Summary of 1976-2001 Warm Water Assessment

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This report summarizes gill net sampling carried out by the New York State Department of Environmental Conservation (DEC) to assess fish stocks in New York waters of Lake Ontario's eastern basin. Warm water assessment is a long-term trend-through-time sampling program designed to provide an annual overview of the warm water fish community. The sampling provides information on a wide variety of species and variables, but is targeted at establishing abundance indices from catch per unit effort (CPUE) data, with emphasis on smallmouth bass, walleye, yellow perch, and white perch.

Sampling Procedures

The 1976-2001 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, 8 feet deep, and ranging in size from 2-6 inch stretch mesh by ½ inch size increments. 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 bottom to approximately 8 feet above bottom.

From 1976-79, the sampling utilized 900 foot multifilament net gangs (each net panel 100 ft long), half set at the 30-foot depth contour, and half set in deeper water between the 30 foot contour and the top of the thermocline. The 1976-79 sampling also excluded Chaumont, Black River, and Henderson Bays. In 1980, a number of significant modifications were made in the sampling. Net panel length was reduced from 100 to 50 feet (all other specifications remained the same); the number of net gangs set was increased; Chaumont, Black River, and Henderson Bays were included among the locations sampled; and a stratified random sample design was used to select netting sites. This new design used three depth strata (stratum 1, 12-30 ft; stratum 2, 31-50 ft; stratum 3, 51-100 ft), plus five area strata (Figure 1). Species diversity and mean catch were highest in depth strata 1 and 2, and sampling effort was concentrated there. Both were sampled in proportion to their surface areas, with 10 and 9 net gangs, respectively, scheduled each year. 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 respective surface areas. 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 1989-2001.

In 1993, 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 cost and availability of multifilament netting of the proper specifications.

Corrections for changes in sample and net design that occurred between 1979 and 1993 have been described previously (Eckert 1986, 1998). Adjustments for differences in areas sampled in 1976-79 versus later years were made using the 1980-85 data. Assuming that the relative species distribution between areas of the eastern basin remained the same from 1976-85, the 1980-85 data were used to calculate indices of relative species catch within the five geographic areas. These species specific area abundance indices were then used to adjust the 1976-79 data for those areas of the eastern basin which were not sampled. Adjustments for the change from multifilament to monofilament mesh gill nets were calculated from 34 paired mono/multifilament net gangs set in 1990-93. Significant differences in CPUE data were found among eight species. Multifilament nets caught significantly higher numbers of brown bullhead and pumpkinseed, while monofilament nets caught significantly higher numbers of white perch, rock bass, smallmouth bass, yellow perch, walleye and freshwater drum. No significant differences were

detected in the ages or sizes of fish collected in the two net types. 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 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 equal to their respective surface areas within New York waters of the eastern basin (stratum 1: 0.20828; stratum 2: 0.18845; stratum 3: 0.60327).

Numbers of warm and cold water fish captured in deeper areas during the August assessment are largely dependent on water temperatures. Although a mix of warm and cold water species can be found in net gangs subjected to fluctuating water temperatures, experience had shown that catches of warm water fish were consistently zero in areas inundated by cold hypolimnetic waters. To avoid the unnecessary killing of cold warm species such as lake trout, net gangs scheduled for locations in stratum 3 which had stable bottom temperatures less than 50°F were often deleted prior to 1996. Whenever a scheduled net gang was deleted due to cold water temperatures, catches of all warm water fish were simply assumed to equal zero. Beginning in the mid 1990s, shifts in the distributions of alewives, rainbow smelt, and lake trout to greater depths were documented in Lake Ontario coincidental with the establishment of dreissenid mussels (O'Gorman et al. 2000). Due to concerns that factors such as increasing water clarity might also increase depth distributions of some warm water fish species, all scheduled net locations have been utilized since 1996 regardless of bottom water temperatures.

Results and Discussion

2001 Summary:

The 2001 warm water assessment was conducted July 30 through August 9 by Cape Vincent staff utilizing the R/V Seth Green. A total of 29 standard net gangs were set as scheduled at randomly chosen locations within the depth and area strata. One net gang (stratum 1, area 1) was found to have significantly shifted position overnight, and was broken off while being hauled after retrieving only three of the nine net panels. Attempts to retrieve the remaining six net panels were unsuccessful. This occurred on the last morning of scheduled netting, and due to weather and other sampling constraints, a replacement net gang could not be set. Catch calculations for 2001 are therefore based on only 28 standard net gangs; nine net gangs in stratum 1. The thermocline was shallow throughout the 2001 sampling, with significant fluctuations during both sample weeks. The warmest bottom temperature observed in stratum 3 was only 57.5°F at a depth of just 53 ft, with temperatures as low as 42°F in the deepest portions of stratum 3. Two net gangs set in stratum 2 had bottom temperatures ranging from 47.5-54.2°F, while all of the remaining net gangs in strata 1 and 2 were at temperatures of 65.5°F or warmer.

Species and numbers of fish captured by depth strata, and stratified CPUE estimates with their corresponding 95% confidence limits are presented in Table 1. As in other years, numbers of fish and warm water fish species diversity were highest in strata 1 and 2, declining substantially in stratum 3. Total catch of warm water fish species was just 616, the lowest total catch among the years sampled, with only 52 in stratum 3, the second lowest total observed (only 1995 was lower). Low catches of warm water fish in stratum 3 and higher than average catches of cold water species (particularly lake trout) can be attributed at least in part to the shallow thermocline and corresponding colder water temperatures encountered. Yellow perch, smallmouth bass, walleye, and rock bass were the most commonly captured species contributing 79.2% of the total number of warm water fish sampled (yellow perch 37.8%, smallmouth bass 21.4%, walleye 11.0%, and rock bass 8.9%). One lake sturgeon was captured in the 28 standard net gangs set in 2001 marking the fifth consecutive year, and the sixth year among the last seven, that at least one individual has been observed. Two additional lake sturgeon were captured in the three net panels of the partially retrieved net gang set in stratum 1. Prior to 1995, only one lake sturgeon was captured in the 16 years of sampling (that occurred in 1981). The three lake sturgeon captured in 2001 ranged in length from 34.5-38.4 inches, and were all released quickly without apparent injury.

Species Trends 1976-2001:

Catch per unit effort data for warm water fish collected in the 1976-2001 assessments are shown in Table 2. Trends in abundance for the total of all warm water fish, and for 14 of the more important warm water species, are presented in Figures 2-6. Figures 2-6 also contain graphs of 3-year moving average catches plotted against the midpoint of the 3-years averaged (i.e., average 1976-78 catch plotted against 1977, average 1977-79 catch plotted against 1978, etc.). This is a method often used to help dampen fluctuations due to yearly sample variation, and to more clearly shown trends in catch data. Overall the warm water fish community in New York waters of Lake Ontario's eastern basin has undergone significant change during the 26-year sampling period, declining from a high of approximately 200-250 fish per net gang in 1976-79, to just over 20 fish per net gang in 1995-2001 (Table 2, Figure 2). This has involved significant declines among most species that were abundant at the start of the assessment program. The stratified mean for all warm water species in 2001 was just 15.73 fish per standard 450 ft net gang, the second lowest total observed among the years sampled.

Yellow perch, white perch, rock bass, gizzard shad, and alewife, were all important members of the warm water community in 1976-79, and have all shown a pattern of declining abundance over the 26-year sampling period. Of these species, gizzard shad showed the earliest and most precipitous decline in abundance (Table 2, Figure 4), declining from a high of approximately 50 fish per net gang in 1977 and 1978 to less than one fish per net gang in 1982. Gizzard shad abundance has remained low since, with zero catches in 1995-97 and again in 2001. White perch were arguably the most common pan fish in Lake Ontario in the 1970s with catches averaging 90 fish per net gang in 1976-79 (Table 2, Figure 3). White perch catches declined through the 1980s and early 1990s, reaching a low of just 0.06 fish per net gang in 1995. Abundance appears have increased somewhat in recent years, but white perch catches remain very low compared to 1976-79, highly variable, and concentrated in the larger embayments. Yellow perch (Tables 2 and 5, Figure 2) catches declined dramatically in the early and mid 1980s, but have remained comparatively stable since at lower abundance levels. Fall trawl sampling conducted by the USGS Oswego Biological Field Station showed increased production of age 0 yellow perch in 1991-95, raising expectations for increased abundance and increased gill net catches in subsequent years (O'Gorman and Burnett 2001). However, these stronger year classes were apparently negated by increases in mortality rates, including increases among age 0-2 fish (perch too small to be exploited by recreational or commercial fisheries). The fact that yellow perch were the most commonly captured fish in the 2000 and 2001 assessment netting is due largely to decreases in catches of other species. Rock bass catch rates declined sharply in the early 1980s; remained moderately stable through the early 1990s, but then began a second more gradual decline that still continues (Tables 2 and 6, Figure 3). The stratified mean CPUE estimate for 2001 was just 1.22 rock bass per net gang, the lowest estimate among the years sampled. Alewife catches show more yearly variation, with an overall pattern of declining catches from the late 1970s through the early 1990s, followed by consistently low catches through 2001 (Table 2, Figure 6). Other sampling programs confirm lower alewife abundance in Lake Ontario as well as shifts in temporal distribution, particularly in the eastern basin since the mid 1990s (O'Gorman et al. 2000, O'Gorman et al. 2001, Schaner and Lantry 2001). Alewife catches in the warm water netting are also potentially influenced by gill net selectivity. Since only larger adult alewives are readily captured in the smallest mesh sizes used (2 inch stretch mesh), comparatively small changes in age composition or growth rate may significantly change vulnerability to the standard net gangs used.

Smallmouth bass have always been an important component of the Lake Ontario warm water community, and the most commonly sought species in the eastern basin recreational fishery (McCullough and Einhouse 1999). From 1976-1979 smallmouth bass were typically the third or fourth most commonly captured fish in the assessment netting (Table 2), with CPUE estimates less than half the most common species. As abundance of these other species declined, smallmouth bass became an increasingly larger proportion of the fish sampled, and since 1986 have been either the first or second most commonly captured species in the assessment netting. Smallmouth bass have shown a cyclic pattern of abundance over the 26-year sample period, with

obvious peaks in CPUE estimates around 1980 and 1989 (Tables 2 and 4, Figure 2). These peaks were directed attributable to recruitment of large numbers of bass from the strong 1973 and 1983 year classes, respectively (Chrisman and Eckert 1999). Catches of age 2-4 bass in the assessment netting also indicated strong year classes in 1987, 1988, 1995, and 1997 (Chrisman and Eckert 1999; Eckert 2000). Despite the presence of four strong year classes since 1987, smallmouth bass catches began an overall pattern of decline in 1990. The 2001 CPUE estimate was just 2.99 bass per net gang, the lowest CPUE estimate among the years sampled and a 40.3% reduction compared to the 2000 CPUE estimate.

Declines in smallmouth bass CPUE since 1990 are most directly linked to increases in mortality of bass between ages 3 and 6 (Chrisman and Eckert 1999; Lantry et al. 1999; Eckert 2000). Lake Ontario smallmouth bass are not fully vulnerable to the standard gill net gangs used until approximately 12 inches long. Bass catches observed in the 1970's and 1980's tended to peak at age 6 (mean length of approximately 12 inches) for any given year class. Catches of younger smaller fish recorded in earlier years for the same year class were typically lower, even though the actual number of fish at younger ages must have been higher. Beginning in the late 1980's, the modal or peak CPUE for each year class began a noticeable shift towards younger and smaller fish, declining to age 3 or 4 for most year classes produced after 1986. Although absolute estimates of annual mortality are not possible for fish that are incompletely vulnerable to the sampling gear used, estimates of relative mortality were calculated for each year class using the ratio of age 3 CPUE divided by age 6 CPUE (Lantry et al. 1999). This analysis showed fairly consistent ratios of less than 1.0 for the 1973-85 year classes (age 6 catches higher than age 3 catches), suddenly increasing to values above 1.0 beginning with the 1986 year class (age 6 catches lower than age 3 catches indicating an increase in relative mortality between ages 3 and 6).

