Lake Superior Committee
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Status and Trends of Prey Fish Populations in Lake Superior, 2010[1]

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Abstract

The Great Lakes Science Center has conducted daytime nearshore bottom trawl surveys of Lake Superior (15-80 m bathymetric depth zone) each spring since 1978 to provide long-term trends of relative abundance and biomass of the fish community. Between 27 April and 23 June 2010, 62 stations distributed around the perimeter of the lake were sampled with 12-m Yankee bottom trawls towed cross-contour. The 2010 estimate of fish community biomass was 1.37 kg/ha, the second lowest in the 33-year survey history. The low biomass estimate continues a trend of declining fish community biomass since 2005. The distribution of biomass across jurisdictions was uneven; levels in Canada East, Canada West, Michigan, Minnesota and Wisconsin waters were 2.65, 0.51, 0.42, 0.03, and 3.94 kg/ha, respectively. Dominant species in the catch, in order of relative abundance, were cisco, rainbow smelt, lake whitefish, bloater, shortjaw cisco, and siscowet lake trout. This is the first year that shortjaw cisco ranked in the top tier of prey species. Compared to 2009 levels, cisco, bloater, lake whitefish, and shortjaw cisco increased while rainbow smelt, lean lake trout and siscowet biomass decreased. Year-class strengths for the 2009 cisco and bloater cohorts were below average but ranked as the tenth strongest year class in the past 33 years. The 2010 cisco age structure was dominated by yearlings, which accounted for 98% of the ciscoes captured. Remaining ciscoes captured were composed of adults mostly from 2003 and 1998 year classes. Year class strength or rainbow smelt was the weakest in the survey record, continuing a decline that began in 2008.

Densities of small- (< 226 mm TL) and intermediate-size (226-400 mm TL) wild (lean) lake trout continued a decreasing trend observed since 1996-1998. Density of large (> 400 mm TL) lean lake trout declined to the lowest level since 1983, prior to the period of recovery. Siscowet lake trout has shown a stable pattern of variable density since 2000. For 2010, densities of small- and intermediate-size siscowet decreased slightly while densities of large siscowet increased slightly. In the 2010 survey, proportions of total lake trout density that were hatchery, lean and siscowet were 5, 33, and 62%, respectively.

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Introduction

The Great Lakes Science Center's Lake Superior Biological Station conducts an annual daytime bottom trawl survey each spring in Lake Superior. The survey is intended to provide long-term trends of relative abundance and biomass of the fish community in nearshore waters. Beginning in 1978, the survey included 43-53 stations in United States (U.S.). Canadian waters were added in 1989 raising the sampling effort to 76-86 stations. In 2005, the number of stations sampled lake-wide was reduced to 58 (Stockwell et al. 2006). In this report, we update the time series with data collected in 2010.

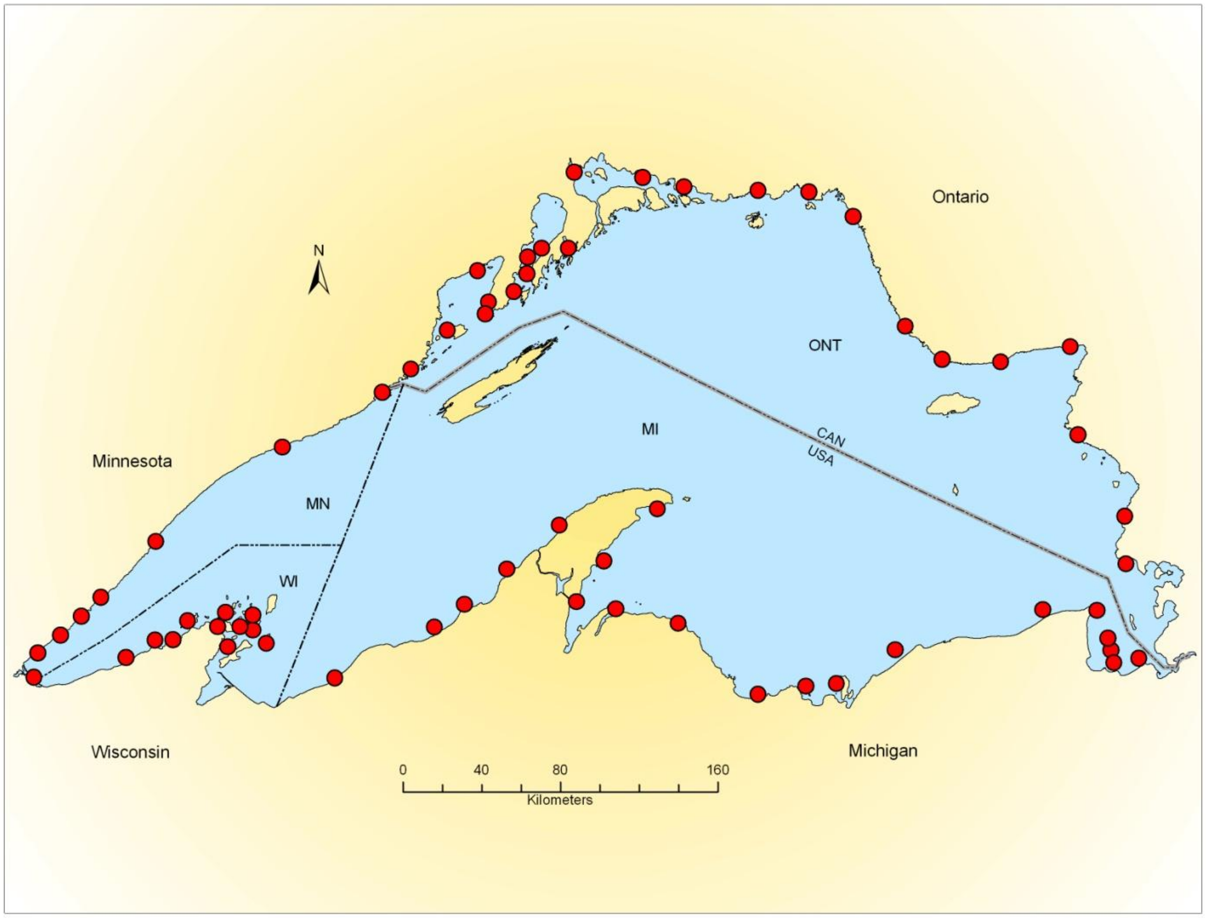

Figure 1. *Locations of 62 stations (red dots) sampled during the 2010 annual spring bottom trawl survey of Lake Superior.*

Methods

Spring Survey

A total of 62 stations distributed around the perimeter of Lake Superior were sampled with bottom trawls during daylight hours between 27 April and 23 June 2010 (Fig. 1). We were able to sample fish at all of the 58 long-term stations. Four additional stations were sampled in 2010 that were historically part of the 86 long-term sites because of favorable logistics.

