# Fisheries Research and Monitoring Activities of the Lake Erie Biological Station, 2011

Department of the Interior
U.S. Geological Survey
Great Lakes Science Center
Lake Erie Biological Station
6100 Columbus Avenue
Sandusky, Ohio 44870

| | |
|---|---|
| Patrick M. Kocovsky, Ph. D. | Research Fishery Biologist |
| William H. Edwards, B.S. | Fishery Technician |
| Rachel Wirick, B.S | Fishery Technician |
| Kevin Keretz, B.S. | Fishery Technician |
| J. Lee Zinn, B.S. | Fishery Technician |
| Richard Kraus, Ph. D. | Station Chief and Research Fishery Biologist |
| Mark Rogers, Ph. D. | Research Fishery Biologist |


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## 1.0 Western Basin Forage Fish Assessment


### Abstract

The U.S. Geological Survey Lake Erie Biological Station completed its eighth consecutive year of a collaborative, multi-agency assessment of fish populations throughout the western basin of Lake Erie in 2011. The objectives of this evaluation were to provide estimates of densities and biomasses of key forage and predator species in Michigan and Ontario waters of the western basin of Lake Erie to the interagency database for assessing seasonal and spatial distributions of fishes and to assess year class strength of key forage and predator species. We sampled 25 stations in Ontario and Michigan waters of the western basin of Lake Erie with bottom trawls in June and September 2011. We calculated catch per hectare (CPH) and weight per hectare (kg) for 15 species in western Lake Erie. We also examined stomach contents from age-2 and older white perch *Morone americana* and yellow perch *Perca flavescens*. Most species had poor or moderate year classes in 2011. Only gizzard shad *Dorosoma cepedianum*, freshwater drum *Aplodinotus grunniens*, and rainbow smelt *Osmerus mordax* had CPH above the 8-year mean. Yearling-and-older silver chub *Machrybobsis storeriana* increased for the second consecutive year, rebounding from 4 consecutive inter-annual declines. The non-native bloody red shrimp *Hemimysis anomala* was found in the diets of both yellow perch and white perch from east of Pelee Island, near the mouth of the Detroit River, and from Maumee Bay. This is the third consecutive year *Hemimysis* has been sampled in yellow perch and white perch diets suggesting *Hemimysis* is established in western Lake Erie.


### Introduction

The United States Geological Survey's (USGS) Lake Erie Biological Station has participated in a collaborative, multi-agency effort to assess forage fish populations in the western basin of Lake Erie since 2004. The primary long-term objective of the bottom trawl assessments is to contribute estimates of forage fish catch per hectare (CPH) and weight per hectare to the interagency database for assessing seasonal and spatial distributions of forage fishes. The short-term objective is to estimate year-class strength of key forage and predator species. Indices of abundance of yellow perch *Perca flavescens* are provided to the Yellow Perch Task Group of the Lake Erie Committee of the Great Lakes Fishery Commission to estimate total allowable catch. Our data augment those collected by the Ontario Ministry of Natural Resources (OMNR) and the Ohio Department of Natural Resources (ODNR), who have cooperatively sampled forage fishes throughout the western basin of Lake Erie in August since 1987. Prior to 2004 most sites sampled by the USGS had been sampled either in August only (Ontario waters) or not at all (Michigan waters). The 2010 season was the eighth consecutive year of this collaboration.

We present estimated CPH and weight per hectare of young-of-year (YOY) and yearling-and-older (YAO) forage fishes in the western basin of Lake Erie in June and September 2011 and trends in CPH and abundance of key species over the entire time series. We also present data on diets of yellow perch and white perch *Morone americana* collected at our trawl sites.

## Methods

### *Trawling*

Sampling sites in Ontario waters of the western basin of Lake Erie were selected from those sampled by OMNR in August. We sampled 19 sites in Ontario waters (Figure 1.1), which is a subsample of the sites sampled by OMNR in the western basin, and six sites from Michigan waters. Sites were sampled in two depth strata, ≤ 6 m (6 sites) and > 6 m (19 sites) following Knight (1992). Spring samples were collected during 13 - 16 June 2011. Autumn samples were collected during 12 - 17 September 2011. We used a 7.9-m (headrope) semi-balloon bottom trawl for all sampling. Prescribed trawling time at a site was 10 minutes.

For small trawl catches, all fish were identified to species and enumerated. For large trawl catches (generally more than 1,000 fish), the number of individuals was estimated using a weight-based subsampling method. The entire catch, except larger individuals, which were removed, enumerated, and weighed by species prior to subsampling, was weighed and then a subsample of fish was weighed. All fish in the subsample were identified to species and enumerated. For each species, the total number of fish in the entire sample was estimated by multiplying the number of fish in the subsample by the ratio of the weight of the entire sample to the weight of the subsample. A maximum of 30 fish of each species and age group were retained and placed on ice for collection of total length (nearest mm) and weight (nearest 0.1 g) in the laboratory. Weights were not measured for YAO of predatory species.

For each trawl sample, we estimated density of each species and age group by dividing the number of fish of each species and age group captured in a trawl sample by the area swept by the trawl. Area swept was estimated as width of the trawl opening multiplied by the distance towed. The width of the trawl opening was estimated previously using an acoustic net mensuration system. The distance towed was estimated from the difference in starting and ending latitude and longitude. Fish age group for spring samples and for most species in autumn samples was determined using age-length keys for species in the western basin developed from historical ODNR samples. For yellow perch captured in autumn samples the length threshold from age-length keys was extended to 120 mm (from 95 mm) because an examination of otoliths from fish between 95 and 135 mm total length revealed that nearly all fish less than 120 mm total length were age 0. For all species except round goby *Neogobius melanostomus* and logperch *Percina caprodes* separate CPH and weight per hectare estimates were made for YOY and YAO. All ages were combined for round goby and logperch, owing to difficulty in determining age based on length alone. The average CPH of each species was calculated as the arithmetic mean of all samples within a season and was expressed as number per hectare. Weight per hectare for a species and age group was calculated for each trawl sample by multiplying average weight for a species and age group by the average CPH and was expressed as kilograms per hectare. Catch efficiency of our gear has not been quantified but is probably low (Herzog et al. 2005), hence density and weight per hectare estimates are probably biased low.

### *Yellow perch and white perch diets*

A maximum of five age-two and older yellow perch and white perch (>150 mm total length for yellow perch and >170 mm total length for white perch) that showed no signs of regurgitation (exposed stomach or visible food content in the mouth cavity) at each trawl site were kept for diet analysis. Total length, weight, and sex of the fish as well as the site and date

were recorded. The digestive tract from each fish was removed and individually frozen in tap water in the field and brought back to the laboratory for diet analysis.

In the laboratory, each fish sample was thawed by immersing in cold tap water. The stomach was isolated from the digestive tract at the esophagus and pyloric caeca. The stomach was placed in a 0.25 mm sieve and cut lengthwise. Stomach contents were placed into a petri dish with soapy tap water to remove the surface tension of the water, thus allowing prey items to sink to the bottom of the dish where they were more easily identified.

Once in the petri dish, stomach contents were quantified using a dissecting microscope and zooplankton, macroinvertebrates, and fish were counted and identified by taxon. A subsample was taken when ≥200 individuals of a particular prey item occurred in a given sample. To subsample, a petri dish was divided into eight equal sections and a count of each prey item was taken until 200 was reached. The area that contained n=200 was recorded and then extrapolated for the entire sample. Diet data from non-empty stomachs were used to calculate percent occurrence by predator species and season for zooplankton, benthic macroinvertebrates, and fish prey. Percent occurrences from 2011 sampling were compared to results from 2005-2010.

## Results

### *Trawling*

All 25 sites were successfully sampled in spring and autumn. All completed samples in autumn were the prescribed 10-minutes in duration. Tow time at two sites in spring, one in Ontario waters and one in Michigan waters, were 9 minutes because trawls became snagged on bottom debris. Because both tows were at least five minutes they were retained for analysis based on past practice. Trawled distance averaged 0.61±0.02 (95% CI) km in both spring and autumn. We did not use net mensuration gear in 2011. Based on 2008 data (Kocovsky et al. 2009) we used a net opening of 5 m for calculating area swept for density calculations.

Most species we monitored had moderate to poor reproductive success as measured by CPH of YOY in 2011. Catch per hectare (Table 1.1) of autumn YOY spottail shiner *Notropis hudsonius* (-91% compared to 2010), trout-perch *Percopsis omiscomaycus* (-43%), walleye *Sander vitreus* (-66%), white bass *Morone chrysops* (-85%), and yellow perch (-77%) were lower than in 2010 and below their 8-year means. Reproductive success of non-native white perch (-34%) was also lower than in 2010 and below its respective 8-year mean. Catch-per-hectare of YOY emerald shiner *Notropis atherinoides* (-10%), gizzard shad *Dorosoma cepedianum* (+6%), logperch (+6%), and smallmouth bass *Micropterus dolomieu* (+3%) were similar to 2010. Emerald shiners were below their 8-year mean. Smallmouth bass were near their 8-year mean. Gizzard shad and logperch were well above their 8-year means. Catch-per-hectare of YOY freshwater drum *Aplodinotus grunniens* (262%) and rainbow smelt *Osmerus mordax* (481%) were well above 2010 values. Catch-per-hectare of YOY freshwater drum was the highest of the 8-year time series. Catch-per-hectare of rainbow smelt and silver chub were moderate for their 8-year time series. Changes and trends in weight-per-hectare (Table 1.2) reflected those for CPH.

Autumn CPH was higher than in 2010 for YAO of several species. Emerald shiner (+498%), freshwater drum (+106%), silver chub *Macrhybopsis storeriana* (+386%), spottail shiner (+121%), and white perch (+111%) were all at least double their 2010 CPH. Catch-per-

hectare of emerald shiner, freshwater drum, spottail shiner, and white perch were also above their 8-year means, while CPH of silver chub was slightly below its 8-year mean. Catch-per-hectare of YAO white bass (-90%) and round goby (-47%) were below those of 2010 and well below their 8-year means. Trout-perch and yellow perch YAO CPH were virtually unchanged from 2010 and only slightly below their 8-year means.

For all species except freshwater drum (14% higher) mean total lengths of YOY (Table 1.3) were within 10% of 8-year means.

Four tubenose gobies *Proterorhinus marmoratus* were captured in Michigan waters approximately 10 km southwest of the mouth of the Detroit River. Total lengths were 36-59 mm, the largest of which were likely adults. These fish were captured at one of the same sites at which tubenose gobies were captured in 2008 (Kocovsky et al. 2011a).

*Yellow perch and white perch diets*

Spring sampling provided 109 age-2-and-older yellow perch stomachs, 104 (95%) of which contained prey (Table 1.4). In spring 2011, benthic macroinvertebrates were present in most yellow perch stomachs (94.2%) and *Hexagenia* sp., Chironomidae, and *Dreissena* sp. were the most common. Zooplankton were present in 25.0% of yellow perch stomachs. Fish prey were present in 16.3% of spring yellow perch diets, with round gobies observed most frequently. During autumn sampling, 89 age-2-and-older yellow perch stomachs were collected and 92% of stomachs contained prey (Table 1.4). Most of the autumn yellow perch stomachs contained benthic macroinvertebrates (90.2%). Zooplankton occurred in 26.8% and fish were present in 15.9% of autumn stomach samples, with round goby occurring in 24.4% of stomachs containing fish. Individual prey items were found to have similar frequencies in both spring and autumn sampling efforts.

