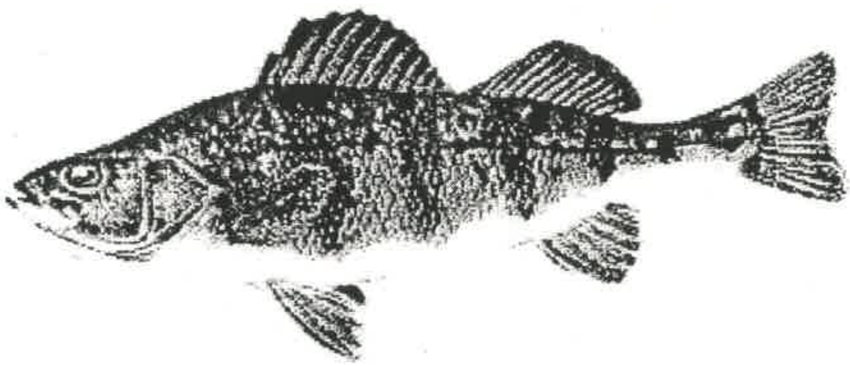
Report of the Lake Erie Yellow Perch Task Group

1998



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Presented to:

~~Standing Technical Committee~~
Lake Erie Committee
Great Lakes Fishery Commission

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Note: The data and management summaries contained in this report are provisional. Every effort has been made to insure their correctness. Contact individual agencies for complete state and provincial data. Data reported in pounds for prior years have been converted from metric tonnes. Please contact the Yellow Perch Task Group or individual agencies before using or citing data published herein.

Introduction

In 1997, the Yellow Perch Task Group (YPTG) was assigned five charges by the Lake Erie Committee. As in previous years, the task group was charged with producing a lake-wide Recommended Allowable Harvest (RAH) partitioned by Lake Erie management unit, and to maintain and update the centralized time-series data set of harvest, effort, growth and maturity and agency or interagency abundance indices of yellow perch. A recent charge undertaken by the YPTG involves using interagency field data in a regression or other predictive model to estimate the relative strength of the age 2 cohort in each management unit as it recruits into the fishery in the subsequent year. Another charge assigned to the YPTG, a determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie, is still being researched by members of the group. More work on that charge will follow concurrently with a new charge exploring the potential for genetic research on Lake Erie yellow perch stocks. Stock delineation and their boundaries need to be defined before we can address the previous charge of minimum spawning stock necessary to sustain yellow perch populations throughout the lake.

Former members of the YPTG were also responsible for the completion of the joint YPTG and Statistics and Modeling Task Group (SAM) report, documenting the procedures used to develop RAH values. This document has been completed and is available from the Great Lakes Fishery Commission office.

1997 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1997 totaled 6.295 million pounds (2,855 metric tonnes or 2.855 million kgs), which was a 30% increase over the 1996 harvest (Table 1). As in recent years, the YPTG partitioned Lake Erie into four Management Units (Units, or MUs; Figure 1) for harvest, effort, age and population analyses. Yellow perch harvest increased substantially for Ontario (+49%), Ohio (+11%) and Pennsylvania (+135%), but decreased in Michigan (-17%) and New York (-47%).

In comparison with 1996, each agency's proportion of the lakewide harvest changed only slightly. Ontario's proportion increased from 53% to 60% of the lakewide harvest, Ohio's proportion decreased from 44% to 38%, Michigan's proportion decreased from 3% to

2%. while New York's and Pennsylvania's shares remained at less than one percent of the total lakewide harvest.

Harvest, fishing effort, and catch rates are summarized for the time period 1987-1997 by management unit, year, agency, and gear type in Table 2, parts a through d. Trends over longer time series (1975-1997) are depicted for harvest (Figure 2), fishing effort (Figure 3), and catch rate (Figure 4) by management unit and gear type. Harvest summed by management unit showed strong increases in Units 1 through 3. Unit 4 (the eastern basin) exhibited a minor increase for the first time since 1987. Ontario experienced sizable harvest increases in all Units. Ontario's harvest increased by 55% in Unit 1, 41% in Unit 2, 62% in Unit 3, and 19% in Unit 4. Michigan's harvest (Unit 1) decreased by 17% over 1996. Ohio's yellow perch harvest experienced modest increases in Units 2 and 3, up 31% and 18%, respectively. Ohio's Unit 1 harvest was down 5% compared to 1996. Pennsylvania's fisheries, albeit small, showed sizable increases: up 158% in Unit 3 and up 38% in Unit 4. New York's harvest declined for the eighth consecutive year to 53% of their 1996 harvest.

Commercial gill net harvest for 1997 increased in all management units over 1996 levels. Ontario has the only gill net fishery remaining on Lake Erie for yellow perch. Harvest from commercial trap nets increased in Units 1 and 2, up 6% and 54%, respectively, but declined in Units 3 and 4, down 43% and 56%, respectively. Sport harvest increased in Units 2 through 4: up 16% in Unit 2, 108% in Unit 3, and 9% in Unit 4, but declined by 8% in Unit 1. *Note: Ontario's Lake Erie sport, trap net and large mesh gill net catches and effort are not calculated in Yellow Perch Task Group reporting procedures and analyses. The task group uses Ontario commercial small mesh gill net fishery data obtained in OMNR fish processor reports (known as processor weight) instead of landed estimates because they are more precise.*

Commercial small mesh gill net effort for 1997 increased sizably in Management Units 1-3 and slightly in Unit 4: up 59% in Unit 1, 71% in Unit 2, 52% in Unit 3 and 1% in Unit 4. Trap net effort for 1997 increased in Unit 1 (up 15%) and Unit 2 (up 49%), remained nearly unchanged (-0.6%) in Unit 3, and decreased by 45% in the small trap net fishery in Unit 4. Compared to 1996, sport fishing effort for 1997 increased by 7% in Unit 1, 82% in Unit 2, 105% in Unit 3, and 64% in Unit 4.

Catch rates (catch per unit of effort, or CPE) for the 1997 commercial gill net fishery decreased in Units 1 and 2: down 3% in Unit 1 and 17% in Unit 2. Small to moderate increases in CPE were realized in Units 3 and 4: up 6% in Unit 3 and 15% in Unit 4. Trap net catch rates declined in Unit 1, down 8%, and Unit 3, down 41%; but increased slightly in Unit 2, up 3%. Trap net catch rates for the small Unit 4 fishery declined for the fifth consecutive year, down 15% compared to 1996. Catch rates for anglers targeting yellow perch declined in Unit 1 (-24%) and Unit 2 (-33%), but increased in Unit 3 (+11%) and Unit 4 (+21%).

The lakewide RAH range recommended by the YPTG for 1997 was 4.2 to 7.9 million pounds lakewide, with a mean RAH of 6.0 million pounds. The Lake Erie Committee supported a total allowable catch (TAC) lakewide allocation of 7.4 million pounds. Partitioned by YPTG Management Unit, TAC values for 1997 were: Unit 1, 2.4 million pounds; Unit 2, 3.6 million pounds; Unit 3, 1.2 million pounds; Unit 4, 0.2 million pounds. The YPTG RAH mean values by Unit from west to east were: 1.9, 2.9, 1.1 and 0.2 million pounds respectively. The harvest of Lake Erie yellow perch in 1997 by management unit did not exceed total allowable catch set by the Lake Erie Committee. The 1997 Lake Erie yellow perch fisheries attained 94.8% of TAC in Unit 1, 80.7% of TAC in Unit 2, 89.3% of TAC in Unit 3 and 20.8% of TAC in Unit 4.

Stock Assessment

Age and Growth

Recruitment of yellow perch year classes to the fishery was generally low and inconsistent from 1990 through 1994. During this time period no large, dominant year classes, as large as those seen in 1982 or 1984, recruited into the fishery. The failure to produce large year classes resulted in yellow perch stock size, harvest and catch rates reaching historic lows from 1991 through 1995. Moderate-sized year classes were produced in 1993 and 1994 which helped reverse the downward trend and have brought on the appreciable increases in harvest realized in 1996 and 1997. Older fish (age 6+) continue to be a component of the trap net and sport fishing harvest from Unit 4 (Table 3), but stronger age 3 and 4 cohorts are starting to make an impact in the fishery. All management units and fisheries should be affected by the incoming recruitment of a potentially very large 1996 year class that should enter the fisheries late in 1998, and fully recruit to all fisheries gear during 1999.

The 1993 and 1994 year classes dominated the fisheries in Management Units 1 through 3 during 1997. In Units 1, 2, and 4 the 1995 year class entered the fishery weaker than expected (Table 3). In Unit 3 it was slightly stronger than expected, but still not comparable to other strong year classes seen in that management unit.

In examination of the growth of 1995 year class, it was observed that length and weight across ages was substantially below the mean value or recent trend since about 1990 (Appendix A). In concern that overall lake productivity might be affecting yellow perch growth, condition, maturity and ultimately recruitment into the fishery, we investigated this issue further. We calculated condition factors for agency fall trawl series for ages 1, 2, and 4 yellow perch in each management unit. Although there was a high degree of variation in yellow perch length, weight and condition factors (K values), there was no apparent decreasing trend in condition for Lake Erie yellow perch. This variation may be attributed to abiotic or biotic factors associated with lake and their effects on the food web. Appendix A also presents some long term trends showing decreasing annual growth in the western and central basins. This issue warrants serious concern and investigation by the Yellow Perch Task Group because of its ability to affect all cohorts, but particularly the magnitude of the incoming age 2 year class as it first enters the fishery. This is especially a concern for those fisheries like gill nets that experience a more knife-edge recruitment on the ascending limb of the selectivity curve (Figure 5), or trap nets that are governed by a minimum size limit, and also display a similar ascending limb in their selectivity curve. If growth is slowed across all ages, effects on selectivity (increases or decreases) across ages may also occur, having concomitant effects on harvest, exploitation and survival of the affected cohorts. The task group analyzed age 2 yellow perch growth differences (by mean length in harvest) observed in the gill net fishery, and when weighted by when the fish were caught, little difference was calculated for an annual estimate of mean length at harvest (Appendix A).

The task group continues to update yellow perch growth in: (1) weight-at-age values recorded annually in the harvest and (2) weight-at-age values taken from interagency trawl and gill net surveys. These values are important in our calculation of available biomass and for calculating harvest in the next year. The task group reviewed and updated yellow perch von Bertalanffy growth model data and F_{opt} values according to methods previously described (YPTG 1996). The YPTG uses this information to provide model predictors that reflect recent conditions and changes in the Lake Erie environment and yellow perch population response to those conditions.

Catch-at-Age Analysis (CAGEAN) and the 1998 Population Estimate

CAGEAN 1997

As discussed in a previous report (YPTG 1996), only data from 1988 to present were incorporated in the CAGEAN model. The accuracy and credibility of the model was improved by reducing the number of parameters used by the model (e.g. selectivity or catchability groups, gear types, age groups), according to the pattern of residual variables, which decreased variability in the shortened data series (T. Quinn - personal communication). Lack of sufficient biological data from Unit 4 has caused analyses for that management unit to be less precise. However, given the current reduced state of the yellow perch population and the small size of the fishery (and low exploitation rates), our CAGEAN results and conservative recommendations for low harvest in Unit 4 are still valid.

The effort lambda, λ_E was adjusted for each gear type as the ratio of the variances of catch observations to effort observations. The 1997-98 CAGEAN model ran efficiently as model iterations were low (usually 3 to 6), no apparent trends were depicted in the residuals, and 50 bootstraps were easily completed. The 1997 CAGEAN estimates of Lake Erie yellow perch populations ages 3 and older are supported by abundance indices from all agencies.

A three-gear (gill net, trap net and sport: harvest, effort, and weight-at-age) version of the CAGEAN model was used to estimate the 1997 population size in numerical abundance and biomass in each management unit. The three-gear version allows factors such as catchabilities and selectivities to be gear specific. Population size estimates were based on a natural mortality rate of 0.4 (M=0.4).

Population size and population parameters such as survival and exploitation rates are presented for a stock size estimate that consists of 1998 age 2 abundance estimates derived from a refined recruitment-regression model (Table 4 and Appendix B). Last year's non-parametric methods were not repeated this year because comparable estimates for 1998 age 2 yellow perch would be expected based on trawl series information. Numbers and biomass by management unit are presented for age 2 and older. Population estimates using the regression model are depicted in Figure 6, and biomass estimates are presented in

Figure 7.

