ILLINOIS NATURAL HISTORY SURVEY

Yellow Perch Population Assessment in Southwestern Lake Michigan, Including Evaluation of Sampling Techniques and the Identification Factors that Determine Yellow Perch Year-Class Strength

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Steven R. Robillard and J. Ellen Marsden

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Steven R. Robillard and J. Ellen Marsden

Center for Aquatic Ecology, Illinois Natural History Survey

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J. Ellen Marsden
Principal Investigator
Center for Aquatic Ecology

Steven R. Robillard
Principal Investigator
Center for Aquatic Ecology

David P. Philipp
Director, Center for Aquatic Ecology

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Tables

Figures

EXECUTIVE SUMMARY

The objectives of this study are to expand the Illinois Department of Natural Resources (IDNR) annual yellow perch stock assessment data, compare catches from IDNR and Illinois Natural History Survey (INHS) monitoring programs, investigate the diel vertical migration of larval yellow perch, monitor population densities of young-of-the-year yellow perch, and identify some of the factors likely to have limited yellow perch recruitment in the past 7 years. We added a supplemental index station to the two IDNR index stations traditionally used in Illinois waters. The location of the IDNR Lake Bluff index station was assessed with respect to the annual yellow perch spawning concentrations to determine whether movements of spawning aggregations affect relative abundance estimates. Effective sampling techniques for larval perch and their prey were investigated, young-of-the-year perch were sampled with a bottom trawl, and programs to monitor yellow perch egg mass densities, post-larval yellow perch abundance, and the effect of adult alewife predation on yellow perch larvae were developed.

The results of this project will enable fish managers to develop effective management strategies for this important sport and historically commercial fish species. New information on specific areas where yellow perch spawning occurs will strengthen IDNR spawning assessments. Larval perch sampling will expand our understanding of the early life history of yellow perch in terms of larval fish movements, feeding behavior, and survival. Early life history data will eventually lead to an understanding of factors that affect juvenile survival and future year-class strength.

The following conclusions are drawn from the third year of the project. These conclusions represent one year of data and cannot stand alone, particularly as some of the objectives depend upon a time-series of data.

1. Results from sampling equidistant sites around the IDNR Lake Bluff index station suggest that the IDNR index station is not the focus of spawning in the Lake Bluff area. During the 1996 spawning season, mean catches of yellow perch were significantly higher at two sites, 1.5-nm south (North Lake Forest) and 4.5-nm south (Fort Sheridan) of the Lake Bluff index site, compared to the other 5 index sites (ANOVA, $p<0.05$). Variability in catches was also greater at those two sites. The relatively high degree of variability in catches at all seven sites indicates that the perch move in and out of these spawning areas throughout the spawning period.

2. Tagged yellow perch were usually recaptured at the site at which they were tagged (55% of recaptures) and we recaptured 2.5% (270 of 13,462) of the tagged fish during the spawning season (03 May - 02 July), thus some long-term residence over the spawning period is implied. However, no effort was expended to catch fish outside the nine mile sample area, as both the sport and commercial fisheries were closed during June. Sport and commercial recapture rate of tagged perch between 01 July and 31 Dec was 2.9% (395 perch).

3. The average length of all measured perch was 229-mm (SD=20-mm) for males, and 306-mm (SD=39-mm) for females. The difference in mean lengths can be attributed to the difference in growth rates between the sexes, since age-distributions were similar (Chi-square, $p>0.05$).

4. Males constituted 97.4% of all measured perch (N=14,607). Females and unknowns were 1.1% and 1.5%, respectively. The male to female sex ratio of unknown-sex fish (i.e., perch which could not be sexed in the field) was 5.4:1; the sex ratio of the perch subsampled for age-analysis was 33:1. The skewness of the sex ratios is likely a function of the sampling gear since males tend to congregate in the nets, however it may also be an indicator of future problems with reproductive potential if the proportion of females in the population is continually reduced.

5. The majority of yellow perch collected in fyke nets during 1996 were age-8 (30%, 1988 year-class); age-7 and older fish comprised 76% of the total catch. Age-distributions for male and female perch were similar. The distribution of ages for both sexes was approximately normally distributed and indicates instability in the population structure, since ages should ideally be skewed toward younger age-groups.

6. Virtually no perch larvae were captured using plankton nets compared to previous years. Larval perch were captured on only 7 nights during the sampling period (03 June - 20 August, 15 nights sampled). A decline in the yearly abundance of perch larvae since 1994 (S. Robillard, unpub. data) may indicate reproductive failure, failure of eggs to successfully hatch, or large-scale post-hatch mortality.

7. We captured one young-of-the-year yellow perch in thirty-four 0.5-nm bottom trawls. Approximately 153,000 m^2 of the lake bottom was sampled. The paucity of young-of-the-year yellow perch may indicate a failure of larval fish to be recruited to the sub-adult population.

8. Alewife stomachs contained very few perch larvae, however the abundance sampling indicated that the density of perch larvae at the sample sites was also low. Additional years of data will be required to look at the effect of alewife predation on perch recruitment under conditions of higher prey (i.e., larval perch) densities.

9. Zooplankton samples collected coincident with larval perch samples are still under analysis.

10. Yellow perch egg masses were located near two intake lines sampled during early June, 1996; no egg masses were located in areas void of substrate likely to catch and hold eggs (i.e., sand). The presence of eggs throughout the spawning season indicates that these sites will likely be effective index stations for future sampling. Egg viability was estimated to be 95% viable for sampled egg masses returned immediately to the laboratory and viewed under a dissecting microscope.

11. Light traps deployed to sample post-larval stage perch were not successful, however this was likely due to the near-absence of emergent larvae in the abundance samples and limited sampling efforts. Macro-zooplankton were successfully captured. Additional years of sampling will be required to assess the efficiency of the gear for sampling larval and post-larval perch populations.

INTRODUCTION

Yellow perch (*Perca flavescens*) are an important commercial and sport fish throughout much of their range in North America. Their schooling behavior promotes sizable captures in commercial gears such as trap nets and gill nets, and their tendency to congregate near shore in the spring makes them readily available to shore fishermen. Due to their excellent taste, their flesh is prized, and currently sells in Illinois for $9 to $11 per pound. The majority of yellow perch harvested in North America are taken from the Great Lakes; yellow perch provide the most important sport fisheries in the four states bordering Lake Michigan, and large-scale commercial fisheries in three of those states.

