Fisheries Research and Monitoring Activities of the Lake Erie Biological Station, 2009

Lake Erie Biological Station - Research Vessel Musky II

Department of the Interior
U.S. Geological Survey
Great Lakes Science Center
Lake Erie Biological Station
2010

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* Reported to: Great Lakes Fishery Commission
Lake Erie Committee Meeting
Windsor, Ontario, 25 March 2010

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1.0 Western Basin forage fish assessment

Abstract

The Lake Erie Biological Station completed its sixth consecutive year of a collaborative, multi-agency assessment of forage fish populations throughout the western basin of Lake Erie in 2009. The objectives of this evaluation were to (1) provide estimates of densities and biomasses of forage fishes throughout the western basin of Lake Erie to the interagency database for assessing seasonal and spatial distributions of forage fishes and (2) assess year class strengths of key forage and predator species. We collected samples at 25 stations in Ontario and Michigan waters of the western basin of Lake Erie with bottom trawls in June, September, and October 2009. We calculated density (number/ha) and biomass (kg/ha) of all forage fishes. We also examined stomach contents from white perch *Morone americana* and yellow perch *Perca flavescens*. Many species had strong year classes in 2009 following several consecutive weaker year classes. Freshwater drum *Aplodinotus grunniens*, gizzard shad *Dorosoma cepedianum*, and round goby *Neogobius melanostomus* had the strongest year classes of the time series. Silver chub *Macrhybopsis storeriana*, experienced the third consecutive year of declining abundance of young-of-year. We found 157 *Hemimysis anomala* in the stomach of a single white perch in autumn, which we believe is the first confirmed consumption of this non-native mysid 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 density and biomass to the interagency database for assessing seasonal and spatial distributions of forage fishes. The short-term objective is to estimate year-class strengths 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 2009 season was the sixth consecutive year of this collaboration.

We present estimated density and biomass of young-of-year (age-0) and yearling-and-older (age-1+) forage fishes in the western basin of Lake Erie in June, September, and October 2009 and trends in density and abundance of key species from over the entire time series (2004-2009). 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 about 55% 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). Spring samples were collected during 8 - 10 June 2009. Autumn samples were collected during 31 September-2 October 2009. We used a 7.9-m (headrope) semi-balloon bottom trawl for all sampling. Prescribed trawling time was 10 minutes.

For small catches, all fish were identified to species and enumerated. For large 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 subsample to the weight of the entire sample. Subsamples of forage fish were placed on ice for examination in the laboratory. In the laboratory, a maximum of 30 fish of each species and age group were measured for total length (nearest mm), and weighed (nearest 0.01 g). Weights were not measured for age-1+ of predatory species.

For each trawl sample, we calculated 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 estimated area swept by the trawl. Age group was determined using age-length keys for species in the western basin developed from historical ODNR samples. For all species except round goby *Neogobius melanostomus*, separate density and biomass estimates were made for age-0 and age-1+. All ages were combined for round goby, owing to difficulty in determining age based on length alone. Area swept was estimated by multiplying the width of the trawl opening by the distance towed. The distance towed was estimated from the difference in starting and ending geographic coordinates, determined using differential Global Positioning System (GPS). We did not use net mensuration gear in 2009. Based on last year's results (Kocovsky *et al.* 2009) we used a net opening of 5 m for calculating area swept. The average density of each species was calculated as the arithmetic mean of all samples within a season and was expressed as number per hectare (ha). Biomass 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 density and was expressed as kilograms per ha (kg/ha).

Yellow perch and white perch diets

For both spring and autumn, stomachs were removed from a maximum of five yellow perch and five white perch, all age-2 and older, at each trawl station. Stomachs were removed and frozen in tap water in the field. In the laboratory, prey items were identified to the lowest reasonable taxonomic level, depending on the taxon and degree of digestion, and enumerated. A subsample was taken for samples that contained more than approximately 200 individuals of any prey item. Diet data were reported as frequency of occurrence by species, season, and year. Only stomachs that contained food items were included in the analysis. We compared frequency of occurrence of zooplankton, benthic macroinvertebrates, and fish in the spring and autumn diets for yellow perch and white perch collected on this survey during 2005-2009 (Kocovsky *et al.* 2009).

Results

Trawling

All 25 sites were successfully sampled in autumn. One site in Ontario waters was not sampled in spring (site ON19) owing to the trawl becoming snagged on the bottom. All completed samples in spring were the prescribed 10-minutes in duration. Tow time at one site (ON 20) in autumn was only 5 minutes owing to the trawl becoming snagged on the bottom. Trawled distance averaged 0.33±0.03 (95% CI) nautical miles (Nmi) in spring and 0.31±0.3 Nmi in autumn.

Several prey species had excellent reproductive success in 2009. The native species freshwater drum *Aplodinotus grunniens* and logperch *Percina caprodes* all had peak age-0 density (Table 1.1) and biomass (Table 1.2) for the time series. Freshwater drum increased 700%, and logperch increased by an order of magnitude over the previous year. Trout-perch *Percopsis omiscomaycus* and walleye *Sander vitreus* had large increases in age-0 compared to 2008. Trout-perch nearly doubled in density and biomass, but remained below the mean for the time series. Emerald shiner *Notropis atherinoides* age-0 abundance was two orders of magnitude higher than in 2008, and was moderate for the time series. Age-0 walleye increased 50% but remained below their peak for the time series and well below 2003 levels. The invasive species round goby had peak densities for the time series. Gizzard shad *Dorosoma cepedianum,* an important diet species for walleye, increased 800%. White perch remained the most abundant species captured in trawls in western Lake Erie.

Densities of age-0 spottail shiner *Notropis hudsonius,* silver chub *Macrhybopsis storeriana*, rainbow smelt *Osmerus mordax*, yellow perch, and white bass *Morone chrysops* were lower than 2008. This was the second consecutive decline for spottail shiner and white bass and the third consecutive decline for silver chub. Densities of white bass and silver chub age-0 were minima for the time series. Similarly, density of rainbow smelt age-0 was an order of magnitude lower than the time-series peak in 2008. Finally, density of yellow perch age-0 was slightly lower than in 2008, following 4 consecutive years of increases. Total lengths (Table 1.3) of most species were above average for the time series.

No tubenose gobies *Proterorhinus marmoratus* and no other new invasive species were captured in 2009. We captured three live, native unionid mussels northwest of Pelee Island during autumn sampling, which we returned to the water immediately. At the same site we also captured a large quantity of dreissenid (*Dreissena* spp.) shells, but few if any live dreissenids.

Yellow perch and white perch diets

We collected 115 and 108 age-2 and older yellow perch during spring and autumn sampling, respectively for diet analysis. Stomachs of 112 (97.4%) of the yellow perch collected in spring and 75 (69.4%) of the perch collected in autumn contained diet items (Table 1.4). Percentages reported here are for stomachs containing diet items. Diets during spring consisted primarily of benthic invertebrates (92.9% of stomachs) and zooplankton (42.0%). Fish were found in 14.3% of stomachs. The predominant benthic organisms in the diet included Chironomidae (64.3%), *Hexagenia sp.* (40.2%), and Turbellaria (34.8%). The most prevalent zooplankton items were *Leptodora kindtii* (28.6%), *Daphnia retrocurva* (15.2%), and cyclopoid copepods (10.7%). Round goby was the most frequently consumed fish (9.8%). The most frequently consumed diet items during autumn consisted largely of benthic macroinvertebrates (90.7%) and fish (32%). The most common benthic organisms found in the stomachs included *Hexagenia sp.* (53.3%) and Turbellaria (28%). The most common fish species found were round goby (16%) and gizzard shad (5.3%).

We collected 95 and 48 age-2 and older white perch during spring and autumn sampling, respectively. Stomachs of 86 (90.5%) white perch collected in spring and 33 (68.8%) collected in autumn contained diet items (Table 1.4). Primary diet items during spring included zooplankton (86.0%) and benthic macroinvertebrates (62.8%). The most prevalent zooplankton items were *Leptodora kindtii* (64%), *Daphnia retrocurva* (36%), and Cyclopoida (34.9%). The most often consumed benthic organisms included Chironomidae (61.7%), Ostracoda (25.6%), and *Hexagenia sp.* (17.4%). Only two unidentifiable fish were found in spring stomach contents. Benthic macroinvertebrates were the most frequently consumed diet items during autumn, occurring in 87.9% of stomachs. *Hexagenia sp.* (66.7%), Chironomidae (39.4%), and Amphipoda (30.3%) were the most frequently occurring benthic taxa found in stomachs collected in autumn. Zooplankton was found in 39.4% of the stomachs and fish were found in 30.3%. The non-native bloody red-shrimp *Hemimysis anomala* was found in one white perch stomach. There is one record in 2006 of specimens that resembled *H. anomala* found in one white perch stomach (Kipp and Ricciardi 2007). This is perhaps the first confirmed record of *H. anomala* in the stomach contents of fish for the western basin of Lake Erie.

Spring diet trends of yellow perch exhibited an overall decline in zooplankton consumption since 2005 (Figure 1.2). Spring benthic invertebrate consumption in yellow perch increased since 2007. Autumn diet trends of yellow perch demonstrated a decline in fish consumption along with an increase in benthic invertebrate consumption since 2007. Zooplankton and benthic invertebrates were the most significant diet items of spring foraging, whereas fish and benthic invertebrates were the most significant items for autumn foraging in yellow perch. White perch exhibited similar diet trends to those of the yellow perch (Figure 1.3). One exception was that consumption of zooplankton by white perch increased during spring from 2008 to 2009. Zooplankton also tended to be consumed more frequently by white perch than by yellow perch during spring.

Discussion

Reproductive success of several species was very good for the time series. There was no clear trend of warm-water or cool-water species reproducing well as in previous years (Kocovsky *et al*. 2007; Kocovsky *et al*. 2008). Freshwater drum had particularly strong reproductive success. The 2009 peak follows several years of low and decreasing age-0 abundance, which may have been linked to adult mortality related to Viral Hemorrhagic Septicemia (VHS). During 2006-2008 large numbers of adult drum died from VHS during their spawning season, particularly in 2006 and 2007 (Kocovsky *et al.* 2008). In 2009, comparatively few dead or dying freshwater drum were observed, and age-0 abundance was the highest in the time series.

Gizzard shad also had excellent reproductive success compared to previous years, setting a new high for the time series. Despite this short-term peak, gizzard shad abundance over the long term is still well below historic means. Successful reproduction of gizzard shad may reflect a release from predation by walleyes. The strong 2003 walleye year class has been heavily exploited (Walleye Task Group 2009) and has supported the commercial fishery since 2006. Walleye year classes have been weak and recruitment has been minimal since 2003 (Walleye

Task Group 2009). Lower numbers of spawning adults in western Lake Erie and small numbers of recruits likely resulted in decreased predatory pressure on gizzard shad, the primary forage of walleye (Ohio Department of Natural Resources 2009), which may explain improved reproductive success of gizzard shad.