Spring sampling provided 76 age-2-and-older white perch stomachs, 65 (86%) of which contained prey (Table 1.4). In spring, zooplankton were present in 84.6% of samples with *Leptodora kindtii* occurring most frequently (68.8% of samples). Benthic invertebrates occurred in 70.8% of spring stomach samples with Chironomidae being most common (56.3% of samples). Fish, especially round gobies, were present but observed infrequently in only 9.2% of stomachs. Ninety age-2-and-older white perch stomachs were collected during autumn sampling and 86% contained prey items (Table 1.4). Benthic macroinvertebrates had the highest percent occurrence (88.3% of samples). Although Chironomidae (66.2%) occurred most frequently in autumn, Nematoda (28.6%) and Sphaeriidae (24.7%) had much higher frequency than in spring sampling. For autumn samples, the percentage of stomachs containing zooplankton decreased to 62.3%. In autumn, a shift from *Leptodora kindtii*, *Daphnia retrocurva* and *Calanoida* sp. to *Bythotrephes* sp. and *Bosmina* sp. was observed (Table 1.4). Similar to spring samples, fish were infrequent prey.

Historically, zooplankton were more common in yellow perch diets in the spring than in autumn. In 2011, however, zooplankton occurrence in spring was the lowest ever observed in our data set with little change between spring and autumn (25.0% in the spring compared to 26.8% in autumn; Figure 1.2). For white perch, the historical trend of higher zooplankton occurrence in the spring compared to autumn remained consistent with zooplankton in 84.6% of stomachs in the spring and in only 62.3% of stomachs in autumn (Figure 1.3). Since 2006, benthic macroinvertebrates have represented an important component of the diets of both yellow and white perch, occurring in >50% of yellow perch stomachs and in >40% of white perch stomachs

regardless of the season. *Hemimysis anomala*, a non-native shrimp, was found in the diet of yellow and white perch in both species during 2011 sampling efforts (Table 1.4). There was not a noticeable difference between the occurrence of fish prey items found in yellow and white perch this year, however historically, both species have had a greater percentage of stomachs containing fish prey in autumn samples compared to spring samples.

**Discussion**

Populations of several ecologically and economically important native fish species remain low in abundance or are on declining trajectories. Recent increasing trends in walleye and freshwater drum are encouraging, but both of these species, as well as yellow perch, remain at historically lower levels of abundance. Meanwhile, invasive species, such as white perch, remain among the most abundant in western Lake Erie. The invasive round goby, although much lower in abundance than at its peak, remains more abundant than most native species. The most recent non-indigenous species, tubenose goby, is established in Michigan waters near Monroe, Michigan, but is probably low in abundance (Kocovsky et al. 2011a). Alewife *Alosa pseudoharengus* is the only invasive species to drastically decline in abundance. For the fourth consecutive year we captured no alewife in western Lake Erie.

Freshwater drum continued an increasing trend since reaching a low in 2007 following the outbreak of Viral Hemorrhagic Septicemia, which corresponded with 3 consecutive years of poor reproductive success. The increase in 2011 was greater in magnitude than the decrease between 2009 and 2010, hence the overall trend remains strongly increasing. Logperch is on a modestly increasing trajectory. Despite a decrease in CPH from 2010, CPH of YOY walleye was the second highest value since 2003. The trend in CPH of YOY walleye is positive, although it remains far below desired values for sustaining fisheries (WTG 2011).

Sampling in 2011 occurred during the second full week of September, which is one week earlier than our typical prescribed sampling period and one week earlier than last year. Despite sampling one week earlier, cumulative degree days (DD, sum of mean daily temperatures; NOAA 2011) from 1 June through our mean sampling date were only 23 DD lower than last year. This minor difference results from warm temperatures in July and September that were well above those of last year and well above the 8-year mean. The minor differences in mean total lengths between 2010 and 2011 are partially attributable to similar cumulative DD when sampling occurred. Warm temperatures also contributed to production of a second gizzard shad cohort, which has occurred in all years except 2008 and 2009, the two years with lowest cumulative DD since at least 2003.

Estimated densities of silver chub YAO increased for the first year since 2005. Despite the observed strong decline since 2004 (Kocovsky et al. 2010) the population remains much more abundant than it was prior to the late 1990s. With the exception of occasional increases in CPH every 3-5 years, silver chub abundance was low between 1960 and 1996 (USGS Lake Erie Biological Station, unpublished data). Thereafter abundance increased more than 2 orders of magnitude and remained above previous high values for most of the period 1997-2001. Recent observed declines are from the historically very high CPH. In a historical context, current silver chub CPH is higher than the 51-year long-term average.

Silver chub was lamented as apparently extirpated from Ontario waters by Scott and Crossman (1972). Despite the comparatively recent increase in abundance, silver chub is a species of special concern in Canada (Boyko and Staton 2010). We captured silver chub in Ontario waters at trawl stations nearest the outlet of the Detroit River, hence the species remains

in Ontario waters. Little is known about the species biology; the only published record on life history is a doctoral dissertation by Kinney (1954). Spawning is thought to be in open water, but this has never been verified (Carlander 1969; Scott and Crossman 1972). We have begun a study of silver chub diets and population status in cooperation with Canadian colleagues and will examine CPH trends in the context of species invasions and other ecological changes in Lake Erie to identify and address potential hypotheses for population fluctuations in silver chub.

For the third consecutive year *Hemimysis anomala* was sampled in the diets of yellow perch and white perch. Three adult yellow perch and one adult white perch contained one or more *Hemimysis* in their diet. Based on diet data it seems *Hemimysis* are now distributed throughout western Lake Erie extending from east of Pelee Island at the far eastern end of the western basin to Maumee Bay at the far southwestern end. There is no sampling program to monitor *Hemimysis*, hence no conclusions about abundance or distribution can be drawn.

**Table 1.1**. Average catch per hectare of young-of-year (YOY) and yearling-and-older (YAO) forage fish of the most common species captured in bottom trawls during June and September 2011 in Ontario and Michigan waters of western Lake Erie. Percent relative standard error (%RSE) is 100*(standard error of the mean/mean). For round gobies, all ages are combined under YAO.

| | Spring | | Autumn | | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | YAO | %RSE | YOY | %RSE | 8-year mean | YAO | %RSE | 8-year mean |
| Gizzard shad | 4.1 | 100.0 | 20.7 | 33.4 | 34.0 | 0.0 | | 1.5 |
| Rainbow smelt | 14.5 | | 20.9 | 64.9 | 61.3 | 0.0 | | 1.4 |
| Silver chub | 3.0 | | | | 0.04 | 1.3 | 76.1 | 1.5 |
| Emerald shiner | 909.0 | 37.4 | 50.4 | 26.9 | 160.7 | 126.9 | 95.4 | 21.8 |
| Spottail shiner | 9.2 | 42.0 | 21.1 | 35.5 | 101.1 | 18.2 | 37.6 | 15.9 |
| Mimic shiner | | | | | 1.4 | | | |
| Trout-perch | 78.1 | 40.2 | 103.9 | 31.3 | 155.7 | 18.6 | 35.8 | 21.3 |
| White perch | 61.4 | 48.3 | 477.0 | 24.0 | 707.1 | 58.3 | | 52.4 |
| White bass | 19.7 | 46.1 | 3.2 | 37.0 | 6.9 | 0.4 | 73.6 | 2.2 |
| Smallmouth bass | 0.4 | 55.3 | 1.1 | 53.0 | 1.1 | 0.0 | | 0.8 |
| Logperch | 0.1 | 100.6 | 2.4 | 35.6 | 2.4 | 0.0 | | 1.5 |
| Yellow perch | 128.1 | 21.8 | 14.8 | 22.6 | 96.5 | 33.7 | 31.4 | 41.2 |
| Walleye | 4.6 | 42.5 | 2.4 | 36.9 | 2.4 | 1.5 | 49.0 | 2.0 |
| Freshwater drum | 2.4 | 56.3 | 23.5 | 59.6 | 7.7 | 1.1 | 42.4 | 1.1 |
| Round goby | 112.7 | 68.7 | | | | 22.9 | 35.4 | 153.9 |

**Table 1.2**. Average weight per hectare (kilograms per hectare) of young-of-year (YOY) and yearling-and-older (YAO) forage fish of the most common species captured in bottom trawls during June and September 2011 in Ontario and Michigan waters of western Lake Erie. Percent relative standard error (%RSE) is 100*(standard error of the mean/mean). All ages of round gobies are combined under YAO.

| | Spring | | Autumn | | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | YAO | %RSE | YOY | %RSE | 8-year mean | YAO | %RSE | 8-year mean |
| Gizzard shad | | | 0.308 | 33.4 | 0.393 | | | 0.046 |
| Rainbow smelt | 0.133 | 55.2 | 0.011 | 64.9 | 0.044 | | | 0.010 |
| Silver chub | 0.044 | 94.9 | | | | 0.046 | 76.1 | 0.055 |
| Emerald shiner | 4.072 | 37.4 | 0.088 | 26.9 | 0.134 | 0.632 | 95.4 | 0.099 |
| Spottail shiner | 0.071 | 42.0 | 0.045 | 35.5 | 0.185 | 0.172 | 41.4 | 0.164 |
| Mimic shiner | | | | | | | | |
| Trout-perch | 0.486 | 40.2 | 0.255 | 31.3 | 0.435 | 0.155 | 35.8 | 0.164 |
| White perch | | | 3.272 | 24.0 | 3.361 | | | 0.075 |
| White bass | | | 0.045 | 37.0 | 0.098 | | | 0.032 |
| Smallmouth bass | | | 0.011 | 53.0 | 0.011 | | | 0.014 |
| Logperch | 0.000 | 99.0 | 0.007 | 35.7 | 0.006 | | | 0.006 |
| Yellow perch | | | 0.090 | 22.6 | 0.426 | 0.789 | 31.4 | 0.234 |
| Walleye | | | 0.129 | 36.9 | 0.136 | | | |
| Freshwater drum | | | 0.461 | 59.6 | 0.104 | | | |
| Round goby | 0.587 | 68.7 | | | | 0.158 | 35.4 | 0.830 |

**Table 1.3**. Mean total length (TL, mm), standard error (SE), and sample size (N) for young-of-year (YOY) and yearling-and-older (YAO) forage fish of the most common species captured during June and September 2011 in Ontario and Michigan waters of the western basin of Lake Erie. For round goby, all ages were combined under YAO.

| | Spring YAO | | | Autumn YOY | | | Autumn YAO | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | TL | SE | N | TL | SE | N | TL | SE | N |
| Gizzard shad | | | | 102.0 | 2.55 | 218 | | | |
| Rainbow smelt | 109.7 | 2.32 | 118 | 45.7 | 0.96 | 103 | 116.5 | 1.92 | 19 |
| Silver chub | 110.1 | 4.88 | 21 | | | | 153.9 | 5.90 | 10 |
| Emerald shiner | 83.9 | 0.67 | 317 | 55.8 | 1.41 | 151 | 89.3 | 0.85 | 81 |
| Spottail shiner | 88.3 | 2.80 | 72 | 56.5 | 1.19 | 296 | 105.7 | 1.06 | 112 |
| Mimic shiner | | | | | | | | | |
| Trout-perch | 88.7 | 0.53 | 338 | 64.7 | 0.40 | 268 | 96.2 | 1.52 | 40 |
| White perch | | | | 80.2 | 0.39 | 730 | | | |
| White bass | | | | 104.4 | 1.59 | 134 | | | |
| Smallmouth bass | | | | 86.9 | 4.57 | 16 | | | |
| Logperch | 70 | | 1 | 56.3 | 2.82 | 16 | 74.0 | | 22 |
| Yellow perch | | | | 83.6 | 0.62 | 264 | | | |
| Walleye | | | | 183.0 | 3.09 | 62 | | | |
| Freshwater drum | | | | 114.3 | 3.22 | 104 | | | |
| Round Goby | 64.9 | 1.17 | 292 | | | | 70.5 | | 304 |

