

Population Trends Among Yellow Perch in the Eastern Basin of Lake Ontario, 1976-1998.

T.H. Eckert

*New York Department of Environmental Conservation
Cape Vincent, New York 13618*

Yellow perch, smallmouth bass, and other warm water fishes have traditionally supported an important recreational fishery in New York waters of Lake Ontario's eastern basin (Stone et al. 1951; Jolliff and LeTendre 1968; Panek 1981; Anonymous 1984). Yellow perch have also been a significant component of commercial fish harvests (Cluett 1997). In the late 1980's, yellow perch abundance in standardized assessment nets declined dramatically (Eckert 1998). Yellow perch abundance has remained low through 1998, despite significant increases in young-of-year (YOY) production in the 1990s (O'Gorman 1995). During this same period, many other changes occurred in the Lake Ontario ecosystem including reductions in phosphorus loadings and lake productivity, reductions in lake-wide alewife abundance, proliferation of dreissenid mussels, increased water clarity, and increased abundance of two piscivores, double-crested cormorants and walleye (Christie et al. 1987; EPA 1993, O'Gorman and Stewart 1999; Ross and Johnson 1997; Eckert 1998).

This report examines population trends in yellow perch in an attempt to understand the important factors influencing abundance. Data utilized were primarily collected in two complementary sampling programs. The first is the warm water assessment program begun in 1976 by the New York State Department of Environmental Conservation (DEC) as a long-term, trend-through-time sampling program to provide an annual overview of the warm water fish community in New York waters of Lake Ontario's eastern basin. The sampling was targeted at establishing abundance indices for a wide variety of species from catch per unit effort (CPUE) data, with emphasis on smallmouth bass, walleye, yellow perch, and white perch. The second program was

bottom trawl sampling conducted in Chaumont and Black River Bays from 1978-95 by personnel from the Lake Ontario Biological Station at Oswego, U.S. Geological Survey (formerly U.S. Fish and Wildlife Service).

Methods

Warm Water Assessment:

The 1976-98 warm water assessment utilized standardized gangs of sinking gill net, set overnight on bottom, parallel to the depth contours. Each net gang consisted of nine equal length net panels, 2.4 m (8 ft) deep, and ranging in size from 51-152 mm (2-6 in) stretch mesh by 12.7 mm (0.5 in) size increments. The sampling was usually scheduled for the first two weeks of August, but has been started as early as July 30 and ended as late as August 25. Depth contours and depth strata boundaries all refer to the maximum water depth, although the nets actually sampled a band of water extending from the bottom to approximately 2.4 m above the bottom.

From 1976-79, the sampling utilized 274 m (900 ft) multifilament net gangs (each net panel 30 m [100 ft] long), half set at the 9-meter (30-ft) depth contour, and half set in deeper water between the 9-meter contour and the top of the thermocline. The 1976-79 sampling also excluded Chaumont, Black River, and Henderson Bays. In 1980, the sampling switched to shorter 137 m (450 ft) net gangs (each net panel 15 m [50 ft] long, but all other specifications remained the same); increased the number of net gangs set; included Chaumont, Black River, and Henderson Bays; and was conducted according to a stratified random sample design. This new design used three depth strata (stratum 1, 4-9 m [12-30 ft]; stratum 2, 10-15 m [31-50 ft]; stratum 3,

16-30 m [51-100 ft]), plus five area strata. The area strata were used primarily to ensure that all major geographic areas within depth strata 1 and 2 were sampled each year in proportion to their surface areas. Species diversity and total catch were highest in depth strata 1 and 2, and both were sampled in proportion to their surface areas with 10 and 9 net gangs respectively scheduled each year. Sampling effort within depth stratum 3 has varied, with 4 net gangs scheduled in 1980-83, 8 net gangs in 1984-88, and 10 net gangs from 1989-98.

In 1993, the sampling was again modified by switching from multifilament gill nets to monofilament gill nets. This latest change was implemented in part to take advantage of the greater efficiency associated with handling monofilament gill nets, and in part due to problems and costs with obtaining multifilament netting of the proper specifications.

Boundary lines between the five area strata make use of prominent landmarks to separate New York waters of the eastern basin into major geographic blocks (Figure A1). Area 1, Grenadier Island Area, covers from Tibbets Point near Cape Vincent to Point Peninsula, including Grenadier and Fox Islands. Area 2, Chaumont Bay Area, covers from Point Peninsula to Pillar Point and includes all of Chaumont and Guffin Bays. Area 3, Black River Bay Area, includes all of Black River Bay from Pillar Point to the northeast tip of Horse Island (near Sackets Harbor). Area 4, Henderson Bay Area, covers all of Henderson Bay and includes the shoreline area from Association Island Cut to Stony Point. Area 5, Stony Island Area, includes the shoals around Stony, Calf, Little Galloo, and Galloo Islands.

Corrections for changes in sample and net design that occurred between 1979 and 1993 have been described previously (Eckert 1986, 1998). Correction factors were applied to the raw multifilament gill net catch data from 1976-92 to calculate "monofilament equivalent" catch values. Mean catch per standard 137 m (450 ft) monofilament net gang, and 95% confidence limits,

were calculated from raw (non-transformed) monofilament or "monofilament equivalent" catch data using standard formulas for stratified random samples (Cochran 1977). Weighting factors for strata 1-3 were based on their respective surface areas within New York waters of the eastern basin (stratum 1: 0.20828; stratum 2: 0.18845; stratum 3: 0.60327).

Measurements of total length (mm) were taken for all yellow perch captured. In years of higher abundance, fish were selected for additional processing according to a stratified random sample design using one centimeter (0.4 in) size groups. In years of lower abundance (11 of 23), all yellow perch sampled were processed completely. The additional processing included total weight (g), determinations of sex and stage of maturity, and removal of a scale sample. Scales were removed from the left side of the fish, below the lateral line, near the end of the pectoral fin as it lay flat against the body. Scales were later pressed on acetate slides. Scale impressions were viewed through a compound microscope and annuli were counted to determine the age of each fish.

Age and sex composition of yellow perch not processed completely were estimated using an appropriate yearly age-length or sex-length key applied by one cm size groups. CPUE values for each age group were calculated by apportioning the total yearly CPUE value by the estimated percent age composition of all fish collected. Yearly comparisons of catches between depth and area strata were made by dividing the CPUE values for each stratum by the highest stratum value. This resulted in a relative CPUE value (ratio) with the area or depth stratum with the highest catch in any particular year set at 1.00. Yellow perch were assumed to be fully vulnerable to the standard net gangs at age 4, and survival rates were calculated from the ratio of the sum of CPUE values for ages $(x+1)$ to $(y+1)$ in sample year $(t+1)$, to the sum of CPUE values of ages x to y in sample year t [e.g., sum ages 5-11 in 1993 / sum ages 4-10 in 1992] (Everhart and Youngs 1981). An index of year class recruitment to the fishable (adult) population was

calculated by summing the gill net CPUE estimates of age 3 and age 4 yellow perch from each year class. It was assumed that summing across two years (ages 3 & 4) would help reduce errors due to yearly sampling variability. Age 3-4 recruitment indices for the 1972 and 1995 year classes were approximated using the average ratio of age 3 to age 4 from the 1973-94 year classes to estimate the missing age CPUE values (age 3 - 1972 year class; age 4 - 1995 year class). Condition factor of an individual fish was calculated by multiplying weight by 100,000 and dividing by length cubed (Everhart and Youngs 1981).

Fall Bottom Trawling:

A second important source of data for yellow perch in New York waters of the eastern basin is fall bottom trawling conducted by personnel from the Lake Ontario Biological Station at Oswego. This sampling was initiated in 1978 to determine the reproductive success of yellow perch and white perch. Although focused on YOY fish, useful samples of older fish were also collected. The surveys were carried out annually in Chaumont and Black River Bays using a 8 m (26-ft) headrope bottom trawl, until terminated in 1995 due to increasing catches of dreissenid mussels. Data from the sampling have not been formally published, but provisional summaries have been presented at the Lake Ontario Committee Meetings (O’Gorman 1996) and a paper describing the results was presented at the 1998 IAGLR conference (O’Gorman and Eckert 1998). CPUE data for YOY yellow perch from the 1978-95 year classes, and annual mortality of age 1-3 fish from the 1977, 1978, and 1991 year classes are presented in this report with the permission of R. O’Gorman, Lake Ontario Biological Station at Oswego.

Results

Warm Water Assessment

Abundance:

Yellow perch abundance as measured by gill net catches has declined significantly (P=0.0001) over the 23-year sample period (Figure 1, Table A1).

From a high of 69.09 per net gang in 1976, and an average of 51.76 per net gang in 1976-79, yellow perch declined to a low of 2.19 per net gang in 1988. Numbers have remained low since 1988, with no apparent trends. The average CPUE for the last eight years (1991-98) has been 5.67 yellow perch per net gang.

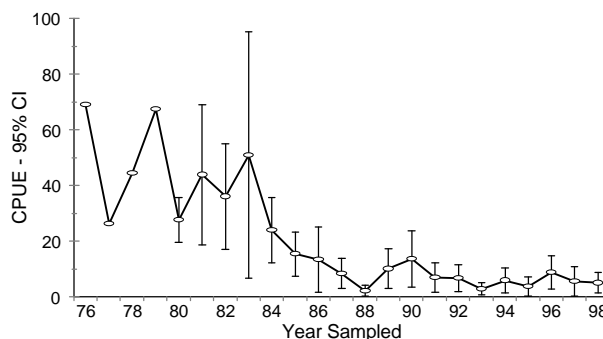


Figure 1. Stratified mean catch per standard 137 m gill net gang, and 95% confidence intervals, for yellow perch from the DEC Lake Ontario warm water assessment.

Comparisons of yellow perch CPUE by depth and area strata show a number of interesting patterns and trends (Tables 1 and A1, Figures A2 and A3).

Table 1. Average relative CPUE values for yellow perch from the DEC Lake Ontario warm water assessment, 1976-98.

Depth Strata:	
1. 4-9 m (12-30 ft)	0.800
2. 10-15 m (31-50 ft)	0.907
3. 16-31 m (51-100 ft)	0.438
Area Strata:	
1. Grenadier Island	0.328
2. Chaumont Bay	0.669
3. Black River Bay	0.689
4. Henderson Bay	0.531
5. Stony Island	0.082

Gill net catches have typically been highest in depth stratum 2 (10-15 m, 31-50 ft), followed closely by depth stratum 1 (4-9 m, 12-30 ft), with generally lower and more variable relative CPUE values in depth stratum 3 (16-31 m, 51-100 ft). Among the five geographic areas, average relative yellow perch

catches (Table 1) are highest in the Black River and Chaumont Bay areas, followed by the Henderson Bay and Grenadier Island areas, with the lowest catches in the Stony Island area. Regression analysis of the relative CPUE data showed statistically significant downward trends in depth stratum 1[4-9 m]($P=0.0438$), and in the Grenadier and Stony Island areas ($P=0.0163$ and 0.0031 respectively). The decline in yellow perch catch in the Stony Island area has been particularly dramatic, with zero catches in 10 of the last 11 years (1990 was the exception) and among 54 of 55 net gangs.