A single sample was taken at each station with a 12-m Yankee bottom trawl towed cross-contour. The median start and end depths for bottom trawl tows were 16 m (range 9-30 m, interquartile range 14-20 m) and 55 m (range 20-134 m, interquartile range 42-72 m), respectively. Median trawl tow duration was 22 minutes (range 7-60 minutes, interquartile range 15-35 minutes). Fish were sorted by species, counted, and weighed in aggregate to the nearest gram. Relative density (fish/ha) and biomass (kg/ha) were estimated by dividing sample counts and aggregate weights by the area of the bottom swept by each trawl (ha). These estimates were then modified by the station-specific weighting given in Stockwell et al. (2006) to retain comparability with unweighted data prior to 2005.

For principal prey species (cisco *Coregonus artedi*, bloater *C. hoyi*, rainbow smelt *Osmerus mordax*, lake whitefish *C. clupeaformis*), year-class strength was estimated as the relative density (fish/ha) of age-1 fish, the first age-class that recruits to the bottom trawl. Densities of age-1 fish were estimated from densities of rainbow smelt < 100 mm, lake whitefish < 160 mm, cisco < 140 mm, and bloater < 130 mm. To be consistent with past reports and to more easily identify the year in which a cohort was produced, year-class strength is plotted against the year in which the cohort was produced (year sampled minus 1). Standard errors (SE) were calculated as $SD/\sqrt{n}$, where SD = the sample standard deviation and n = number of observations. For sample years after 2004 when weighted means were calculated, SE was calculated from the unweighted data. The SE was standardized by the mean to generate relative standard error (RSE = SE/mean*100).

To determine the age structure of Lake Superior cisco in 2010, we used a length-age key to estimate relative density of each age-class as a function of length. To stratify sampling of fish for age determination, we divided Lake Superior into nine regions, and took aging structures from a maximum of 10 ciscoes per 10-mm length bin over a 50-400 mm TL range per region. Ages for all cisco were estimated from scales by a single trained reader. Age estimates from otoliths were not available in 2010. Because we were limited to application of scale age data in 2010, we recognized that the resulting estimate of age composition of cisco may be inaccurate (Yule et al. 2008). To address this deficiency, we used a statistical age key based on age data derived from scales and otoliths collected in 2000-2006, similar to the approach used by Gorman (2007) for rainbow smelt and Gorman et al. (2008) for cisco. Because scales become less reliable as aging structures as coregonids mature (Aass 1972; Mills and Beamish 1980; Yule et al. 2008), we used scales for fish < 250 mm and otoliths for fish ≥ 250 mm. Age estimates from otoliths were acquired by the crack and burn method (Schreiner and Schram 2001). Using this 2000-2006 age data, we generated size-at-age distributions for age classes 1 to 9 and ≥10 years. A default age key based on a composite catch curve and size-at-age distributions was then modified by weighting age classes by the relative abundance of their age-1 abundance. This weighted statistical age key was then applied to 2010 length-frequency distribution to estimate size-age specific density distributions.

Because our bottom trawls capture a broad spectrum of lake trout *Salvelinus namaycush* sizes and life stages, biomass estimates are sensitive to variable capture of large adult fish (Stockwell et al. 2007). Therefore, as in previous reports (Gorman et al. 2008, 2009, 2010), we summarized our lake trout data as density by size bins: small, < 226 mm (≤ ca., age-3), intermediate, 226-400 mm (ca., age 4-8), and large, > 400 mm (>ca., age-8). To dampen inter-annual variation in our density estimates, we used 2-year moving averages for hatchery and wild (lean) lake trout, and 3-year moving averages for siscowet lake trout.

Results

Cisco

Year-class strength for the 2009 cisco cohort was estimated at 18.82 fish/ha, the tenth strongest year-class observed over the 33-year survey and the strongest year-class to appear since 2005 (Fig. 2A). The 2009 cohort was 27% of the survey record mean density and was 2% of the largest 1984 year class (885.62 fish/ha). Year-class strength for the 2009 cohort in U.S. waters was 30.23 fish/ha and 0.50 fish/ha in Canadian waters. For comparison, the density of the strong 2003 year class was estimated at 182.25 fish/ha and moderate 2002 and 2005 year classes were estimated at 35.12 and 24.66 fish/ha, respectively (Fig. 2A). RSE estimated for the 2009 year class was 39%, which is lower than the series average of 50% (Fig. 2B). The RSE for cisco year-class strength (Fig. 2B) exceeded the level of precision (no greater than ± 30% of the mean) recommended by Walters and Ludwig (1981) for stock-recruit data sets.

