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Comparison of Spring and Autumn Bottom Trawl Sampling in the Western Basin of Lake Erie

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Abstract –The Lake Erie Biological Station completed its fourth consecutive year of a collaborative, multi-agency assessment of forage fish populations throughout the western basin of Lake Erie in 2007. The objectives of this evaluation are to determine the best time of year for sampling in order to estimate year-class strength, to examine seasonal distributions of forage fishes, to examine relationships between abundance indices among seasons, and to improve estimates of basin-wide density and biomass of forage fishes. We sampled 25 stations in Ontario and Michigan waters of the western basin of Lake Erie with bottom trawls in June and September 2007. We calculated density (number per hectare) and biomass (kilograms per hectare) of all forage fishes and compared species diversity across seasons and depth strata. We also examined stomach contents from white perch *Morone americana* and yellow perch *Perca flavescens* to describe diets of these two species. Several species, including yellow perch and walleye *Sander vitreus* had stronger year classes in 2007 following three consecutive weaker year classes. Several important forage species also had stronger year classes in 2007 and were abundant throughout the western basin. Fish densities differed among shallow (≤ 6 m) and deep (> 6 m) sites, which supports the two-strata sampling approach recommended by the Lake Erie Forage Task Group. Diets of age-2 and older yellow perch and white perch in 2007 were dominated by zooplankton in June and shifted to benthos in September. Autumn diets of both species exhibited a decrease in the proportion of zooplankton and an increase in the proportion of fish during 2005-2007. Recent analyses of other USGS data sets have underscored the value of nighttime sampling for indices of abundance of yellow perch and walleye. We will explore the possibility of adding nighttime sampling to our western basin program in the future.

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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 objective of the bottom trawl assessments is to determine year-class strength of important prey and predator species. These data are provided to management agencies and several subcommittees of the Lake Erie Committee of the Great Lakes Fishery Commission to assist them in monitoring and managing the Lake Erie fish community. Our data augment data 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. The ODNR also conducts forage fish sampling in the western basin monthly from May through September.

We began a cooperative effort with ODNR and OMNR in 2004 to evaluate forage fish assessment by trawling in June and September at sites in Canadian and Michigan waters of the western basin. In previous years, most of these sites had been sampled either in August only or not at all. The 2007 season was the fourth consecutive year of this collaboration to determine the relative value of spring (June), summer (August), and autumn (September) samples for assessing prey fish communities. The short-term objective is to determine what sampling period is best for determining year class strength of forage fishes. As this data set expands, we will also be able to quantify geographical and seasonal variability in prey species abundance, distribution of prey species within the western basin, and relationships between abundance indices generated from spring, summer, and autumn samples. Ultimately, this research may improve existing basin-wide programs for estimating forage fish density and biomass.

We present estimated density and biomass of young-of-year (YOY) and yearling-and-older (YAO) forage fishes in the western basin of Lake Erie in June and September 2007. We compare values across seasons, depth strata, and years and make comparisons of apparent trends through time. We also present data on diets of yellow perch *Perca flavescens* and white perch *Morone americana*. These data augment our data on yellow perch and white perch diets at our East Harbor site, which have been collected for several years (e.g., Bur et al. 2007). The objective of our diet analysis is to describe the current diet and track changes in diet through time.

Methods

Trawling

Sampling sites in Ontario were chosen from those sampled by OMNR in summer. We selected 19 sites from Ontario waters of Lake Erie (Figure 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 three depth strata (3-6 m, > 6-9 m, and > 9 m). Spring samples were collected during 11 - 13 June 2007. Autumn samples were collected during 17 - 19 September 2007. We used a 7.9-m (headrope) semi-balloon bottom trawl with a mean horizontal opening of 3.9 m for all trawling (measured using SCANMAR acoustic net mensuration gear). The trawl was towed for 10 minutes, on bottom, at an average speed of 4.0 km/hr (range 3.7-4.3km/hr) in June and 3.7 km/hr (range 3.3-3.9 km/hr) in September.

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 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. Subsamples of forage fish were placed on ice for later examination in the laboratory. In the laboratory, fish were measured for total length (nearest mm), and weighed (nearest 0.01 g). For small numbers of fish (30 or fewer), all fish captured were measured and weighed. For larger numbers, subsamples of 30 fish were measured and weighed. Weights were not taken for YAO of predatory species.