Lake Michigan yellow perch have undergone severe fluctuations in abundance in the past few decades. The population in the southern basin increased dramatically in the 1980s (McComish 1986), and the sport and commercial fisheries expanded accordingly. In Illinois waters alone, the estimated annual catch by sport fishermen doubled between 1979 and 1993, from 600,000 to 1.2 million fish (Muench 1981, Brofka and Marsden 1993). Between 1979 and 1989, the commercial harvest in Illinois tripled, in Wisconsin (excluding Green Bay) it increased six-fold, and in Indiana the harvest increased by over an order of magnitude (Baumgartner et al. 1990, Brazo 1990, Hess 1990). However, a federally-funded study recently completed by the Illinois Natural History Survey (Marsden et al. 1993) indicated that the fishery in 1993 was primarily supported by a strong year-class spawned in 1988, and that no strong year-class had been produced since then. Few or no young-of-the-year (YOY) yellow perch were found in lakewide sampling efforts during 1996 (Hess 1997). Consequently, the yellow perch population is aging - the population as a whole was composed of larger and older individuals in 1995 than in 1986 (Robillard et al. 1996).

The ability to manage yellow perch is hampered by insufficient information about population size, stock structure, movements, and factors which affect population growth. Evaluation of the best techniques and locations to collect assessment data is necessary to maximize information access. Recent federally funded research by the Illinois Natural History Survey (INHS) has shown that Lake Michigan yellow perch populations are too large and too mobile for single agency mark-and-recapture studies to be viable (Marsden et al. *in review*). However, annual assessment data of spring spawning populations at index stations, combined with assessment of year-class strength, permit evaluation of the population's relative abundance. These data have been obtained in the past by the Illinois Department of Natural Resources (IDNR) at two gill net index stations, and by the INHS at two sites using fyke nets. There are several inadequacies in these data, however: (1) there is no index station near the southern border of the Illinois shoreline; (2) data from gill nets and fyke nets are not comparable without direct comparison at the same sites during the same time period; (3) it is unknown where spawning concentrations of perch occur, or how stable such locations (if they exist) are from year to year. If foci of spawning concentrations move from year to year, then data from localized index stations may reflect this movement rather than any real information about population size.

To protect yellow perch stocks, fisheries managers should ideally set quotas in accordance with fluctuating population sizes. Assessment of larval and young-of-the-year perch populations may permit prediction of future year-class strength. However, the variances on larval perch abundance data and YOY catches are very high, and the diel and vertical movements of yellow perch larvae and their prey are not well documented in large lakes. Tracking these movements will enhance our understanding of larval fish feeding behavior and early life survival rates, contributing to our ability to monitor year-class strength relative to other years.

The continued decline of the yellow perch population due to reduced recruitment of larvae to the YOY stage has prompted researchers to narrow the focus of investigation to pre-YOY interactions and survival. The effect of alewife predation on perch larvae will be investigated. Development of an annual index for perch egg production will provide an index of reproductive potential and success. Comparison of post-zebra mussel zooplankton samples with pre-mussel samples will provide valuable information on the availability of food for emergent perch larvae, and lend an understanding to the effects of alewife predation on perch larvae in the presence of alternate food sources.

The results of this project will strengthen management strategies for this important sport and commercial species. These findings will be incorporated into yellow perch management strategies by a multi-agency collaboration, which reflects a changing philosophy in the Great Lakes system toward ecosystem management.

METHODS

Sampling gear

Adult yellow perch were collected using fyke nets (INHS) and graded-mesh gill nets (IDNR). We used 1.2 x 1.8-m (4 x 6-ft) doubled-ended fyke nets with a 30.5-m (100-ft) leader between the two double-throated pots. Fyke net mesh was 38-mm (1.5-in) stretched measure. Assessment gill nets were composed of five panels (Table 1).

Table 1. Length and mesh size of panels used in IDNR yellow perch spawning assessment gill nets.

Panel	Length	Mesh size
1	15.2-m (50-ft)	25.4-mm (1-in)
2	30.5-m (100-ft)	38-mm (1.5-in)
3	30.5-m (100-ft)	51-mm (2-in)
4	91.4-m (300-ft)	63-mm (2.5-in)
5	91.4-m (300-ft)	76-mm (3-in)

All plankton sampling was conducted using 0.5-m dia nets with a 5:1 scope. Abundance sampling for yellow perch larvae was performed with a 363-µm mesh net; zooplankton samples were collected using a 72-µm mesh net (some replicate zooplankton samples were collected with a 153-µm mesh net).

A Miller sampler with a 10-cm dia opening and 1000-µm mesh netting was used to sample post-larval stage yellow perch. Light traps were also deployed to sample post-larval stage yellow perch and each trap's contents were rinsed through a 153-µm mesh net.

A bottom trawl with a 4.9-m (16-ft) head rope, 38-mm stretch mesh body, and 13-mm mesh cod end was used to sample post-larval stage and young-of-the-year yellow perch.

Supplemental Index Gill Netting

The Illinois Department of Natural Resources sampled a transect outside Calumet Harbor to monitor spawning yellow perch. All sampling at the Calumet Harbor index station was conducted by J. Camalick, with IDNR and INHS personnel on board his boat. Gill nets were set at depths of 7.2 and 10.8-m (4 and 6 fathoms) on 20 May, 1996, and at 14.6 and 18.3-m (8 and 10 fa) on 21 May, 1996. Nets were fished for approximately 24-hr. All fish in all nets were counted. Subsamples of 25 fish from each gill net panel were collected. Subsampled fish were weighed to the nearest 10-g, measured (total length) to the nearest 5-mm, and dissected to determine reproductive status. Ages were estimated from otoliths. If the total catch for any panel was less than 25, all fish in that panel were subsampled.

Calibration of Data from Fyke Netting and Gill Netting

No calibration was performed during this segment. Our research vessel, the *Sculpin*, was out of commission due to transmission problems with the starboard engine during the IDNR index assessment. Calibration sampling will be continued in the next segment.