**Table 1.4**. Percent occurrence of prey items found in the diets of age-2-and-older yellow perch and white perch collected during spring and autumn 2011 in Ontario and Michigan waters of Lake Erie's western basin. Abbreviation: n=number of stomachs containing prey.

| | | Yellow Perch | | White Perch | |
|---|---|---|---|---|---|
| Prey Type | Prey Item | 2011 Spring (n=104) | 2011 Autumn (n=82) | 2011 Spring (n=65) | 2011 Autumn (n=77) |
| **Zooplankton** | | **25.0** | **26.8** | **84.6** | **62.3** |
| | *Bosmina* sp. | 1.9 | 4.9 | 7.8 | 29.9 |
| | *Bythotrephes* sp. | 1.0 | 18.3 | 3.1 | 27.3 |
| | Calanoida sp. | 3.8 | 1.2 | 23.4 | 1.3 |
| | Cyclopoida sp. | 8.7 | 4.9 | 20.3 | 31.2 |
| | *Daphnia retrocurva* | 8.7 | 1.2 | 46.9 | 9.1 |
| | *Daphnia* sp. | 1.9 | 0.0 | 7.8 | 2.6 |
| | *Leptodora kindtii* | 16.3 | 4.9 | 68.8 | 10.4 |
| | Sididae | 2.9 | 0.0 | 15.6 | 1.3 |
| **Benthic Macroinvertebrates** | | **94.2** | **90.2** | **70.8** | **88.3** |
| | Amphipoda | 13.5 | 3.7 | 10.9 | 6.5 |
| | Cestoidea | 0.0 | 0.0 | 1.6 | 0.0 |
| | Chironomidae | 48.1 | 45.1 | 56.3 | 66.2 |
| | Coleoptera | 3.8 | 0.0 | 4.7 | 1.3 |
| | Culicidae | 0.0 | 0.0 | 1.6 | 0.0 |
| | *Dreissena* sp. | 42.3 | 23.2 | 15.6 | 7.8 |
| | Gastropoda | 10.6 | 11.0 | 0.0 | 2.6 |
| | *Hemimysis anomala* | 1.9 | 1.2 | 0.0 | 1.3 |
| | *Hexagenia* sp. | 26.0 | 19.5 | 3.1 | 16.9 |
| | Hirudinea | 4.8 | 4.9 | 3.1 | 13.0 |
| | Hydracarina | 1.9 | 2.4 | 4.7 | 0.0 |
| | Nematoda | 0.0 | 6.1 | 1.6 | 28.6 |
| | Oligochaeta | 1.0 | 4.9 | 4.7 | 13.0 |
| | Ostracoda | 18.3 | 4.9 | 6.3 | 9.1 |
| | Plecoptera | 0.0 | 0.0 | 1.6 | 0.0 |
| | Sphaeriidae | 13.5 | 17.1 | 3.1 | 24.7 |
| | *Trichoptera* sp. | 12.5 | 3.7 | 9.4 | 9.1 |
| | Unidentified insect | 0.0 | 0.0 | 3.1 | 0.0 |
| **Fishes** | | **16.3** | **15.9** | **9.2** | **14.3** |
| | Emerald shiner | 1.9 | 1.2 | 1.6 | 1.3 |
| | Round goby | 10.6 | 8.5 | 3.1 | 5.2 |
| | Spottail shiner | 1.0 | 1.2 | 1.6 | 0.0 |
| | White perch | 0.0 | 1.2 | 0.0 | 0.0 |
| | Yellow perch | 1.0 | 0.0 | 0.0 | 0.0 |
| | Unidentified fish | 1.9 | 7.3 | 1.6 | 7.8 |

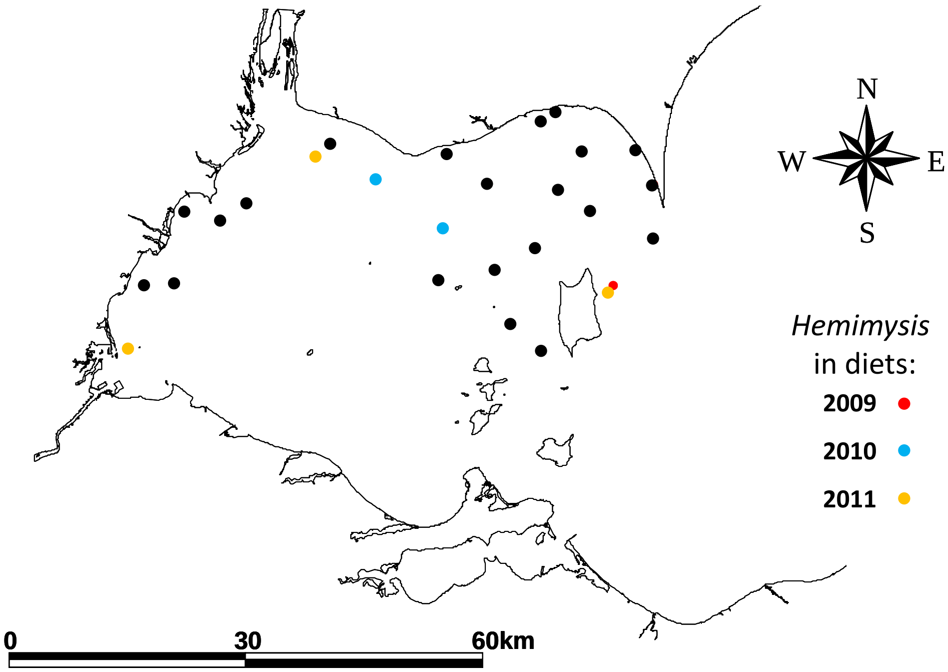


**Figure 1.1**. Locations of sites sampled with a bottom trawl in June and September in the western basin of Lake Erie, 2011, and sites where *Hemimysis anomala* was found in diets of white perch or yellow perch.

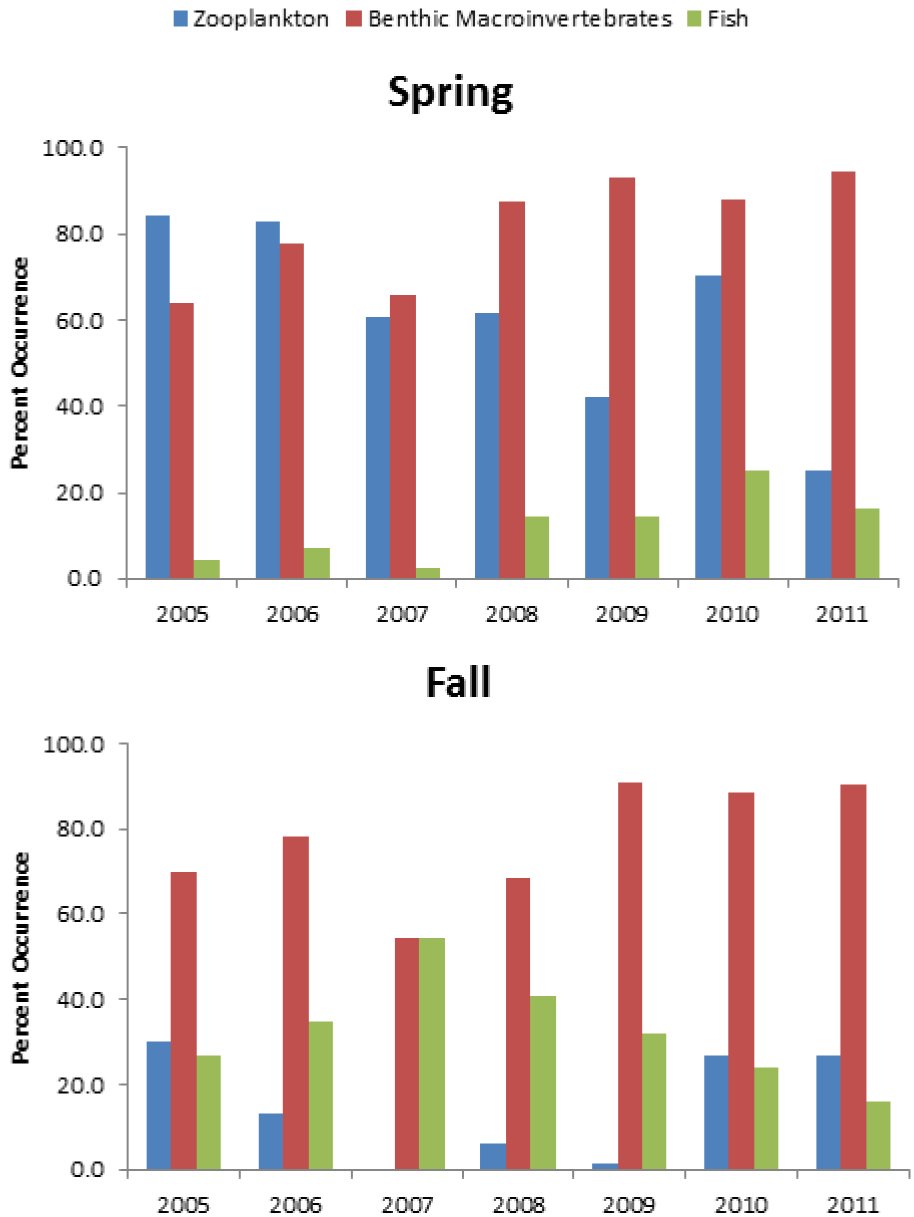


**Figure 1.2**. Percent frequency of occurrence of zooplankton, benthic invertebrates, and fish in the diet of age-2 and older yellow perch collected in spring (A) and autumn (B) in Ontario and Michigan waters of western Lake Erie.

