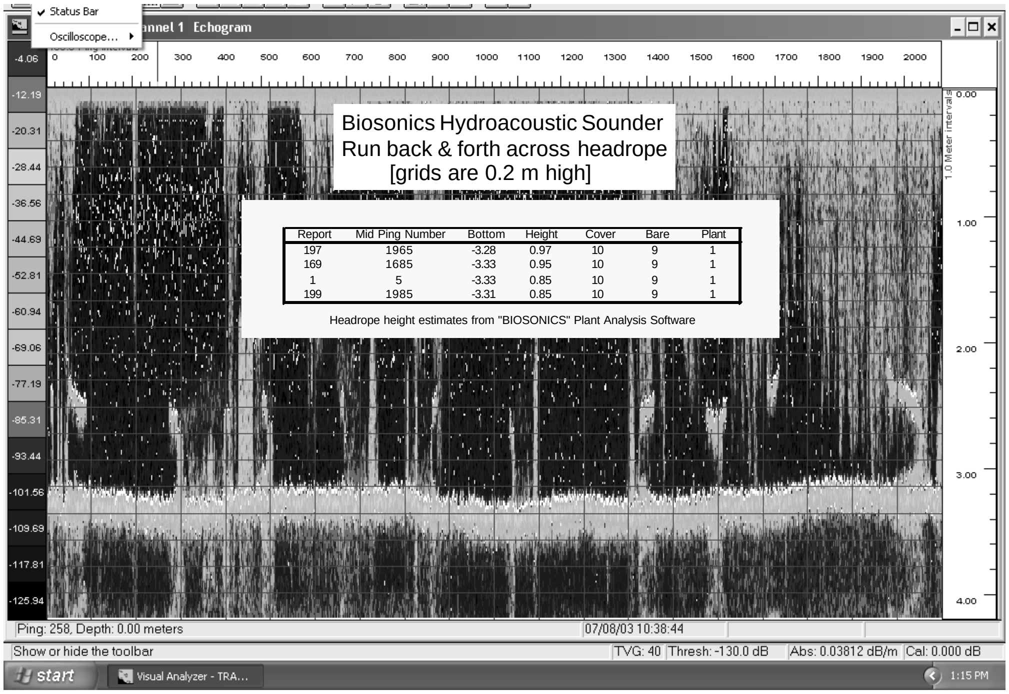

Figure 3.1.3 Biosonics 5000 DT hydroacoustic sounder readings to measure headrope height of MDNR large mesh sturgeon trawl.

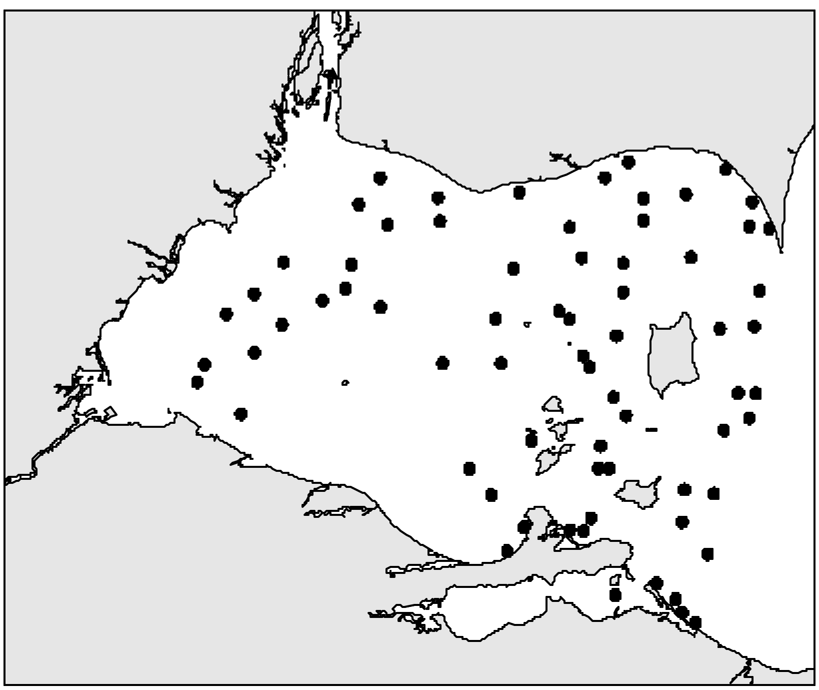

Figure 3.2.1 Trawl locations for the western basin interagency bottom trawl survey, August 2005.

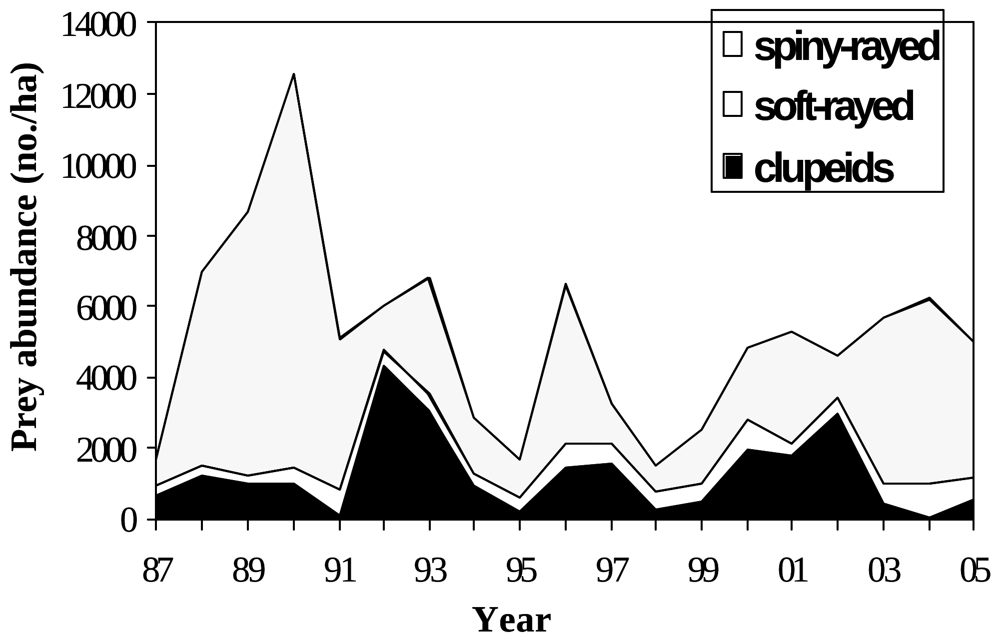

Figure 3.2.2 Mean density (no. / ha) of prey fish by functional group in western Lake Erie, August 1987-2005.