Of the eight remaining species shown in Figures 3-6 , four show a rather obvious downward trend in abundance, while one species shows an overall upward trend. Northern pike (Figure 6) shows an early and dramatic decline in CPUE over the years sampled similar to gizzard shad, but in contrast to gizzard shad, was never a major component of the warm water catch in the eastern basin. White sucker and brown bullhead (Figure 4), and common carp (Figure 6), all show a pattern of declining abundance over the 26-year sampling period, although yearly CPUE estimates are relatively more variable than for the more common species. Channel catfish, pumpkinseed, and freshwater drum (Figure 5) all show relatively high variability in yearly CPUE estimates, with no obvious long-term trends in abundance, especially if the high data points observed in 1979 are discounted. Walleye is the only relatively common species that has shown a long-term trend with increased abundance (Figure 3), but CPUE estimates have also declined for this species since 1993.

Distribution Shifts:

Analysis of changes in depth or geographic distribution was attempted using relative catches of smallmouth bass, yellow perch, and rock bass (the three most common species over the range of years sampled), plus the total of all warm water species. Relative CPUE values were calculated separately each year for the three depth strata, and the five area strata, from the 1980-2001 sampling. The mean catch in each of the three depth strata in any given year was divided by the highest depth strata value for that year; and similarly, the mean catch in each of the five area strata (depth strata 1 and 2 only) was divided by the highest area strata value for that year. This resulted in a value of 1.0 for the depth and area strata that had the highest mean catch for that species or species group in any given year, with values less than 1.0 for the remaining two depth and four area strata that are directly proportional to the catch within that strata (Tables 3-6, Figures 7-14). Trends in the relative CPUE values over the 22-year sampling period were tested using least-squares regression analysis (SAS 1985).

Graphs of relative CPUE by depth strata for the total of all warm water species (species listed in Table 2), smallmouth bass, yellow perch, and rock bass, are given in Figures 7-10 respectively. Despite trends in depth distribution noted in other sampling programs for alewife, rainbow smelt, and lake trout (O'Gorman et al 2000), there was no evidence in the warm water gill netting for changes in either the relative catches of all

warm water species among the three depth strata, or for changes in relative catch in depth stratum 3 for smallmouth bass, yellow perch, or rock bass. Relative catches of all warm water fish (Table 3, Figure 7) showed no significant trends, with typically the highest least variable catches in depth stratum 1 (12-30 ft, 22-year average 0.968), lower more variable catches in depth stratum 2 (31-50ft; 22-year average 0.802); and the lowest and most variable catches in depth stratum 3 (51-100 ft; 22-year average 0.346). Smallmouth bass, yellow perch, and rock bass, all had slightly higher average relative catches in depth stratum 2 than in stratum 1, and all showed some statistically significant (P>0.05) trends in relative catches in depth strata 1 and 2. Smallmouth bass (Table 4, Figure 8) show a statistically significant trend towards higher relative catch in depth stratum 1 (P>0.0281), even though the 22-year average is slightly higher in stratum 2 (0.822 vs. 0.779), with the highest relative catches in stratum 1 in 8 of the last 10 years. Yellow perch (Table 5, Figure 9) show the opposite trend, with a significant downward trend in relative catches in depth stratum 1 (P>0.0153). Rock bass (Table 6, Figure 10) relative catches show both a statistically significant upward trend in depth stratum 1 (P>0.0126), and a statistically significant downward trend in depth stratum 2 (P>0.0204).

Graphs of relative CPUE by area strata for the total of all warm water species, smallmouth bass, yellow perch, and rock bass, are given in Figures 11-14 respectively. Relative catches for the total of all warm water species (Table 3, Figure 11) show a statistically significant upward trend in Chaumont Bay (P>0.0257), and a statistically significant downward trend in Henderson Bay (P>0.0141). It is interesting to note that despite the presence of a significant downward trend in Henderson Bay over the 22-year sampling period, relative catches were highest in this area in 2000 and 2001, indicating that the downward trend in catch which began in 1991 may be ending. Smallmouth bass relative catches (Table 4, Figure 12) show statistically significant downward tends in the Grenadier Island (P>0.0216) and Stony Island (P>0.0008) areas, and a statistically significant upward trend in the Chaumont Bay area. Relative catch data for yellow perch (Table 5, Figure 13) only show downward trends, with statistically significant patterns in the Grenadier Island (P>0.0138) and Stony Island (P>0.0020) areas. Although relative catches of yellow perch have never been high in the Stony Island area, catches have been particularly low in since 1988, with zero catches in 11 of the last 14 years (5 net gangs per year, 12-50 ft depths), and only three individual perch caught total in the last two years. Rock bass was the only species or group examined which failed to show any statistically significant trends in relative catch from 1980-2001, although dramatic differences in relative catch were clearly evident among the five areas.

References

Chrisman, J.R. and T.H. Eckert. 1999. Population trends among smallmouth bass in the eastern basin of Lake Ontario, 1976-97. Section 2 in Final Report: To assess the impact of double-crested cormorant predation on smallmouth bass and other fish of the eastern basin of Lake Ontario. NYSDEC Special Report - February 1, 1999. New York State Department of Environmental Conservation, Bureau of Fisheries, Albany, N.Y.

Cochran, W.G. 1977. Sampling Techniques, 3rd edition. John Wiley and Sons, New York.

Eckert, T.H. 1986. 1985 warm water assessment. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Gananoque, Ontario, March 4-5, 1986, Appendix VII, pages 327-342.

Eckert, T.H. 1998. Summary of 1976-97 warm water assessment. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Niagara Falls, Ontario, March 24-25, 1998.

Eckert, T.H. 2000. Summary of 1976-99 warm water assessment. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Niagara-on-the-Lake, Ontario, March 28-29, 2000.

Lantry, B.F., T.H. Eckert, and C.P. Schneider. 1999. The relationship between the abundance of smallmouth bass and double-crested cormorants in the eastern basin of Lake Ontario. Section 12 in Final Report: To assess the impact of double-crested cormorant predation on smallmouth bass and other fish of the eastern basin of Lake Ontario. NYSDEC Special Report - February 1, 1999. New York State

Department of Environmental Conservation, Bureau of Fisheries, Albany, N.Y.

McCullough, R.D. and D.W. Einhouse. 1999. Lake Ontario eastern basin creel survey, 1998. Section 4 in Final Report: To assess the impact of double-crested cormorant predation on smallmouth bass and other fish of the eastern basin of Lake Ontario. NYSDEC Special Report - February 1, 1999. New York State Department of Environmental Conservation, Bureau of Fisheries, Albany, N.Y.

O'Gorman, R., J.H. Elrod, R.W. Owens, C.P. Schneider, T.H. Eckert, and B.F. Lantry. 2000. Shifts in depth distributions of alewives, rainbow smelt, and age-2 lake trout in southern Lake Ontario following establishment of dreissenid. Transactions of the American Fisheries Society 129: 1096-1106.

O'Gorman, R., and J.A.D. Burnett. 2001. Fish community dynamics in northeastern Lake Ontario with emphasis on the growth and reproductive success of yellow perch (*Perca flavescens*) and white perch (*Morone americana*), 1978 to 1997. Journal of Great Lakes Research 27(3): 367-383.

O'Gorman, R., R.W. Owens, T.H. Eckert, and B.F. Lantry. 2001. Status of major prey fish stocks in the U.S. waters of Lake Ontario, 2000. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Niagara Falls, N.Y., March 27-28, 2001.

SAS Institute. 1985. SAS procedures guide for personal computers, version 6 edition. SAS Institute, Cary, North Carolina.

Schaner, T. and B.F. Lantry. 2001. Pelagic planktivores. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Niagara Falls, N.Y., March 27-28, 2001.

Table 1. Numbers of fish caught, stratified mean catch per standard 450 ft gill net gang, and 95% confidence intervals, for the 2001 warm water assessment netting conducted July 30 - August 9 in New York waters of Lake Ontario's eastern basin.

	Number Caught				Strat.	95% CI	
Common Name	Stratum 1	Stratum 2	Stratum 3	Total	CPUE	Lower	Upper
Warm Water Species:							
Lake Sturgeon	1	0	0	1	0.02	-0.03	0.08
Longnose Gar	1	0	0	1	0.02	-0.03	0.08
Alewife	1	4	14	19	0.95	-0.39	2.29
Northern Pike	3	0	0	3	0.07	-0.04	0.18
White Sucker	13	4	0	17	0.38	0.11	0.66
Silver Redhorse	2	0	0	2	0.05	-0.02	0.12
Shorthead Redhorse	1	0	0	1	0.02	-0.03	0.08
Brown Bullhead	14	0	0	14	0.32	-0.16	0.81
Channel Catfish	2	2	0	4	0.09	0.00	0.18
White Perch	44	1	0	45	1.04	-0.64	2.72
Rock Bass	31	24	0	55	1.22	0.45	1.99
Pumpkinseed	11	1	0	12	0.28	-0.26	0.81
Smallmouth Bass	101	31	0	132	2.99	1.46	4.51
Yellow Perch	89	111	33	233	6.37	1.17	11.58
Walleye	38	25	5	68	1.70	0.50	2.91
Freshwater Drum	4	5	0	9	0.20	-0.04	0.43
Warm Water Total	356	208	52	616	15.73	10.01	21.45
Cold Water & Misc Species:							
Lake Whitefish	0	0	1	1	0.06	-0.08	0.20
Brown Trout	0	1	0	1	0.02	-0.03	0.07
Lake Trout	0	0	48	48	2.90	0.34	5.45
Burbot	0	0	7	7	0.42	-0.15	1.00
Standard Gill Net Gangs	9	9	10	28			

Table 2. Stratified mean catch per unit effort data from the 1976-2001 warm water assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

	Mean Catch per 450 ft Monofilament Gill Net Gang												
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Lake Sturgeon	0	0	0	0	0	0.02	0	0	0	0	0	0	0
Longnose Gar	0	0	0	0	0.04	0	0	0.04	0	1.19	0.04	0	0
Bowfin	0	0	0	0	0.02	0.02	0	0	0	0	0	0	0
American Eel	0	0	0.06	0.03	0	0	0	0	0	0	0	0	0
Alewife	20.96	2.07	14.83	11.57	4.30	8.18	7.53	6.90	17.65	3.35	7.61	2.32	9.64
Gizzard Shad	17.82	53.45	47.38	19.95	4.52	2.78	0.10	0.29	0.87	0.50	0.48	0.44	0.24
Northern Pike	0.83	1.04	0.93	0.16	0.08	0.02	0.04	0.06	0.02	0.17	0.17	0.08	0
Goldfish X Carp	0	0	0	0.17	0	0	0	0	0	0	0	0	0
Common Carp	0.25	0.55	0.33	0.45	0.17	0.10	0.35	0.21	0.17	0.17	0.10	0.20	0.23
Golden Shiner	0	0	0	0	0.02	0	0	0	0.04	0.02	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0.15	0	0	0	0	0
Quillback	0	0	0	0.31	0.04	0.06	0	0.04	0	0	0.02	0	0.02
Longnose Sucker	0	0	0	0	0.02	0	0	0	0	0	0	0	0
White Sucker	4.04	0.63	2.90	3.11	1.84	1.42	4.34	1.40	1.58	0.93	2.47	1.49	0.91
Silver Redhorse	0.06	0.05	0.20	0.43	0.04	0.10	0.15	0.38	0.06	0	0.02	0.02	0.07
Shorthead Redhorse	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Bullhead	1.12	0.20	1.41	4.17	0.66	0.23	1.29	0.76	0.86	1.70	2.14	1.96	0.61
Channel Catfish	0.41	1.03	1.75	3.64	0.60	0.56	1.27	0.86	0.29	0.63	1.25	0.77	0.97
Stonecat	0	0.04	0.26	0.08	0	0.23	0.30	0.02	0.04	0.06	0.04	0	0
Trout-perch	0	0	0	0	0	0.15	0.15	0	0.08	0	0	0.08	0.15
White Perch	63.00	136.42	74.11	86.98	26.20	44.53	25.98	34.02	20.78	12.23	13.94	11.14	4.87
White Bass	0	0	0.13	0	0.02	0.06	0.26	0	0.06	0.02	0.06	0.06	0.13
Rock Bass	7.10	10.75	22.13	13.94	14.69	10.09	7.06	4.69	6.99	3.96	7.58	4.76	4.94
Pumpkinseed	0	0.44	0.06	3.06	0.14	0.32	0.73	0.43	0.09	0.59	0.57	0.40	0.25
Bluegill	0	0	0	0	0	0	0.04	0	0	0	0	0	0
Smallmouth Bass	24.51	24.05	26.04	35.74	38.02	23.47	14.55	14.96	12.44	9.76	18.14	10.89	15.92
Largemouth Bass	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0.04	0.02	0.02	0.02	0.06	0.02	0.10	0	0	0.02
Yellow Perch	69.09	26.20	44.44	67.32	27.63	43.81	36.07	50.85	24.02	15.35	13.32	8.36	2.19
Walleye	0.05	0.20	0.12	0.27	0.28	0.12	0.59	0.09	0.09	0.41	0.19	0.75	0.80
Freshwater Drum	0.19	0	0.74	1.43	0.34	0.09	0.34	0.59	0.31	0.25	0.16	0.25	0.45
Total	209.43	257.13	237.81	252.83	119.72	136.42	101.19	116.82	86.50	51.38	68.30	43.98	42.42

