Yellow Perch Population Assessment in Southwestern Lake Michigan

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INTRODUCTION

Yellow perch (*Perca flavescens*) is an important commercial and sport fish throughout much of its range in North America. Its schooling behavior promotes sizable captures in commercial gears such as trap nets and gill nets, and the tendency of yellow perch to congregate nearshore in the spring makes this species accessible to shore anglers. The majority of yellow perch harvested in North America are taken from the Great Lakes; yellow perch provide the most important sport fisheries in the four states bordering Lake Michigan and until 1997 supported large-scale commercial fisheries in three of those states.

Lake Michigan yellow perch have undergone severe fluctuations in abundance during the past several decades. The population in the southern basin increased dramatically in the 1980s (McComish 1986), and the sport and commercial fisheries expanded accordingly. In Illinois waters alone, the estimated annual catch by sport fishermen doubled between 1979 and 1993, from 600,000 to 1.2 million fish (Muench 1981, Brofka and Marsden 1993). Between 1979 and 1989, the commercial harvest in Illinois tripled, in Wisconsin (excluding Green Bay) it increased six-fold, and in Indiana the harvest increased by over an order of magnitude (Brazo 1990, Hess 1990). However, the yellow perch fishery in Illinois waters during the early and mid-1990's was primarily supported by a strong year-class spawned in 1988 (Marsden and Robillard 2004). Few or no young-of-the-year (YOY) yellow perch were found in lake-wide sampling efforts during 1994-1997 (Hess 1998), but significantly greater survival of the 1998 year-class occurred. The 1998 year-class dominated Lake Michigan Biological Station (LMBS) spring adult assessments between 2000 and 2004 (previous segments of F-123-R). During this period, LMBS trawling efforts detected moderate year-class strength during 2002 and 2004. In 2005, the age structure of yellow perch began to shift towards younger fish so that 52% of the catch was age-3 (2002 year-class) and the 1998 year-class (age-7) contributed 37% of the catch. Additionally, age-0 CPUE from trawling assessments during 2005 and 2010 were the highest recorded in Illinois waters since 1988. During 2006-2008, the 2002 and 2003 year-classes dominated LMBS spring adult assessments and sport harvest collections. Then, in 2009 and 2010 LMBS yellow perch samples (fishery independent and sport harvest) were dominated by the 2005 year-class, while the 2002 and 2003 year-classes also contributed significantly to the fishable population (Redman et al. 2011a). Despite the presence of multiple year-classes within the population, lake wide assessments show that current yellow perch abundance remains low, particularly in comparison to abundance observed in the late 1980s and early 1990s (Makauskas and Clapp 2010). Thus, there continues to be concern about the survival and growth of yellow perch and sustainability of the population in Lake Michigan.

To protect yellow perch stocks, fisheries managers should set harvest targets in accordance with fluctuating population sizes. However, the ability to successfully set these harvest targets for yellow perch is hampered by insufficient information about population size, natural mortality, reproductive potential, and factors affecting the growth and survival of juveniles. The continued decline of the yellow perch population due to reduced survival of larvae to the demersal age-0 stage has prompted researchers to narrow the focus of investigation to spawning behavior and success along with age-0 interactions and survival. Reproductive potential influences the ability of the population to respond to external forces such as overfishing or environmental fluctuations. Thus, accurate estimates of fecundity and knowledge of how reproductive potential varies over the life of yellow perch in Lake Michigan are crucial to the development of appropriate management strategies to ensure the persistence of this species. Fecundity (Brazo et al. 1975) and egg quality (Heyer et al. 2001) have been shown to increase with age in yellow perch. Additionally, marine larvae produced by younger spawners have been shown to experience higher mortality than larvae produced by older, more experienced spawners (O'Farrell and Botsford 2006). Thus, estimates of reproductive potential based on biomass estimates alone risk oversimplifying and overestimating reproductive output. Assessment of pelagic and demersal age-0 yellow perch along with additional juvenile (age-1 and age-2) life stages may permit prediction of future year-class strength. However, variability of larval yellow perch abundance data and age-0 catches is very high, and much remains unknown about the early life history of yellow perch in large lakes. Particularly, how the hydrodynamics of Lake Michigan influence the advection of larval yellow perch from nearshore spawning sites to the offshore pelagic zone as well as eventual settlement into benthic nearshore nursery habitat. The ability to couple physical and biological data will not only enhance our understanding of pelagic age-0 yellow perch feeding behavior, early life-stage movement, and survival rates but also contribute to our ability to monitor year-class strength relative to other years. Characterizing the mechanisms influencing ontogenetic diet and habitat shifts will contribute to our basic understanding of the offshore pelagic stage of age-0 yellow perch in Lake Michigan. Annual assessment age-0 yellow perch returning to the benthic nearshore areas in the fall, abundance and diet of juvenile (age-1 through age-3) yellow perch, coupled with 20+ years of data collected on yellow perch in Illinois waters of Lake Michigan will help to identify critical bottlenecks that limit survival between early life stages and recruitment to the sport fishery.

Concurrent with the decrease in larval fish recruitment, zooplankton density in southern Lake Michigan has declined, and the assemblage structure has shifted. Nearshore densities of zooplankton in southern Lake Michigan during 1990–2010 were consistently lower than densities in the late 1980s, when yellow perch abundance and harvest were dramatically higher (Dettmers et al. 2003, Clapp and Dettmers 2004, Redman et al. 2011a). Furthermore, zooplankton taxonomic composition in June shifted from abundant cladocerans (about 30% by number) mixed with large-bodied copepods during 1988–1990 to abundant smaller copepods and rotifers, but few cladocerans during 1996-1998. *Daphnia retrocurva* dominated the daphnid community in nearshore waters of southern Lake Michigan during 1972-1984, but declines in abundance occurred following the invasion of *Bythotrephes cederstroemi* in 1986 (Madenjian et al. 2002, Barbiero and Tuchman 2004). Declines in several other Cladocerans species, such as *Eubosmina coregoni*, *Daphnia pulicaria*, and *Leptodora kindti*, have also been attributed to the invasion of this predatory cladoceran (Makarewicz et al. 1995, Barbiero and Tuchman 2004). Additionally, in earlier studies we evaluated how the shift in southern Lake Michigan's zooplankton assemblage influenced growth and survival of larval yellow perch using laboratory experiments (Graeb et al. 2004). One observation made during these experiments was that some yellow perch larvae failed to inflate their swim bladder (Czesny et al. 2005). Swim bladder inflation is usually associated with the nutritional state of fish larvae and can affect survival of these fish to later life stages. Thus, the status and composition of the zooplankton community in both nearshore and offshore waters of Lake Michigan greatly impacts the recruitment success of yellow perch.

Results of this project will help strengthen management strategies for this important sport fish species. These findings will be incorporated into yellow perch management decisions through multi-agency collaboration, which reflects a changing philosophy in the Great Lakes fisheries from jurisdictional to lake-wide management.

METHODS & RESULTS

Study 101. Yellow perch population assessment in southwestern Lake Michigan

Job 101.1: Monitor the adult yellow perch population on a seasonal basis
Objective: Monitor the age and size structure of yellow perch on a seasonal basis.

Adult yellow perch were sampled from May 7th through July 30th, 2013 at Waukegan and Lake Forest, IL. During 2007 through 2012 adult yellow perch were sampled during May and June using monofilament gill nets consisting of 100-ft panels of 2.0, 2.5, 3.0, and 3.5-in stretched mesh. In 2013, a 100-ft panel of 1.5-in stretched mesh was added to the monofilament gill net configuration and nets were set in 10, 15, and 20 meters of water for approximately 24 hours on seven occasions. Because catch per unit effort data (CPUE) is typically zero heavy and possesses a high variance to mean ratio, a negative binomial distribution was specified while examining annual variability of CPUE (Power and Moser 1999). Spring (May and June) effort was eight net nights and CPUE (fish/net night) was significantly greater than 2012 but not different from 2007-2011 (18.8 ± 40.2 (SD) $p<0.001$; Figure 1). Total effort during July was six net nights and mean CPUE was 25.8 ± 44.0 (SD) yellow perch. A total of 305 yellow perch (97 females and 208 males) were collected with 55% of males collected in May and 80% females sampled in July. Fish ranged from 2-14 years old and mean total length was 186.0 ± 48.6 mm (Figure 2). In 2013, ovaries were taken from 12 females ranging from 156-327 mm total length. Fecundity of these fish ranged from 6,572 – 100,941 eggs.