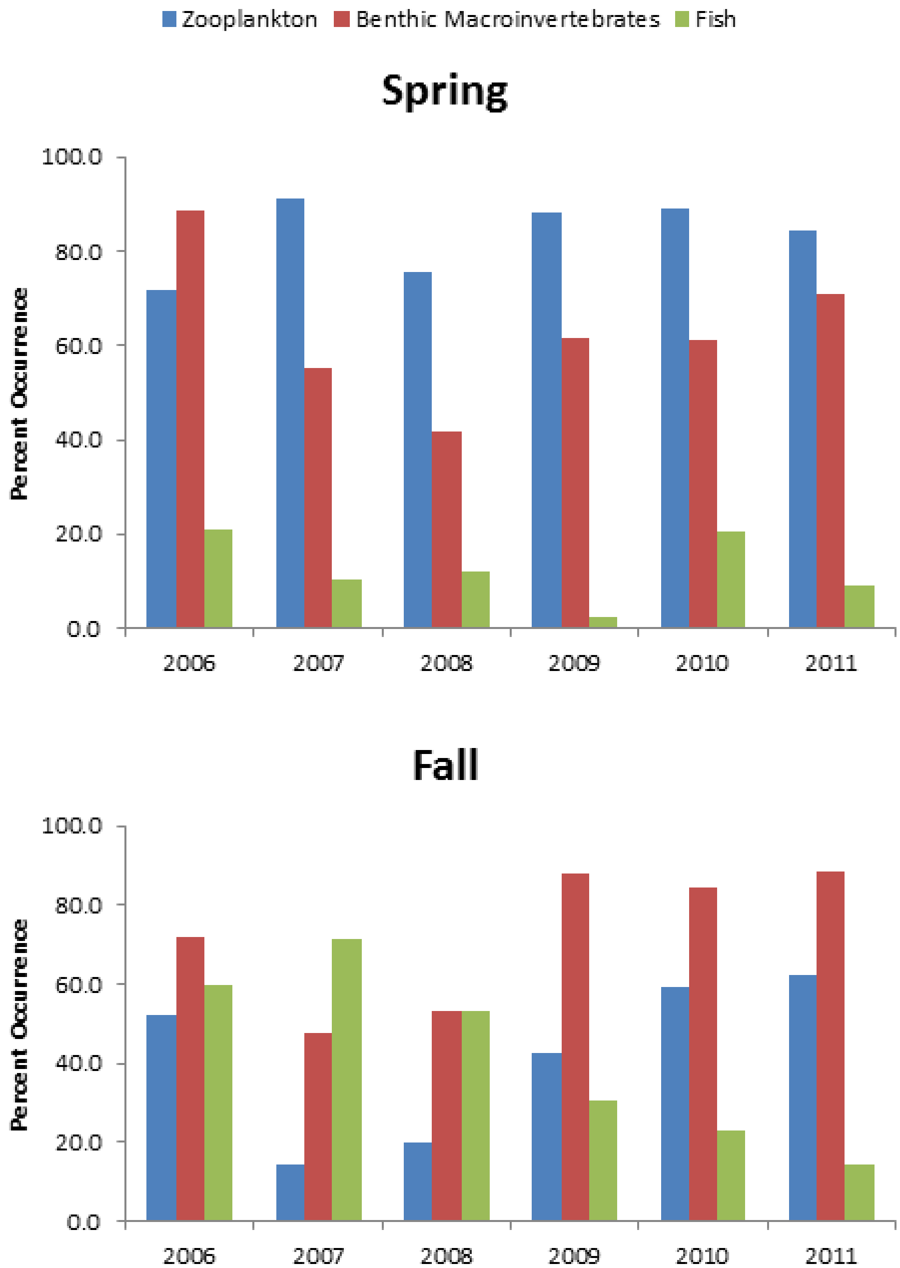


**Figure 1.3**. Percent frequency of occurrence of zooplankton, benthic invertebrates, and fish in the diet of age-2 and older white perch collected in spring (A) and autumn (B) in Ontario and Michigan waters of western Lake Erie.

## 2.0 East Harbor Forage Fish Assessment

### Abstract

The Lake Erie Biological Station has conducted bottom trawl assessments of fish populations in western Lake Erie near East Harbor State Park, Ohio, each summer and autumn from 1961 to 2008 and in autumn only beginning in 2009. The objective is to estimate relative abundance and provide indices of recruitment of common YOY fish species. We sampled at 3.1, 4.5, and 6.1-m depths with bottom trawls to index forage fish year class strength. Catch-per-hectare (CPH) of most young-of-year YOY forage fishes in 2011 was greater than their 15-year means. Gizzard shad *Dorosoma cepedianum,* emerald shiner *Notropis atherinoides,* and freshwater drum *Aplodinotus grunniens* increased to the third highest CPH in the 15-year time series. Catches of silver chub *Macrhybopsis storeriana* increased to the second highest CPH since 1997. Walleye *Sander vitreus,* white perch *Morone americana,* and white bass *M. chrysops* CPH declined in 2011, yet remained above their 15-year means. Mean total lengths of five species of YOY fishes captured in 2011 were below their respective 20-year means.

### Introduction

The U.S. Geological Survey, Lake Erie Biological Station (LEBS) has conducted annual bottom trawl surveys during summer and autumn near East Harbor State Park, Ohio from 1961 to 2008 and during autumn only beginning in 2009. The objectives of these surveys have been to estimate relative abundance and growth of young-of-year (YOY) of common fish species. Abundance indices and growth data from these surveys provide an index of recruitment for these important species.

This report includes results from the autumn 2011 LEBS trawl survey. For selected fish species, we evaluated recruitment trends by comparing the 2011 autumn abundance values of YOY individuals with long-term (15-year) LEBS average. We then compared catch per hectare (CPH) and total lengths of YOY with results from previous years.

### Methods

*Trawling*

Trawl surveys were conducted during autumn (11 and 12 October 2011) in western Lake Erie near East Harbor State Park, Ohio (Figure 2.1). On consecutive days (weather permitting) duplicate trawls were conducted at the 3-, 4.5-, and 6-m depth contours during morning (one half hour after sunrise to 1200) and night (one half hour after sunset until completed, always before 0100 the following day) with a 7.9-m (headrope) bottom trawl. Prior to 2008, data from afternoon (1200 through one half hour before sunset) sampling were also included. The trawl was towed for 10 minutes on bottom at an average speed of 3.5 km/h (range 2.2-4.1 km/h). Area swept (ha) was calculated as width of the trawl opening (3.9 m, measured using SCANMAR acoustic net mensuration gear) multiplied by the distance towed. This value differs from the value we use for trawling throughout the western basin (5 m), which was measured using different mensuration gear. The research vessel used to tow the trawl and the design of the trawl and doors have been constant throughout the entire time series, hence there is no reason to

believe that the true dimensions of the trawl when towed have changed. Thus, we have retained the smaller value of 3.9 m to maintain continuity of the historical time series. The distance towed was estimated as the difference in starting and ending coordinates, determined using differential GPS. Total sampling effort was 4 h (24 tows). Fish caught in the trawls were identified to species and counted.

The forage species gizzard shad *Dorosoma cepedianum*, emerald shiner *Notropis atherinoides*, spottail shiner *N. hudsonius*, trout-perch *Percopsis omiscomaycus*, logperch *Percina caprodes*, and silver chub *Macrhybopsis storeriana* were categorized as either YOY or yearling-and-older (YAO). The spiny-rayed species yellow perch *Perca flavescens*, white perch *Morone americana*, white bass *M. chrysops*, walleye *Sander vitreus*, and freshwater drum *Aplodinotus grunniens*) were categorized as YOY, yearling, or age-2 and older. All ages were combined for round goby *Neogobius melanostomus*.

*Young-of-year CPH and growth*

For each species, we calculated an index of abundance for 2011 based on catches of YOY fish caught in the trawls during autumn. This index was calculated as the arithmetic mean number of YOY fish caught per hectare swept by the bottom trawl. Percent relative standard error (RSE) of the index was calculated by dividing the standard error by the mean number caught per hectare and then multiplying this ratio by 100. For each species, relative potential recruitment was then evaluated by comparing the YOY fish abundance index for autumn 2011 with its respective long-term mean (15 years). Similarly, changes in growth rate were evaluated for each species by comparing mean total lengths of YOY individuals captured in autumn 2011 with its respective long-term autumn mean (20 years) using t-tests.

**Results and Discussion**

Autumn CPH in 2011 for seven of the 12 YOY target species were above their respective 15-year means (Table 2.1). Despite declining in 2010 to the lowest level in its 15-year time series, CPH of gizzard shad in 2011 increased to the third highest value since 1996 (517 individuals/ha; Figure 2.2). This was the first year the mean CPH of gizzard shad was above its 15-year mean since 1999. Emerald shiner mean CPH in 2011 increased for a second straight year (2268 individuals/ha; Figure 2.3) after a decrease in 2009, which continues an increasing trend since 2004. Mean CPH of freshwater drum was above its long-term mean for only the second year since 2002 (Figure 2.6). Young-of-year silver chub have only been captured in five years since 1999 (Figure 2.5). In 2011, mean CPH of silver chub increased to nearly three times the CPH in 2010 to the second highest CPH since 1996. This was the first time in its 15-year time series that silver chub CPH increased for a second consecutive year.

Although mean CPH decreased for four of five spiny-rayed species in 2011, white perch, white bass, and walleye CPH remained higher than their 15-year means (Table 2.1). Young-of-year white perch CPH decreased from 1492 individuals/ha in 2010 to 1170 in 2011 yet remained above its 15-year mean for the fifth consecutive year (Figure 2.6). Catch-per-hectare of white bass in 2011 declined for only the second time since 2004 (Figure 2.7). Catch-per-hectare of YOY yellow perch has been below its 15-year mean ten of the past twelve years (Figure 2.8). Since 2003, mean CPH of white perch, yellow perch and walleye declined in 2004, 2006, 2009, and 2011 (Figure 2.6 and Figure 2.8 respectively).

Mean total lengths of emerald shiner, white bass, walleye, and freshwater drum were greater than their respective 20-year means (Table 2.2). Mean CPH for those species were also higher. Mean total lengths of gizzard shad, spottail shiner, white perch and yellow perch were lower than the 20-year mean. Logperch mean length was below the long-term average, although the difference was not statistically significant because of small sample size (N=4; Table 2.2).

**Table 2.1**. Autumn Catch-per-hectare (CPH) of young-of-year fish from bottom trawling near East Harbor State Park, Ohio, in 2011 and the mean autumn CPH for 1996-2010. Relative standard error (expressed as a percent) is calculated as standard error of the mean CPH for a species divided by mean CPH and multiplied by 100.

| | Catch-per-hectare | | Relative standard error | |
|---|---|---|---|---|
| Species | 2011 | 1996-2010 mean | 2011 | 1996-2010 mean |
| Gizzard shad | 517 | 113 | 66 | 34 |
| Emerald shiner | 2268 | 1108 | 41 | 38 |
| Spottail shiner | 18 | 66 | 31 | 37 |
| Trout-perch | 52 | 72 | 28 | 28 |
| White perch | 1171 | 1020 | 21 | 22 |
| White bass | 8 | 7 | 34 | 48 |
| Yellow perch | 76 | 109 | 84 | 26 |
| Walleye | 15 | 12 | 25 | 33 |
| Freshwater drum | 104 | 38 | 28 | 41 |
| Silver chub | 4 | 0.52 | 63 | 67 |
| Channel catfish | 2 | 0.21 | 34 | 57 |
| Round goby | 81 | 122 | 31 | 31 |

**Table 2.2**. Mean total lengths (mm) of YOY fishes collected from bottom trawl catches near East Harbor State Park, Ohio, during autumn 2011 and mean for 1991-2010. Sample sizes are in parentheses and SE=standard error. Positive t-values indicate that mean total length in 2011 was greater than the 20-year mean; negative values indicate the reverse. Significant differences occurred when $P \leq 0.05$.

| | 2011 | | 1991-2010 | | 2011 vs. 1991-2010 | |
|---|---|---|---|---|---|---|
| Species | Mean (N) | SE | Mean | SE | t-value | P |
| Gizzard shad | 75 (233) | 1.1 | 98 | 2.9 | -1.72 | 0.0859 |
| Emerald shiner | 62 (125) | 1.1 | 58 | 1.6 | -9.55 | <0.0001 |
| Spottail shiner | 69 (76) | 2.4 | 77 | 1.6 | -4.77 | <0.0001 |
| Trout-perch | 75 (124) | 0.8 | 75 | 1.0 | -1.96 | 0.0506 |
| White perch | 70 (109) | 1.2 | 75 | 1.3 | -3.64 | 0.0003 |
| White bass | 132 (41) | 3.2 | 117 | 6.5 | 1.32 | 0.1860 |
| Yellow perch | 82 (69) | 1.5 | 84 | 1.3 | -3.82 | 0.0001 |
| Walleye | 195 (85) | 2.7 | 185 | 3.9 | 5.30 | <0.0001 |
| Freshwater drum | 124 (134) | 2.4 | 101 | 5.4 | 12.25 | <0.0001 |
| Logperch | 66 (4) | 2.9 | 68 | 2.4 | 0.82 | 0.4131 |