For each trawl tow, 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 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 YOY and YAO. All ages were combined for round goby, owing to difficulty in determining age based on length alone. Area swept was calculated as width of the trawl opening multiplied by the distance towed. The distance towed was measured as the difference in

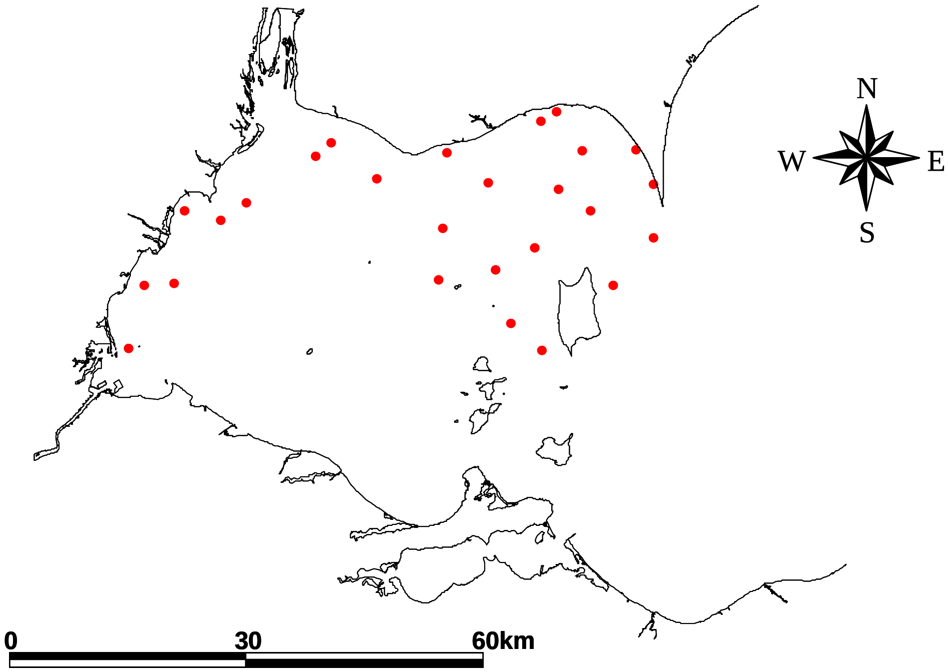

Figure 1. Location of sites sampled with a bottom trawl in June and September in the western basin of Lake Erie, 2007.

starting and ending latitude-longitude determined using differential Global Positioning System. 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. We tested for differences in species diversity in spring and density of YOY in autumn for each species across the three depth strata using ANOVA. We also examined differences across only 2 depth strata (< 6 m and $\geq$ 6 m) using a t-test. The latter test was done because the Lake Erie Forage Task Group recommends these depth strata for choosing sampling sites. Tests for differences in densities were restricted to YOY captured in autumn. Calculations of density and biomass and statistical tests were done in SAS.

Yellow perch and white perch diets

In both seasons, we removed stomachs 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 the field. In the laboratory, prey items in stomachs were identified to the lowest reasonable taxonomic level, enumerated, and measured. Weights were calculated for individual invertebrates from length measurements and appropriate length-weight regressions (see Bur *et al.* 2007). Diet data were reported as frequency of occurrence and mean percent weight (Wallace 1981) by species and by season. Only stomachs that contained food items were included in the analysis. We compare mean percent weights of zooplankton, benthic macroinvertebrates, and fish in the spring and autumn diets for yellow perch and white perch collected on this survey during 2005-2007 (see Bur *et al.* 2006, 2007).

Results

Forage Fish Density and Biomass

All 25 sites were sampled in spring and autumn. Sampling was unsuccessful at one site in Ontario waters in June, owing to the net getting caught on bottom debris. Twenty different species were captured in trawls. Species captured in very low numbers included: one YOY rock bass *Ambloplites rupestris* and one YOY bluegill *Lepomis macrochirus* in Michigan waters; and one common carp *Cyprinus carpio*, one yellow bullhead *Ameiurus natalis*, two white suckers *Catostomus commersonii*, and one YOY lake whitefish *Coregonus clupeaformis* in Ontario waters.