We compiled CPUE, length and fecundity data from 361 yellow perch collected during 2007-2013 to examine annual variation in relative abundance and size of gravid females as well as estimate the relationship between female length and fecundity. Mean CPUE of females during May and June was similar in 2007-2011 ranging from 10-14 fish/net night, but decreased significantly in 2012 and remained low in 2013 (CPUE = 2.25 ± 4.3 fish/net night; $p < 0.001$; Figure 3). Over the course of the study, we caught mature females ranging from approximately 156 - 365 mm TL. During 2007, the length distribution of females was slightly skewed towards fish less than 270 mm and skewed towards females over 260 mm during 2008. A slightly bimodal distribution was observed in 2009 with a significant contribution from females less than 230 mm and greater than 280 mm. The 2010 length distribution was slightly skewed toward females < 250 mm, while in 2011 the majority of females were between 230-320 mm TL. During 2012 and 2013, females were present at a variety of sizes, but very few fish were caught. Based on these annual differences in relative abundance and size distribution we might expect reproductive output to vary annually given that fecundity increased exponentially with length (Figure 4). To linearize the relationship, both total length and fecundity were log transformed. A slope heterogeneity test revealed that the total length-fecundity relationship of yellow perch did not differ among collection years ($p=0.08$), thus the relationship between total length and fecundity was modeled irrespective of year. A strong linear relationship was observed between fecundity and total length (fecundity= -3.6 + 3.36total length; $p<0.001$, $R^2=0.87$). Fecundity ranged from approximately 6,572 eggs for a 156 mm female to 141,067 eggs for a 336 mm female. Our results indicate that larger females produced more eggs thus temporal changes in the abundance and size structure of the spawning stock have the potential to impact egg production at the population level in Lake Michigan.

Job 101.2: Determine the age composition of angler-caught yellow perch
Objective: Estimate age composition and, if possible, sex composition of angler-caught fish to better parameterize a lake-wide catch-age model.

Anal spines were collected from 76 yellow perch harvested by pedestrian anglers at Montrose Harbor, IL from June 6th - 28th 2013. All yellow perch spines were cleaned, sectioned, and mounted for age determination. Four spines were eliminated from age analysis due to damage during the preparation process or <75% reader agreement (N = 72). Angler harvested yellow perch ranged in age from 3-8 years and 140 - 357 mm in length (Figure 5). From 2005 to 2012, pedestrian angler harvest was dominated by two or three year-classes beginning when yellow perch recruit to the recreational fishery at age-3 (Figure 6). This trend continued in 2013 as pedestrian harvest largely consisted of age-3 and age-4 fish (2010 and 2009 year-classes) that collectively comprised over 80% of the total harvest. Mean total length of age-3 and age-4 yellow perch was 206 ± 28 mm (SD) and 246 ± 33 mm (SD) respectively.

Job 101.3: Sample demersal age-0 yellow perch and their food resources in nearshore waters
Objective: Determine the relative abundance of demersal age-0 yellow perch and the availability of their macroinvertebrate and zooplankton prey.

A bottom trawl with a 4.9-m head rope, 38-mm stretch mesh body, and 13-mm mesh cod end was used to sample age-0 yellow perch north of Waukegan Harbor. Due to minor engine problems and limited availability of an experienced boat captain, daytime bottom trawling for age-0 yellow perch was restricted to a single sampling event on August 9th, 2013. Sampling occurred at four depth stations (3, 5, 7.5 and 10 m) and water temperature was recorded at each depth station. All fish collected were counted and total length was measured to the nearest 1 mm. Total effort during 2013 was approximately 15,894 m^2 and six round goby and no age-0 yellow perch were collected (Figure 7).

Thirty-six replicate zooplankton samples were collected at two historical sites near Waukegan Harbor, IL between May 7th and October 8th, 2013. Samples were immediately preserved in 10% sugar formalin. A 64-µm mesh, 0.5-m diameter plankton net was towed vertically from 0.5 m off the bottom to the surface at 10 m depth sites. In the lab, samples were processed by examining up to three 5-ml subsamples taken from adjusted volumes that provided a count of at least 20 individuals of the most dominant taxa. Zooplankton were enumerated, identified to the lowest taxon possible and measured. Mean June-July zooplankton density (includes rotifers and veligers) in 2013 was 30.6 ind./L (Figure 8), which is the highest recorded since 2004. This increase is largely attributable to the detection of higher densities of rotifers (61% and 76% of the total density) during this sampling period compared to previous years. Mean June-July (months combined) crustacean zooplankton density was 5.6 ind./L and continues to be well below the critical density of 10 ind./L suggested for effective foraging by larval yellow perch (Bremigan et al. 2003).

Total zooplankton densities remained relatively stable from May through July ranging from 26.9 to 31.3 ind./L. Densities peaked during August at 74.4 ind./L and then returned to approximately 30 ind./L in September and October (Figure 9). Mean monthly crustacean zooplankton density followed a similar trend; density was low during May, June, and July (<7 ind./L), increased to 22.3.7 ind./L during August and then declined to 11.6 ind./L during September and 7.5 ind./L in October (Figure 9). Copepod nauplii dominated the zooplankton assemblage during May whereas rotifers were the most abundant taxa during June – August (Figure 10). Calanoid copepods and bosmina also contributed significantly to the zooplankton assemblage during this time period. Other cladocerans (e.g. *Polyphemus*, *Ceriodaphnia*, *Leptodora*, *Diaphanosoma*, *Chydoridae*) that were commonly found in samples during 1988-1990 remain either rare or absent in samples.

Benthic invertebrates were collected monthly during June through October in 7.5 meters of water at a site north of Waukegan Harbor. A petite ponar grab (with 232 cm^2 sampling area) was used to collect these samples due to poor conditions for SCUBA divers. During each sampling event, two replicate ponar grabs were collected and preserved in 95% ethanol. Back at the laboratory, all samples were sieved through a 363-μm mesh net to remove sand. Organisms were then sorted from the remaining sediment and identified to the lowest taxon possible, typically to genus. Total length (mm) and head capsule width (where applicable) were measured for each individual. All taxa were enumerated and total density estimates were calculated by dividing the total number of organisms counted by the sample area. Based on ponar grabs, the overall density of benthic invertebrates near Waukegan, IL increased from June through October; a trend that was largely driven by an increase in the density of mollusks. Percent composition of benthic invertebrates consisted of primarily nematods and chironomids during June, chironomids, mollusks, nematods, ostracods, and oligochaets in August, and by September over 75% of taxa collected consisted of mollusks (Figure 11). Amphipods and hydracarina were also collected, but in much smaller quantities. Composition of mollusks collected also varied, initially consisting of predominately sphaeriidae during June (45%) and July (79%) and shifting to almost entirely quagga mussels in September and October (89 and 82% respectively). Gastropods (freshwater snails) were also present in smaller quantities throughout the sampling season.

Job 101.4: Sample juvenile (age-0 through age-3) yellow perch in nearshore waters
<u>Objective:</u> Monitor the abundance and diet of juvenile yellow perch on a seasonal basis.

2013 sampling

Juvenile yellow perch were sampled on 16 occasions from May 7th through October 8th, 2013 using 10-m gill net panels of 6, 8, 10, 12, 16 and 19 mm bar mesh. During each sampling event, nets were fished for two to four hours in 3-10 meters of water at historical sites near Waukegan Harbor, IL. Total effort was 71.0 hours during which we captured 439 yellow perch. Seasonal CPUE of yellow perch (all mesh sizes combined) was highly variable and ranged from less than one fish/hr during May, June, and October to as high as 22 fish/hr in September (Figure 12). Yellow perch collected in small mesh gill nets ranged from 61-226 mm TL and the length distribution of yellow perch varied by month (Figure 13). Overall, the mean total length of yellow perch increased with mesh size and month, with the exception of October when few yellow perch were sampled (Table 1).