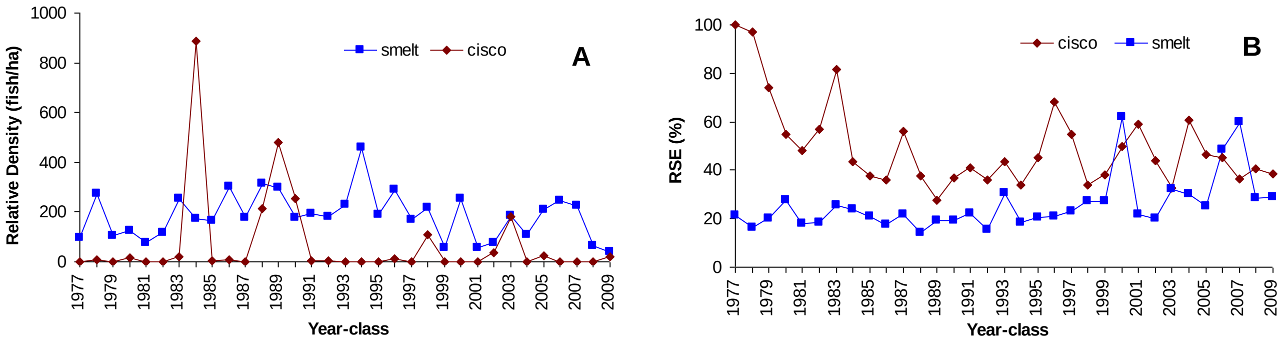

Figure 2. ***(A)*** *Year-class strength (number of age-1 fish/ha) for cisco and rainbow smelt for all nearshore sampling stations in Lake Superior for cohorts produced from 1977 to 2009. Only U.S. waters were sampled for the 1977-1988 year classes.* ***(B)*** *RSE (relative standard error) of year-class strengths.*

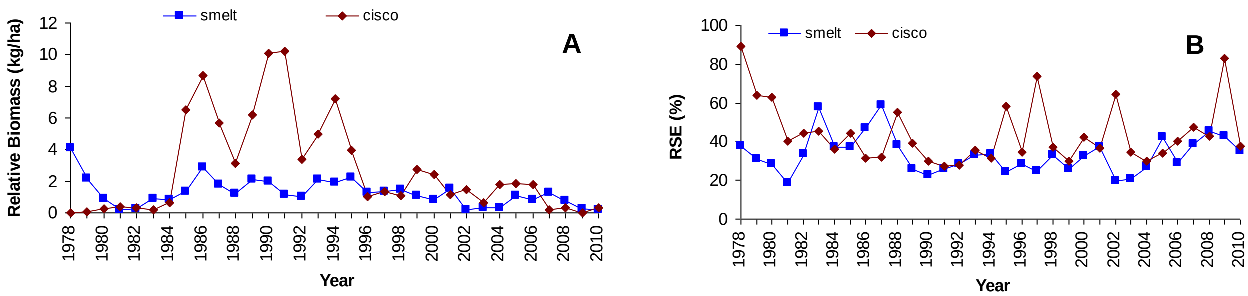

Figure 3. ***(A)*** *Mean relative biomass (kg/ha) of age-1 and older cisco and rainbow smelt for all nearshore sampling stations in Lake Superior, 1978-2010. Canadian waters were not sampled until 1989.* ***(B)*** *RSE (relative standard error) of mean biomass.*

Mean relative biomass of age-1 and older cisco (0.30 kg/ha) in 2010 was higher than in 2009 (0.02 kg/ha) (Fig. 3A), due largely to the appearance of the moderate 2009 year class. Despite the increase in biomass, the trend in population biomass has continued downward since 2004-2006 when biomass averaged ≥ 1.80 kg/ha and is well below the long term 1978-2006 average of 2.90 kg/ha. The RSE of age-1 and older cisco estimated biomass was 38% in 2010, which was lower than the survey average of 44% and represents a sharp decline from 83% observed in 2009 (Fig. 3B).

Relative biomass of cisco increased slightly in Wisconsin and Michigan waters owing to the appearance of the 2009 cohort (Fig. 4A). The weak showing of the 2009 cohort in Minnesota and Canadian waters contributed to a continuation of low biomass in those jurisdictions (Fig 4). If yearlings are removed from our 2010 biomass estimates, all jurisdictions would be similar and show declining biomass across all jurisdictions since 2004-2006 (Fig. 4). Relative biomass estimates as a percent of long-term means was low in Wisconsin (24.72%), very low in W. Ontario (4.19%) and Michigan (2.61%), and extremely low in E. Ontario (0.76%) and Minnesota (0.00%). This pattern is consistent with low cisco recruitment since 2003.

The 2010 cisco age structure was dominated by the 2009 year class and accounted for 98% of the mean relative density (Fig. 5A) and the remaining 2% were adults age 5 and older (Fig. 5B). The moderate to large 1998, 2002, 2003, 2005 cohorts accounted for 15, 20, 47, and 12% of the mean relative density, respectively, of adults age 5 and older.

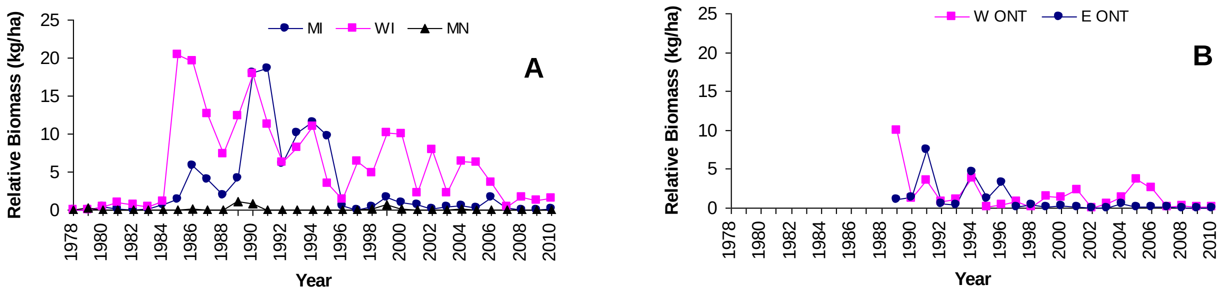

Figure 4. *Mean relative biomass (kg/ha) of age-1 and older cisco in nearshore waters of Lake Superior: (**A**) Michigan (MI), Wisconsin (WI), and Minnesota (MN), 1978-2010. (**B**) eastern and western Ontario, 1989-2010. Eastern and Western Ontario waters are divided in the northeast corner of Lake Superior near Marathon, Ontario.*