Reproductive success of forage species was mixed in 2007. Several species had improved reproductive success compared to the previous three years. Gizzard shad *Dorosoma cepedianum* and spottail shiner *Notropis hudsonius* (Table 1) had the highest density of the four-year time series (see Kocovsky et al. 2005, 2006, and 2007 for previous year's data). Both were also captured throughout Ontario and Michigan waters of the western basin; gizzard shad was captured at 17 of 25 sites sampled in autumn, triple the number of sites in 2006, whereas spottail shiner was captured at 20 sites, double the number in 2006. Conversely, rainbow smelt *Osmerus mordax*, trout-perch *Percopsis omiscomaycus*, emerald shiner *Notropis atherinoides*, mimic shiner *Notropis volucellus*, and logperch *Percina caprodes* (Table 1) all had the lowest YOY density of the four-year time series. The invasive round goby also had the lowest density of the time series. Round gobies were captured at only 15 of 25 sites in autumn, fewer than in previous years.

The primary native predatory species all had the best reproductive success since 2003. Yellow perch, walleye *Sander vitreus*, and white bass *Morone chrysops* rebounded from several consecutive years of weak year classes.

Table 1. Average density (number 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 2007 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**	**YAO**	**%RSE**
Alewife	0	--	0.2	99.8	0	--
Gizzard shad	0	--	26.9	36.5	0	--
Rainbow smelt	14.1	46.8	14.9	22.7	2.8	53.6
Silver chub	1.9	51.1	0	--	1.1	60.3
Emerald shiner	2,150	39.3	7.8	32	4.4	38.3
Spottail shiner	8.3	57.5	177.6	45.6	4.4	55.3
Mimic shiner	0.3	95.4	0	--	0	--
Trout-perch	38.7	44.2	37.3	27.4	9.7	38
White perch	39.2	27.7	593.9	29.5	7.3	46.8
White bass	3.4	32.2	8	47.1	2.9	100
Smallmouth bass	0	--	0.9	50	0	--
Logperch	0	--	0	--	0	--
Yellow perch	34.1	24	203.9	39	3.7	20.6
Walleye	0.5	67.8	3.1	36.7	0	--
Freshwater drum	1.6	44.4	0.2	99.8	0.4	69.3
Round goby	5.9	31.7	--	--	20.2	33

Walleye YOY density was double the previous high value, yellow perch was more than triple the previous high value, and white bass was 58% higher. Variation in catch was also low compared to past years for all three species. Site-to site variation in catch of yellow perch was high, but YOY were captured at all but three sites in autumn. Similar numbers of YOY walleye and white bass were captured at most sites deeper than 9 m. Although the overall density of white bass was higher in 2007, individuals of this species were captured at fewer sites (N = 10) than in 2006 (N = 15). Non-native white perch had a moderate year class and remains the most abundant predator in the western basin.

Biomass estimates were generally consistent with density estimates (Table 2). As in previous years (*e.g.*, Kocovsky *et al*. 2007), white perch biomass was greater than the combined biomass of all other species reported. Total lengths of prey and predator species (Table 3) were comparable to previous years.

Species diversity did not vary among the shallow (> 3-6 m), moderate (> 6-9 m), and deep (> 9 m) strata ($F_{2, 22} = 0.77$, $P = 0.48$). Diversity also did not differ among stations in water < 6 m deep compared to those in water $\geq$ 6 m deep ($t_{0.05, 16} = 1.33$, $P = 0.20$). Density of YOY in autumn did not vary among three

Table 2. Average biomass (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 2007 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**	**YAO**	**%RSE**
Alewife	0	--	0.001	99.6	0	--
Gizzard shad	0	--	0.216	31.1	0	--
Rainbow smelt	0.064	48.2	0.006	27.1	0.021	65.1
Silver chub	0.101	60.2	0	--	0.048	71.7
Emerald shiner	6.184	37.4	0.01	33.2	0.019	38.2
Spottail shiner	0.097	58.4	0.423	52	0.052	66.3
Mimic shiner	0.002	9.8	0	--	0	--
Trout-perch	0.223	46	0.094	28.1	0.047	44.5
White perch	0.46	46.5	2.074	27.4	--	--
White bass	0.014	78.5	0.178	46.7	--	--
Smallmouth bass	0	--	0.01	58.4	0	--
Logperch	0	--	0	--	0	--
Yellow perch	0.418	23.9	0.795	37.5	--	--
Walleye	--	--	0.148	35.3	0	--
Freshwater drum	--	--	0.003	99.9	--	--
Round goby	0.02	30.4	--	--	0.105	28.7

depth strata for any of the nine species investigated (ANOVA, $0.09 \leq F_{2,22} \leq 2.16$, $0.14 \leq P \leq 0.92$). Conversely, densities of YOY white perch, white bass, emerald shiner, yellow perch, and walleye were higher in deep (≥ 6 m) water than in shallow (< 6 m) water (Table 4).

