Inland Seas Angler

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Highlights of the Annual Lake Committee Meetings

Great Lakes Fishery Commission proceedings, Windsor, ON

This second of a series of annual special reports is a summary of Lake Michigan. This lake committee report is from the annual Lake Committee meetings hosted by the Great Lakes Fishery Commission in March 2014. We encourage reproduction with the appropriate credit to the GLSFC and the agencies involved. Our thanks to Brian Breidert, IN DNR; Dale Hanson, Charles Bronte and Mark Holey, USFWS; and also thanks to the staffs of the GLFC and USGS for their contributions to these science documents. Thanks also to the Great Lakes Fishery Commission, its staff, Chris Goddard & Marc Gaden, for their efforts in again convening and hosting the Upper Lake Committee meetings in Duluth.

Lake Michigan

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Abbreviation	Expansion
CPH	Catch per hectare
CWT	Coded Wire Tag
KT	1,000 metric tons
MDNR	MI Dept of Natural Resources
USFWS	US Fish and Wildlife Service
WTG	Walleye Task Group
YAO	age 1 and older
YOY	Young of the year (age 0)

Status of Pelagic Prey Fishes in Lake Michigan, 2013

ABSTRACT

Acoustic surveys were conducted in late summer/early fall during the years 1992-1996 and 2001-2013 to estimate pelagic prey fish biomass in Lake Michigan. Midwater trawling during the surveys as well as target strength provided a measure of species and size composition of the fish community for use in scaling acoustic data and providing species-specific abundance estimates. The 2013 survey consisted of 27 acoustic transects (546 km total) and 31 midwater trawl tows. Mean prey fish biomass was 6.1 kg/ha (relative standard error, RSE = 11%) or 29.6 kilotonnes (kt = 1,000 metric tons), which was similar to the estimate in 2012 (31.1 kt) and 23.5% of the long-term (18 years) mean. The numeric density of the 2013 alewife year class was 6% of the time series average and this year-class contributed 4% of total alewife biomass. Alewife ≥age-1 comprised 96% of alewife biomass. In 2013, alewife comprised 86% of total prey fish biomass, while rainbow smelt and bloater were 4 and 10% of total biomass, respectively. Rainbow smelt biomass in 2013 was essentially identical to the rainbow smelt biomass in 2012 and was 6% of the long term mean. Bloater biomass in 2013 was 0.6 kg/ha, only half the 2012 biomass, and 6% of the long term mean. Mean density of small bloater in 2013 was lower than peak values observed in 2007-2009 and was 23% of the time series mean. In 2013, pelagic prey fish biomass in Lake Michigan was similar to Lake Huron, but pelagic community

composition differs in the two lakes, with Lake Huron dominated by bloater.

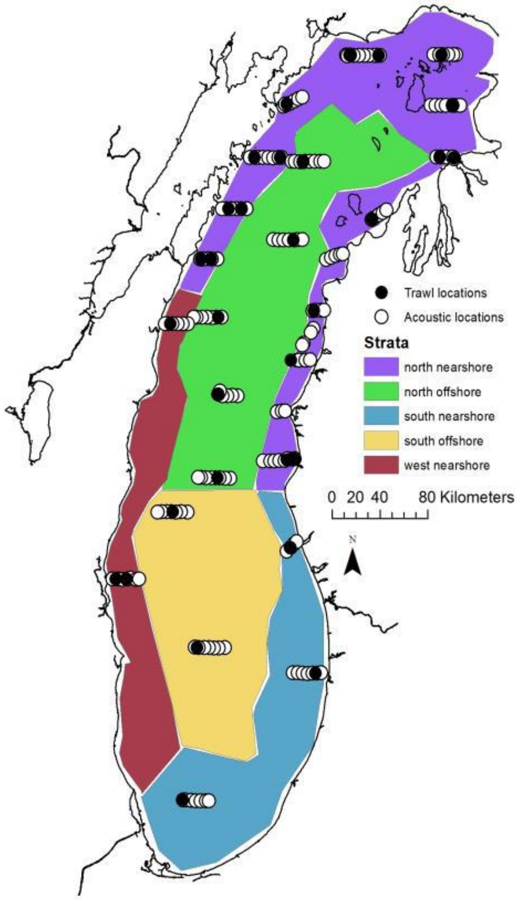

Figure 1. Map of Lake Michigan showing strata used in design and analysis of the lakewide acoustic assessment. Symbols represent acoustic and midwater trawl locations for 2013.

Alewife – Alewife density in 2013 (385 fish/ha) was 25% of density observed in 2012 and was 23% of the long-term (1992-2013) mean of 1,674 fish/ha. The primary difference between 2012 and 2013 was the very low density of age-0 alewife in 2013. Age-0 alewife density (72 fish/ha, Figure 2), was 6% of the long-term mean of 1,212 fish/ha. Total alewife biomass (5.2 kg/ha) in 2013 was similar to 2012 and 40% of the long-term mean of 13.2 kg/ha. Biomass of age-1 or older (YAO) alewife was relatively constant from 2001-2007 (Figure 3), increased in 2008-2010, and then declined by 72% from 2010 to 2012. In 2013 biomass of the YAO group was 5.0 kg/ha, which consisted of fish from the 2008-2012 year-classes. Biomass estimates of YAO alewife in 2013 from both the acoustic and bottom trawl surveys were similar to those in 2012.

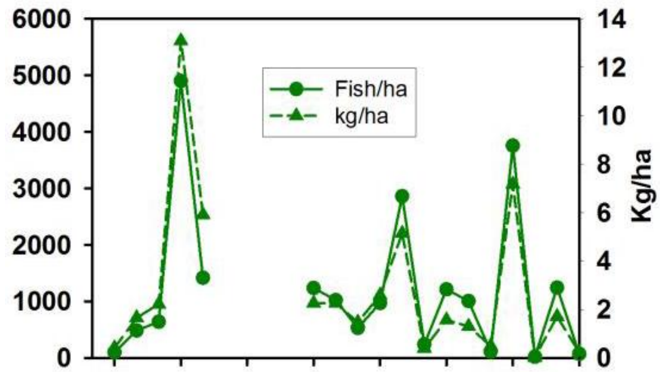

Figure 2. Acoustic estimates of age-0 alewife density and biomass in Lake Michigan, 1992-2013

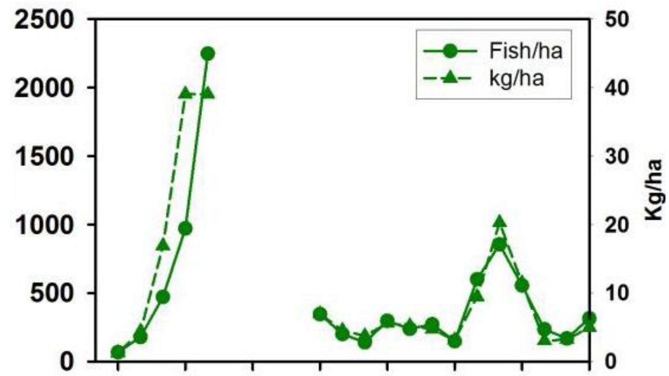

Figure 3. Acoustic estimates of age-1 or older alewife density in Lake Michigan, 1992-2013

Rainbow smelt – Density of rainbow smelt generally increased from 2002-2008 (Figure 4), before declining to much lower levels in 2009-2013. However, biomass has been consistently low since 2007. Rainbow smelt density in 2013 (89 fish/ha) was the second lowest in the time series. Biomass of rainbow smelt in 2013 (0.24 kg/ha) was similar to the 2012 biomass (0.25 kg/ha) and was only 6% of the long term mean. Rainbow smelt > 90 mm in length constituted roughly 50% of the population and 90% of biomass. Both acoustic and bottom trawl survey results showed biomass in 2013 was similar to 2012, but the acoustic biomass estimate was nearly four times the bottom trawl estimate. Both acoustic and bottom trawl survey results indicate that rainbow smelt are far less abundant than in the early 1990s.

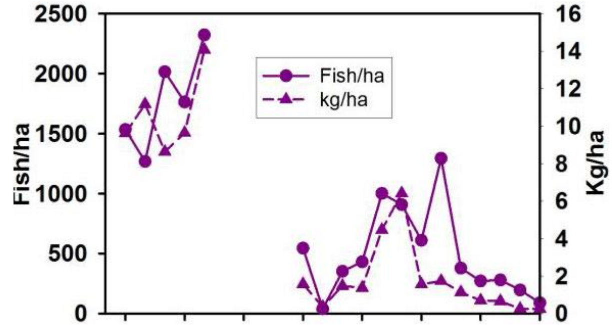

Figure 4. Acoustic estimates of rainbow smelt density and biomass in Lake Michigan, 1992-2013

<u>Bloater</u> – Much like rainbow smelt, bloater continue to be present at low densities relative to the 1990s. Mean density of bloater in 2013 (39 fish/ha) was the second lowest in the time series. Small bloater have been highly variable from 2001-2013 (Figure 5), while large bloater showed a weak decreasing trend in this time period, with the lowest density and biomass in the time series observed in 2013 (Figure 6).

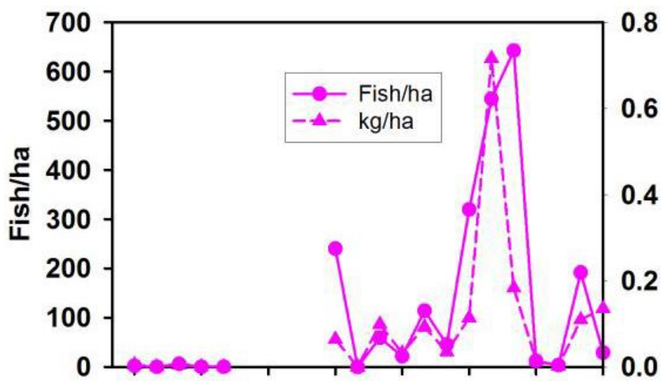

Figure 5. Acoustic estimates of small bloater density and biomass in Lake Michigan, 1992-2013

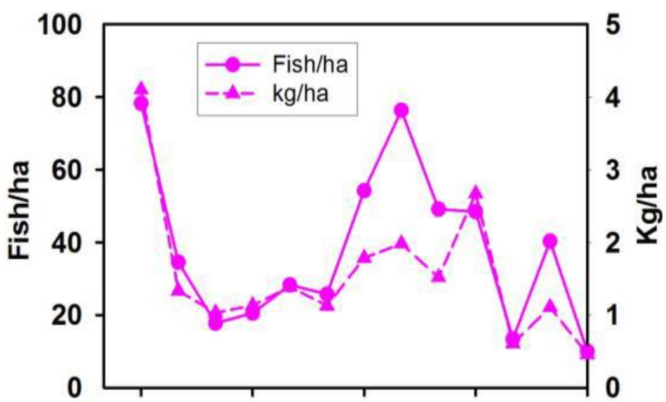

Figure 6. Acoustic estimates of large bloater density and biomass in Lake Michigan, 2001-2013

The results of the 2013 Lake Michigan acoustic survey indicate continued variability in alewife biomass, persistently low biomass of rainbow smelt and bloater, and continued low abundance of native species. Peak alewife biomass occurred in 1995 and 1996 (40 kg/ha), and the two highest values during 2001-2013 (2009-2010) were only half as much as in 1995-1996. Total prey fish biomass in 2013 was the second lowest ever observed in the acoustic survey (Figure 7). Total pelagic fish biomass in Lake Michigan (6.1 kg/ha) was similar to that in Lake Huron in 2013 (6.1 kg/ha, O'Brien et al. 2014) as well as Lake Superior in 2011.