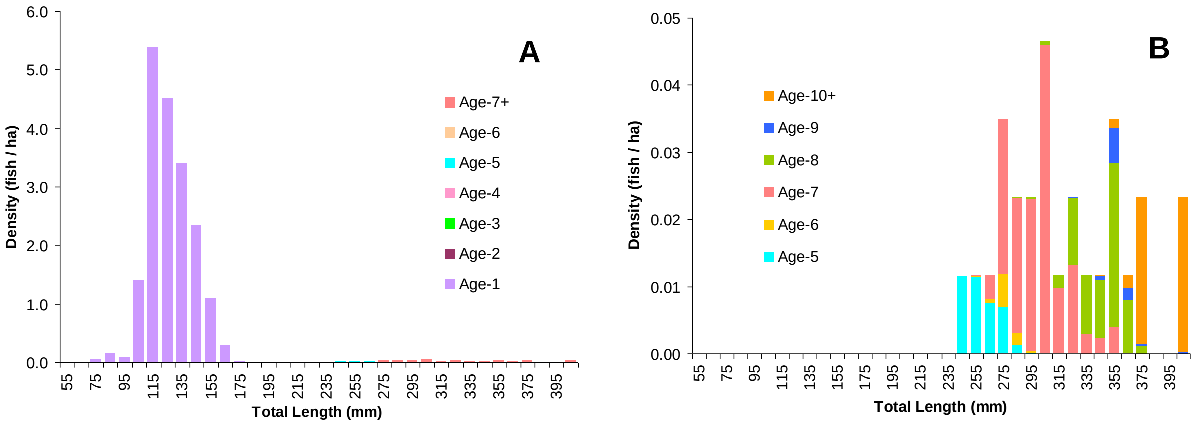

Figure 5. Estimated *age-length distribution of cisco caught at all nearshore sampling stations in Lake Superior in 2010. Panel A, all ages, panel B, >4 yrs.*

Rainbow Smelt

Year-class strength of the 2009 rainbow smelt cohort dropped to a record low of 41.03 fish/ha. This continues a declining trend following the last peak of 246.58 fish/ha for the 2006 cohort (Fig. 2A). Year-class strength for the 2009 cohort was 22.1% of the average over the 33-yr survey period (185.3 fish/ha). RSE was relatively low (28.9%, Fig. 2B) and similar to the 33-yr average (25.7%), due to consistently low catches across all jurisdictions. The 2009 year-class was stronger in U.S. waters (58.8 fish/ha) compared to Canadian waters (12.50 fish/ha).

Mean relative biomass for age-1 and older rainbow smelt was 0.22 kg/ha, the third lowest in the 33 survey record, and continued a declining trend following the most recent maximum of 1.29 kg/ha in 2007. The 2009 biomass estimate was 17% of the 33-year mean of 1.26 kg/ha (Fig. 3A). RSE of the 2009 biomass estimate was 35%, which is close to the 33-year survey mean of 33.3% (Fig. 3B). Relative biomass of rainbow smelt declined 83% in Michigan waters, remained unchanged in Minnesota waters and increased 273% in Wisconsin waters. Rainbow smelt biomass decreased 55% in W. Ontario waters and 91% in E. Ontario waters (Fig. 6B**)**. In all jurisdictions except Wisconsin, relative biomass estimates were <10% of the long-term average; in Wisconsin, the estimate was 84% of the long-term average.

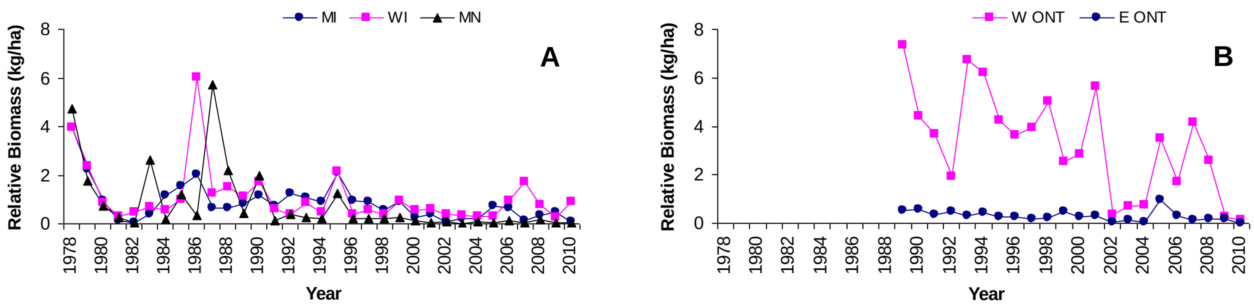

Figure 6. *Mean relative biomass (kg/ha) of age-1 and older rainbow smelt in nearshore waters of Lake Superior: (**A**) Michigan, Wisconsin, and Minnesota, 1978-2010. (**B**) Eastern and Western Ontario, 1989-2010.*

Bloater

The 2009 bloater year-class strength was relatively weak (2.45 fish/ha) and well below the 33-year average of 10.5 fish/ha, though about five times larger than the previous 3 year classes (average of 0.46 fish/ha). By comparison the 2005 cohort strength was 15.84 fish/ha Fig. 7A). Year-class strength was greater in U.S. waters (3.97 fish/ha) compared to Canadian waters (0.00 fish/ha). RSE of bloater yearling density in 2009 was 39%, which is within the 33-year survey range of 22-65% (Fig. 7B).

Although mean relative lake-wide biomass of age-1 and older bloater increased modestly from 0.09 kg/ha in 2009 to 0.19 kg/ha in 2010, the overall trend has been downward since 2006 when buoyed by the appearance of the moderate 2005 year class, lake-wide biomass was 1.36 kg/ha (Fig. 8A). Following the lowest estimated biomass in the 33-year survey in 2009, the estimate for 2010 was the second smallest. RSE for the 2010 biomass estimate was 47%, which is within the 33-year survey range of 32-64% (Fig. 8B).

Between 2009 and 2010, bloater biomass declined in Michigan, Minnesota, and W. Ontario waters to levels <0.04 kg/ha but increased in Wisconsin and E. Ontario waters to >0.33 kg/ha (Fig. 9). Overall, bloater biomass was relatively low in all jurisdictions, at or below levels observed at the beginning of the survey record in 1978.