Rainbow smelt reproductive success was comparatively low in 2009. This low followed extremely high recruitment of the 2008 year class as evidenced by high numbers of age-1 rainbow smelt throughout Lake Erie. In Lake Ontario, which has lower species diversity than western Lake Erie, rainbow smelt had a 2-yr cycle of high followed by low age-0 abundance, which was attributed to density dependence owing to cannibalism by age-1 and older rainbow smelt on age-0 (Walsh *et al.* 2007). The pattern has deteriorated in recent years as rainbow smelt numbers have declined drastically. The two year cycle is apparent in western Erie with even year's age-0 abundance higher than subsequent year's (LEBS unpublished data).

We did not capture any tubenose goby during trawling in 2009. Research on tubenose gobies in Lake Erie has shown a strong association with macrophyte cover and a weaker association with substrate type (Kocovsky *et al.* in review). Spring sampling was conducted prior to establishment of dense macrophytes, and autumn sampling was conducted nearly 2 weeks later and water temperatures were 1.5° to 2° C lower than in 2008. These differences in sampling conditions may have sufficed to make habitat less suitable for tubenose gobies, which may migrate during the year in response to macrophyte cover (Kocovsky *et al.* in review). We recommend that others sampling in western Lake Erie continue to be aware of the potential to capture tubenose gobies as they are well established around the Bass Islands. Tubenose goby poses a potential threat to native darters, particularly johnny darter *Etheostoma nigrum*, which have similar spawning habitat, and rainbow darter *E. caeruleum*, which has a similar diet as tubenose gobies (French and Jude 2001). The primary external diagnostic characters are tubular protruding nostrils, a more slender body than round gobies, lateral and dorsal patches of grey pigment, and lack of black spot on the posterior margin of the anterior dorsal fin (Hubbs *et al.* 2004).

Table 1.1. Average density (number per hectare) of young-of-year (age-0) and yearling-and-older (age-1+) forage fish of the most common species captured in bottom trawls during June and September 2009 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 age-1+.

	Spring		Autumn			
Species	**Age-1+**	**%RSE**	**Age-0**	**%RSE**	**Age-1+**	**%RSE**
alewife	--	--	--	--	--	--
gizzard shad	--	--	134.9	60.3	--	--
rainbow smelt	32.1	68.4	21.6	58.6	1.2	42.8
silver chub	5.0	76.2			0.5	46.6
emerald shiner	66.7	49.7	137.9	54.4	15.8	72.2
spottail shiner	18.6	71.4	52.8	65.8	15.7	56.0
mimic shiner	--	--	--	--	--	--
trout-perch	201.3	59.9	123.3	44.8	12.3	25.7
white perch	--	--	720.7	32.6	--	--
white bass	--	--	0.7	49.3	--	--
smallmouth bass	--	--	0.8	55.6	--	--
logperch	0.15	100.1	7.1	63.8	3.1	49.8
yellow perch	--	--	95.2	40.9	--	--
walleye	--	--	2.0	43.2	--	--
freshwater drum	--	--	15.8	48.7	--	--
round goby	101.5	28.8	--	--	518.1	23.9

Table 1.2. Average biomass (kilograms per hectare) of young-of-year (age-0) and yearling-and-older (age-1+) forage fish of the most common species captured in bottom trawls during June and September 2009 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 age-1+.

	Spring		Autumn			
Species	**Age-1+**	**%RSE**	**Age-0**	**%RSE**	**Age-1+**	**%RSE**
alewife	--	--	--	--	--	--
gizzard shad	--	--	1.462	60.3	--	--
rainbow smelt	0.147	65.2	0.012	57.9	0.005	42.3
silver chub	0.171	85.5	--	--	0.025	46.8
emerald shiner	0.299	50.7	0.155	54.5	0.072	72.2
spottail shiner	0.246	80.3	0.153	65.8	0.187	56.1
mimic shiner	--	--	--	--	--	--
trout-perch	1.289	62.5	0.421	44.7	0.116	25.8
white perch	--	--	3.330	32.6	--	--
white bass	--	--	0.008	50.6	--	--
smallmouth bass	--	--	0.008	54.8	--	--
logperch	0.0002	101.2	0.019	64.2	0.016	50.3
yellow perch	--	--	0.470	40.9	--	--
walleye	--	--	0.132	43.2	--	--
freshwater drum	--	--	0.073	48.8	--	--
round goby	0.396	32.7	--	--	3.10	23.9

Table 1.3. Mean total length (TL, mm), standard error (SE), and sample size (N) for young-of-year (age-0) and yearling-and-older (age-1+) forage fish of the most common species captured during June and September 2009 in Ontario and Michigan waters of the western basin of Lake Erie. For round goby, all ages were combined under age-1+.

	Spring Age-1+			**Autumn Age-0**			**Autumn Age-1+**		
Species	**TL**	**SE**	**N**	**TL**	**SE**	**N**	**TL**	**SE**	**N**
alewife	--	--	--	--	--	--	--	--	--
gizzard shad	--	--	--	103.5	1.3	161	--	--	--
rainbow smelt	--	--	--	48.9	0.9	76	95.2	9.4	6
silver chub	137.4	10.1	14	--	--	--	171.0	3.9	4
emerald shiner	85.0	0.8	146	54.1	0.8	162	89.2	0.9	45
spottail shiner	100.9	2.5	54	65.5	1.6	106	108.5	1.1	64
mimic shiner	--	--	--	--	--	--	--	--	--
trout-perch	88.2	0.7	250	73.3	0.4	323	102.1	0.7	83
white perch	--	--	--	71.4	0.9	219	--	--	--
white bass	--	--	--	97.4	8.8	5	--	--	--
smallmouth bass	--	--	--	86.8	6.0	6	--	--	--
logperch	57.0	--	1	66.6	2.2	36	89.0	--	1
yellow perch	95.1	1.2	101	80.9	0.5	208	106.0	1.3	11
walleye	--	--	--	197.7	3.4	15	--	--	--
freshwater drum	--	--	--	65.4	3.6	77	--	--	--
round goby	--	--	--	--	--	--	64.4	1.5	322

Table 1.4. Diet of age-2 and older yellow and white perch collected during spring and autumn 2009 in Ontario and Michigan waters of western Lake Erie. Values are expressed as percent frequency of occurrence. Abbreviation: n= stomachs containing diet items.

	Yellow Perch		**White Perch**	
Prey Item	Spring (n=112)	Autumn (n=75)	Spring (n=86)	Autumn (n=33)
Leptodora kindtii	28.6	0.0	64.0	12.1
Daphnia sp.	2.7	0.0	8.1	0.0
Daphnia retrocurva	15.2	0.0	36.0	0.0
Bosmina sp.	0.9	0.0	3.5	0.0
Copepoda (Cyclopoida)	10.7	1.3	34.9	3.0
Copepoda (Calanoida)	0.9	0.0	11.6	6.1
Sididae	1.8	0.0	29.1	12.1
Zooplankton	**42.0**	**1.3**	**86.0**	**39.4**
Amphipoda	3.6	2.8	9.3	30.3
Chironomidae	64.3	9.3	61.7	39.4
Oligochaeta	2.7	0.0	0.0	0.0
Nematoda	14.2	9.3	11.6	12.1
Decapoda	0.0	0.0	0.0	3.0
Trichoptera sp.	25.0	0.0	14.0	6.1
Gastropoda	11.6	4.0	0.0	0.0
Hexagenia sp.	40.2	53.3	17.4	66.7
Dreissena sp.	23.2	21.3	2.2	18.2
Sphaeriidae	19.6	1.3	3.5	6.1
Hirudinea	3.6	0.0	5.8	18.2
Ostracoda	8.9	0.0	25.6	15.2
Turbellaria	34.8	28.0	7.0	3.0
Benthic Invertebrates	**92.9**	**90.7**	**62.8**	**87.9**
emerald shiner	0.0	1.3	0.0	3.0
spottail shiner	0.0	0.0	0.0	3.0
trout-perch	0.0	1.3	0.0	0.0
white perch	0.9	0.0	0.0	0.0
gizzard shad	0.0	5.3	0.0	9.1
mimic shiner	0.0	1.3	0.0	0.0
smallmouth bass	0.0	0.0	0.0	0.0
round goby	9.8	16.0	0.0	9.1
unidentified fish	6.3	12.0	2.3	12.1
Fish	**14.3**	**32.0**	**2.3**	**30.3**

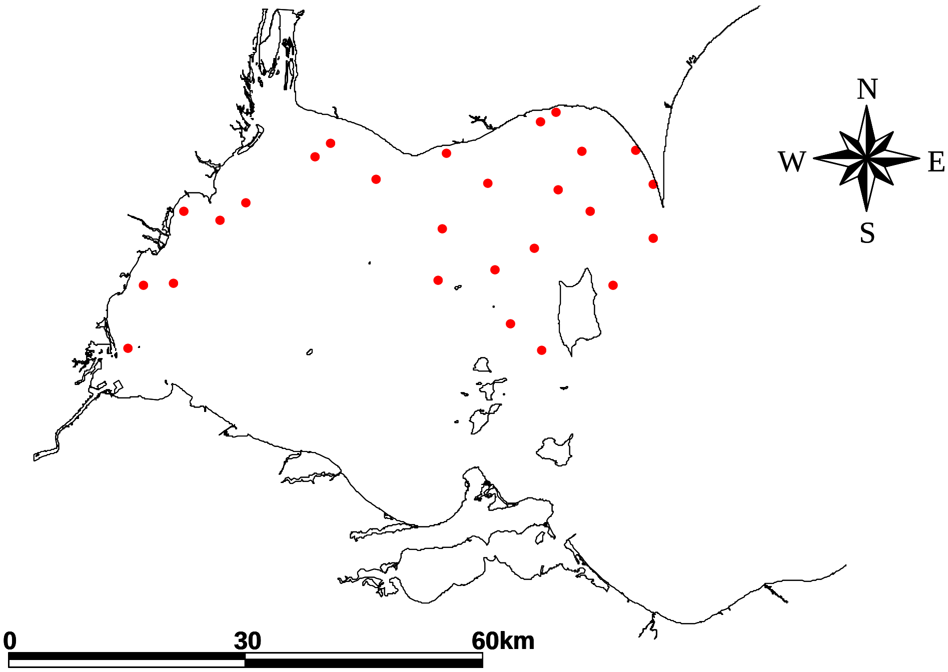

Figure 1.1. Location of sites (n=25) sampled with a bottom trawl in June and September in the western basin of Lake Erie, 2009.