Backcasting population estimates for 1997, and comparing to YPTG (1997) model projections, stock size estimates of age 3 and older fish increased slightly (i.e., they were underestimated last year) in all management units (YPTG 1997 and this report: Tables 4 and 5). Our estimates were within the stated coefficients of variation stated in last year's report that calculate variation around the estimate. Comparing this year's CAGEAN to last year's total population estimates for ages 3+: Unit 1 increased 21%, Unit 2 increased 3%, Unit 3 increased 13%, and Unit 4 decreased 6%. When incorporating all (2-6+) ages, our models from last year overestimated populations in Management Units 1, 2, and 4 largely based on the reduction in the entry of the age 2 fish to the fishery. In Unit 3, our estimate of recruitment for age 2 yellow perch was just above the predicted range. Our recruitment estimation last year overestimated age 2 population by 82% in Unit 1, by 55% in Unit 2, and by 72% in Unit 4. The recruitment regression underestimated the age 2 cohort by 44% in Unit 3. As previously discussed, growth declines for Age 2 fish and specific gear selectivity (Figure 5, Appendix A) may have lead to their reduced recruitment, which in turn could give an underestimate to CAGEAN's first estimate of the 1995 year class as it entered the fishery in each management unit. These estimates have generally followed a pattern of increasing abundance of the year class represented by the age 2 cohort for the first few years after successive annual CAGEAN runs. This process improves precision of the cohort estimate with time.

Backcast estimates of biomass for ages 2+ at the start of 1997 were lower than projected in the YPTG 1997 report, in part due to reduction in growth and weight-at-age values. Age 2+ backcast values were lower than YPTG 1997 projections by 10% in Unit 1, 8% in Unit 2, 2% in Unit 3 and 23% in Unit 4. Backcast estimates slightly increased the biomass of ages 3+ yellow perch in Unit 1 and 2, up 17% and 8% respectively. Backcast estimates reduced biomass in Unit 3 by 10% and by 17% in Unit 4.

A problem in the moderate to severe underestimation of the age 2 cohort occurs when this smaller numerical estimate is not corroborated with similar tendencies in interagency trawl and partnership gill net index series. These potentially erroneous values are then projected forward into the next year as age 3 in the yield per recruit scenario, ultimately giving rise to a lower projected harvest range and RAH. The YPTG investigated methods to calculate an alternate estimate for age 2 cohort in 1997. Conversely, if the age 2 estimate is adjusted upward too far, then the age 3 estimate would be high, leading to an RAH value that could be potentially too high, causing overharvest, increased exploitation and reduced survival. Certainly the opposite scenario could occur if growth was significantly higher than average, leading to an overestimate of abundance.

We have adjusted age 2 cohort estimates for 1997 for Units 1-3 by incorporating a regression of partnership gill net catches of age 2 against the age 2 cohort in that season produced by this year's CAGEAN long data series output. No partnership gill net information was available for Unit 4. These calculations increased the numbers in the age 2 cohorts in 1997 for Management Units 1-3. The methodology and projected population abundance, biomass and projected RAH information for this second scenario are presented in Appendix C.

Recruitment Estimator for Incoming Age 2 Yellow Perch

In recent years, age 2 yellow perch recruits have been projected using regressions of annual index trawling values for each year class as young-of-the-year and yearlings against CAGEAN estimates of abundance for those year classes as age 2 fish. By using CAGEAN as a method of backcasting age 2 population size and recruitment, it has been shown that our prior methods of calculating age 2 yellow perch entering the fishery using either the old regressions or the three-year, age 2 averaging method (YPTG 1995, 1996) were not robust and did not predict actual magnitude of age 2 entry very well. Typically in most cases, the old regression model overestimated age 2 severely (YPTG 1995, 1996) and the averaging method underestimated age 2 recruits. Further investigations into the effect of changes in growth at early ages and selectivity of the fisheries is warranted to improve the precision of this estimator.

In 1997-98 the Yellow Perch Task Group continued to refine the recruitment module and has improved the trawl data series that goes into calculating the least-squares regression values against calculated CAGEAN age 2 values. Trawl values were also pooled across season and agency where available to gather additional index series. Greater precision was gained by compiling data in arithmetic and/or geometric mean catch per hour tow. The YPTG presents the most significant regression equations used in calculating age 2 yellow perch from the 1996 year class entering the fishery in 1998 in Appendix B, Table B-1. Raw data from trawl index series for the time period examined are presented in Appendix

B, Table B-2, while a key summarizing abbreviations used for the trawl series is presented as a Legend in Appendix B. The YPTG chose a mean estimator from the significant regression lines to describe age 2 yellow perch available to the fishery beginning in 1998. Area discrepancies across management units were taken into consideration (i.e. Unit 4 data was not applicable in Units 1 and 2), and also omitted were regressions that produced negative slopes or did not have index values for 1997.

1998 Population Size Projection

Stock size estimates for 1998 (age 3 and older) were projected from the CAGEAN 1997 population size estimates and age-specific survival rates in 1997 (Tables 5 and 6). Recruitment of the 1996 year class in 1998 (age 2 fish) was estimated from the revised recruitment-regression module (Table 6, Appendix B). Stock size estimates for 1998 (age 3 and older) were projected from the CAGEAN 1997 population size estimates and age-specific survival rates in 1996 (Tables 5 and 6).

At the request of the Lake Erie Committee (LEC) and the Standing Technical Committee (STC) last year, the YPTG changed the way it calculates and reports standard errors and ranges about our mean estimates for each age (YPTG 1997). At the request of LEC and STC, the YPTG adopted the Lake Erie Walleye Task Group (WTG) calculation method in 1997. This method calculates the coefficient of variation (CV, Table 6), using the mean and standard deviation from the last year in the time series of CAGEAN in each management unit, instead of the bootstrap mean of means that was used in the past. This new method has been adopted as a standard procedure from last year (Table 6). The net effect will be wider ranges for the 1998 population estimates and RAH's for each management unit.

For 1998, stock size estimates of age 2 and older yellow perch show a sizable increase of 230% in Unit 1, 142 % in Unit 2, 165% in Unit 3, and 5% in Unit 4 (Tables 4 and 5, Figure 6). Stock size estimates of age 3 and older fish show a sizable decrease in all management units in 1998: down 56% in Unit 1, down 46% in Unit 2, down 19% in Unit 3 and down 34% in Unit 4, due to the weak recruitment, possible underestimate of abundance, and poor growth of the 1995 year class and the higher exploitation and lower survival of the older age groups.

Biomass estimates for age 2 and older fish for 1998 increase greatly over 1997 levels in all Units except Unit 4 (Table 4, Figure 7) due, again, to the entrance of the strong 1996 year class. Ages 2+ biomass estimates are +97% in Unit 1, +74% in Unit 2, +69% in Unit 3 and -9% in Unit 4. Biomass estimates of age 3 and older yellow perch available at the start of 1998 are substantially lower than 1997 in all management units: Unit 1, -44%; Unit 2, -36%; Units 3 and 4, each -23%. Yellow perch populations in all units will be dominated by fish from the 1996 year class, but the 1993 and especially the 1994 year class are persisting in all management units. Yellow perch ages 6 and older will continue to persist in the Eastern Basin fishery.

Survival rates for ages 2 and older perch in 1997 declined markedly in all management units (Figure 8). This trend was also exhibited for survival of ages 3 and older yellow perch in all units (Figure 9). Overall survival trends since 1988 show a general (slow) increase in survival across all management units until this past year. Exploitation rates for ages 2 and older fish in 1997 increased substantially in all management units (Figure 10). The same trend for exploitation of age 3 and older yellow perch is evident in all units (Figure 11). Overall trends for exploitation showed a slight decreasing trend up until last year, but are influenced in each management unit independently by periodic spikes that coincide with the entry of strong year classes into the fishery. The 1997 rebound in exploitation both for ages 2+ and 3+ was most likely due to the large increase in the TAC for each management unit compared to 1996, which was not backed up by a sizable gain in the population abundance or biomass estimates, and the overestimate of potential age 2 yellow perch entering the fishery.

Yield per Recruit; F_{opt} and F_{age}

The yield per recruit model used to calculate a recommended harvest in 1998 is modified from that used in 1997 by several different factors. The first of which is how we calculate F_{opt}. The basic assumption of the yield per recruit model is that the desired harvest strategy is to optimize the return in weight per recruit. The optimum harvest rate, F_{opt}, is determined by growth rate versus natural mortality rate. For temperate waters, F_{opt} is modified to $F_{0.1}$, which corresponds to 10% of the rate of increase in yield per recruit, which can be obtained by increasing F (fishing mortality) at low levels of fishing. A full description of the model inputs, as well as the steps required to determine a scaled $F_{0.1}$, are given in previous reports (YPTG 1991, 1992, 1995). Since we have updated our growth information, the YPTG determined updates to von Bertalanffy inputs and F_{opt} calculations and outputs were also necessary. For Management Units 1, 2 and 4, knife-edge full recruitment in the F-OPTMAXX model (YPTG 1995, 1996) was set at age equal to 3.5 years, whereas in unit 3 it was set to 3.0 years based on recent selectivity and CAGEAN information. Updated F_{opt} values are presented in Table 7. F_{opt} values in general decreased slightly for Management Units 2 through 4, but increased in Unit 1. The second factor in calculating yield per recruit that was modified was the way the YPTG treats fishing mortality by age (F_{age}). In previous years (see YPTG 1996 or 1997, for example), a method of calculating F_{age} was employed that resulted in values of F for specific ages being greater than F_{opt} for that age. This was a compensatory mechanism of the model calculations because F_{age} was less than F_{opt} for other ages that did not exhibit full recruitment. This method was modified such that under full recruitment F_{age} is equal to F_{opt} (not greater) and for those ages where full recruitment is not attained, F_{age} is calculated by the equation: $F_{age} = F_{opt} * s_{(age)}$, where $s_{(age)}$ is the selectivity for that age. Selectivity at a specific age is calculated from the last year of the CAGEAN run (or a similar year's conditions in CAGEAN runs if the new year is expected to differ significantly from the previous year's fishery), based on the ratio of F for that age to F for the age of full recruitment (see "F" column from Table 6 and "s(age)" column from Table 7). This method produces a more conservative estimate of F_{age}, more akin to a Ricker method, and will result in a lower estimate of harvest (and RAH) than the previous method. This is also a more desirable calculation in that at no time do we recommend an F value for any age group that is higher than F_{opt}. This is the same method of calculating F_{opt} that has been adopted by the WTG.

The third factor updated in the yield per recruit calculations is a change in methods of calculating mean weight-at-age in the population (Table 6) and mean weight-at-age in harvest (Table 7). In both cases, a five-year time series average was used in each management unit for these calculations. Because of the recent changes and variability seen in growth, the YPTG determined that shortening the time series used in calculating these averages to just two years would be more appropriate in reflecting current conditions seen across the lake and would be more responsive to changes in each unit. These values are based on a high number of samples taken from interagency surveys by all agencies. These values have been calculated and updated in Tables 6 and 7. Presenting two year averages will become standard procedure. These same values have been incorporated in the alternate scenario presented in Appendix C.

The 1998 harvest estimates for age 2 and older fish are summarized by management unit in Table 7. These values are the sum of the estimates of the harvest in numbers of each age group. The harvest estimates are derived (as described above) by scaling the F_{opt} value by the selectivity for that age, s(age), and applying the resulting F and exploitation (u) to the 1998 population projection for that age. The harvest in weight is then calculated by multiplying the age specific catch (in millions of fish) by the mean weight in the harvest (2 year average, 1996-1997).

The 1998 harvest values are in the same range to slightly less than those calculated for 1997 and seen in the 1997 harvest. Projected 1998 harvest values are somewhat more conservative compared to last year based on new methods for calculating F_{age} and weight-at-age in the population and harvest. Two big factors in where the 1998 harvest lands is the full recruitment of the 1995 year class (which from our initial indications was weak, but may be underestimated due to poor growth) and the entry of the large 1996 year class (which is one of the largest seen in our interagency trawl and gill net surveys for at least a decade, but may also be affected by poor growth).

Recommended Allowable Harvests

In 1997, a lakewide harvest of 7.4 million pounds of yellow perch was adopted by the Lake Erie Committee. The YPTG recommended an RAH of 6.1 million pounds with a range of 4.2 million to 7.9 million pounds. The 1997 lakewide harvest was 6.295 million pounds. The TAC (Total Allowable Catch) for 1997 was presented by management unit by the YPTG and the LEC. Allocation for Unit 1 was 2.4 million pounds, and harvest was 2.275 million pounds. Allocation for Unit 2 was 3.6 million pounds, and harvest was 2.907 million pounds. Allocation for Unit 3 was 1.2 million pounds, and harvest was 1.072 million pounds. Allocation for Unit 4 was 0.2 million pounds, and harvest was 0.04 million pounds. For 1998, we present two harvest scenarios by management unit (Table 8 and Appendix C, Table 8C). This first strategy employs the CAGEAN estimates of population size for ages 3 to 6+ and a scaled $F_{0.1}$ (or F_{opt}) exploitation strategy and uses the updated mean recruitment-regression equation from interagency trawls for incoming age 2 yellow perch (Tables 6 and 7, and Appendix B). The second strategy incorporates partnership index gill net regression information as alternate estimates of the 1995 cohort in Units 1-3. The YPTG also again has provided a wider harvest range by calculating population-at-age standard errors (from use of the CV previously described) within management unit using the same methodology and formula as the WTG.