Age Composition:

Yellow perch sampled in warm water gill nets have ranged from age 2 to age 11, with the modal age group varying from age 3-6 (age 3 and 4: 8 years each; age 5: 5 years; age 6: 1 year) [Table A2]. Mean age ranged from a high of 5.03 in 1983 to a low of 3.55 in 1994, and has shown (Figure 2) a statistically significant decline ($P=0.0005$). Percent composition of perch age 6-11 has also shown a significant decrease ($P=0.0019$) [Figure 2], and age 7 has been the oldest yellow perch sampled since 1993, while age 6 was the oldest sampled in 1998.

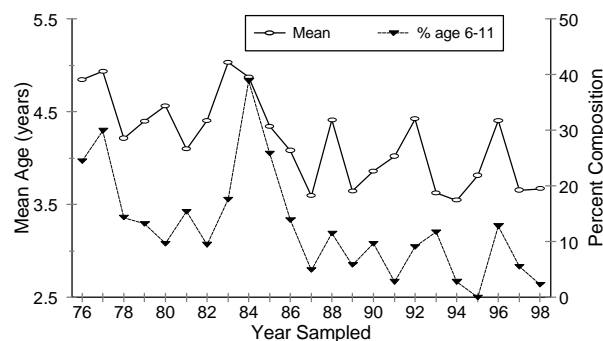
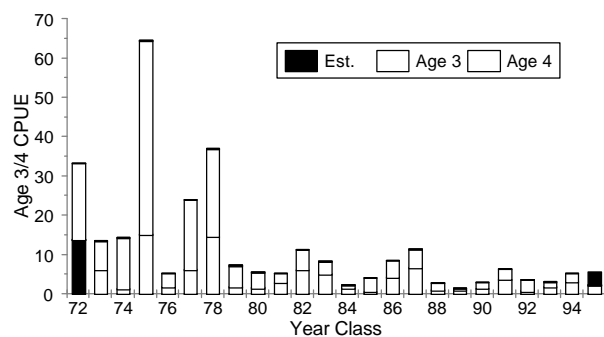


Figure 2. Mean age and percent contribution of ages 6-11 for yellow perch from the DEC Lake Ontario warm water assessment.

Age 3-4 Recruitment Index:

Using the sum of age 3 and age 4 CPUE values in successive years as an index of recruitment to the adult yellow perch population (including estimated age 3 and age 4 CPUE values for the 1972 and

1995 year classes), there have been four strong year classes evident in the years sampled: 1972, 1975, 1977, and 1978 (Figure 3). In addition, CPUE values for age 5 and older yellow perch (Table A3) suggest that the 1969-71 year classes were also strong. There have been no strong yellow perch year classes recruited to the adult population since 1978, and the age 3-4 recruitment index does show a statistically significant decline ($P=0.0033$). Visual inspection of the indices in Figure 3 suggest three general recruitment stanzas among the year classes sampled; the 1972-78 year classes which recruited to the adult population at an average index of 27.39, the 1979-87 year classes with an average index of

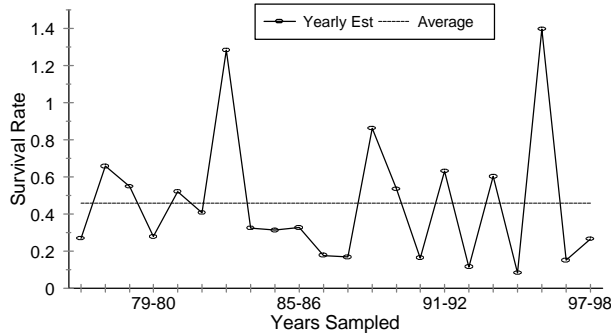


7.09, and the 1988-95 year classes with an average index of 3.88.

Figure 3. Age 3-4 recruitment index for yellow perch from the DEC Lake Ontario warm water assessment.

Survival Rates:

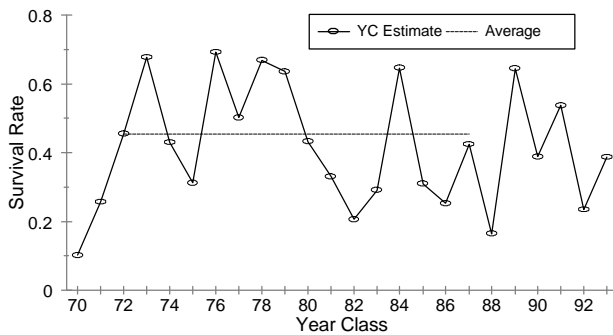
Annual survival rates of yellow perch age 4 and older by year sampled and year class are shown in Figures 4 and 5 respectively. Survival rate estimates between years sampled (Figure 4) average 45.7%, and show no statistically significant upward or downward trend ($P=0.8297$). Estimates for sample years 1982-83 and 1995-96 are both above 100% which is theoretically impossible, and the estimate for 1988-89 is 86% which seems unreasonably high. These high survival rates are most likely the result of catchability variations from year to year, and while these differences in catchability do increase variability in the CPUE data and complicate analysis and interpretation, there is no evidence of a



systematic change which would invalidate general trends or multiple year averages.

Figure 4. Annual survival rates of yellow perch ages 4-11 from the DEC Lake Ontario warm water assessment.

Estimates of survival rates by year class for yellow perch age 4 and older (Figure 5) range from 10.2% (1970 year class) to 69.3% (1976 year class). As with the yearly estimates (Figure 4), survival rates by year class show no statistically significant trend over the years sampled ($P=0.7372$). The average of



those year classes with complete age 4-11 CPUE data is 45.4%, the average of all (1970-93) year classes is 41.6%.

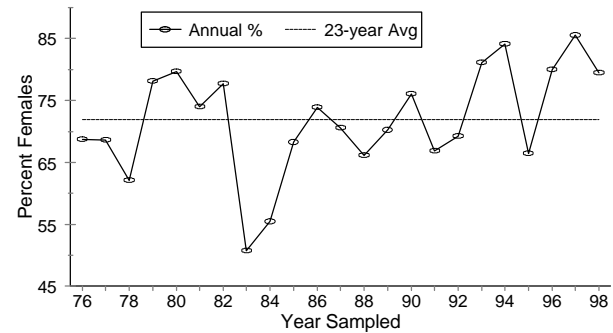
Figure 5. Survival rates by year class of yellow perch age 4 and older from the DEC Lake Ontario warm water assessment.

Although annual survival rates show no significant upward or downward trends, catch curves (CPUE by age by year class) do seem to show a shift

towards younger modal age groups (Table A3, Figure A5). The modal age groups for catch curves of the 1973-80 year classes are all age 4 or older. In contrast, the modal age group is age 3 for 10 of the 14 year classes between 1981 and 1994. Possible explanations for this apparent shift towards younger modal ages include decreases in yellow perch survival in recent years, and/or an increase in size (growth) of younger fish increasing their vulnerability to the gill nets used.

Sex Composition:

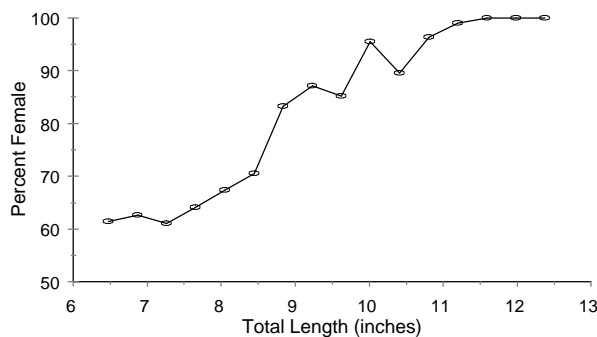
Female yellow perch have dominated the warm water gill net catches each year except 1983, when females comprised only 50.7% (Figure 6). The average sex composition over the 23-year sample period has been 71.9% female. Percent female composition has been well above the long-term average for 5 of the last 6 years, and regression



analysis shows a statistically significant positive slope at the 6.3% level. These observations suggest a possible trend in recent years towards higher percent female composition.

Figure 6. Sex composition (% females) of yellow perch sampled in the DEC Lake Ontario warm water assessment.

Sex composition also changes significantly with size (Figure 7). Using the combined 1976-98 data, percent female composition is lowest among the smallest fish, and only about 60% of the yellow perch sampled were female at a size of approximately 165 mm (6.5 in). Percent female composition increases rapidly as size increases, approaching 100% female for yellow perch 305 mm

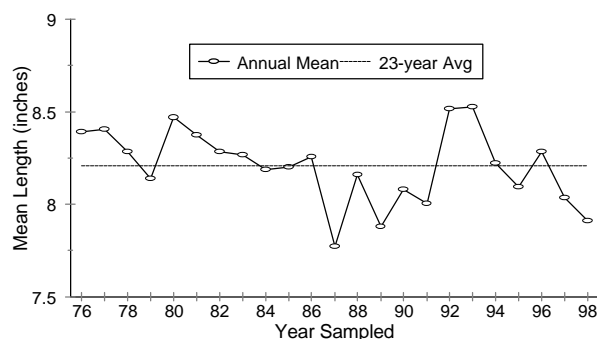


(12 in) long and larger.

Figure 7. Sex composition (% female) by length for yellow perch sampled in the 1976-98 DEC Lake Ontario warm water assessment.

Size Composition and Growth:

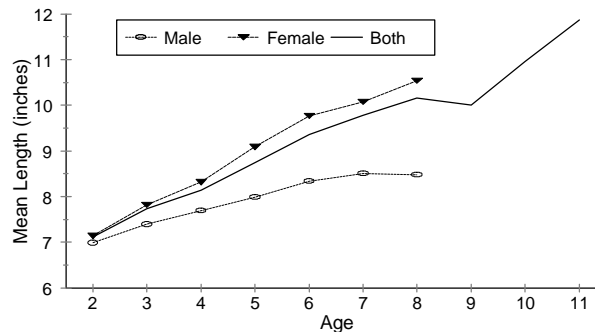
Length composition of yellow perch sampled in the 1976-98 assessment is presented in Table A4 and Figures 8 and A6. Yearly mean length has varied



from a low of 197.4 mm (7.77 in) in 1987 to a high of 216.6 mm (8.53 in) in 1993. A regression line through the yearly mean lengths does suggest a possible decline (P=0.0771), which is not unexpected given the significant decrease in mean age (Figure 2).

Figure 8. Mean length of yellow perch sampled in DEC Lake Ontario warm water assessment.