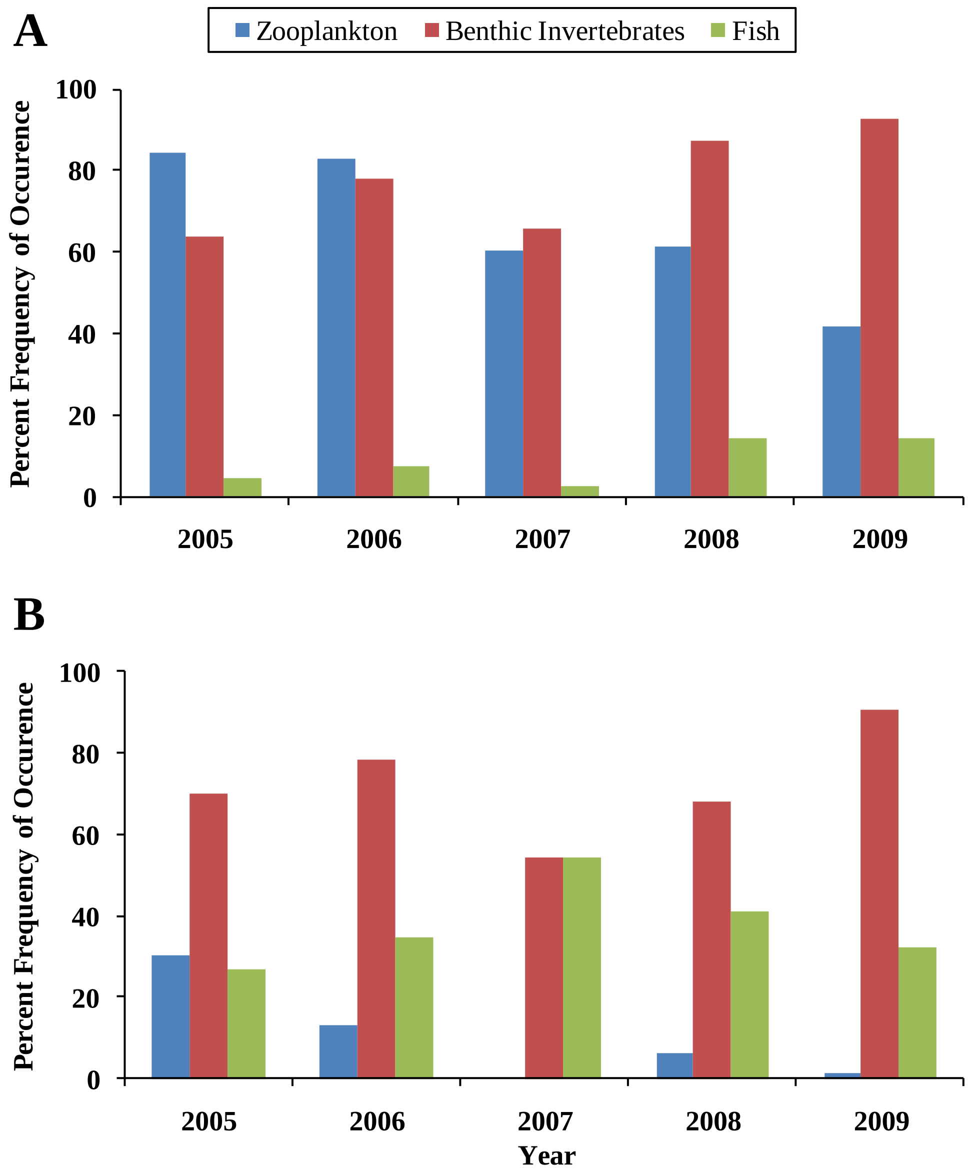

Figure 1.2. Percent frequency of occurrence of zooplankton, benthic invertebrates, and fish in the diet of age-2 and older yellow perch collected in Ontario and Michigan waters of western Lake Erie. Stomachs were collected in spring (A) and autumn (B) since 2005.

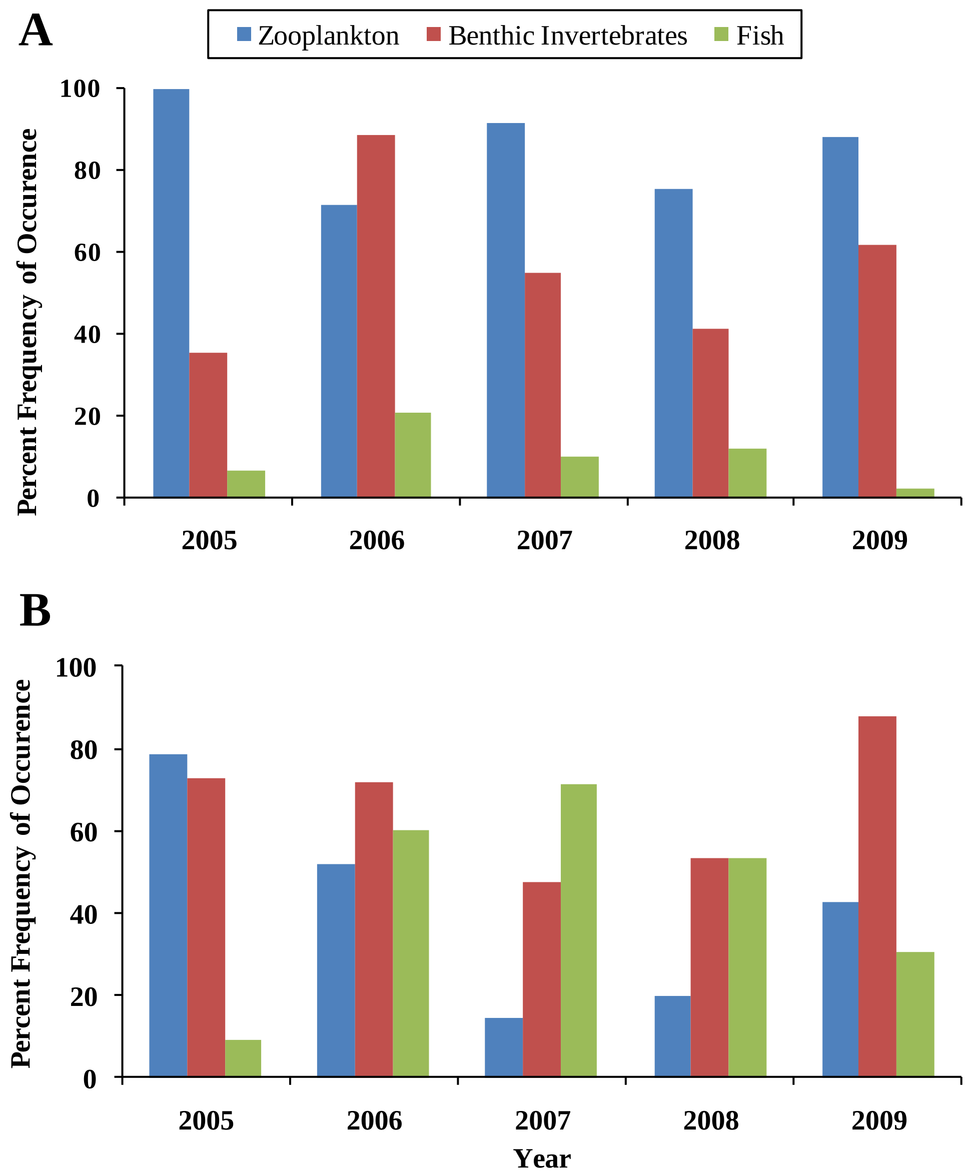

Figure 1.3. Percent frequency of occurrence of zooplankton, benthic invertebrates, and fish in the diet of white perch collected in Ontario and Michigan waters of western Lake Erie. Stomachs were collected in spring (A) and autumn (B) since 2005.

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 in 2009. Catch-per-unit-effort of most age-0 forage fishes in 2009 were less than their 15-year means. Mean densities for three species exceeded the long term mean. Mean density of age-0 white perch *Morone americana* was above the long-term mean despite a decline from last year. Densities of both yellow perch *Perca flavescens* and walleye *Sander vitreus* fell below their long term mean and were less than half their densities in 2008. Catches of freshwater drum *Aplodinotus grunniens* exceeded their 15-year mean for the first time since 2001. For six species, mean total lengths of age-0 individuals captured in 2009 were less than 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 in 2009. The objectives for these surveys have been to determine relative abundance and growth of comparatively common young-of-year (age-0) fish species. Relative abundance indices and growth data from these surveys provide information on potential recruitment of these important species.

This report includes results from the autumn 2009 LEBS trawl survey. For selected fish species, we evaluated recruitment by comparing the 2009 autumn abundance values of age-0 individuals with long-term (15-year) LEBS average catches. We then compare relative abundances and total lengths of age-0 fish species with results from previous years.

Methods

Trawling

Trawl surveys were conducted during autumn (19 and 20 October 2009) 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 to approximately 0100 the following day) with a 7.9-m (headrope) bottom trawl. Prior to 2008, data from afternoon (1200 through 1800) 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. 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) in each season. Fish caught in the trawls were identified to species and counted.

Forage species (*e.g.*, alewife *Alosa pseudoharengus*, gizzard shad *Dorosoma cepedianum*, emerald shiner *Notropis atherinoides*, spottail shiner *N. hudsonius*, trout-perch *Percopsis omiscomaycus*, and rainbow smelt *Osmerus mordax*) were categorized as either age-0 or yearling-and-older. Spiny-rayed fish (*e.g.*, yellow perch, white perch, white bass *Morone* *chrysops*, walleye *Sander vitreus*, and freshwater drum *Aplodinotus grunniens*) were categorized as age-0, yearling, or age-2 and older. All ages were combined for round goby *Neogobius melanostomus*.

Age-0 abundance and growth

For each species, we calculated an index of abundance for 2009 based on catches of age-0 fish caught in the trawls during autumn. This index was calculated as the arithmetic mean number of age-0 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 age-0 fish abundance index for autumn 2009 with its respective long-term autumn mean (14 years for round goby and 15 years for the remaining species). We used the 14-year mean for round goby because the species was first captured in this survey in 1996. Similarly, changes in growth rate were evaluated for each species by comparing mean total lengths of age-0 individuals captured in autumn 2009 with its respective long-term (14 years for round goby and 20 years for the remaining species) autumn mean with a t-test.

Results and Discussion

Abundances in autumn 2009 for eight of the eleven age-0 target species were lower than their respective 15-year means (Table 2.1). Alewife abundance has been below its 15-year mean since 2002 (Figure 2.2). Although still below its 15-year mean since 2000, the number of gizzard shad/ha increased from 8 in 2008 to 33 in 2009. Prior to 2000, catches of both species were quite variable. Rainbow smelt abundance has been quite low (< 2 individuals/ha) in seven of the last nine years (Figure 2.3). Emerald shiner abundance in 2009 (190 individuals/ha) declined from 2008 (475 individuals/ha; Figure 2.4). Abundance of trout-perch has been lower than its 15-year mean for the past six of eight years, while that of spottail shiner has been below average for seven of the past ten years (Figure 2.5).