Prey fish biomass in Lake Michigan remains at levels much lower than in the 1990s, and the estimate of total lakewide biomass (29.6 kt) from acoustic sampling was the second lowest in the time series. This is in contrast to 2008-2010, when biomass was relatively high (but still lower than in the 1990s). This recent decline, resulting primarily from decreased alewife biomass, demonstrates the dynamic nature of the pelagic fish community in Lake Michigan. Because of predation and a weak 2013 alewife year class, it seems likely that biomass of alewife will be lower in 2014 than in 2013. However, a strong 2014 year class could offset mortality of older fish.

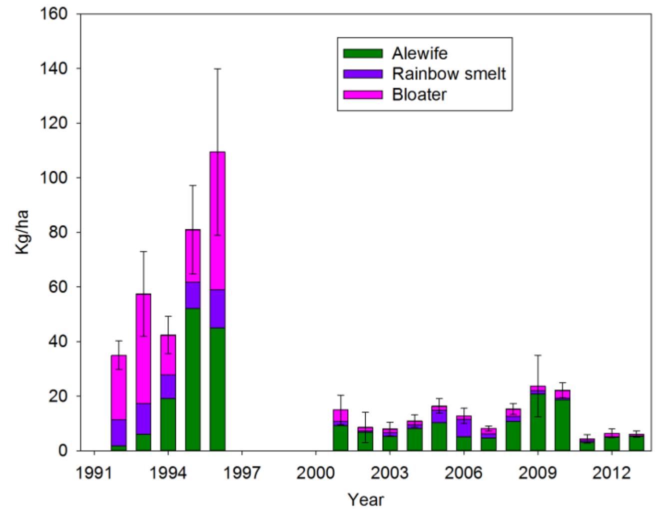

Figure 7. Acoustic estimates of total prey fish biomass in Lake Michigan, 1992-2013.

The large difference between prey fish biomass in the 1990s and the 2000s resulted primarily from a decrease in large bloater abundance, but alewife and rainbow smelt declined as well. Bloater densities showed an increasing trend 2001-2009, driven primarily by increases in small bloater. A similar pattern was observed in Lake Huron, but only in Lake Huron has there been any evidence of increased abundance resulting from recruitment to larger sizes, as bottom trawl estimates of large bloater density have increased in recent years in Lake Huron but not in Lake Michigan. Alewife were the dominant component of pelagic prey fish biomass in 2013, and numerically constituted 75% of fish density. Limited recruitment of small bloater, numerical dominance of alewife, along with the continued absence of other native species, suggests that little progress is being made toward meeting the Fish Community Objective of maintaining a diverse planktivore community, particularly relative to historical diversity.

Bloater and emerald shiner were historically important species, but bloater currently exist at low biomass levels and emerald shiner have not been captured in Lake Michigan by GLSC surveys since 1962. Similarly, kiyi are absent from offshore regions of Lake Michigan, which is in stark contrast to Lake Superior, where Yule et al. (2013) found kiyi to be the most numerous species in 2011. As a result, large areas of Lake Michigan which were formerly occupied by fish are now devoid of fish, and movement of energy and nutrients through diel vertical migration has essentially disappeared. In Lake Huron, collapse of the alewife population in 2003-2004 was followed by resurgence in emerald shiner abundance in 2005-2006 and by increased abundance of cisco. Given evidence from acoustic surveys from lakes Michigan and

Huron. It appears that emerald shiners are suppressed by all but the lowest levels of alewife abundance.

While it is clear that abundance patterns for alewife have been driven in large part by continued high predation pressure, it is not clear what led to the drastic decline in bloater abundance from the 1980s to present. Recent stock-recruit modeling for bloater in Lakes Michigan and Huron indicated that sex ratio had an important impact on recruitment. Based on ages of bloater captured in the bottom trawl survey, relatively high levels of age-0 bloater in 2007-2009 acoustic surveys (Figure 5) are reflected in age composition of YAO bloaters in recent years, as most of the larger bloater aged in 2009-2011 were hatched in 2007-2009, adding support to the belief that bloater become fully recruited to the bottom trawl by age-3. Data from both acoustic and bottom trawl surveys suggest that recruitment has not been sufficient to offset mortality. We hypothesize that predation on small bloater by salmonines could be an important limit to recruitment at times (see Warner et al. 2008) as these small fish are found in the same location as alewife and at times can be important to some predators. Both Lake Michigan surveys suggest that recruitment in Lake Michigan is much more limited than in Lake Huron, where high densities of small bloater in 2007-2008 preceded increases in the abundance of larger bloater. ✧

Status and Trends of Prey Fish Populations in Lake Michigan, 2013

Abstract

The U.S. Geological Survey Great Lakes Science Center has conducted lake-wide surveys of the fish community in Lake Michigan each fall since 1973 using standard 12-m bottom trawls towed along contour at depths of 9 to 110 m at each of seven index transects. All seven established index transects of the survey were completed in 2013. Lake-wide biomass of alewives in 2013 was estimated at 29 kilotonnes (kt, 1 kt = 1000 metric tonnes), which was more than three times the 2012 estimate. However, the unusually high standard error associated with the 2013 estimate indicated no significant increase in lake-wide biomass between 2012 and 2013. Moreover, the age distribution of alewives remained truncated with no alewife exceeding an age of 5. The population of age-1 and older alewives was dominated (i.e., 88%) by the 2010 and 2012 year-classes. Record low biomass was observed for deepwater sculpin (1.3 kt) and ninespine stickleback (0.004 kt) in 2013, while bloater (1.6 kt) and rainbow smelt (0.2 kt) biomasses remained at low levels. Slimy sculpin lake-wide biomass was 0.32 kt in 2013, marking the fourth consecutive year of a decline. The 2013 biomass of round goby was estimated at 10.9 kt, which represented the peak estimate to date. Burbot lake-wide biomass (0.4 kt in 2013) has remained below 3 kt since 2001. Numeric density of age-0 yellow perch (i.e., < 100 mm) was only 1 fish per ha, which is indicative of a relatively poor year-class. Lake-wide biomass estimate of dreissenid mussels in 2013 was 23.2 kt. Overall, the total lake-wide prey fish biomass estimate (sum of alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, round goby, and ninespine stickleback) in 2013 was 43 kt, with alewives and round gobies constituting 92% of this total.

The basic unit of sampling in our surveys is a 10-minute tow using a bottom trawl (12-m headrope) dragged on contour at 9-m (5 fathom) depth increments.

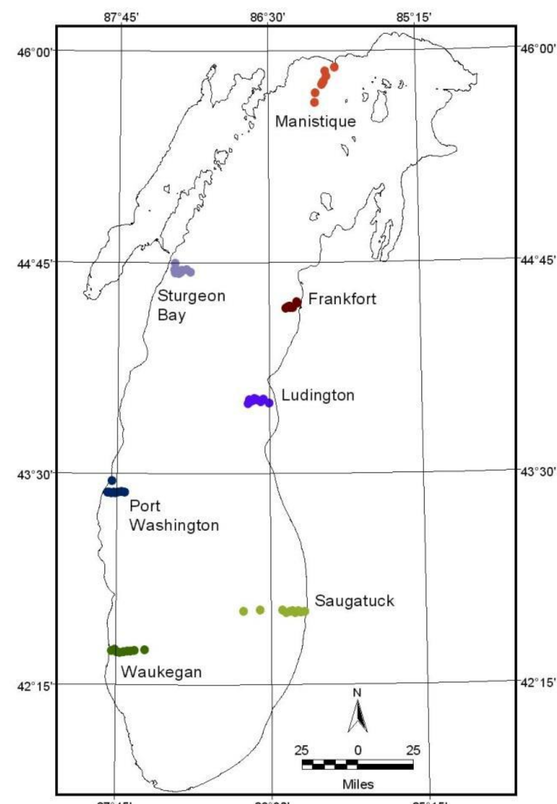

Figure 1. Established sampling locations for GLSC bottom trawls in Lake Michigan.

Alewife – According to the bottom trawl survey results, adult alewife biomass density increased from 1.4 kg per ha in 2012 to 8.2 kg/ha in 2013 (Figure 2).

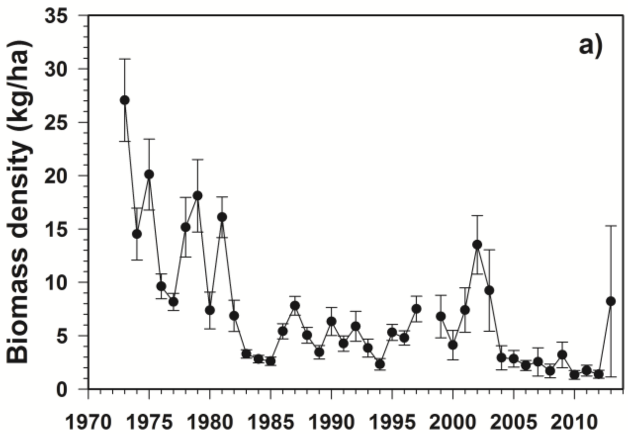

Figure 2. Density of adult alewives in Lake Michigan, 1973-2013

Given the extremely high standard errors for the 2013 estimates, adult alewife biomass density has appeared to remain at a low level during 2004-2013 (Figure 2). This continued depression of adult alewife abundance may reflect a recently intensified amount of predation exerted on the alewife population by Chinook salmon due to four factors: (1) a relatively high percentage of wild Chinook salmon in Lake Michigan, (2) increased migration of Chinook salmon from Lake Huron in search of alewives, (3) increased importance of alewives in the diet of Chinook salmon in Lake Michigan between the 1990s and the 2000s (Jacobs et al. 2013), and (4) a decrease in the energy density of adult alewives during the late 1990s. The long-term temporal trends in adult alewife biomass, as well as in alewife recruitment to age 3, in Lake Michigan are attributable to consumption of alewives by salmonines.