Female yellow perch were significantly longer in



length (ANOVA, P<0.05) than males at all ages, except age 2 (Figure 9). Analysis of covariance also showed statistically significant differences in the 23-year composite length-weight relationships for male and female perch (females being slightly heavier), although estimated differences are very small.

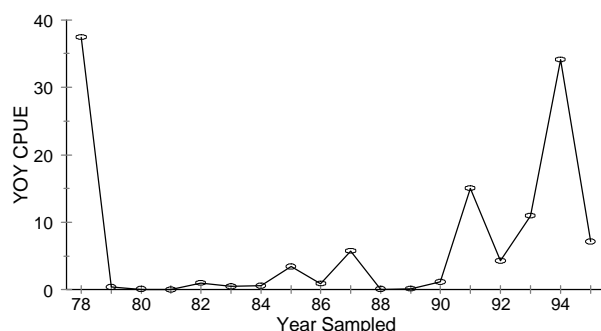
Figure 9. Mean lengths of yellow perch by sex and age from the 1976-98 DEC Lake Ontario warm water assessment.

Since female yellow perch are significantly different in size from male perch (except age 2), and since they dominate the catch particularly among the larger older age groups, analysis of growth trends in the 1976-98 assessment data focused on female fish. Mean length and mean condition factor of female perch ages 2-7 are summarized in Figures A7 and A8 respectively. Statistically significant variations in length and condition factor between years (ANOVA, P<0.05) were noted for all age groups. However, significant trends in mean length were detected only among age 2 (P=0.0167) and age 3 (P=0.0038) fish. Both were upward trends. Trends were more apparent in mean condition factor, with statistically significant downward trends (P<0.05) in female yellow perch ages 2-5 and age 7, but with no significant trend among age 6 fish.

USGS Fall Bottom Trawling

Catches of young-of-year (YOY or age 0) yellow perch from the 1978-95 fall bottom trawling are shown in Figure 10. These data show a strong year class of yellow perch in 1978, followed by 12 years (1979-90) of poor to mediocre YOY production.

Large catches of age 1 fish in fall 1978 (unpublished USGS file data) also point to a strong yellow perch year class in 1977. Trawl catches



increased dramatically after 1990 with strong year classes in 1991 and 1994, and above average year classes in 1992, 1993, and 1995. The average CPUE for the 1991-95 year classes was 14.29 YOY yellow perch per trawl tow versus an average CPUE of 1.16 YOY yellow perch for the 1979-90 year classes.

Figure 10. CPUE data for YOY yellow perch collected in USGS fall bottom trawling in Chaumont and Black River Bays.

Comparisons of the fall bottom trawl data (Figure 10) with the age 3-4 gill net recruitment index (Figure 3) show good agreement up through the 1990 year classes. Both sampling programs showed strong 1977&78 year classes followed by poor to mediocre 1979-90 year classes. However, beginning with the 1991 year classes, bottom trawling showed significantly higher production of YOY, while gill nets continued to show very poor recruitment to the adult population.

Sample sizes of older fish were sufficient to permit calculation of survival rates for perch ages 1-3 from the strong 1977, 1978, and 1991 year classes. Annual survival of age 1-3 yellow perch averaged 52% for the 1977&78 year classes, compared to only 28% annual survival for the 1991 year class, suggesting a dramatic change between the two time periods.

Discussion

Warm water assessment gill netting documented a dramatic decline in yellow perch in New York waters of Lake Ontario's eastern basin through the 1980s, corroborating reports from anglers complaining about reduced perch harvest and abundance. Many factors may be involved in this decline, but the most important seem to be related to declines in reproductive success and eventual recruitment to the adult population. Gill net CPUE data for age 3-4 yellow perch show no strong recruitment since the 1978 year class, and even suggest lower average recruitment since the 1988 year class. As fish from the strong year classes produced in the 1970s matured and passed through the population, abundance declined and mean age and percent composition of older fish decreased. Changes in survival rates of yellow perch age 4 and older does not appear to be a significant factor. Survival estimates have varied from year to year and between year classes, partially due to variations in catchability, but without any apparent trend. Growth rates have also varied from year to year, but except for increased length of age 2 and age 3 fish, have shown no significant trends. Condition factor has shown a significant downward trend over the years sampled among most age groups, but in the absence of a trend towards lower survival, would not seem to be linked to the observed population declines. This would suggest that yellow perch were not growth limited, and that changes in ecosystem productivity were not major factors related to perch population declines.

Alewife predation on larval fish has been shown to be a potentially major factor limiting yellow perch year class strength (Brandt et al. 1987; O'Gorman 1995); and catches of YOY yellow perch in USGS bottom trawls correlate well with data on alewife abundance and distribution (O'Gorman and Stewart 1999). High alewife abundance does appear to have limited perch larval survival up through 1990, effectively limiting year class recruitment and probably resulting in the initial perch population declines. As the alewife population declined lake-wide and as distribution changed, further reducing spring alewife abundance in the eastern basin, YOY

yellow perch production began to increase dramatically. It was expected that this increased YOY production, observed since 1991, would quickly become evident as increased catches of older yellow perch in the warm water assessment

The fact that yellow perch catches in the warm water assessment netting have not increased substantially as the 1991 and subsequent year classes recruited, appears to be related to a decrease in survival of younger perch relative to the 1970s. Data to document a decrease in survival are limited to the USGS trawl data comparing age 1-3 yellow perch from the 1991 year class to the 1977&78 year classes (28% survival in 1991 versus 52% in 1977&78). Catch curves of yellow perch gill net data do show a shift towards younger modal age groups, and a similar shift in eastern basin smallmouth bass catch curves was linked to decreased juvenile survival (Lantry et al. 1998; Chrisman and Eckert 1998). However, yellow perch also show increased growth among age 2 and age 3 fish, and an increase in average size would substantially increase vulnerability to the nets used, potentially resulting in similar shifts in modal age group.

A number of factors could have decreased age 1-3 yellow perch survival between the 1970s and 1990s, but increased predation appears to be among the more logical. Two piscivores have increased in the eastern basin since the mid 1980s, walleye and double-crested cormorants (Eckert 1998, Ross and Johnson 1997). Numbers of yellow perch consumed by double-crested cormorants are known to be large (Ross and Johnson 1997; Johnson et al. 1998; Schneider and Adams 1998), and have increased in recent years as double-crested cormorant numbers have increased and as alewife numbers have declined redirecting cormorant feeding towards other fish species. Walleye also consume yellow perch (Schneider et al. 1998) but the impacts of their predation cannot be properly measured or modeled without more precise estimates of walleye abundance and distribution in New York waters of the eastern basin.

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Table A1. Stratified catch per standard 137 m gill net gang, 95% confidence intervals, relative annual CPUE by depth strata, and relative annual CPUE by area for depth strata 1 and 2, for yellow perch from August warm water assessment netting in New York waters of Lake Ontario's eastern basin.

Year Sampled	Strat. CPUE	95% CI		Rel CPUE by Depth			Relative CPUE by Area					
		Lower	Upper	Strat 1	Strat 2	Strat 3	Area 1	Area 2	Area 3	Area 4	Area 5	
1976	69.09											
1977	26.20											
1978	44.44											
1979	67.32											
1980	27.63	19.64	35.63	1.00	0.96	0.44	1.00	0.59	0.77	0.83	0.14	
1981	43.81	18.68	68.93	0.99	1.00	0.54	0.41	0.41	1.00	0.40	0.39	
1982	36.07	17.09	55.06	1.00	0.72	0.23	0.84	0.42	1.00	0.30	0.26	
1983	50.85	6.58	95.12	1.00	0.72	1.00	0.48	0.56	0.11	1.00	0.07	
1984	24.02	12.30	35.73	0.59	1.00	0.43	0.65	0.88	1.00	0.57	0.50	
1985	15.35	7.47	23.23	0.94	1.00	0.14	0.41	0.59	0.60	1.00	0.04	
1986	13.32	1.54	25.10	1.00	0.74	0.59	0.31	0.65	1.00	0.65	0.06	
1987	8.36	3.02	13.71	1.00	0.96	0.17	0.14	1.00	0.33	0.29	0.02	
1988	2.19	0.30	4.08	0.65	1.00	0.13	0.74	1.00	0	0.80	0	
1989	10.06	2.93	17.18	0.43	1.00	0.80	0.01	1.00	0.34	0.36	0	
1990	13.61	3.52	23.70	0.59	1.00	0.44	0.14	0.82	1.00	0.21	0.08	
1991	6.97	1.69	12.24	1.00	0.77	0.34	0.01	0.78	1.00	0.05	0	
1992	6.72	1.82	11.63	0.66	1.00	0.70	0.15	0.85	1.00	0.47	0	
1993	2.78	0.59	4.97	0.74	1.00	0.33	0.01	0.49	0	1.00	0	
1994	5.87	1.29	10.44	0.93	1.00	0.01	0	0.26	1.00	0.64	0	
1995	3.68	0.31	7.05	1.00	0.62	0.06	0	1.00	0.62	0.44	0	
1996	8.76	2.75	14.77	0.39	1.00	0.90	0.10	0.32	1.00	0.19	0	
1997	5.53	0.32	10.74	0.63	0.76	1.00	0.10	0.09	1.00	0.28	0	
1998	5.01	1.27	8.74	0.68	1.00	0.09	0.73	1.00	0.32	0.61	0	

Table A2. Percent age composition and mean age of yellow perch collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1976-98.

Year Sampled	Percent Frequency by Age Group										Mean Age
	2	3	4	5	6	7	8	9	10	11	
1976	0	8.7	28.2	38.6	19.4	4.8	0.2	0.1	0	0	4.84
1977	1.5	5.0	28.7	34.8	23.6	5.8	0.5	0	0	0	4.93
1978	0.4	34.1	29.3	21.9	8.7	5.6	0	0	0	0	4.21
1979	0.4	2.7	73.3	10.4	7.9	4.7	0.6	0	0	0.1	4.40
1980	0.2	22.2	12.2	55.8	7.0	2.1	0.3	0.3	0	0	4.56
1981	0.5	33.3	40.8	10.1	13.1	1.8	0.4	0	0.1	0	4.10
1982	0	5.1	62.1	23.3	6.4	2.8	0.1	0.1	0	0	4.41
1983	0	3.1	10.7	68.7	15.7	1.5	0.4	0	0	0	5.03
1984	5.5	11.6	16.7	27.3	34.4	4.3	0.2	0	0	0	4.87
1985	4.5	39.1	16.0	14.6	13.3	9.7	2.6	0	0	0.2	4.34
1986	2.4	37.6	38.9	7.2	4.1	5.8	2.7	1.0	0.3	0	4.08
1987	25.6	18.1	39.4	12.0	1.6	1.2	0.8	0.8	0.4	0	3.59
1988	0	24.3	39.7	24.5	3.4	3.2	1.6	1.6	1.6	0	4.41
1989	7.9	42.3	35.6	8.3	3.9	1.5	0.5	0	0	0	3.64
1990	0.7	49.1	30.6	10.0	5.4	3.0	0.7	0	0.7	0	3.86
1991	2.2	15.1	66.7	13.2	1.9	0.3	0.3	0	0	0.3	4.02
1992	5.1	14.1	26.9	44.8	6.9	1.7	0	0	0.4	0	4.42
1993	11.6	49.3	16.7	10.7	11.0	0.7	0	0	0	0	3.62
1994	0	61.1	27.8	8.3	1.0	1.8	0	0	0	0	3.55
1995	1.8	20.1	72.9	5.1	0	0	0	0	0	0	3.81
1996	0.4	21.2	32.6	32.9	8.8	4.0	0	0	0	0	4.41
1997	1.4	57.2	22.8	13.1	4.1	1.4	0	0	0	0	3.66
1998	1.0	45.6	41.3	9.7	2.4	0	0	0	0	0	3.67

Table A3. CPUE data by age and year class for yellow perch collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1976-98.