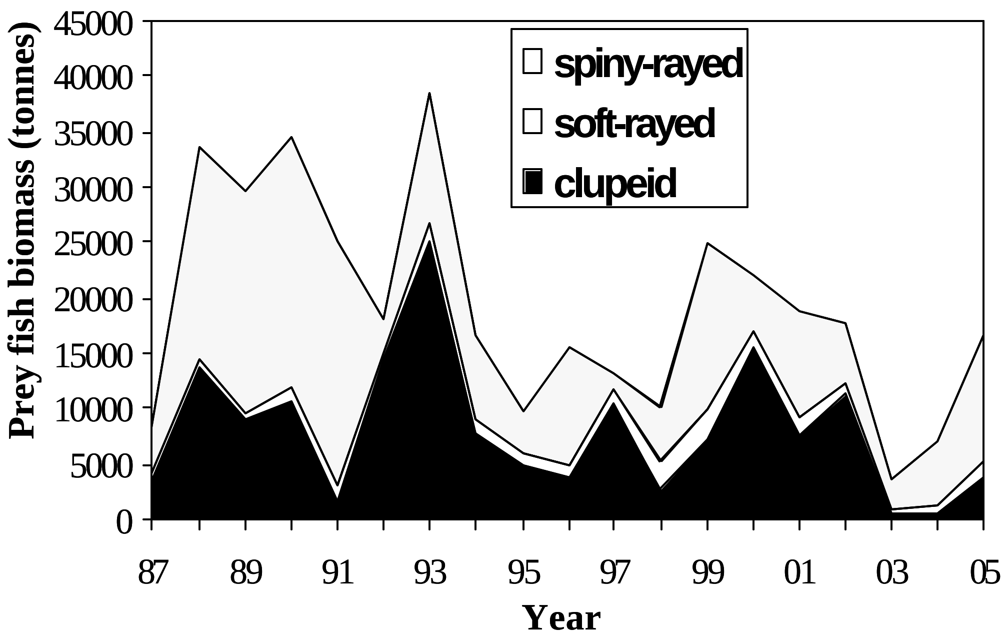

Figure 3.2.3 Mean biomass (tonnes) of prey fish by functional group in western Lake Erie, August 1987-2005.

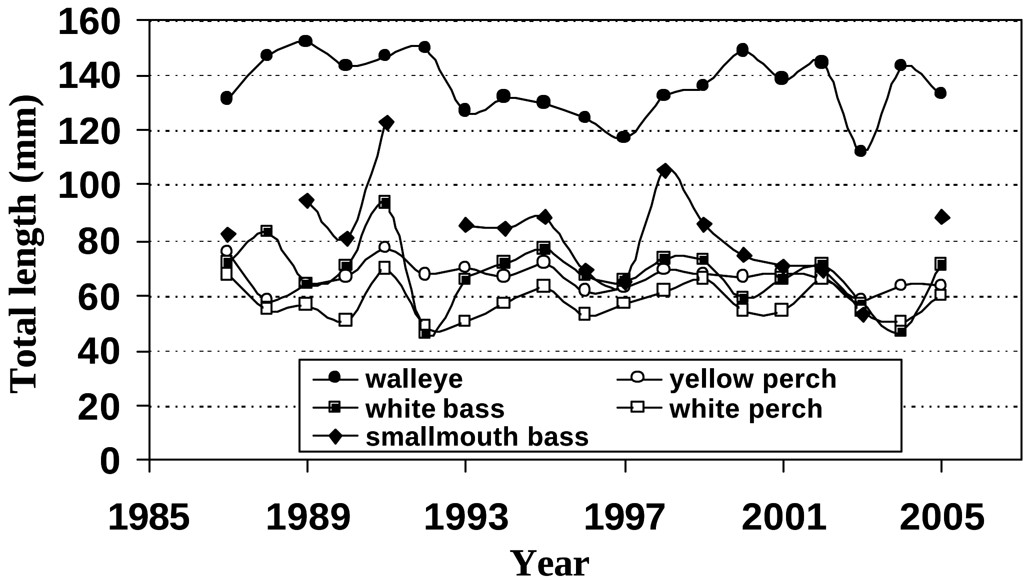

Figure 3.2.4 Mean total length (mm) of select age-0 fishes in western Lake Erie, August 1987- 2005.

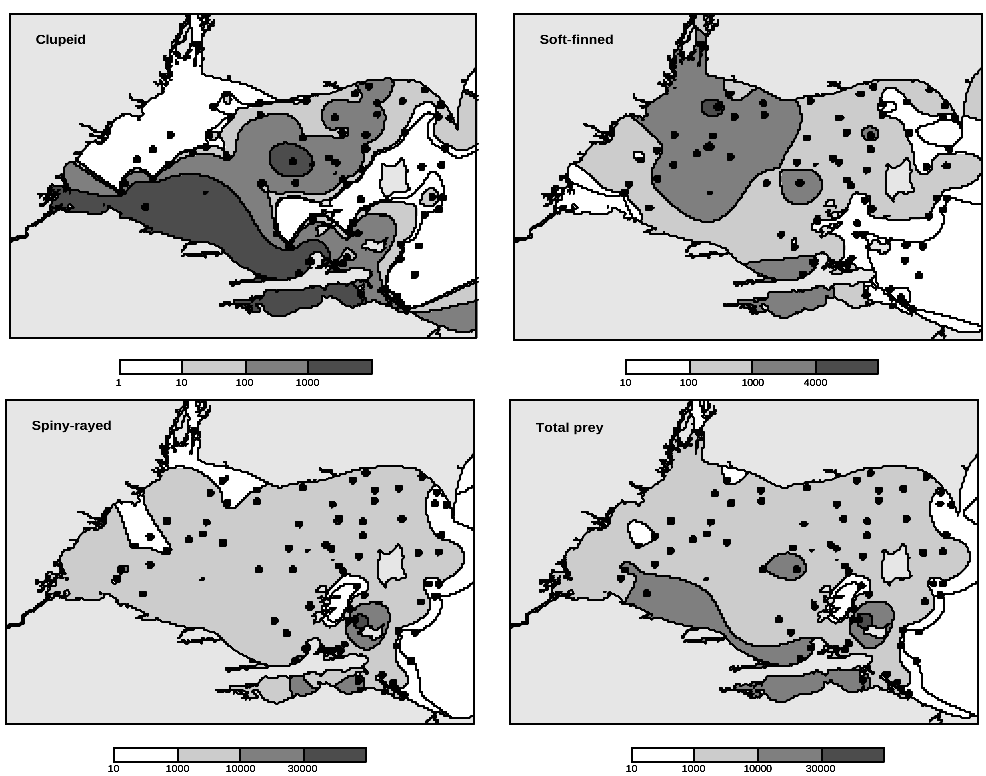

Figure 3.2.5 Spatial distribution of clupeids, soft-finned, spiny-rayed, and total forage abundance (individuals per hectare) in western Lake Erie, 2005. Black dots are locations for trawling and contour levels vary with the each functional fish group.