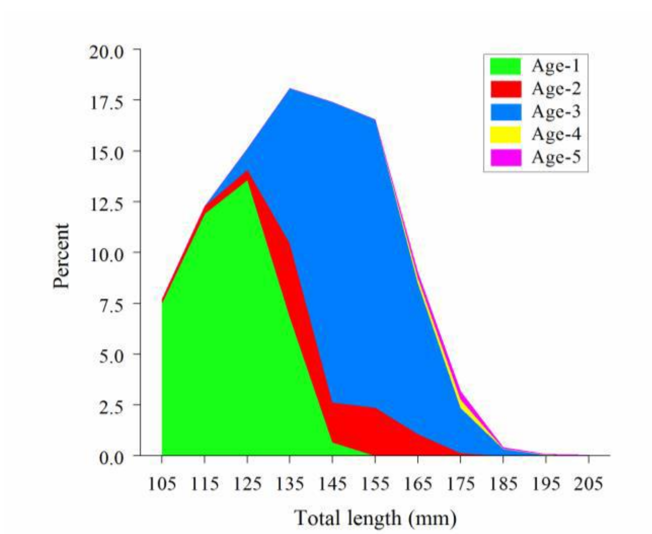

Figure 3. Age-length distribution of alewives in bottom trawls in Lake Michigan, 2013. Smaller alewives were captured but not included herein.

We estimated that 41% and 47% of adult alewives captured in the bottom trawl during 2013 were age-1 and age-3 fish, respectively (Figure 3). Of the 314 alewives aged from the 2013 bottom trawl survey, only 8 and 6 alewives were age-4 and age-5 fish, respectively, and none of these 314 alewives were older than 5 years old. Thus, the recent trend of age truncation in alewife population age structure continued in 2013, with the oldest alewife being only 5 years old (Figure 3). Prior to 2008, age-8 alewives were routinely captured.

Our results for temporal trends in adult alewife density were in general agreement with results from the lake-wide acoustic survey, which reported biomass of adult alewife during 2004-2013 to be relatively low in comparison to the biomass during 1994-1996. However, Warner did report a substantial increase in adult alewife biomass during 2007-2010 that was not detected by the bottom trawl survey. On average, for adult alewife biomass density, the acoustic estimate exceeded the bottom trawl estimate by a factor of three to four. But, in 2013, the acoustic estimate (5.0 kg/ha) was not significantly different from the bottom trawl estimate (8.2 kg/ha).

Bloater – Bloaters are eaten by salmonines in Lake Michigan, but are far less prevalent in salmonine diets than alewives. For large (≥ 600 mm) lake trout, over 30% of the diets offshore of Saugatuck and on Sheboygan Reef were composed of adult bloaters during 1994-1995, although adult bloaters were a minor component of lake trout diet at Sturgeon Bay. For Chinook salmon, the importance of bloater (by wet weight) in the diets has declined between 1994-1995 and 2009-2010. For small (< 500 mm) Chinook salmon the proportion declined from 9% to 6% and for large Chinook salmon the proportion declined from 14% to <1%. The bloater population in Lake Michigan also supports a valuable commercial fishery, although its yield has generally been declining since the late 1990s.

Although adult bloater biomass density increased from 0.11 kg per ha in 2012 to 0.41 kg per ha in 2013, adult bloater biomass density in the Lake Michigan, based on our survey results, has remained at a 5 relatively low level for nearly a decade (Figure 4). These low biomass densities represent a continuation of an overall declining trend since 1989.

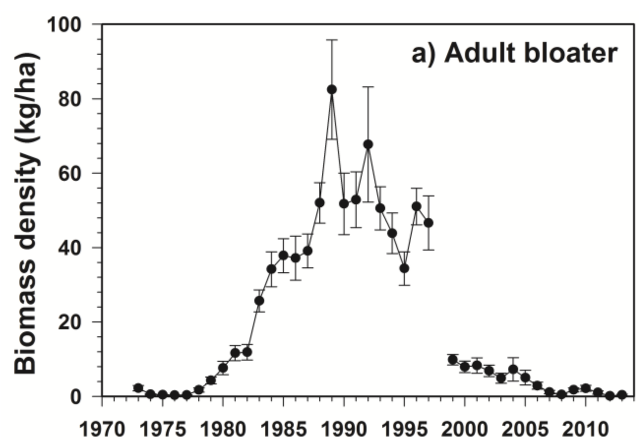

Figure 4. Adult bloater in Lake Michigan, 1973-2013

The exact mechanisms underlying the relatively poor bloater recruitment since 1992, and the resultant low biomass of adult bloater, remain unknown. Of the mechanisms that have been recently evaluated, reductions in fecundity associated with poorer condition and egg predation by slimy and deepwater sculpins are likely contributing to the reduced bloater recruitment, but none is the primary regulating factor.

Rainbow smelt – Adult rainbow smelt are an important part of the diet for intermediate-sized (400 to 600 mm) lake trout in the nearshore waters of Lake Michigan. For Chinook salmon, rainbow smelt comprised as much as 18% in the diets of small individuals in 1994-1996, but that dropped precipitously to 2% in 2009-2010 and rainbow smelt has been consistently rare in the diets of larger Chinook salmon since 1994. The rainbow smelt population supports commercial fisheries in Wisconsin and Michigan waters.

Despite the nominal increase in adult rainbow smelt biomass density from 0.02 kg per ha in 2012 to 0.05 kg per ha in Results from both the acoustic and bottom trawl surveys indicated that rainbow smelt biomass in Lake Michigan during 1992-1996 was roughly four times higher than rainbow smelt biomass during 2001-2013.

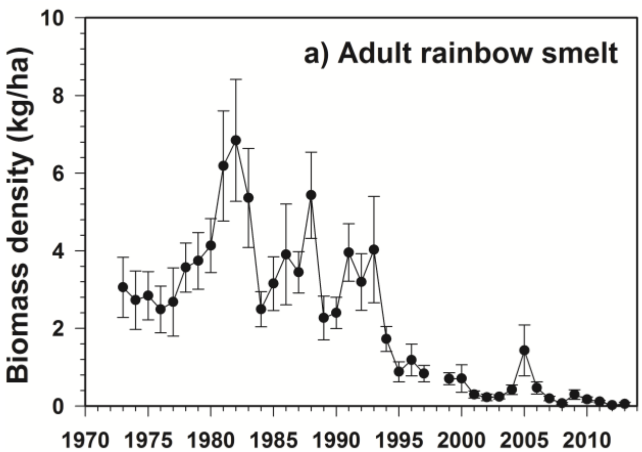

Figure 5. Adult rainbow smelt in Lake Michigan, 1973-2013

Sculpins – From a biomass perspective, the cottid populations in Lake Michigan have been dominated by deepwater sculpins, and to a lesser degree, slimy sculpins. Spoonhead sculpins, once fairly common, suffered declines to become rare to absent by the mid 1970s (Eck and Wells 1987). Spoonhead sculpins were encountered in small numbers in our survey between 1990 and 1999, but have not been sampled since 1999.

Slimy sculpin is a favored prey of juvenile lake trout in nearshore regions of the lake, but is only a minor part of adult lake trout diets. When abundant, deepwater sculpin can be an important diet constituent for burbot in Lake Michigan, especially in deeper waters.

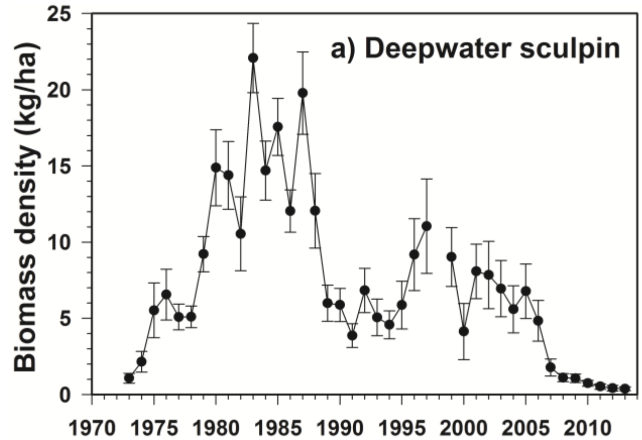

Figure 6. Deepwater Sculpin in Lake Michigan, 1973-2013

Deepwater sculpin biomass density was 0.38 kg per ha in 2013 (Figure 6a), which was only 5% of the long-term average biomass and the lowest estimate of the time series. For every year since 2009, this biomass estimate has reached a record low. During 1990-2005, both deepwater sculpin biomass density and numeric density trended neither downward nor upward. However, biomass of deepwater sculpin sampled in the bottom trawl has declined precipitously since 2005. Madenjian and Bunnell (2008) demonstrated that deepwater sculpins have been captured at increasingly greater depths since the 1980s. Therefore, one potential explanation for the recent declines in deepwater sculpin densities is that an increasing proportion of the population is now occupying depths deeper than those sampled by our survey (i.e., 110 m). Furthermore, because the deepwater sculpin has historically occupied deeper depths than any of the other prey fishes of Lake Michigan, a shift to waters deeper than 110 m would seem to be a reasonable explanation for the recent declines in deepwater sculpin densities.

Slimy sculpin biomass density was 0.09 kg per ha in 2013, marking the fourth consecutive year of a decline. Biomass density of slimy sculpins in 2013 approached the minimal levels observed during 1984-1986 and 1990. Slimy sculpin abundance in Lake Michigan appeared to be regulated, at least in part, by predation from juvenile lake trout. We attribute the slimy sculpin recovery that occurred during the 1990s to, in part, the 1986 decision to emphasize stocking lake trout on offshore reefs. Likewise, the slimy sculpin decline since 2009 coincided with a substantial increase in the rate of stocking juvenile lake trout into Lake Michigan.