Table 2 (continued). Stratified mean catch per unit effort data from the 1976-2001 warm water assessment netting.

	Mean Catch per 450 ft Monofilament Gill Net Gang												
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Lake Sturgeon	0	0	0	0	0	0	0.02	0	0.02	0.06	0.04	0.10	0.02
Longnose Gar	0	0.08	0	0	0.48	0.35	0	0	0.02	0.02	0.08	0	0.02
Bowfin	0	0	0	0.02	0	0	0	0	0	0	0	0	0
American Eel	0	0.02	0	0	0	0	0	0	0	0	0	0	0
Alewife	0.59	1.29	1.27	2.26	0.18	0	0.48	0.92	0	0.06	0.12	0.26	0.95
Gizzard Shad	0.69	1.26	1.39	1.79	0.12	0.06	0	0	0	0.08	0.08	0.13	0
Northern Pike	0.02	0	0.15	0.04	0.10	0.06	0.04	0.04	0.08	0.06	0.06	0.08	0.07
Goldfish X Carp	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Carp	0.37	0.35	0.29	0.33	0.35	0.06	0.10	0.15	0.12	0.10	0.33	0.04	0
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0.06	0	0	0	0	0	0	0	0	0
Quillback	0.04	0.04	0.08	0	0.04	0	0	0.04	0	0.04	0	0	0
Longnose Sucker	0	0	0	0	0	0	0	0	0	0	0	0	0
White Sucker	0.75	3.47	0.41	0.88	1.18	0.81	1.13	2.01	1.31	1.02	1.02	0.35	0.38
Silver Redhorse	0.17	0.29	0.22	0.18	0	0.08	0.12	0.02	0.13	0.12	0.10	0.12	0.05
Shorthead Redhorse	0	0	0	0	0	0.02	0	0	0.02	0	0	0	0.02
Brown Bullhead	0.84	0.66	0.86	0.87	0.35	0.35	0.06	0	0.83	0.06	0.21	0.21	0.32
Channel Catfish	2.40	3.34	1.20	1.35	1.12	0.35	0.19	0.47	1.42	0.75	0.68	0.54	0.09
Stonecat	0.02	0	0.02	0	0	0	0	0	0	0	0	0	0
Trout-perch	0	0	0.12	0	0	0	0	0	0	0	0	0	0
White Perch	7.95	4.36	7.83	5.49	5.04	6.01	0.06	0.31	0.48	0.29	1.36	0.92	1.04
White Bass	0.08	0	0.10	0	0.02	0	0	0	0	0.04	0	0	0
Rock Bass	7.53	8.08	6.86	3.09	6.99	3.99	1.41	3.79	2.33	2.13	3.08	1.47	1.22
Pumpkinseed	0.64	0.78	0.14	0.34	0.23	0.04	0.06	0.04	0.08	0.29	0.27	0.31	0.28
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0
Smallmouth Bass	39.05	21.72	29.40	19.13	19.91	11.99	5.01	6.98	6.03	9.36	10.68	5.01	2.99
Largemouth Bass	0	0	0	0	0	0	0	0	0	0.02	0	0	0
Black Crappie	0.02	0.06	0	0	0.04	0	0	0	0	0.02	0	0	0
Yellow Perch	10.06	13.61	6.97	6.72	2.78	5.87	3.68	8.76	5.53	5.01	4.47	8.58	6.37
Walleye	0.96	1.31	1.68	1.59	3.84	3.29	1.91	2.97	1.76	2.13	1.32	1.53	1.70
Freshwater Drum	0.53	0.62	0.34	0.43	0.52	0.74	0.63	0.23	0.41	0.25	0.50	0.25	0.20
Total	72.71	61.35	59.34	44.57	43.32	34.08	14.91	26.73	20.58	21.94	24.40	19.92	15.73

Table 3. Stratified mean catch per standard 450 ft 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 all warm water fish from warm water assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

Year	Strat.	95% CI		Rel CPUE by Depth			Relative CPUE by Area				
Sampled	CPUE	Lower	Upper	Strat 1	Strat 2	Strat 3	Area 1	Area 2	Area 3	Area 4	Area 5
1976	209.43										
1977	257.13										
1978	237.81										
1979	252.83										
1980	119.72	86.40	153.04	1.00	0.76	0.39	0.63	0.43	0.32	1.00	0.41
1981	136.42	93.47	179.36	1.00	0.93	0.25	0.60	0.62	0.78	1.00	0.39
1982	101.19	71.72	130.65	0.94	1.00	0.21	0.89	0.61	0.86	1.00	0.51
1983	116.82	35.94	197.69	1.00	0.87	0.51	0.59	0.58	0.36	1.00	0.33
1984	86.50	62.65	110.34	1.00	0.58	0.13	0.51	0.39	0.65	1.00	0.45
1985	51.38	38.83	63.94	1.00	0.84	0.04	0.61	0.84	0.77	1.00	0.40
1986	68.30	42.17	94.44	0.96	1.00	0.41	0.64	0.86	0.87	1.00	0.50
1987	43.98	30.19	57.76	1.00	0.55	0.06	0.46	1.00	0.68	0.87	0.40
1988	42.42	29.70	55.13	1.00	0.77	0.36	0.43	0.49	0.51	1.00	0.62
1989	72.71	46.85	98.58	0.84	0.88	1.00	0.34	0.82	0.49	1.00	0.43
1990	61.35	41.54	81.16	0.84	1.00	0.51	0.99	1.00	0.69	0.97	0.53
1991	59.34	43.05	75.63	0.99	1.00	0.51	0.47	1.00	0.51	0.29	0.36
1992	44.57	31.62	57.53	1.00	0.68	0.44	0.77	1.00	0.39	0.92	0.29
1993	43.32	31.32	55.32	1.00	0.59	0.45	0.55	0.73	1.00	0.69	0.37
1994	34.08	23.91	44.25	1.00	0.90	0.21	0.38	1.00	0.87	0.78	0.45
1995	14.91	10.13	19.69	1.00	0.50	0.05	0.47	1.00	0.74	0.65	0.59
1996	26.73	13.48	39.99	0.94	1.00	0.50	0.54	0.61	1.00	0.15	0.41
1997	20.58	12.67	28.49	1.00	0.69	0.32	0.44	0.96	1.00	0.50	0.46
1998	21.94	14.58	29.30	1.00	0.59	0.25	0.68	1.00	0.44	0.60	0.43
1999	24.40	16.70	32.09	1.00	0.91	0.48	0.38	1.00	0.74	0.51	0.23
2000	19.92	11.48	28.36	0.79	1.00	0.37	0.65	0.68	0.37	1.00	0.24
2001	15.73	10.01	21.45	1.00	0.58	0.13	0.56	0.69	0.22	1.00	0.31

Table 4. Stratified mean catch per standard 450 ft 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 smallmouth bass from warm water assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

Year	Strat.	95% CI		Rel CPUE by Depth			Relative CPUE by Area				
Sampled	CPUE	Lower	Upper	Strat 1	Strat 2	Strat 3	Area 1	Area 2	Area 3	Area 4	Area 5
1976	24.51										
1977	24.05										
1978	26.04										
1979	35.74										
1980	38.02	17.40	58.64	0.56	0.61	1.00	1.00	0.36	0.07	0.27	0.98
1981	23.47	14.28	32.67	0.95	1.00	0.26	0.60	0.67	0.52	0.58	1.00
1982	14.55	6.04	23.07	0.58	1.00	0.23	1.00	0.81	0.44	0.33	0.86
1983	14.96	9.70	20.22	0.44	1.00	0.08	0.66	0.23	0.58	0.52	1.00
1984	12.44	7.03	17.86	1.00	0.95	0.03	1.00	0.16	0.21	0.47	0.85
1985	9.76	5.35	14.17	0.52	1.00	0.00	0.83	0.32	0.04	0.22	1.00
1986	18.14	7.51	28.76	0.57	1.00	0.70	0.86	0.34	0.52	0.35	1.00
1987	10.89	5.93	15.86	1.00	0.74	0.01	0.84	0.10	1.00	0.49	0.84
1988	15.92	9.96	21.87	0.96	1.00	0.26	0.47	0.29	0.33	0.76	1.00
1989	39.05	14.35	63.75	0.29	0.39	1.00	0.52	0.05	0.41	0.97	1.00
1990	21.72	13.13	30.31	0.38	1.00	0.57	1.00	0.28	0.02	0.45	0.68
1991	29.40	14.64	44.16	0.33	1.00	0.72	0.37	1.00	0.08	0.25	1.00
1992	19.13	11.45	26.80	1.00	0.86	0.96	0.74	0.50	0.08	1.00	0.41
1993	19.91	12.87	26.96	0.65	0.69	1.00	0.73	0.70	0.30	1.00	0.53
1994	11.99	7.75	16.23	1.00	0.94	0.60	0.48	0.72	0.00	1.00	0.93
1995	5.01	3.20	6.82	1.00	0.54	0.06	0.81	0.67	1.00	0.69	0.69
1996	6.98	2.99	10.97	1.00	0.98	0.37	0.59	1.00	0.91	0.10	0.34
1997	6.03	4.00	8.05	1.00	0.66	0.24	0.59	1.00	0.49	0.78	0.43
1998	9.36	4.95	13.78	1.00	0.44	0.46	0.55	1.00	0.27	0.81	0.84
1999	10.68	6.84	14.51	1.00	0.98	0.51	0.27	1.00	0.59	0.31	0.23
2000	5.01	2.65	7.38	0.93	1.00	0.48	1.00	0.80	0.28	0.80	0.86
2001	2.99	1.46	4.51	1.00	0.31	0.00	0.23	1.00	0.09	0.38	0.40