Autumn abundances in 2009 for three of the five age-0 spiny-rayed species evaluated (white bass, yellow perch, and walleye) were lower than their respective 15-year means (Table 2.1). The abundance of age-0 yellow perch in 2009 declined below its 15-year mean (Figure 2.6) after showing an increase the past two years. Similarly, walleye abundance declined from 12 individuals/ha in 2008 to 2 individuals/ha in 2009, a level well below its 15-year mean. The mean catch/ha in 2009 for age-0 white bass was well below the 15-year mean and was the third lowest since 1998 (Figure 2.7). Age-0 freshwater drum abundance in 2009 increased above its 15-year mean (Figure 2.8) for only the second time since 2001 and the third time since 1995. Although white perch abundance declined in 2009, mean catch/ha remained above its 15-year mean for the third consecutive year since 2003.

After increasing in 2008 above its 13-year mean (131/ha) for the first time since 2001, mean abundance for round goby in 2009 decreased to 54 individuals/ha. This estimate was similar to mean abundance in 1997 and 2007, when the following year showed considerable increase (Figure 2.9). Catch of gobies peaked in 1999 and by 2003 the number of gobies in trawl catches dropped considerably.

Differences in mean total length between 2009 and the previous 20 years were recorded for some species. For five (gizzard shad, emerald shiner, spottail shiner, white perch, and white bass) of nine species examined, mean total lengths of age-0 fish in 2009 were less than their respective 20-year means (Table 2.2: t-tests, $P < 0.05$). However, the results for white bass ($N = 1$) should be interpreted with caution due to small sample size. Departures below respective 20-year mean total lengths ranged from 4% (white perch) to 19% (gizzard shad). Conversely, mean total length in 2009 for freshwater drum was greater than the long-term mean. During each of the past five years the mean total length of age-0 yellow perch equaled or exceeded the long-term mean (Figure 2.10) and there was no significant difference between mean total lengths in 2009 and their 20-year mean (Table 2). Similarly, the 2009 mean total length of walleye exceeded the long-term mean length during four of the last five years (no age-0 walleye were collected in 2006).

Table 2.1. Autumn densities of age-0 fish from bottom trawling an area near East Harbor State Park, Ohio in western Lake Erie for 2009 and the mean autumn densities for 1994-2008 (15-year mean). Densities are expressed as the mean number per hectare swept by the trawl. Relative standard error (expressed as a percent) is calculated as standard error of the mean number per hectare for a species divided by mean number per hectare and multiplied by 100.

	Number/hectare		Relative standard error (%)	
Species	**2009**	**15-year mean**	**2009**	**15-year mean**
alewife	0	27	--	52
gizzard shad	33	121	32	31
rainbow smelt	7	5	86	58
emerald shiner	190	1086	36	39
spottail shiner	33	68	44	35
trout-perch	59	76	18	27
white perch	1415	978	18	22
white bass	1	5	84	48
yellow perch	56	108	17	27
walleye	2	13	37	36
freshwater drum	44	39	15	43

Table 2.2. Mean total lengths (mm) of age-0 fishes collected from bottom trawl catches near East Harbor State Park, Ohio in western Lake Erie during autumn of 2009 and 1989-2008 (20-year mean). Sample sizes are in parentheses and SE=standard error. Scientific names of species are listed in Table 1. Positive t-values indicate that mean total length in 2009 was greater than the 20-year mean; negative values indicate the reverse. Significant differences occurred when $P \leq 0.05$.

	2009		**1989-2008**		**2009 vs. 1989-2008**	
Species	**Mean (N)**	**SE**	**Mean**	**SE**	**t-value**	**P**
gizzard shad	81 (89)	2.4	100	2.7	-9.65	<0.0001
emerald shiner	50 (102)	1.0	58	1.6	-9.56	<0.0001
spottail shiner	74 (103)	0.9	77	1.6	-3.08	0.0021
trout-perch	75 (120)	0.6	75	1.0	-1.13	0.2590
white perch	72 (55)	1.0	75	1.3	-3.03	0.0025
white bass	53 (1)	8.1	121	5.4	-3.80	0.0002
yellow perch	83 (59)	0.6	84	1.2	-0.52	0.6052
walleye	185 (10)	3.7	186	4.1	-0.09	0.9300
freshwater drum	107 (100)	1.6	99	5.3	4.03	<0.0001

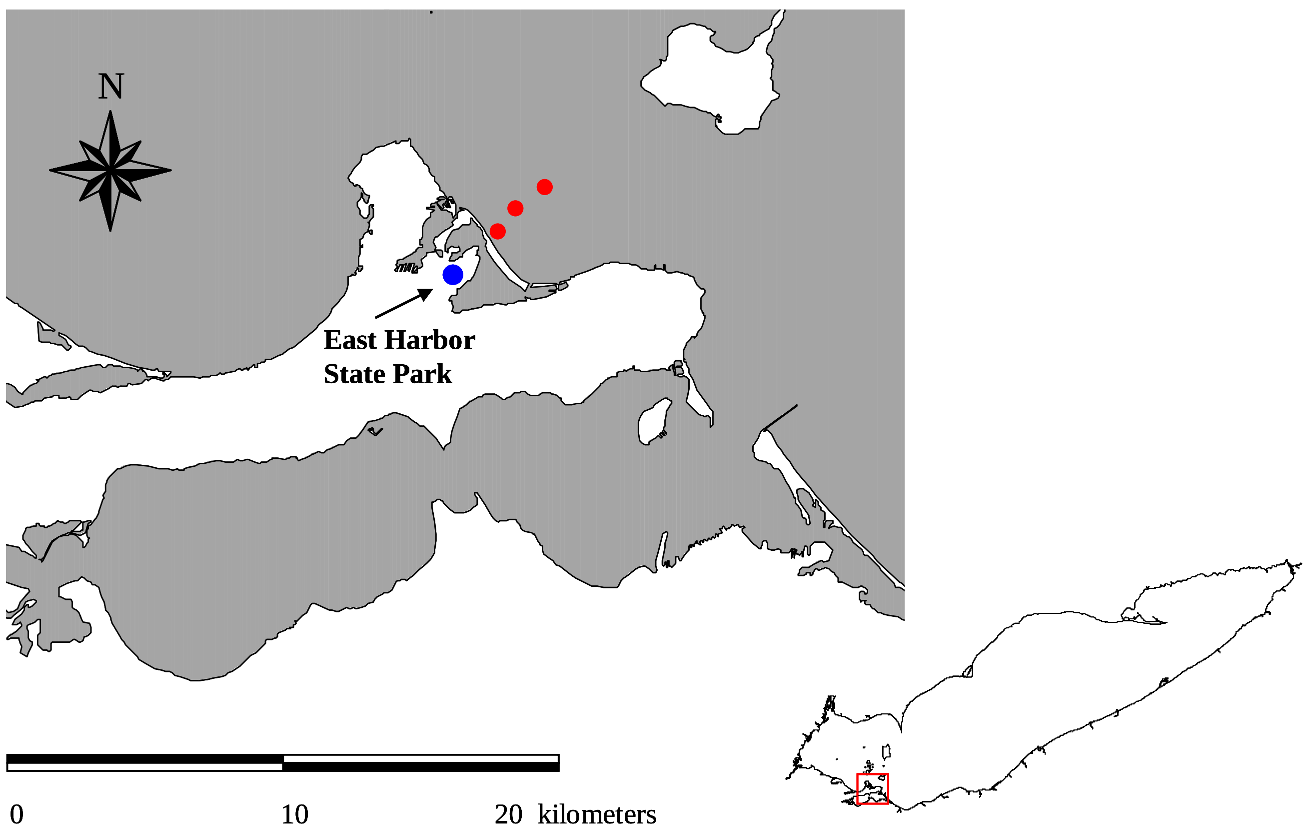

Figure 2.1. Location of sites sampled by the USGS Lake Erie Biological Station (red filled circles) offshore of East Harbor State Park (blue filled circle) in the western basin of Lake Erie.

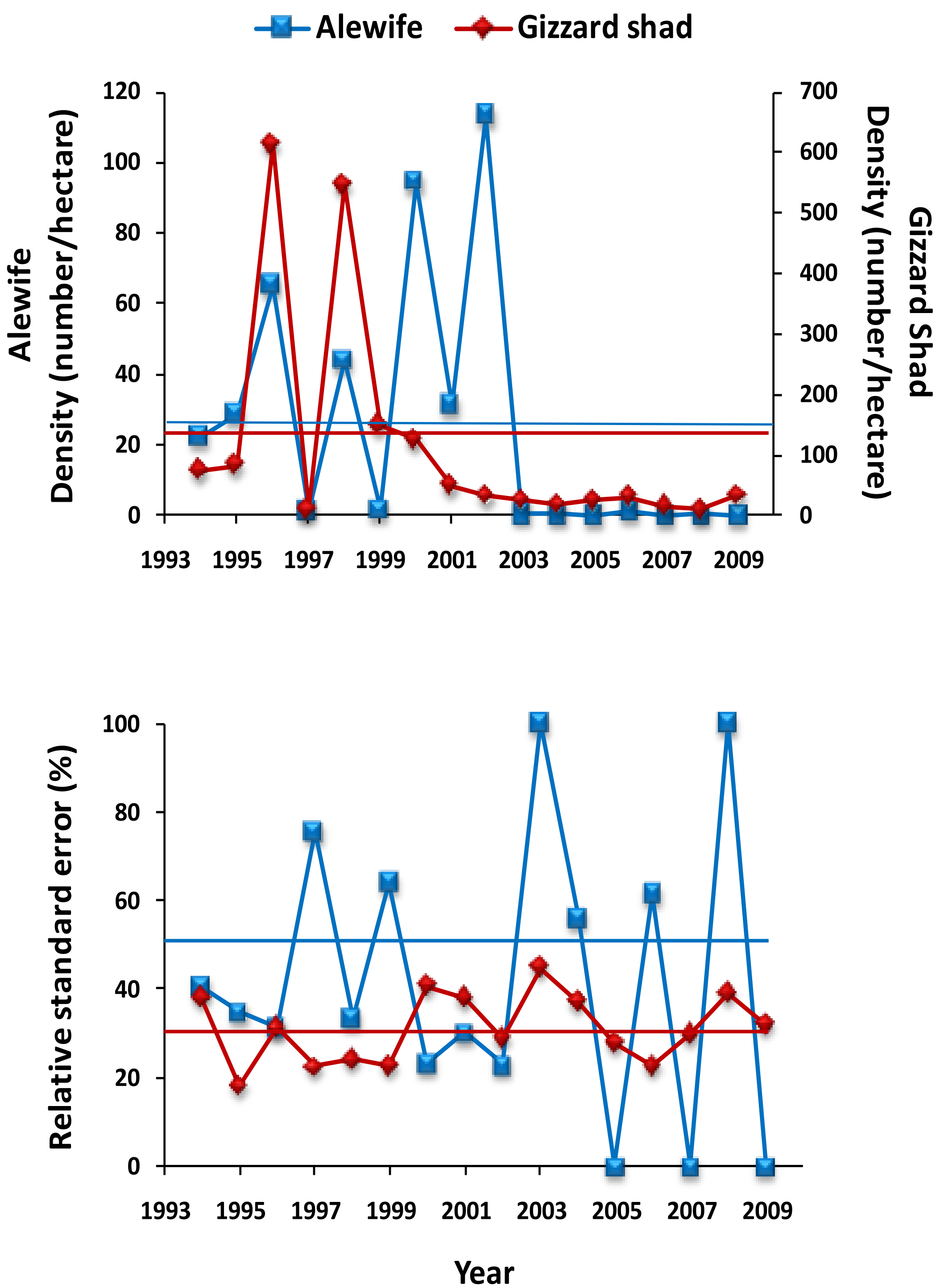

Figure 2.2. Density (top) and relative standard error (bottom) for age-0 alewife and gizzard shad in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