Stomach analysis

We examined the stomachs of 291 juvenile yellow perch collected during 2012 (28 were empty). Yellow perch used for diet analysis ranged from 53-161 mm TL and mean length was 86.8 ± 27 mm TL (SD). Overall, the diet of juvenile yellow perch was dominated by zooplankton (77%) and smaller quantities of benthic invertebrates. Based on historical trawl samples and recent evidence that age-0 yellow perch are typically less than 75 mm in total length at the end of the first growing season, yellow perch were conservatively split into two groups; less than 80 mm and greater than 80 mm TL (Dub et al. 2014, Redman et al. 2011b). Diets of yellow perch less than 80 mm TL consisted primarily of cladocerans (mainly Bosmina spp. and smaller quantities of Chydoridae spp.; Figure 14). Calanoid copepods and chironomids were also found in the diet of these fish, but in much smaller quantities. Conversely, diets of yellow perch greater than 80 mm TL were dominated by benthic invertebrates, predominately hydracarina (80%) and larval chironomids (Figure 14). Cladocera, ostracods, and fishes (23 round goby, one yellow perch, and 19 unidentifiable) were also were also present but in much lower numbers.

Job 101.5: Survey nearshore substrate with a focus on historical yellow perch spawning grounds
Objective: Collect high resolution substrate data in the nearshore with focus on historical yellow perch spawning grounds.

On August 6th and 20th, 2013 representatives from EdgeTech provided operational training on the use of side scan sonar. Training consisted of six hours of classroom instruction followed by 10 hours of on the water data collection. During these dates, a reconnaissance side scan survey grid consisting of 10, 2.5 km long survey lines were completed in approximately eight meters of water at historical yellow perch spawning grounds (Waukegan Wiremill) south of Waukegan, IL (Figure 15). Transects were spaced 100 m apart and range was set to either 100 m or 75 m for portions of the survey allowing for 100% and 50% overlap between survey lines respectively. Post processing of collected data was conducted by Ocean Tech Services, LLC in Atlantic City, NJ. During post processing it was determined that data beyond a 60 m range was of low quality and removed from the analysis. Once the data was trimmed, transects were merged to produce a geo-referenced mosaic that will allow for future substrate delineation based on varying backscatter characteristics (Figure 15).

Job 101.6: Data analysis and report preparation
Objective: Analyze data and prepare reports, manuscripts and presentations.

Data from the above jobs were processed, analyzed, and summarized. This annual report was prepared from the data.

CONCLUSIONS

Adult yellow perch

To improve our annual assessment of the adult yellow perch population we targeted fish in deeper waters (10-20 m) with gill nets set during the spring and summer. Mean CPUE during May and June was significantly greater than 2012, at 22 fish/net night (SD 40.3; Figure 1). While catch per mesh was not recorded in 2013, CPUE of age-3 and younger yellow perch never comprised greater than 15% of the total catch from 2007-2012. Conversely, in 2013, age-3 yellow perch constituted 60% of all yellow perch sampled (Figure 2). Thus it is likely that the addition of the 1.5-in mesh panel, along with the strong year-class observed at age-0 in 2010 (F123 R-17), contributed to the decrease in age and increase in CPUE we observed relative to 2012. When age-2 and age-3 yellow perch are excluded from our analysis, likely making our comparison more consistent with previous years, CPUE during May and June combined was similar to 2012 at 10.3 ± 20.1 (SD) and mean total length was 199.7 ± 56.4 mm. Overall, lakewide CPUE continues to show a long-term decline in the abundance of adult yellow perch and the current abundance remains well below levels detected in the late 1980's and early 1990's.

Investigation of the female spawning stock in southwestern Lake Michigan from 2007-2013 indicated that fecundity increased exponentially with total length; this supports the contention that estimates of population level reproductive potential should account for both size composition of spawners and spawner biomass (Figure 4). Despite the overall increase in adult yellow perch CPUE, relative abundance of females during May and June of 2013 was similar to 2012 and significantly lower than 2007-2011 (Figure 3). Female yellow perch consisted of 12% of all fish sampled during May and June compared to 49% during July (80% of all females, all of which were spent) when female CPUE was 12.7 ± 21.1 (SD). Therefore it is not surprising that, despite our additional gill net panel, May and June female CPUE did not show the same increase as overall adult CPUE in 2013. A similar trend was observed in 2009 during an extended assessment of the adult population where female CPUE during August and September was more than double the CPUE of May and June (F123 R-16). Additional information on the timing and location of spawning as well as the movement of gravid females is required to better assess spawner abundance and reproductive potential. Continued sampling during and beyond the sampling season will allow us to better under understand seasonal movements and demographics of yellow perch.

In an effort to determine the age structure of yellow perch harvested by pedestrian anglers, anal spines were collected from fish at Montrose Harbor during June, 2013. Harvested yellow perch ranged from age-3 through age-8; however, over 80% were age-3 and age-4 (Figure 6). Given that the fishery was largely supported by age-3 and age-4 fish, it is likely that the 2010 year-class will continue to constitute a large portion of the harvested population in 2014. While assessment of gender has been sporadic based on angler involvement and remains largely unknown, previous segments (F123 R) suggest harvest may be skewed towards large females. Given the significant contribution of large females to the overall spawning, additional attempts are required to better assess the demographics of the harvested population. Overall, sport anglers primarily harvested yellow perch from the 2009-2010 year-class. As a strong year-class beyond 2010 has yet to be identified, it is extremely important to protect current age-3 and age-4 yellow perch to ensure a future spawning population and potential for improved year-class strength.

2013 Year-class

Despite decreased effort in 2013, CPUE of age-0 yellow perch collected in bottom trawls in recent years has been low compared to that detected during 2005 and 2010. Previously, relatively high CPUE in 1998 led to a comparatively strong year-class as seen by its dominance in LMBS 2000-2004 fyke netting (previous segments of F-123-R). A similar pattern occurred with the 2002, 2005, and most recently, 2010 year-classes. All of these year-classes were caught in relatively high abundance at age-0 and were detected at significant levels in our adult assessments by age 4. The 2002 year-class contributed significantly to adult assessments and angler catches during 2006-2008, 2009 was the first year the 2005 year-class dominated both our adult assessment and sport harvest collections (previous segments of F-123-R), and presently, the 2010 year-class is dominating both angler harvest and our adult assessment. These results suggest that strong CPUE of age-0 yellow perch is a reasonable indicator of recruitment success. Yellow perch year-class strength remains very erratic from year to year and recent CPUEs are extremely low compared to sampling in the late 1980s (1987 and 1988). Despite measureable year-classes in 2002, 2004, 2005, and 2010, CPUE of age-0 yellow perch is nowhere near that of the late 1980s;

as such, yellow perch populations are likely not sufficiently strong to support extensive fishing pressure.

The forage base available to young yellow perch has changed in species composition and abundance over the last several decades, and many of these changes are linked to exotic species invasions. Mean zooplankton densities were significantly higher during 1988 in comparison to 1989-1990 and 1996-2012 (Dettmers et al. 2003, previous segments of F-123-R). Zooplankton densities since 1996 have barely reached even half of the densities found during the late 1980s when multiple strong year-classes were produced. These shifts within the zooplankton community may be related to the establishment of several recent invaders. The spiny water flea (*Bythotrephes longimanus*) was first detected in Lake Michigan during 1986 and was established in offshore waters lake-wide by 1987 (Barbiero and Tuchman 2004). Barbiero and Tuchman (2004) attributed a dramatic reduction in several native cladocerans species to the establishment of this exotic cladoceran in offshore waters of Lake Michigan. Declines in once dominant benthic macroinvertebrate groups such as *Diporeia*, cladocerans and sphaeriids in nearshore waters of Lake Michigan are attributed to bottom-up effects of decreased phosphorus loading during 1980-1987 and continued declines of *Diporeia* coinciding with the invasion of zebra mussels during the 1990s (Madenjian et al. 2002) and quagga mussels during the early 2000s (Nelepa et al. 2009). Dreissenid mussels have drastically reduced phyto- and zooplankton levels (Vanderploeg et al. 2012) and altered the abundance of benthic macroinvertebrates in the Great Lakes (Leach 1993; Stewart et al. 1998). The presence of these invaders and other exotic species have had major impacts on the food web and may exacerbate and alter the complex set of factors that affect yellow perch year-class strength. Over the last three decades, yellow perch year-class strength has been linked to zooplankton availability for first feeding larvae (Dettmers et al. 2003; Redman et al. 2011b). Foraging success of yellow perch larvae in Green Bay was poor when zooplankton density dropped below 10 ind./L (Bremigan et al. 2003) and June-July zooplankton densities in six of the last ten years have been at or below this level within Illinois waters of Lake Michigan. Our results indicate higher densities of rotifers during June and July compared to previous years. While rotifers may be preyed upon by newly hatched yellow perch larvae (Fulford et al. 2006) prolonged consumption may result in reduced growth and survival (Graeb et al. 2004). Thus, continued monitoring of nearshore zooplankton and benthic invertebrate densities is needed to further explore the role of food availability in yellow perch recruitment success.