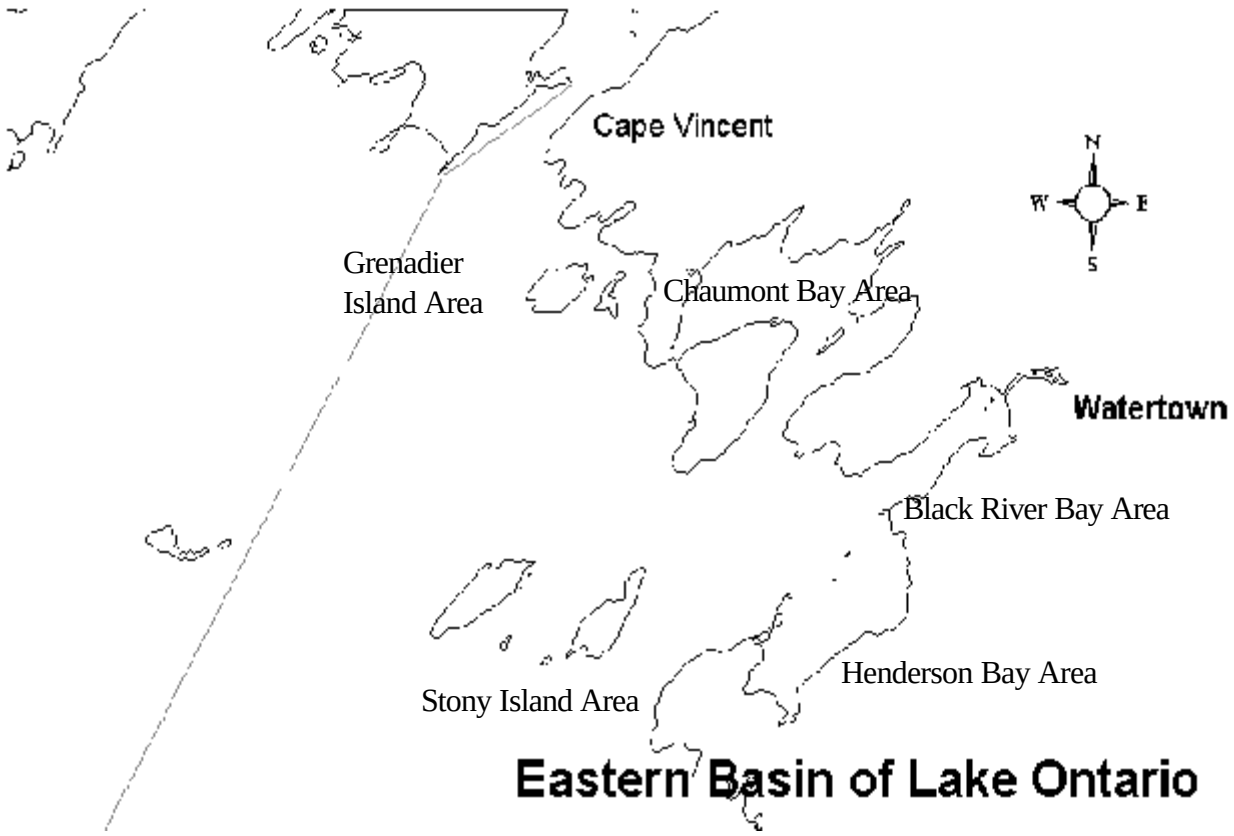
Table 5. Stratified mean catch per standard 450 ft gill net gang, 95% confidence intervals, relative annual CPUE by depth strata, and relative annual CPUE by area for depth strata 1 and 2, for yellow perch from warm water assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

Year	Strat.	95% CI		Rel CPUE by Depth			Relative CPUE by Area				
Sampled	CPUE	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	0.42	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	0.58	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	0.12	0.80	1.00	0.00	0.83	0.00
1989	10.06	2.93	17.18	0.43	1.00	0.80	0.01	1.00	0.34	0.36	0.00
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	0.00
1992	6.72	1.82	11.63	0.66	1.00	0.70	0.15	0.85	1.00	0.47	0.00
1993	2.78	0.59	4.97	0.74	1.00	0.33	0.01	0.49	0.00	1.00	0.00
1994	5.87	1.29	10.44	0.93	1.00	0.01	0.00	0.26	1.00	0.64	0.00
1995	3.68	0.31	7.05	1.00	0.62	0.06	0.00	1.00	0.62	0.44	0.00
1996	8.76	2.75	14.77	0.39	1.00	0.90	0.10	0.32	1.00	0.19	0.00
1997	5.53	0.32	10.74	0.63	0.76	1.00	0.10	0.09	1.00	0.28	0.00
1998	5.01	1.27	8.74	0.68	1.00	0.09	0.73	1.00	0.32	0.61	0.00
1999	4.47	1.39	7.54	0.69	0.34	1.00	0.00	0.36	0.27	1.00	0.00
2000	8.58	1.25	15.91	0.33	1.00	0.48	0.25	0.07	0.16	1.00	0.01
2001	6.37	1.17	11.58	0.80	1.00	0.27	0.39	0.04	0.07	1.00	>0.01

Table 6. Stratified mean catch per standard 450 ft 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 rock bass from warm water assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

Year	Strat.	95% CI		Rel CPUE by Depth			Relative CPUE by Area				
Sampled	CPUE	Lower	Upper	Strat 1	Strat 2	Strat 3	Area 1	Area 2	Area 3	Area 4	Area 5
1976	7.10										
1977	10.75										
1978	22.13										
1979	13.94										
1980	14.69	8.59	20.79	0.72	1.00	0.75	1.00	0.23	0.44	0.18	0.66
1981	10.09	5.21	14.96	0.50	1.00	0.27	0.70	0.11	1.00	0.30	0.24
1982	7.06	2.86	11.27	0.38	1.00	0.21	0.81	0.11	1.00	0.28	0.62
1983	4.69	1.93	7.45	0.59	1.00	0.08	1.00	0.08	0.75	0.19	0.18
1984	6.99	3.00	10.98	0.53	1.00	0.24	1.00	0.18	0.33	0.20	0.87
1985	3.96	1.78	6.14	0.64	1.00	0.04	1.00	0.03	0.05	0.10	0.56
1986	7.58	4.05	11.11	0.44	1.00	0.27	0.89	0.07	1.00	0.41	0.46
1987	4.76	2.05	7.46	1.00	0.39	0.06	1.00	0.12	0.90	0.28	0.93
1988	4.94	2.04	7.84	0.90	1.00	0.36	0.80	0.08	1.00	0.19	0.66
1989	7.53	3.16	11.91	0.33	0.91	1.00	1.00	0.00	0.77	0.10	0.55
1990	8.08	3.36	12.80	1.00	0.67	0.31	0.35	0.00	0.11	1.00	0.27
1991	6.86	2.79	10.93	0.58	1.00	0.24	1.00	0.15	0.85	0.12	0.07
1992	3.09	1.67	4.50	0.61	1.00	0.46	1.00	0.41	0.27	0.41	0.27
1993	6.99	1.50	12.48	1.00	0.72	0.27	1.00	0.03	0.81	0.08	0.21
1994	3.99	1.17	6.81	0.39	1.00	0.18	1.00	0.00	0.12	0.12	0.54
1995	1.41	0.42	2.40	0.93	1.00	0.09	0.61	0.00	0.56	0.11	1.00
1996	3.79	0.00	7.74	1.00	0.71	0.52	1.00	0.05	0.87	0.03	0.42
1997	2.33	0.89	3.77	1.00	0.39	0.04	0.19	0.76	1.00	0.14	0.50
1998	2.13	0.97	3.28	1.00	0.27	0.15	1.00	0.03	0.65	0.08	0.48
1999	3.08	0.89	5.26	0.57	1.00	0.23	1.00	0.12	0.45	0.44	0.11
2000	1.47	0.67	2.27	1.00	0.53	0.13	1.00	0.25	0.83	0.11	0.27
2001	1.22	0.45	1.99	1.00	0.77	0.00	1.00	0.03	0.62	0.23	0

Figure 1. Map of New York waters of Lake Ontario's eastern basin showing the five area strata used in the DEC 1980-2001 warm water assessment.



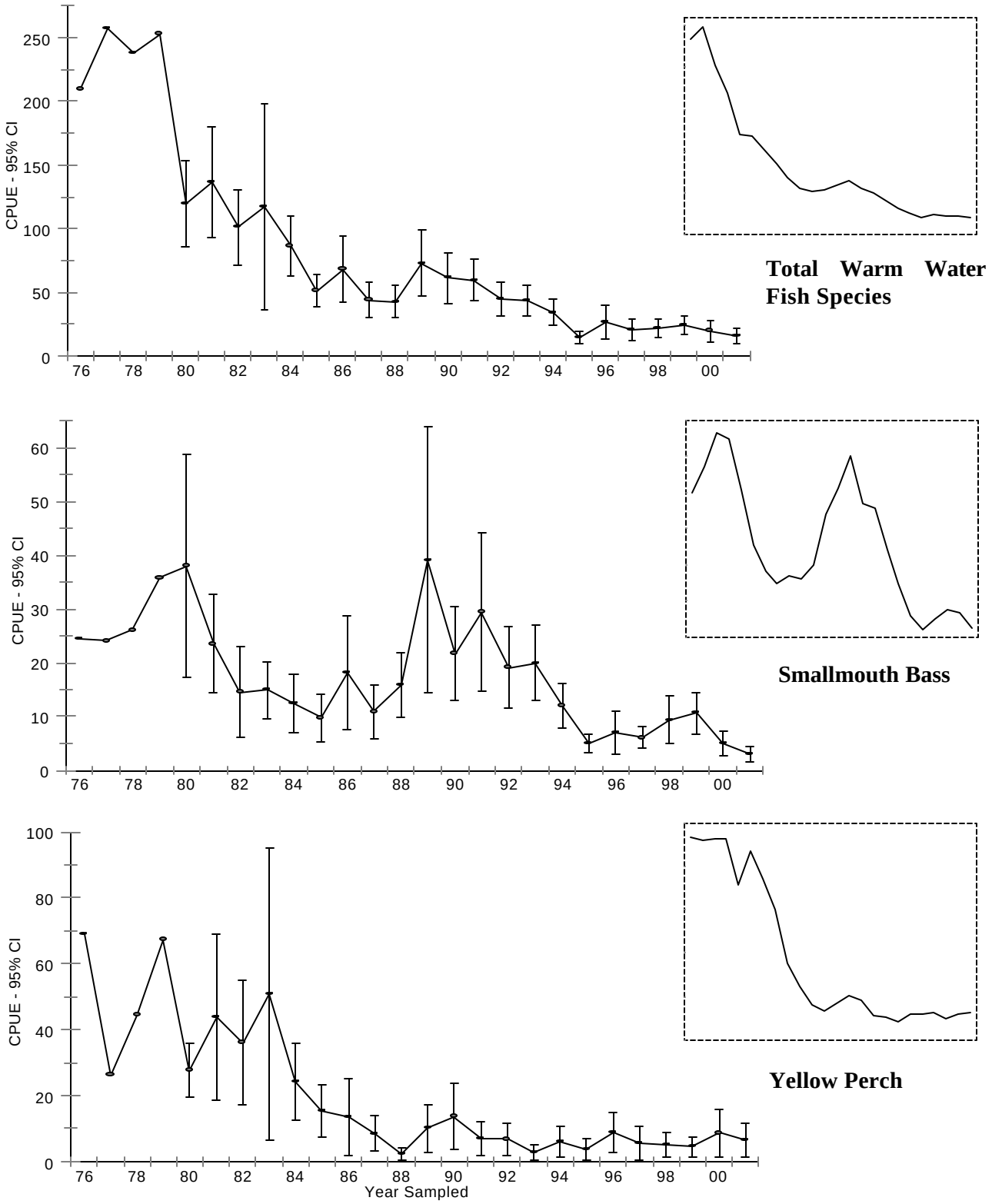


Figure 2. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for all warm water fish, smallmouth bass, and yellow perch, from the 1976-2001 warm water assessment conducted in New York waters of Lake Ontario's eastern basin. The inset graphs show 3-year moving average catch per unit effort data plotted against the mid point of the years sampled.