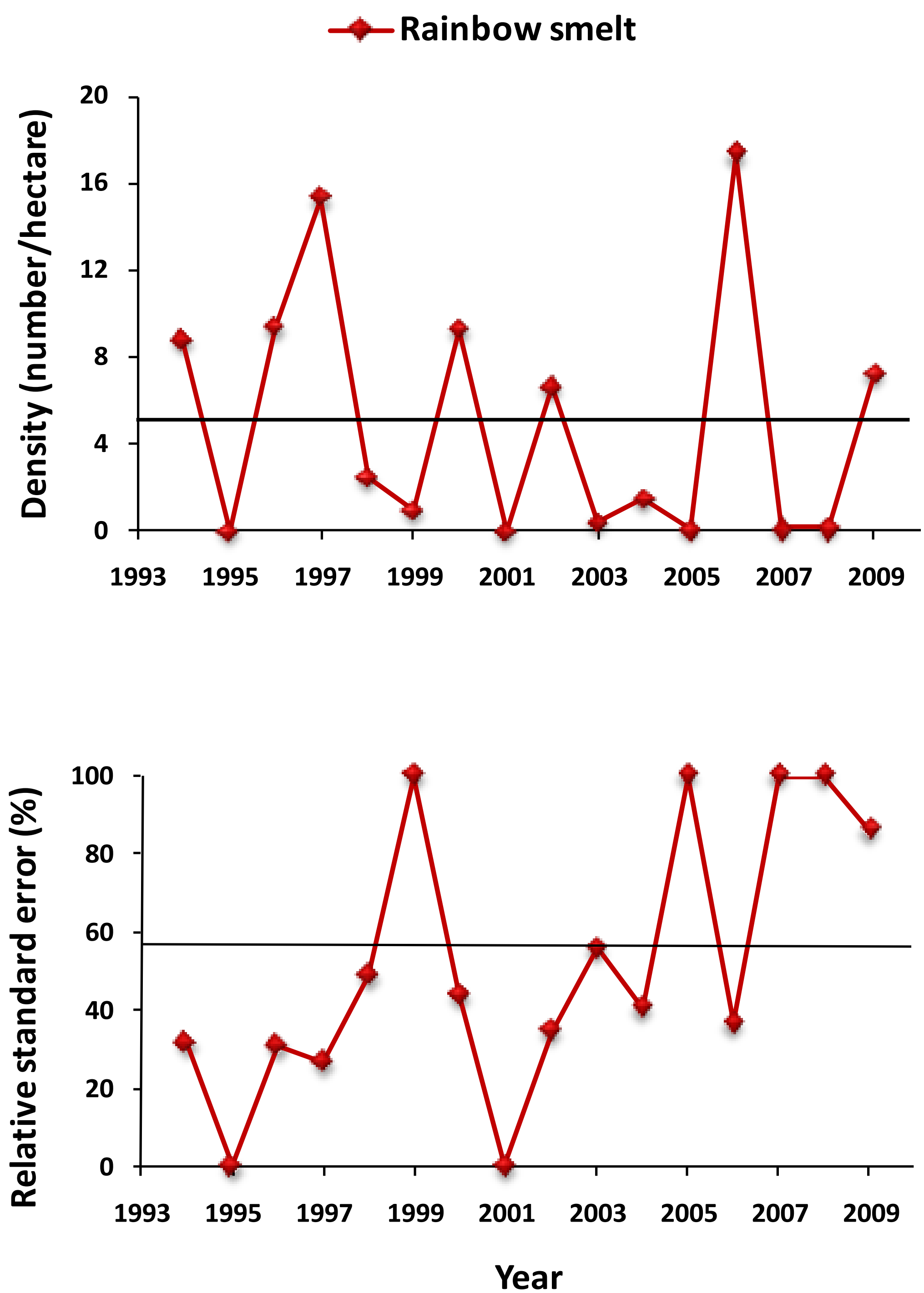

Figure 2.3. Density (top) and relative standard error (bottom) for age-0 rainbow smelt in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

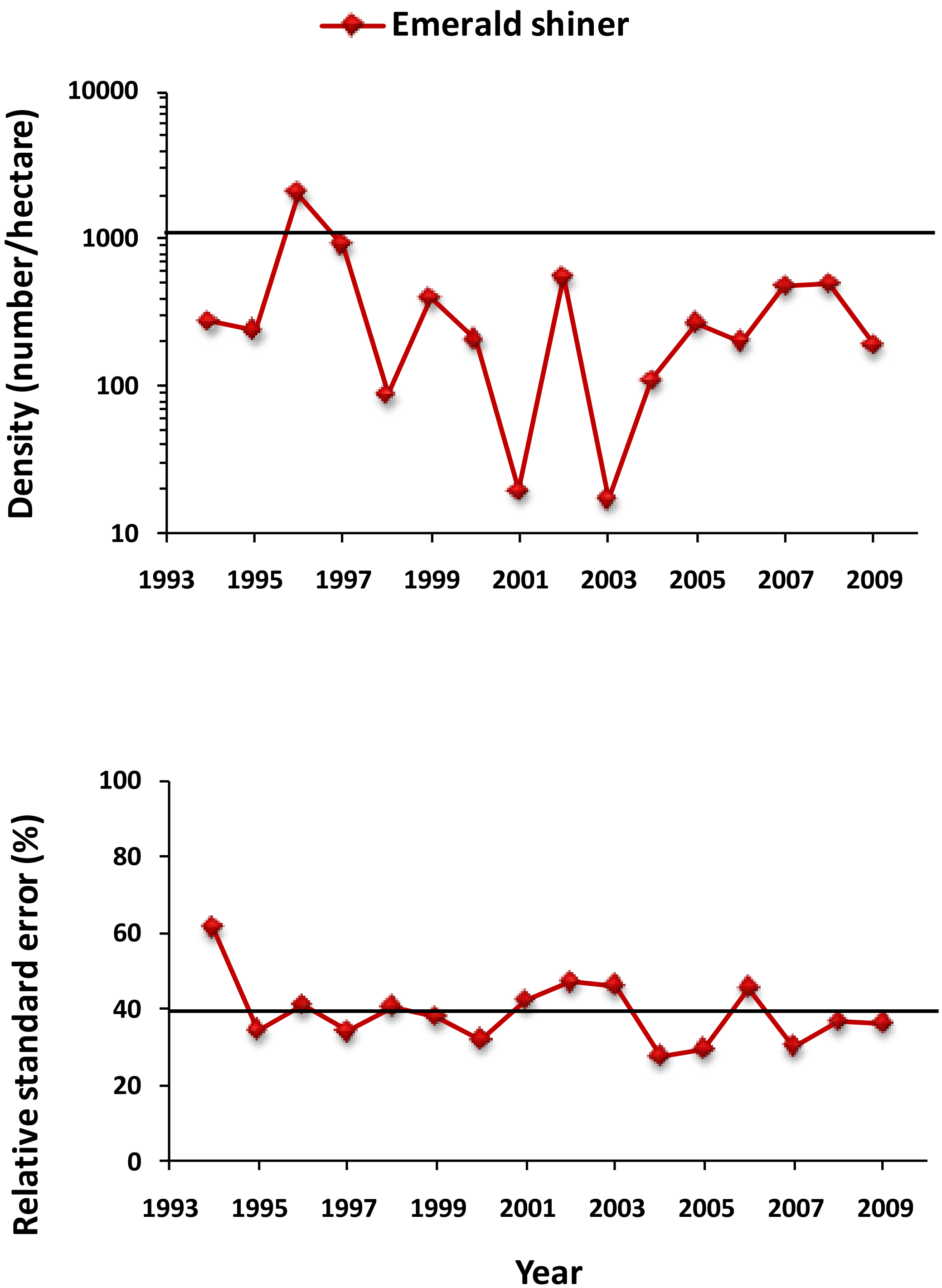

Figure 2.4. Density (top) and relative standard error (bottom) for age-0 emerald shiner in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