Juvenile yellow perch

Relative abundance of juvenile yellow perch sampled in small mesh gill nets was greatest during September at 22 fish/hr. Age-0 yellow perch return to the benthic nearshore areas during fall months when they possess sufficient swimming capabilities or favorable winds are present (Weber et al. 2011). While the age of juvenile yellow perch captured in small mesh gill nets has been shown to range from age-0 to age-3, previous research suggests that age-0 yellow perch are less than 80 mm at the end of the first growing season in southwestern Lake Michigan (Dub et al. 2014). During August, September and October of 2012 yellow perch less than 80 mm constituted 55% of 300 yellow perch sampled. Comparatively in 2013, yellow perch less than 80 mm represented only 3.4% of the 274 yellow perch collected during the same time frame. Thus while previous segments (F123 R) noted that peaks in juvenile yellow perch CPUE during August and September corresponded with the return of age-0 yellow perch to benthic nearshore habitats (Miehls and Dettmers 2011), increased CPUE during September during 2013 appears to be related nearshore or increased movement of age-1 and older yellow perch. Additionally, the apparent absence of age-0 yellow perch from our collection efforts further highlights the variability of yellow perch recruitment and, specifically, low age-0 yellow perch abundance since 2010. Future efforts are required to better understand the nearshore movements of juvenile yellow perch to identify potential bottlenecks influencing year-class strength.

During ontogeny yellow perch undergo several diet shifts from zooplankton to benthic invertebrates and when gape becomes large enough, to piscivory (Creque and Czesny 2011). In 2012, diets of juvenile yellow perch were comprised primarily of zooplankton and, to a lesser extent, benthic invertebrates and fishes. The increased contribution of round goby to diets to juvenile yellow perch diets represents a novel forage source that may promote increased growth and allow for rapid progression through bottlenecks during early life. Assessing the age structure and diets of juvenile yellow perch sampled from small mesh gill nets will allow us to examine factors influencing growth, which may be crucial for future survival beyond the first growing season (Dub et al. 2014). Integrating these results with other sampling efforts will allow us to capture a complete view of yellow perch life history in Illinois waters of Lake Michigan.

Nearshore spawning grounds

Exploratory examination of historical yellow perch spawning grounds suggests that the area immediately south of the Waukegan Wiremill intake pipe consists of a heterogeneous mix of substrate ranging from large boulders to fine sand particles (Figure 15). Future mapping along with ground truthing, will allow us to delineate and quantify areas suitable for yellow perch spawning. Identification of critical habitats will allow for the protection of a key resource for this valuable native sport fish.

Management Implications

In 2005, bottom trawl surveys indicated the greatest CPUE of age-0 yellow perch recorded since 1988. The 2005 year-class recruited to LMBS sampling gear at age-4 and significantly contributed to our assessment of angler harvest in both 2009 and 2010 and continued to dominate our population assessment until age-7 in 2012 (Figure 6). The 2010 year-class appears to be following a similar trajectory as bottom trawl surveys indicated the greatest CPUE of age-0 yellow perch since 2005 (F123 R-17). While it is likely that recruitment to our sampling gear occurred a year-earlier than usual, the eventual large contribution of the 2010 year-class is unsurprising. In 2013, the fishable yellow perch population was predominately supported by two consecutive year-classes (2009-2010), there is a need to protect these year-classes so they can reach their full reproductive potential. Poor recruitment during 1999-2001, 2008-2009 and 2011-2013 taken with the continued trend of low abundance of adult yellow perch throughout Lake Michigan (Makauskas and Clapp 2010) raises concerns about the growth and future survival of yellow perch. Our long-term data still clearly demonstrate that recruitment is highly variable and low when compared to recruitment during the 1980s. Thus, it remains important to conserve the adult stock to the greatest degree possible so that the spawning stock can reach full reproductive potential and their offspring can take advantage of beneficial recruitment conditions when they occur. Given the current population characteristics, management for limited harvest is necessary to protect the future of the Lake Michigan yellow perch population.

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TABLES

Table 1. Mean length (± standard deviation) and number of yellow perch sampled in small mesh gill nets from each mesh and month near Waukegan Harbor in 2013.

	6	8	10	12	16	19	Total**
May	-	76.8 (4.7), 3	-	-	140.0 (6.1), 2	-	101.6 (34.4), 5
June	-	77.4 (6.6), 9	-	-	-	186, 1	88.2 (34.9), 10
July	-	79.5 (13.0), 22	89.2 (12.2), 47	127.4 (29.5), 20	148.0 (20.8), 20	166.5 (14.2), 11	110.9 (35.2), 121
August	61.2, 1	92.2 (15.4), 11	98.8 (14.5), 29	115 (7.2), 19	143.6 (25.3), 12	172.5 (24.1), 8	115.5 (30.4), 80
September	70.1, 1	106.4 (18.8), 21	104.5 (11.5), 21	121.4 (14.2), 87	130.7* (14.5), 7	*	126.1 (22.7), 191
October	-	-	-	116.0 (3.7), 2	-	-	120.4 (8.0), 3
Total	65.6 (6.3), 2	89.7 (19.0), 66	95.4 (14.1), 97	121.4 (16.9), 128	143.3 (21.3), 41	169.9 (18.5), 20	

* 52 yellow perch with a mean length of 150.6 (17.1) were collected in September from either 16 or 19 mm mesh.
** Includes yellow perch that were not sorted by mesh during collection.

FIGURES

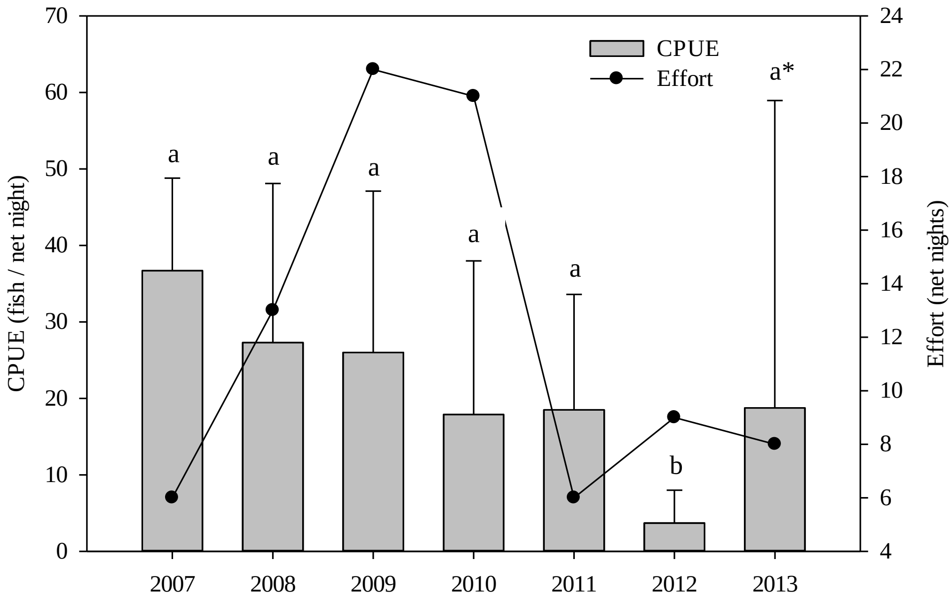

Figure 1. Annual mean CPUE (+ 1 SD) of yellow perch collected in gill nets during May and June at Waukegan and Lake Forest, Illinois during 2007-2013. *A 100-ft panel of 1.5-in mesh was added in 2013.