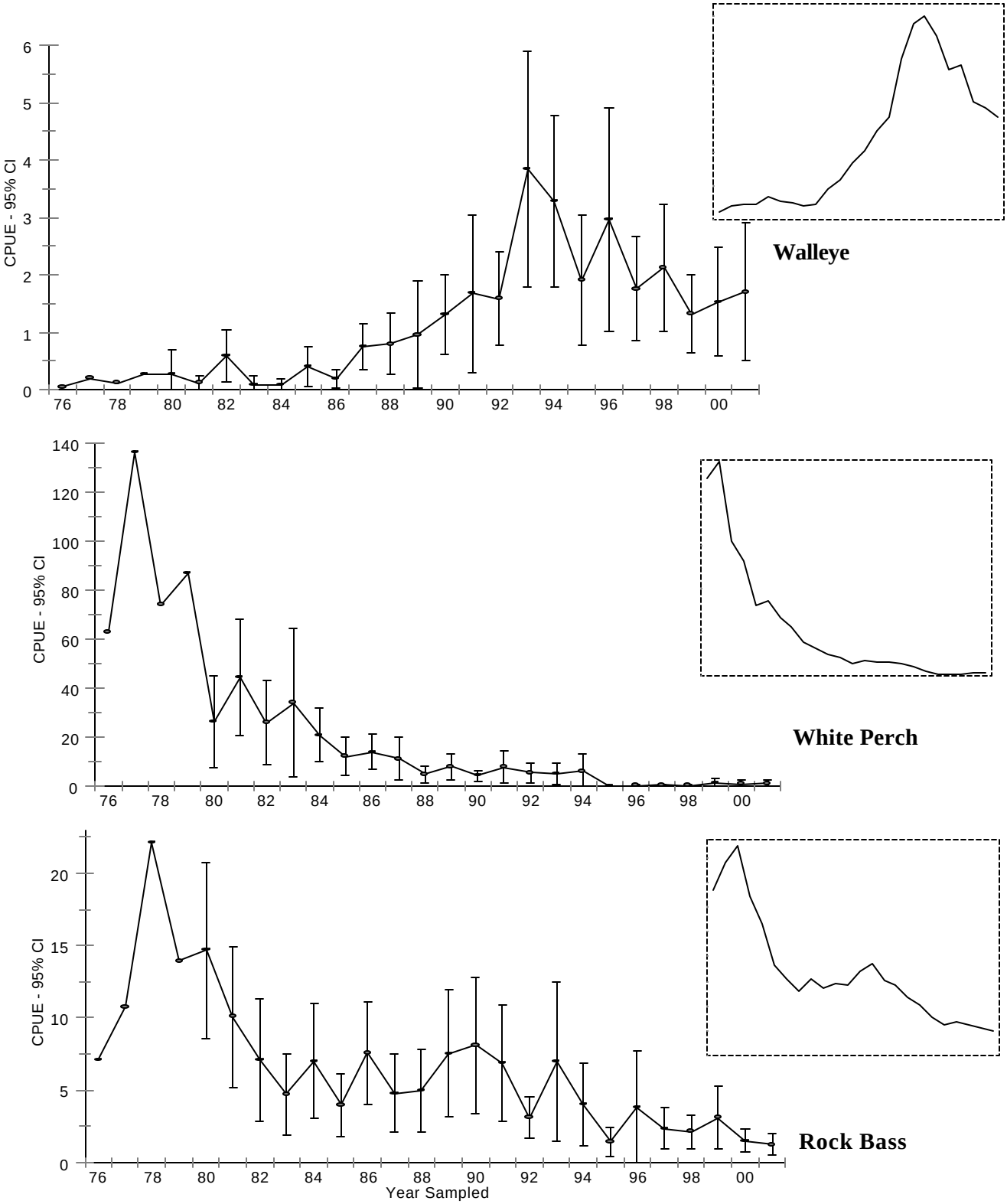


Figure 3. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for walleye, white perch, and rock bass, from the 1976-2001 warm water assessment conducted in New York waters of Lake Ontario's eastern basin. The inset graphs show 3-year moving average catch per unit effort data plotted against the mid point of the years sampled.

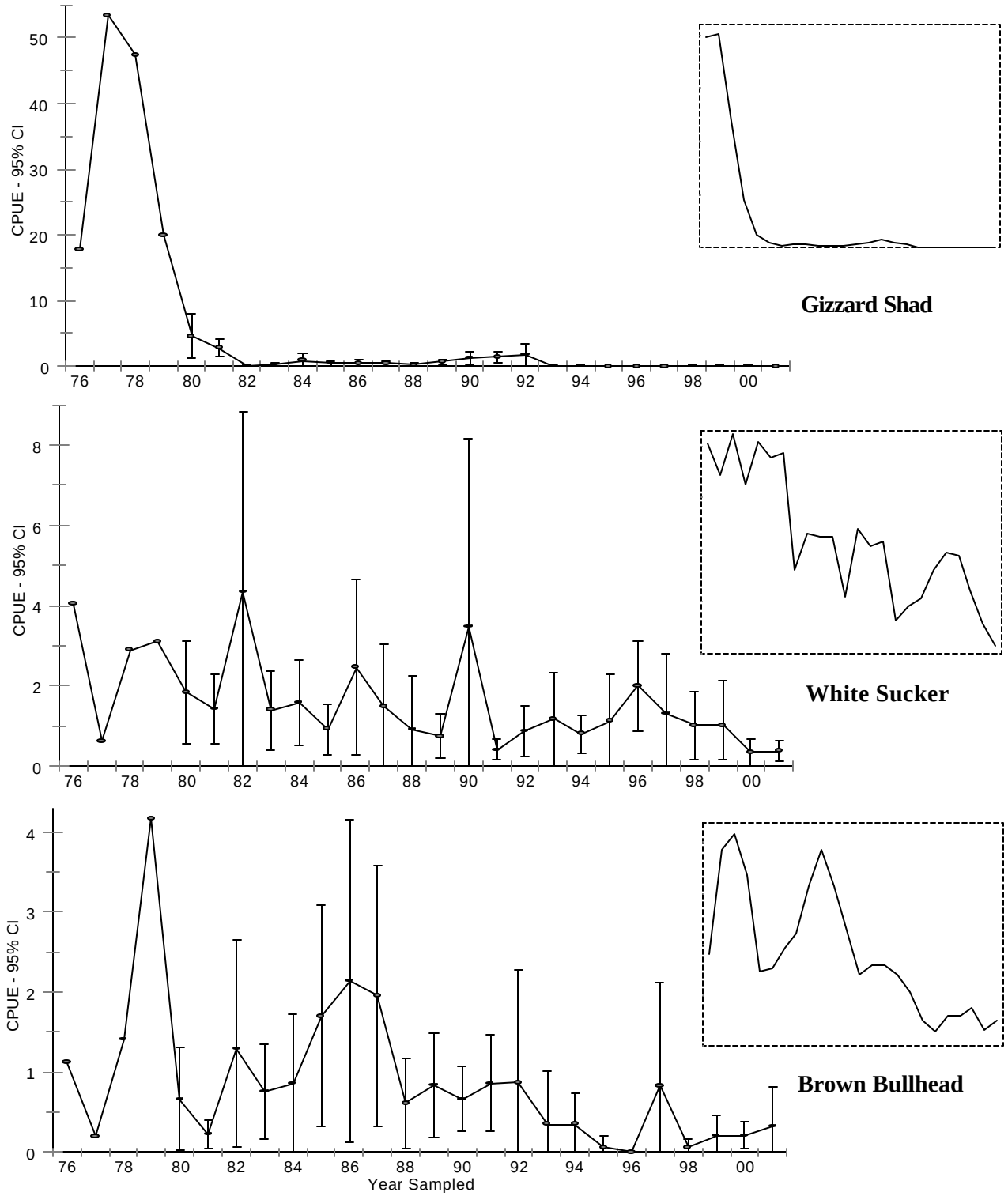


Figure 4. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for gizzard shad, white sucker, and brown bullhead, from the 1976-2001 warm water assessment conducted in New York waters of Lake Ontario's eastern basin. The inset graphs show 3-year moving average catch per unit effort data plotted against the mid point of the years sampled.

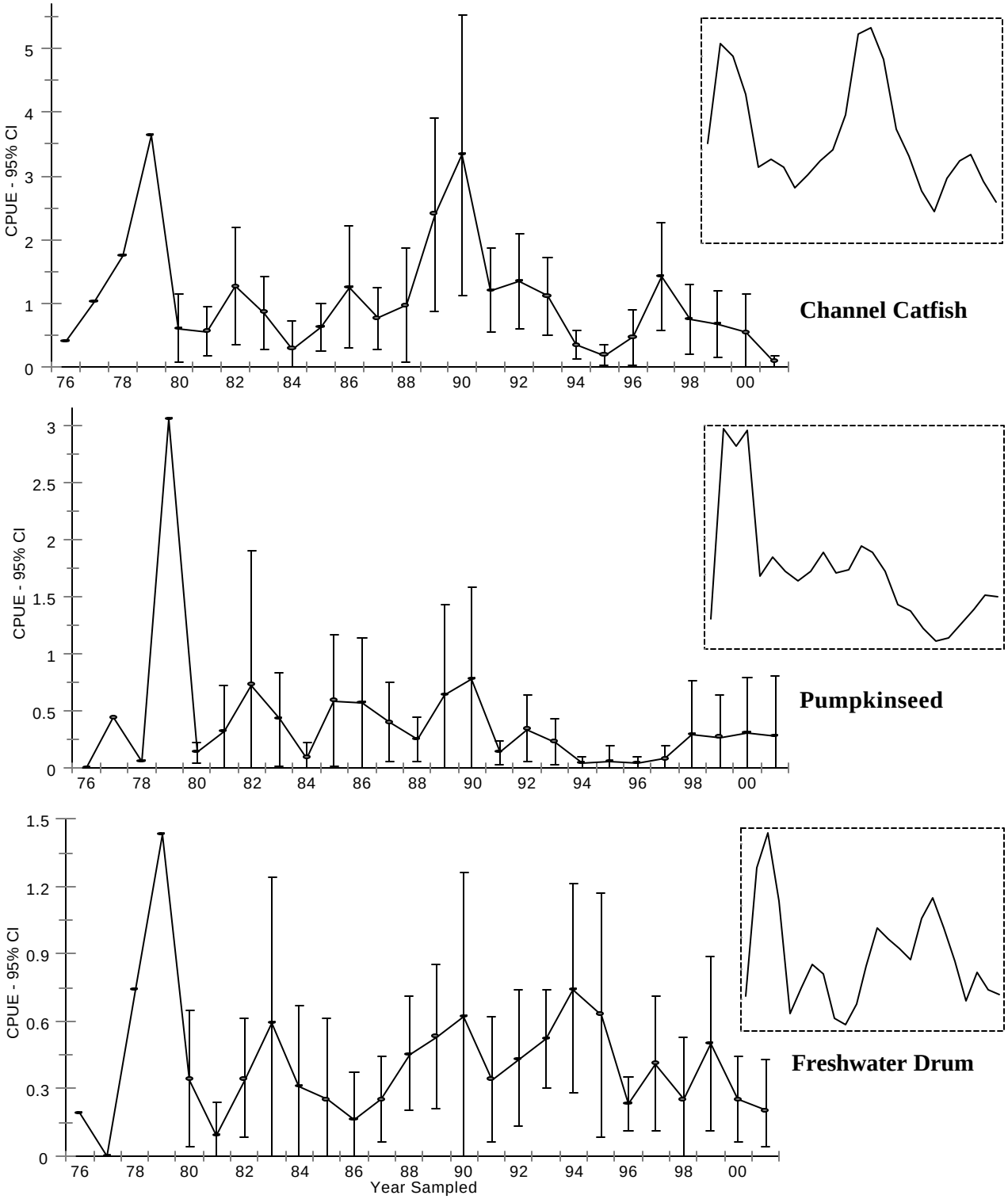


Figure 5. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for channel catfish, pumpkinseed, and freshwater drum, from the 1976-2001 warm water assessment conducted in New York waters of Lake Ontario's eastern basin. The inset graphs show 3-year moving average catch per unit effort data plotted against the mid point of the years sampled.