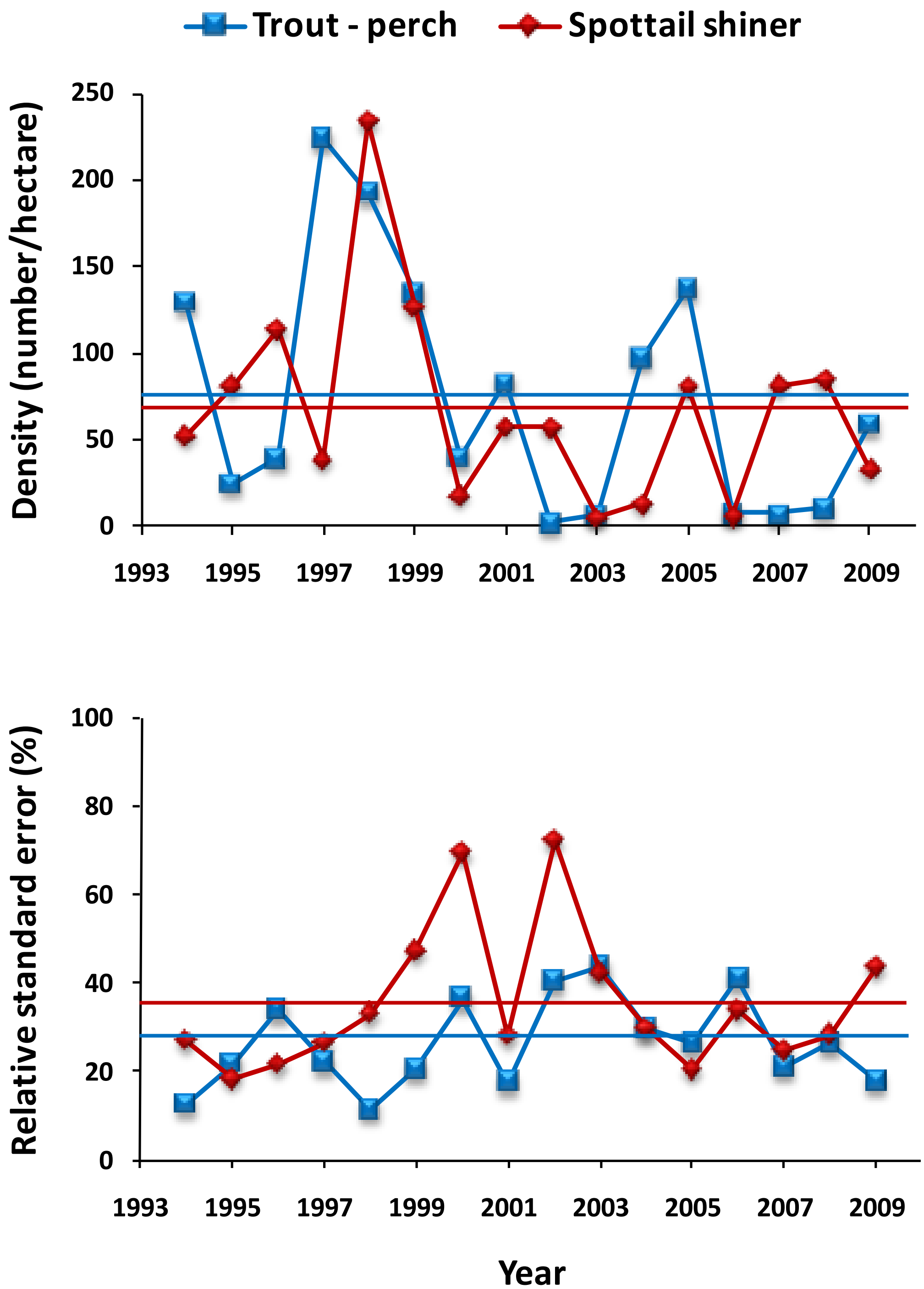

Figure 2.5. Density (top) and relative standard error (bottom) for age-0 spottail shiner and trout-perch in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

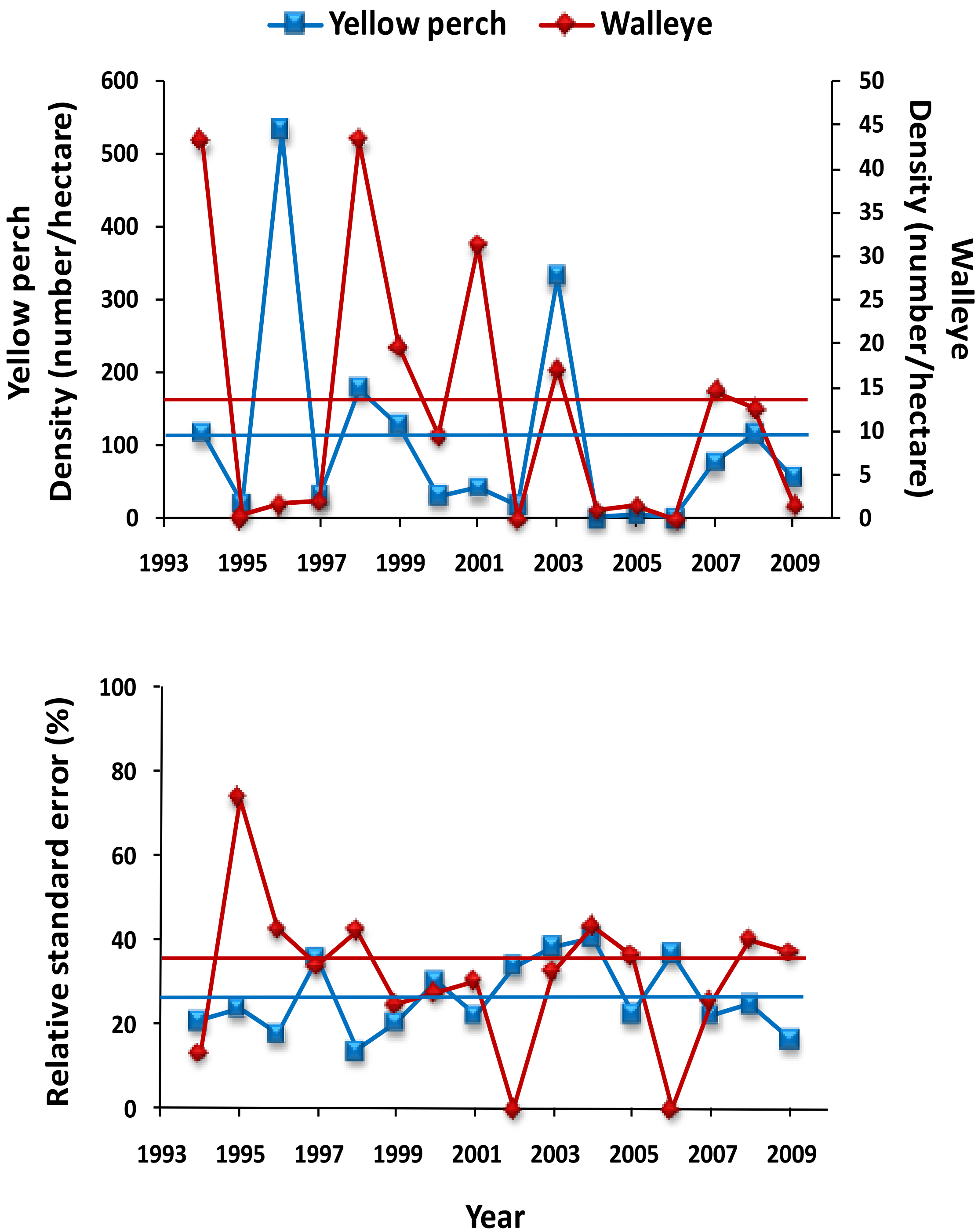

Figure 2.6. Density (top) and relative standard error (bottom) for age-0 yellow perch and walleye in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

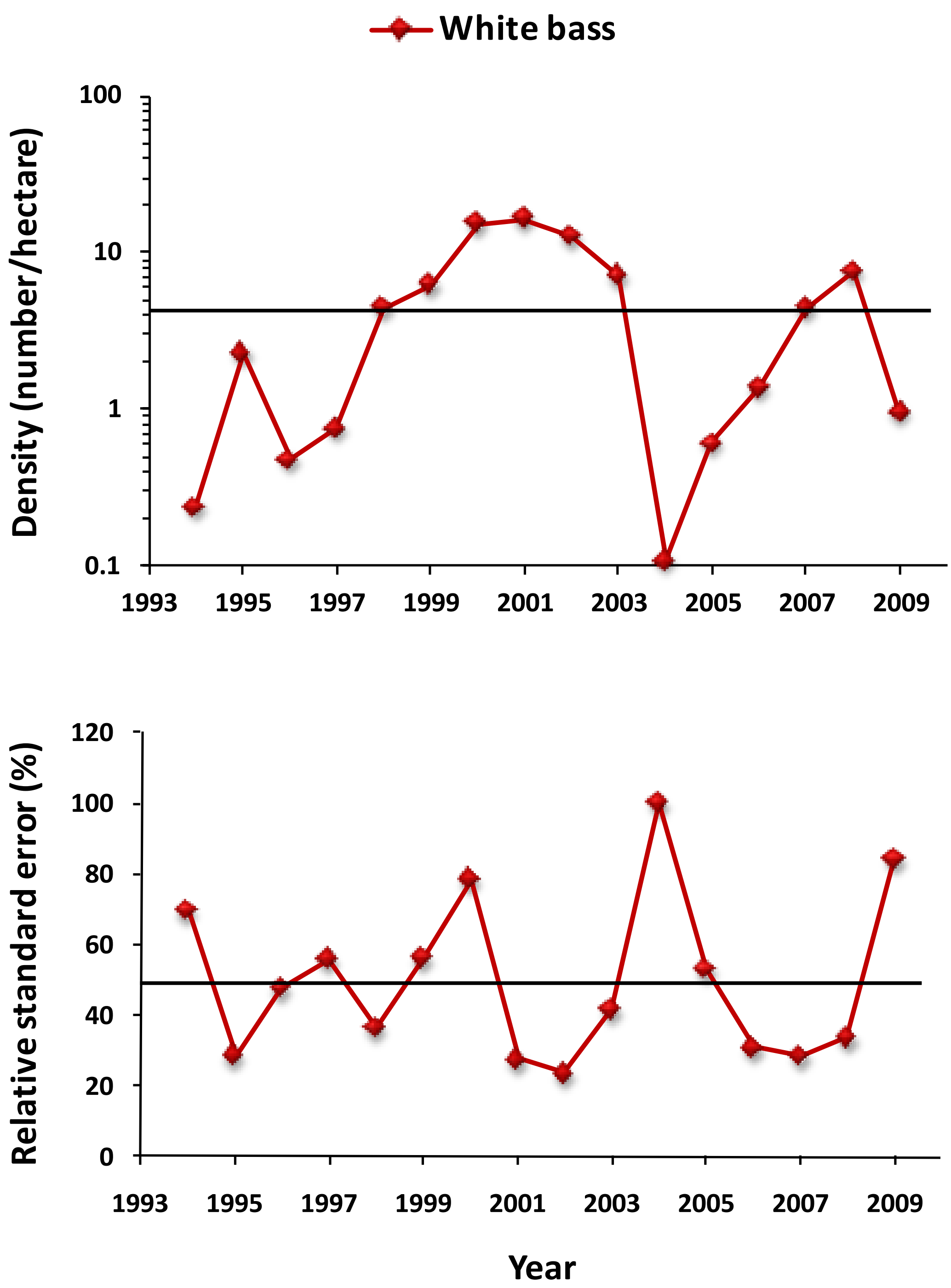

Figure 2.7. Density (top) and relative standard error (bottom) for age-0 white bass in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