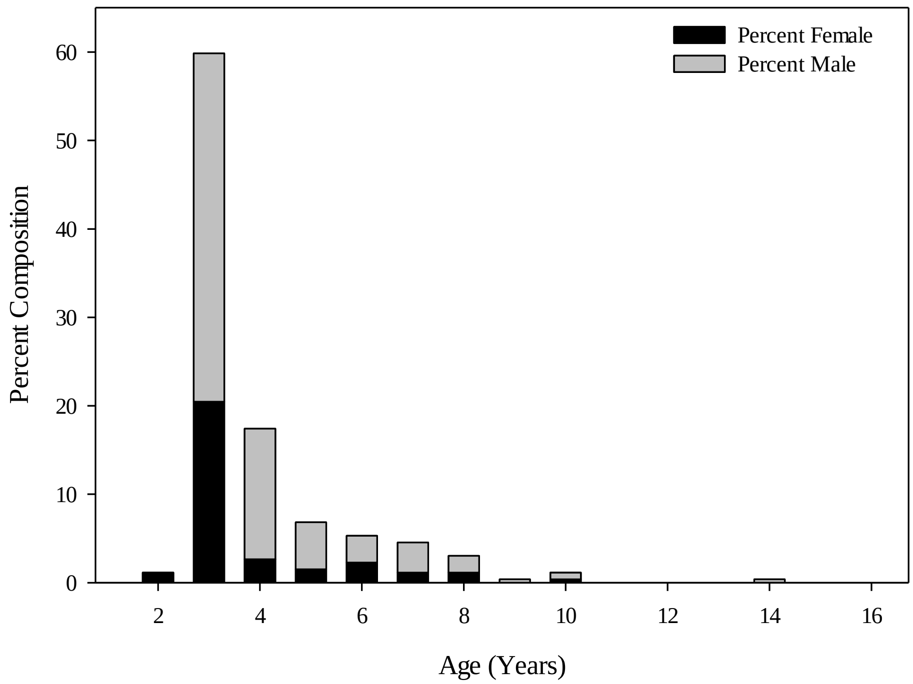

Figure 2. Age composition of adult female and male yellow perch collected using gill nets at Waukegan and Lake Forest, IL during the spring of 2013.

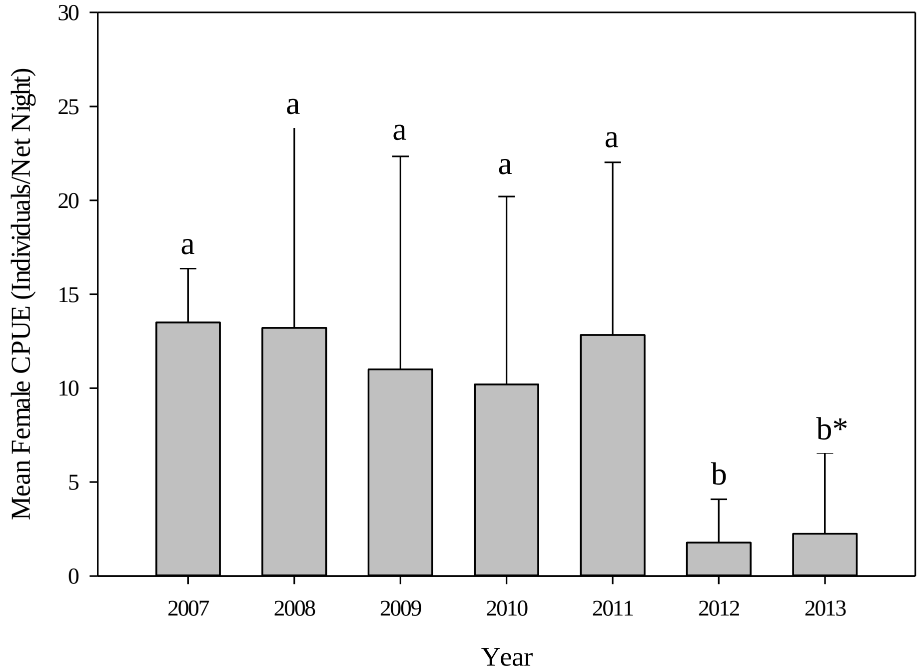

Figure 3. Mean CPUE (+ 1 SD) of gravid female yellow perch collected in gill nets at Waukegan and Lake Forest, Illinois during the spring from 2007-2013. *A 100-ft panel of 1.5-in mesh was added in 2013.

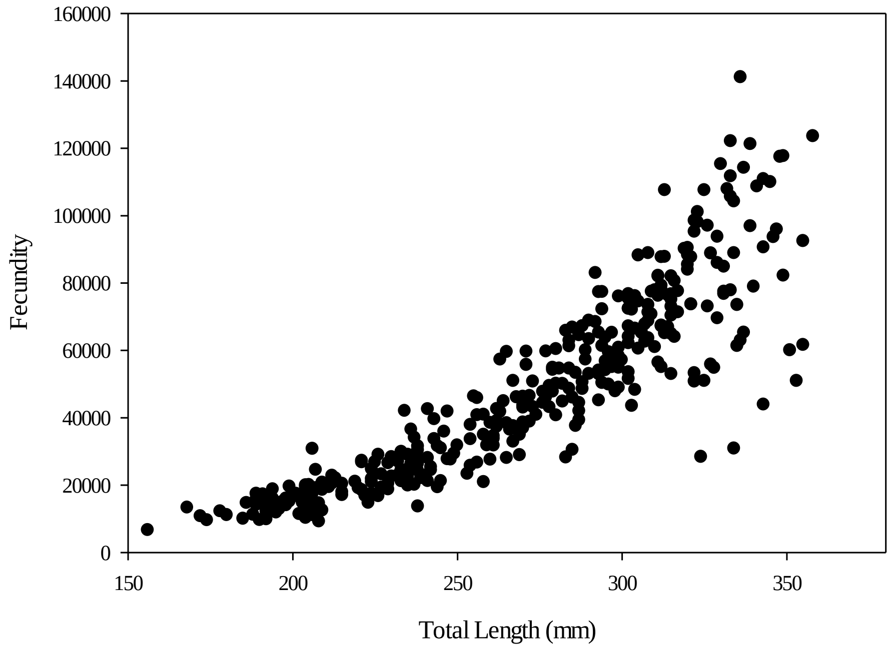

Figure 4. Relationship between total length and fecundity of yellow perch collected in gill nets during 2007-2013.