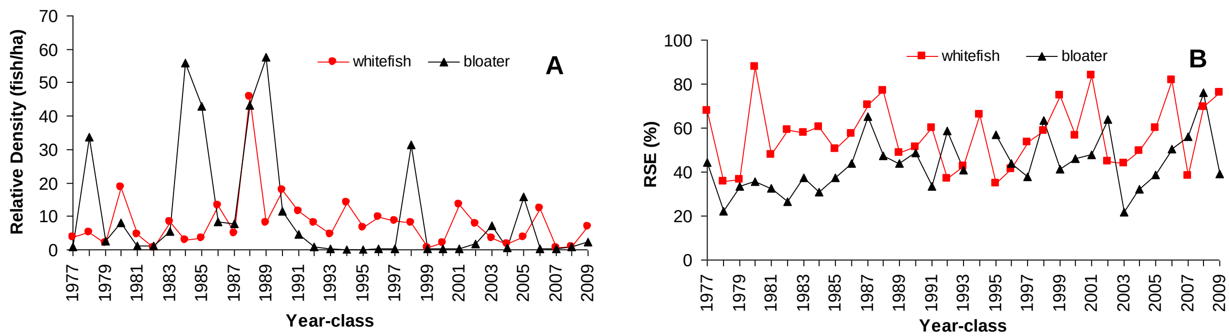

Figure 7. ***(A)*** *Year-class strength (number of age-1 fish/ha) for bloater and lake whitefish for all nearshore sampling stations in Lake Superior for cohorts produced from 1977 to 2009. Only U.S. waters were sampled for the 1977-1988 year-classes.* ***(B)*** *RSE (relative standard error) of year-class strengths.*

Lake Whitefish

Lake whitefish year-class strength increased lake-wide from lows of 0.54 and 0.98 fish/ha for the 2007 and 2008 cohorts, respectively, to 6.89 fish/ha for the new 2009 cohort (Fig. 7A). RSE for lake whitefish year-class strength was 76%, which is within the 33-year survey range of 35-98% (Fig. 7B). The 2009 year-class was substantially stronger in U.S. (11.15 fish/ha) than in Canadian waters (0.05 fish/ha). For comparison, average lake-wide year-class strength for lake whitefish over the 33-year survey period was 8.01 fish/ha.

Mean relative biomass for age-1 and older lake whitefish in all waters increased slightly from 0.09 kg/ha in 2009 to 0.19 kg/ha in 2010, but does not reverse the decline from the peak of 2.04 kg/ha in 2008 (Fig. 8A). The low biomass estimates of 2009-2010 represent a departure from the long-term trend of relatively stable biomass from 1996 to 2008. RSE for 2009 was 50%, which is well within the 33-year survey range of 29-66% (Fig. 8B).

Whitefish biomass remained low across all U.S. and Canadian jurisdictions (Fig. 10). In Wisconsin, biomass increased slightly from 0.24 to 0.78 kg/ha between 2009 and 2010, but remains well below the 2005-2008 average of 9.68 kg/ha (Fig. 10A). Biomass estimates in Michigan, Minnesota and E. Ontario waters continued a decline that started in 2008 and remained below 0.05 kg/ha. Like Wisconsin, biomass in W. Ontario waters increased slightly, from 0.18 to 0.21 kg/h between 2009 and 2010, but well below the 2005-2008 average of 1.04 kg/ha (Fig. 10B).

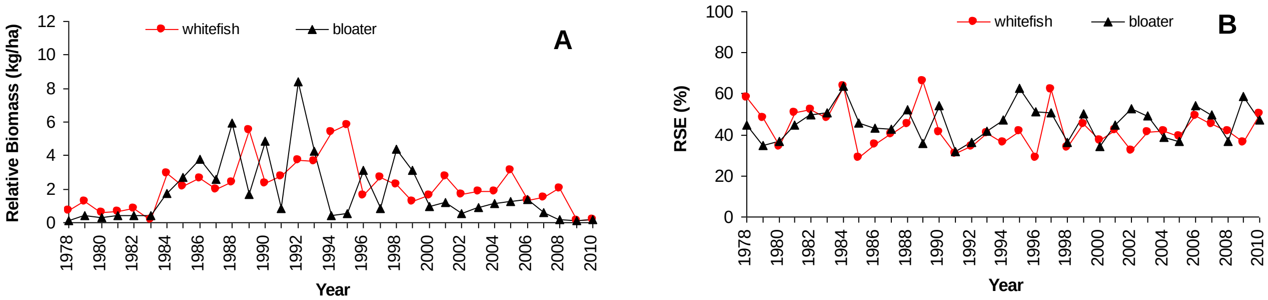

Figure 8. ***(A)*** *Mean relative biomass (kg/ha) of age-1 and older bloater and lake whitefish for all nearshore sampling stations in Lake Superior, 1978-2010. Canadian waters were not sampled until 1989.* ***(B)*** *RSE (relative standard error) of mean biomass.*

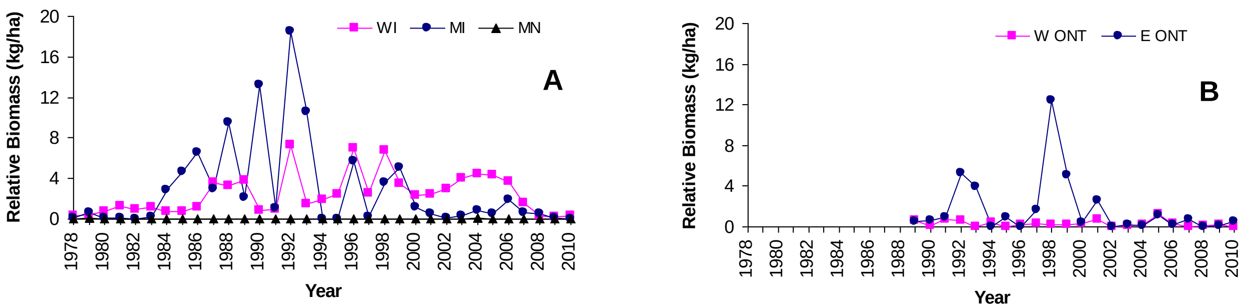

Figure 9. *Mean relative biomass (kg/ha) of age-1 and older bloater in nearshore waters of Lake Superior: (**A**) Michigan, Wisconsin, and Minnesota, 1978-2010. (**B**) Eastern and Western Ontario, 1989-2010.*

Other Species

Ninespine stickleback – The lake-wide estimate of mean relative biomass for ninespine stickleback *Pungitius pungitius* was a low 0.01 kg/ha in 2010 and similar to 2009 (Fig. 11A). The low 2010 estimate continues a declining trend in stickleback biomass compared to an average of 0.03 kg/ha for 2005-2008 and contrasts with 1978 and 1996 lake-wide average of 0.21 kg/ha (Fig. 11A).