The recommended allowable harvest (RAH) by management unit, and summed for a lakewide total, is presented in Tables 8 and 8C. The Yellow Perch Task Group is aware that recovery of yellow perch stocks in all management units may hinge on the progression of the 1996 year class to reproductive age and size. Recovery signs (increased abundance and biomass and survival, reduced exploitation and production of good year classes) were evident until last year in Units 1, 2 and 3, but may have been handed a setback in 1997 with increased exploitation well above F_{opt}. Recovery and strong to moderate year classes are not apparent in Unit 4. The YPTG is concerned about the delay (or inability) of the 1995 year class to recruit into the fishery during 1997 and is urging caution in setting allowable catch levels too high in hopes of either the 1995 year class re-emerging or based on the potential strength of the 1996 year class entering the fishery (which is also exhibiting slow growth). Until we get a good read on the strengths of the 1995 and 1996 year classes, which are just really beginning to contribute to the fishery, the task group would prefer that TAC's are somewhat conservative. The task group is aware of the problems of ultraconservative TAC estimates that could be generated by under-representing the age 2 cohort and compounding the problem in yield per recruit calculations for the subsequent year.

The Yellow Perch Task Group recommends for management units 1 through 3 adopting a 1998 harvest distribution by Management Unit in the range of values from the mean to the maximum of the range found in Table 8 to those values found in the minimum to the mean of the range found in Table 8C (Table 9). There is some overlap between the two ranges found in the two scenarios. Presented by management unit these suggested 1998 RAH values would be: Unit 1, 2.2-2.6 million pounds; Unit 2, 2.6-3.3 million pounds; and Unit 3, 1.1-1.4 million pounds. In Management Unit 4, the Yellow Perch Task Group, based on our analyses and the small fisheries and poor recruitment existent there, recommends a harvest in the range from 50 thousand to 140 thousand pounds.

Additional Task Group Charges

Spawning Stock Biomass

The task group was also charged to "...continue the effort to establish a minimum stock size which management agencies should stay above to sustain perch stocks. Inherent in this charge is the development and documentation of indicators and methodology for determining stock size."

Several models are under review by the task group. Indicators of spawning stock size have included catch rates for mature yellow perch during or immediately following spawning, and indicators of recruitment have included indices of juvenile abundance or catch rates of two year old fish as they become vulnerable to the fisheries. A number of problems in the analysis and interpretation have been considered during the review. For example, the relationship between the size of the spawning stock and the resulting recruitment is confounded by the occurrence of highly variable year class strengths, which is typical for yellow perch and other species which are present in Lake Erie. Also, the changing habitat and the presence of a succession of invading species such as zebra mussels must be considered in the evaluation of the success of yellow perch.

The task group members deemed this charge to be of lower priority since we were awaiting results of the charge regarding genetics work. It seemed more appropriate to define/identify a specific Lake Erie yellow perch stock or stocks before proceeding in these calculations (of total unexploited population number and biomass, for example) and model iterations. This genetic work will be a cornerstone for defining these potentially important biologic units (stocks) and is integral to the completion of this charge. Also required for these models are updated estimates of fecundity from various locations across the lake. This data continues to be gathered; however, final results are not presently available.

During winter 1998, we have initiated contact and will seek the guidance of Dr. Ransom Myers (Dalhousie University, Halifax, Nova Scotia) who has been instrumental in developing similar biomass models and estimates for coastal fisheries and their testing and discussion (Hutchings and Myers 1994, Myers and Barrowman 1994, 1995 and 1996, Myers et al. 1995a, Myers et al. 1995b, Gilbert 1997, Myers 1997 and Francis 1997). Some of this work has been instrumental in describing the collapse and rehabilitation potential of East

Coast fish stocks. The Yellow Perch Task Group will continue to pursue this topic with Dr. Myers. This work will also investigate and ascertain stock-recruitment relationships in which the YPTG has shown long-term interest. The YPTG will continue to evaluate this method of estimating populations, ever cautious that the minimum stock size does not become a target for the fishery to exploit the population down to on an annual basis.

Yellow Perch Stock Genetics

A new charge for the Yellow Perch Task Group in 1997-1998 was to "explore the potential for genetic research on yellow perch stocks in Lake Erie." In addressing this charge, the Yellow Perch Task Group collected samples of five adult female yellow perch from several different locations around the lake (Sandusky Bay, Gibraltar Island (Bass Isl.), Fairport, Erie, Dunkirk, and Long Point Bay) during the post-spawn season for genetic analysis by Dr. Carol Stepien of Case Western Reserve University at Cleveland, Ohio. Dr. Stepien is renowned in her work on Lake Erie fish species genetics, especially percids. Her initial work on these samples involved analysis of ten western basin female adult yellow perch on mitochondrial DNA (mtDNA) sites. This work showed that there existed very little variation between samples across sites. She has stated from this initial exploration that the western basin's Lake Erie yellow perch populations were probably influenced by large population fluctuations (and subsequent recolonization). She has stated that she intends to do more work on our full sample of Lake Erie yellow perch at the mtDNA level and will also use new nuclear DNA region testing to determine if this technique is more expressive of local, rapid changes (Lansman et al. 1981), thereby determining if specific stock lineage can be ascertained. We will continue to assist and promote this important work in stock identification and delineation.

Conclusions

It is the view of the Yellow Perch Task Group that the long term time series monitoring of the yellow perch population and harvest continue, and that effort continue to be devoted to understanding the population changes which are occurring. The Task Group is continuing to monitor yellow perch growth rates, as dry weight information was collected in 1996 and 1997 will be continued in 1998. These data will serve as baseline comparisons of yellow perch condition throughout the lake, and will be comparable to dry weight data obtained from 1984-1986 (Hayward and Margraf 1988).

The YPTG will also continue to address current charges regarding long term data sets, RAH, age 2 recruitment estimators. The YPTG will continue to explore age 2 growth, backcasting, and selectivities, all selectivity curves for each fishery, the F_{opt} procedure and fishing mortalities at specific ages for incorporation into following task group reports in order to better track how fisheries will perform in subsequent years with projected yellow perch populations. We will also look at other independent estimators of population abundance that could be used to complement and verify CAGEAN outputs and trends. We will continue to track the 1995 year class and CAGEAN estimates of it after another fishing year. The YPTG plans a renewed effort to examine abiotic and biotic factors influencing yellow perch growth and condition and their effect on yellow perch entering the fishery at age 2 and selectivity at all ages. We will also apply these findings to how we address projection of age 2 recruitment into the next year and our projected population abundance, biomass, and harvest estimates and recommendations.

Task group members are pleased to be working with Dr. Stepien addressing the genetics issues and with Dr. Myers investigating the spawning stock biomass and stock-recruitment issues and look forward to making substantial progress on these charges in the coming year.

Acknowledgments

The remaining members of the Yellow Perch Task Group acknowledge the efforts and contributions of Jerry Paine (OMNR) to the task group, and we wish him well in his retirement. His insight and dedication to Lake Erie yellow perch management have been an example and a challenge to us all; his camaraderie will be missed. The task group also thanks Andy Cook (OMNR), Don Einhouse (NYSDEC), Gene Emond (ODW) and Jeff Tyson (ODW) for providing data for this year's report.

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Table 1. Summary of Lake Erie yellow perch harvest in pounds for 1987-1997, by management unit (Unit) and agency.

		Ontario*		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch
Unit 1	1987	2,862,090	59	1,730,925	36	224,910	5	--	--	--	--	4,817,925
	1988	3,186,225	61	1,865,430	36	167,580	3	--	--	--	--	5,219,235
	1989	3,157,560	59	1,900,710	35	332,955	6	--	--	--	--	5,391,225
	1990	1,781,640	67	652,680	24	231,525	9	--	--	--	--	2,665,845
	1991	648,270	46	681,345	48	94,815	7	--	--	--	--	1,424,430
	1992	687,960	59	405,720	35	66,150	6	--	--	--	--	1,159,830
	1993	1,139,985	62	577,710	31	123,480	7	--	--	--	--	1,841,175
	1994	710,010	59	434,385	36	66,150	5	--	--	--	--	1,210,545
	1995	524,790	38	784,980	57	77,175	6	--	--	--	--	1,386,945
	1996	704,167	36	1,125,716	57	134,810	7	--	--	--	--	1,964,693
	1997	1,091,844	48	1,071,025	47	111,819	5	--	--	--	--	2,274,688
Unit 2	1987	5,538,960	88	758,520	12	--	--	--	--	--	--	6,297,480
	1988	5,596,290	93	421,155	7	--	--	--	--	--	--	6,017,445
	1989	5,578,650	84	1,071,630	16	--	--	--	--	--	--	6,650,280
	1990	2,873,115	75	952,560	25	--	--	--	--	--	--	3,825,675
	1991	2,171,925	76	683,550	24	--	--	--	--	--	--	2,855,475
	1992	2,522,520	83	500,535	17	--	--	--	--	--	--	3,023,055
	1993	1,933,785	80	493,920	20	--	--	--	--	--	--	2,427,705
	1994	1,300,950	55	1,045,170	45	--	--	--	--	--	--	2,346,120
	1995	1,073,835	57	804,825	43	--	--	--	--	--	--	1,878,660
	1996	1,290,998	61	823,425	39	--	--	--	--	--	--	2,114,423
	1997	1,826,180	63	1,079,882	37	--	--	--	--	--	--	2,906,062
Unit 3	1987	2,002,140	84	238,140	10	--	--	141,120	6	--	--	2,381,400
	1988	2,487,240	78	526,995	17	--	--	178,605	6	--	--	3,192,840
	1989	2,414,475	63	1,199,520	31	--	--	211,680	6	--	--	3,825,675
	1990	2,127,825	76	504,945	18	--	--	185,220	7	--	--	2,817,990
	1991	1,212,750	75	253,575	16	--	--	152,145	9	--	--	1,618,470
	1992	1,190,700	82	185,220	13	--	--	77,175	5	--	--	1,453,095
	1993	606,375	78	145,530	19	--	--	24,255	3	--	--	776,160
	1994	379,260	48	359,415	45	--	--	55,125	7	--	--	793,800
	1995	465,255	80	83,790	14	--	--	30,870	5	--	--	579,915
	1996	512,293	72	186,695	26	--	--	9,041	1	--	--	708,029
	1997	829,353	77	219,664	20	--	--	23,360	2	--	--	1,072,377
Unit 4	1987	573,300	90	--	--	--	--	50,715	8	13,230	2	637,245
	1988	568,890	98	--	--	--	--	2,205	<1	8,820	2	579,915
	1989	438,795	78	--	--	--	--	0	0	121,275	22	560,070
	1990	282,240	88	--	--	--	--	0	0	37,485	12	319,725
	1991	160,965	87	--	--	--	--	0	0	24,255	13	185,220
	1992	114,660	85	--	--	--	--	0	0	19,845	15	134,505
	1993	72,765	85	--	--	--	--	0	0	13,230	15	85,995
	1994	52,920	83	--	--	--	--	0	0	11,025	17	63,945
	1995	33,075	83	--	--	--	--	0	0	6,615	17	39,690
	1996	30,495	82	--	--	--	--	2,205	6	4,472	12	37,172
	1997	36,171	87	--	--	--	--	3,049	7	2,387	6	41,607
Lakewide Totals	1987	10,976,490	78	2,727,585	19	224,910	2	191,835	1	13,230	<1	14,134,050
	1988	11,838,645	79	2,813,580	19	167,580	1	180,810	1	8,820	<1	15,009,435
	1989	11,589,480	71	4,171,860	25	332,955	2	211,680	1	121,275	1	16,427,250
	1990	7,064,820	73	2,110,185	22	231,525	2	185,220	2	37,485	<1	9,629,235
	1991	4,193,910	69	1,618,470	27	94,815	2	152,145	3	24,255	<1	6,083,595
	1992	4,515,840	78	1,091,475	19	66,150	1	77,175	1	19,845	<1	5,770,485
	1993	3,752,910	73	1,217,160	24	123,480	2	24,255	<1	13,230	<1	5,131,035
	1994	2,443,140	55	1,838,970	42	66,150	1	55,125	1	11,025	<1	4,414,410
	1995	2,096,955	54	1,673,595	43	77,175	2	30,870	1	6,615	<1	3,885,210
	1996	2,537,953	53	2,135,836	44	134,810	3	11,246	<1	4,479	<1	4,824,317
	1997	3,783,548	60	2,370,571	38	111,819	2	26,409	<1	2,387	<1	6,294,734

* processor weight

Table 2a. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 1 (Western Basin) by agency and gear type, 1987-1997.