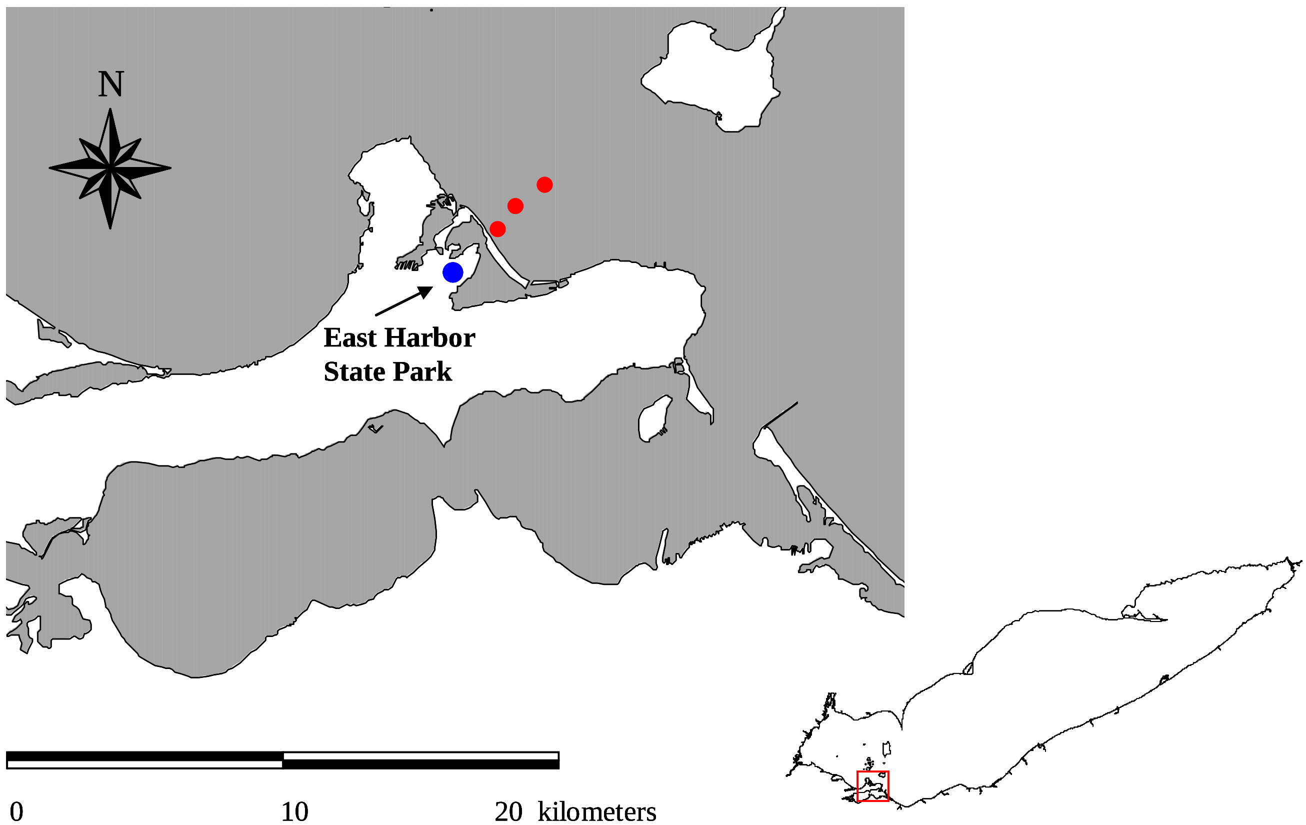


**Figure 2.1**. Location of sites sampled by the USGS Lake Erie Biological Station (red filled circles) offshore of East Harbor State Park (blue filled circle) in the western basin of Lake Erie.

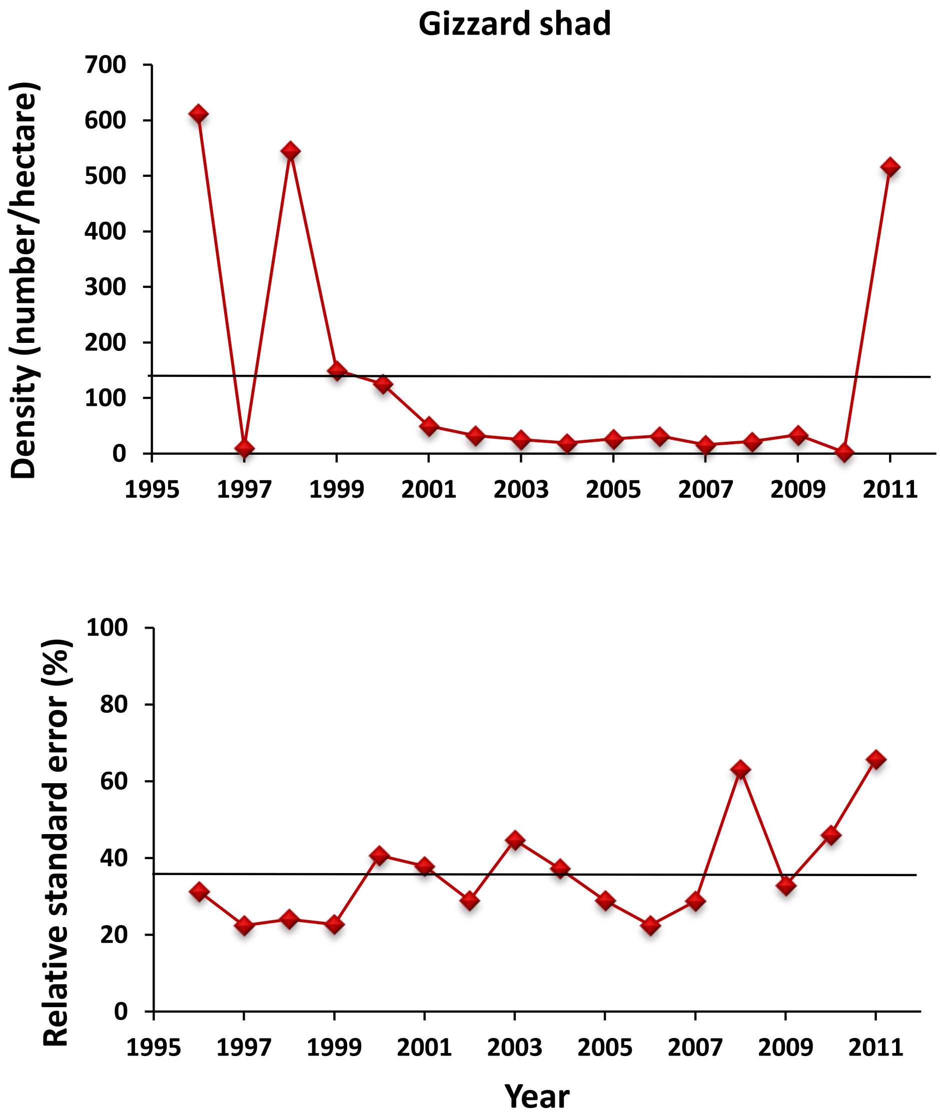


**Figure 2.2**. Catch per hectare (top) and relative standard error (bottom) for YOY gizzard shad in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

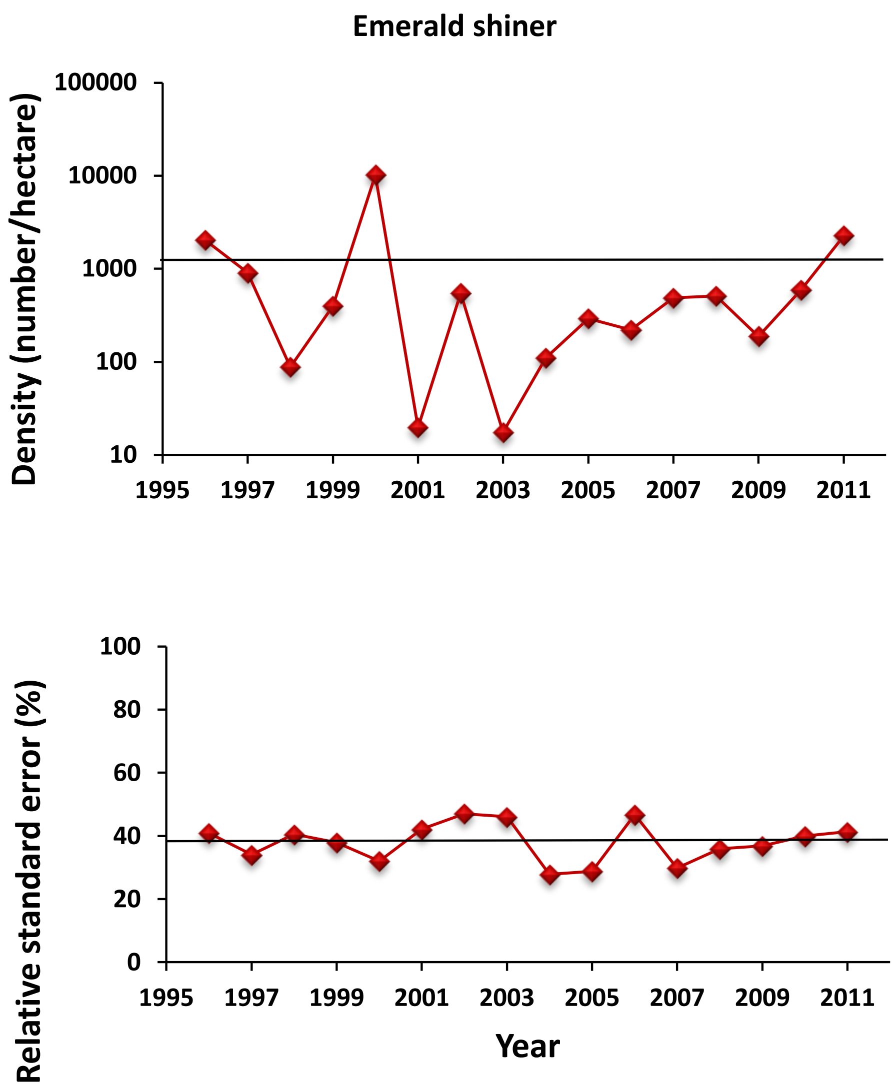


**Figure 2.3**. Catch per hectare (top) and relative standard error (bottom) for YOY emerald shiner in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