Round goby – Round gobies have been observed in bays and harbors of Lake Michigan since 1993, and were captured in the southern main basin of the lake as early as 1997. Round gobies were not captured in the GLSC bottom trawl survey until 2003, however. By 2002, round gobies had become an integral component of yellow perch diet at nearshore sites in southern Lake Michigan. Round gobies also had become an important constituent of the diet of burbot in northern Lake Michigan by 2005. Round gobies are also fed upon by smallmouth bass and lake trout, and more recently by lake whitefish, in Lake Michigan.

Round goby biomass density exhibited a peak value of 3.1 kg per ha in 2013; however, there was an unusually high degree of uncertainty, arising from the bulk of the round gobies being caught in a single trawl tow at the 18-m depth at Waukegan, associated with this estimate (Figure 7). In general, standard errors associated with the reported mean biomass densities for round goby were relatively high. Given this high degree of uncertainty, round goby abundance in Lake Michigan may already be leveling off in response to control by piscivores.

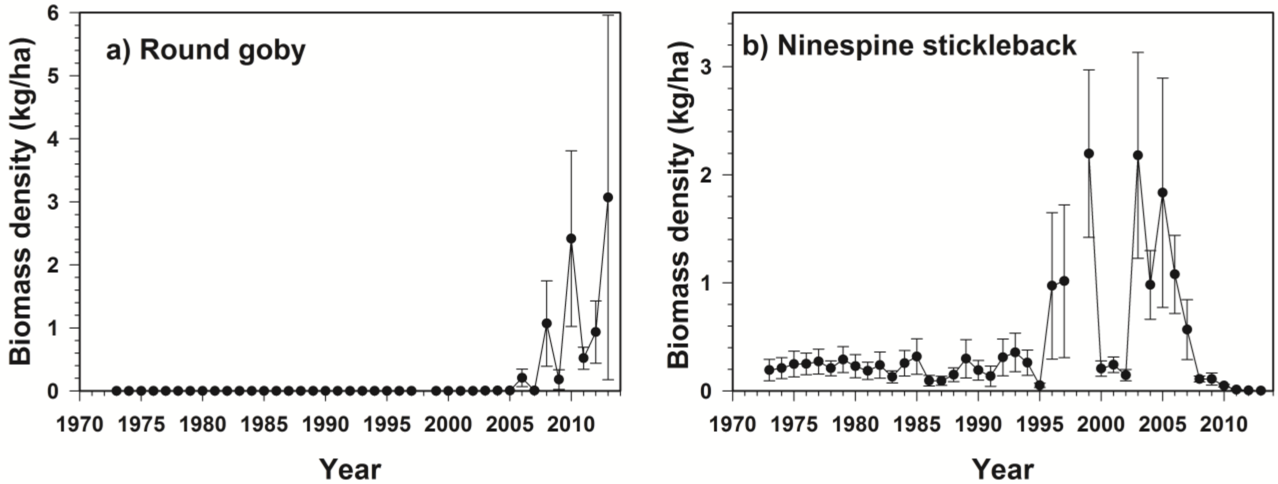

Figure 7. Biomass density of round goby (a) and ninespine stickleback (b) in Lake Michigan, 1973-2013.

<u>Ninespine stickleback</u> – Two stickleback species occur in Lake Michigan. Ninespine stickleback is native, whereas threespine stickleback is non-native and was first collected in the GLSC bottom trawl survey during 1984. Ninespine stickleback is generally captured in far greater densities than the threespine. Relative to other prey fishes, ninespine sticklebacks are of minor importance to lake trout and other salmonines. In northern Lake Michigan, for example, sticklebacks occur infrequently in the diet of lake trout. Biomass density was only 1 g per ha in 2013 (Figure 7b), the lowest value of the time series and only 0.3% of the long-term average. Biomass of ninespine stickleback remained fairly low from 1973-1995, increased dramatically in 1996-1997, and exhibited larger interannual variability between 1999 and 2007. Since 2008, however, biomass has been maintained at near record-low levels. The relatively high mean level of ninespine stickleback abundance during 1996-2007 has been attributed to dreissenid mussels somehow enhancing ninespine stickleback spawning and nursery habitat, perhaps through proliferation of *Cladophora*. One plausible explanation for the low ninespine stickleback abundance during 2008-2013 is that piscivores have begun to incorporate ninespine sticklebacks into their diets as the abundance of alewives has remained at a low level.

LAKE-WIDE BIOMASS

We estimated a total lake-wide biomass of prey fish available to the bottom trawl in 2013 of 43 kilotonnes (kt) (1 kt = 1000 metric tonnes) (Figure 8a). Total prey fish biomass was the sum of the population biomass estimates for alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, ninespine stickleback, and round goby. Total prey fish biomass in Lake Michigan has trended downward since 1989, primarily due to a dramatic decrease in bloater biomass (Figure 8a). During 2002-2012, decreases in alewife and deepwater sculpin biomasses also contributed to the continued decrease in total prey fish biomass. Total biomass first dropped below 30 kt in 2007, and remained below 30 kt during 2007-2012, but then increased to 43 kt in 2013. This increase must be interpreted with caution, however, due to the high degree of uncertainty in the 2013 biomass estimates for alewife and round goby.

As Figure 8b depicts, the 2013 prey fish biomass was apportioned as: alewife 67.0% (29.0 kt), round goby 25.0% (10.8 kt), bloater 3.7% (1.6 kt), deepwater sculpin 3.1% (1.3 kt), slimy sculpin 0.7% (0.3 kt), rainbow smelt 0.5% (0.2 kt), and ninespine stickleback < 0.1% (0.004 kt).

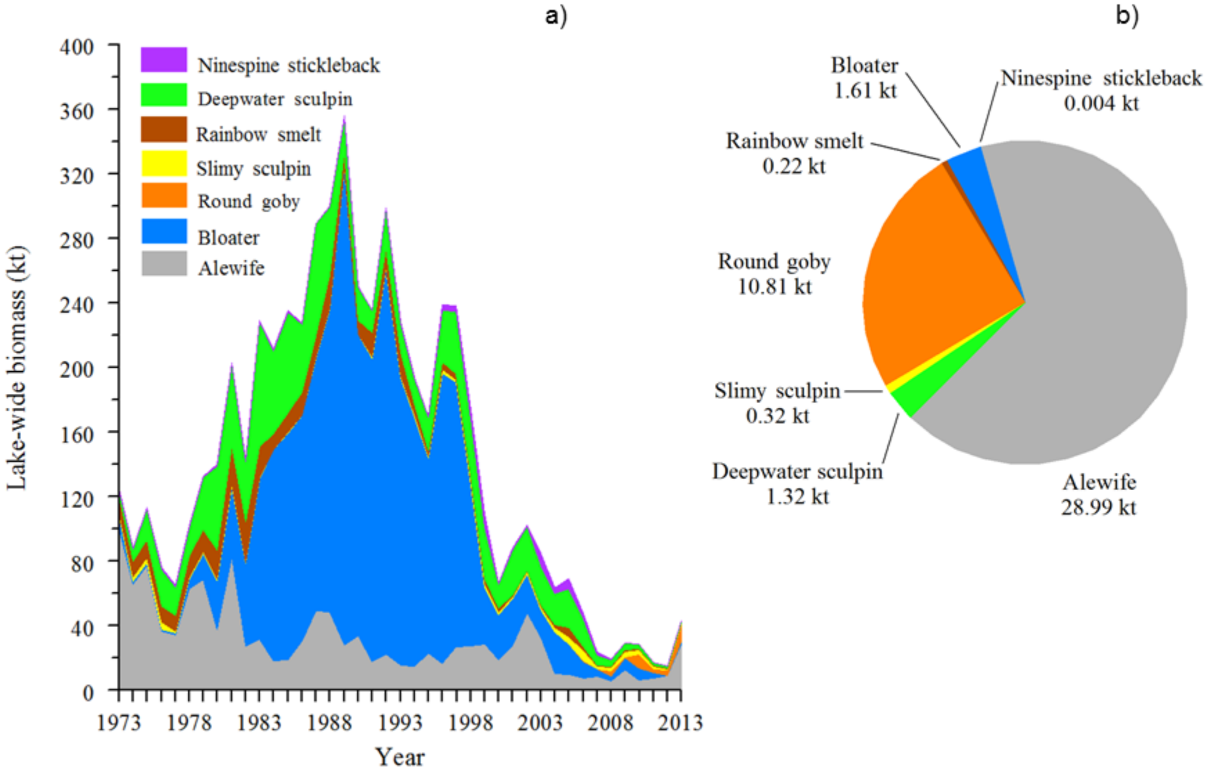

Figure 8. Estimated lake-wide biomass of prey fishes in Lake Michigan, 1973-2013 (a) and species composition in 2013 (b).

OTHER SPECIES OF INTEREST

Burbot – Burbot and lake trout represent the native top predators in Lake Michigan. The decline in burbot abundance in Lake Michigan during the 1950s has been attributed to sea lamprey predation. Sea lamprey control was a necessary condition for recovery of the burbot population in Lake Michigan.

Burbot collected in the bottom trawls are typically large individuals (>350 mm TL); juvenile burbot apparently inhabit areas not usually covered by the bottom trawl survey.

Age-0 yellow perch – The yellow perch population in Lake Michigan has supported valuable recreational and commercial fisheries. The 2005 year-class of yellow perch was the largest ever recorded (Figure 9) and the 2009 and 2010 year-classes also were higher than average. Strong yellow perch recruitment in these recent years was likely attributable to a sufficient abundance of female spawners and favorable weather. Numeric density of the 2013 year-class was only 1 fish per ha, indicative of a relatively weak year-class.

A comparison of the biomass density of dreissenid mussels (6.6 kg per ha) with biomass density of all species of fish (13 kg per ha) caught in the bottom trawl in 2013 indicated that 34% of the daytime benthic biomass available to the bottom trawl was dreissenid mussels (Figure 10b).

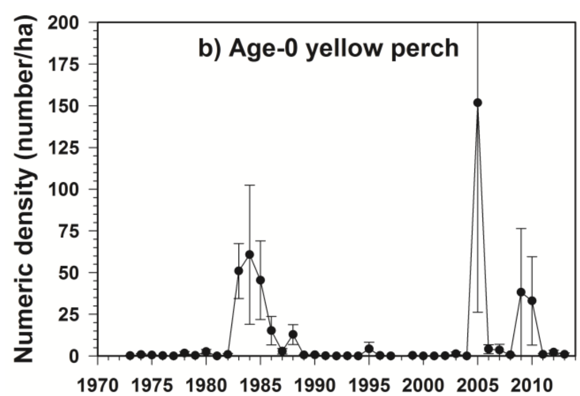

Figure 9. Density of age-0 yellow perch in Lake Michigan, 1973-2013.