Yellow perch and white perch diets

Stomach samples were collected from 55 yellow perch and 88 white perch. Nearly all (90%) of these stomachs contained food items. During spring, yellow perch diets were dominated by zooplankton

Table 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 2007 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**
Alewife	--	--	0	71.0	--	1	--	--	0
Gizzard shad	--	--	0	89.9	2.23	130	--	--	0
Rainbow smelt	92.7	1.50	113	46.1	0.57	101	120.8	2.49	13
Silver chub	162.5	9.68	11	--	--	--	159.8	12.66	6
Emerald shiner	71.3	0.61	476	58.1	1.69	45	83.9	0.98	21
Spottail shiner	109.4	2.44	37	60.4	1.43	225	107.6	1.83	11
Mimic shiner	42.5	2.50	2	--	--	--	--	--	0
Trout-perch	86.6	1.09	113	68.9	0.63	134	83.4	2.18	78
White perch	93.9	2.72	7	66.7	0.42	578	--	--	0
White bass	146.0	15.00	2	116.5	3.58	42	--	--	0
Smallmouth bass	--	--	0	92	8.06	5	--	--	0
Logperch	--	--	0	--	--	--	--	--	0
Yellow perch	100.0	0.58	117	73.8	0.33	404	--	--	0
Walleye	--	--	0	182.8	3.46	17	--	--	0
Freshwater drum	--	--	0	122.0	--	1	--	--	0
Round Goby	57.3	1.99	64	--	--	--	67.3	1.41	136

Table 4. Mean and standard error (SE) of density (number per hectare) of young-of-year forage and predator species by depth stratum in the western basin of Lake Erie in September 2007. For each species, the mean densities of each stratum were compared with a t-test.

	Mean		SE			
Species	**< 6 m**	**≥ 6 m**	**< 6 m**	**≥ 6 m**	$t_{(0.05, 23)}$	***P***
Gizzard shad	35.1	24.8	31.7	9.9	0.3	0.77
Rainbow smelt	6.5	17.0	6.5	3.8	1.4	0.20
Emerald shiner	1.8	9.2	1.1	3.0	2.3	0.03
Spottail shiner	114.5	193.4	42.0	100.9	0.7	0.48
Trout-perch	23.1	40.8	9.3	12.5	1.1	0.27
White perch	156.0	703.3	54.4	212.8	2.5	0.02
White bass	0	10.0	0	4.6	2.2	0.04
Yellow perch	13.8	251.3	4.8	96.9	2.4	0.02
Walleye	0	3.9	0	1.4	2.8	0.01

(52% mean percent weight) and benthic macroinvertebrates (45%; Table 5). *Daphnia retrocurva* was the dominant zooplankton consumed by weight (37%) and percent frequency (40%). *Leptodora kindtii* and *Daphnia sp*. contributed 15 percent of the spring diet by weight. Among benthic macroinvertebrates consumed, Chironomidae dominated by weight (20%) and was the most frequently consumed prey by yellow perch during spring (53%). Fish accounted for only 3% of the diet by weight. Emerald shiner was the only fish species identified in yellow perch stomachs during spring.

Five benthic taxa were identified in yellow perch stomachs in autumn (Table 5). Benthic macroinvertebrates dominated the autumn diet by mean percent weight (54%), followed by fish (46%; Figure 2). The dominant benthic invertebrates in autumn diets by weight were *Hexagenia sp.* and Nematoda (both 18% mean weight). Collectively, Chironomidae, Sphaeriidae, and *Trichoptera sp.* accounted for 17% of the diet by weight. Round goby, gizzard shad, and unidentified fish occurred in equal proportions and accounted for the entire fish portion of the diet. Zooplankton were absent from autumn yellow perch diets. Spring white perch diets were dominated by zooplankton (81% mean percent weight) (Table 6). The most abundant zooplankton taxon was *D. retrocurva* (64 %) followed by *L. kindtii., Daphnia sp.,* Copepoda, and Sididae composing the remaining 18% by weight. White perch consumed three different benthic macroinvertebrate taxa during spring for a combined 14% of mean percent weight. Chironomidae occurred most frequently in white perch stomachs (41%) and accounted for the most prey weight among benthic invertebrates (10%). Fish contributed 4% of the spring diet by weight.