Validation of Index Station Locations

Fyke nets were set at the IDNR Lake Bluff index station and either 1.5, 3, or 4.5 nautical miles (nm) north and south of that index station (Figure 1). Nets were set along the 5-m depth contour line, usually parallel to shore. All nets were fished for approximately 24-hr. Four sampling units (Lake Bluff +/- 1.5, 3, and 4.5-nm) were completed; i.e., 12 sets of 3 nets per day. An additional set at the Lake Bluff +/- 1.5-nm sites was conducted to compensate for the small catch at the start of the season (03 May, 12 perch total). Catch data were analyzed using ANOVA (Zar 1984).

We sampled an additional complete sampling unit between 11 July and 17 July, and one net was set at the Lake Bluff site and 4.5-nm south of that site (Fort Sheridan) on 13 August to recapture tagged perch. No fish were subsampled or tagged from these samples.

Subsamples of 25 yellow perch (668 total) from each net were collected from the first 10 sets for dissection to determine sex, maturity, and age. The remaining fish were tagged (~1,000 max. per net) using individually numbered Floy tags, measured for total length, and externally examined to determine sex and reproductive status. All other fish captured in each fyke net were counted, and non-target species were recorded. All fish, except the subsampled fish, were released.

Yellow Perch Population Structure

Biological data (i.e., length, weight, sex, and maturity) were obtained from all INHS subsampled yellow perch, and the ages of the fish were estimated from sagittal otoliths as per Robillard and Marsden (1996); otoliths from one fish were not aged. Additional fish for which the sex could not be determined in the field were collected from nets fished between 03 May and 02 July (251 fish total) to serve as an index of unknown-sex fish captured during the spawning season. Unknown-sex fish were measured, dissected in the laboratory, and ages were estimated from sagittal otoliths. Age data were analyzed using Chi-square (Zar 1984).

Diel Larval Perch and Plankton Sampling

Abundance estimates

Samples were collected near Waukegan Harbor (Figure 2) on fifteen nights between 03 June and 20 August, 1996. The net was pushed at the surface with a bow-mounted frame at a speed of approximately 2-m•sec^{-1}. One 5-m and one 10-m (bottom depth) transect was sampled ~1.5-nm both north and south of the harbor entrance. A calibrated General Oceanics™ standard flowmeter mounted in the mouth of the net was used to determine the volume of lake water sampled. Each 0.5-nm surface push sampled approximately 160-m^3 of water. Larval fish were extracted from plankton samples and identified to genus, species when possible. Ostracods were extracted and enumerated.

Vertical movement

No vertical movement sampling was attempted during this segment because the number of larval perch collected in the abundance samples did not vary significantly from zero.

Young-of-the-Year Sampling

Trawling for young-of-the-year (YOY) yellow perch was conducted approximately weekly (8 times) between 15 August and 28 October, 1996, at various depths between 3 and 10-m, at a speed of approximately 2-m•sec^{-1}. All sampling occurred north of Waukegan Harbor. Each 0.5-nm transect sampled approximately 4519-m^2 of the lake bottom. YOY yellow perch and non-target species were recorded.

Alewife Predation on Yellow Perch Larvae

Adult alewife were sampled using a gill net fished for approximately 30-min on five of the same nights as larval perch abundance sampling occurred; samples were collected at the two 10-m (bottom depth) larval perch sampling sites. The gill net was composed of three panels with stretched measures of 25.4-mm (1-in), 38-mm (1.5-in), and 44-mm (1.75-in). Each panel was 30.5-m (100-ft) in length; i.e., total length of the net was 91.5-m (300-ft).

All alewife were measured to the nearest 1-mm (total length) and dissected to remove the entire digestive tract. Some stomachs were stored in 10% formalin; others were stored in 95% ethanol until examination. In the laboratory, samples were examined and presence or absence of phytoplankton, zooplankton, amphipods and isopods, insect larvae, and larval fish were noted. Intact larval fish were identified to lowest possible taxon.

Zooplankton Sampling

Zooplankton samples were collected on the same nights as larval fish samples between 04 June and 20 August (11 samples) and samples were collected independent of larval perch sampling on 14 August. Replicate, vertical-lift samples were collected at the two 10-m (bottom depth) larval perch sampling sites. A Kahlisco flowmeter mounted inside the mouth of the net was used to monitor the volume of water sampled. Each vertical lift sampled approximately 1.9-m^3 of water.

In the laboratory, zooplankton were grouped into seven broad taxa: Cladocerans (Daphnia and Bosminids), cyclopoid copepodites, calanoid copepodites, copepod nauplii, *Macrothrididae* spp., *Chydoridae* spp., and *Sididae* spp. Other rare taxa in the samples were noted. A maximum of twenty individuals of each taxa (except nauplii) were measured using an image analysis program (Optimus ver. 3.0).

Egg and Post-larval Perch Sampling

Yellow perch egg masses were counted by scuba divers along the abandoned US Steel and Dexter Corporation water intake lines, located approximately 1-nm south of Waukegan Harbor, and along the Zion municipal water intake (Figure 2, Table 2). Eggs were subsampled from each egg mass and transported back to the laboratory where the percentage of viable eggs was estimated using a dissecting microscope.

Table 2. Summary of egg census dives.

Date	Site	Transect length (m)	Depth range (m)	Substrate
03 June	Dexter	200	4 - 6	cobble
12 June	US Steel	59, 50	4 - 6	cobble, sand
14 June	US Steel	105	2 - 5	cobble
25 June	North Point	39	5 - 6	sand
27 June	US Steel	105, 105	5 - 6	cobble, sand
01 July	Zion	105	5 - 7	sand

Post-yolk-sac yellow perch were sampled using a Miller sampler towed behind the *Sculpin* on 24 September. One 2-nm transect was sampled along the 5-m (bottom depth) contour line at a speed of 2.8-m•sec^{-1}.

Light traps were deployed twice during the sampling season. One trap of each design was suspended on a tethered line at the 10-m (bottom depth) larval perch sampling site, south of Waukegan Harbor, on 14 August and 20 August, 1996. Trap designs were alternated between depths on the two nights; i.e., the box model was set at depths of 1 and 6-m on 14 August and at 3 and 8-m on 20 August. Contents of the traps were rinsed through 153-mm mesh nets and examined for the presence of larval fish.

RESULTS

Supplemental Index Gill Netting
A total of 232 yellow perch were captured in IDNR assessment gill nets at the Calumet Harbor index station.