Although total prey fish biomass in 2013 was higher than that estimated for years 2007-2012, total prey fish biomass was still relatively low during 2013. Further, uncertainty in the 2013 total prey fish biomass estimate was extremely high. Prudently, we conclude that, based on the bottom trawl

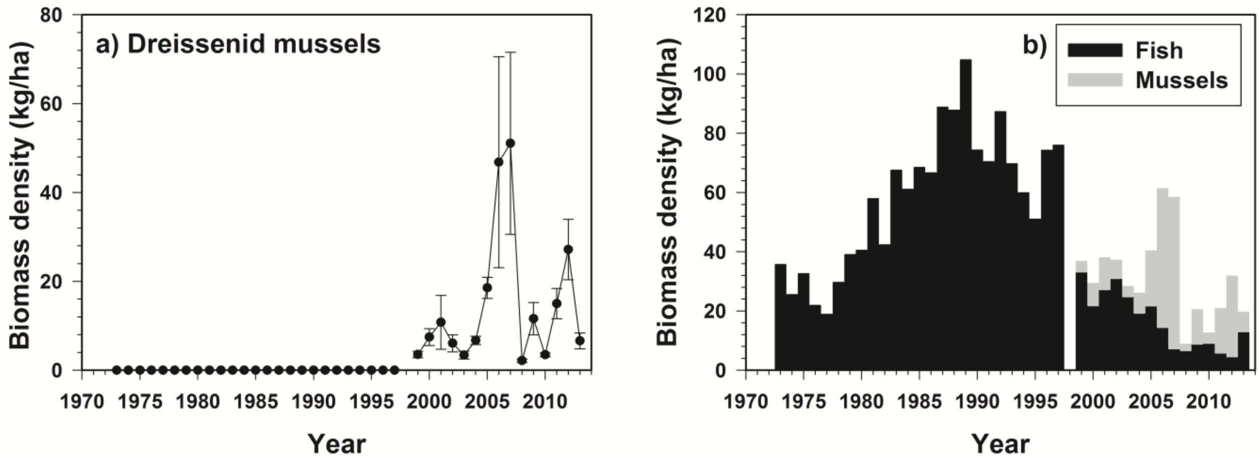

Figure 10. Panel (a) depicts biomass density of dreissenid mussels in the bottom trawl in Lake Michigan between 1999 (first year mussels were weighed) and 2013. Panel (b) depicts biomass of dreissenids and total fish biomass estimated by the bottom trawl between 1973 and 2013.

survey results, total prey fish biomass in Lake Michigan has remained at a low level during 2007-2013. This low level of prey fish biomass was attributable to a suite of factors, two of which can be clearly identify as: (1) a prolonged period of poor bloater recruitment since 1992 and (2) intensified predation on alewives by Chinook salmon during the 2000s. Adult alewife density has been maintained at a relatively low level over the last 10 years and the age distribution of the adult alewife population has become especially truncated in recent years. As recent as 2007, alewives as old as age 9 were sampled in this survey whereas the oldest alewife sampled in 2013 was age 5. Whether or not the alewife population in Lake Michigan will undergo a collapse in coming years (similar to what occurred in Lake Huron) will depend on several factors. Primarily, the extent to which predation by salmonines influences the survival of the large 2010 alewife year-class is critical. Salmonine predation on the 2012 alewife year-class will also be important. In addition, alewife sustainability will depend on the ability of alewife spawning stock to produce another strong year-class in the next few years, which will at least partially depend on appropriate environmental factors being met (Madenjian et al. 2005b).

According to the bottom trawl survey estimates, native fishes represented only 7.5% of the total prey fish biomass in Lake Michigan in 2013. Native deepwater sculpin and ninespine stickleback were at record-low levels in 2013, biomass of native slimy sculpin continued a 4-year downward trend in 2013, and biomass of native bloater remained low in 2013. When interpreting the bottom trawl survey results, the possibility that two of these native species, deepwater sculpin and bloater, shifted their habitat use to deeper waters during recent years should be considered. If this shift did indeed occur, then the bottom trawl estimates for these two fishes may represent extreme underestimates of their biomass in Lake Michigan.

Scientists and managers continue to ask critical questions regarding the importance of “bottom-up” effects on prey fish biomass in Lake Michigan. For example, to what extent do (1) ongoing declines in total phosphorus (Evans et al. 2011), (2) the proliferation in dreissenid mussels, and (3) the resultant diminishment of the spring phytoplankton bloom (Fahnenstiel et al. 2010) reduce the capacity of Lake Michigan to produce the biomass of prey fish that was observed only two decades ago? We point out that the Lake Michigan ecosystem has already demonstrated its capacity to produce a strong year-class of alewives in 2010 despite the changes described above. Nonetheless, having a complete understanding of the answers to these questions will require additional years of surveillance, across-lakes comparisons, and food-web analyses.

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Salmonid Stocking Totals for Lake Michigan 1976-2013

The Great Lakes Fishery Commission's fish stocking database is designed to summarize federal, provincial, state, and tribal fish stocking events. This database contains agency provided records dating back to the 1950's and is available online at: http://www.glfc.org/fishstocking. A summary of lake trout stocking locations, described by priority area in *A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan*, is also included (Figure 1).

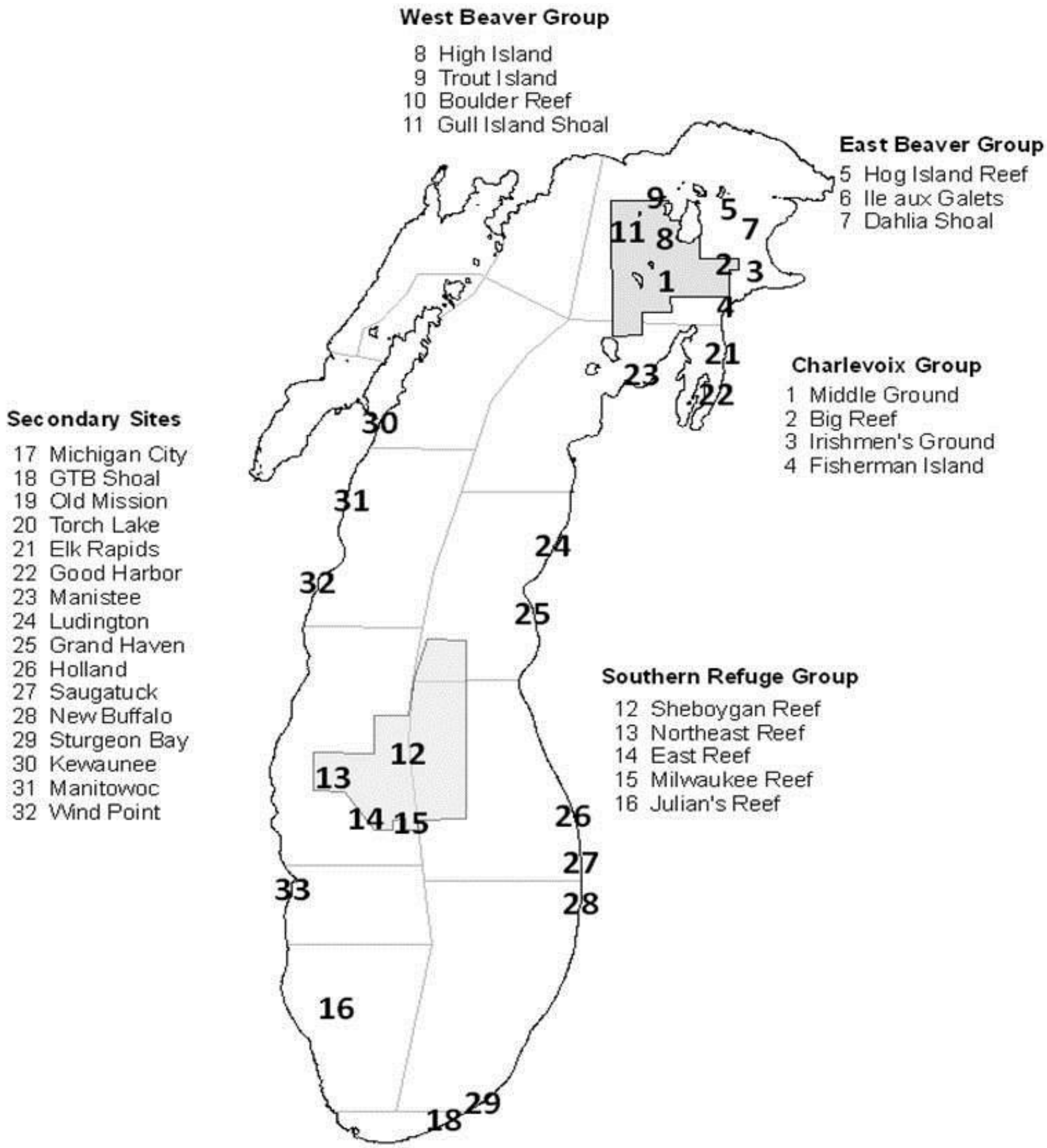

Figure 1. First and 2nd priority areas as described in *A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan*

Table 1. Millions of salmonids, fingerling and yearling stages combined, stocked in Lake Michigan between 1976 and 2013.