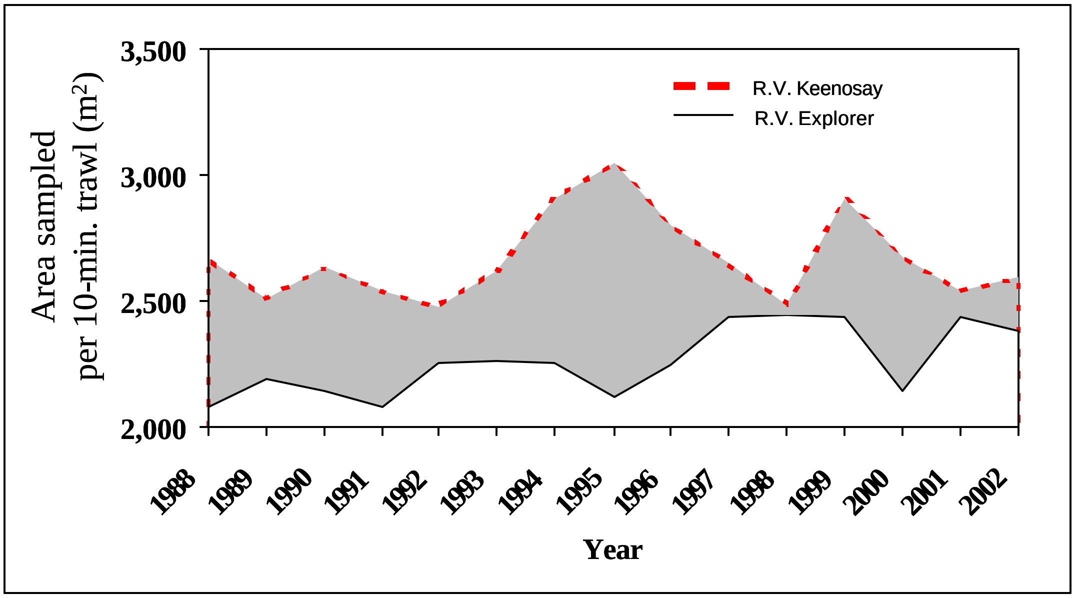

Figure 3.3.1. Average area sampled (m^2/10 minute tow) during the Interagency Trawling Program for the R.V. Keenosay and the R.V Explorer.

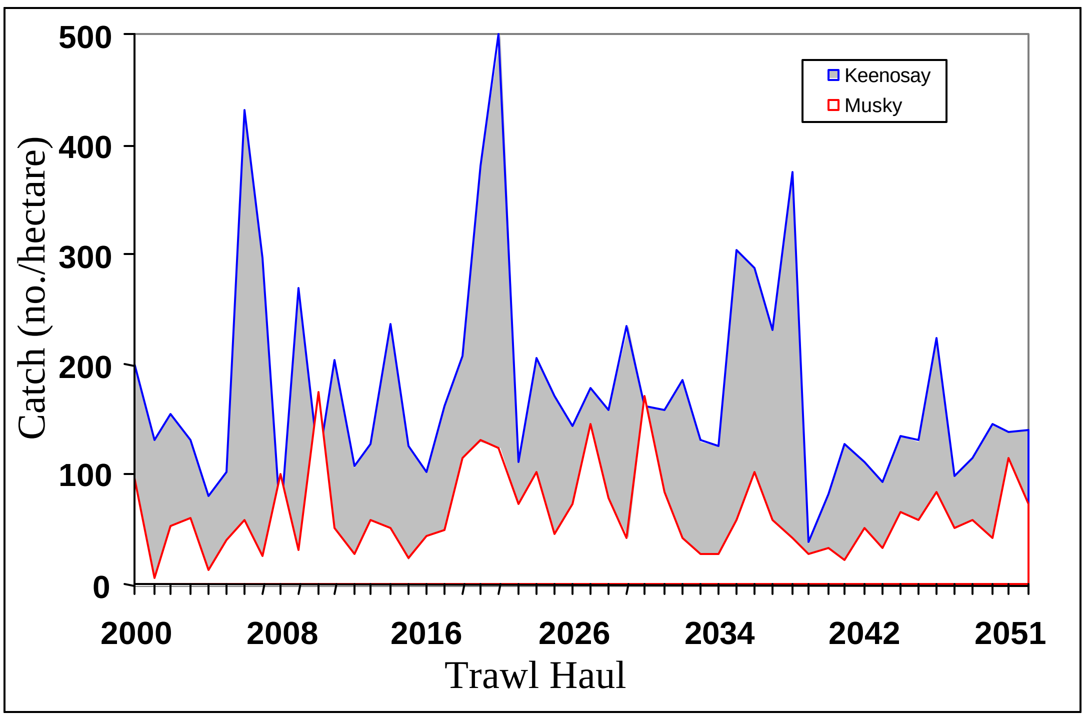

Figure 3.3.2 Catch-per-hectare of age-0 walleye for the R.V. Keenosay and the R.V. Musky II during the comparative trawling experiment. Gray area represents “bias” in the estimate associated with trawl catchability (avoidance due to vessel noise etc.).

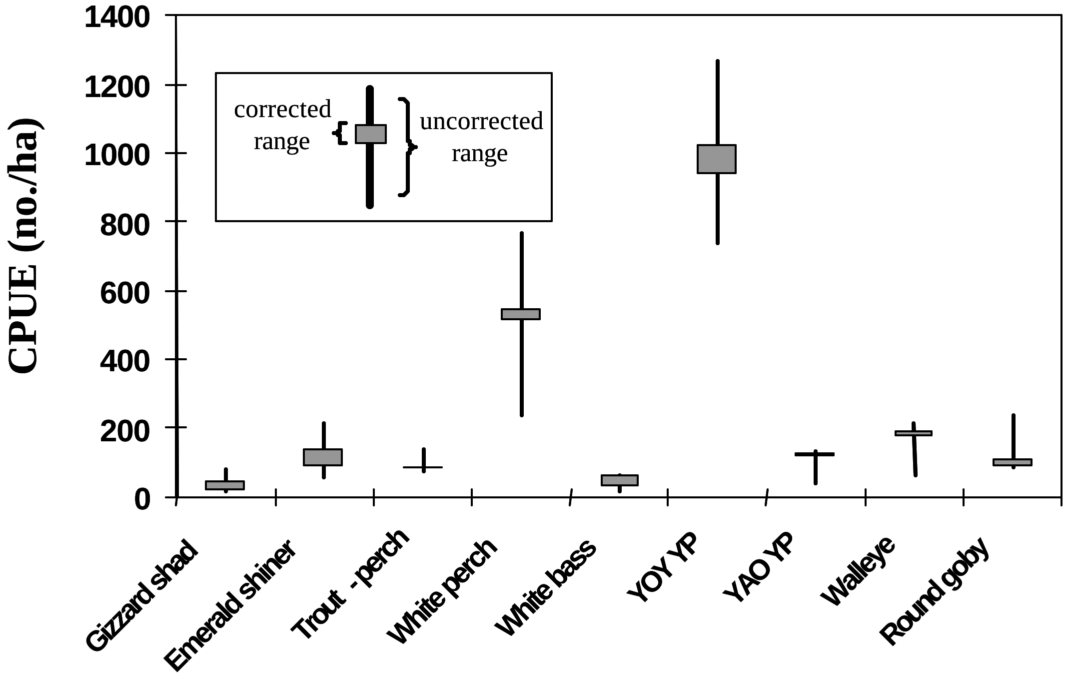

Figure 3.3.3. Species-specific CPUE data for Interagency Trawling Program. Uncorrected CPUE range indicates range of combined data prior to application of the FPC. Corrected CPUE range indicates range of combined data after application of the FPC.