Calibration of Data from Fyke Netting and Gill Netting
No results.

Validation of Index Station Locations
A total of 22,014 yellow perch were captured in thirteen net sets (3 nets/set) between 03 May and 02 July, 1996. The greatest concentrations of yellow perch were captured south of the IDNR Lake Bluff index site (Figure 3). Catches at the North Lake Forest and Fort Sheridan sites were significantly greater than those at the other five sites (ANOVA, $p<0.05$). Within-site variation in catches was also significant ($p<0.05$) and likely indicates that concentrations of perch move between sites throughout the spawning season.

A total of 13,462 perch were tagged from the first thirteen net sets. We recaptured 270 tagged perch between 31 May through 02 July (spawning season) and an additional 69 between 11 July and 13 August. We also recaptured 81 tagged perch at the Lake Bluff site within one day when the net was reset immediately following tagging; these fish were excluded from the data set prior to analysis. The majority (55%) of recaptured yellow perch were recaptured at the site at which they were tagged (Table 3).

Table 3. Number of tagged yellow perch recaptured by INHS, during the 1996 spawning season, by site, and number and percent of recaptured fish tagged at that site (minimum 24-hr at liberty).

Site	No. recaptures at site	No. recaptures tagged at site	% of recaptures tagged at site
Waukegan	3	2	66.67
North Chicago	3	0	0
Great Lakes	4	0	0
Lake Bluff	163	128	78.53
North Lake Forest	67	20	29.85
South Lake Forest	28	1	3.57
Fort Sheridan	71	34	47.89
All sites	339	185	54.57

Sport and commercial fishermen returned 395 tags (Table 4) in the first six months after the season was reopened (i.e., July through December); tag returns from a single angler constituted 12% of the total sport returns.

Six tagged perch from a previous study (F-93-R), in which perch were tagged between 1989 and 1991 in Illinois waters, were also captured in our nets. An additional eight fish tagged as part of

F-93-R were also recovered by commercial and sport fishermen during 1996. The longest any of these fish was at liberty was 2,502 days (Table 5).

Nontarget species captured in the fyke nets included 1223 alewife (*Alosa pseudoharengus*), 123 white sucker (*Catostomus comersoni*), 61 lake chub (*Couesius plumbeus*), 49 longnose sucker (*Catostomus catostomus*), 2 rock bass (*Ambloplites rupestris*), 2 sculpin (*Cottus* spp.), 1 green sunfish (*Lepomis cyanellus*) and 1 burbot (*Lota lota*). Nontarget species were captured in 42 of the 50 nets.

Table 4. Number of tagged yellow perch recaptured by INHS and sport and commercial fishermen, by tagging site, between 31 May and 31 December, 1996 (minimum 24-hr at liberty).

Site	# tagged	INHS	Other	% total recaptures
Waukegan	756	7	21	3.70
North Chicago	272	0	8	2.96
Great Lakes	381	8	12	5.25
Lake Bluff	4,210	187	140	7.77
North Lake Forest	3,522	70	80	4.26
South Lake Forest	712	12	16	3.93
Fort Sheridan	3,609	55	118	4.79
All sites	13,462	339	395	5.45

Table 5. Yellow perch, tagged in a previous INHS study (1989-1991), recaptured by commercial and sport fishermen and INHS between 03 May and 31 December, 1996.

	Tagging		Recapture		
Tag #	Date	Site [a]	Date	Location	Days at liberty
7362	8/25/89	A	7/1/96	Kenosha, WI	2,502
9800	9/21/89	A	6/19/96	Lake Bluff, IL	2,463
14036	5/21/90	A	6/28/96	Kenosha, WI	2,230
15233	5/23/90	A	8/13/96	Wilmette, IL	2,274
18191	5/24/90	B	7/14/96	Chicago, IL	2,243
23586	5/31/90	B	6/28/96	Lake Bluff, IL	2,220
24751	5/31/90	B	11/7/96	Calumet, IL	2,352
27037	6/1/90	B	6/28/96	Fort Sheridan, IL	2,219
29688	6/6/90	C	8/96	Evanston, IL	2,248
32029	9/18/90	A	6/27/96	Lake Bluff, IL	2,109
32303	9/26/90	A	6/28/96	Lake Bluff, IL	2,102
33372	9/27/90	A	6/26/96	North Lake Forest, IL	2,099
44357	5/30/91	A	8/16/96	Evanston, IL	1,905
48031	6/7/91	C	7/12/96	Michigan City, IN	1,862

[a] See Figure 1.

Yellow Perch Population Structure

The average length of all measured perch was 229-mm (SD= 20-mm) for males (Figure 4), and 306-mm (SD= 39-mm) for females. The smallest subsampled perch (119-mm, 16.37-g) was an age-1 ripe male; the largest perch (362-mm, 603.2-g) was an age-11 spent female.

Males constituted 97.4% of all measured perch (N=14,617). Females and unknowns were 1.1% and 1.5%, respectively. The male to female sex ratio of subsampled fish was 33:1; the ratio of unknown-sex perch (i.e., fish which could not be sexed in the field) was 5.4:1. The majority of females classified as unknowns in the field were less than age-8; the age of males centered around the mean of age-8 (Table 6).

Inability to express gametes to determine sex of the fish was either due to immaturity of the fish (15% of females, 37% of males), or to a variety of testicular problems in male fish such as cysts (15%), constricted testes (6%), undeveloped testes (5.7%), or tumors and deformations (11% combined). Females are more difficult to sex than males, due to the difficulty of expressing eggs; the ratio of females in the 'unknown sex' samples was much higher than in the random subsamples of fish from the fyke nets.

The 1988 year-class (age-8) made up the greatest portion (30%) of the subsampled fish captured with fyke nets (Figure 5); age-7 and older fish comprised 76% of the total catch. Four 1982 year-class (age-14) and two 1981 year-class (age-15) yellow perch were collected in the subsampled fish; over 60% of the subsampled fish were age-8 or older. No age-4 fish were present in the subsample.

Table 6. Age-distributions of yellow perch classified as unknown-sex in the field, collected using fyke nets, near Lake Bluff, IL, between 03 May and 26 June, 1996.