Year Class	CPUE by Age of Capture										CPUE Sum	
	2	3	4	5	6	7	8	9	10	11		
1965											0	0.00
1966									0		0	0.00
1967								0.08	0		0	0.08
1968							0.11	0	0	0.05		0.17
1969						3.31	0.13	0	0		0	3.45
1970					13.40	1.52	0	0	0		0	14.93
1971				26.70	6.19	2.50	0.40	0.09	0.05		0	35.92
1972			19.50	9.12	3.88	3.17	0.09	0	0		0	35.76
1973		5.98	7.52	9.71	5.29	0.58	0.17	0.04	0		0	29.29
1974	0	1.31	13.02	7.02	1.92	0.78	0.04	0	0	0.03		24.13
1975	0.40	15.14	49.33	15.40	5.74	1.02	0.19	0	0		0	87.23
1976	0.18	1.79	3.37	4.42	2.33	0.77	0.04	0	0.05		0	12.96
1977	0.26	6.13	17.87	8.41	7.98	1.04	0.40	0.14	0.03		0	42.25
1978	0.04	14.57	22.40	34.93	8.26	1.49	0.36	0.07	0.04		0	82.16
1979	0.21	1.84	5.42	6.56	2.04	0.77	0.07	0.04	0		0	16.95
1980	0	1.56	4.01	2.25	0.54	0.10	0.04	0	0.09	0.02		8.61
1981	0	2.80	2.45	0.96	0.14	0.07	0.05	0	0		0	6.46
1982	1.31	6.00	5.18	1.00	0.08	0.15	0.09	0	0.03		0	13.83
1983	0.70	5.01	3.29	0.54	0.39	0.40	0.02	0	0		0	10.35
1984	0.32	1.51	0.87	0.84	0.73	0.02	0	0	0		0	4.29
1985	2.14	0.53	3.58	1.36	0.13	0.11	0	0	0		0	7.87
1986	0	4.26	4.16	0.92	0.47	0.02	0	0	0		0	9.83
1987	0.79	6.68	4.65	3.01	0.31	0.11	0	0	0		0	15.55
1988	0.09	1.05	1.81	0.30	0.06	0	0	0	0			3.31
1989	0.15	0.95	0.46	0.49	0	0.35	0	0				2.40
1990	0.34	1.37	1.63	0.19	0.77	0.08	0					4.38
1991	0.32	3.59	2.68	2.89	0.23	0						9.71
1992	0	0.74	2.86	0.72	0.12							4.44
1993	0.07	1.86	1.26	0.49								3.67
1994	0.04	3.17	2.07									5.27
1995	0.08	2.29										2.36
1996	0.05											0.05

Table A4. Percent length composition and mean length of yellow perch (total length - inches) collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1976-98.

Year Sampled	Percent Frequency by Length Group (Total Length - inches)										Mean Length
	4	5	6	7	8	9	10	11	12	13	
1976	0	0	7.1	31.3	37.6	14.6	7.5	1.5	0.4	0	8.39
1977	0	0	3.9	28.6	42.9	22.1	2.6	0	0	0	8.41
1978	0.2	0.3	5.8	37.9	32.1	19.3	4.2	0.3	0	0	8.28
1979	0	0	6.2	44.7	31.3	14.1	3.4	0.2	0.1	0	8.14
1980	0	0	2.5	34.3	34.9	19.5	8.1	0.6	0	0	8.47
1981	0	0	5.2	36.5	32.2	18.8	5.4	1.5	0.3	0	8.38
1982	0	0.1	5.8	39.7	29.2	19.5	5.0	0.6	0	0	8.29
1983	0	0	3.7	42.4	33.5	16.7	3.3	0.4	0	0.1	8.27
1984	0	0	6.7	46.7	26.0	13.5	6.2	0.4	0.5	0	8.19
1985	0	0	7.5	46.4	24.2	13.5	7.1	1.3	0	0	8.20
1986	0	0	6.1	41.4	31.5	12.9	5.8	2.4	0	0	8.26
1987	0	0	16.1	52.0	23.4	7.3	0.8	0.4	0	0	7.77
1988	0	0	3.2	50.0	29.0	11.3	6.5	0	0	0	8.16
1989	0	0.5	10.2	59.5	17.1	7.3	3.4	2.0	0	0	7.88
1990	0	0	4.6	52.4	29.6	9.5	2.7	1.1	0	0	8.08
1991	0	0	3.8	53.9	31.5	8.5	1.9	0	0.3	0	8.00
1992	0	0	5.6	37.3	28.3	15.5	8.6	4.3	0.4	0	8.52
1993	0	0	0.7	40.6	23.9	25.4	5.8	3.6	0	0	8.53
1994	0	0	0.0	51.3	32.6	11.5	3.6	1.1	0	0	8.22
1995	0	0	3.0	53.7	32.3	8.5	1.8	0.6	0	0	8.09
1996	0	0	0.8	44.5	36.9	10.6	5.9	1.3	0	0	8.28
1997	0	0.7	0.7	61.5	25.2	4.9	4.9	2.1	0	0	8.03
1998	0	0	1.4	59.5	35.3	3.3	0.5	0	0	0	7.91

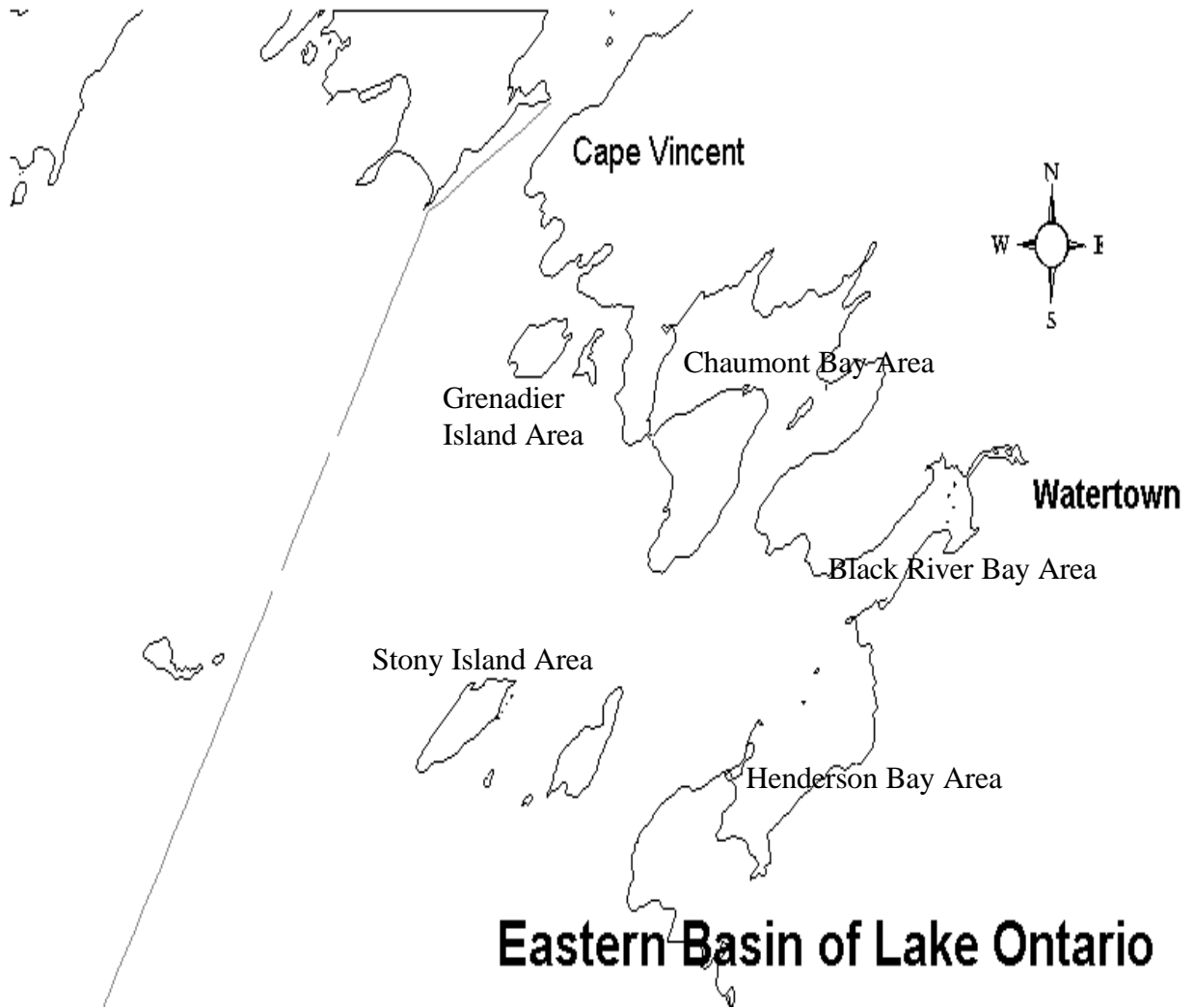


Figure A1. Map of New York waters of Lake Ontario's eastern basin showing the five area strata used in the DEC 1980-98 warm water assessment.