4.0 Acoustic Survey Program

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

Introduction

The Forage Task Group (FTG) introduced in 1993 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 state-of-the-art 120-kHz split-beam system (Simrad EK60, ES120-7C transducer) was purchased for the Lake Erie acoustic program through another coordinated GLFC-LEC cost sharing arrangement. This new general purpose transceiver (GPT) was used throughout the 2005 east basin survey, and because of a much increased data storage capacity (compared to the EY500 system), raw acoustic data (rather than processed datagrams) were collected for the first time in the 13-year history of this program.

Throughout this acoustic monitoring program data collection has been coordinated among FTG member agencies with several research vessels (Argo, Erie Explorer, Keenosay, Musky II, and Perca) participating in various aspects of the data collection and calibration. Recent year's surveys and ongoing data analysis has been principally coordinated between the Ontario Ministry of Natural Resources (OMNR) and New York State Department of Environmental Conservation (NYSDEC).

Beyond maintaining the 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 NYSDEC 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 EK60 GPT/transducer. Significant progress was made this winter to build and refine post-processing applications in Echoview, SAS (SAS 1992) and Excel that integrate data flow and analysis. This ongoing process 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 in 2006.

Two FTG members continue to participate in a GLFC-sponsored Great Lakes Acoustic Study Group charged with preparing an array of standard operating procedures for Great Lakes acoustic investigations. In addition, these principal 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 participation in fisheries/academic conferences at the Great Lakes regional level (eg. IAGLR 2004, 2005) and national (AFS 2003, CCFR 2003) and international forums (Swedish Acoustics Workshop 2004, ICES 2002). In continuing this pursuit, we are planning another acoustic-related presentation at this year's International Association of Great Lakes Research (IAGLR) conference in Windsor, ON.

Methods

The 2005 east basin acoustic survey was completed during July 5 to July 12 (Figure 4.1.1). Acoustic data collection using the new EK60 GPT and ES120-7C transducer was completed in five non-consecutive nights, between the hours of 9:30 PM and 5:30 AM at an approximate vessel speed of 5.8 knots aboard the survey vessel *Erie Explorer*. In all, 12 transects, spanning a total distance of 177 nm over bottom depths of 15m and greater were surveyed during this period. Five nights of companion mid-water trawling was conducted aboard the *RV Argo* from July 5 to July 13, 2005 using a trawl with fishing dimensions of 36 m^2 ; and 21 tows were collected throughout the basin. An acoustic trawl mensuration apparatus – NetMind – was used to assist in monitoring performance and depth targeting of the mid-water trawl. Collectively, the two survey vessels acquired 37 temperature profiles of the water column at the ends and intermediate points along acoustic transects.

In addition to completing the standard east basin survey in 2005, an independent acoustic exercise was conducted during the night of July 13 to compare Lake Erie's two split-beam echosounders (Figure 4.1.2). This exercise was undertaken to enable calibration of the 2005 (and future) raw acoustic data collected with the new GPT (EK60) to the existing 8-year (1997 – 2004) time series of split-beam data that was logged with the old GPT (EY500) in a processed datagram format. The two echosounders were operated simultaneously aboard the *RV Erie Explorer* at a staggered rate of one ping per second with their respective transducers mounted approximately 7 m apart. Two parallel 6-nm transects located along the 20- and 30-m depth contours, respectively in the east-central region of Long Point Bay were sampled with each GPT configured to record both raw and processed data telegrams. This dual data recording format was done to enable a comprehensive analysis and comparison of acoustic variables within a common software environment.

Results

Presentation of eastern basin acoustic survey results has been suspended while the principal investigators remain immersed in other initiatives pertaining largely to data processing/analysis methods, software/hardware expansion/upgrades, and EY500-EK60 GPT calibration exercise (see Introduction). New standard analysis procedures will be applied to the time series and efforts are currently underway to analyze the entire 9-year time series of split-beam acoustic data and facilitate resumption of an annual FTG reporting cycle in March 2007.

Discussion

A thorough reporting of acoustic survey results has been planned for several years but annual constraints on staff time has repeatedly postponed this more comprehensive analysis of the split-beam acoustic data. Additional major hurtles have now been addressed during this past year with; 1) the acquisition of a new 120 kHz split-beam GPT/transducer, 2) significant progress in pre-analysis data management procedures (eg. create Echoview files encompassing entire acoustic transects with standardized noise & data exclusions, and variable definitions), 3) continued developments in the automation of post-processing data management and analysis steps within integrated multi-program softwares – Echoview, SAS and Excel, and 4) further refinements on standardized methodology for estimating fish densities and expressing estimate precision. Survey results are anticipated to be available for reporting in 2006. In addition, we anticipate that a standard operations procedure manual describing survey design, data collection techniques, echo processing methods, and fish abundance estimation for the east basin acoustic assessment program will be prepared in the coming year.

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

In 2000 the Lake Erie acoustic survey was expanded to include the central basin. From 2000 through 2003 the acoustic surveys consisted of three acoustic transects, based on loran-TD lines equally spaced within the basin. Midwater trawling was conducted concurrent to the acoustic data collection. In December 2003 the FTG held a hydroacoustic workshop in Port Dover, Ontario. As a result of preliminary analysis and discussion at the workshop, a new experimental design was suggested for the central basin acoustic survey, scheduled for July of 2004 (Johnson et al. 2005). The new survey design required an additional vessel and sounding unit, and would increase the number of transects from three in previous surveys to eight in July of 2004. The new sample design proved to be an efficient use of available equipment and personnel and was kept in place for the July 2005 survey. As in past surveys, midwater trawling from separate vessels is conducted concurrent to acoustic data collection to ground truth species composition and aid in single target detection analysis if needed.

Methods

In 2005 the central basin acoustic survey was conducted from July 11- July 15. Sample design was identical to the acoustic survey of July 2004, with eight cross basin acoustic transects (Johnson et. al. 2005). Midwater trawling was conducted on half of each transect and temperature profiles were collected by trawling vessels concurrent to the acoustic data collection. In 2005, acoustic data were collected aboard the R/V Musky II and R/V Almar, each with Biosonics DT-5000 120 kHz split beam sounding units. Midwater trawling was conducted by the R/V Keenosay and R/V Grandon (Figure 4.2.1). Acoustic transects with concurrent trawling were completed between 2100 and 0530 hours and all other sampling protocols were kept similar to standard operating procedures for Great Lakes acoustics surveys.