Year-class	Age	Male (N=212)	Female (N=39)
1994	2	3	4
1993	3		5
1992	4		1
1991	5	1	2
1990	6	22	7
1989	7	36	8
1988	8	98	9
1987	9	20	
1986	10	21	
1985	11	4	1
1984	12	3	
1983	13	4	1
1982	14		
1981	15		
1980	16		1

Diel Larval Perch and Plankton Sampling
Relatively few yellow perch larvae were captured with the 0.5-m plankton nets, deployed at the surface at night, compared to previous years (Marsden et al. 1993, Robillard et al. 1995, 1996). No larval yellow perch were captured prior to 12 June. Average catch-per-unit-effort (CPUE) of larval perch between 09 June and 02 July ranged between 0 and 4.6 fish•100m^{-3}, compared to CPUEs of over 100 fish•100m^{-3} in previous years (Marsden et al. 1993; Robillard et al. 1995). Reduced abundances of alewife larvae were also noted. The abundance of ostracods, a zooplankter, which had been relatively constant over all sampling periods between 1992 and 1994 (unpublished data), declined by more than two orders of magnitude.

No attempt was made to sample vertical strata to monitor larval perch diel movements was made because larval perch densities never increased above 5 fish•100m^{-3}.

Young-of-the-Year Sampling
One YOY yellow perch was captured in thirty-four 0.5-nm transects, yielding a CPUE of 0.007 (fish•1000m^{-2}) for the year. The most abundant fish species captured were alewife (37.9%), spottail shiner (*Notropus hudsonius*, 32%), and rainbow smelt (*Osmerus mordax*, 23.1%). Small numbers of 3-spine stickleback (4%) and 9-spine stickleback (1%) were also captured. One or more Johnny darter (*Etheostoma nigrum*), longnosed dace (*Rhinichthys cataractae*), sculpin, trout-perch (*Pecopsis omiscomaycus*), gizzard shad (*Dorosoma cepedianum*), shiner (*Notropis* spp.), adult lake whitefish (*Coregonus clupeaformis*), and round whitefish *(Prosopium cylindraceum*) were also captured, and cumulatively represented < 2% of the total catch.

Alewife Predation on Yellow Perch Larvae
Stomach and intestinal tract contents from a total of 197 adult alewife were examined. Only 2.5% of the stomachs contained larval fish (Table 7). The maximum number of fish larvae found in a single stomach was 4; four other stomachs contained a single fish larvae or remnants (i.e., eye stalks or vertebral column). Of all larval fishes, only 2 could be identified with any certainty as larval perch. More larvae were intact in fish collected during dusk than those collected 1 or more hours after sundown. Four stomachs contained spiny water flea (*Bythotrophes cederstromi*) tail spines; spines were too numerous to count and appeared as a compacted mass wedged into the stomach. Eleven stomachs were completely empty (3.7%).

Table 7. Prey items found in the stomach and intestinal tracts of 197 adult alewife sampled between 02 July and 18 July, 1996, using graded-mesh gill nets set for 30-min, after dusk, outside Waukegan Harbor.

Prey taxa	Number of stomachs containing item(s)	Percent sample
phytoplankton	119	60.4
zooplankton	130	72.6
amphipods / isopods	9	4.6
insect larvae	93	47.2
larval fish	5	2.5

Zooplankton Sampling
Zooplankton samples were collected and analysis is in progress.

Egg and Post-larval Perch Sampling
SCUBA divers found a total of 10 egg masses in a total of 768 m surveyed; divers explored an area approximately 4 m wide. Egg masses were found on the south side of both intake lines (Dexter Paint and US Steel) on cobble substrates, generally in crevaces among the cobbles. No eggs were found on sand substrates north of the intake lines or at the Zion and North Point sand sites. Viability of the eggs was 95% viable for 9 of the egg masses examined; eggs in the other egg mass were 70% viable.

Eggs collected on 03 June appeared to have been newly fertilized (i.e., not eyed, little movement of larvae); eggs collected on 12 and 14 June had developed eyes, yet no eye pigments, and hatched as the egg masses reached room temperature. Hatch was induced in most eggs (~90%) within 24-hr of returning to the lab (aquaria were at ambient room temperature); larvae were motile and began feeding within 48-hr after hatch on rehydrated *Spirulina*, a blue-green algae, that was dripped into the aquarium.

CONCLUSIONS

These conclusions have been drawn from the third year of sampling.

Mean catch of adult perch at the seven sampling sites around the IDNR Lake Bluff index station were similar to catches taken in 1994 (Robillard et al. 1995). Mean catch and variability in catches was greatest at the North Lake Forest and Fort Sheridan sites. Variability in catches at all of the sampling sites implies that the fish move frequently during the spawning period, rather than spawning in one limited area. Therefore, limited sampling at a single index station (e.g., two days per year at the Lake Bluff index site) may reflect the daily movements of spawning fish rather than the true abundance of fish in that area.

Recaptures of tagged perch at the site at which they were tagged implies that some perch do reside in spawning areas for more than 24-hr. Data on movements outside of our study area, during the peak of spawning, were limited due to the absence of angler and commercial harvest during the month of June. Total recapture rate was markedly higher (5.4%) for the first six months after the commencement of tagging compared to a previous INHS tagging study (1.3% within 6 months of the start of tagging, Marsden et al. 1993) and may indicate that perch are significantly less abundant than they were in 1991.

The greatest portion (30%) of yellow perch collected with fyke nets in 1996 were age-8 (1988 year-class). The average length of all measured fish was 229-mm for males and 306-mm for females, although age-distributions were similar. The stretched measure of INHS fyke nets is designed to capture fish 150 mm and greater. This length is approximately the length that females reach by age-3 and males by age-4 in Lake Michigan (Becker 1983). Under optimal conditions of population stability, the greatest proportion of fish sampled would be smaller and younger than those captured during our sampling. These results confirm that, due to reduced juvenile survival in the past several years and limited recruitment of juvenile fish to the adult population, the average age and length of the yellow perch population in Lake Michigan is continuing to increase.

Larval perch were nearly absent from samples collected during 1996. Similarly, abundances of perch larvae for 1995 were also low (Robillard et al. 1996). The absence of larval perch may indicate that the reduced abundance of adult perch combined with the skewed sex ratio is affecting the reproductive success of the population.