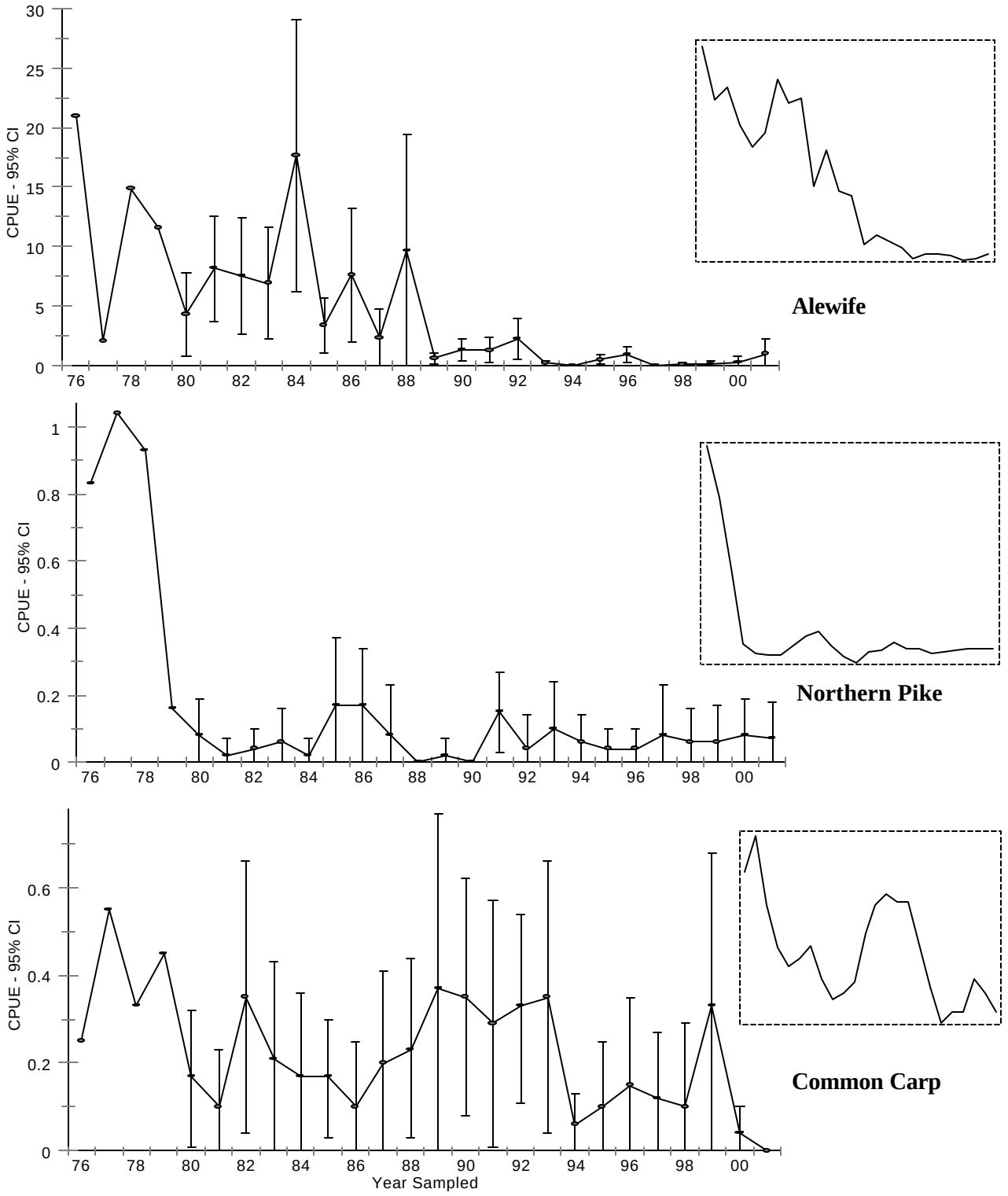


Figure 6. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for alewife, northern pike, and common carp, from the 1976-2001 warm water assessment conducted in New York waters of Lake Ontario's eastern basin. The inset graphs show 3-year moving average catch per unit effort data plotted against the mid point of the years sampled.

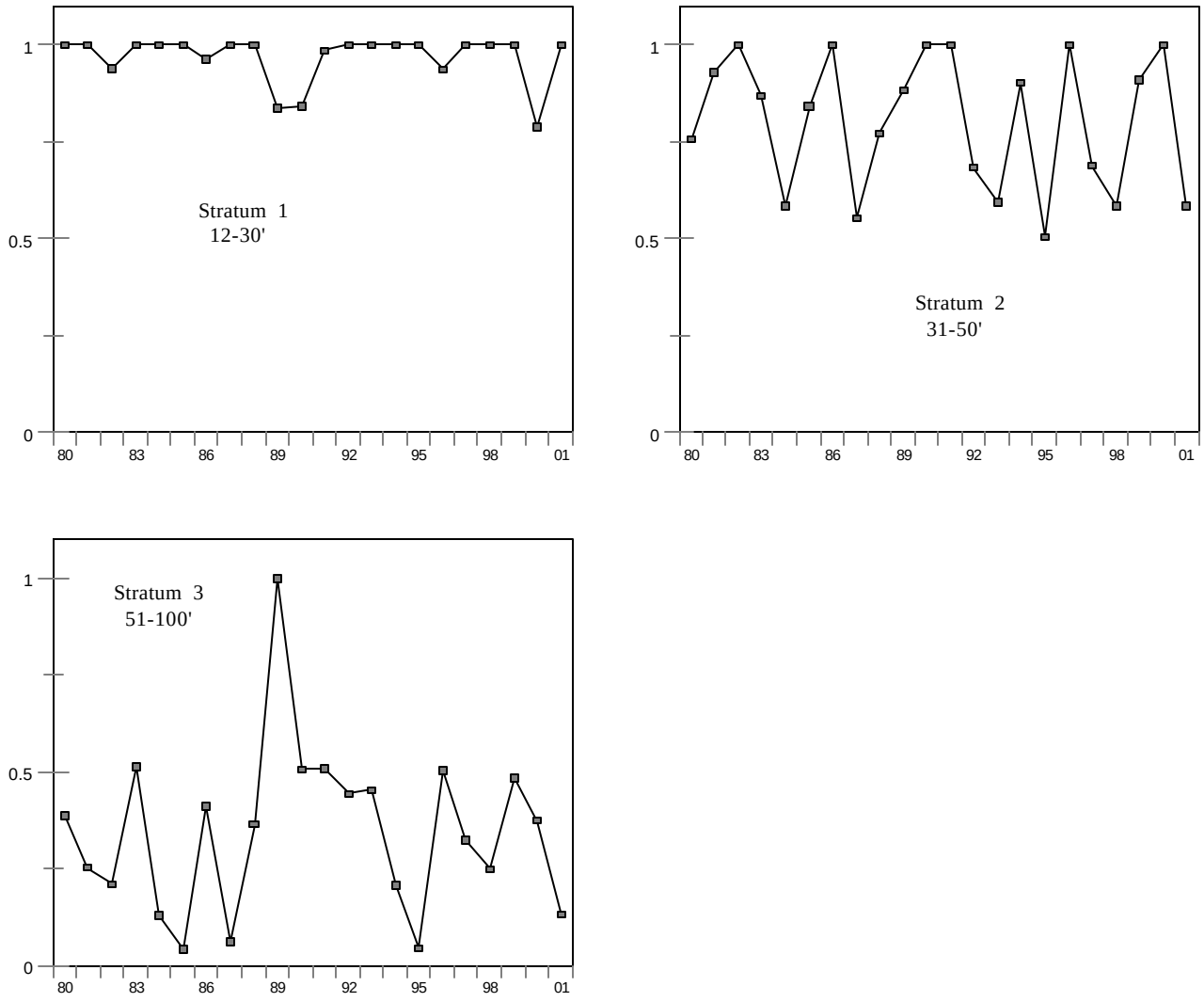


Figure 7. Relative CPUE by depth strata for all warm water fish collected in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

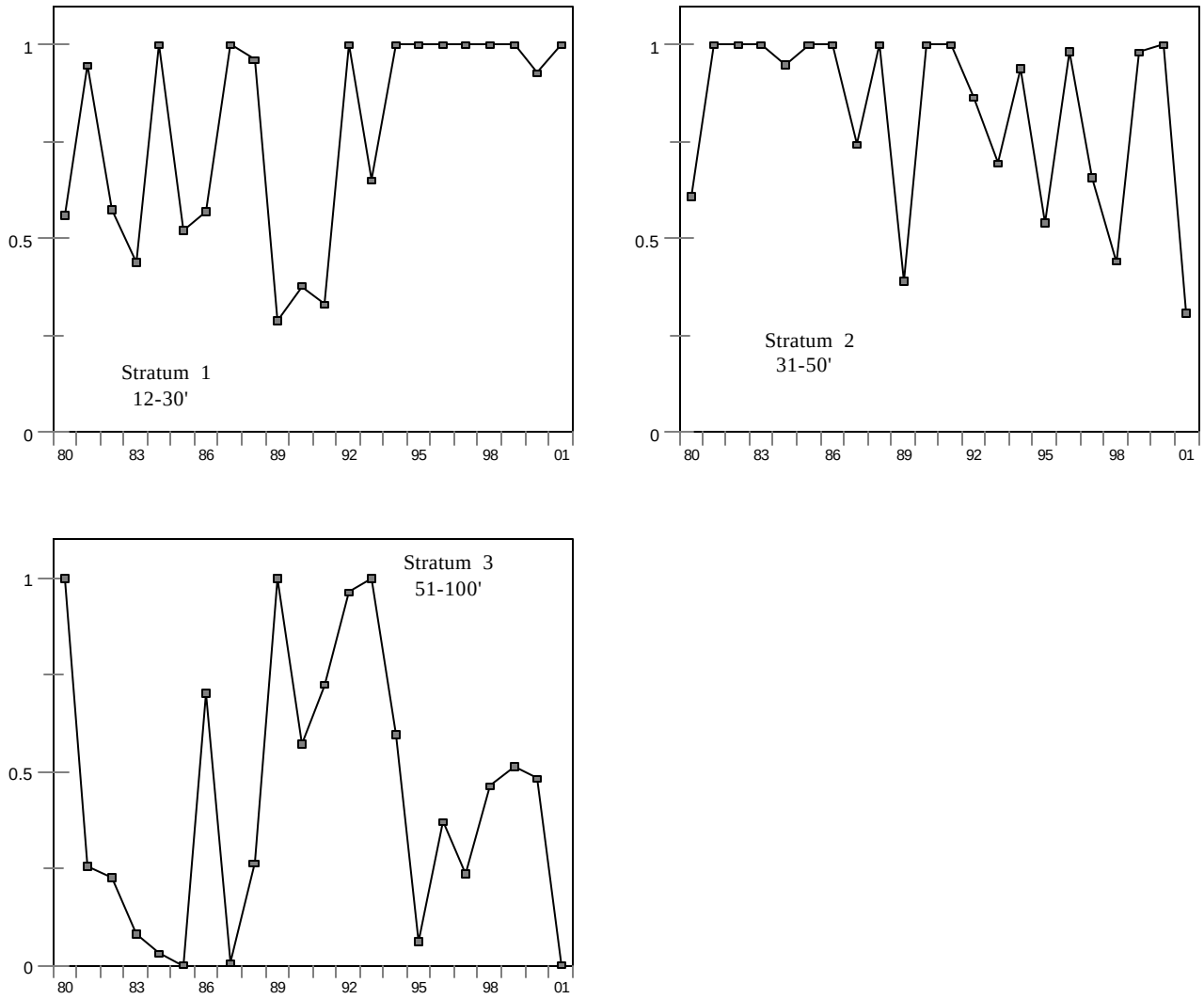


Figure 8. Relative CPUE by depth strata for smallmouth bass collected in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