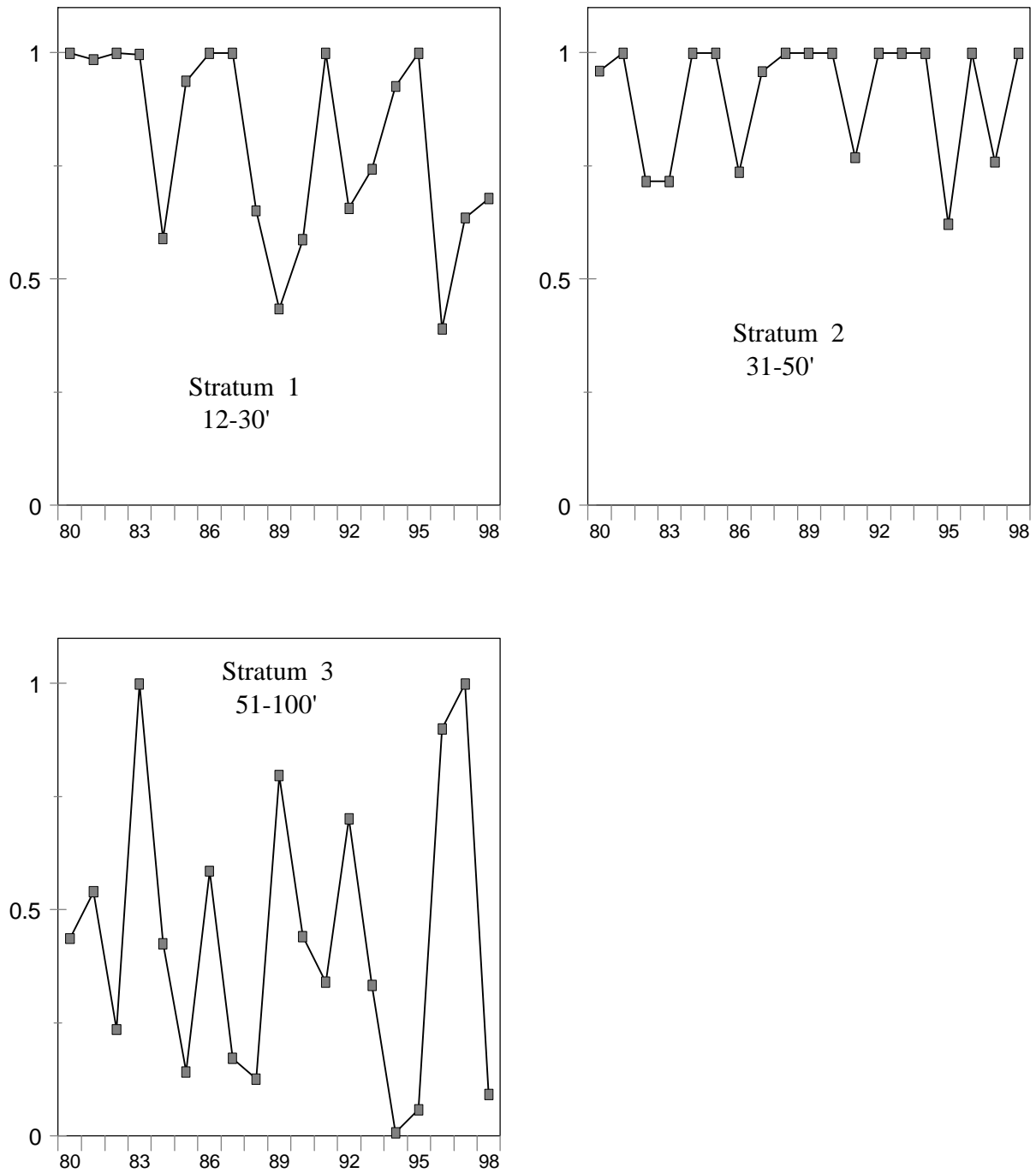


Figure A2. Relative CPUE by depth strata for yellow perch collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-98. Relative CPUE on Y-axis, year collected on X-axis.

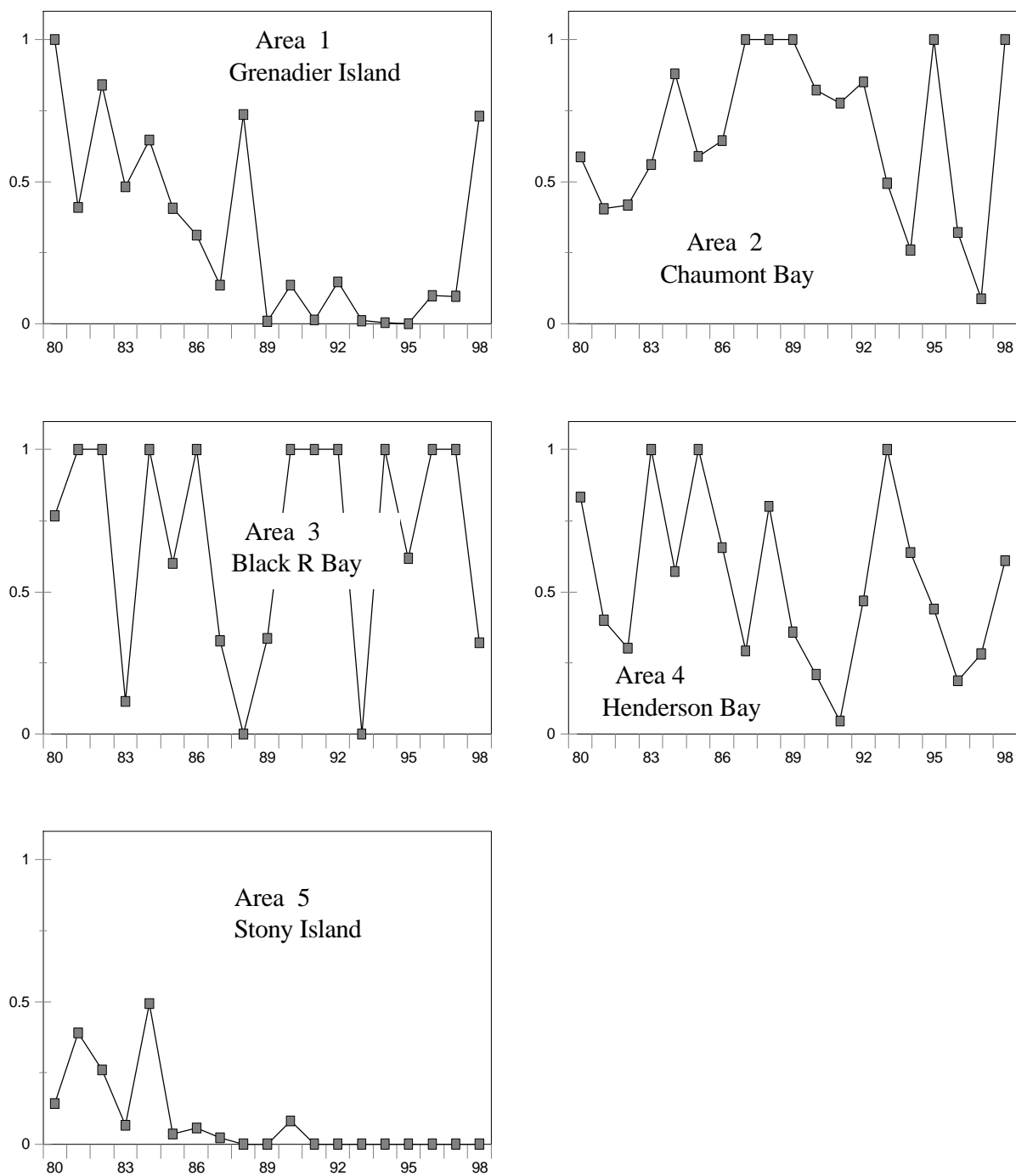


Figure A3. Relative CPUE by geographic area for yellow perch collected in depth strata 1 and 2 in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-98. Relative CPUE on Y-axis, year collected on X-axis.

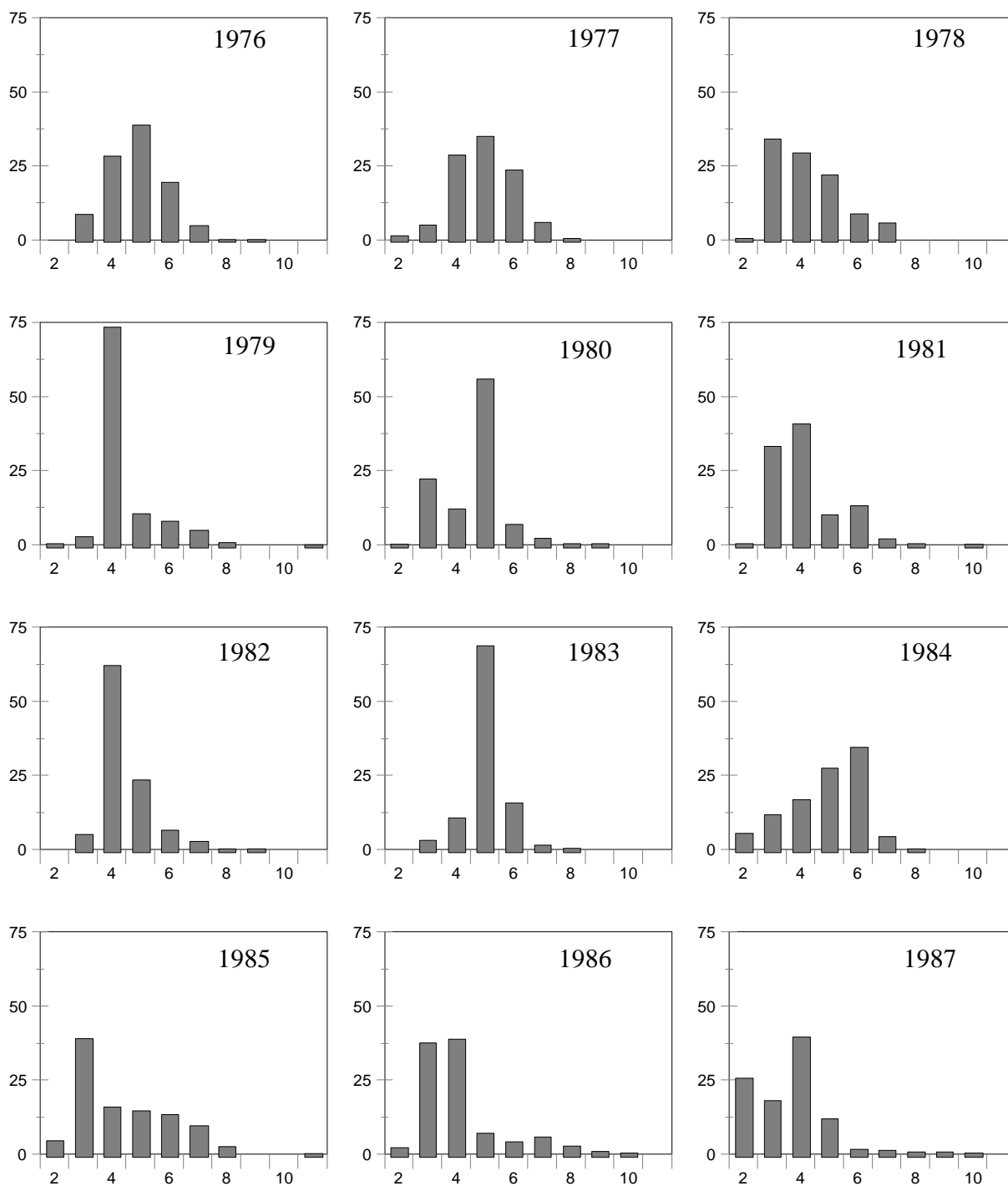


Figure A4. Age frequency distributions of yellow perch collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1976-98. Percent frequency on Y-axis, age in years on X-axis, year collected shown on each chart.