One young-of-the-year yellow perch was captured in thirty-four 0.5-nm bottom trawls. Approximately 153,000-m^2 of the lake bottom was sampled. The paucity of young-of-the-year yellow perch may indicate a failure of larval fish to be recruited to the subadult population. Increased water clarity observed in the past four years, which is likely due to filtration by zebra mussels, may directly affect YOY catches by increasing avoidance of sampling gear. However, trawling at night, when visual gear avoidance should be reduced, did not increase catch rates in 1995 (Robillard et al. 1996). The increased water clarity is a consequence of reduced plankton populations. Water clarity may also affect juvenile yellow perch survival by increasing their susceptibility to predation by visual feeders such as alewife.

The effect of alewife predation on yellow perch larvae cannot be addressed due to the near-absence of larval perch and because we only have one year of data. Relatively few alewife had larval fish as a component of stomach contents, so several years of effort at various densities of larvae will be necessary to place any confidence on the percent of yellow perch recruitment lost to predation by alewife.

No conclusions can be drawn from the zooplankton sample data as analysis has not yet been completed.

Yellow perch egg masses collected at two intake lines south of Waukegan were nearly 100% viable, however the survival of these larvae post-hatch was not investigated. The absence of emergent larvae in the abundance samples dictated that post-larval sampling be limited in effort and as a consequence, no post-larval stage perch were collected.

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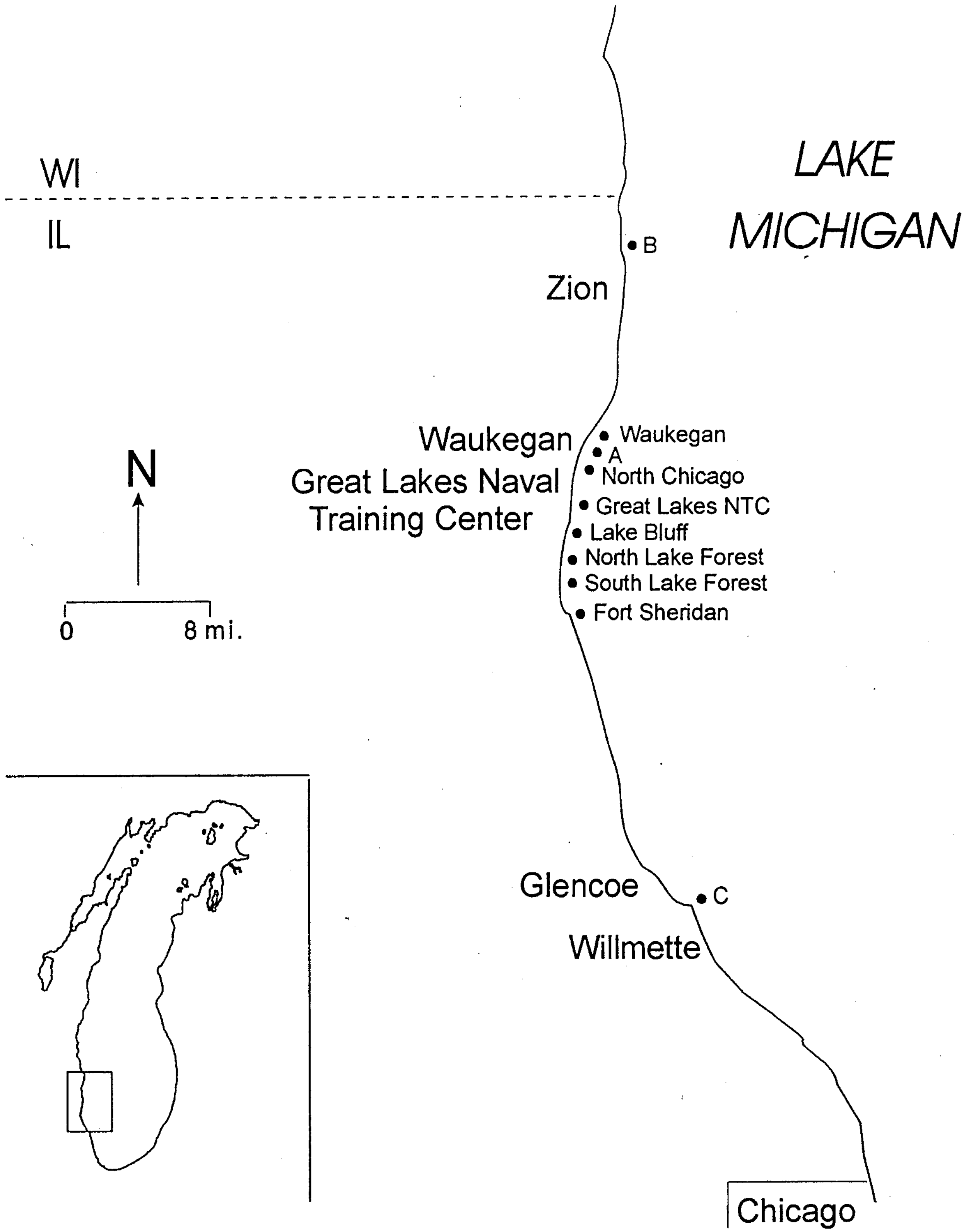

Figure 1. Index sites for adult yellow perch sampling.