	Atlantic Salmon	Brook Trout	Brown Trout	Chinook Salmon	Coho Salmon	Lake Trout	Rainbow Trout	Splake	Total
1976	0.020	0.075	1.129	3.317	3.196	2.548	1.863	0.000	12.148
1977	0.019	0.643	1.160	2.977	3.087	2.418	1.312	0.000	11.616
1978	0.046	0.248	1.503	5.365	2.685	2.539	1.933	0.000	14.319
1979	0.000	0.196	1.228	4.984	4.044	2.497	2.589	0.000	15.538
1980	0.000	0.204	1.292	6.106	2.943	2.791	2.630	0.000	15.967
1981	0.020	0.208	1.169	4.747	2.451	2.642	1.971	0.000	13.208
1982	0.045	0.259	2.139	6.312	2.181	2.746	2.525	0.000	16.207
1983	0.000	0.300	2.180	6.539	2.364	2.241	2.595	0.000	16.219
1984	0.000	0.233	1.803	7.710	2.954	1.565	3.111	0.034	17.410
1985	0.000	0.307	1.798	5.956	3.181	3.782	1.825	0.054	16.903
1986	0.000	0.197	1.434	5.693	2.291	3.297	2.222	0.115	15.249
1987	0.000	0.117	1.341	5.801	2.305	1.998	1.831	0.018	13.411
1988	0.017	0.466	1.516	5.417	3.210	2.546	1.429	0.104	14.706
1989	0.060	0.150	1.504	7.859	2.334	5.377	1.845	0.088	19.217
1990	0.000	0.400	1.772	7.129	2.380	1.317	1.600	0.050	14.648
1991	0.000	0.326	1.383	6.238	2.471	2.779	1.975	0.396	15.568
1992	0.000	0.272	1.615	5.795	2.712	3.435	1.689	0.099	15.618
1993	0.000	0.294	1.759	5.530	1.709	2.697	1.680	0.141	13.809
1994	0.000	0.269	2.172	5.837	1.497	3.854	2.220	0.166	16.015
1995	0.000	0.328	1.876	6.549	2.401	2.265	1.878	0.151	15.448
1996	0.000	0.180	1.787	6.193	3.112	2.141	1.849	0.201	15.463
1997	0.000	0.115	1.804	5.745	2.620	2.235	1.864	0.155	14.538
1998	0.000	0.408	1.742	5.721	2.059	2.302	1.618	0.097	13.948
1999	0.000	0.191	1.649	4.324	2.765	2.348	1.680	0.077	13.034
2000	0.000	0.045	1.666	4.049	2.499	2.260	1.244	0.079	11.842
2001	0.000	0.102	1.749	4.518	2.765	2.382	1.849	0.131	13.495
2002	0.000	0.514	1.754	4.015	2.690	2.224	1.861	0.126	12.721
2003	0.000	0.024	1.649	4.422	3.124	2.609	2.078	0.104	14.010
2004	0.000	0.001	1.601	4.303	1.687	2.354	1.583	0.122	11.651
2005	0.000	0.000	1.523	4.306	2.561	2.887	2.170	0.099	13.546
2006	0.000	0.001	1.611	3.253	2.430	3.255	1.788	0.166	12.504
2007	0.000	0.000	1.471	3.173	2.269	3.626	2.000	0.125	12.664
2008	0.000	0.005	1.469	2.725	2.029	3.122	1.618	0.087	11.055
2009	0.000	0.000	1.632	3.020	1.746	3.177	2.069	0.000	11.644
2010	0.000	0.041	1.426	3.295	2.516	3.432	1.677	0.000	12.387
2011	0.000	0.000	1.336	3.219	2.567	3.454	1.833	0.000	12.409
2012	0.000	0.000	1.523	3.243	2.743	3.599	1.929	0.000	13.037
2013	0.000	0.000	1.443	1.761	2.546	3.571	1.906	0.000	11.227
10 year mean	0.000	0.005	1.504	3.230	2.309	3.248	1.857	0.060	12.212

Table 4. Number of fingerling and yearling salmonids, excluding USFWS stocked lake trout, stocked in Wisconsin waters of Lake Michigan, 1976 – 2013.

Year	Brook trout	Brown trout	Chinook salmon	Coho salmon	Lake trout	Rainbow trout	Splake
1976	6,900	298,212	1,291,840	716,773	-	999,629	-
1977	643,352	802,193	912,608	491,346	-	712,031	-
1978	242,625	1,233,101	2,017,149	499,300	-	622,642	-
1979	187,330	959,542	1,963,811	319,865	-	1,211,340	-
1980	184,900	1,046,493	2,429,500	491,876	-	1,146,838	-
1981	199,867	1,014,198	1,848,260	318,500	-	996,752	-
1982	259,000	1,820,693	2,520,700	216,040	49,417	1,041,628	-
1983	300,158	1,554,818	2,791,700	356,500	31,480	1,492,804	-
1984	225,042	1,184,934	2,891,850	551,494	20,440	1,380,834	34,160
1985	307,065	1,170,070	2,740,800	1,044,222	-	431,891	54,488
1986	188,296	882,934	2,377,567	267,171	76,000	801,044	115,000
1987	94,777	836,762	2,263,484	624,432	-	562,192	-
1988	466,486	1,020,904	1,409,293	1,019,866	-	307,678	28,880
1989	150,100	972,699	2,713,891	511,286	-	495,281	-
1990	315,148	1,229,055	2,379,331	498,355	-	460,591	-
1991	326,100	981,523	1,734,618	402,804	-	586,922	147,000
1992	272,420	1,228,615	1,523,139	568,519	-	569,380	43,830
1993	294,094	1,333,311	1,600,120	-	-	679,181	40,000
1994	268,586	1,261,136	1,548,557	457,249	-	798,327	71,700
1995	327,957	1,325,118	1,901,420	722,081	-	553,441	-
1996	167,794	1,301,118	1,726,957	563,588	-	565,880	69,912
1997	114,530	1,279,830	1,917,116	514,712	-	569,950	40,000
1998	307,765	1,242,769	1,591,539	504,894	-	533,092	22,000
1999	190,669	1,181,306	1,308,766	520,224	-	521,351	26,667
2000	44,580	1,056,347	1,010,830	253,712	-	197,940	-
2001	101,500	1,257,559	1,502,607	512,774	-	641,747	54,502
2002	50,388	1,211,758	1,419,303	595,491	-	545,539	28,509
2003	23,877	1,080,538	1,511,206	540,145	-	758,275	22,086
2004	-	1,021,711	1,502,885	484,840	-	430,601	43,859
2005	-	952,104	1,475,456	515,978	-	553,861	16,259
2006	-	1,009,330	1,166,185	387,639	-	578,444	80,056
2007	-	994,566	1,112,683	610,282	-	705,133	44,352
2008	-	885,728	725,605	282,930	-	393,297	-
2009	-	934,420	995,804	344,471	-	636,329	-
2010	40,546	735,493	1,234,994	345,464	-	446,247	-
2011	-	704,755	1,127,575	433,348	-	436,427	-
2012	-	722,800	1,175,925	542,554	-	398,547	-
2013	-	609,743	802,091	383,732	-	410,973	-
10 year mean	4,055	857,065	1,131,920	433,124	-	498,986	18,453

Table 7. Number of fingerling and yearling salmonids, excluding USFWS stocked lake trout, stocked in Michigan waters1 of Lake Michigan, 1976 – 2013.

Year	Brook trout	Brown trout	Chinook salmon	Coho Salmon	Lake trout	Rainbow trout	Splake
1976	61,290	537,333	1,845,218	2,219,892	-	600,627	-
1977	-	206,470	1,576,202	2,314,130	-	276,102	-
1978	-	125,038	2,523,554	1,801,961	-	1,140,591	-
1979	-	198,781	2,306,700	3,317,032	75,000	980,763	-
1980	-	105,458	2,902,892	2,243,008	62,000	1,300,584	-
1981	8,000	32,000	2,204,741	1,707,164	453,230	557,693	-
1982	-	300,000	2,685,086	1,645,435	90,000	1,066,127	-
1983	-	574,006	2,975,730	1,879,957	-	723,464	-
1984	8,000	529,560	3,874,237	1,969,449	-	1,307,049	-
1985	-	505,532	2,258,470	1,692,954	-	737,300	-
1986	8,600	491,795	2,402,453	1,579,181	-	632,877	-
1987	22,500	415,941	2,428,952	1,331,287	-	668,411	17,747
1988	-	400,136	2,670,933	1,732,590	-	544,315	75,000
1989	-	425,792	3,777,744	1,682,229	-	735,897	88,000
1990	85,000	542,646	3,639,756	1,464,945	-	600,680	50,000
1991	-	287,844	3,312,255	1,655,396	-	761,077	249,200
1992	-	285,885	3,415,426	1,734,592	-	602,577	55,496
1993	-	320,294	3,107,027	1,578,646	-	502,736	101,030
1994	-	810,716	3,465,751	626,914	-	779,086	94,548
1995	-	452,731	3,729,454	1,201,734	105,628	683,967	150,819
1996	-	400,468	3,529,424	1,885,735	-	603,058	131,499
1997	-	434,014	3,045,101	1,722,219	-	592,339	114,974
1998	-	399,584	3,170,173	1,100,039	-	517,785	75,000
1999	-	364,808	2,295,649	1,796,218	-	522,438	50,664
2000	-	509,815	2,314,490	1,785,240	-	571,862	79,139
2001	-	419,081	2,260,965	1,794,647	-	548,172	76,090
2002	-	406,917	2,037,558	1,568,973	149,927	604,173	97,434
2003	-	428,240	2,379,317	2,106,472	-	600,896	81,500
2004	1,000	463,150	2,260,211	666,474	-	574,119	77,732
2005	-	434,300	2,283,737	1,507,100	-	571,596	82,606
2006	-	500,831	1,609,841	1,658,880	-	612,736	86,200
2007	-	334,376	1,590,909	1,125,860	-	534,092	80,350
2008	4,960	460,897	1,529,994	1,215,149	-	545,926	86,993
2009	-	574,669	1,580,535	861,145	80,000	727,554	-
2010	-	550,563	1,575,713	1,609,802	47,000	552,294	-
2011	-	490,793	1,575,545	1,628,923	80,000	732,358	-
2012	-	629,683	1,591,019	1,750,685	80,993	686,083	-
2013	-	566,290	562,223	1,589,829	63,912	711,087	-
10 year mean	596	500,555	1,615,973	1,361,385	35,191	624,785	41,388

Footnotes: 1Reported value represents MI DNR stocking totals which may be different than the total numbers stocked within Michigan statistical districts.

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2013 Lake Michigan Lake Trout Working Group Report

This report provides a brief overview of the status of lake trout populations and restoration efforts in Lake Michigan from the spring lakewide assessment plan (LWAP) survey and fall spawner surveys (refer to Figure 1 for sampling locations).