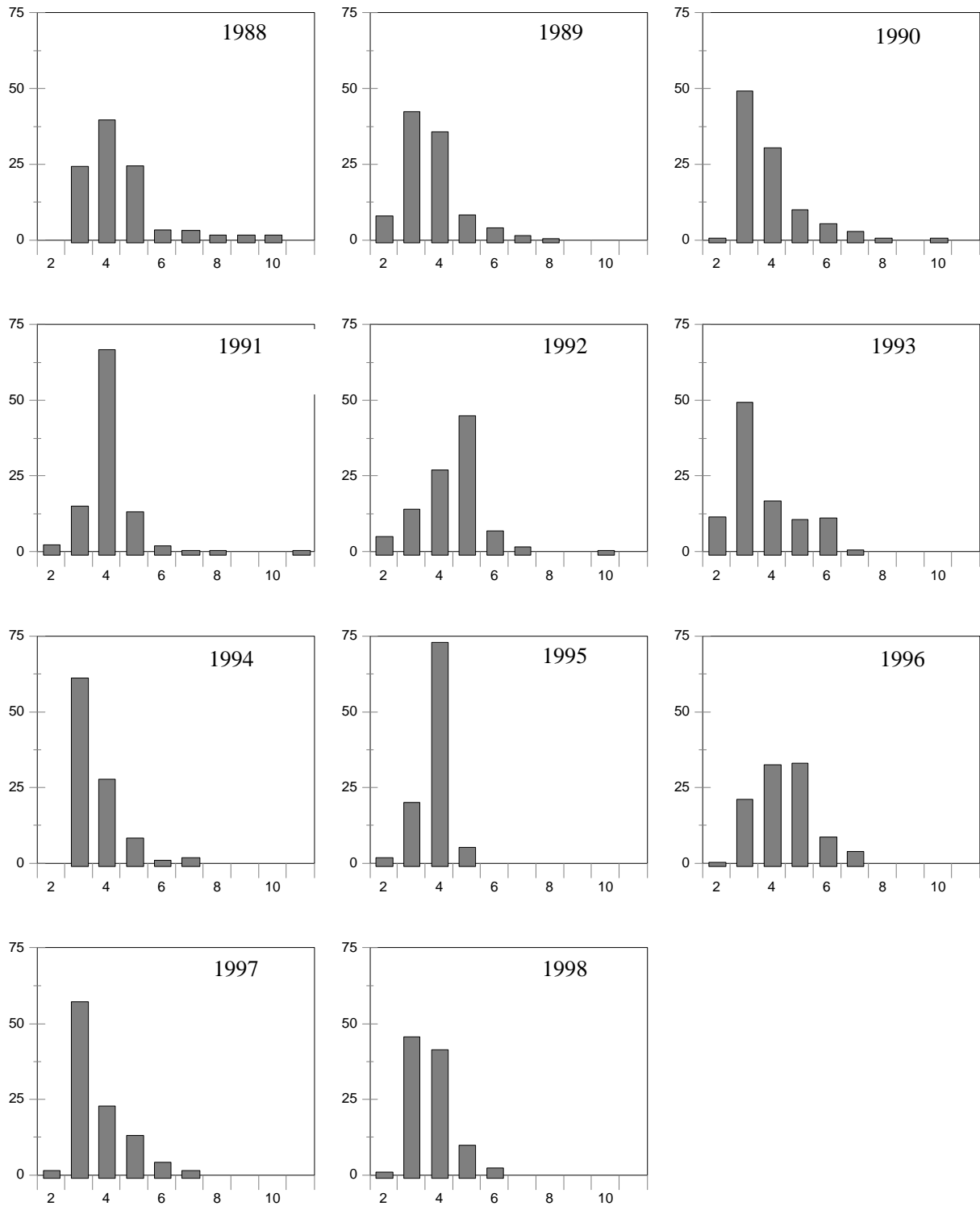


Figure A4 - continued. Age frequency distributions of yellow perch.

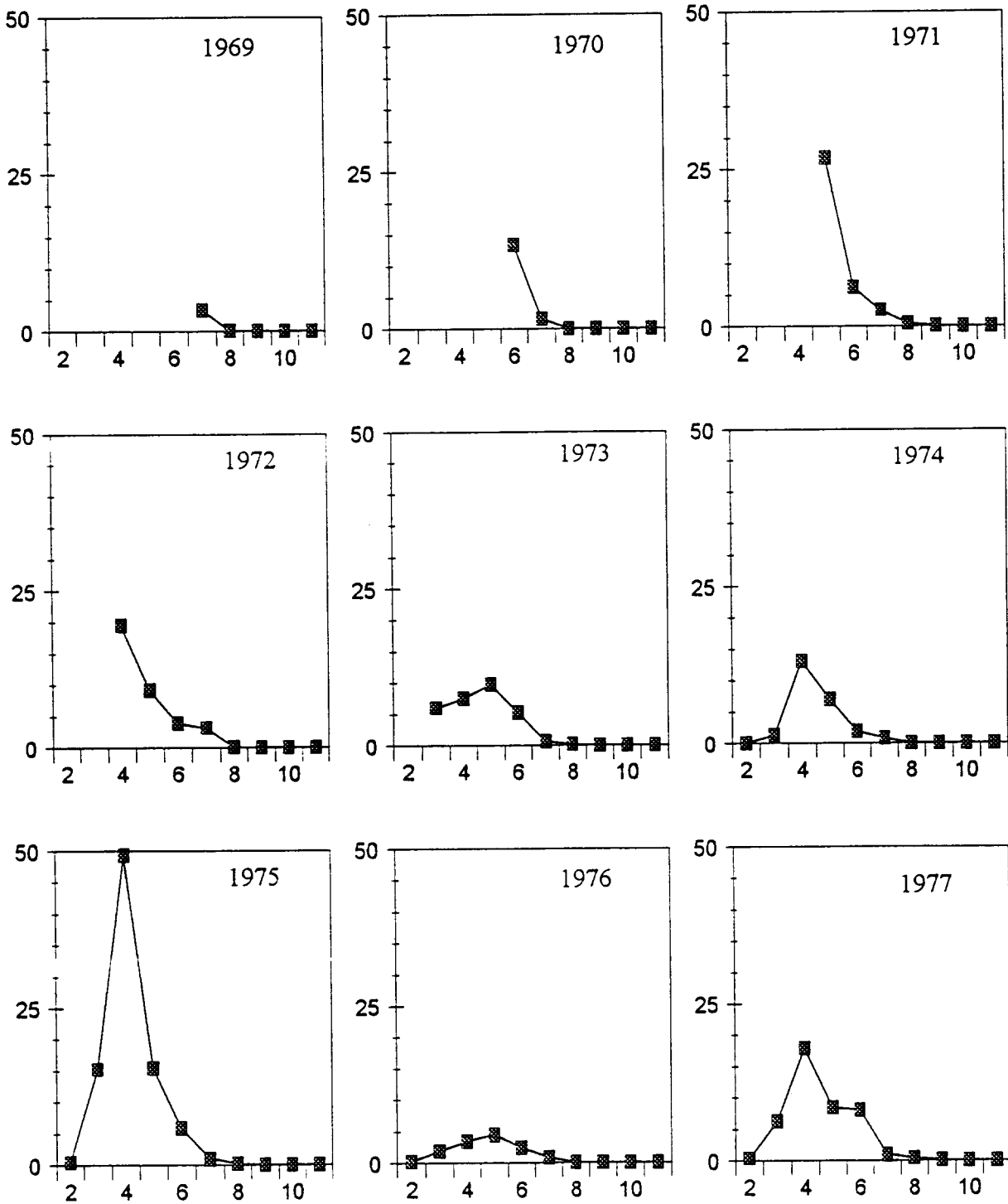


Figure A5. Catch curves (CPUE data vs age at capture) for the 1969-95 yellow perch year classes collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin. CPUE data on Y-axis, age in years on X-axis, year class shown in each chart.

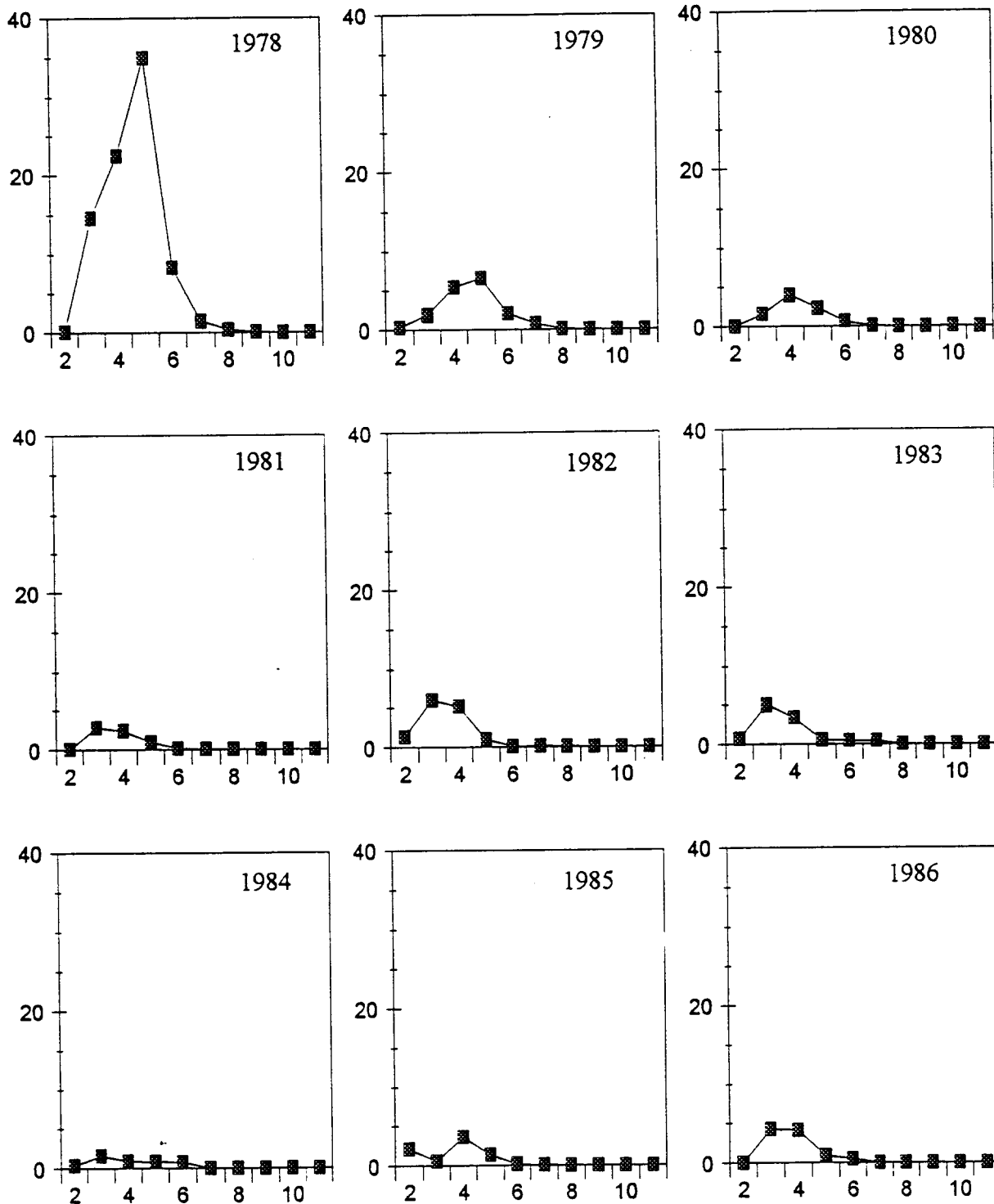


Figure A5 - continued. Catch curves for the 1969-95 yellow perch year classes.