		Unit 1			
		Ohio		Michigan	Ontario
	Year	Trap Nets	Sport	Sport	Gill Nets
Catch (pounds)	1987	306,495	1,424,430	224,910	2,862,090
	1988	626,220	1,239,210	167,580	3,186,225
	1989	864,360	1,036,350	332,955	3,157,560
	1990	463,050	189,630	231,525	1,781,640
	1991	196,245	485,100	94,815	648,270
	1992	123,480	282,240	66,150	687,960
	1993	158,760	418,950	123,480	1,139,985
	1994	165,375	269,010	66,150	710,010
	1995	108,045	676,935	77,175	524,790
	1996	200,313	925,403	134,810	704,167
	1997	211,876	859,149	111,819	1,091,844
Catch (Metric) (tonnes)	1987	139	646	102	1,298
	1988	284	562	76	1,445
	1989	392	470	151	1,432
	1990	210	86	105	808
	1991	89	220	43	294
	1992	56	128	30	312
	1993	72	190	56	517
	1994	75	122	30	322
	1995	49	307	35	238
	1996	91	420	61	319
	1997	96	390	51	495
Effort *(a)*	1987	7,078	1,046,115	452,460	14,730
	1988	6,900	1,153,182	494,158	9,616
	1989	8,418	1,028,551	696,973	12,716
	1990	6,299	350,000	634,255	18,305
	1991	7,259	700,719	164,517	13,629
	1992	6,795	350,433	120,979	9,221
	1993	7,092	530,012	244,455	12,006
	1994	5,937	469,959	224,744	11,734
	1995	5,103	598,977	123,616	11,136
	1996	4,869	772,078	193,733	8,614
	1997	5,580	834,934	192,605	13,704
Catch Rates *(b)*	1987	19.64	3.8	1.1	88.12
	1988	41.16	4.2	0.5	150.27
	1989	46.57	2.8	1.7	112.61
	1990	33.34	1.4	1.3	44.14
	1991	12.26	2.4	1.9	21.57
	1992	8.24	2.8	2.1	33.84
	1993	10.15	2.6	1.9	43.06
	1994	12.63	2.2	1.1	27.44
	1995	9.60	4.3	2.8	21.37
	1996	18.66	4.9	3.3	37.07
	1997	17.20	3.7	2.8	36.12

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts

(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 2b. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 2 (western Central Basin) by agency and gear type, 1987-1997

		Unit 2		
		Ohio		Ontario
	Year	Trap Nets	Sport	Gill Nets
Catch (pounds)	1987	22,050	736,470	5,538,960
	1988	46,305	374,850	5,596,290
	1989	200,655	870,975	5,578,650
	1990	650,475	302,085	2,873,115
	1991	302,085	381,465	2,171,925
	1992	145,530	355,005	2,522,520
	1993	114,660	379,260	1,933,785
	1994	304,290	740,880	1,300,950
	1995	257,985	546,840	1,073,835
	1996	323,334	500,091	1,290,998
	1997	498,945	580,937	1,826,180
Catch (Metric) (tonnes)	1987	10	334	2,512
	1988	21	170	2,538
	1989	91	395	2,530
	1990	295	137	1,303
	1991	137	173	985
	1992	66	161	1,144
	1993	52	172	877
	1994	138	336	590
	1995	117	248	487
	1996	147	227	585
	1997	226	263	828
Effort *(a)*	1987	630	429,239	20,940
	1988	448	402,180	17,315
	1989	1,403	572,612	25,679
	1990	6,238	400,676	31,613
	1991	6,480	452,277	34,739
	1992	4,753	340,917	35,348
	1993	2,558	320,891	25,569
	1994	7,139	538,977	23,441
	1995	6,467	388,238	18,337
	1996	5,834	316,736	14,572
	1997	8,721	575,365	24,974
Catch Rates *(b)*	1987	15.87	4.0	119.96
	1988	46.88	2.4	146.58
	1989	64.86	3.4	98.52
	1990	47.29	1.5	41.22
	1991	21.14	2.2	28.35
	1992	13.89	3.0	32.36
	1993	20.33	3.1	34.30
	1994	19.33	3.3	25.17
	1995	18.09	3.5	26.56
	1996	25.13	4.2	40.18
	1997	25.91	2.8	33.15

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 2c. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 3 (eastern Central Basin) by agency and gear type, 1987-1997

		Unit 3					
		Ohio		Ontario	Pennsylvania		
	Year	Trap Nets	Sport	Gill Nets	Gill Nets	Trap Nets	Sport
	1987	46.305	191.835	2.002.140	141,120		
	1988	330.750	196.245	2.487.240	178.605		
	1989	635.040	564.480	2,414.475	211.680		
Catch	1990	447.615	57.330	2,127,825	185.220		
(pounds)	1991	185.220	68,355	1,212,750	152.145		
	1992	101.430	83.790	1,190,700	77.175		
	1993	68.355	77.175	606,375	24.255		
	1994	141.120	218.295	379,260	55,125		
	1995	63.945	19,845	465,255	30.870		
	1996	103.414	83,281	512.293	0	5.292	3.749
	1997	54,776	164.888	829.353	0	7.398	15.962
	1987	21	87	908	64		
	1988	150	89	1,128	81		
	1989	288	256	1.095	96		
Catch	1990	203	26	965	84		
(Metric)	1991	84	31	550	69		
(tonnes)	1992	46	38	540	35		
	1993	31	35	275	11		
	1994	64	99	172	25		
	1995	29	9	211	14		
	1996	47	38	232	0	1.7	2.4
	1997	25	75	376	0	3.4	7.2
	1987	668	129.316	6.667	1,538		
	1988	4.781	172,490	6.203	1,418		
	1989	7,281	248,530	7,098	1,037		
Effort	1990	7,376	31,881	12,472	1,978		
(a)	1991	4,516	54,607	12,247	2,018		
	1992	3.361	84,445	14,540	1,321		
	1993	2.610	96.619	10.017	620		
	1994	3.053	173,706	8,169	1.442		
	1995	3,258	42,234	6,843	1,465		
	1996	2.730	69.887	6,184	0	185	12.850
	1997	2.455	126,530	9.423	0	441	43.377
	1987	31.44	3.6	136.19	41.61		
	1988	31.37	2.7	181.85	57.12		
	1989	39.56	4.1	154.27	92.57		
Catch Rates	1990	27.52	1.9	77.37	42.47		
(b)	1991	18.60	2.0	44.91	34.19		
	1992	13.69	1.8	37.14	26.50		
	1993	11.88	1.7	27.45	17.74		
	1994	20.96	2.3	21.06	17.34		
	1995	8.90	1.3	30.83	9.56		
	1996	17.18	2.8	37.57		9.19	0.81
	1997	10.18	3.1	39.90		7.61	0.94

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 2d. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 4 (Eastern Basin) by agency and gear type, 1987-1997

		Unit 4					
		New York		Ontario	Pennsylvania		
	Year	Trap Nets	Sport	Gill Nets	Gill Nets	Trap Nets	Sport
Catch (pounds)	1987	13,230		573,300	50,715		
	1988	8,820		568,890	2,205		
	1989	17,640	103,635	438,795	0		
	1990	19,845	17,640	282,240	0		
	1991	15,435	8,820	160,965	0		
	1992	11,025	8,820	114,660	0		
	1993	6,615	6,615	72,765	0		
	1994	4,410	6,615	52,920	0		
	1995	3,122	6,615	33,075	0		
	1996	2,822	1,650	30,495	0	0	2,205
	1997	1,241	1,146	36,171	0	0	3,049
Catch (Metric) (tonnes)	1987	6		260	23		
	1988	4		258	1		
	1989	8	47	199	0		
	1990	9	8	128	0		
	1991	7	4	73	0		
	1992	5	4	52	0		
	1993	3	3	33	0		
	1994	2	3	24	0		
	1995	1.4	3	15	0		
	1996	1.3	0.8	14	0	0	1
	1997	0.6	0.5	16	0	0	1.4
Effort *(a)*	1987	1,602		4,908	632		
	1988	2,132		2,719	8		
	1989	1,136	65,370	2,628	0		
	1990	981	24,463	3,924	0		
	1991	918	22,090	3,859	0		
	1992	632	52,398	3,351	0		
	1993	761	26,297	2,008	0		
	1994	555	14,800	1,642	0		
	1995	532	12,115	1,375	0		
	1996	533	6,535	1,063	0	0	7,292
	1997	292	8,905	1,073	0	0	13,747
Catch Rates *(b)*	1987	3.75		52.97	36.39		
	1988	1.88		94.89	125.00		
	1989	7.04		75.72			
	1990	9.17	0.35	32.62			
	1991	7.63	0.59	18.92			
	1992	7.91	0.36	15.52			
	1993	3.94	0.37	16.43			
	1994	3.60	0.42	14.62			
	1995	2.63	0.76	10.91			
	1996	2.40	0.50	13.01			0.60
	1997	2.05	0.35	14.91			0.98

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 3. Lake Erie 1997 yellow perch harvest (numbers of fish) by gear, age and management unit (Unit).

Gear	Age	Unit 1 Number	Unit 1 %	Unit 2 Number	Unit 2 %	Unit 3 Number	Unit 3 %	Unit 4 Number	Unit 4 %	Lakewide Number	Lakewide %
Gill Nets	1	0	0.0	10,238	0.1	0	0.0	0	0.0	10,238	0.1
	2	45,044	1.0	1,414,800	19.7	328,689	10.9	2,617	1.9	1,791,150	12.0
	3	2,620,718	56.8	4,431,511	61.8	1,668,469	55.5	67,576	48.5	8,788,274	58.9
	4	1,668,258	36.2	990,342	13.8	788,282	26.2	52,112	37.4	3,498,994	23.4
	5	246,961	5.4	292,749	4.1	209,692	7.0	10,627	7.6	760,029	5.1
	6+	31,980	0.7	32,885	0.5	9,125	0.3	6,522	4.7	80,512	0.5
	Total	4,612,961		7,172,525		3,004,257		139,454		14,929,197	
Trap Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	25,641	3.8	2,508	0.2	0	0.0	0	0.0	28,149	1.2
	3	459,826	67.9	1,045,954	69.4	115,688	65.7	268	11.1	1,621,736	68.6
	4	134,608	19.9	304,420	20.2	28,885	16.4	473	19.6	468,386	19.8
	5	40,033	5.9	85,008	5.6	14,533	8.2	654	27.0	140,228	5.9
	6+	16,985	2.5	70,082	4.6	17,066	9.7	1,024	42.3	105,157	4.4
	Total	677,093		1,507,972		176,172		2,419		2,363,656	
Sport	1	0	0.0	3,211	0.2	0	0.0	0	0.0	3,211	0.1
	2	292,037	7.2	145,251	8.5	18,156	4.1	143	1.8	455,587	7.4
	3	2,128,643	52.7	1,215,413	71.4	236,157	52.9	999	12.2	3,581,212	57.8
	4	1,335,886	33.1	256,504	15.1	102,681	23.0	1,686	20.6	1,696,757	27.4
	5	262,689	6.5	38,745	2.3	66,779	15.0	2,029	24.8	370,242	6.0
	6+	16,435	0.4	42,273	2.5	22,271	5.0	3,308	40.5	84,287	1.4
	Total	4,035,690		1,701,397		446,044		8,165		6,191,296	
All Gear	1	0	0.0	13,449	0.1	0	0.0	0	0.0	13,449	0.1
	2	362,722	3.9	1,562,559	15.1	346,845	9.6	2,760	1.8	2,274,886	9.7
	3	5,209,187	55.9	6,692,878	64.5	2,020,314	55.7	68,843	45.9	13,991,222	59.6
	4	3,138,752	33.7	1,551,266	14.9	919,848	25.4	54,271	36.2	5,664,137	24.1
	5	549,683	5.9	416,502	4.0	291,004	8.0	13,310	8.9	1,270,499	5.4
	6+	65,400	0.7	145,240	1.4	48,462	1.3	10,854	7.2	269,956	1.1
	Total	9,325,744		10,381,894		3,626,473		150,038		23,484,149	

Table 4 Estimates of Lake Erie yellow perch population size, biomass, exploitation and survival rates from the three gear CAGEAN model. S is the annual survival rate and u is the annual exploitation rate. Results are presented for ages 2+ and ages 3+ from 1988 through 1998 by management unit (Unit).