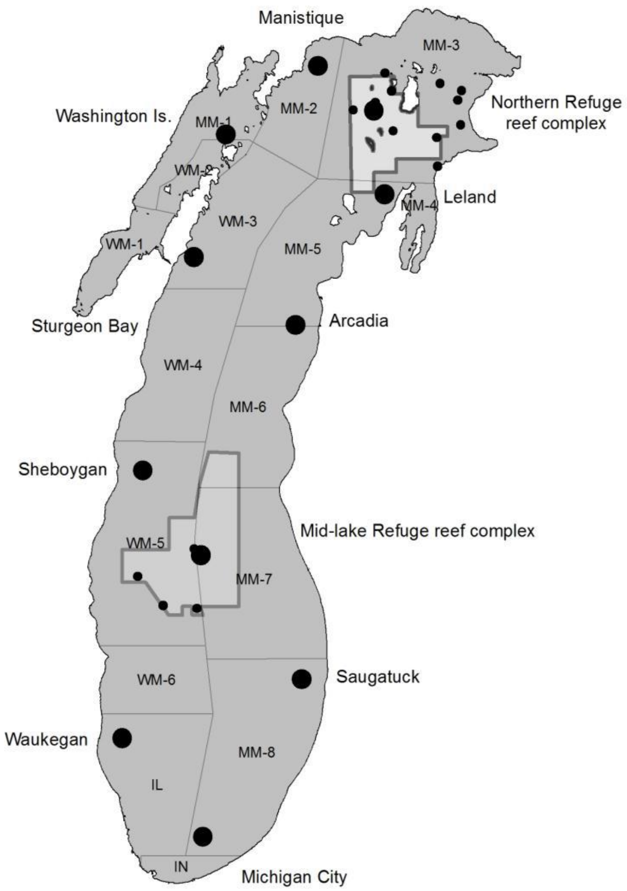

Figure 1. The large black circles show the nine nearshore spring LWAP sampling sites and the two offshore complexes within and near the refuges; the small black circles represent reefs that are sampled within each refuge reef complex.

Objective 1 (Increase genetic diversity): Increase the genetic diversity of lake trout by introducing morphotypes adapted to survive and reproduce in deep-water, offshore habitats, while continuing to stock shallow-water morphotypes.

Results: Klondike Reef strain from Lake Superior has been recommended for introduction to deep-water habitats; the Lake Michigan Committee (LMC) has decided that a limited number should be stocked experimentally. In 2012, about 80,000 Klondike Reef strain yearlings were stocked on Northeast Reef in the Mid-lake Refuge (MLR), also known as the Southern Refuge (Figure 1). In 2013, about 130,000 Klondike Reef strain yearlings were stocked on Northeast Reef. Lean lake trout from Seneca Lake (Finger Lakes, NY), Apostle Islands (Lake Superior), and Lewis Lake (Lake Michigan remnant) have been selected as the primary lean lake trout strains. Additionally, a remnant, nearshore form of lean lake trout from Parry Sound (Lake Huron) has been raised in USFWS hatcheries. In 2013, about 203,000 Parry Sound strain yearlings were stocked within the Northern Refuge reef complex, and roughly 46,000 Parry Sound strain fall fingerlings were stocked in Wisconsin nearshore waters.

Objective 2 (Increase overall abundance): By 2014, increase densities of lake trout populations in targeted rehabilitation areas to levels observed in other Great Lakes locations where recruitment of wild fish to the adult population has occurred. To achieve this objective, CPUE in spring assessments should consistently exceed 25 lake trout per 1000 ft of graded-mesh (2.0 – 6.0 inch) gill net fished.

Results: In 2013, six gillnet lifts were performed in each nearshore LWAP location except for Manistique, which was not sampled in 2013. Three lifts were completed on the Mid-lake Refuge, while 32 lifts were completed within the Northern Refuge reef complex. On a lakewide basis, spring CPUE has remained substantially below the target level of 25 lake trout per 1000 ft of gill net (horizontal line) (Figure 2). At most locations, lake trout abundance was well below the target level in 2013. However, lake trout abundance has, at times, approached or exceeded the target level in a few statistical districts (Illinois waters, MM-5, MM-6, WM-3, and WM-5) and in the MLR. In 2013, spring CPUE was equal to 35.8 lake trout per 1000 ft of gill net in the Mid-lake Refuge reef complex, whereas spring lakewide CPUE was 6.5 lake trout per 1000 ft of gill net (Figure 2).

Data on the age composition of spawning lake trout is not routinely reported by all agencies. Consequently, the second part of Objective 4 regarding age composition of the lake trout spawners could not be assessed.

Objective 3 (Detect egg deposition): By 2021, detect a minimum density of 500 viable eggs/m2 (eggs with thiamine concentrations > 4 nmol/g) in previously stocked areas. This milestone should be achieved by 2025 in newly stocked areas.

Results: Egg deposition rates have remained low at the sites where egg deposition has been measured in northern Lake Michigan during 2000-2013. Nearly all of the measured densities of lake trout eggs have been less than 60 eggs/m2 (Figure 2).

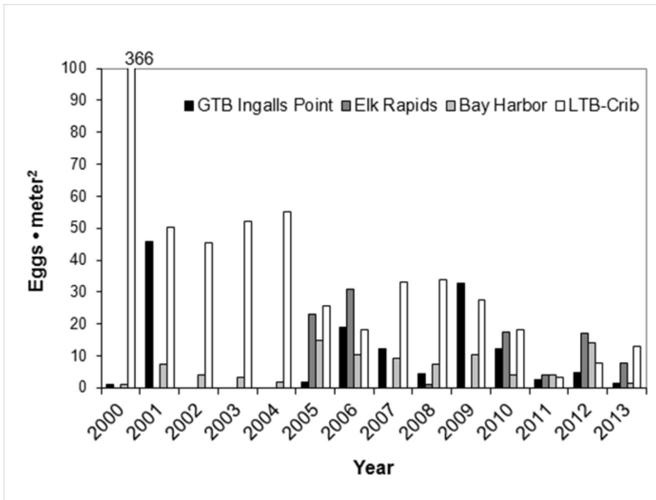

Figure 2. Numbers of lake trout eggs observed per square meter in northern Lake Michigan fall egg deposition surveys, 2000-2013.

<u>Objective 4 (Detect recruitment of wild fish)</u>: Consistent recruitment of wild lake trout in targeted rehabilitation areas should occur as follows: by 2022 detect age-1 fish in bottom trawls, by 2025 detect age-3 fish in spring graded-mesh-gill-net assessments, and by 2028 consistently detect sub-adults.

Results: The rate of natural reproduction by lake trout in Lake Michigan has increased during the past 10 years. On a lakewide basis, the percentage of lake trout without a fin clip of the total lake trout catch in the spring LWAP survey increased from 1.2% in 2004 to 6.5% in 2013 (Figure 4). This increase coincided with a period of reduced abundance of alewives, which are suspected of interfering with lake trout reproduction via predation on lake trout fry and via reduction of thiamine levels in lake trout eggs, thereby lowering egg survival. The recently estimated rate of marking error (fish released from the hatchery without a fin clip) for lake trout is 3%, and therefore percentages of unclipped lake trout exceeding 3% imply natural reproduction. At Waukegan, the percentage of lake trout without a fin clip of the total lake trout catch from the spring LWAP survey ranged from 11.1% to 16.3% during 2011-2013 (Figure 4). In 2011 and 2012, about 20% of the juvenile lake trout incidentally caught in gill nets set for bloaters off the Door Peninsula and Mid-lake Reef in Wisconsin during February were unclipped fish, and most of these lake trout were <500 mm in total length. During February 2013, gill nets fished off the Door Peninsula yielded lake trout catches with 22% (29 of 129) of the fish unclipped, while lake trout caught in bottom trawls near Manitowoc had an unclipped rate of 21% (7 of 33). In addition, of the catches of lake trout in the 2012 and 2013 fall spawner surveys in Illinois waters, 50% (262 of 528) and 54% (242 of 452), respectively, of the fish were unclipped. Lastly, of 14 lake trout caught in the USGS Great Lakes Science Center (GLSC) fall bottom trawl survey of Lake Michigan during September 2013, 6 lake trout (43%) were unclipped. One of these unclipped lake trout was an age-0 wild fish (only 57 mm in total length) caught at the Waukegan transect. Since 2005, 24 of the 127 lake trout, or 19% of the lake trout, caught in the GLSC bottom trawl survey were unclipped. Prior to 2005, less than 2% of the lake trout caught in the GLSC bottom trawl survey were unclipped.

Lake trout stocking

The U. S. Fish and Wildlife Service stocked a total of 2.95 million yearling (14-16 months old) lake trout into Lake Michigan in 2013. Stocking totals for each state jurisdiction were 124,021 in Illinois, 42,386 in Indiana, 2,078,629 in Michigan, and 708,951 in Wisconsin. All yearling fish received an AD fin clip paired with a coded wire tag. The stocked yearling lake trout consisted of five strains: Apostle Islands (291,632 fish), Lewis Lake (1,093,537 fish), Seneca Lake (1,237,335 fish), Klondike Reef (128,542 fish), and Parry Sound (202,941 fish). All Klondike Reef strain lake trout were stocked at Northeast Reef, and all Parry Sound strain yearlings were stocked in the Northern Refuge reef complex. Additionally, 415,198 fall fingerlings were stocked into nearshore waters of Lake Michigan during 2013. Fall fingerling stocking totals for each state jurisdiction were 52,500 in Indiana, 252,289 in Michigan, and 110,409 in Wisconsin. Fall fingerling totals by strain were 68,744 Parry Sound strain, 131,664 Lewis Lake strain, and 214,790 Seneca Lake strain. All Parry Sound strain fall fingerlings were stocked into nearshore Wisconsin waters.

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SEA LAMPREY CONTROL IN LAKE MICHIGAN 2013

During 2013, adult sea lamprey abundance in Lake Michigan was estimated to be 57,596 (95% CI; 52,971-63,496), which was within the target range. The number of A1-A3 marks on lake trout from spring assessments in 2013 has not yet been analyzed.

LAMPRICIDE CONTROL

Lake Michigan has 511 tributaries. One hundred twenty-six tributaries have historical records of larval sea lamprey production, and of these, 90 tributaries have been treated with lampricides at least once during 2004-2013. Forty tributaries are treated on a regular cycle. Figure 1 provides details on the application of lampricides to Lake Michigan tributaries and lentic areas during 2013.

- Lampricide treatments were completed in 45 tributaries and 2 lentic areas.

- This was the second year of an expanded large-scale treatment strategy in northern Lake Michigan. Thirty-one sea lamprey producing tributaries were treated as part of this continuing effort and the following nine tributaries were treated for the second consecutive year: Brevort and Black rivers, Davenport, Hog Island, Big Stone and Big Sucker creeks, Carp Lake, Gulliver Lake, and Wycamp Lake outlets.

- Four streams were treated for the first time in over 20 years: Mile, Swan (Kalamazoo River tributary), Southtown, and Point Patterson creeks.