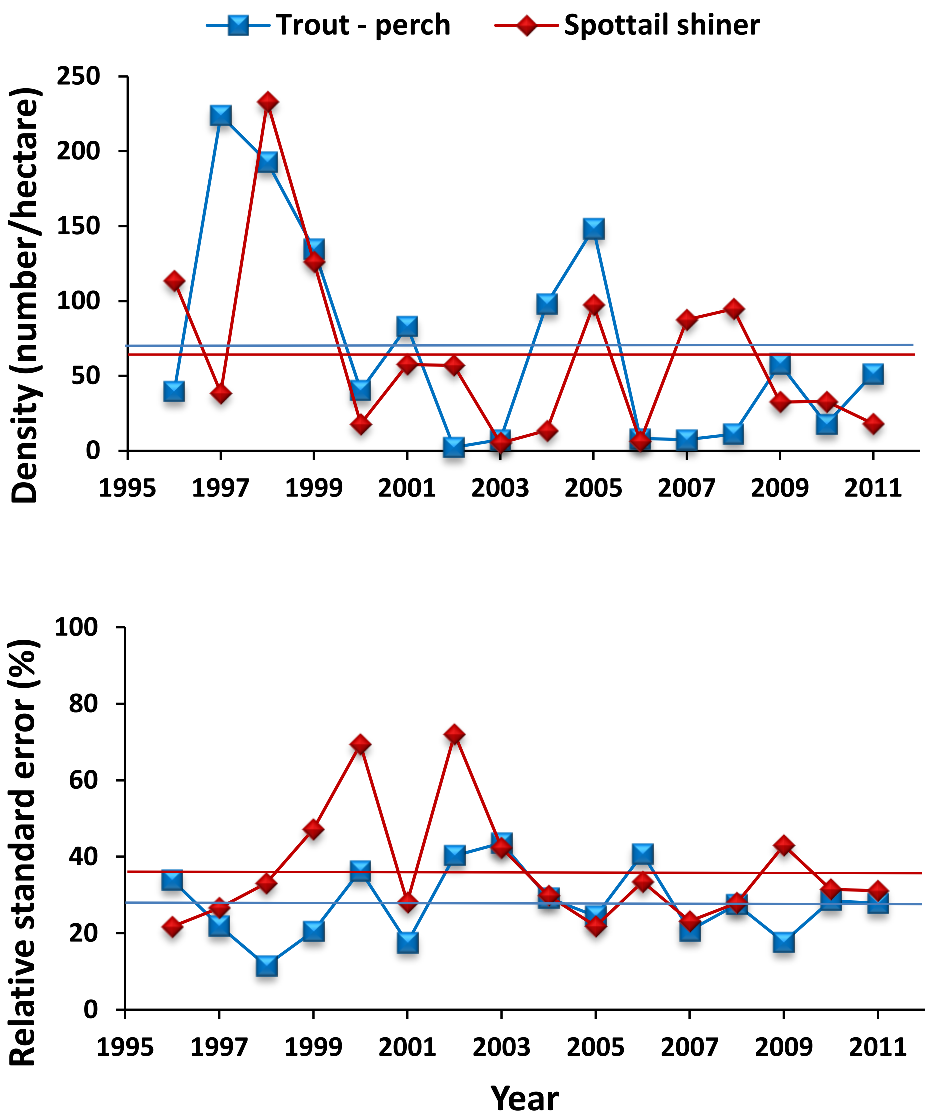


**Figure 2.4**. Catch per hectare (top) and relative standard error (bottom) for YOY trout-perch and spottail shiner in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

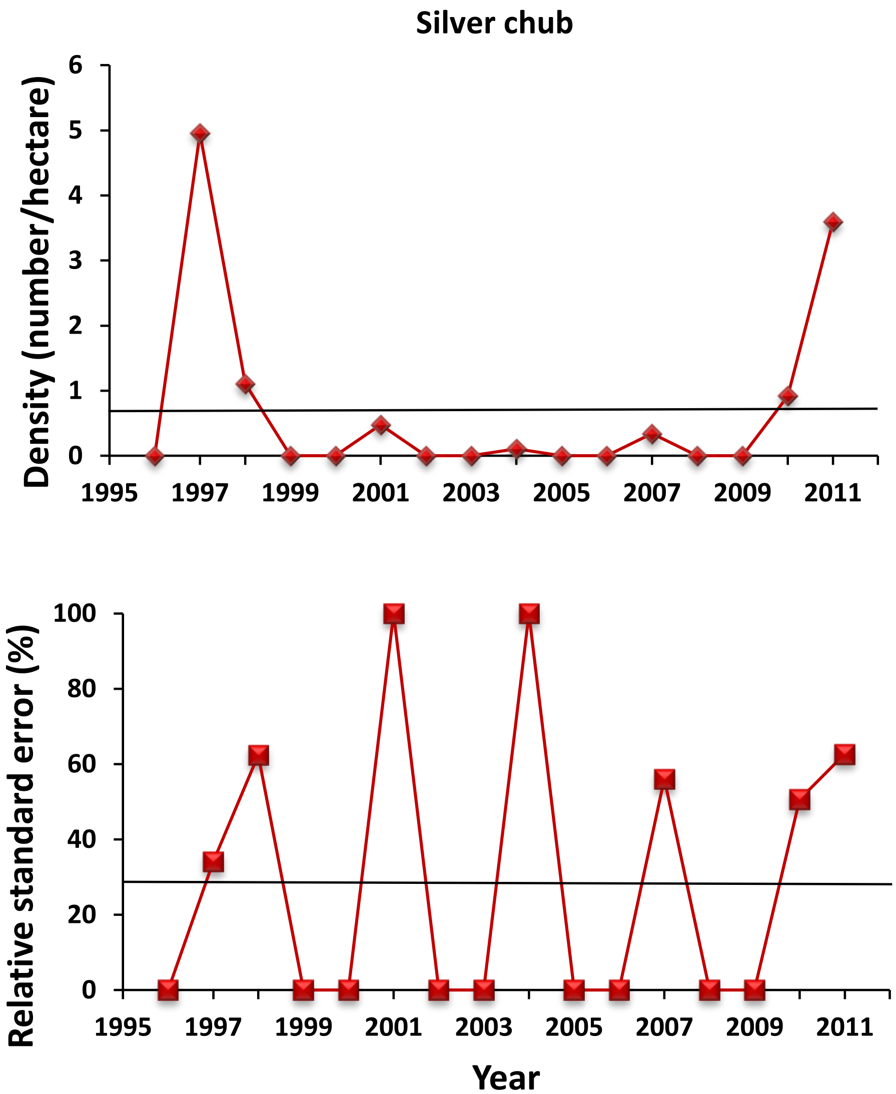


**Figure 2.5**. Catch per hectare (top) and relative standard error (bottom) for YOY silver chub in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

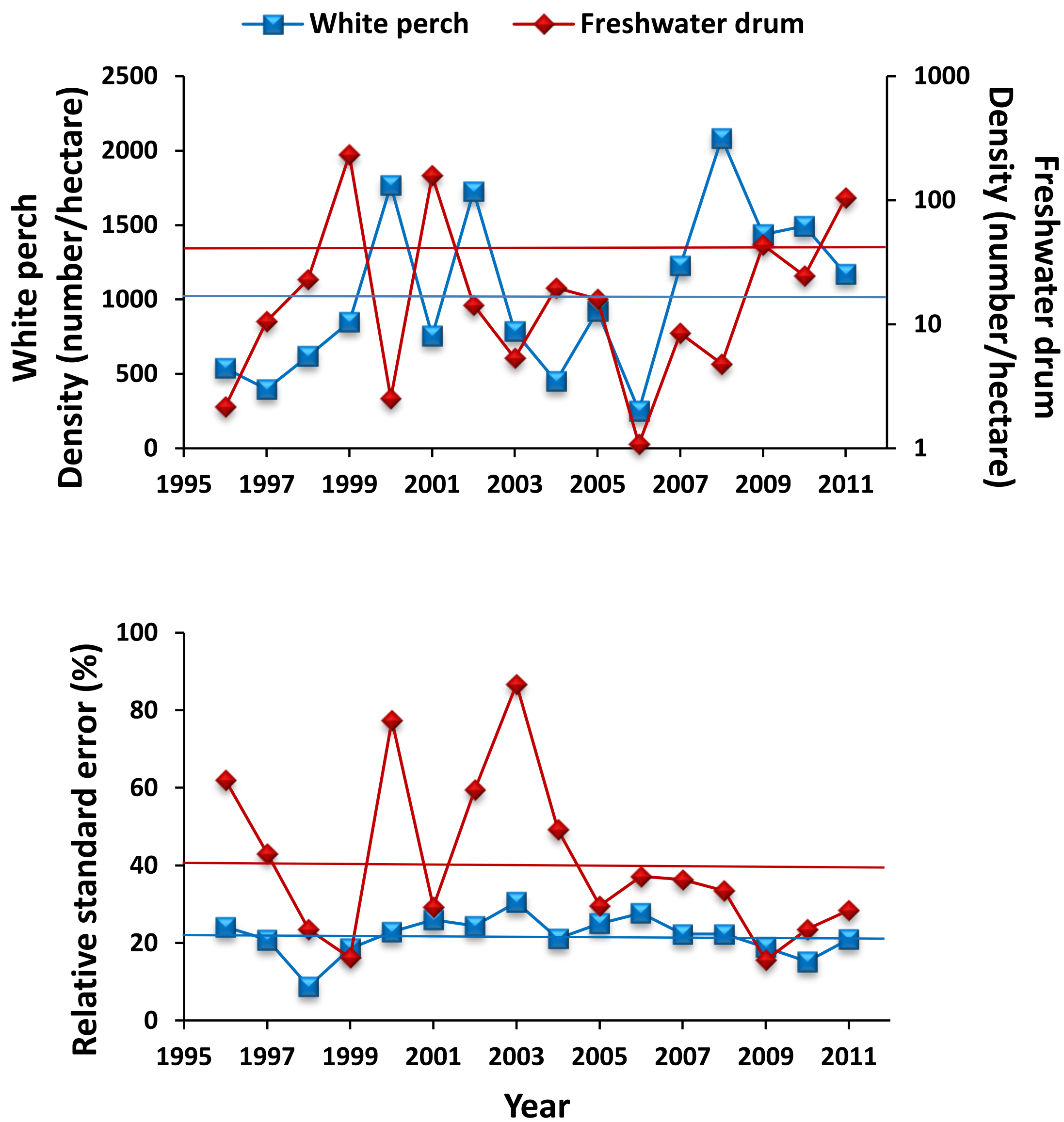


**Figure 2.6**. Catch per hectare (top) and relative standard error (bottom) for YOY white perch and freshwater drum in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

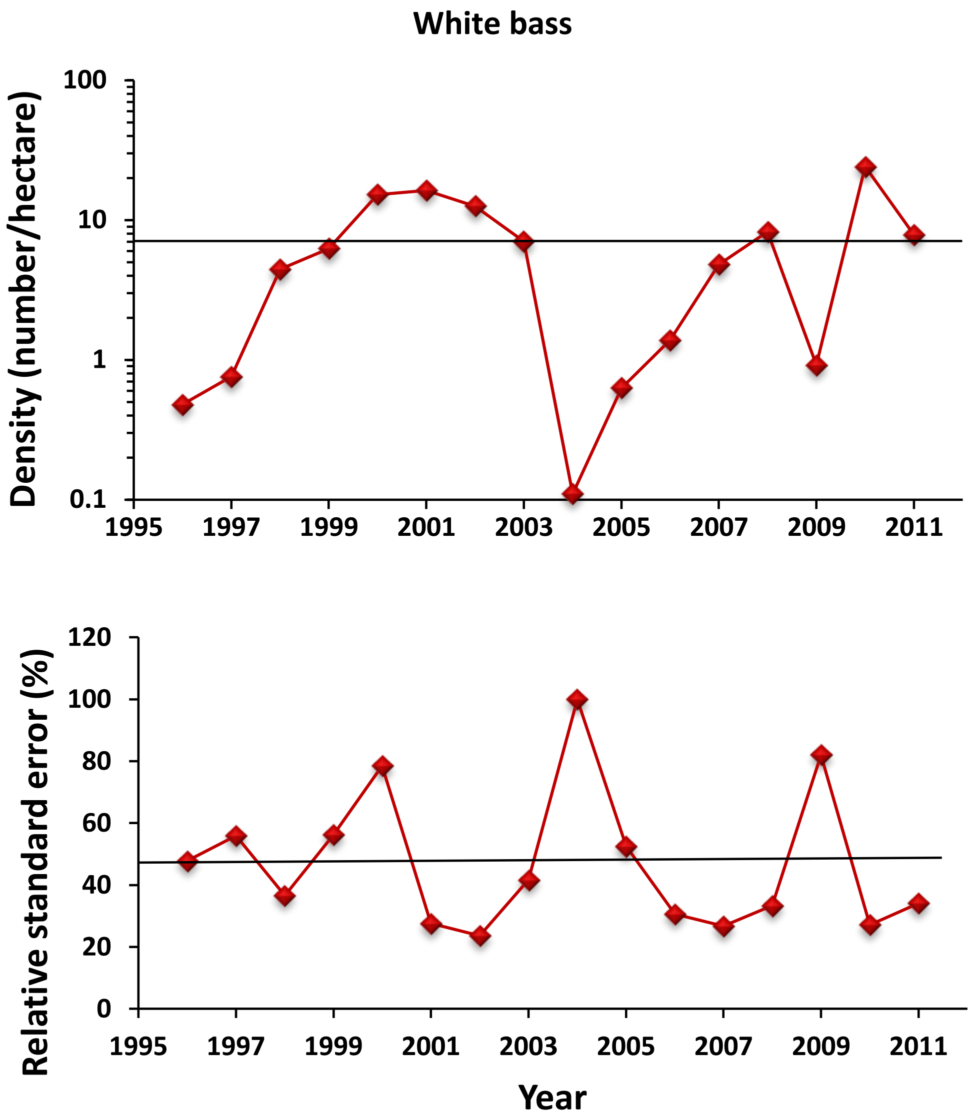


**Figure 2.7**. Catch per hectare (top) and relative standard error (bottom) for YOY white bass in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