	Year	Number - Ages 2+ (millions)	Biomass - Ages 2+ (millions kg)	Biomass - Ages 2+ (millions lbs)	S	u	Number - Ages 3+ (millions)	Biomass - Ages 3+ (millions kg)	Biomass - Ages 3+ (millions lbs)	S	u
Unit 1	1988	84 214	9 889	21 805	0 465	0 255	55 005	7.182	15 836	0 367	0 381
	1989	42 013	5 256	11 591	0 332	0 426	39 164	5 019	11 067	0 309	0 456
	1990	19 364	3 069	6 768	0 356	0 394	13 930	2.356	5.194	0 247	0 538
	1991	17 055	2 028	4 472	0 415	0 319	6 896	1.012	2.232	0 239	0 549
	1992	19 200	2 206	4 864	0 470	0 249	7 072	0.932	2.056	0.297	0.472
	1993	14 554	1 689	3.724	0 399	0 340	9 027	1.311	2.892	0.295	0.474
	1994	19 532	2 207	4 867	0 512	0 196	5 803	0.821	1.810	0.325	0.435
	1995	39 704	4 133	9 112	0 555	0 143	10 009	1 282	2.827	0.413	0.321
	1996	47 012	5 069	11 178	0 519	0 187	22 026	2 629	5.797	0.420	0.312
	1997	27 329	3 178	7 008	0 390	0 351	24 406	2 916	6 430	0 366	0 382
	1998	89 973	6 246	13 773			10 663	1 646	3 630		
Unit 2	1988	94 114	12 803	28 230	0 516	0 191	51 725	7 956	17 543	0 422	0 310
	1989	52 054	8 180	18 037	0 376	0 368	48 561	7 917	17 457	0 360	0 390
	1990	27 543	4 501	9 926	0 330	0 428	19 591	3 563	7 857	0 229	0 561
	1991	31 093	4 252	9 375	0 393	0 346	9 089	1 648	3 634	0 227	0 564
	1992	39 292	4 801	10 586	0 460	0 261	12 234	1 843	4 063	0 298	0 470
	1993	25 594	3 096	6 826	0 364	0 384	18 086	2 553	5 629	0 296	0 473
	1994	27 609	3 517	7 755	0 493	0 220	9 312	1 535	3 384	0 320	0 441
	1995	27 731	3 678	8 110	0 479	0 238	13 617	2 027	4 469	0 368	0 379
	1996	47 025	5 717	12 605	0 537	0 165	13 278	2 038	4.494	0 386	0 356
	1997	35 229	4 482	9 882	0 389	0 352	25 242	3 530	7 783	0 323	0 437
	1998	85 413	7 790	17 178			13 712	2 269	5 004		
Unit 3	1988	70 661	13 100	28 886	0 520	0 186	60 955	11 593	25 562	0 497	0 215
	1989	41 754	7 724	17 032	0 466	0 254	36 768	7 221	15 921	0 439	0 288
	1990	25 872	5 342	11 778	0 478	0 239	19 467	4 603	10 149	0 419	0 314
	1991	21 157	3 724	8 211	0 456	0 267	12 379	2 741	6 043	0 380	0 363
	1992	13 830	2 529	5 577	0 438	0 289	9 650	2 075	4 575	0 376	0 369
	1993	8 056	1 546	3 410	0 447	0 278	6 063	1 309	2 887	0 397	0 342
	1994	14 004	1 676	3 695	0 567	0 128	3 601	0 958	2 112	0 423	0 309
	1995	12 440	1 740	3 836	0 547	0 153	7 936	1.220	2 691	0 493	0 221
	1996	15 838	2 162	4 766	0 569	0 125	6 801	1 125	2 481	0 476	0 242
	1997	14 990	1 824	4 022	0 489	0 225	9 015	1 398	3 082	0 401	0 337
	1998	39 737	3 086	6 805			7 333	1 077	2 375		
Unit 4	1990	7 226	1 473	3 248	0 572	0 121	6 641	1 415	3 120	0 567	0 128
	1991	4 441	1 011	2 229	0 556	0 141	4 135	0 973	2 146	0 551	0 147
	1992	2 677	0 582	1 283	0 616	0 067	2 470	0 575	1 269	0 614	0 070
	1993	2 028	0 424	0 935	0 600	0 087	1 650	0 384	0 846	0 591	0 097
	1994	1 743	0 286	0 630	0 618	0 065	1 216	0 249	0 550	0 605	0 080
	1995	2 917	0 429	0 946	0 649	0 026	1 076	0 264	0 583	0 630	0 050
	1996	3 344	0 363	0 800	0 638	0 040	1 894	0 271	0 597	0 619	0 063
	1997	2 337	0 359	0 792	0 601	0 086	2 132	0 346	0 764	0 595	0 093
	1998	2 449	0 325	0 716			1 404	0 265	0 584		

Table 5. Yellow perch stock size (millions of fish) at the start of the year, estimated by CAGEAN for the years 1988 to 1997. The 1998 population estimates use age 2 estimates derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices.

	Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Unit 1	2	29.209	2.849	5.434	10.159	12.128	5.527	13.729	29.695	24.986	2.924	79.310
	3	26.143	18.989	1.838	3.456	5.426	6.929	3.142	8.122	17.889	15.152	1.735
	4	24.266	10.091	6.279	0.447	0.789	1.605	2.052	1.073	3.411	7.640	5.749
	5	1.995	8.284	2.814	1.344	0.085	0.189	0.438	0.613	0.407	1.316	2.605
	6+	2.601	1.800	2.999	1.649	0.771	0.304	0.171	0.201	0.320	0.299	0.574
	2 and Older	84.214	42.013	19.364	17.055	19.200	14.554	19.532	39.704	47.012	27.329	89.973
	3 and Older	55.005	39.164	13.930	6.896	7.072	9.027	5.803	10.009	22.026	24.406	10.663
Unit 2	2	42.389	3.494	7.952	22.005	27.058	7.508	18.297	14.114	33.747	9.988	71.701
	3	16.634	26.717	2.133	4.593	10.170	14.438	3.965	10.634	8.266	20.118	5.553
	4	34.065	8.180	11.111	0.678	0.812	2.907	4.174	1.441	4.051	3.394	6.630
	5	0.636	13.189	2.335	1.683	0.101	0.200	0.825	1.176	0.445	1.352	0.968
	6+	0.390	0.474	4.012	2.134	1.151	0.541	0.348	0.365	0.516	0.377	0.560
	2 and Older	94.114	52.054	27.543	31.093	39.292	25.594	27.609	27.731	47.025	35.229	85.413
	3 and Older	51.725	48.561	19.591	9.089	12.234	18.086	9.312	13.617	13.278	25.242	13.712
Unit 3	2	9.706	4.987	6.405	8.778	4.180	1.994	10.403	4.504	9.037	5.975	32.404
	3	7.869	6.469	3.315	4.230	4.943	2.438	1.193	6.414	2.891	5.781	3.720
	4	51.916	4.056	2.937	0.977	0.785	1.205	0.708	0.418	3.063	1.339	2.255
	5	0.945	25.647	1.760	0.820	0.181	0.191	0.350	0.248	0.200	1.418	0.522
	6+	0.225	0.597	11.455	6.353	3.741	2.228	1.352	0.855	0.646	0.478	0.836
	2 and Older	70.661	41.754	25.872	21.157	13.830	8.056	14.004	12.440	15.838	14.990	39.737
	3 and Older	60.955	36.768	19.467	12.379	9.650	6.063	3.601	7.936	6.801	9.015	7.333
Unit 4	2			0.585	0.306	0.207	0.378	0.526	1.841	1.450	0.205	1.045
	3			0.508	0.372	0.190	0.134	0.240	0.340	1.216	0.959	0.135
	4			1.004	0.248	0.157	0.105	0.065	0.129	0.209	0.752	0.583
	5			0.357	0.370	0.069	0.073	0.038	0.029	0.074	0.120	0.421
	6+			4.771	3.144	2.054	1.338	0.872	0.578	0.395	0.301	0.265
	2 and Older			7.226	4.411	2.677	2.028	1.743	2.917	3.344	2.337	2.449
	3 and Older			6.641	4.135	2.470	1.650	1.216	1.076	1.894	2.132	1.404

Table 6 Projection of the 1998 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN. 1998 age 2 estimates are derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices. CV is coefficient of variation in stock size for the last year of CAGEAN runs.

			1997 Parameters				Rate Functions						1998 Parameters				Stock Biomass		
			Stock Size (numbers)				Mortality Rates				Survival Rate		Stock Size (numbers)			Mean Weight in Pop. (kg)	(millions kg)		(millions lbs.)
	CV	Age	Mean	Std. Err.	Min.	Max.	(F)	(Z)	(A)	(u)	(S)	Age	Mean	Min.	Max.		1997	1998	1998
Unit 1		2	2.924	0.715	2.208	3.639	0.122	0.522	0.407	0.095	0.593	2	79.310	47.304	111.316	0.058	0.262	4.600	10.143
	0.242	3	15.152	3.707	11.445	18.859	0.569	0.969	0.621	0.364	0.379	3	1.735	1.310	2.159	0.086	1.657	0.149	0.329
		4	7.640	1.869	5.771	9.509	0.676	1.076	0.659	0.414	0.341	4	5.749	4.343	7.156	0.124	0.975	0.713	1.572
		5	1.316	0.322	0.994	1.637	0.676	1.076	0.659	0.414	0.341	5	2.605	1.968	3.242	0.214	0.203	0.557	1.229
		6+	0.299	0.073	0.226	0.372	0.471	0.871	0.581	0.314	0.419	6+	0.574	0.433	0.714	0.395	0.081	0.227	0.500
		Total	27.329	6.686	20.643	34.016	0.541	0.941	0.610	0.351	0.390	Total	89.973	55.358	124.587		3.178	6.246	13.773
		(3+)	24.406	5.971	18.435	30.377	0.606	1.006	0.634	0.382	0.366	(3+)	10.663	8.054	13.271		2.916	1.646	3.630
Unit 2		2	9.988	2.019	7.969	12.006	0.187	0.587	0.444	0.141	0.556	2	71.701	55.899	87.503	0.077	0.952	5.521	12.174
	0.202	3	20.118	4.066	16.052	24.184	0.710	1.110	0.670	0.429	0.330	3	5.553	4.431	6.675	0.117	2.682	0.650	1.433
		4	3.394	0.686	2.708	4.079	0.854	1.254	0.715	0.487	0.285	4	6.630	5.290	7.970	0.169	0.509	1.120	2.471
		5	1.352	0.273	1.079	1.626	0.854	1.254	0.715	0.487	0.285	5	0.968	0.773	1.164	0.280	0.247	0.271	0.598
		6+	0.377	0.076	0.301	0.454	0.373	0.773	0.538	0.260	0.462	6+	0.560	0.447	0.673	0.407	0.091	0.228	0.503
		Total	35.229	7.120	28.110	42.349	0.544	0.944	0.611	0.352	0.389	Total	85.413	66.840	103.986		4.482	7.790	17.178
		(3+)	25.242	5.101	20.140	30.343	0.729	1.129	0.677	0.437	0.323	(3+)	13.712	10.941	16.483		3.530	2.269	5.004
Unit 3		2	5.975	1.397	4.578	7.372	0.074	0.474	0.377	0.059	0.623	2	32.404	14.649	50.159	0.062	0.426	2.009	4.430
	0.234	3	5.781	1.352	4.429	7.133	0.541	0.941	0.610	0.351	0.390	3	3.720	2.850	4.589	0.102	0.784	0.379	0.837
		4	1.339	0.313	1.026	1.651	0.541	0.941	0.610	0.351	0.390	4	2.255	1.728	2.782	0.155	0.222	0.350	0.771
		5	1.418	0.332	1.087	1.750	0.541	0.941	0.610	0.351	0.390	5	0.522	0.400	0.644	0.178	0.275	0.093	0.205
		6+	0.478	0.112	0.366	0.590	0.124	0.524	0.408	0.097	0.592	6+	0.836	0.641	1.032	0.305	0.117	0.255	0.562
		Total	14.990	3.505	11.485	18.495	0.315	0.715	0.511	0.225	0.489	Total	39.737	20.267	59.207		1.824	3.086	6.805
		(3+)	9.015	2.108	6.907	11.123	0.514	0.914	0.599	0.337	0.401	(3+)	7.333	5.618	9.048		1.398	1.077	2.375
Unit 4		2	0.205	0.098	0.108	0.303	0.016	0.416	0.340	0.013	0.660	2	1.045	1.009	1.080	0.057	0.013	0.060	0.132
	0.476	3	0.959	0.457	0.502	1.416	0.098	0.498	0.392	0.077	0.608	3	0.135	0.071	0.200	0.092	0.137	0.013	0.028
		4	0.752	0.358	0.394	1.110	0.180	0.580	0.440	0.137	0.560	4	0.583	0.305	0.860	0.120	0.119	0.070	0.154
		5	0.120	0.057	0.063	0.178	0.180	0.580	0.440	0.137	0.560	5	0.421	0.220	0.622	0.173	0.022	0.073	0.161
		6+	0.301	0.143	0.157	0.444	0.021	0.421	0.344	0.017	0.656	6+	0.265	0.139	0.391	0.412	0.068	0.109	0.241
		Total	2.337	1.114	1.224	3.451	0.110	0.510	0.399	0.086	0.601	Total	2.449	1.744	3.153		0.359	0.325	0.716
		(3+)	2.132	1.016	1.116	3.148	0.119	0.519	0.405	0.093	0.595	(3+)	1.404	0.735	2.073		0.346	0.265	0.584

Table 7. Estimated harvest of Lake Erie yellow perch for 1998. The exploitation rate is derived from optimal yield policy, and the stock size estimates are from CAGEAN and trawl regressions. Stock size and catch are presented in millions of fish. Catch weight is presented in millions of kilograms and pounds.