Sculpins – Mean relative biomass for all three sculpin species combined (spoonhead *Cottus ricei*, slimy *C. cognatus*, and deepwater *Myoxocephalus thompsonii*) increased in 2010, punctuating a declining trend paralleling that observed for ninespine sticklebacks since 1993 (Fig. 11A). The 2010 increase was caused by a sharp increase in abundance of slimy sculpin, which represented 81% of sculpin biomass. Deepwater sculpins represented 13% and spoonhead sculpins represented 6% of the estimated biomass. The sharp increase in slimy sculpin abundance reverses a recent trend where deepwater sculpins dominated the assemblage (2006-2009). Prior to 2006 slimy sculpins were the dominant species in the group, with the exception of 1984 when deepwater sculpins represented 55% of the biomass. Slimy sculpins averaged 68% of the total sculpin biomass across all years, but represented a higher percentage from 1978 to 1983 (81%) compared to 1984 to 2001 (64%) and 2002-2009 (37%).

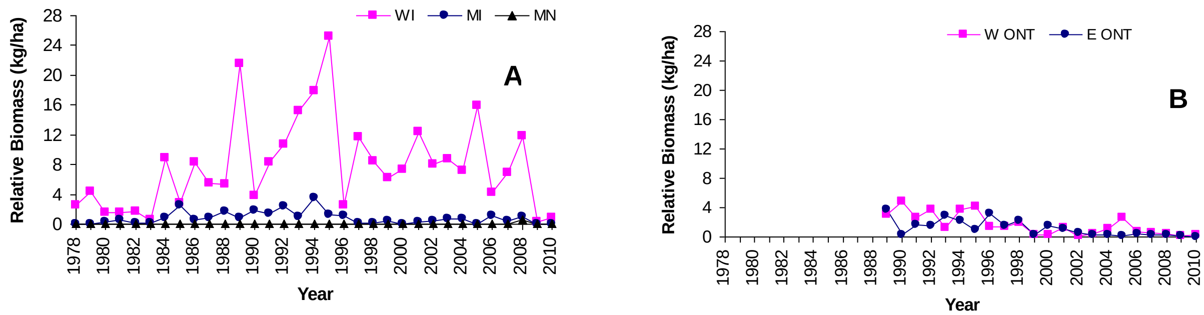

Figure 10. *Mean relative biomass (kg/ha) of age-1 and older lake whitefish in nearshore waters of Lake Superior: (**A**) Michigan, Wisconsin, and Minnesota, 1978-2010. (**B**) Eastern and Western Ontario, 1989-2010.*

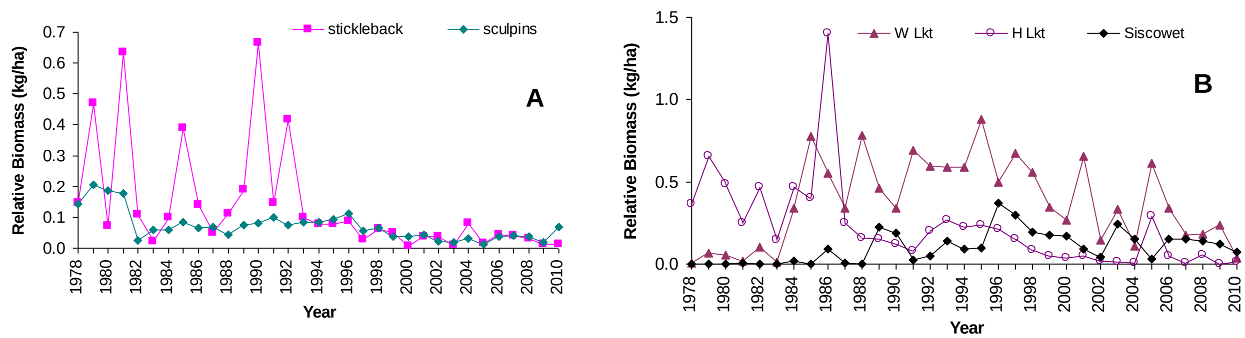

Figure 11. *Mean relative biomass (kg/ha) of age-1 and older (**A**) ninespine stickleback and sculpins (slimy, spoonhead, and deepwater combined), and (**B**) lake trout (wild-lean, hatchery, and siscowet) for all nearshore sampling stations in Lake Superior, 1978-2010. Canadian waters were not sampled until 1989.*

<u>Lake Trout</u> – After the near-zero record in 2009, biomass of hatchery lake trout remained low in 2010 (0.01 kg/ha) (Fig. 11B). Biomass of wild (lean) lake trout decreased from 0.24 kg/ha in 2009 to 0.04 kg/ha in 2010, the fourth lowest recorded biomass for wild lake trout. All previous low values (<0.10 kg/ha) were observed prior to 1984, a time when wild lake trout populations were recovering (Hansen et al. 1995). Between 2009 and 2010, biomass of siscowet lake trout decreased from 0.12 to 0.08 kg/ha, continuing a declining trend beginning 2007 (Fig. 11B).