Post processing of the 2005 and all previous years acoustic data will be done using Echoview 3.4 software and applications in SAS 9.1 developed by FTG members to calculate density estimates. Analysis and interpretation of results is occurring in conjunction with the east basin acoustic survey in order to provide uniformity in post processing procedures, forage density and biomass estimates, and precision between the two surveys.

Results

In 2005, due to mechanical problems with one sounding unit, seven of the eight proposed transects were completed. The completed transects represent approximately 297 nautical miles of acoustic data. A total of 64 midwater trawls were completed in conjunction with the acoustic transects. In general, midwater catches of smelt and emerald shiners were lower in 2005 than in 2004. The thermocline ranged from 9 to 16 meters in Ohio waters.

Discussion

We are in the process of editing and conducting a preliminary analysis of all acoustic transects collected to date. At this time we have completed most of the pre-analysis edits in accordance with protocols established through the FTG's acoustic working group.

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 (Trometer et. al. 2004). The survey of the eastern and central basins is typically conducted in late summer. In 1997, a pilot program was conducted by Sandusky Fisheries Research Unit staff adjacent to Sheldon's Marsh in July to assess the feasibility of using acoustic technology in the shallow waters of the western basin. The pilot study showed much promise and results indicated an offshore to nearshore gradient in forage-sized fish abundance. 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. In 2005 companion midwater trawling was conducted during the acoustic survey. While currently unprocessed, the 2004 data will be used in conjunction with the 2005 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

Fishery acoustic sampling was conducted on the night of July 28-29, 2005, to assess the large-scale spatial distribution and density of pelagic forage fishes in western Lake Erie. The large-scale approach consisted of three transects in Ohio and Ontario waters of western Lake Erie (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. Mid-water trawl sampling stations which corresponded with acoustic sampling transects were sampled the night of acoustic sampling by the OMNR R.V. *Keenosay*. Due to inclement weather, only one transect (AT-2) and corresponding mid-water trawls were completed.

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

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

Initial Results

Data collected in 2004 and 2005 will be analyzed to provide estimates of forage-sized fish biomass, density, and spatial distribution using Biosonics and Echoview software. Spatial maps will be derived using ArcView GIS software and sample size and power analysis, will be run to develop sampling strata and sample sizes for future west basin acoustics survey. Initial processing of 2005 data suggests that forage fish densities in the upper three meters (327,304/ha) are far higher (63x) than those located in the remaining water column (5,185/ha). Pelagic fish species, such as gizzard shad and emerald shiners, are likely denser at the surface, and suggests that these species are under-represented in standard inter-agency bottom trawls. Bottom oriented forage species were likely excluded during the data processing stage, thereby under estimating bottom fish densities. Further refining of data processing methodology and investigation of alternative processing software will be necessary before these conclusions can be fully supported.

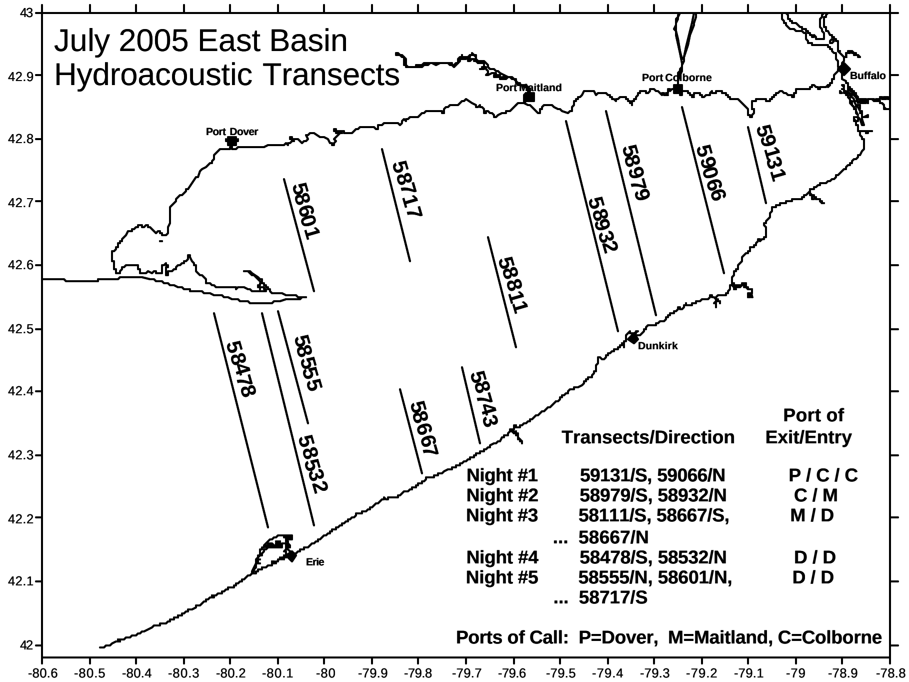

Figure 4.1.1 Transects sampled during the July 2005 eastern basin fisheries acoustic survey

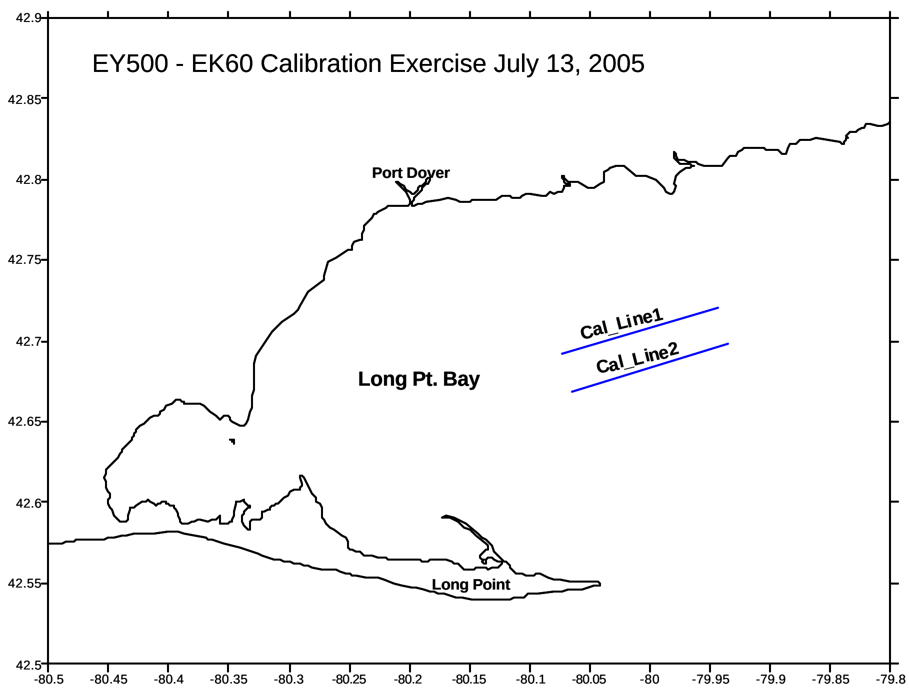

Figure 4.1.2 Transects sampled simultaneously with Simrad EY500 and EK60 120 kHz split-beam echosounders during a GPT calibration exercise in Long Pt. Bay, Lake Erie , July 13, 2005