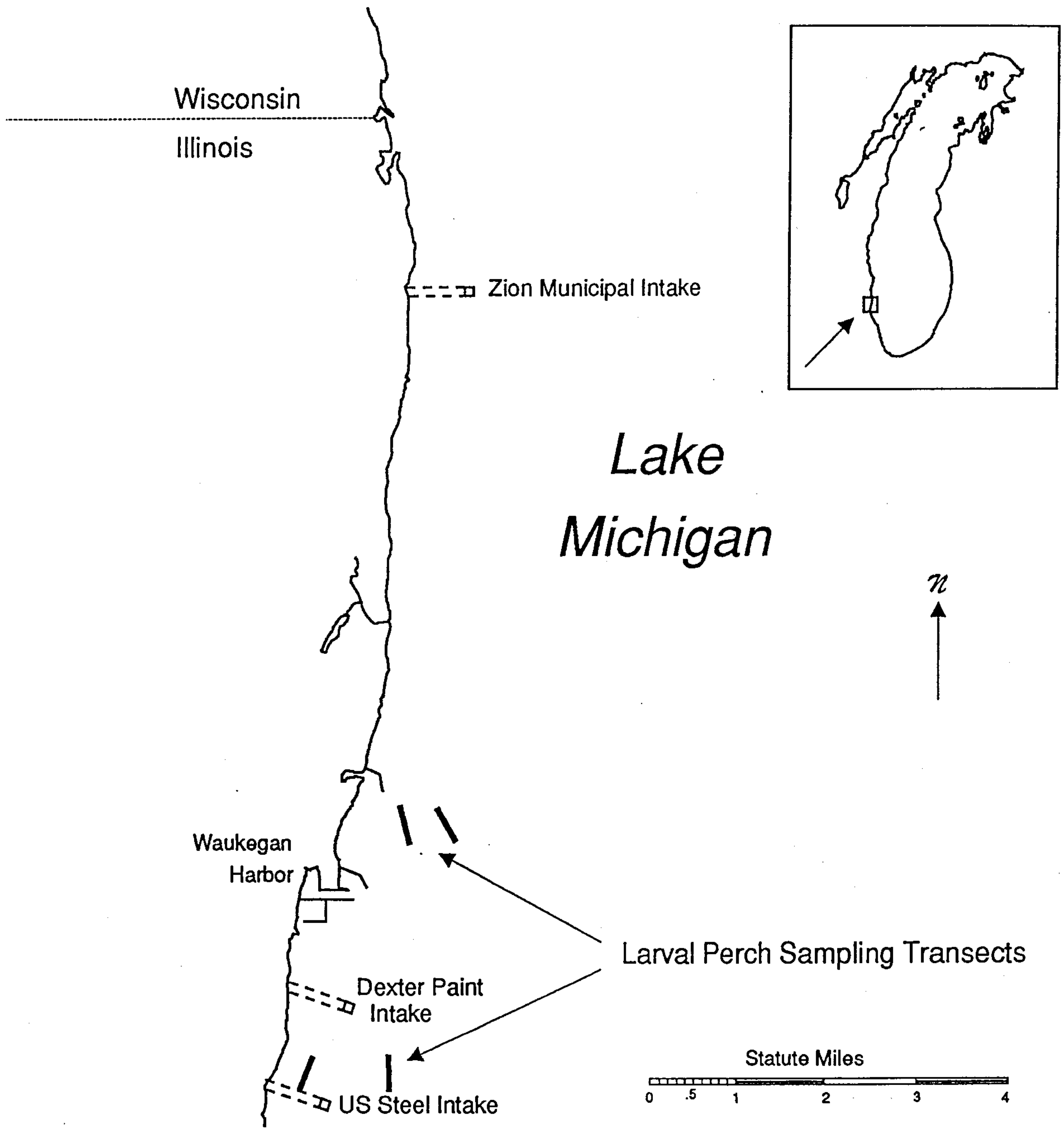

Figure 2. Index sites for yellow perch egg and larval perch sampling.

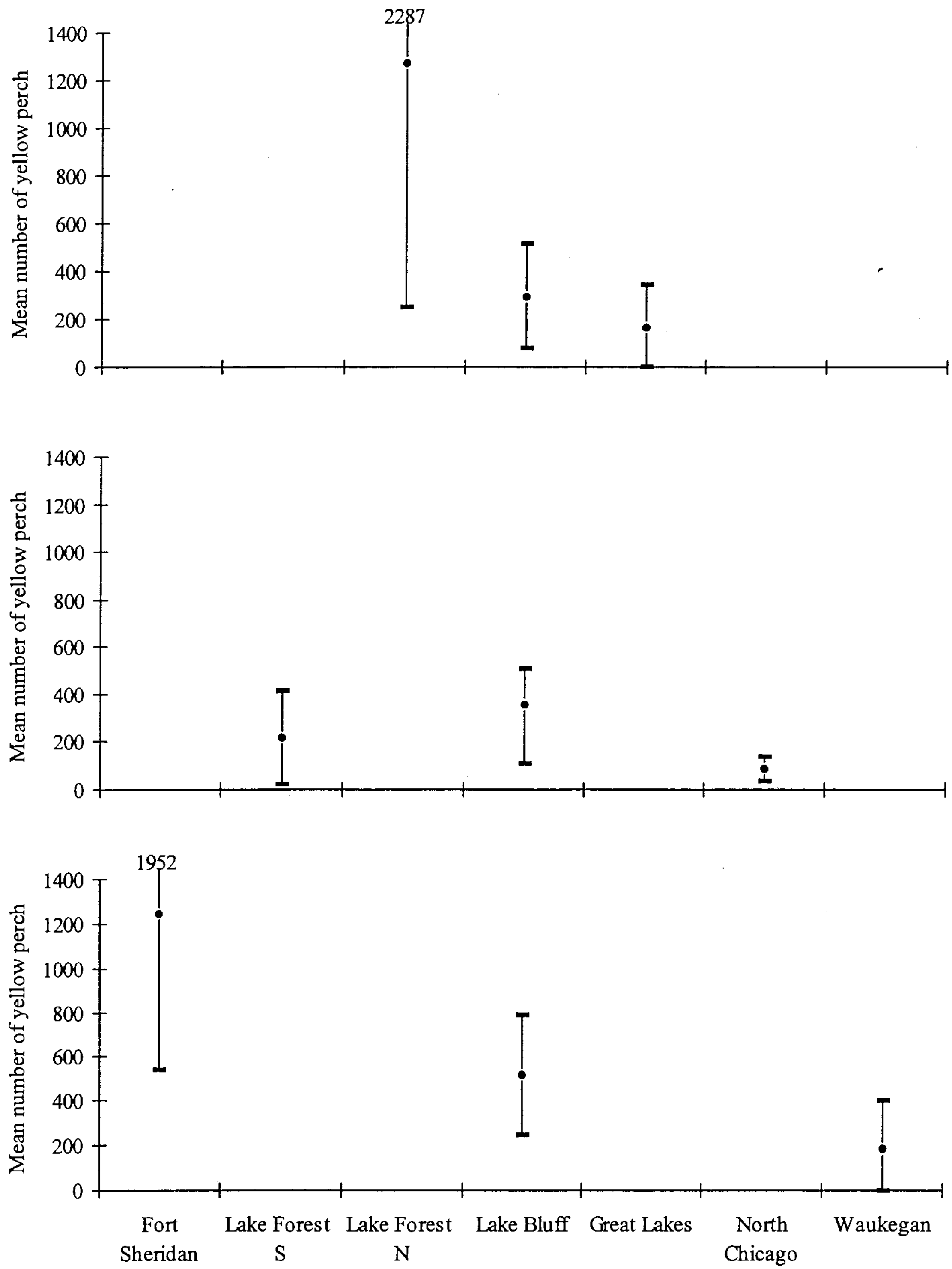

Figure 3. Mean number of yellow perch captured in fyke nets at the Illinois Department of Natural Resources Lake Bluff index station and at three distances (1.5, 3, and 4.5 nautical miles) north and south of that index station between 03 May and 16 July, 1996. Nets were set four times at each sequence of sites. Error bars represent one standard deviation above and below the mean.