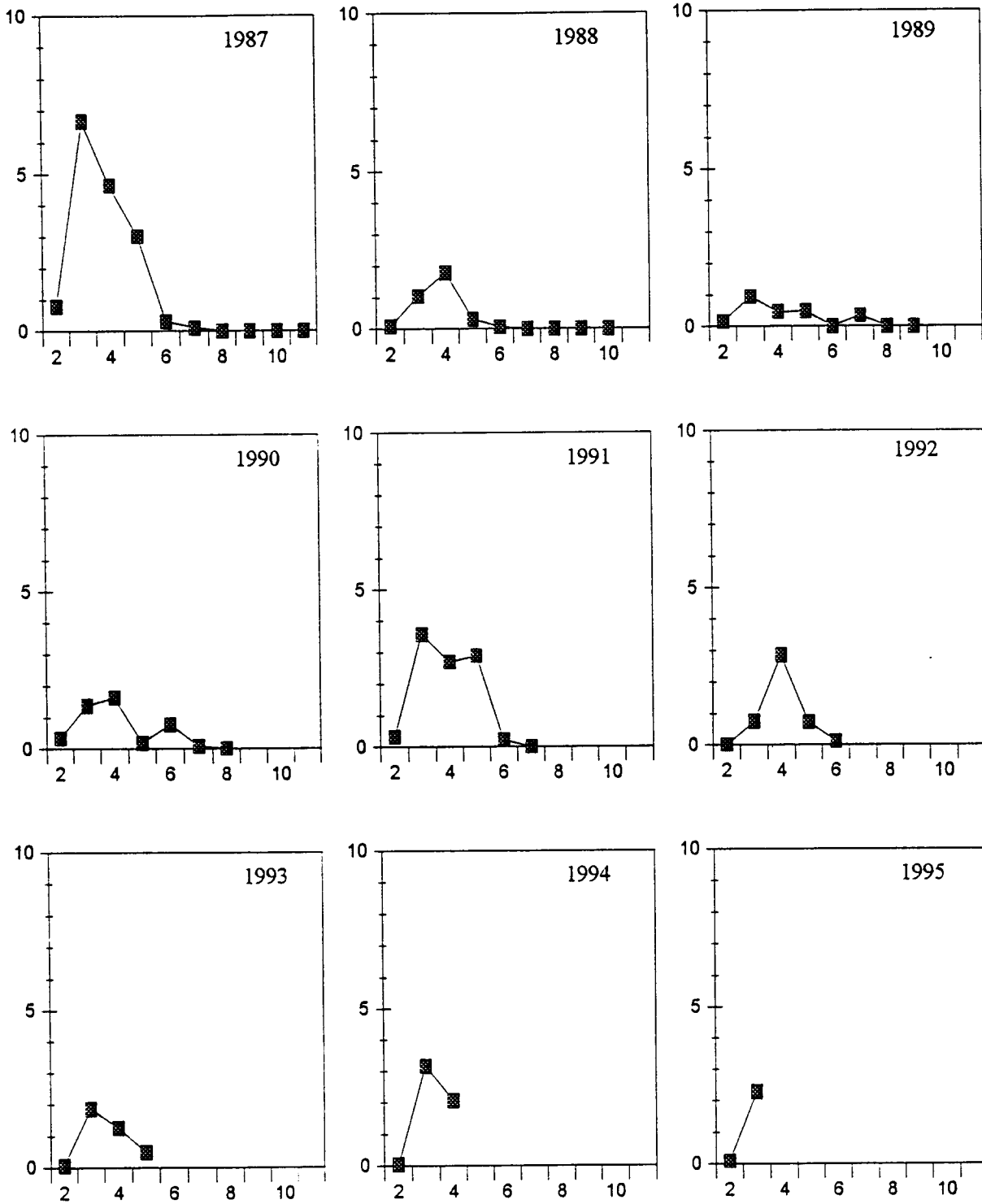


Figure A5 - continued. Catch curves for the 1969-95 yellow perch year classes.

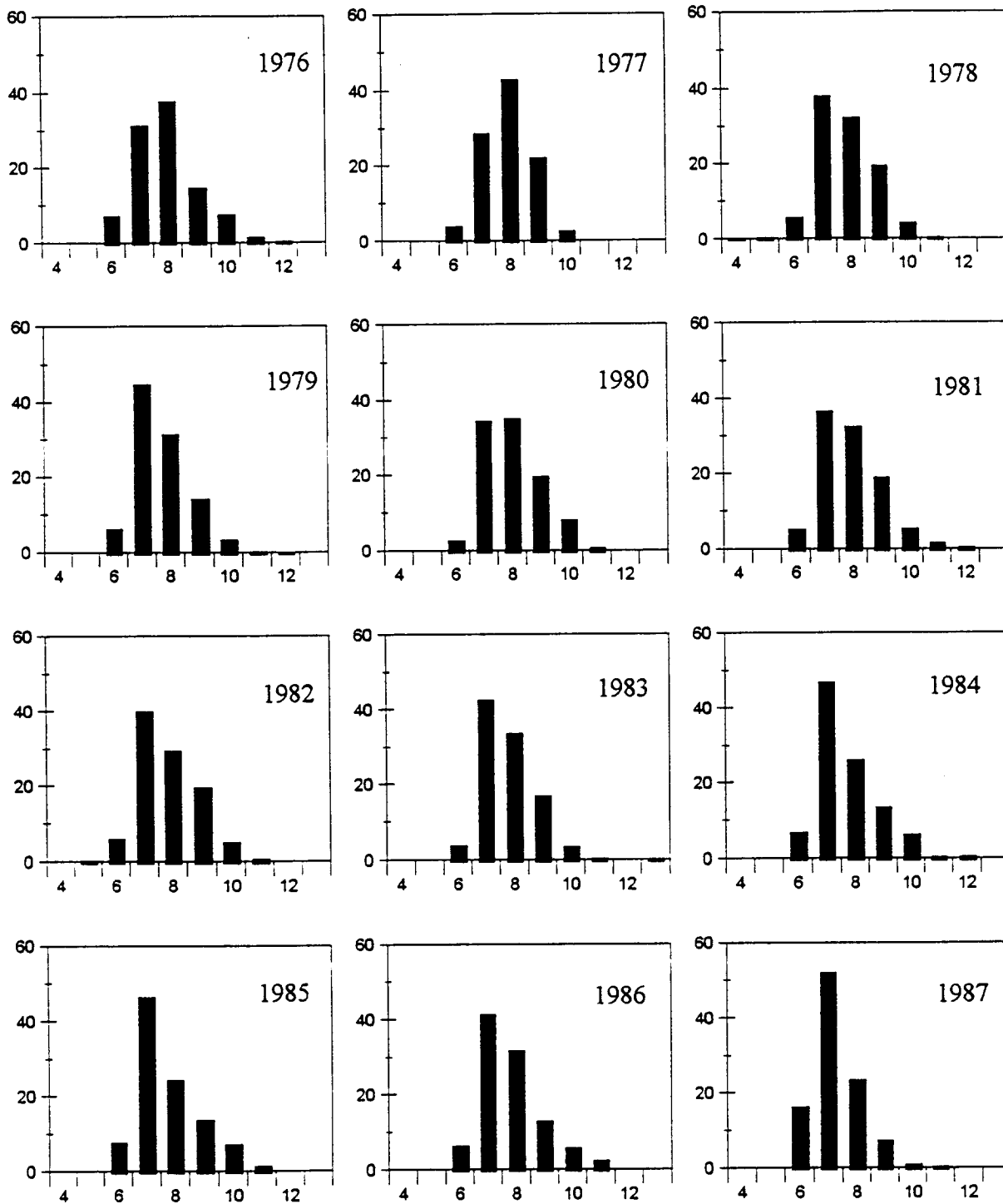


Figure A6. Length frequency distributions (total length in inches) of yellow perch collected in August warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1976-98. Percent frequency on Y-axis, inch groups on X-axis, year collected shown on each chart.