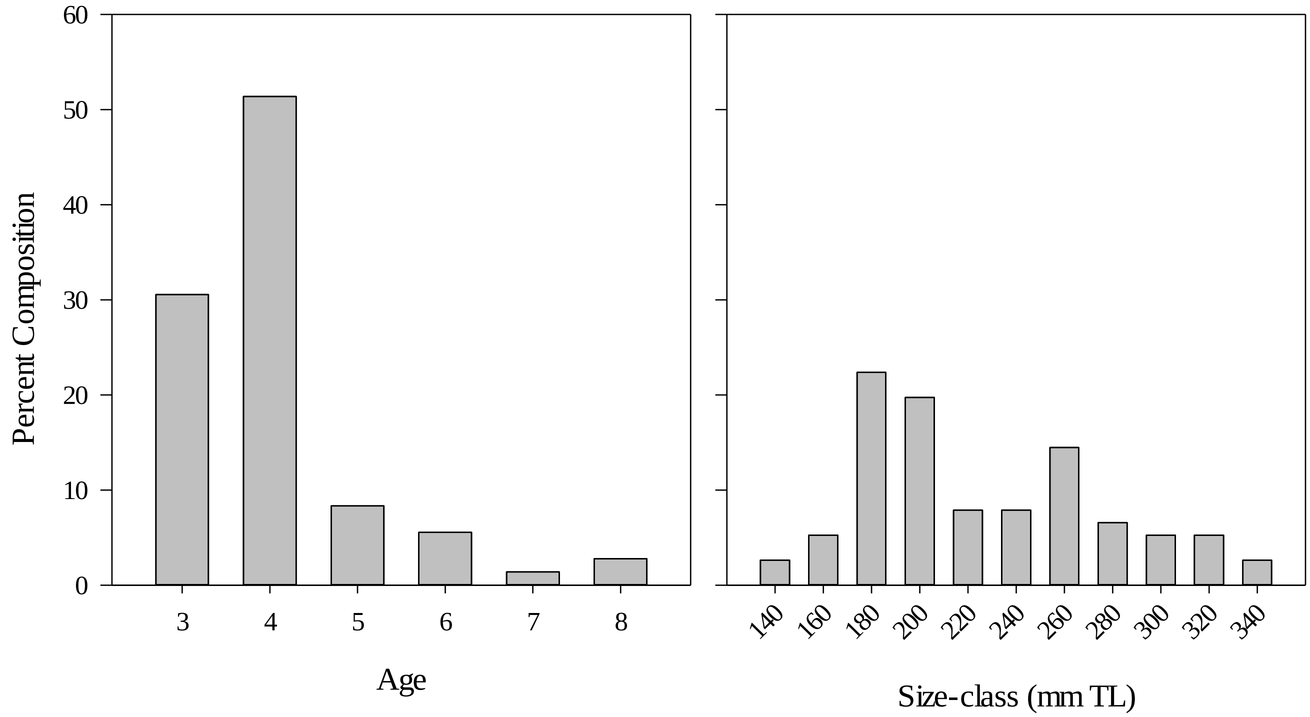

Figure 5. Age and length distributions of yellow perch harvested by pedestrian anglers at Montrose Harbor during 2013.

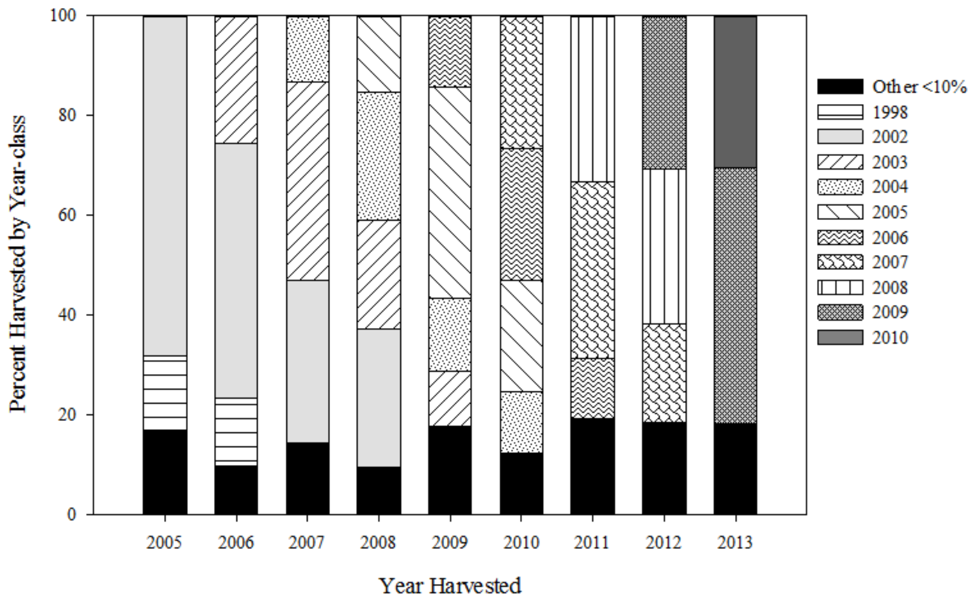

Figure 6. Relative contribution of yellow perch year-classes to pedestrian angler harvest. Year-classes with less than 10% contribution are included in the “other” category.

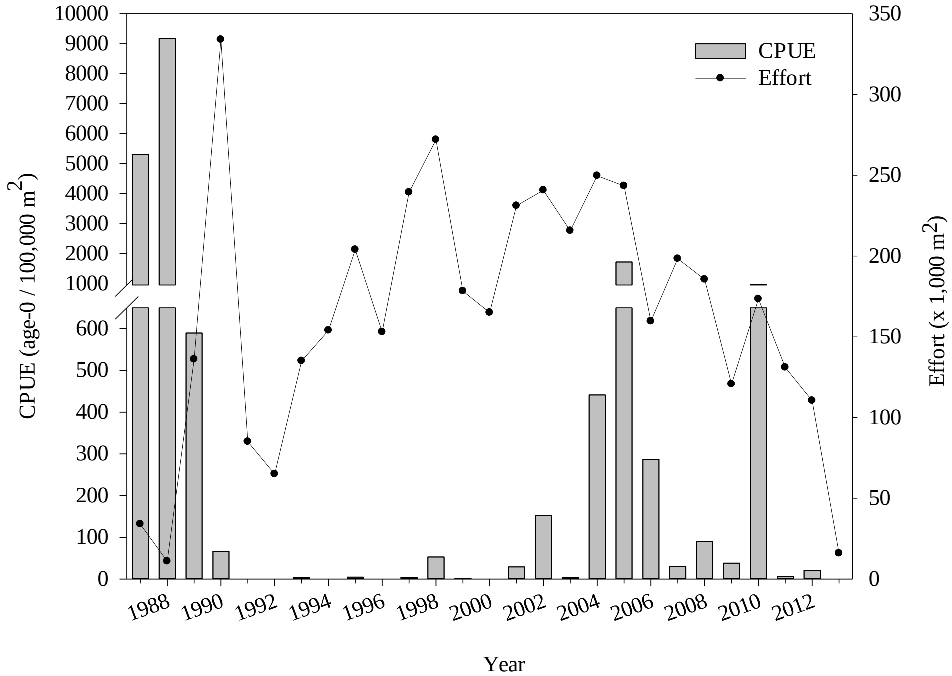

Figure 7. Relative abundance of age-0 yellow perch collected by daytime bottom trawls north of Waukegan Harbor, IL during 1987-2013.

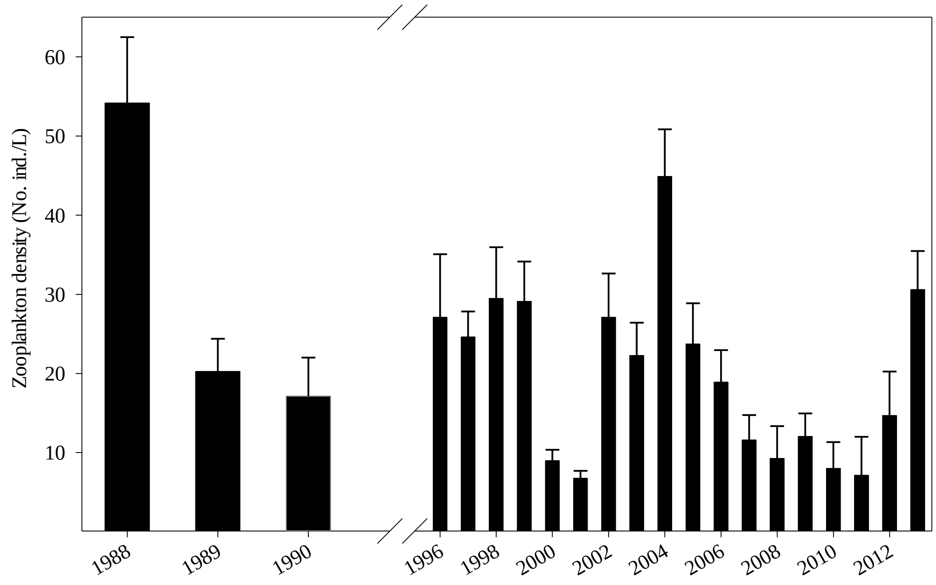

Figure 8. Mean density of zooplankton (+ 1 SE) present in Illinois waters of Lake Michigan near Waukegan during June-July for years 1988-2013.