Fish were the dominant prey found in white perch diets in autumn, accounting for 48% by weight followed by benthic macroinvertebrates (42%) and zooplankton (10%; Figure 3). Unidentified fish contributed the most by weight to the fish portion of white perch diets (24% of total weight) with emerald shiner and round goby collectively adding another 24.5%. *Hexagenia sp.* dominated the benthic macroinvertebrate portion of the autumn diet (40% of total weight). Copepoda and *L. kindtii* were the only zooplankton taxa found in the stomachs of white perch in autumn.

Table 5. Diet of age-2 and older yellow perch collected during June and September 2007 in Ontario and Michigan waters of western Lake Erie, expressed as mean percent (%) weight of all prey items and percent frequency of occurrence.

	Spring (n = 44)		**Autumn (n = 25)**	
Prey Item	**Mean % Weight**	**% Frequency**	**Mean % Weight**	**% Frequency**
Leptodora kindtii	11.4	28.9	0.0	0.0
Daphnia sp.	3.4	5.3	0.0	0.0
Daphnia retrocurva	37.3	39.5	0.0	0.0
Total Zooplankton	**52.1**		**0.0**	
Chironomidae	20.6	52.6	4.4	9.1
Nematoda	0.0	2.6	18.2	18.2
Sphaeriidae	3.5	26.3	4.6	9.1
Hirudinea	7.3	5.3	0.0	0.0
Trichoptera sp.	5.8	18.4	8.3	9.1
Dreissena sp.	5.0	15.8	0.0	9.1
Hexagenia sp.	2.6	13.2	18.2	27.3
Total Benthos	**44.8**		**53.7**	
Emerald shiner	2.7	2.6	0.0	0.0
Gizzard shad	0.0	0.0	18.2	18.2
Round goby	0.0	0.0	18.2	18.2
Unidentified fish	0.0	0.0	9.9	18.2
Total fish	**2.7**		**46.3**	

Table 6. Diet of age-2 and older white perch collected during June and September 2007 in Ontario and Michigan waters of western Lake Erie, expressed as mean percent (%) weight of all prey items and percent frequency of occurrence.

	Spring (n = 44)		**Autumn (n = 25)**	
Prey Item	**Mean % Weight**	**% Frequency**	**Mean % Weight**	**% Frequency**
Leptodora kindtii	7.7	31.0	4.8	4.8
Daphnia sp.	6.5	24.1	0.0	0.0
Daphnia retrocurva	63.5	81.0	0.0	0.0
Copepoda	0.8	43.9	4.8	4.8
Sididae	2.5	12.1	0.0	0.0
Total Zooplankton	**81.0**		**9.6**	
Chironomidae	10.0	41.4	1.5	14.3
Hirudinea	1.8	1.7	0.0	0.0
Hexagenia sp.	2.6	5.2	40.2	42.9
Total Benthos	**14.4**		**41.7**	
Emerald shiner	3.4	3.4	15.0	19.0
Round goby	0.0	0.0	9.5	9.5
Unidentified fish	0.9	6.9	23.5	47.6
Total fish	**4.3**		**48.0**	

Compared to 2006 (Bur *et al*. 2007), yellow perch diets in 2007 exhibited a decrease in percent composition of zooplankton in both spring and autumn diets, whereas white perch experienced a decrease in zooplankton only in autumn diets (Figures 2 and 3). Further, the percent composition of benthic macroinvertebrates decreased in the spring diet of white perch, and in the autumn diet of yellow perch. Conversely, the percent composition of fish in the diet increased for yellow perch during spring, and increased for both yellow perch and white perch during autumn.

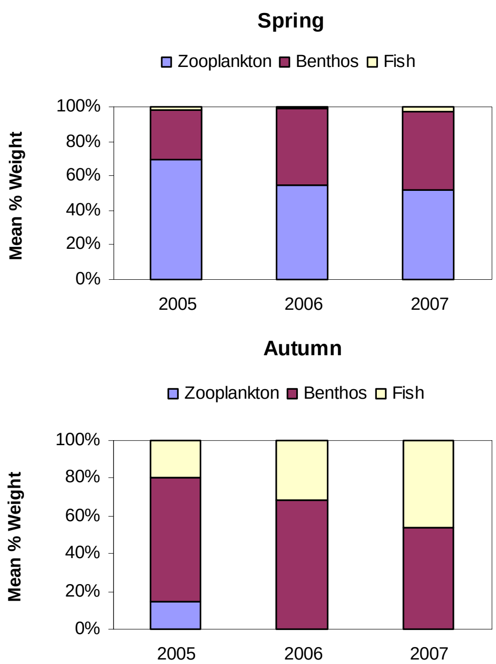

Figure 2. Mean percent weight of zooplankton, benthos, and fish in stomachs of age-2 and older yellow perch collected in Ontario and Michigan waters of western Lake Erie. Stomachs were collected in June and September during 2005-2007.