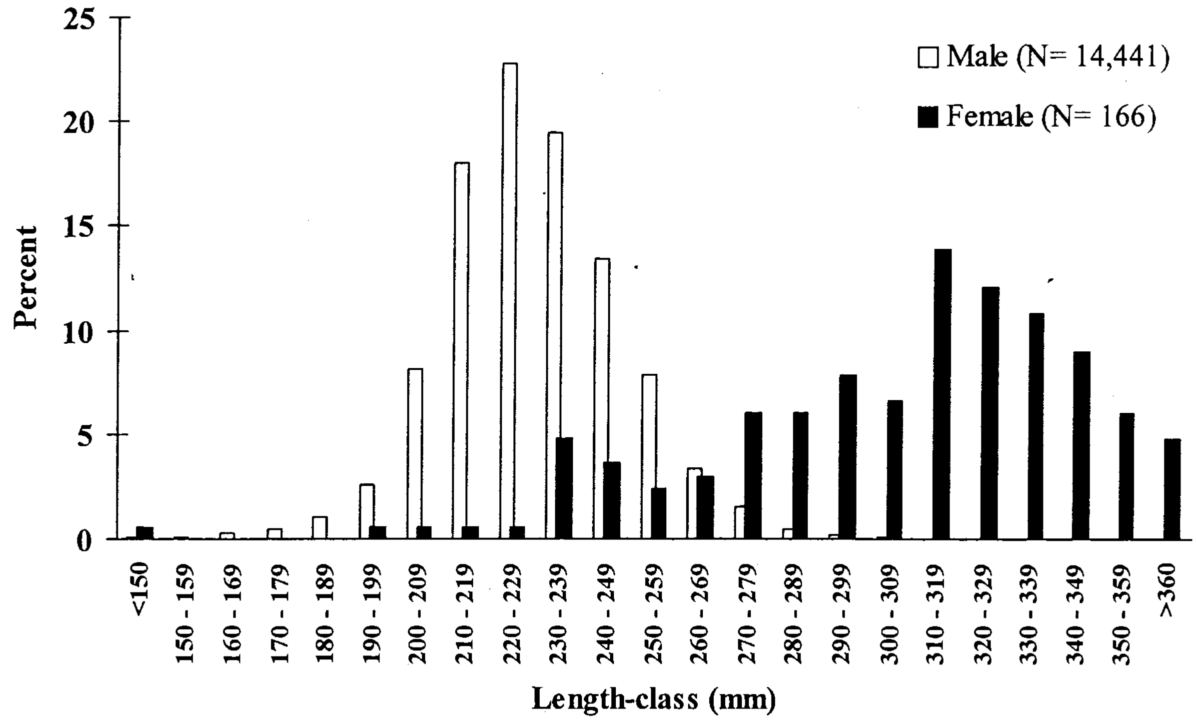

Figure 4. Length-frequency distributions of yellow perch captured in INHS fyke nets between 03 May and 02 July, 1996, in Lake Michigan, near Lake Bluff.

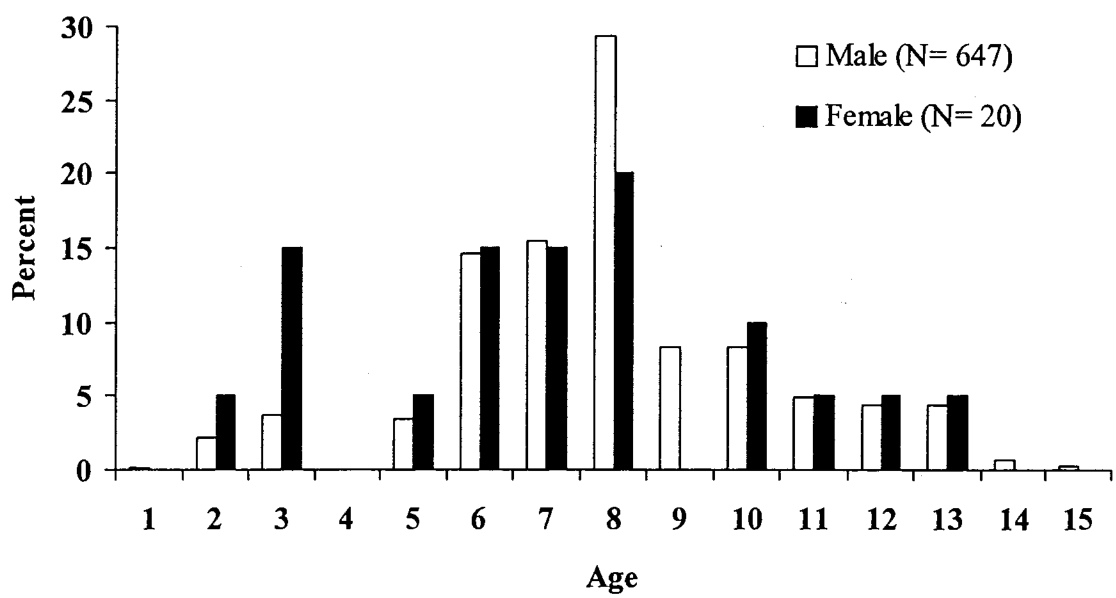

Figure 5. Age-frequency distributions of yellow perch captured in INHS fyke nets between 03 May and 26 June, 1996, in Lake Michigan, near Lake Bluff.

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