Densities of small, intermediate and large hatchery lake trout decreased to 0.01, 0.01, and 0.02 fish/ha in 2010, respectively (Fig. 12A), consistent with the decline beginning in 1993-1996. Densities of all sizes of wild (lean) lake trout decreased in 2010, continuing a declining trend that started in 1996-1998 (Fig. 12B). From 2008 to 2010, density of small wild lake trout declined from 0.15 to 0.06 fish/ha; these values represent the lowest in the 1978-2010 time series. Density of intermediate-size lean trout decreased from 0.24 in 2009 to 0.07 fish/ha in 2010, the lowest in the time series after 1978. Density of large wild lake trout decreased from 0.14 kg/ha in 2009 to 0.10 kg/ha in 2010, continuing a decline from a recent peak of 0.43 kg/ha in 2006. Siscowet lake trout showed a pattern of variable but generally increasing density since 1980 (Fig. 12C). From 2006 to 2008, densities of small- and intermediate-size siscowet lake trout increased from 0.10 to 0.12 and 0.08 to 0.15 fish/ha, respectively. In 2009 and 2010, densities of siscowet lake trout were lower; 0.07 kg/ha for small fish and 0.11-0.12 kg/ha for intermediate-size fish. Densities of large siscowet lake trout have fluctuated between

0.10 and 0.07 fish/ha since 2000. In 2010 the proportions of total lake trout density that were hatchery, wild and siscowet were 10, 30, and 60%, respectively.

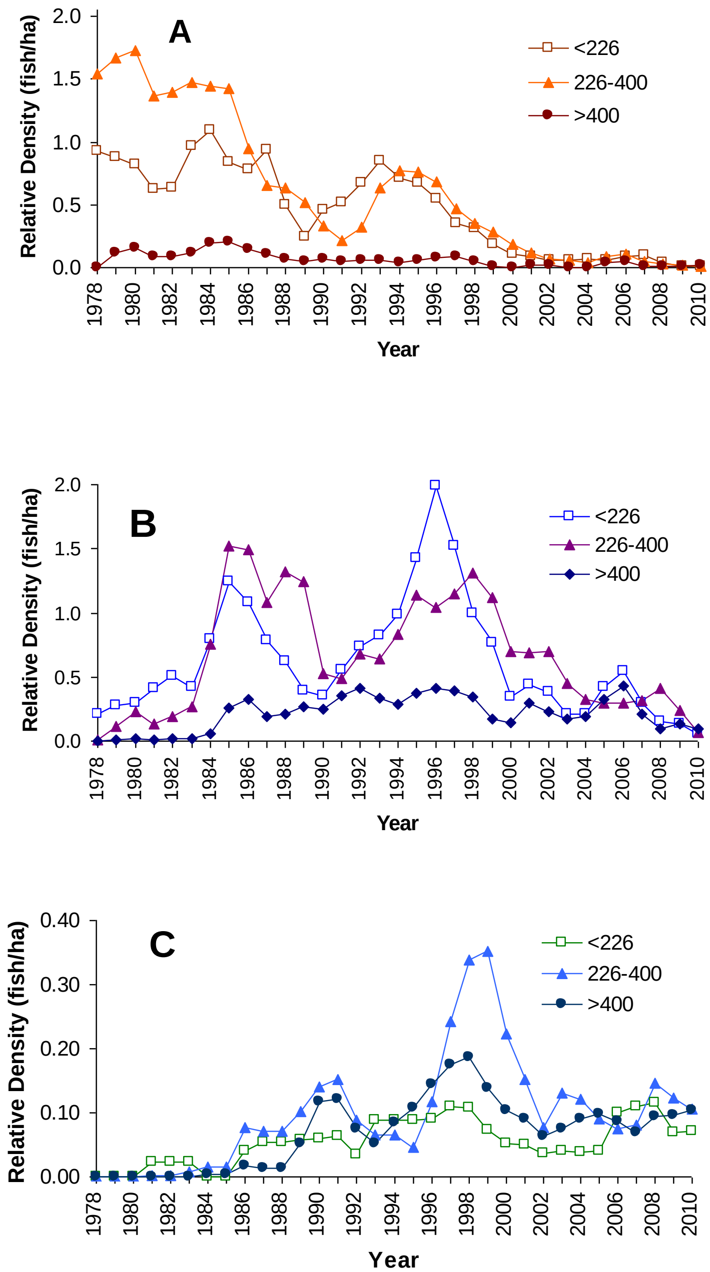

Figure 12. *Mean relative density (fish/ha) of age-1 and older lake trout for all nearshore sampling stations in Lake Superior, 1978-2010. Canadian waters were not sampled until 1989. Densities for hatchery and wild (lean) lake trout are 2-year running averages and densities for siscowet lake trout are 3-yr running averages. Densities are shown for three length bins: <226 mm, 226-400 mm, and >400 mm TL. (**A**) hatchery lake trout, (**B**) wild (lean) lake trout, (**C**) siscowet lake trout.*