		Stock Size (numbers)			Exploitation Rate				Catch (millions of fish)			Mean Wt. in Harvest	Catch (millions of kg) - RAH			Catch (millions of lbs) - RAH		
	Age	Mean	Min.	Max.	F(opt)	s(age)	F(age)	(u)	Mean	Min.	Max.	(kg)	Mean	Min.	Max.	Mean	Min.	Max.
Unit 1	2	79.310	47.304	111.316	0.519	0.180	0.094	0.074	5.863	3.497	8.229	0.084	0.492	0.294	0.691	1.086	0.648	1.524
	3	1.735	1.310	2.159	0.519	0.842	0.437	0.296	0.513	0.388	0.639	0.104	0.053	0.040	0.066	0.118	0.089	0.147
	4	5.749	4.343	7.156	0.519	1.000	0.519	0.339	1.952	1.474	2.429	0.128	0.250	0.189	0.311	0.551	0.416	0.686
	5	2.605	1.968	3.242	0.519	1.000	0.519	0.339	0.884	0.668	1.101	0.161	0.142	0.108	0.177	0.314	0.237	0.391
	6+	0.574	0.433	0.714	0.519	0.697	0.362	0.253	0.145	0.110	0.181	0.258	0.037	0.028	0.047	0.083	0.062	0.103
	Total	89.973	55.358	124.587					9.357	6.136	12.578	0.104	0.976	0.659	1.292	2.151	1.452	2.850
	(3+)	10.663	8.054	13.271					3.494	2.640	4.349	0.138	0.483	0.365	0.601	1.065	0.805	1.326
Unit 2	2	71.701	55.899	87.503	0.477	0.219	0.104	0.082	5.881	4.585	7.178	0.102	0.600	0.468	0.732	1.323	1.031	1.614
	3	5.553	4.431	6.675	0.477	0.831	0.397	0.273	1.518	1.211	1.825	0.126	0.191	0.153	0.230	0.422	0.337	0.507
	4	6.630	5.290	7.970	0.477	1.000	0.477	0.318	2.106	1.680	2.531	0.143	0.301	0.240	0.362	0.664	0.530	0.798
	5	0.968	0.773	1.164	0.477	1.000	0.477	0.318	0.308	0.245	0.370	0.186	0.057	0.046	0.069	0.126	0.101	0.152
	6+	0.560	0.447	0.673	0.477	0.437	0.208	0.156	0.087	0.070	0.105	0.255	0.022	0.018	0.027	0.049	0.039	0.059
	Total	85.413	66.840	103.986					9.900	7.792	12.009	0.118	1.172	0.924	1.420	2.584	2.038	3.130
	(3+)	13.712	10.941	16.483					4.019	3.207	4.831	0.142	0.572	0.456	0.688	1.261	1.006	1.516
Unit 3	2	32.404	14.649	50.159	0.466	0.137	0.064	0.051	1.652	0.747	2.556	0.113	0.187	0.084	0.289	0.412	0.186	0.637
	3	3.720	2.850	4.589	0.466	1.000	0.466	0.312	1.160	0.888	1.431	0.127	0.147	0.113	0.182	0.325	0.249	0.401
	4	2.255	1.728	2.782	0.466	1.000	0.466	0.312	0.703	0.539	0.867	0.141	0.099	0.076	0.122	0.219	0.167	0.270
	5	0.522	0.400	0.644	0.466	1.000	0.466	0.312	0.163	0.125	0.201	0.167	0.027	0.021	0.034	0.060	0.046	0.074
	6+	0.836	0.641	1.032	0.466	0.229	0.107	0.084	0.070	0.054	0.086	0.246	0.017	0.013	0.021	0.038	0.029	0.047
	Total	39.737	20.267	59.207					3.747	2.352	5.142	0.127	0.477	0.307	0.648	1.053	0.677	1.428
	(3+)	7.333	5.618	9.048					2.095	1.606	2.585	0.139	0.291	0.223	0.359	0.641	0.491	0.791
Unit 4	2	1.045	1.009	1.080	0.391	0.069	0.035	0.028	0.029	0.028	0.030	0.106	0.003	0.003	0.003	0.007	0.007	0.007
	3	0.135	0.071	0.200	0.391	0.544	0.213	0.159	0.022	0.011	0.032	0.121	0.003	0.001	0.004	0.006	0.003	0.008
	4	0.583	0.305	0.860	0.391	1.000	0.391	0.270	0.157	0.082	0.232	0.130	0.020	0.011	0.030	0.045	0.024	0.067
	5	0.421	0.220	0.622	0.391	1.000	0.391	0.270	0.114	0.060	0.168	0.137	0.016	0.008	0.023	0.034	0.018	0.051
	6+	0.265	0.139	0.391	0.391	0.117	0.046	0.037	0.010	0.005	0.014	0.161	0.002	0.001	0.002	0.003	0.002	0.005
	Total	2.449	1.744	3.153					0.332	0.187	0.477	0.131	0.043	0.024	0.063	0.096	0.053	0.138
	(3+)	1.404	0.735	2.073					0.303	0.158	0.417	0.133	0.040	0.021	0.059	0.089	0.046	0.131

Table 8. Lake Erie yellow perch harvest estimates for 1998. All estimates are based on CAGEAN outputs and the F(opt) fishing strategy. **The model estimates the 1996 year class recruiting into the fishery in 1998 by parametric regression (Regression Model). Values are rounded from Table 7 to the nearest one hundred thousand pounds and one hundred thousand kilograms except Unit 4. Harvest and TAC from 1997 is included for comparative purposes.**

	1998 Yield (Millions of Pounds)			1997 fishery (Millions of Pounds)			
	RAH						
	Mean	Min.	Max.	Harvest	TAC	RAH	RAH Range
Unit 1	2.2	1.5	2.8	2.274	2.4	1.9	1.4 - 2.4
Unit 2	2.6	2.0	3.1	2.906	3.6	2.9	2.2 - 3.6
Unit 3	1.1	0.7	1.4	1.072	1.2	1.1	0.5 - 1.6
Unit 4	0.10	0.05	0.14	0.042	0.2	0.2	0.1 - 0.3
Total	**5.9**	**4.2**	**7.5**	6.294	7.4	6.1	4.2 - 7.9

1998 Yield (Millions of Kilograms)

	RAH		
	Mean	Min.	Max.
Unit 1	1.0	0.7	1.3
Unit 2	1.2	0.9	1.4
Unit 3	0.5	0.3	0.6
Unit 4	0.04	0.02	0.06
Total	**2.7**	**1.9**	**3.4**

Table 9. Lake Erie yellow perch RAH scenarios for 1998. All estimates are based on CAGEAN outputs and the F(opt) fishing strategy. Scenario 1 is our standard RAH with CAGEAN and yield per recruit analyses. Scenario 2 uses the recalculation of the 1995 cohort in 1997 from Partnership gill net regression data.

Scenario 1 : 1998 Yield

	RAH (millions of pounds)	
	Mean	Max.
Unit 1	2.2	2.8
Unit 2	2.6	3.1
Unit 3	1.1	1.4
Unit 4	0.10	0.14
Total	**6.0**	**7.5**

Scenario 2 : 1998 Yield

	RAH (millions of pounds)	
	Min.	Mean
Unit 1	1.7	2.6
Unit 2	2.5	3.3
Unit 3	0.5	1.2
Unit 4	0.05	0.14
Total	**4.8**	**7.2**

YPTG Suggested RAH Range

	RAH (millions of pounds)	
	Min.	Max.
Unit 1	2.2	2.6
Unit 2	2.6	3.3
Unit 3	1.1	1.4
Unit 4	0.05	0.14
Total	**6.0**	**7.4**

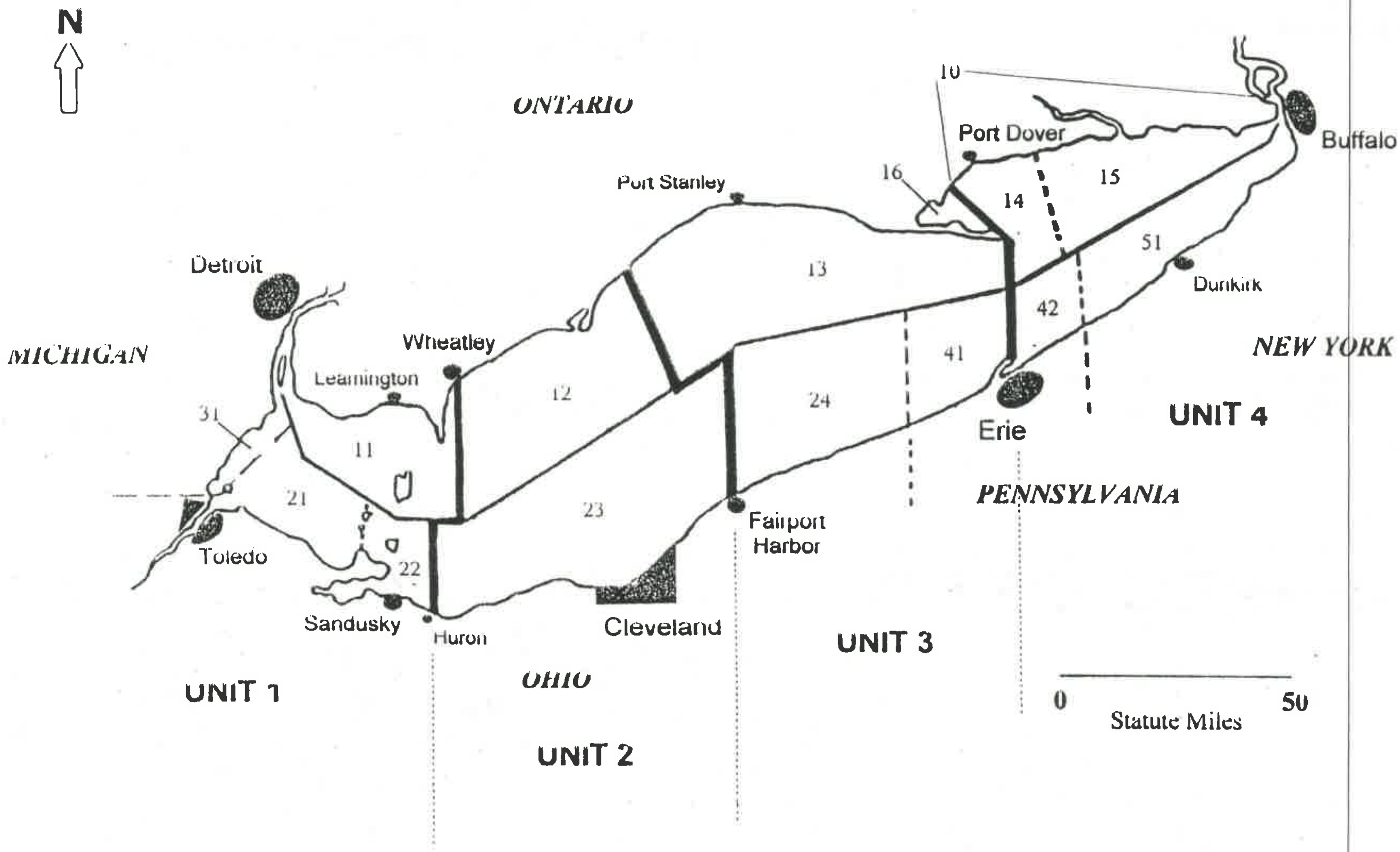

Figure 1. Lake Erie Management Units defined and used by the Yellow Perch Task Group.