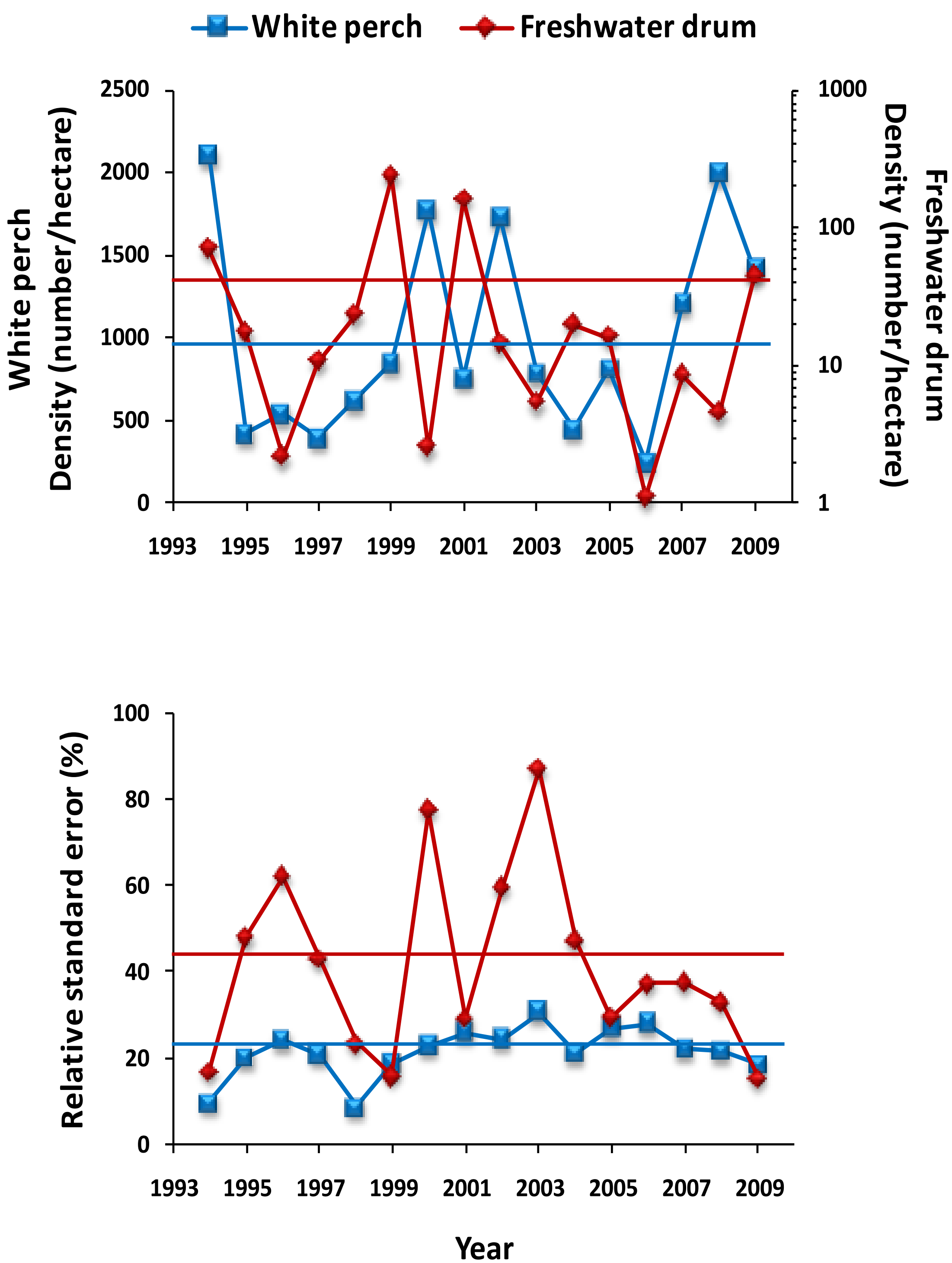

Figure 2.8. Density (top) and relative standard error (bottom) for age-0 white perch and freshwater drum in western Lake Erie near East Harbor State Park, Ohio, during autumn 1994-2009. Horizontal bars represent means.

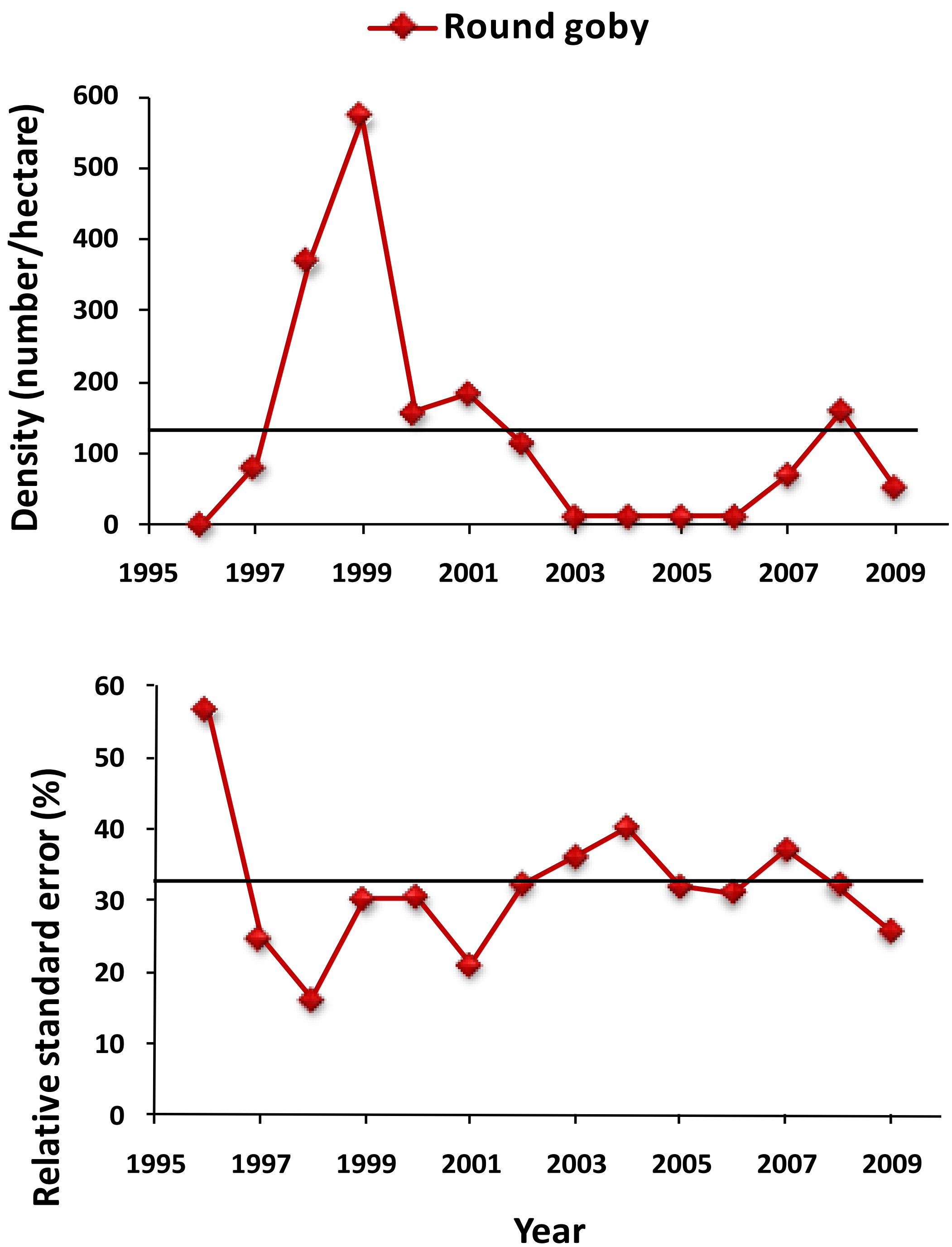

Figure 2.9. Density (top) and relative standard error (bottom) for age-0 and older round goby in western Lake Erie near East Harbor State Park, Ohio, during autumn 1996-2009. Horizontal bars represent means.

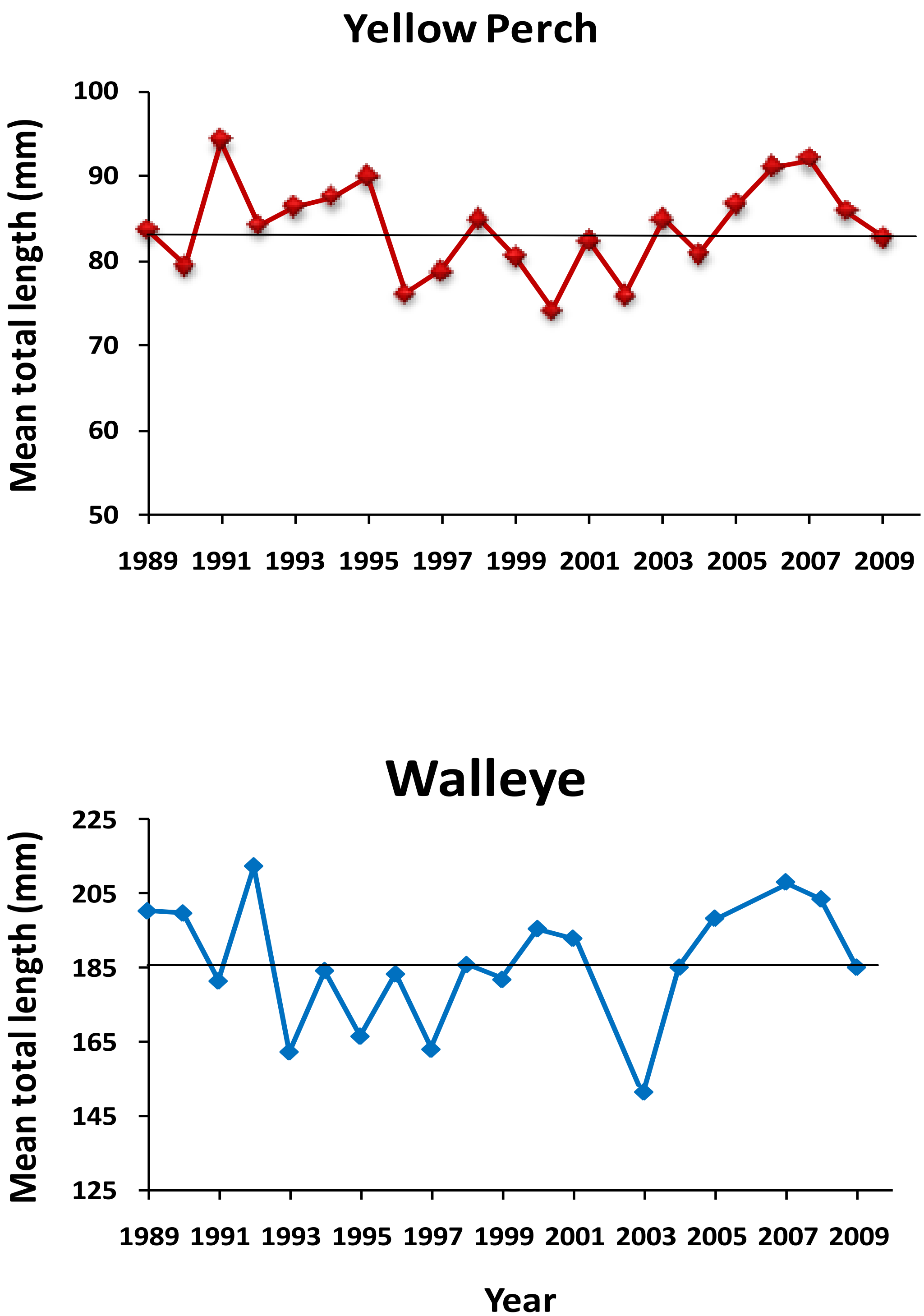

Figure 2.10. Mean total length of age-0 yellow perch and walleye in western Lake Erie near East Harbor State Park, Ohio, in autumn 1989-2009. Horizontal bars represent means.