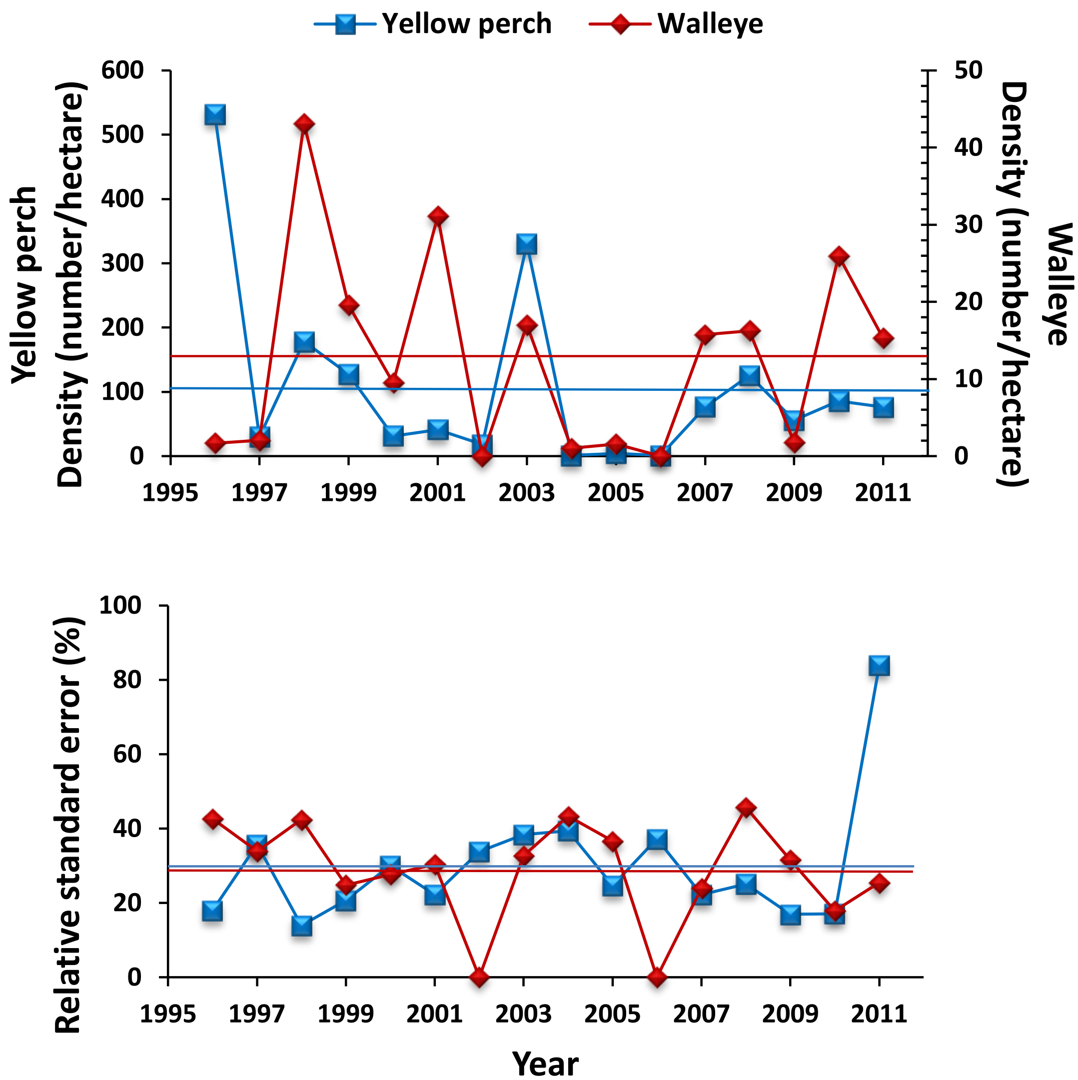


**Figure 2.8**. Catch per hectare (top) and relative standard error (bottom) for YOY yellow perch and walleye in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

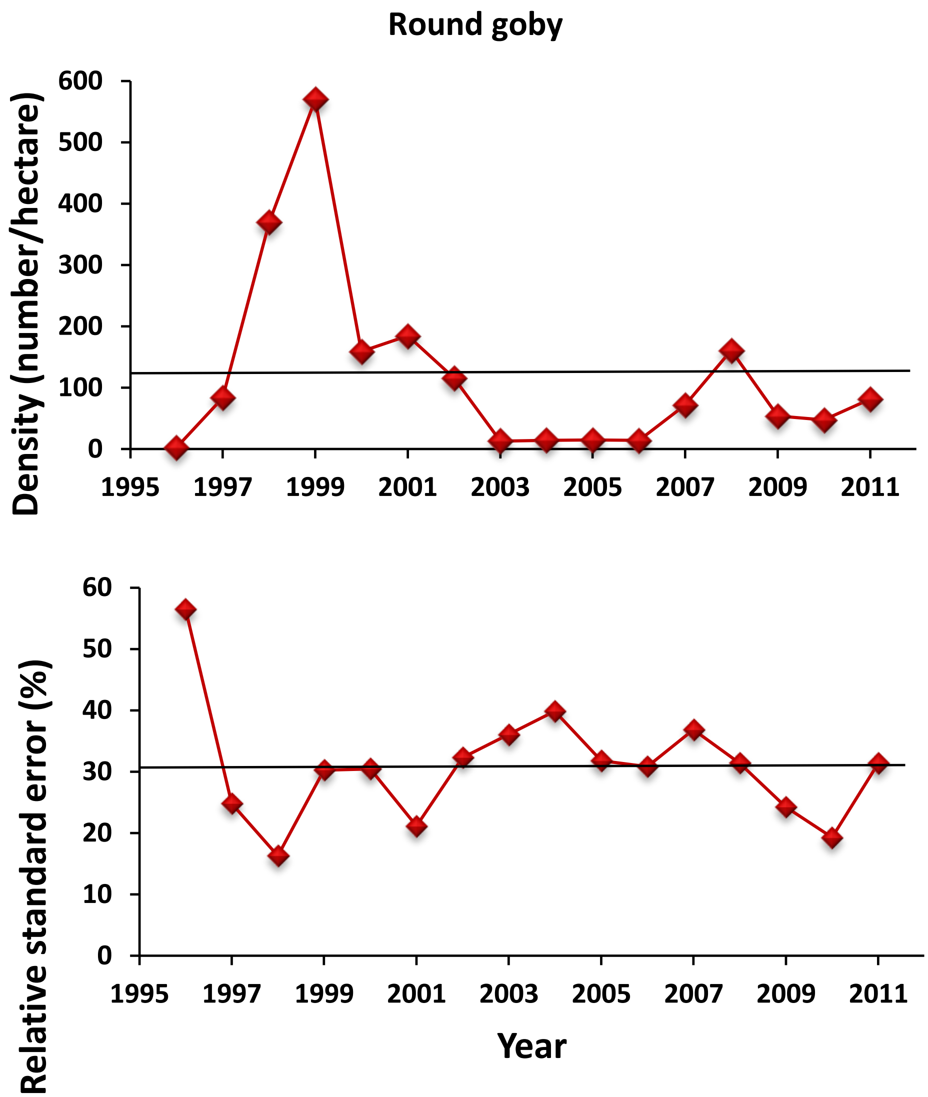


**Figure 2.9**. Catch per hectare (top) and relative standard error (bottom) for YOY and older round goby in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2011. Means are represented by horizontal bars.

## 3.0 Commercial Fishery Sampling

### Abstract

We collected samples from landings of Catostomidae, harvested under the colloquial category "mullet," from commercial trap nets in western Lake Erie in autumn 2011. Harvests of all species we typically sample in spring and autumn, which includes yellow perch *Perca flavescens*, white perch *Morone americana*, white bass *Morone chrysops*, and lake whitefish *Coregonus clupeaformis*, were not sampled in 2011. Mullet samples from the commercial fishery comprised six species, with white sucker *Catostomus commersonii* and shorthead redhorse *Moxostoma macrolepidotum* accounting for 94% by number. Mean ages, mean total lengths, and mean lengths at age were similar for these species. Mean length at age was also very similar for both species. Rare species in the harvest included black redhorse *Moxostoma duquesnii* and spotted sucker *Minytrema melanops*, both of which are on the northern periphery of their ranges and prefer riverine habitats. Other catostomids landed as mullet in the commercial fishery were *Moxostoma erythrurum* and *Moxostoma anisurum*.

### Introduction

The U.S. Geological Survey Lake Erie Biological Station (LEBS) has sampled fishes from commercial trap nets in the western basin of Lake Erie since the 1960s. The objective of this program is to describe the age and length structure of the commercial harvest. We typically summarize age structure and mean total length-at-age for white perch *Morone americana*, white bass *M. chrysops*, and yellow perch *Perca flavescens* collected from commercial trap nets in western Lake Erie during spring and autumn, but in 2011 we were unable to obtain samples. In 2010 we began investigating the species composition and age and length distributions of fish categorized as "mullet" by commercial fishermen. We know of no existing monitoring program for this colloquial category of fish. Our 2010 results, which were limited to a single 45-kg (100-lb) sample, revealed that the category mullet comprised at least the genera *Catostomus, Moxostoma, and Minytrema* within the family Catostomidae (Kocovsky et al. 2011b). *Minytrema* sp. in the harvest was somewhat surprising given its presumed rarity in Lake Erie (Kocovsky et al. 2011b). Because only genera within the family Catostomidae were harvested as mullet we refer to mullet hereafter as Catostomidae or catostomids.

### Methods

Catostomids were provided from landed harvest from commercial trap nets set in Ohio waters of western Lake Erie in October 2011. Total length (nearest mm) and weight (nearest g) of all specimens were measured. Ages were estimated from thin sections of pectoral fin rays. The entire left pectoral fin was removed from each fish sampled and allowed to dry for several days. The first several fin rays were then mounted in an epoxy resin for sectioning. A low-speed saw with two parallel blades was used to cut a thin section from the base of the first ray, which was then polished and examined under a compound microscope to estimate age. One technician examined all cross sections and interpreted annuli following Beamish and Harvey (1969).

## Results and Discussion

We sampled approximately 180 kg (400 lbs.) of commercially harvested catostomids in October 2011. Six species were represented in the harvest. White sucker *Catostomus commersonii* (67%) and shorthead redhorse *Moxostoma macrolepidotum* (27%) were 94% of the harvest. Three golden redhorse *Moxostoma erythrurum*, two black redhorse *Moxostoma duquesnii*, two spotted sucker *Minytrema melanops*, and one silver redhorse *Moxostoma anisurum* were the remaining 6 percent. Hence, the colloquial category "mullet" seems restricted to the catostomid genera *Catostomus*, *Moxostoma*, and *Minytrema*.