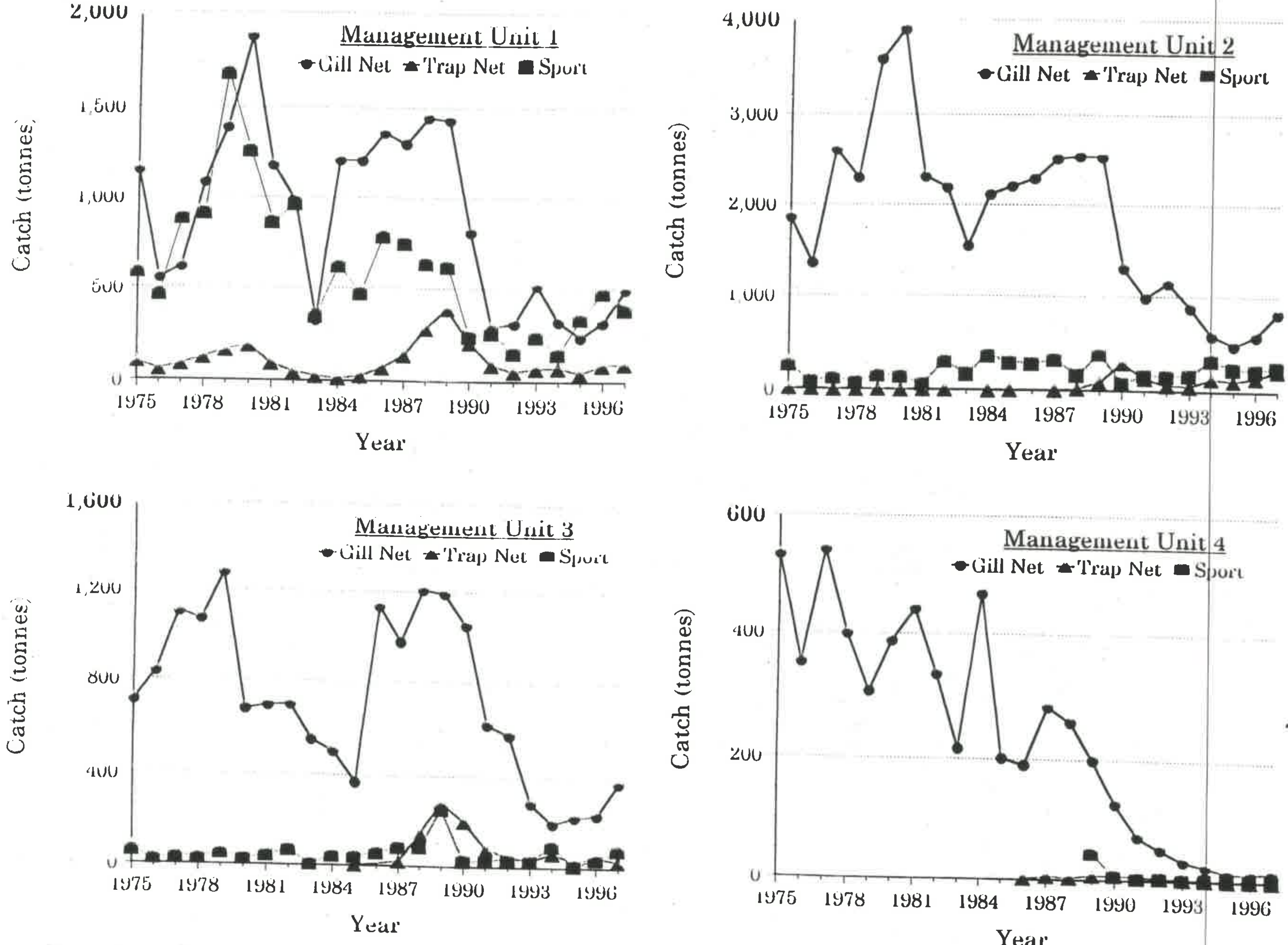

Figure 2. Lake Erie yellow perch harvest by management unit and gear type.

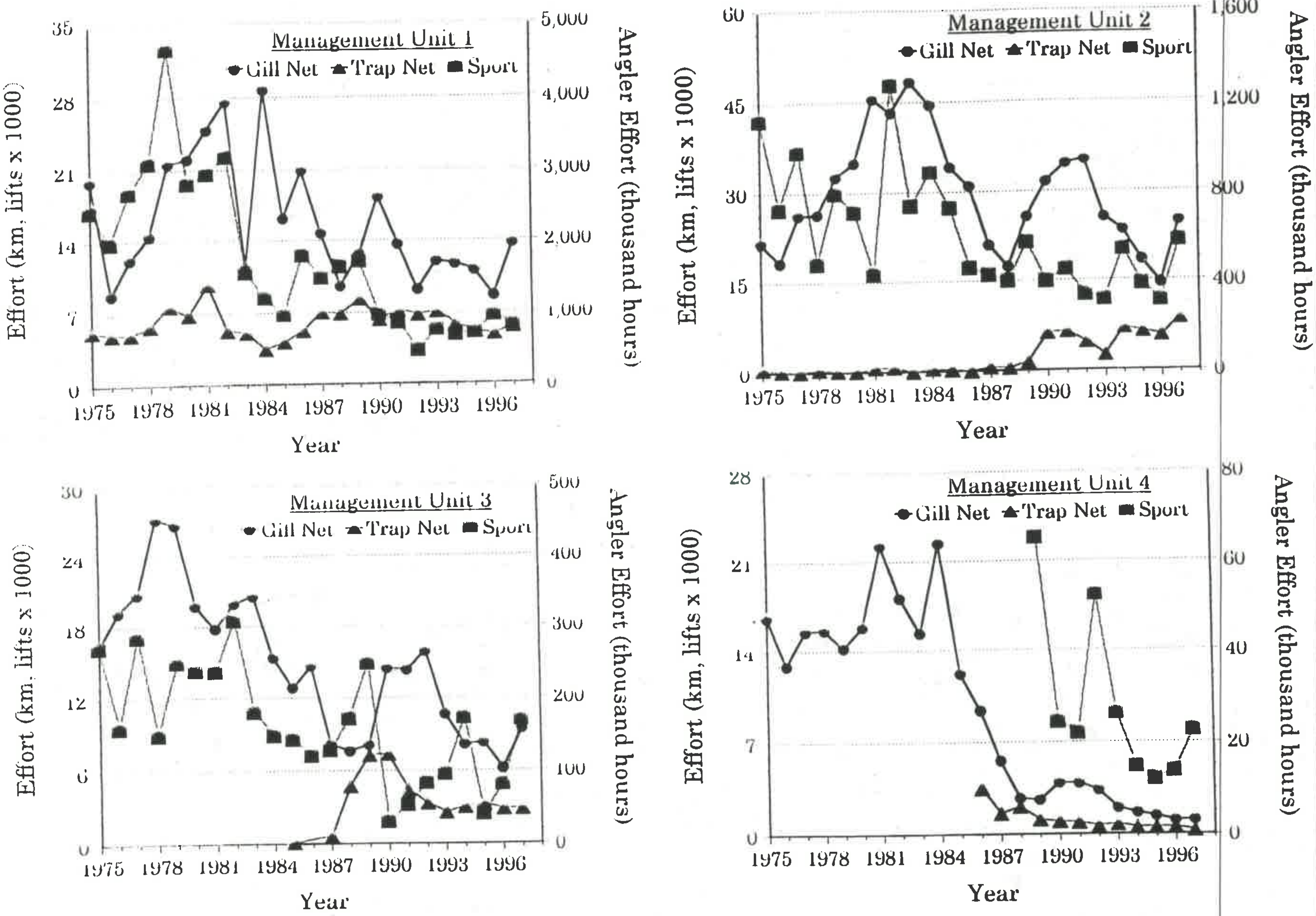

Figure 3. Lake Erie yellow perch effort by management unit and gear type.

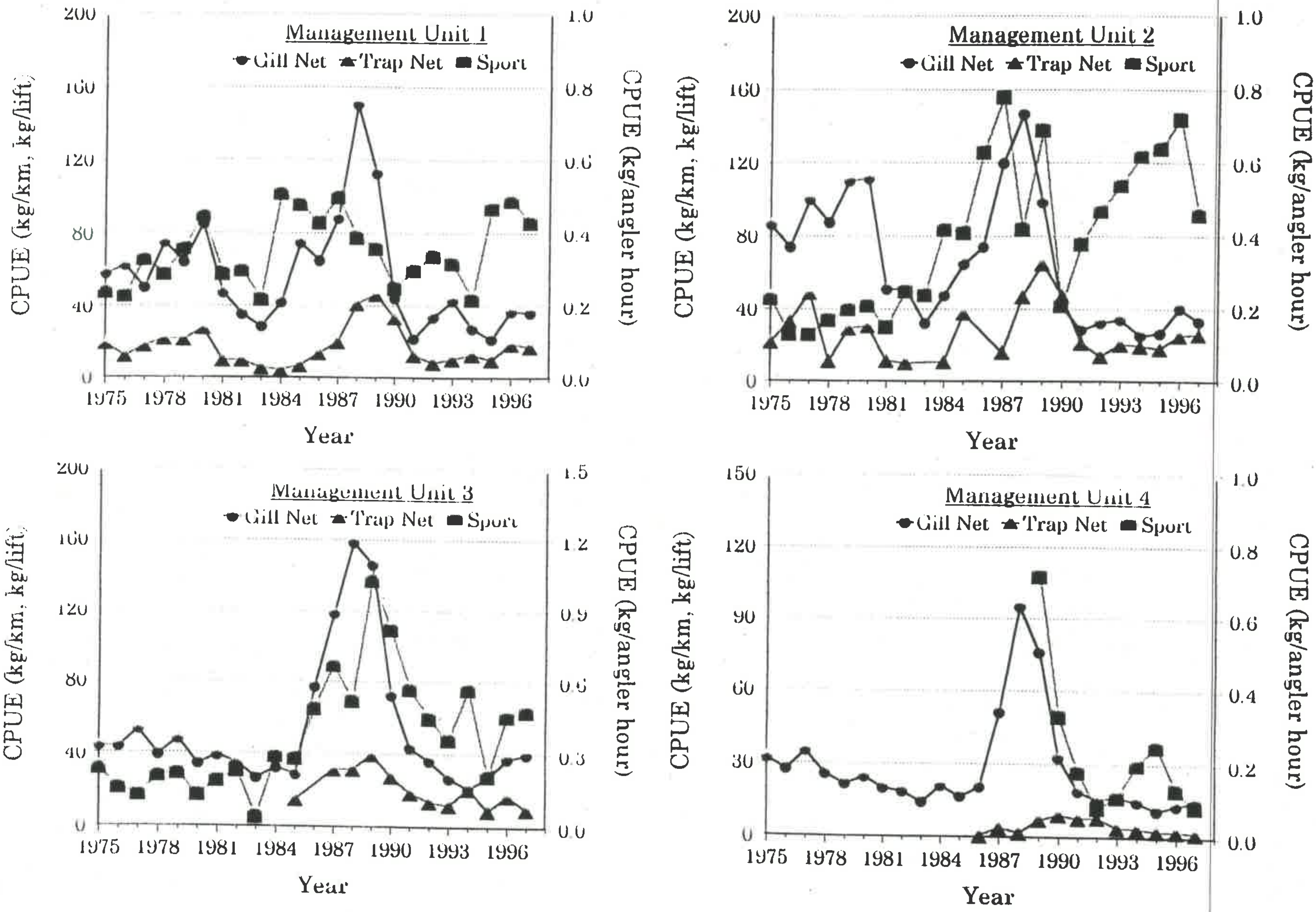

Figure 4. Lake Erie yellow perch catch per unit effort by management unit and gear type.

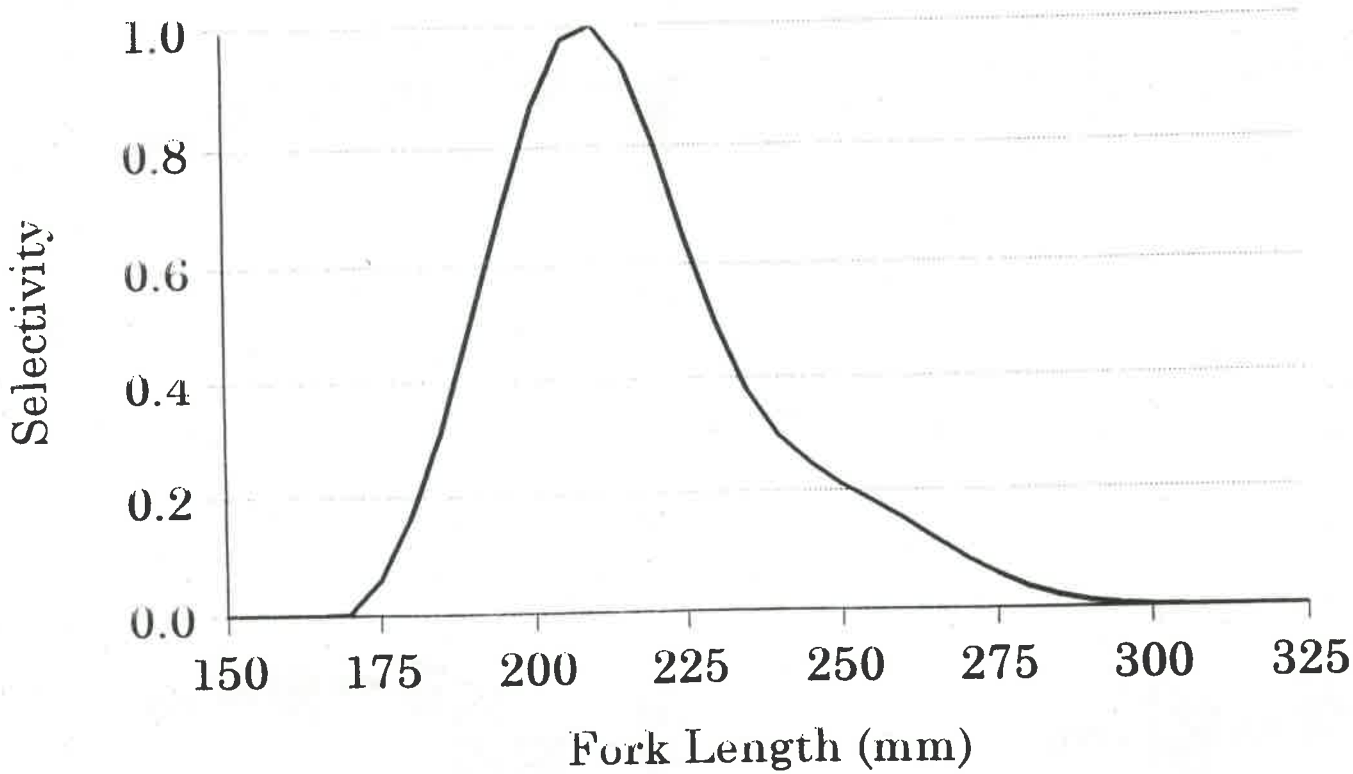

Figure 5. Selectivity of 2.25" (small mesh) monofilament gill nets for Lake Erie yellow perch. An approximate conversion (P. Ryan, pers. comm.) from fork length (FL) to total length (TL) in mm is: TL = FL / 0.95 .