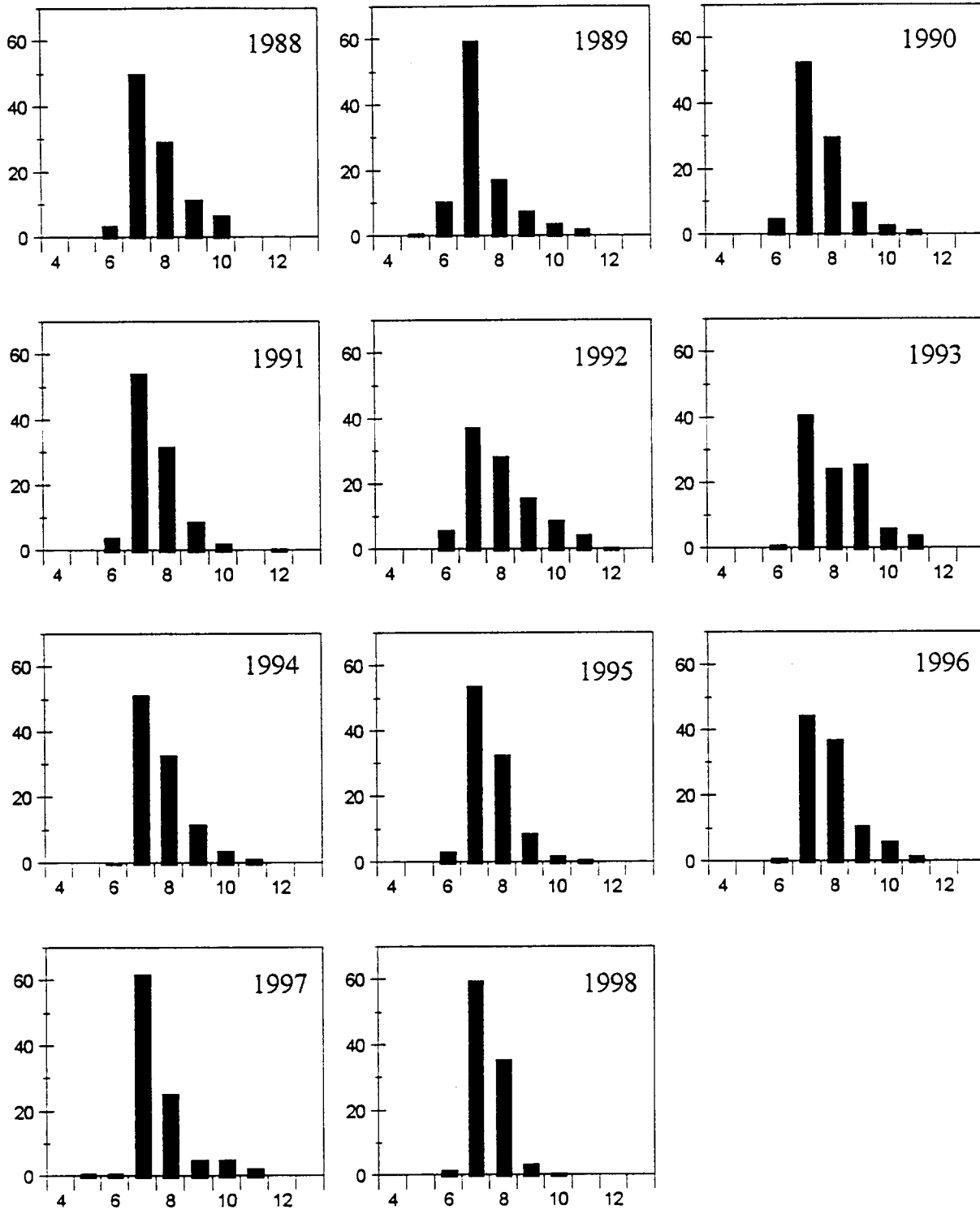


Figure A6 - continued. Length frequency distributions of yellow perch.

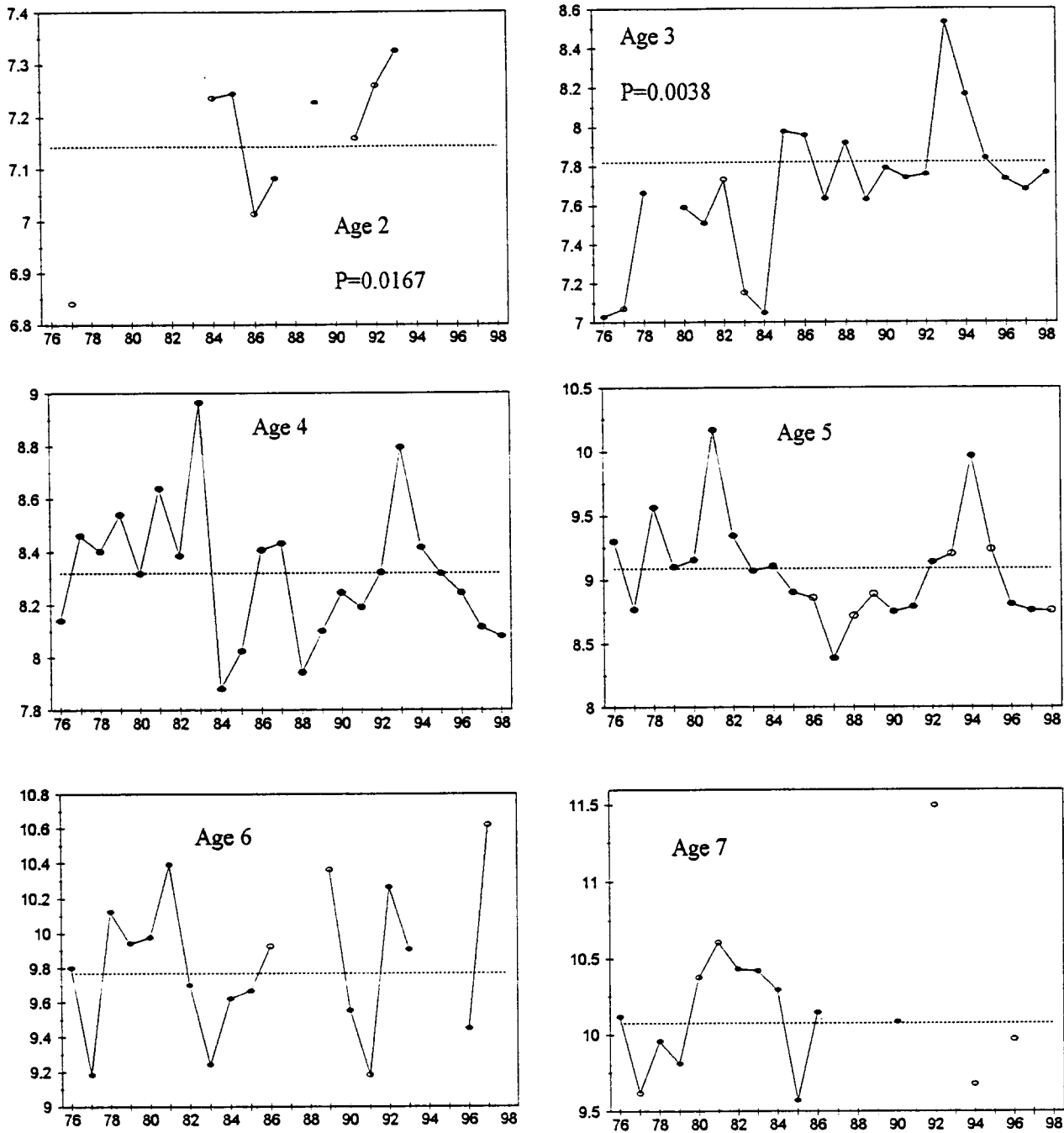


Figure A7. Mean lengths of female yellow perch collected in August warm water assessment in New York waters of Lake Ontario's eastern basin, 1976-98. Year sampled on X-axis; total length in inches on Y-axis; dotted horizontal lines show the 23-year composite mean length; sample sizes greater than 9 fish shown with filled markers; sample sizes 4-9 fish shown with open markers; blanks represent samples of 3 or less for any particular age and year; age group and significance level of regression through yearly means shown in each graph.

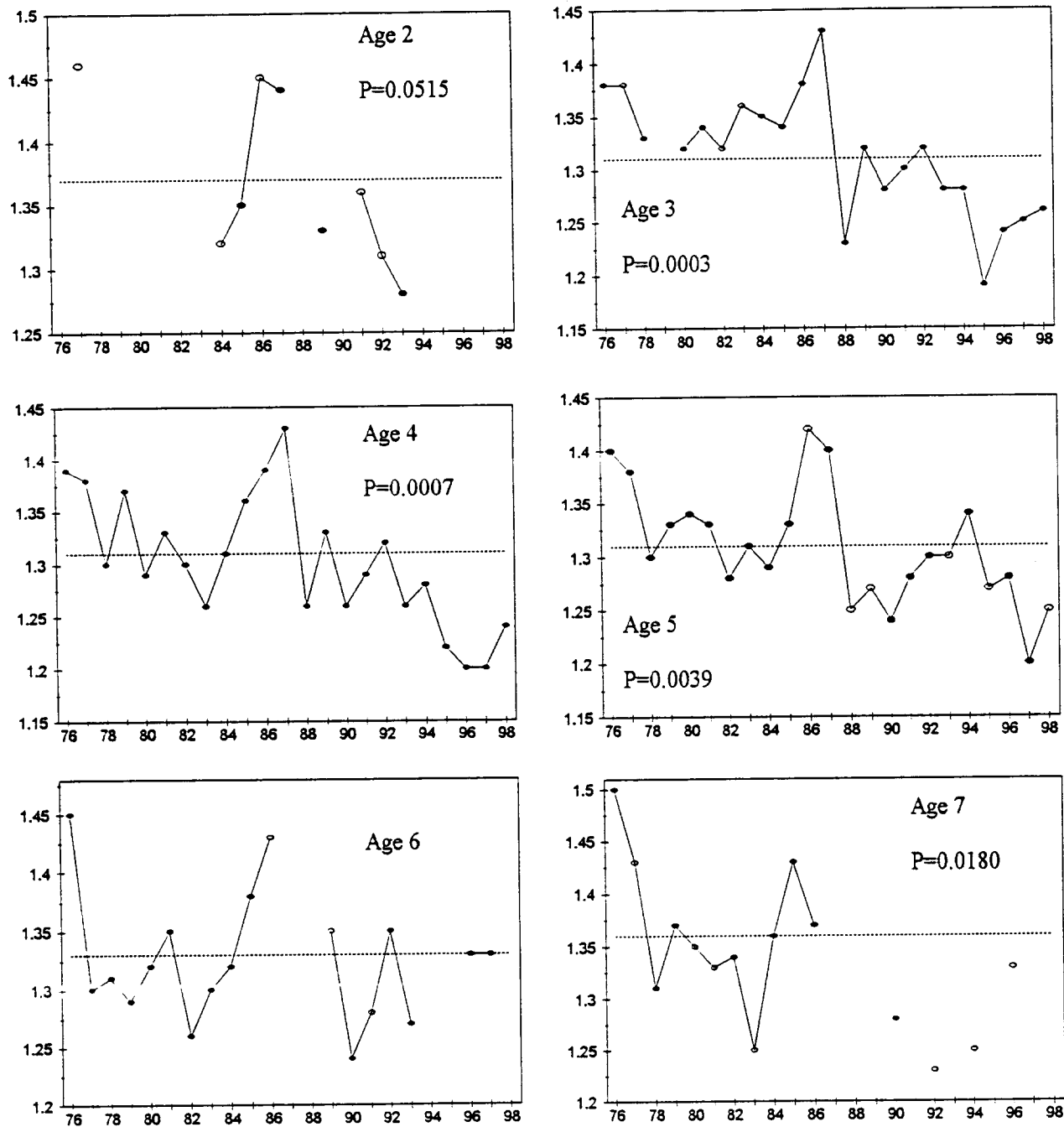


Figure A8. Mean condition factor for female yellow perch collected in August warm water assessment in New York waters of Lake Ontario's eastern basin 1976-98. Year sampled on X-axis; condition factor on Y-axis; dotted horizontal lines show the 23-year composite mean; sample sizes greater than 9 fish shown with filled markers; sample sizes 4-9 fish shown with open markers; blanks represent samples of 3 or less for any particular age and year; age group and significance level of regression through yearly means shown in each graph.