Although we report diet data for only three years (2005 – 2007), several trends emerged. Autumn white perch diets have exhibited a decrease in percent composition of zooplankton and benthic macroinvertebrates since 2005, but the percent composition of fish has increased (Bur *et al.* 2006, 2007; Figure 2). Autumn and spring yellow perch have exhibited a decrease in percent composition of zooplankton since 2005. Conversely, the percent composition of fish in autumn yellow perch diets and benthic macroinvertebrates in spring yellow perch diets have both increased since 2005. Continued collection of yellow perch and white perch diets will allow for a more detailed analysis of diet trends in future years.

Discussion

Reproductive success of yellow perch and walleye rebounded after three consecutive years of poor success. The index of autumn yellow perch YOY was the highest since USGS began sampling throughout the western basin in 2004 (Kocovsky *et al.* 2005, 2006, 2007). Autumn abundance of walleye YOY was also the highest in USGS records. Cool spring temperatures (C. Knight, ODNR, personal communication) may have positively affected both walleyes and yellow perch. Reduced risk of cannibalism and abundant forage are biotic factors that may have contributed to high YOY walleye abundance. Small numbers of older walleyes owing to several years of poor recruitment and high commercial and recreational harvests of walleyes may have reduced the risk of cannibalism, which has been demonstrated to negatively affect walleye recruitment (e.g., Forney 1976; Hansen et al. 1998). Chevalier (1973) concluded that cannibalism was a major source of mortality of YOY walleyes in Oneida Lake. Cannibalism on early life stages of walleyes has never been studied in Lake Erie but was speculated to be low by Madenjian et al. (1996). Strong year classes of preferred walleye prey, especially gizzard shad, provided ample forage for young walleyes and may have contributed to the strong year class (see Madenjian et al. 1996).

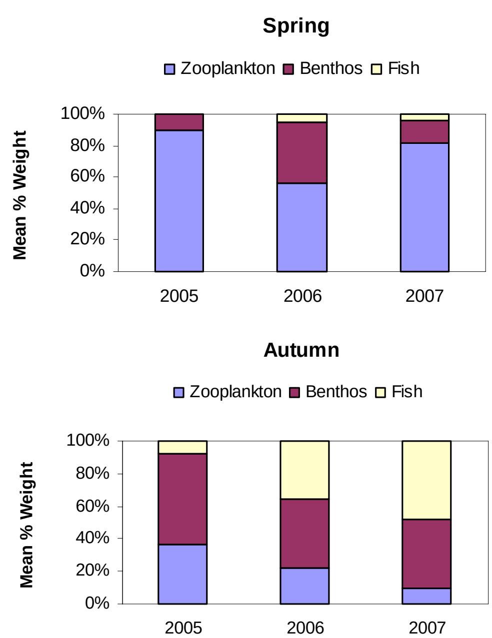

Figure 3. Mean percent weight of zooplankton, benthos, and fish in stomachs of age-2 and older white perch collected in Ontario and Michigan waters of western Lake Erie. Stomachs were collected in June and September during 2005-2007.

Trends in total length over time varied by species. For most of the soft-rayed forage species, changes in total length were negatively related to changes in density (Kocovsky *et al.* 2005, 2006, 2007). Total length of spiny-rayed predators generally increased with density, as did total length of rainbow smelt, trout-perch, and freshwater drum. Thus, there may be a negative effect of density on growth of soft-rayed forage fish species but not of spiny-rayed or predator species. We will continue to monitor trends in length and density.

The outcome of our analysis of species diversity by depth strata was contrary to previous years (Kocovsky *et al.* 2005, 2006, 2007), in which we reported higher species diversity in deeper strata. We attribute this difference to the reproductive success of several species, many of which were distributed more widely across the western basin than in previous years. We will continue to assess species diversity across depth strata as this data set expands.