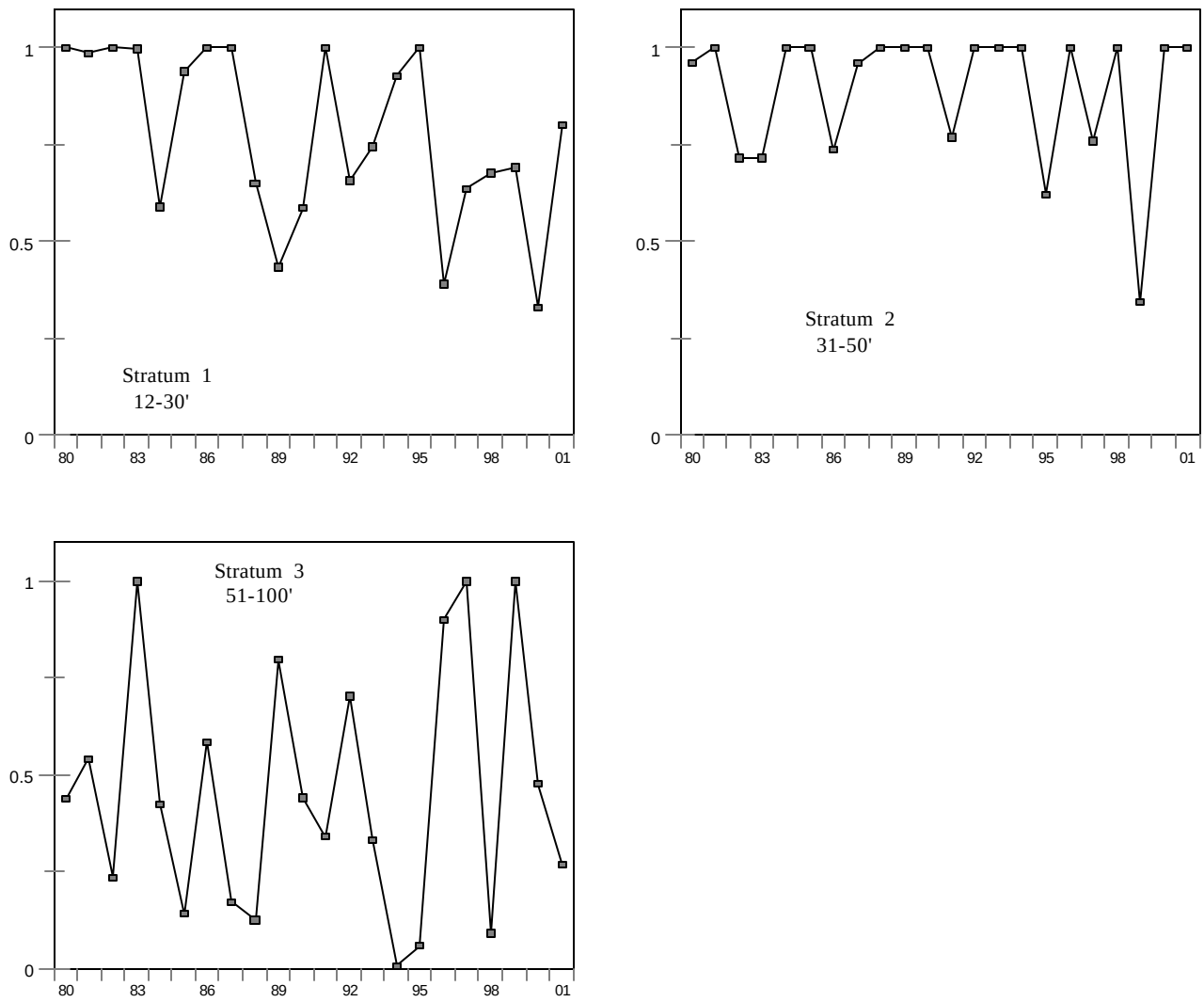


Figure 9. Relative CPUE by depth strata for yellow perch collected in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

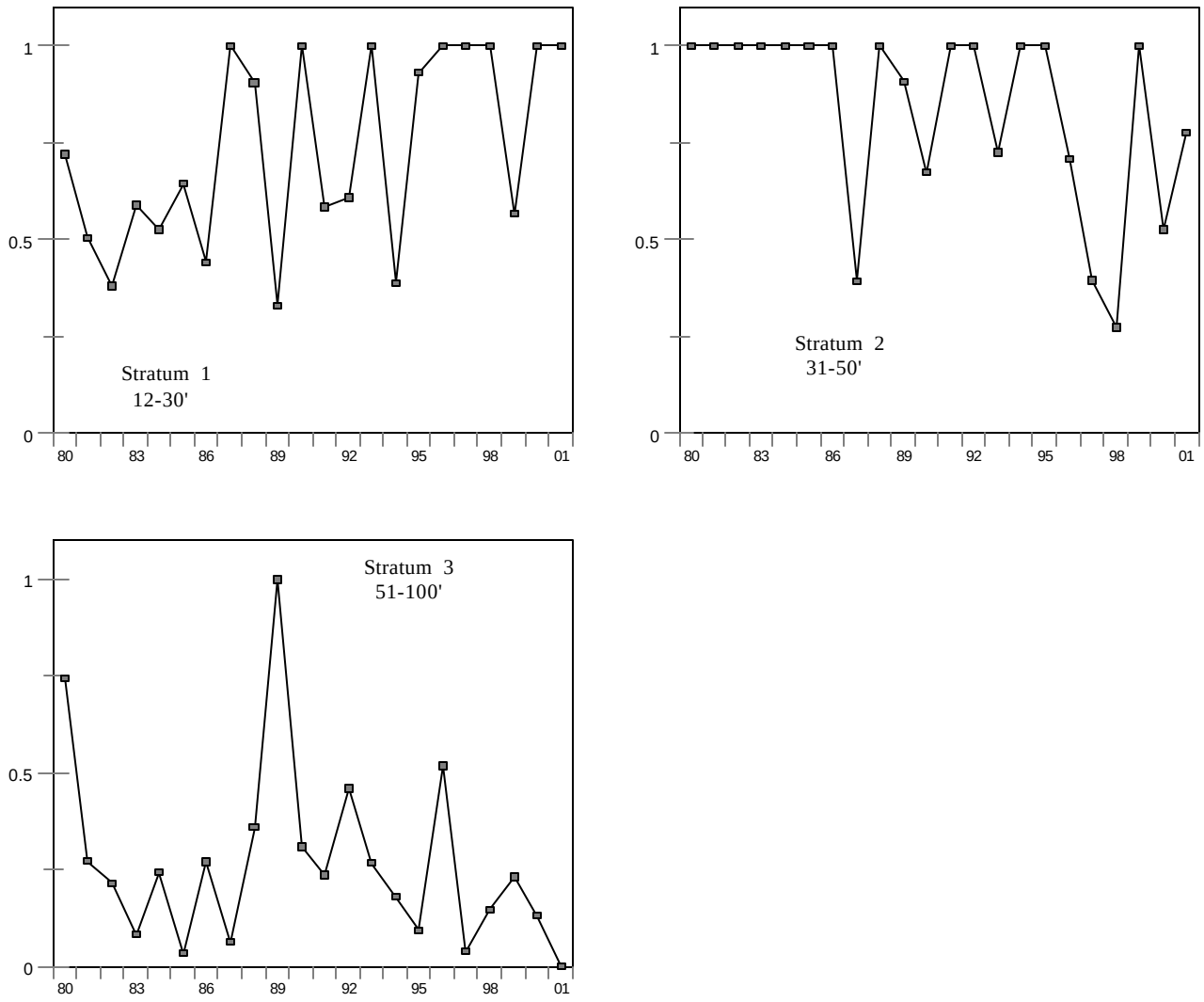


Figure 10. Relative CPUE by depth strata for rock bass collected in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

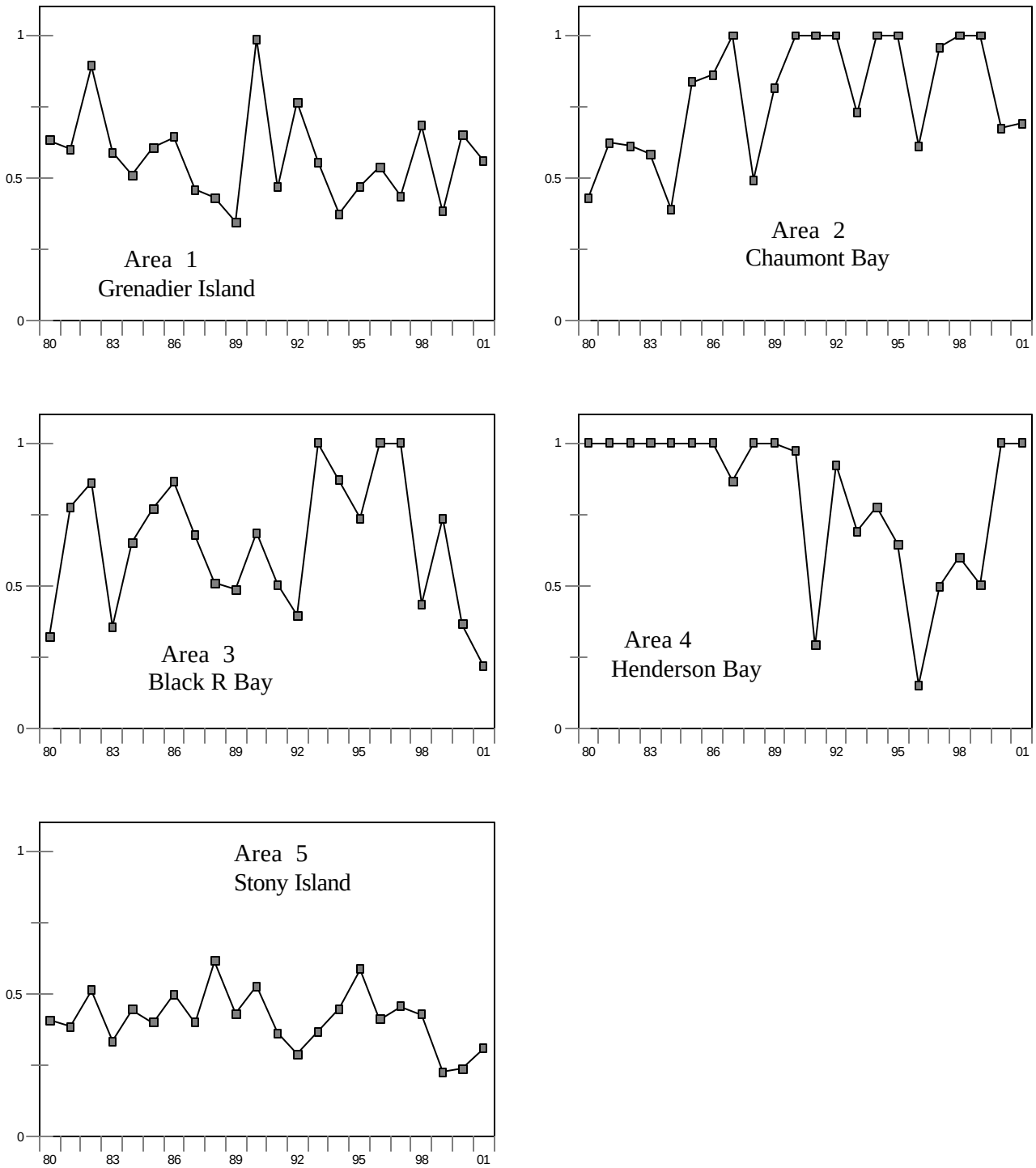


Figure 11. Relative CPUE by geographic area for all warm water fish collected in depth strata 1 and 2 in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