3.0 Commercial Fishery Sampling

Abstract

We collected samples of white perch *Morone americana* in spring and autumn, lake whitefish *Coregonus clupeaformis* in autumn, and white bass *M. chrysops* in spring from commercial trap nets set in western Lake Erie in 2009. The spring white perch sample (N = 169) was dominated by the 2005 year class (43% of the total sample), and the autumn white perch sample (N = 111) was dominated by the 2007 year class (49%). The lake whitefish (N = 327) sample was dominated by the 2003 year class (56%). The white bass sample (N = 165) was dominated by the 2007 year class (38%) and the 2005 year class (32%). Mean total length at ages 3 and 6 for white perch in spring was the same for the 2006 and 2003 year classes, respectively, as for the 2005 year class (at age 3) and the 2002 year class (at age 6), calculated from historical data. Similarly, mean total length at age 5 for lake whitefish (males in autumn) was the same for the 2004, 2003, and 2001 year classes.

Introduction

The U.S. Geological Survey Lake Erie Biological Station (LEBS) has collected fish samples from commercial trap nets in the western basin of Lake Erie since the 1960s (Bur *et al.* 2006). The objectives of this activity were to estimate growth rates and population age structures of commercially harvested species. In this report we summarize age structure and mean total length-at-age for white perch *Morone americana*, lake whitefish *Coregonus clupeaformis*, and white bass *M. chrysops* collected from commercial trap nets in western Lake Erie during 2009. We also compare mean total lengths at age 5 for three comparatively large year classes of lake whitefish (males only: 2001, 2003, and 2004) and at ages 3 and 6 for two year classes (both sexes: age 3, 2005 and 2006; age 6, 2003 and 2002) for white perch. The results are intended to provide insights into trends in age structure and growth rates for both species. Unlike previous years, samples for yellow perch *Perca flavescens*, were not collected during 2009 owing to no commercial quota for yellow perch being allocated to western Lake Erie.

Methods

All white perch samples were collected from commercial trap nets set offshore of West Harbor, Ohio in western Lake Erie. Spring samples of white perch were collected on 11 and 12 May 2009. Autumn samples of white perch were collected on 13 November and 3 December 2009. All white bass samples were collected from nets set offshore of Cedar Point Ohio on 27 and 29 May 2009. Lake whitefish samples were collected on 12, 19, and 23 November and on 1 December 2009. All samples represented landed catches.

For all three species, total length (nearest mm) of each specimen was measured. Weight (nearest g) of nearly all specimens was also measured. Sex and maturity of each specimen were determined by inspecting the gonads. Sagittal otoliths were removed, and ages of specimens were estimated by examining whole and sectioned otoliths in the laboratory.

Prior to 2003, ages of specimens were estimated by examining scales. Due to the low number of years in which otoliths were examined and low sample sizes for most age classes, we were not able to compare length-at-age for fish collected in 2009 with those collected in most years. For white perch collected in spring we calculated the 95% confidence interval for mean total length at ages 3 and 6 (both sexes) for the 2006 and 2003 year classes, respectfully, and compared them with the intervals calculated for the 2005 (at age 3) and 2002 (at age 6) year classes, based on historical data (Stapanian *et al.* 2009). Similarly, we calculated 95% confidence interval for mean total length at age 5 for male lake whitefish in autumn for the 2004 year class (this report) and compared it with intervals calculated for the 2001 and 2003 year classes (Stapanian *et al.* 2009). This analysis was restricted to males due to a lack of age-5 females collected.

Results and Discussion

In the spring white perch sample, 10 year classes were represented (Table 3.1, N = 169). Estimated age ranged from 2 to 11 years, and the 1998-2000 year classes were represented only by females. The 2005 year class dominated the sample (43%). Mean total length at age 3 for the 2006 year class (95% confidence intervals: females: 219.2 ± 5.0 mm; males: 211.0 ± 3.9 mm) was the same as for the 2005 year class (females: 224.4 ± 2.8 mm, n = 46; males: 209.1 ± 3.9 mm, n = 33 [calculated from Stapanian *et al.* 2009]). Similarly, mean total length at age 6 for the 2003 year class (females: 268.8 ± 4.9 mm, n = 17; males: 252.5 ± 12.1 mm) was not different than that for the 2002 year class (females: 275.5 ± 5.4 mm, n = 17; males: 256.5 ± 19.3 mm, n = 10 [calculated from Stapanian *et al.* 2009]).

The autumn white perch sample (Table 3.2, N = 111) was dominated by the 2007 year class (49% of the total sample), and five year classes were represented. Estimated age ranged from 2 to 8 years. Females represented 70% of the sample. Comparisons of total length at age will be conducted in future reports if LEBS continues to sample commercially caught white perch in autumn.

The white bass sample (Table 3.3, N = 165) was dominated by the 2007 and 2005 year classes (38% and 32% of the total sample, respectively). Estimated ages ranged from 2 to 8 years. Females outnumbered males by a ratio of nearly 2:1 and six year classes were represented in the sample. This was the first year in which LEBS collected and analyzed samples of white bass collected from commercial fishers according to current protocols. Comparisons of total length at age will be conducted in future reports if LEBS continues to sample commercially caught white bass.

The lake whitefish sample (Table 3.4, N = 327) was dominated by the 2003 year class (56% of the total sample), and 14 year classes were represented in the sample. Estimated ages ranged from 4 to 18 years. More males (80% of the total sample) than females were represented, due in large part to the unusually large (n = 137) number of males from the 2003 year class. No females older than age 13 were recorded. Mean total length at age 5 for males in the 2004 year class (490.2 ± 9.0 mm) was the same as that for the 2003 year class (493.8 ± 4.8 mm, n = 70 [calculated from Stapanian *et al.* 2009]) Future reports will compare size at age of individual year classes as sample sizes permit.

Table 3.1. Summary statistics for white perch (N = 169) collected from commercial trap net catches in western Lake Erie during spring 2009. All individuals were sexually mature. Abbreviations: n = sample size, F = female, M =male, SE = standard error.

				Total length (mm)		Weight (g)	
Year class	**Gender**	**Age**	**n**	**Mean**	**SE**	**Mean**	**SE**
2007	M	2	3	192.0	23.4	95.7	24.7
2006	F	3	19	219.2	11.2	167.6	29.7
	M	3	10	211.0	6.4	139.9	16.5
2005	F	4	35	239.8	15.9	232.3	45.5
	M	4	38	229.9	22.2	201.5	33.0
2004	F	5	5	257.2	17.9	299.2	67.9
	M	5	1	240.0	--	248.0	--
2003	F	6	13	268.6	9.0	317.7	49.8
	M	6	17	252.5	25.5	287.4	44.7
2002	F	7	8	283.8	4.4	412.1	28.4
	M	7	6	274.0	6.6	309.3	49.2
2001	F	8	6	278.5	8.0	399.8	41.3
	M	8	4	270.8	3.1	344.3	27.0
2000	F	9	1	305.0	--	448.0	--
1999	F	10	2	304.0	9.9	514.5	24.7
1998	F	11	1	302.0	--	530.0	--

Table 3.2. Summary statistics for white perch (N = 111) collected from commercial trap net catches in western Lake Erie during autumn 2009. All individuals were sexually mature. Abbreviations: n = sample size, F = female, M =male, SE = standard error.

				Total length (mm)		Weight (g)	
Year class	**Sex**	**Age**	**n**	**Mean**	**SE**	**Mean**	**SE**
2007	F	2	34	222.8	25.7	172.5	73.8
	M	2	20	197.3	10.0	107.9	21.6
2006	F	3	12	240.0	17.2	231.3	68.8
	M	3	3	204.3	26.4	128.7	66.5
2005	F	4	30	259.6	20.0	315.5	85.5
	M	4	8	245.4	13.3	231.6	48.8
2003	F	6	2	224.0	55.2	186.5	137.9
	M	6	1	241.0	--	188.0	--
2001	M	8	1	295.0	--	433.0	--

Table 3.3. Summary statistics for white bass (N = 165) collected from commercial trap net catches in western Lake Erie during autumn 2009. All individuals were sexually mature. Abbreviations: n = sample size, F = female, M =male, SE = standard error.

				Total length (mm)		Weight (g)	
Year class	**Gender**	**Age**	**n**	**Mean**	**SE**	**Mean**	**SE**
2007	F	2	27	290.3	10.9	313.3	42.6
	M	2	35	265.0	10.9	223.3	31.0
2006	F	3	7	324.6	16.5	430.9	62.2
	M	3	6	309.3	7.1	342.7	38.4
2005	F	4	43	355.7	100.5	484.9	86.2
	M	4	10	319.3	9.0	380.5	52.3
2003	F	6	13	373.3	18.0	622.2	123.3
	M	6	5	345.4	10.4	474.4	58.9
2002	F	7	11	385.5	8.9	685.8	79.3
	M	7	1	361.0	--	496.0	--
2001	F	8	5	380.0	12.6	659.0	105.1
	M	8	2	347.5	19.1	497.0	158.4

Table 3.4. Summary statistics for lake whitefish (N = 327) collected from commercial trap net catches in western Lake Erie during autumn 2009. All individuals were sexually mature. Abbreviations: n = sample size, F = female, M =male, SE = standard error.

				Total length (mm)		**Weight (g)**	
Year class	**Gender**	**Age**	**n**	**Mean**	**SE**	**Mean**	**SE**
2005	F	4	2	469.0	22.6	1014.0	480.8
	M	4	28	481.4	15.6	1048.2	113.0
2004	F	5	1	512.0	--	1184.0	--
	M	5	17	490.2	18.9	1150.2	161.1
2003	F	6	47	523.7	21.5	1417.8	219.4
	M	6	136	518.4	21.5	1335.0	185.0
2002	F	7	9	525.3	15.1	1496.4	235.2
	M	7	44	518.6	14.7	1344.9	169.6
2001	F	8	4	574.5	51.6	1908.5	624.9
	M	8	19	549.3	29.1	1545.1	274.3
2000	M	9	4	574.0	16.0	1866.5	198.5
1999	M	10	4	581.0	21.9	1969.8	432.0
1998	F	11	2	602.5	3.5	2296.5	280.7
	M	11	2	546.0	4.2	1691.0	182.4
1997	M	12	1	566.0	--	2001.0	--
1996	F	13	1	609.0	--	2166.0	--
	M	13	2	601.5	12.0	2195.5	68.6
1995	M	14	1	635.0	--	2681.0	--
1994	M	15	1	572.0	--	2102.0	--
1993	M	16	1	641.0	--	2709.0	--
1991	M	18	1	604.0	--	2523.0	--

4.0 Acknowledgements

We thank F. Reynolds, T. Reynolds, J. Smith, and J. Swartz for providing samples of commercially-harvested fish. We would also like to thank M. Bur, T. Cherry, D. Hall, and B. Giesler for assistance in the field and L. Kolb for assistance in preparing this report. Constructive reviews were provided by B. Lantry, M. Walsh, C. Knight, J. McKenna, and J. Johnson.

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