Our analysis of differences in density across depth strata supports a two-stratum sampling design rather than a three-stratum design. This outcome is consistent with recommendations by the Forage Task Group of the Lake Erie Committee and contrary to the design originally used when this evaluation was begun. Our original design weighted the number of sampling sites within a depth stratum in proportion to the area of that depth stratum within the western basin; thus, having three strata instead of two is more of an analytical issue than a design issue. We see no reason to alter our site selection as a result of this outcome. Furthermore, we analyzed densities by depth stratum for only 2007 data, so we cannot know whether the same pattern will hold for past or future years. Next season we will expand our analysis of density and depth to include all years.

Other research we are conducting on our East Harbor data series has revealed the apparent importance of night sampling to recruitment indices of several western basin species, particularly walleye and yellow perch. Stapanian *et al.* (in review) reported that patterns of abundance of walleye and yellow perch varied with the season and time of day sampling took place, and that omitting night sampling may result in conservative indices of abundance and conservative estimates of absolute abundance. Kocovsky *et al.* (in review) reported that more precise estimates of abundance of yellow perch for setting harvest quotas resulted from reduced sampling regimens that eliminated sampling during daylight hours but retained sampling during night. Sampling during night (defined here as one half hour after sunset through 0100) has been conducted at our East Harbor site since 1961, yielding a continuous 47-year time series. Conversely, night sampling currently is not being conducted by any other agency or at any other sites within the western basin. Over the coming year we will work with ODNR and OMNR to design and propose evaluations of the benefit of nighttime sampling throughout the western basin to determine if results from our single-site sampling merit extension to the remainder of the western basin.

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References

Bur, M. T., M. A. Stapanian, P. M. Kocovsky, W. H. Edwards, and J. M. Jones. 2006. Surveillance and status of fish stocks in western Lake Erie, 2005. Report to the Great Lakes Fishery Commission, Lake Erie Committee Meeting, Windsor, Ontario, March, 2006.

Bur, M. T., M. A. Stapanian, P. M. Kocovsky, W. H. Edwards, and M. J. Porta. 2007. Surveillance and status of fish stocks in western Lake Erie, 2007. Report to the Great Lakes Fishery Commission, Lake Erie Committee Meeting, Ypsilanti, Michigan, March, 2007.

Chevalier, J. R. 1973. Cannibalism as a factor in first year survival of walleye in Oneida Lake. Transactions of the American Fisheries Society 102:739-744.

Hansen, M. J., M. A. Bozek, J. R. Newby, S. P. Newman, and M. D. Staggs. 1998. Factors affecting recruitment of walleyes in Escanaba Lake, Wisconsin, 1958-1996. North American Journal of Fisheries Management 18:764-774.

Kocovsky, P. M., M. T. Bur, and M. A. Stapanian. 2005. Comparison of spring and autumn bottom trawl sampling in the western basin of Lake Erie. Report to the Great Lakes Fishery Commission, Lake Erie Committee Meeting, Niagara Falls, Ontario, March, 2005.

Kocovsky, P. M., M. T. Bur, and M. A. Stapanian. 2006. Comparison of spring and autumn bottom trawl sampling in the western basin of Lake Erie.

Report to the Great Lakes Fishery Commission, Lake Erie Committee Meeting, Windsor, Ontario, March, 2006.

Kocovsky, P. M., M. T. Bur, M. A. Stapanian, and W. H. Edwards. 2007. Comparison of spring and autumn bottom trawl sampling in the western basin of Lake Erie. Report to the Great Lakes Fishery Commission, Lake Erie Committee Meeting, Ypsilanti, Michigan, March, 2007.

Kocovsky, P. M., M. A. Stapanian, and C. T. Knight. *In review*. Evaluating sampling regimens for indices of yellow perch abundance in Lake Erie. North American Journal of Fisheries Management.

Madenjian, C. P., J. T. Tyson, R. L. Knight, M. W. Kershner, and M. J. Hansen. 1996. First-year growth, recruitment, and maturity of walleyes in western Lake Erie. Transactions of the American Fisheries Society 125:821-830.

Stapanian, M. A., J. V. Adams, P. M. Kocovsky, M. T. Bur, and W. H. Edwards. *In review*. Effects of season and time of day on patterns of abundance of young-of-year yellow perch and walleye in Lake Erie. Journal of Great Lakes Research.

Wallace, R. K. 1981. An assessment of diet-overlap indexes. Transactions of the American Fisheries Society 110:72-76.