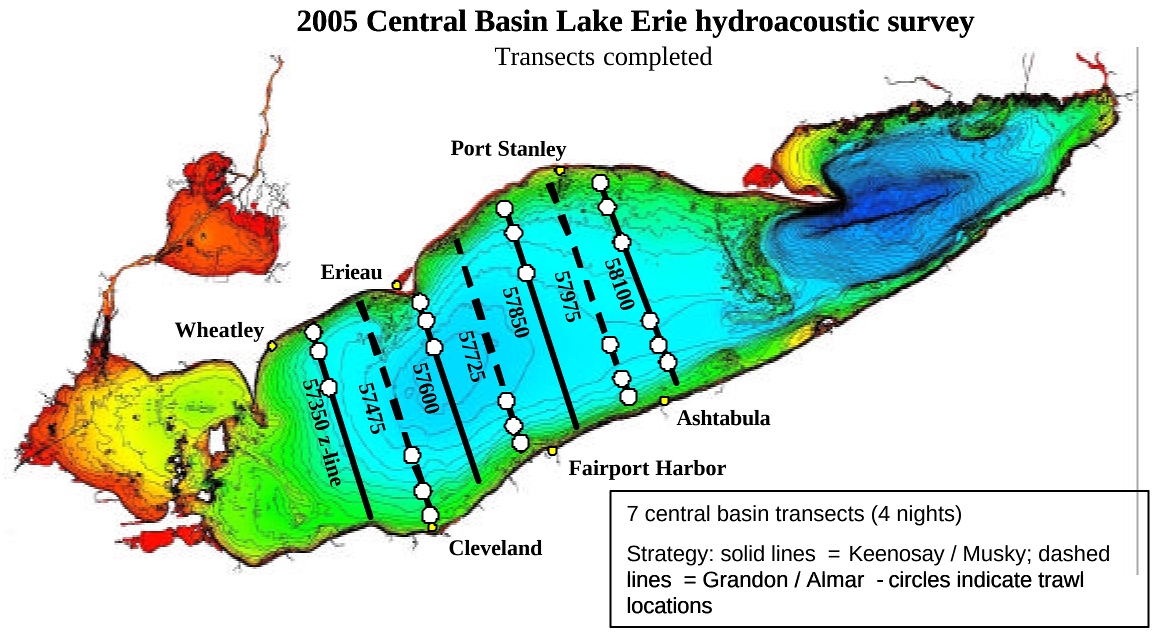

Figure 4.2.1 Seven completed central basin acoustic survey transects for July 11-15, 2005. Transects were run along Loran-C TD lines. Dashed line indicates acoustic data were collected aboard the R/V Almar, with trawling done aboard the R/V Grandon. Solid line indicates acoustic data are collected aboard the R/V Musky, with trawling done aboard the R/V Keenosay. Circles indicate approximate trawling locations.

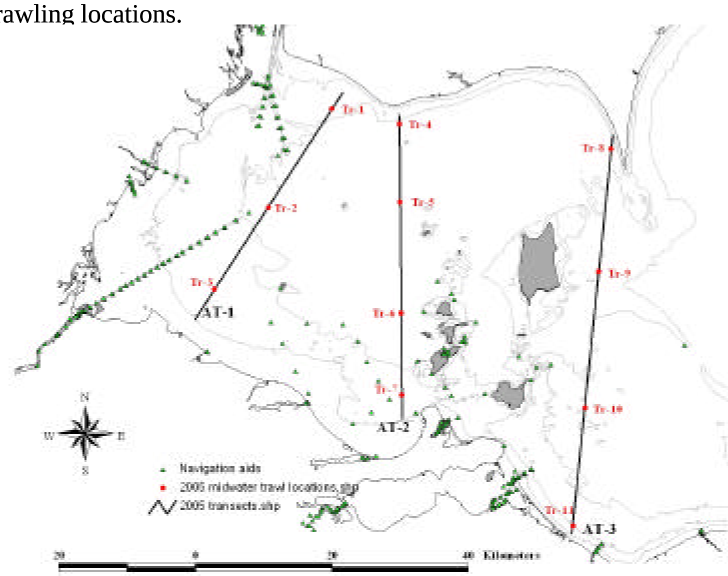

Figure 4.3.1 Three proposed acoustic survey transects and companion midwater trawling locations for the western basin July 25-29, 2005. Due to inclement weather, only transect 2 and its associated trawls were completed.

5.0 Interagency Lower Trophic Level Monitoring Program

(by T. Johnson and E. Trometer)

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. The year 2005 marks the seventh year of this monitoring program. Due to updates occurring with the database, only 2005 data is presented.

For this report, we present a summary of data on epilimnetic temperature, Secchi depth, total phosphorus, chlorophyll a and hypolimnetic or bottom dissolved oxygen. Stations included in this analysis are 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 5.0.1).

Epilimnetic Temperature

Epilimnetic temperature was recorded 1 meter below the water surface at each station. Mean temperature was 21.1 ^{o}C for the western basin, 20.3 ^{o}C for the central basin and 19.2 ^{o}C for the eastern basin. Relative to previous years, 2005 was one of the warmer years.

Secchi Depth

As expected, Secchi depth was lowest in the west basin, and highest in the east basin (Figure 5.0.2). Secchi depth was highest in late June and early July and lowest in September and October. Mean Secchi depth was 2.5 m for the western basin, 5.2 m for the central basin and 6.9 m for the eastern basin. Relative to previous years, Secchi was higher (i.e. clearer water) in all basins.

Total Phosphorus

As in previous years, total phosphorus concentration was highest in the west basin and lowest in the east basin (Figure 5.0.3). Total phosphorus was lowest in June and highest in October in the western and central basin and fairly even seasonally in the eastern basin. Relative to previous years, total phosphorus was lower in all basins.

Chlorophyll *a*

Chlorophyll *a* showed a similar trend to TP - declining from west to east (Figure 5.0.4). Seasonally, chlorophyll *a* was highly variable in the western and central basin, and much less variable in the eastern basin. The lowest values were observed in June. Mean chlorophyll *a* was 5.5 µg/L for the western basin, 3.4 µg/L for the central basin and 1.9 µg/L for the eastern basin. Relative to previous years, these values are about average for the western basin, and are higher for the central and eastern basins.

Hypolimnetic Dissolved Oxygen

Figure 5.0.5 illustrates the mean hypolimnetic dissolved oxygen (DO) concentration (i.e. below the thermocline) for each basin of Lake Erie during periods when the water column was stratified. Stratification began in early June and continued through September in the central and eastern basin. The hypolimnetic DO is highest in the east basin. DO was not measured at stations 17 and 18 and only stations 15 and 16 showed stratification in 2005. The west basin rarely stratifies due to its shallow depth. The only stations where stratification occurred were 5 and 8 and there were a few occasions where the temperature reached 4 mg/L or lower. In the central basin stratification occurred at stations 9, 10, 11, 12, and 13. By mid July DO less than 4 mg/L were observed only at stations 9 and 10 and continued through the end of September.