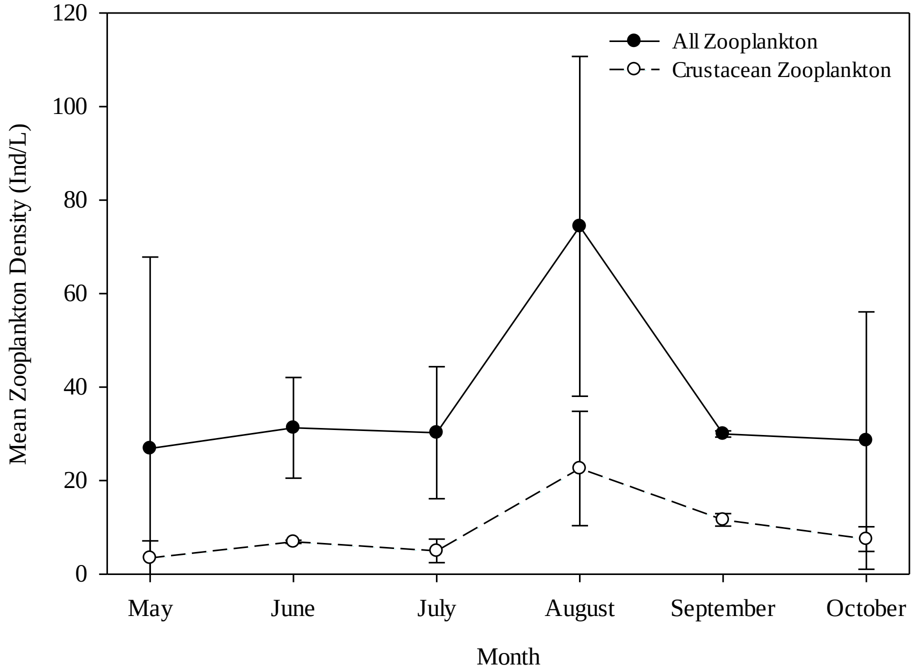

Figure 9. Mean monthly zooplankton density (± 1 SD) in nearshore Illinois waters of Lake Michigan near Waukegan during May – October, 2013. Closed circles (●) represent total zooplankton, whereas open circles (○) represent crustacean zooplankton.

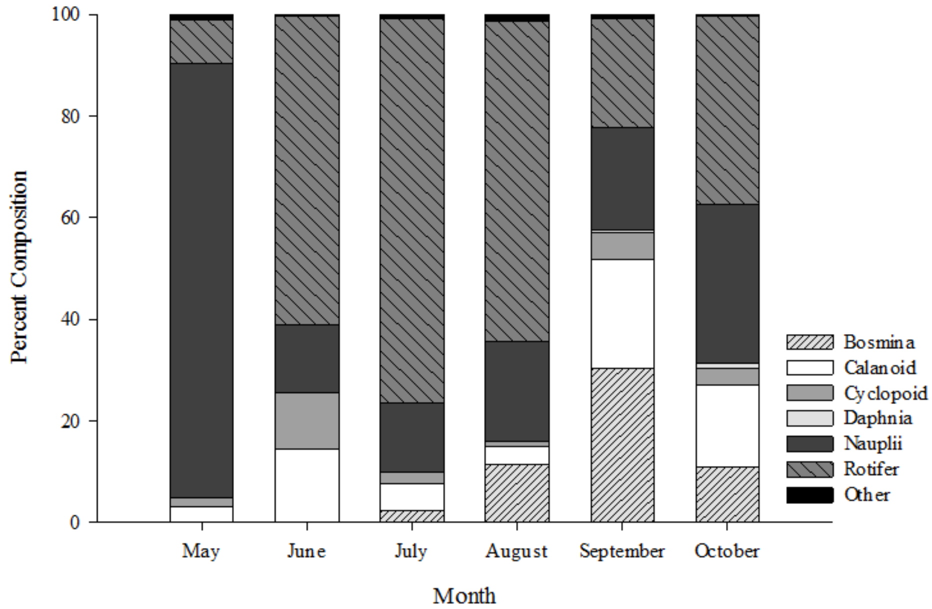

Figure 10. Monthly percent composition of zooplankton found in nearshore Illinois waters of Lake Michigan near Waukegan during May – October, 2013.

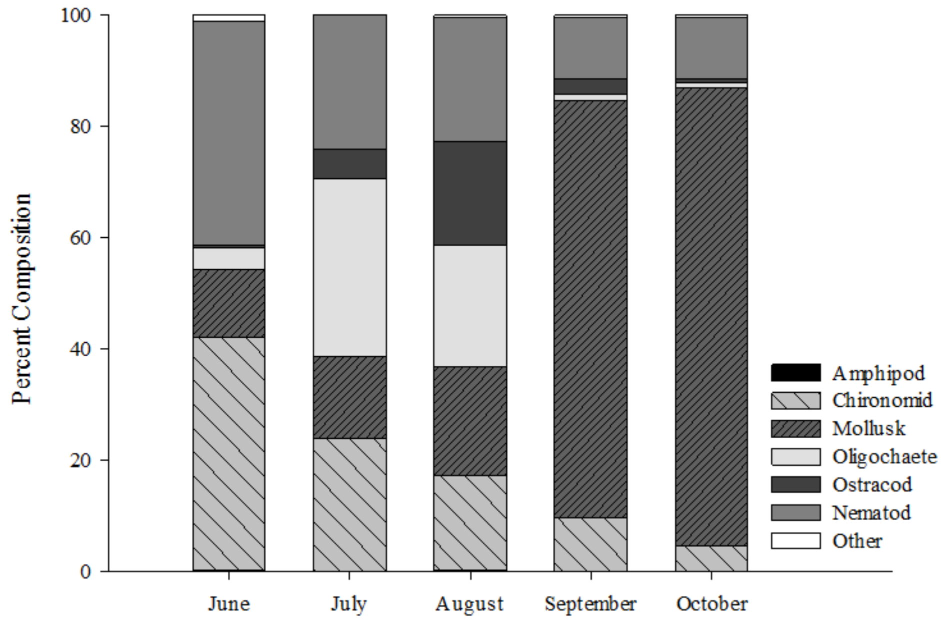

Figure 11. Percent composition of benthic invertebrates found in Lake Michigan substrate near Waukegan using monthly ponar grabs from June through October, 2013.

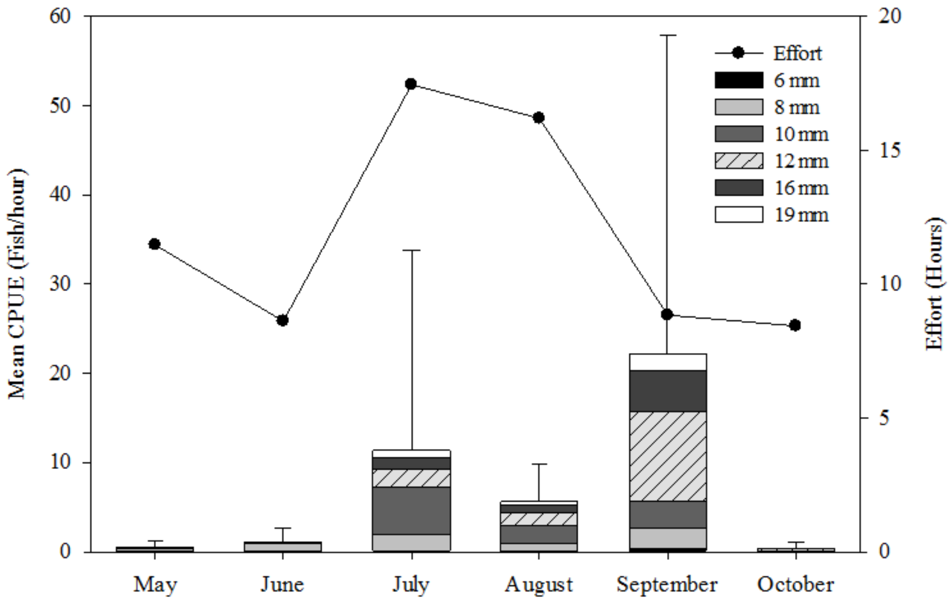

Figure 12. Mean monthly CPUE (+ 1 SD) of yellow perch collected in small mesh gill nets fished in 3-10 meters of water near Waukegan Harbor, IL during May - October, 2013.