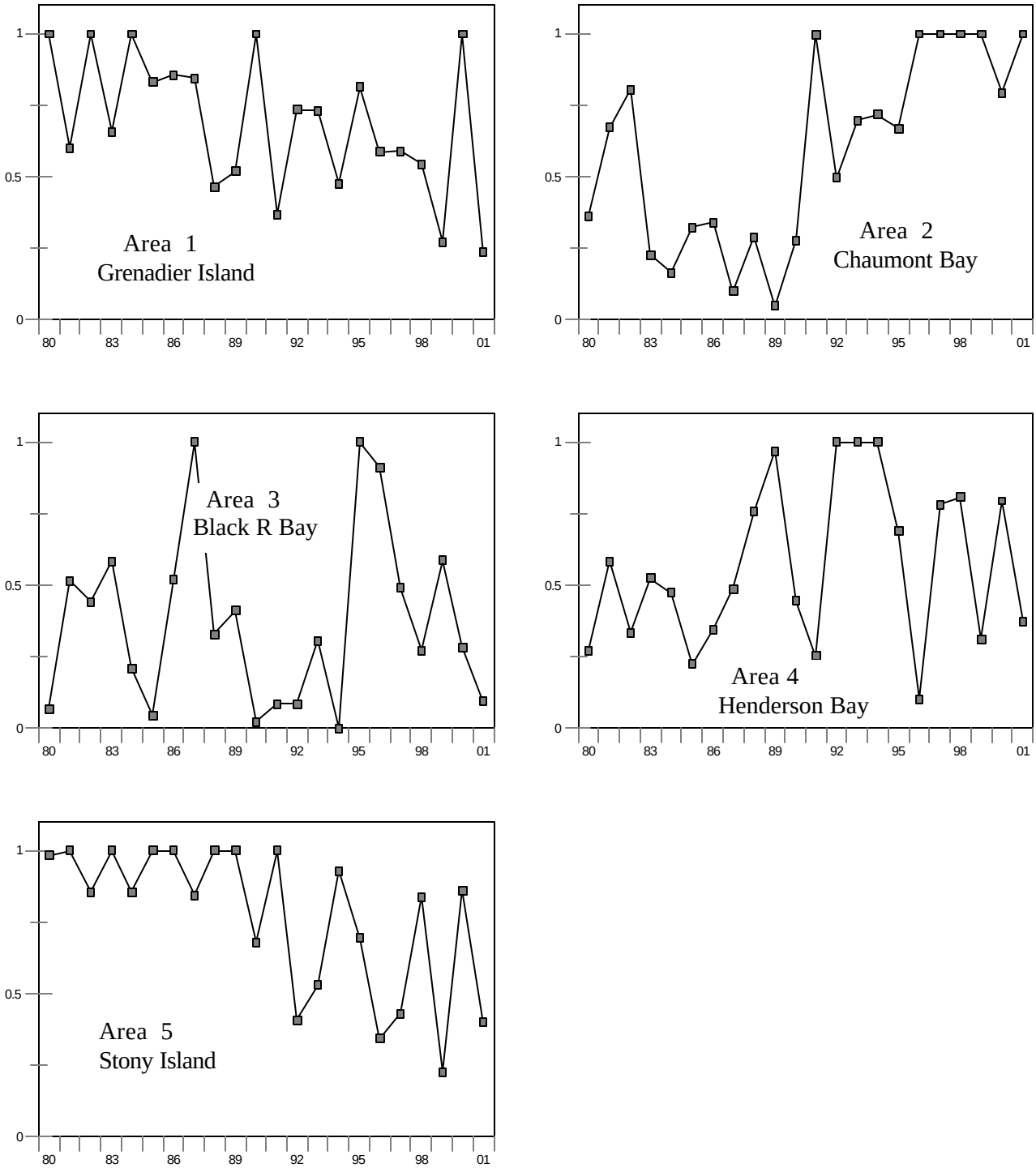


Figure 12. Relative CPUE by geographic area for smallmouth bass collected in depth strata 1 and 2 in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

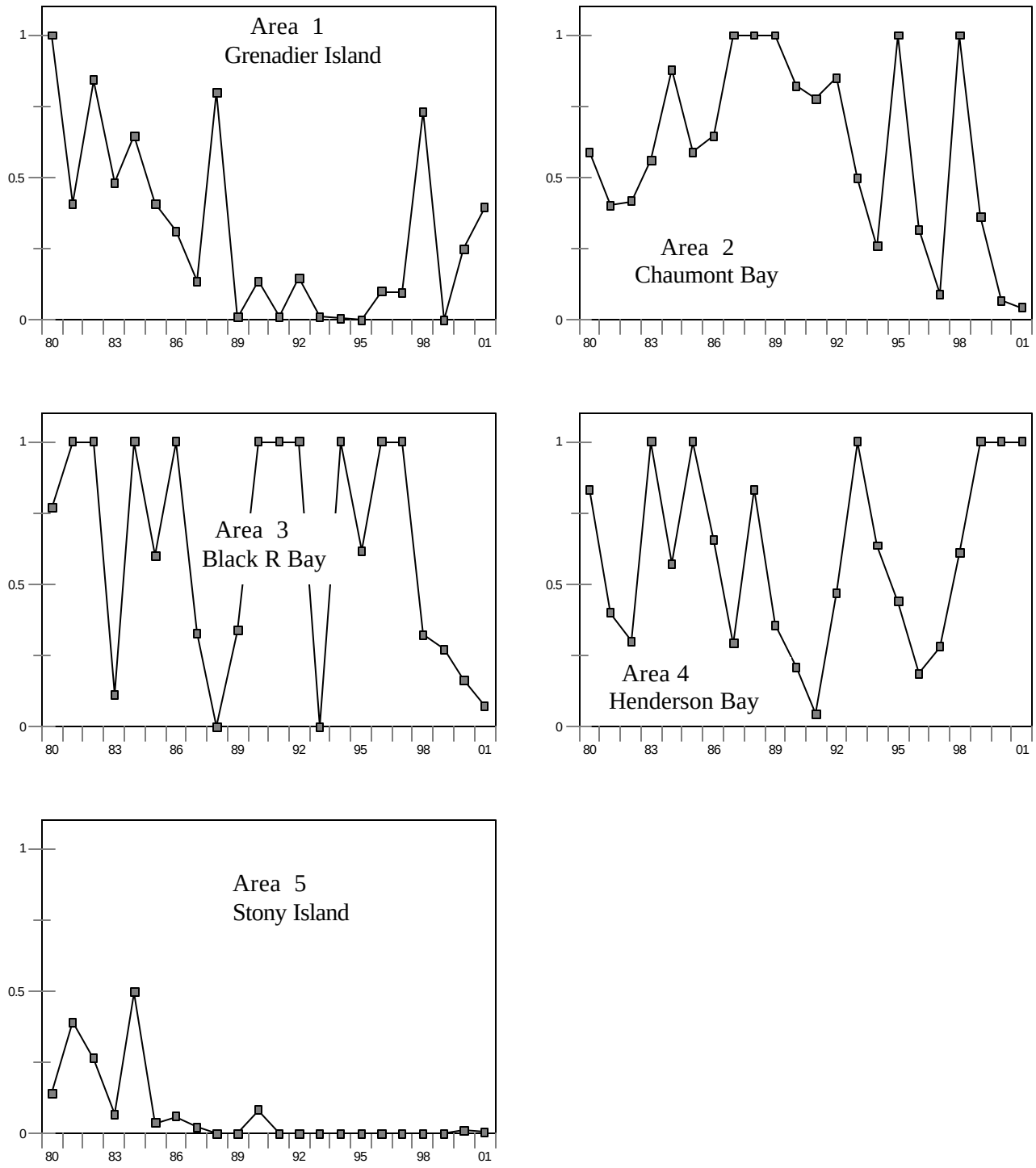


Figure 13. Relative CPUE by geographic area for yellow perch collected in depth strata 1 and 2 in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.

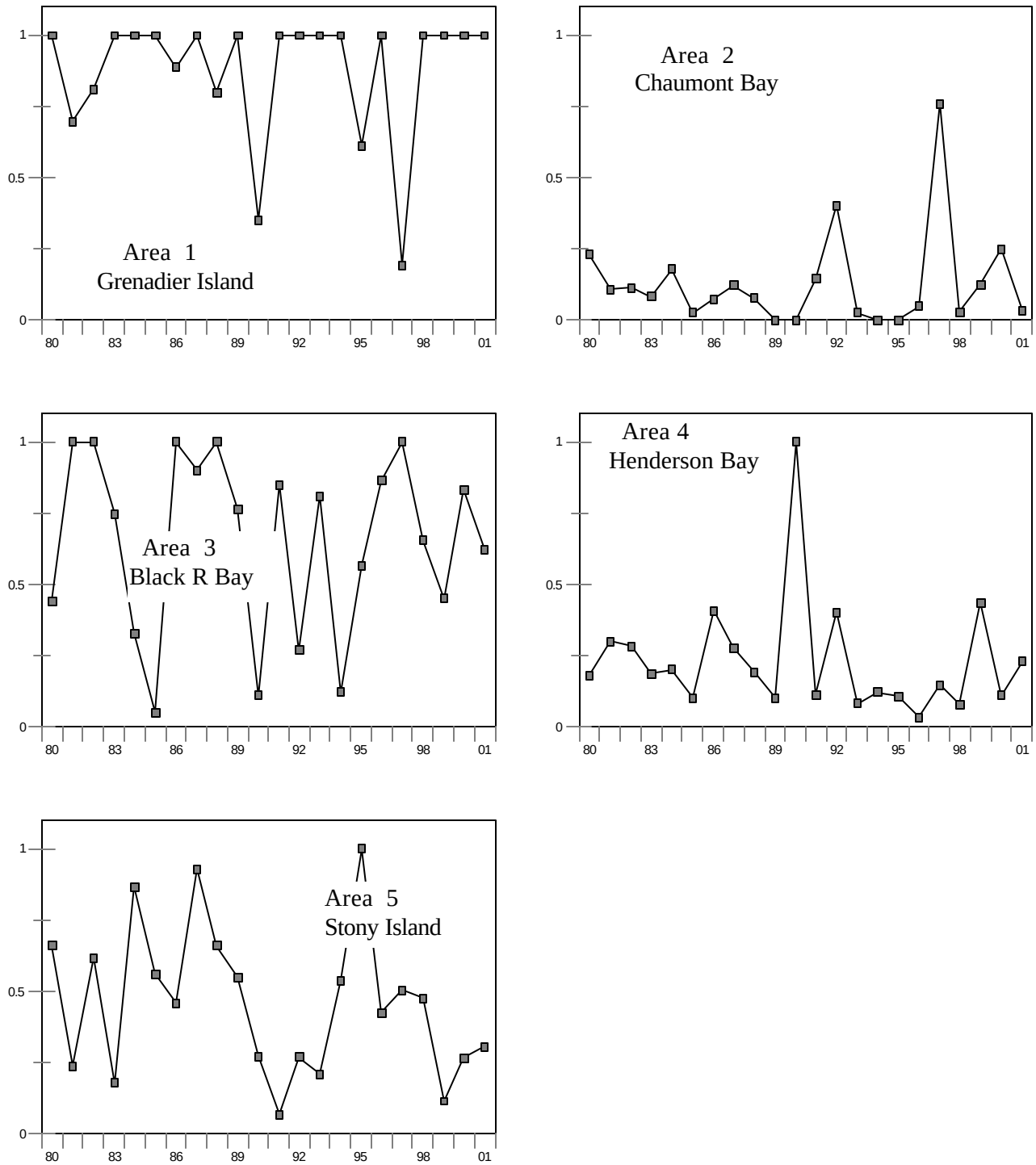


Figure 14. Relative CPUE by geographic area for rock bass collected in depth strata 1 and 2 in warm water assessment netting in New York waters of Lake Ontario's eastern basin, 1980-2001. Relative CPUE on Y-axis, year collected on X-axis.