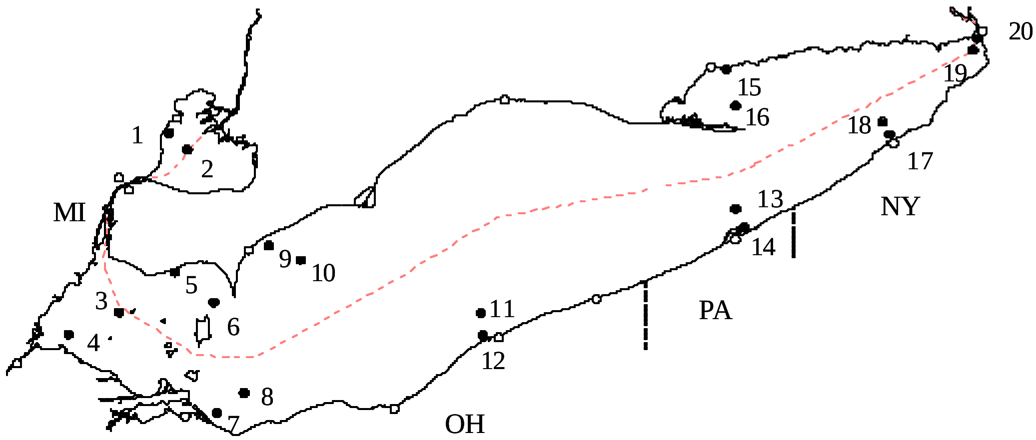

Figure 5.0.1 Lower trophic level sampling stations in Lakes Erie and St.Clair.

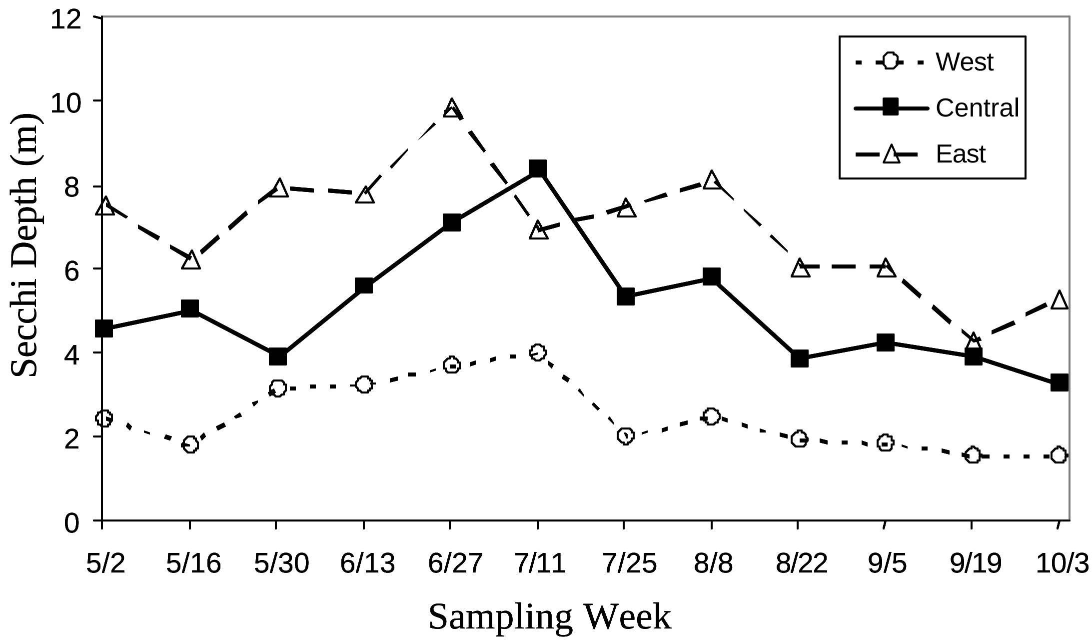

Figure 5.0.2. Average annual Secchi depth (m) by basin in Lake Erie, 2005.

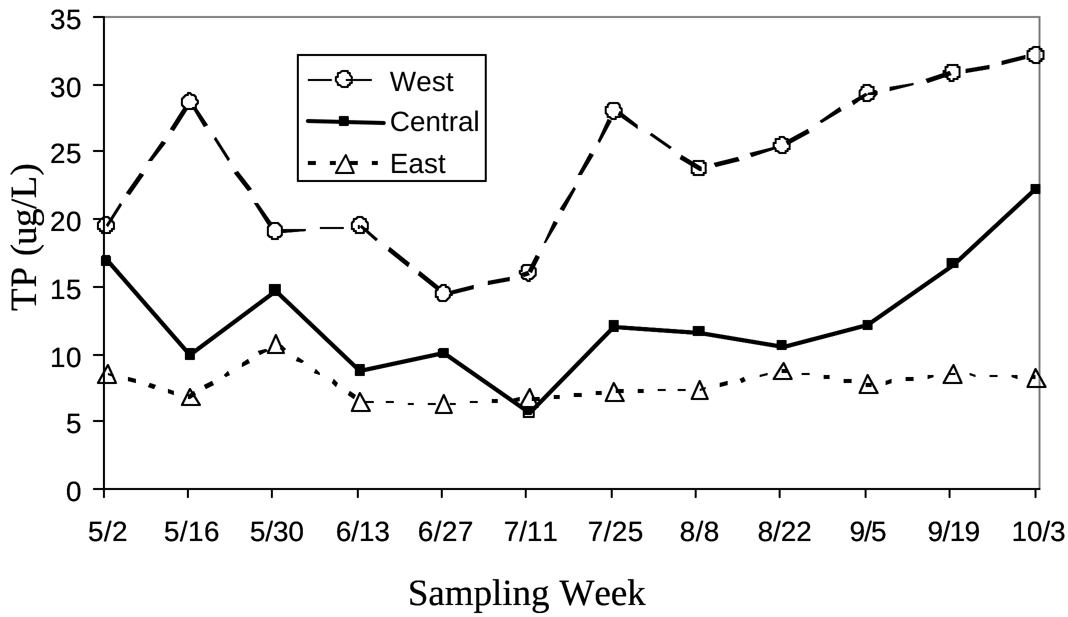

Figure 5.0.3. Average annual total phosphorus by basin in Lake Erie, 2005.