- The Ford River treatment was postponed due to high-water conditions in late April through early May. The upper Ford River and its tributaries along with tributaries to the Cedar River were treated during mid-May. The mainstream treatments of both rivers were conducted during late May when stream discharge fell within normal limits.

- Bursaw, Marblehead, Swan, Parent, and Southtown creeks were treated with lampricide under extremely low discharge conditions.

- The lower portion of the Manistique River (harbor area within the break walls) was treated with GB. Based on collections and observations during treatment, a high larval sea lamprey density consisting of large larvae was evident.

- Bulldog Creek was retreated in September due to residuals after the first treatment in June.

The Manistee River was treated for the second consecutive year due to the presence of residual lampreys. Treatment of the Manistee River was delayed until early August, due to non-target species concerns.

- Upstream distribution of sea lampreys in the North Branch of the Pentwater River significantly increased the distance of stream that required treatment compared to distribution during 2011.

Barriers

The Commission has invested in 12 barriers on Lake Michigan. Of these, five were purpose-built as sea lamprey control barriers and seven were constructed for other purposes, but have been modified to block sea lamprey migrations.

- Field crews visited 128 structures on tributaries to Lake Michigan to assess sea lamprey blocking potential and to improve the information in the BIPSS.

- Pere Marquette River – Planning for decommissioning of the electrical barrier continued. Custer Township, Pere Marquette Watershed Council, Conservation Resource Alliance, Michigan Department of Natural Resources (MIDNR) and the Spicer group partnered with the Service and Commission on the decommission, which is expected to be completed during 2014.

Ensure Blockage to Sea Lamprey Migration

- Boardman River – Surveys for larvae were conducted upstream from the Union St. Dam to ensure there was no escapement after dam repairs were made in 2012-2013. Surveys to look for sea lamprey nests and young-of-year larvae were also conducted. No spawning activity was noted and no young-of-year larvae were collected upstream from the dam. Results of the inspection report completed during 2012 indicated that the dam is structurally sound with no major defects or obvious paths for escapement. The report provided optimal elevations for the stoplogs for all spillways and the fish ladder to effectively block sea lampreys. The Service coordinated with Traverse City Parks and Recreation Department to place an additional stoplog in each section of the south spillway to increase the crest elevation by six inches.

- White River – During fall 2012, with the cooperation of the City of Hesperia Department of Public Works, stoplogs in four bays were replaced and sealed with hydraulic cement at the wood-concrete interface. An angle iron lip was installed on the face of the top stop logs in each of the four bays. No young-of-year lampreys were found upstream of the Hesperia Dam during 2013 fall electrofishing surveys.

- Grand River – The City of Grand Rapids along with several citizens groups have proposed removal of the 6th Street Dam on the Grand River to provide for more varied use of the downtown rapids area. The plan called for removal of the existing structure and creation of an artificial rapids complex that can be used by kayakers and fishermen. A new inflatable crest structure has been proposed one mile upstream of the current location. A stakeholder meeting was held in Grand Rapids to clarify technical details of the proposed inflatable crest/velocity sea lamprey barrier.

- alarm substance field trials on the Carp Lake River Outlet (tributary to Lake Michigan). When adults were released into the river prior to application, the alarm cue application motivated upstream movements and vigorous attempts to pass the barrier (the source of the odor). There was also evidence of increased trap captures as a consequence of the increased activity.

- The Wagner lab conducted EPA-funded sea lamprey

- Consultations to ensure blockage at barriers in 10 streams were conducted with partner agencies during 2013.

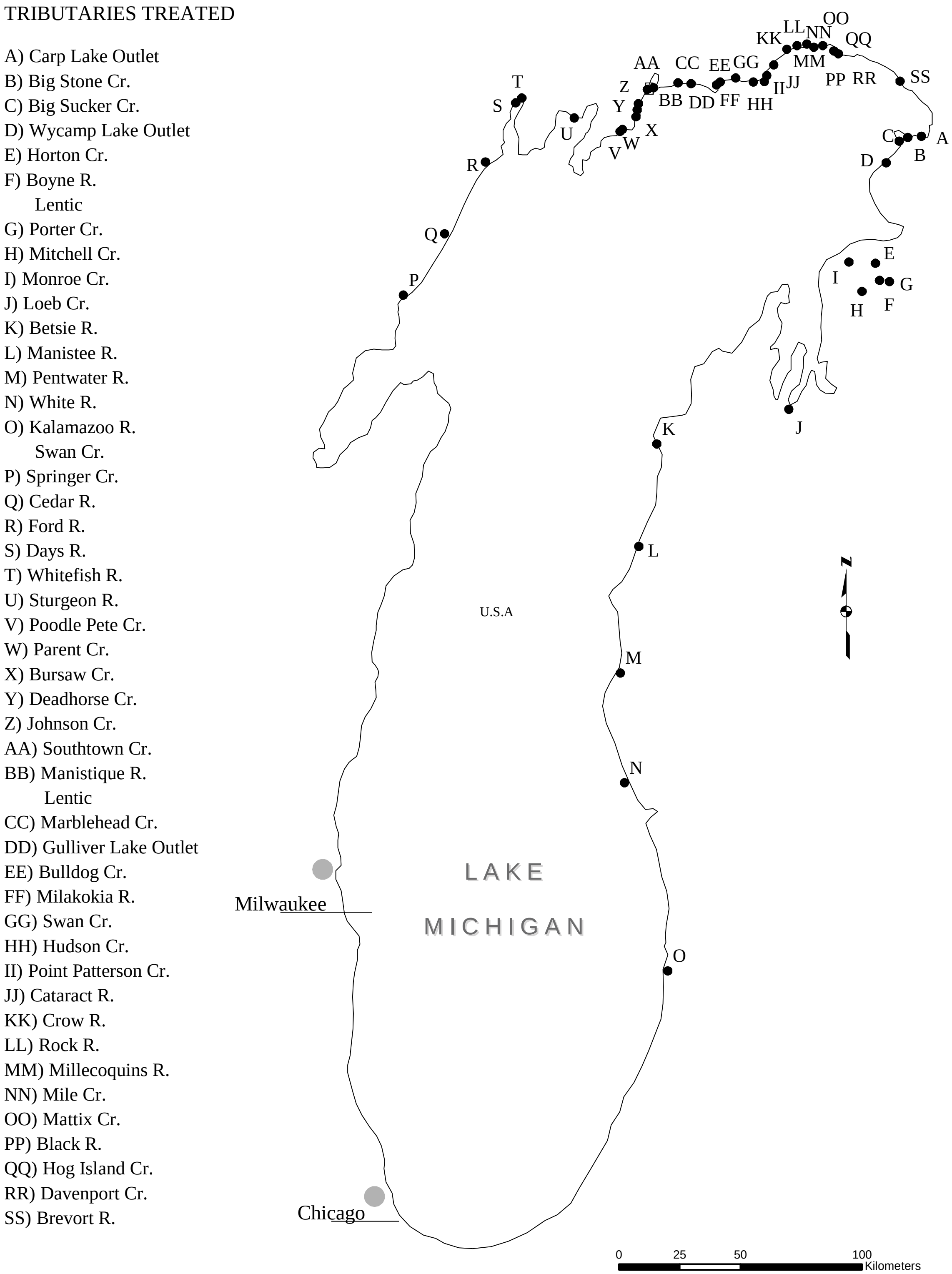

Figure 1. Location of Lake Michigan tributaries treated with lampricides during 2013.

New Construction

- Manistique River – The U.S. Army Corps of Engineers (USACE) is the lead agency administering a project to construct a sea lamprey barrier to replace a deteriorated structure in the Manistique River. Project partners include the Commission, Service, MIDNR, City of Manistique, and Manistique Papers Inc. The existing dam location was identified as the most feasible site for a new barrier. The project is currently on hold while the Michigan Department of Environmental Quality completes a permit review and potential wetland mitigation requirements.

- White River - The USACE is the lead agency administering a project to construct a sea lamprey barrier on the White River. Project partners include the Commission, Service, and MIDNR. Service staff met with the USACE and MIDNR to discuss location and design of a new barrier.

- Little Manistee River - The USACE is the lead agency administering a project to construct a new sea lamprey barrier or to modify the current dam at the MIDNR egg taking facility. Project partners include the Commission, Service, and MIDNR. Service staff met with the USACE and MIDNR to discuss location and design of a new barrier.

Larval Assessment

Tributaries considered for lampricide treatment during 2014 were assessed during 2013 to define the distribution and estimate the density and size structure of larval sea lamprey populations.

- Larval assessment surveys were conducted on a total of 113 tributaries and offshore of 14 tributaries. The status of larval sea lamprey populations in historically infested Lake Michigan tributaries and lentic areas is presented in Tables 3 and 4.

- Surveys to estimate the abundance of larval sea lampreys were conducted in 34 tributaries.

- Surveys to detect the presence of new larval sea lamprey populations were conducted in 21 tributaries. No new populations were discovered.

- Post-treatment assessments were conducted in 25 tributaries and 3 lentic areas to determine the effectiveness of lampricide treatments during 2012 and 2013.

- Surveys to evaluate barrier effectiveness were conducted in 11 tributaries. Sea lamprey larvae were found upstream from blocking structures on the Kewaunee and Boardman rivers and Trail Creek. Infestations on the Boardman River and Trail Creek were from escapement prior to recent repairs; no new recruitment was observed in 2013. Casco Creek (Kewaunee River) and Trail Creek have been scheduled for treatment during 2014.

- Surveys to collect larval sea lampreys for pheromone extraction were conducted in five tributaries.

Juvenile Assessment

- Based on standardized fall assessment data, the marking rate during 2012 was 13 A1-A3 marks per 100 lake trout >533mm. The marking rate has been greater than the target of 5 per 100 fish for at least the previous 10 years, declined during 2006-2011, then increased during 2012 (Figure 3).

- Trapping for out-migrating juveniles was conducted in the Rapid, Tacoosh, and Big South Branch Pere Marquette rivers during October and November. Fyke nets were set in each river and 29 sea lampreys were captured (Rapid – 20, Tacoosh – 2, Big South Branch – 7).

Adult Assessment

- A total of 10,587 sea lampreys were trapped at 18 sites in 17 tributaries (Table 5, Figure 4).

- The estimated population of adult sea lampreys was 57,596 (95% CI; 52,971-63,469 and was within the target range of 59,000 ± 14,000 (Figure 5).

- Adult sea lamprey migrations were monitored in the Boardman and Betsie rivers through a cooperative agreement with the Grand Traverse Band of Ottawa and Chippewa Indians.

✧

End