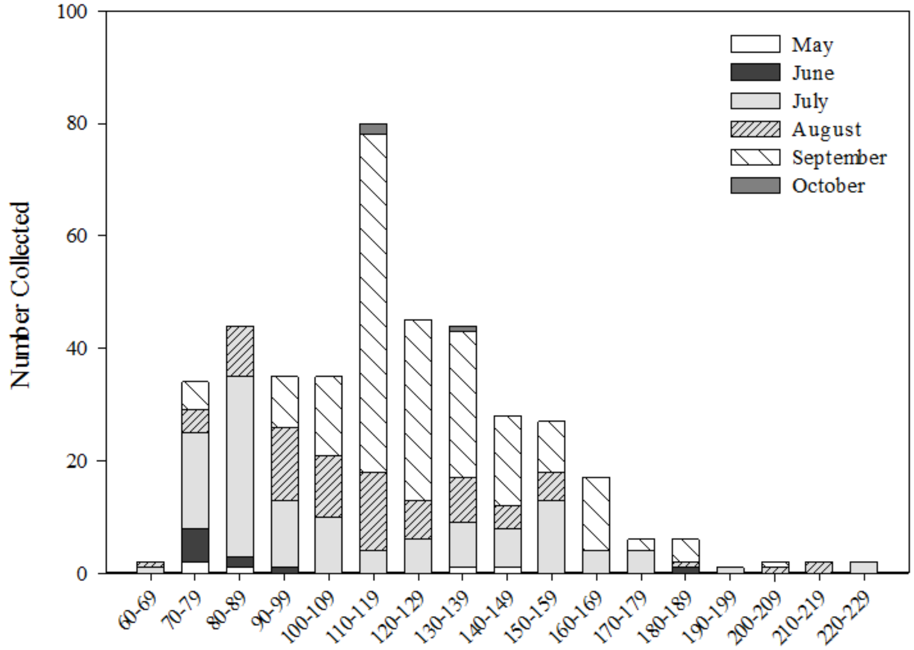

Figure 13. Total length distribution of yellow perch collected in small mesh gill nets fished in 3-10 meters of water near Waukegan Harbor, IL during May - October, 2013.

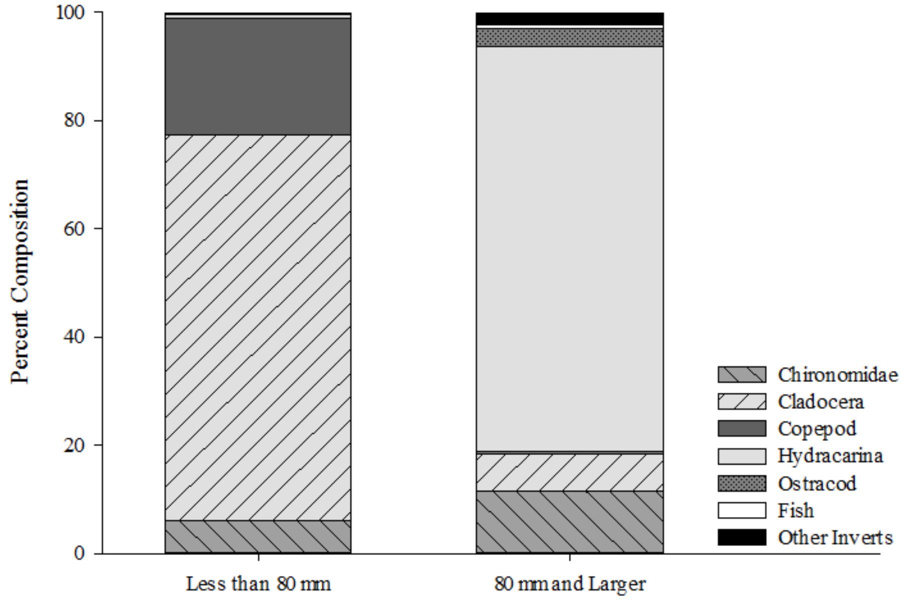

Figure 14. Diet composition of juvenile yellow perch collected in small mesh gill nets near Waukegan Harbor, IL during 2012.

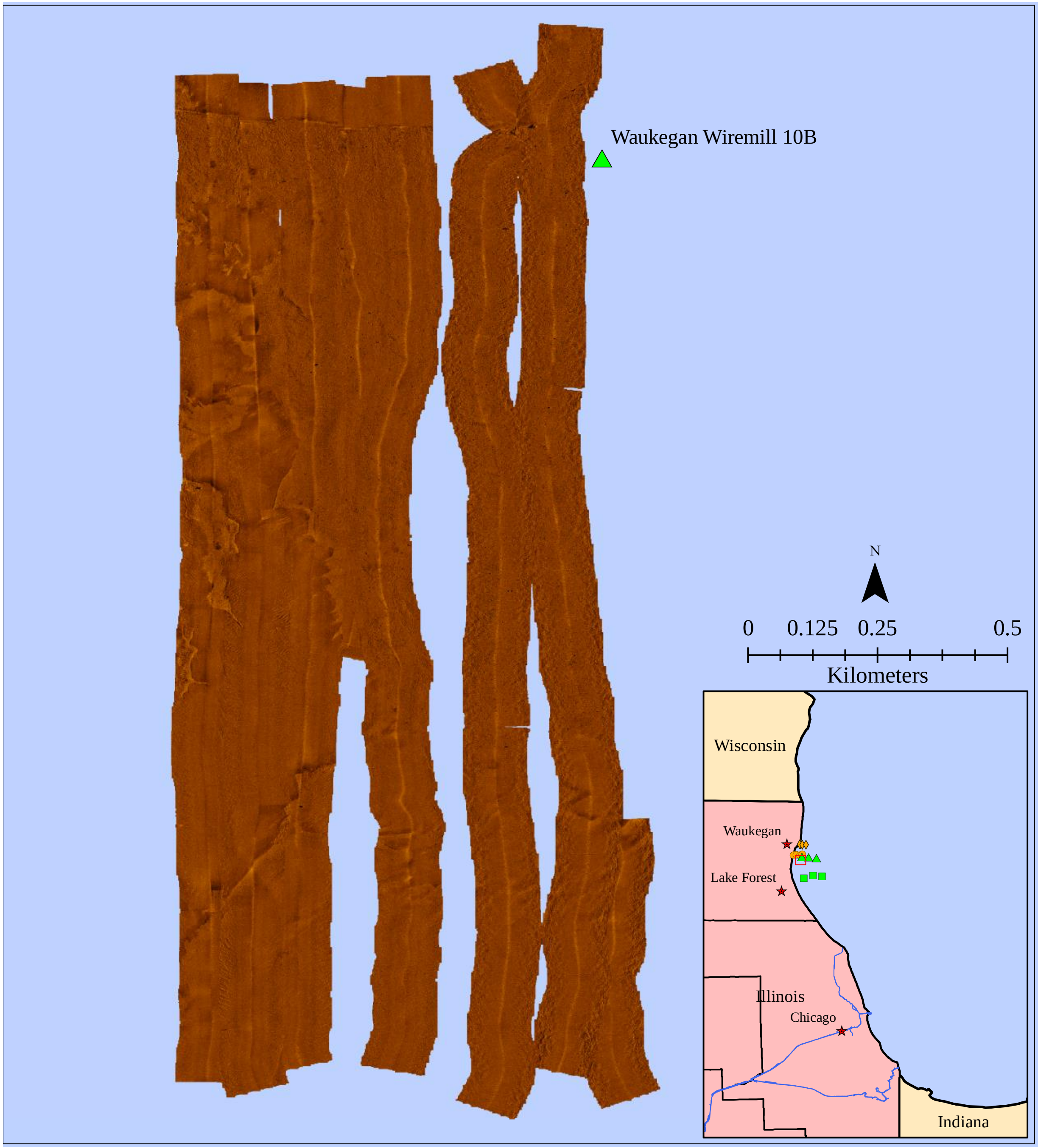

Figure 15. Mosaic of side scan transects completed near Waukegan, IL during 2013. Location of small mesh and large mesh gill net sites are indicated by orange and green symbols respectively.