Age distributions differed slightly for shorthead redhorse and white sucker (Figure 3.1). For white sucker, ages ranged from two to 13 years. The distribution was bimodal with modes at age 5 and age 9. Maximum age was 13 years. Mean age of harvested white sucker was 6 years. For shorthead redhorse, ages ranged from three to 13 years. The distribution was weakly bimodal with modes at 4-5 and 7 years and a maximum age of 13 years. Mean age of shorthead redhorse was 5.9 years. Sylvester and Berry (2006) reported that age estimates of white sucker from cross sections of pectoral spines were biased low compared to age estimates from otoliths for fish whose estimated age using otoliths was greater than 7 years. They were unable to validate age estimates. It is possible that our age estimates are biased low for older fish. Because a large proportion of our fish were estimated to be older than age 7, true age distributions may be even more right skewed if older fish ages are underestimated with the fin ray method.

Length distributions were bimodal for both white sucker and shorthead redhorse (Figure 3.2). White sucker had modes at 400-424 and 450-474 mm total length. Shorthead redhorse had modes at 350-374 and 425-449 mm. Maximum length of harvested fish was between 550 and 574 mm for both species. Mean lengths of shorthead redhorse (425 mm) and white sucker (431 mm) differed by only 6 mm. Mean length at age was similar for both species (Figure 3.3).

Species other than white sucker and shorthead redhorse are primarily riverine species characterized as uncommon in lakes and impoundments (Page and Burr 1991). Of these black redhorse (Jenkins 1980) and spotted sucker (Gilbert and Burgess 1979) are probably the least likely to inhabit lakes. Spotted sucker reportedly prefers clearer water and firmer substrates than golden redhorse, black redhorse, and silver redhorse. The rarity of spotted sucker and black redhorse are also due in part to Lake Erie being on the northern periphery of their ranges, which also accounts in part for black redhorse being a species at risk in Canada (Reid 2006).

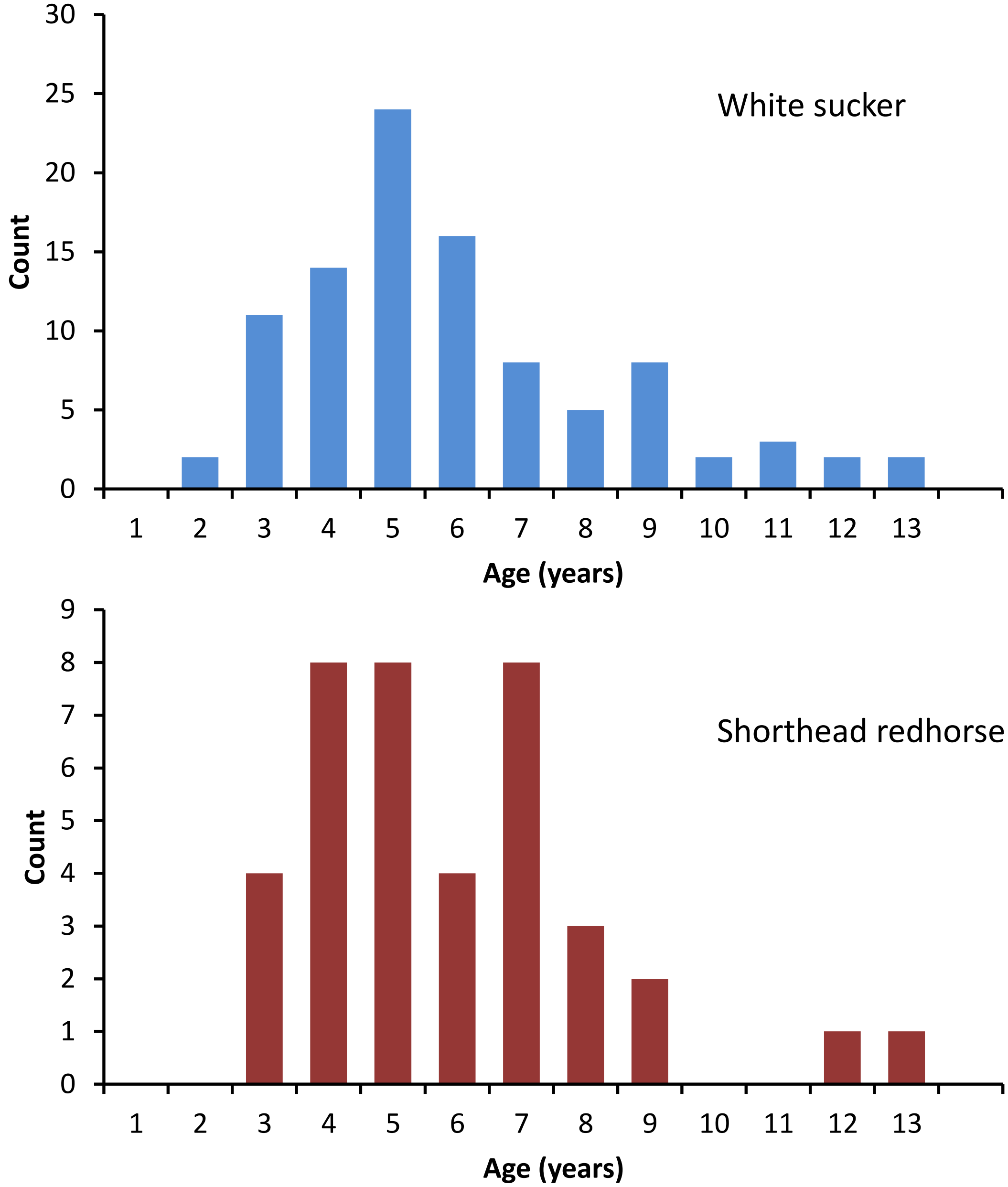


Figure 3.1. Age distributions of landed commercial harvest of white sucker *Catostomus commersonii* and shorthead redhorse *Moxostoma macrolepidotum* from western Lake Erie in autumn 2011.

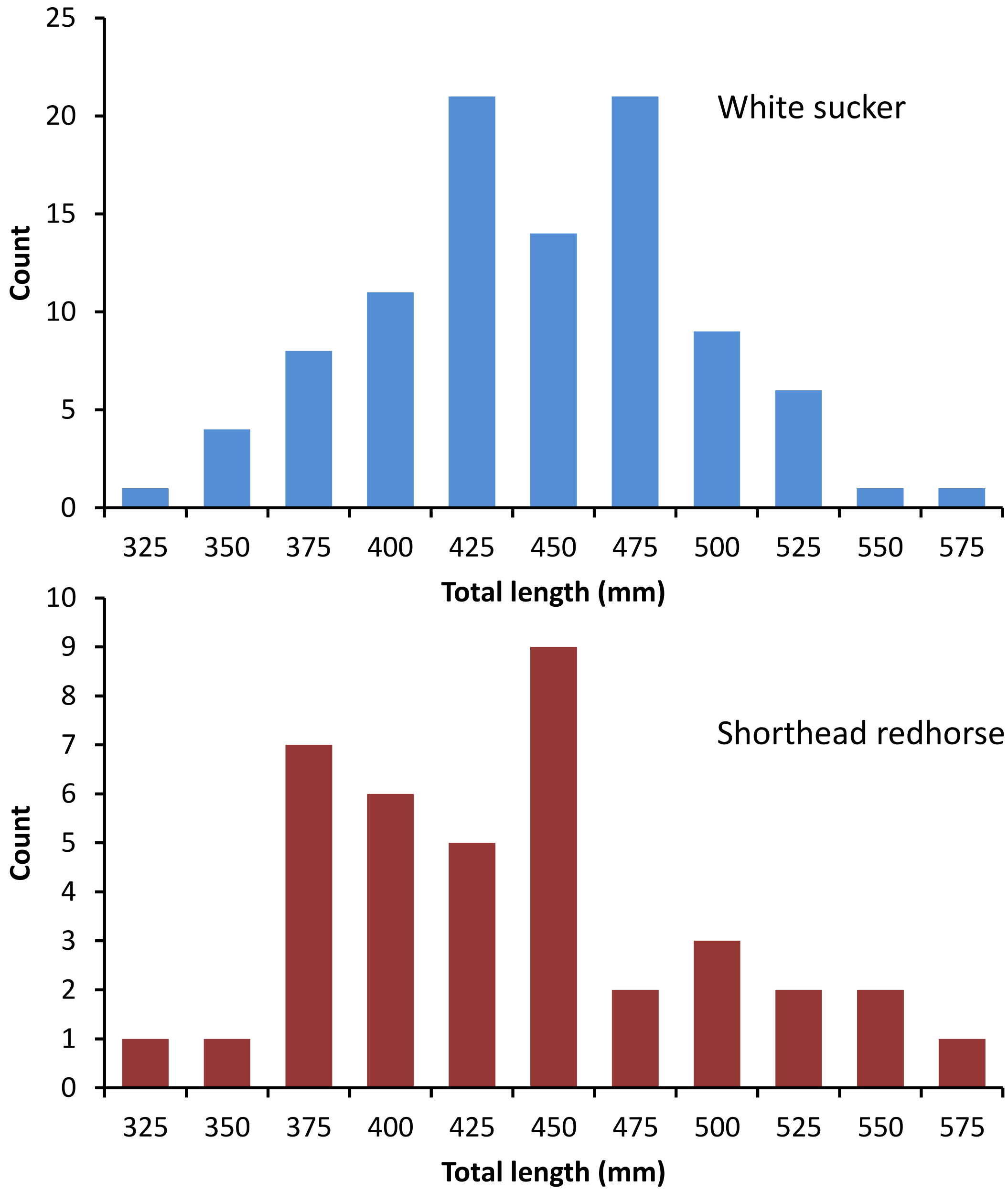


Figure 3.2. Length distributions of landed commercial harvest of white sucker *Catostomus commersonii* and shorthead redhorse *Moxostoma macrolepidotum* from western Lake Erie in autumn 2011.

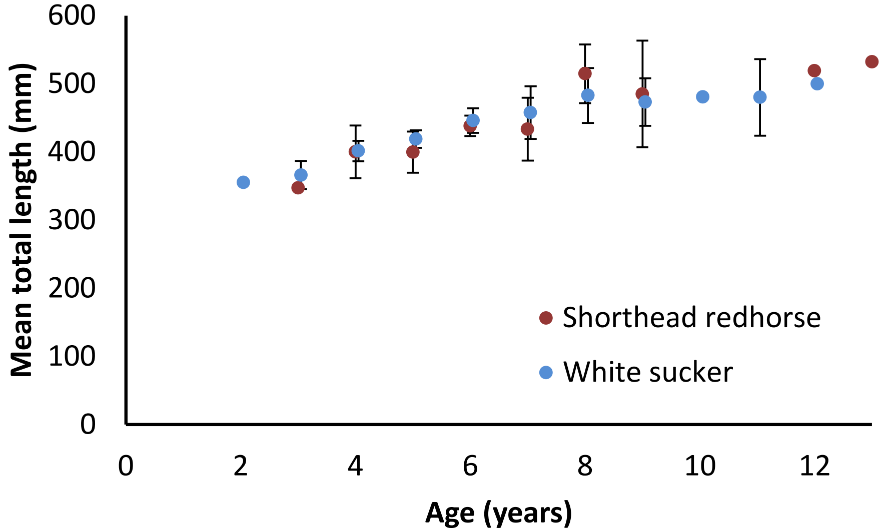


Figure 3.3. Mean lengths-at-age of landed commercial harvest of white sucker *Catostomus commersonii* and shorthead redhorse *Moxostoma macrolepidotum* from western Lake Erie in autumn 2011.

## 4.0 Acknowledgements

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