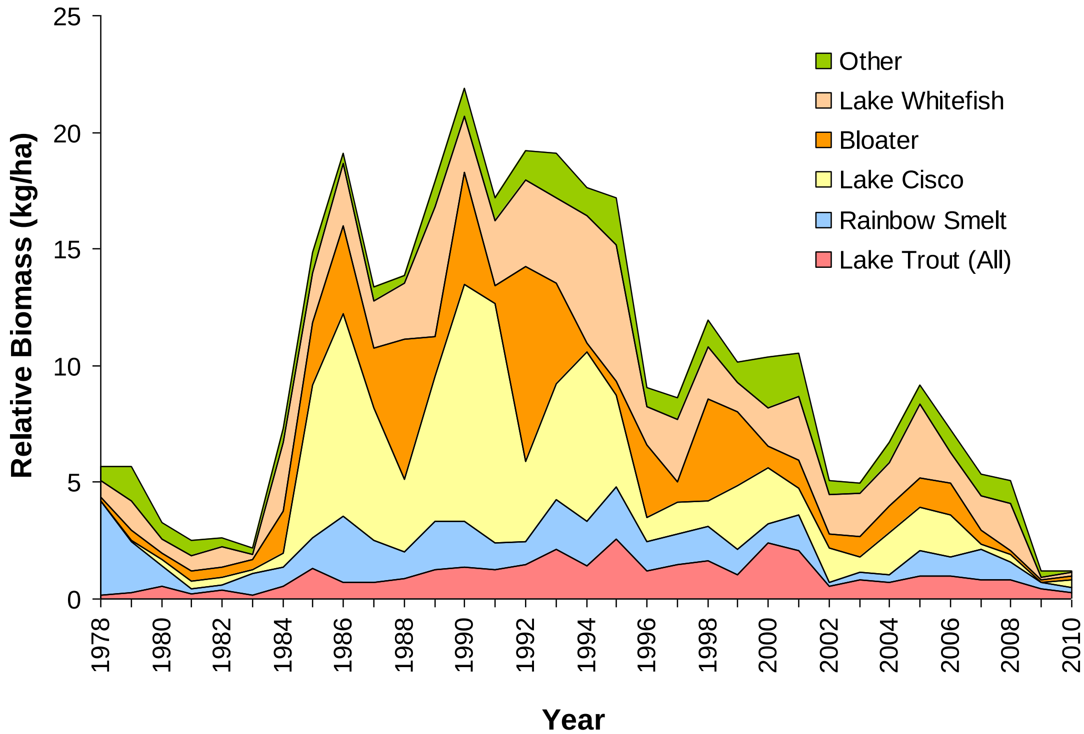

Figure 13. *Mean relative biomass (kg/ha) of the fish community caught in bottom trawls at all nearshore sampling stations in Lake Superior, 1978-2010. Canadian waters were not sampled until 1989.*

Lake Superior Fish Community

Mean biomass of all fish species caught during the spring bottom trawl survey declined 85% since 2005 when it was 9.16 kg/ha to 1.37 kg/ha in 2010 (Fig. 13). Decreased biomass in 2006-2010 was a result of declines in estimated biomass of cisco, bloater, lake whitefish, rainbow smelt and lake trout. In 2010, principal species contributing to community biomass were cisco (22%), rainbow smelt (16%), lake whitefish (14%), bloater (12%), siscowet lake trout (11%), and shortjaw cisco *C. zenithicus (8%)*. The remaining 17% of the community biomass was composed of slimy sculpin (4%), longnose sucker *Catostomus catostomus* (4%), lean lake trout (2%), pygmy whitefish *Prosopium coulteri* (2%), trout-perch *Percopsis omiscomaycus* (2%) and burbot *Lota lota* (2%). Each of the remaining species (ninespine stickleback, kiyi *C. kiyi*, hatchery lake trout, spoonhead sculpin, and deepwater sculpin) represented <1% of the community biomass. This structure contrasts with the 2006 community when cisco represented the highest percentage of biomass for any species (26%), followed by bloater (20%), lake whitefish (20%), and rainbow smelt (12%).

Changes in estimated community biomass over the 33-year time series have been largely the result of changes in abundance of major prey species (Fig. 13). Rainbow smelt was the dominant prey fish prior to 1981 and afterwards dominance shifted to native prey species; cisco, bloater, and lake whitefish. Principal factors associated with changes in the community have been recovery of lake trout, increased mortality of rainbow smelt, sustained recruitment of lake whitefish, and variable recruitment of large year classes of cisco and bloater (Gorman and Hoff 2009). Annual variation in community biomass since 1984 has been driven by recruitment variation in cisco, bloater and lake whitefish. Recruitment of large year classes of cisco in 1984, 1988-1990, and 1998 resulted in subsequent short-term increases in prey fish biomass (Fig. 13). Recruitment of the most recent large year class in 2003 yielded smaller and less sustained increases in biomass than previous years. The appearance of the weak 2009 year class of cisco in 2010 resulted in a slight increase in community biomass. Unlike previous strong year classes of cisco that showed lake-wide synchrony, the 2009 year class was limited largely to Wisconsin waters. These yearling cisco represented 75% of total cisco biomass; if that fraction (0.23

kg/ha) was deducted from the 2010 estimate of community biomass (1.37 kg/ha), the result (1.15 kg/ha) would be less than the 2009 estimate (1.22 kg/ha), the lowest value in the 33-year survey record. Since 2006, densities of adult cisco (≥4 yrs) in our spring bottom trawl samples have declined to levels at or below levels observed prior to recovery of cisco before 1984.

Recent declines in lake-wide biomass of cisco, bloater, and lake whitefish to levels near or below that observed prior to recovery in the late 1970s - mid-1980s is consistent with a hypothesis of strong lake trout predation. In Wisconsin waters, whitefish biomass in 2009 and 2010 was the lowest in the 33-yr survey record for this jurisdiction (and also lake-wide). The reduction of prey fish biomass, reduced recruitment of large cisco year classes, reduced mean sizes and younger age structure of rainbow smelt (Gorman 2007) all support the hypothesis of strong predation pressure by lake trout stocks and that lake trout populations may now be food limited. For the first time, shortjaw cisco, a species of special concern in the U.S. and Canada (Gorman and Todd 2007), has been included in the top six species contributing to community biomass. The resurgence of shortjaw cisco was most evident in E. Ontario waters, where shortjaw cisco have always persisted (Gorman and Todd 2007) and in Wisconsin waters, primarily the Apostle Islands region, where shortjaw cisco has shown strong recruitment from the 2003 year class. Gorman (2011) predicted that under sustained predation pressure from recovered lake trout populations, shortjaw cisco should become the predominant deepwater cisco because its large size provides protection from predation that smaller bloaters lack. Thus, the apparent comeback of shortjaw cisco may be indicative that lake trout are exerting strong predation pressure on the Lake Superior fish community. The abundance of small and intermediate-size lean (wild) lake trout dropped to the lowest levels in the 33-year survey record. These trends suggest that cannibalism of younger life stages by adult lake trout may be causing recruitment failure. Declines in lean lake trout lipid content reported by Paterson et al. (2009) are also consistent with declines in prey fish biomass and resulting food limitation in Lake Superior. In the future, we expect prey fish biomass to continue to fluctuate as a result of recruitment variation, however, predation mortality will likely dampen those fluctuations and maintain the relatively low prey fish biomass observed in recent years.

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