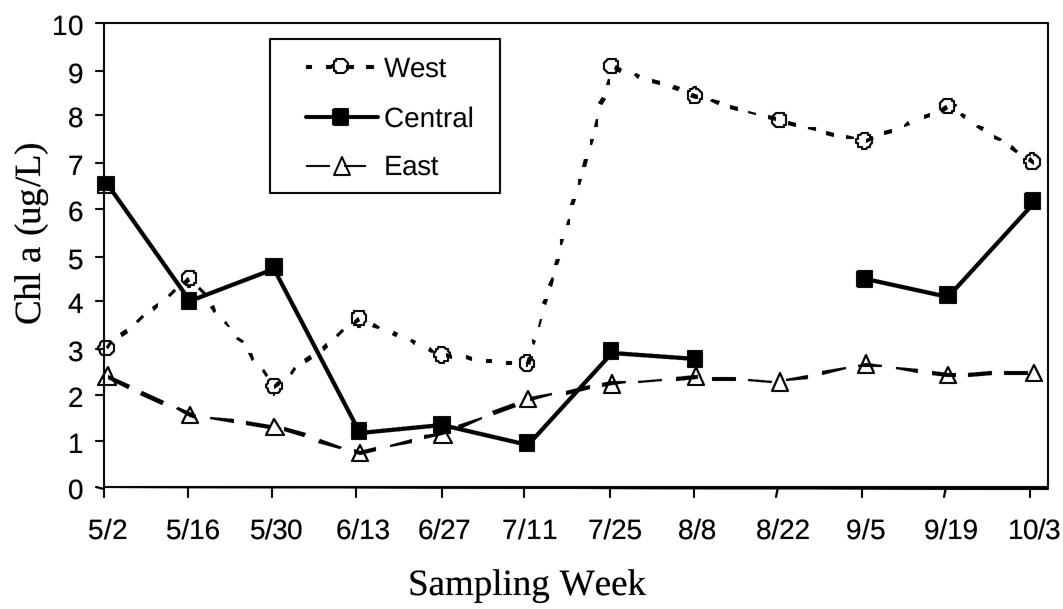

Figure 5.0.4. Average annual chlorophyll a by basin in Lake Erie, 2004.

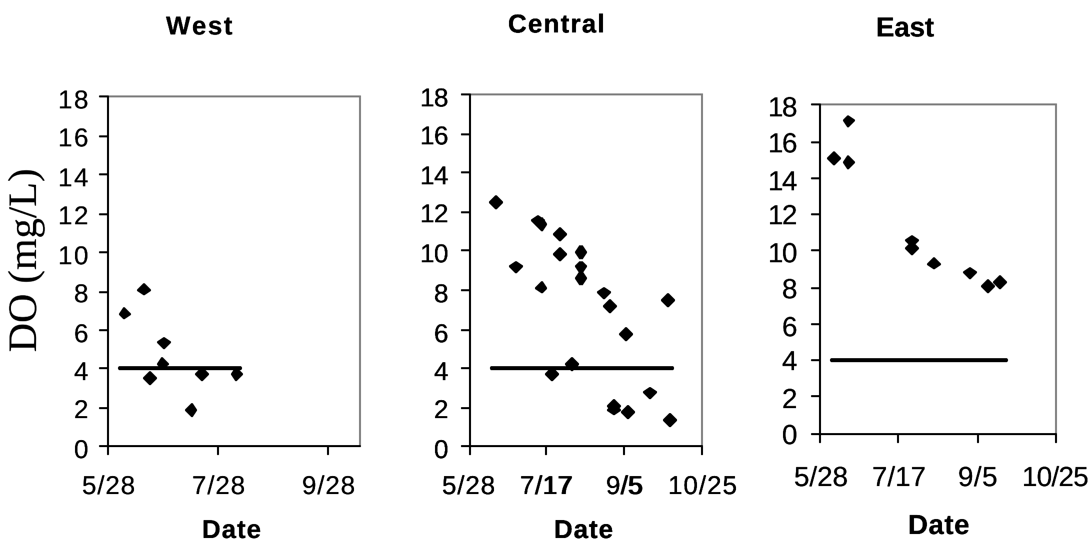

Figure 5.0.5. Mean hypolimnetic dissolved oxygen (mg/L) for each basin of Lake Erie, 2005. Data are presented only when water column is stratified. The horizontal line represents 4 mg/L, a level below which oxygen becomes limiting to the distribution of many freshwater fish.

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). Round goby are now treated as a regular forage species and abundance information is reported in section 2.0. Please refer to previous Forage Task Group reports for information on the spread and distribution of round goby in Lake Erie.

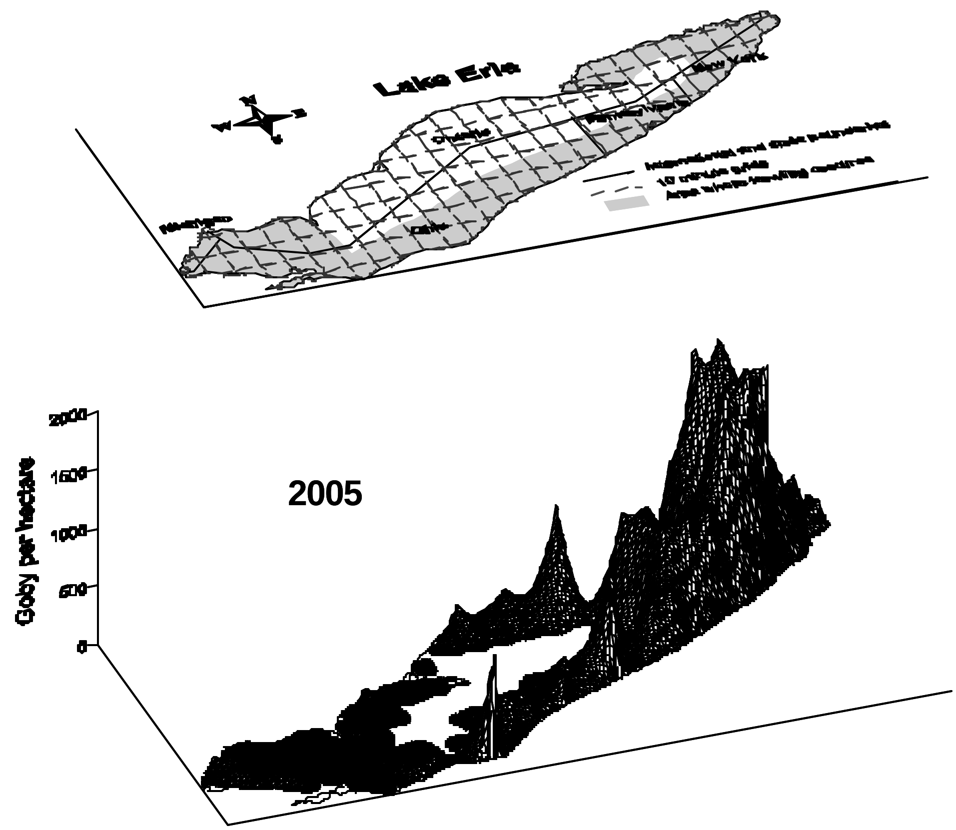

Figure 6.0.1 Two dimensional base map (upper) and three dimensional maps of round goby distribution in Lake Erie as density per hectare 2005 estimated from bottom trawl catches. The base map shows state and provincial boundaries, the ten minute grid system used for trawl data summarization, and the area 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 Protocol for Use of Forage Task Group Data and Reports

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

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

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

Acknowledgments

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

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