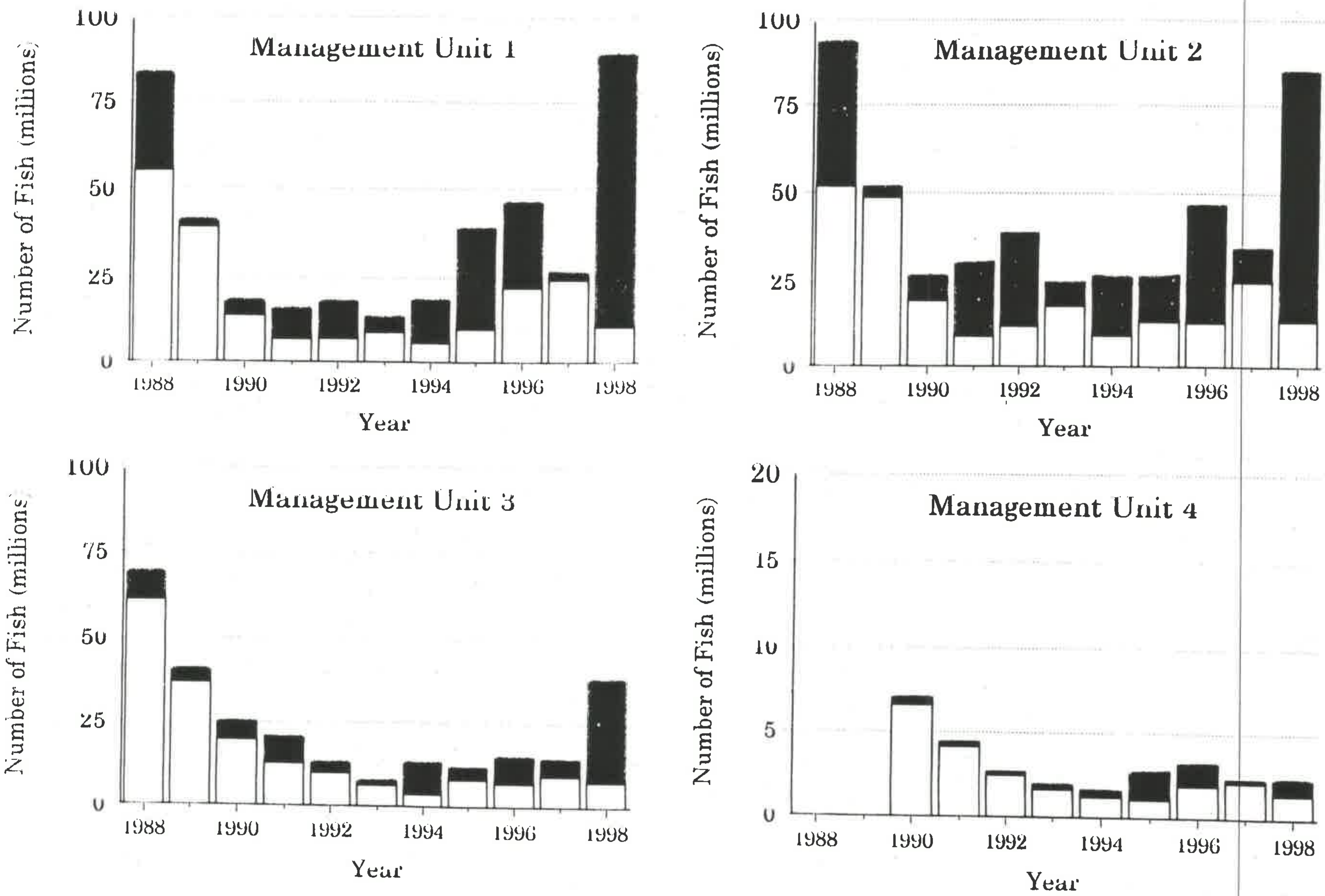

Figure 6. Lake Erie yellow perch population estimates by management unit for ages 2 (dark bars) and ages 3+ (light bars). Estimates for 1998 are from CAGEAN and parametric regressions for age 2.

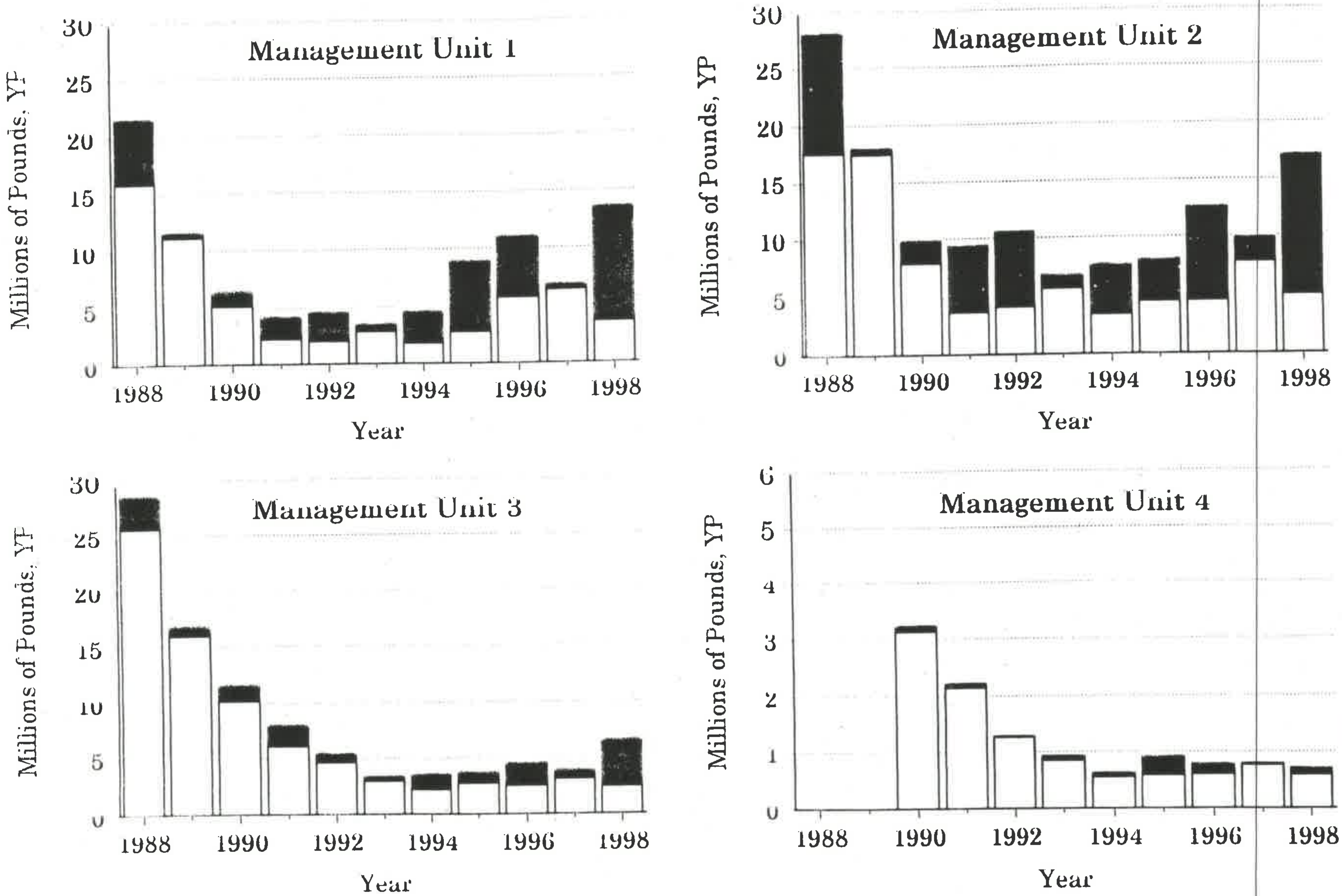

Figure 7. Lake Erie yellow perch biomass estimates by management unit for ages 2 (dark bars) and 3+ (light bars). Estimates for 1998 are from CAGEAN and parametric regressions for age 2.

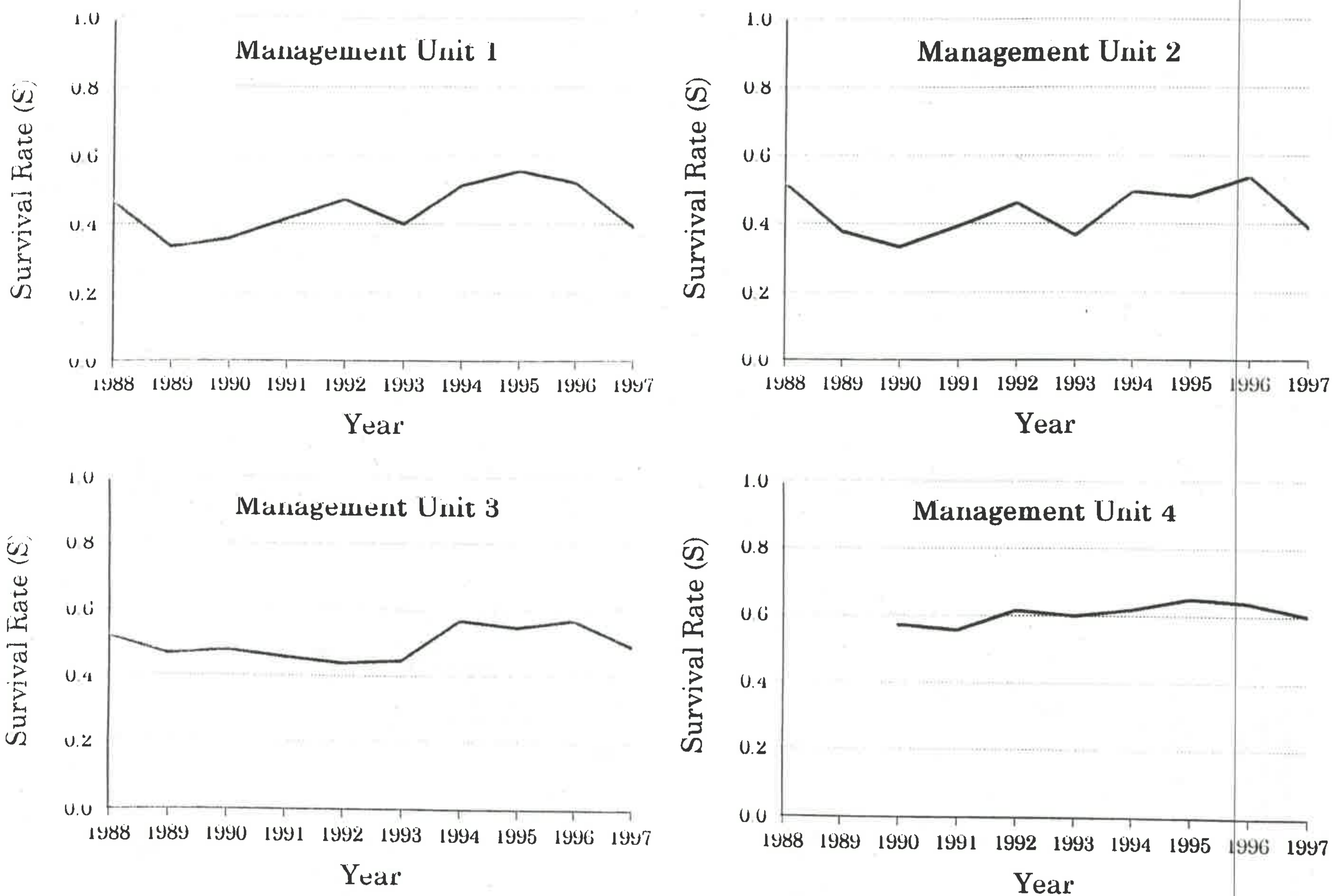

Figure 8. Survival rates of age 2 and older Lake Erie yellow perch, 1988 - 1997. Estimates are derived from CAGEAN.

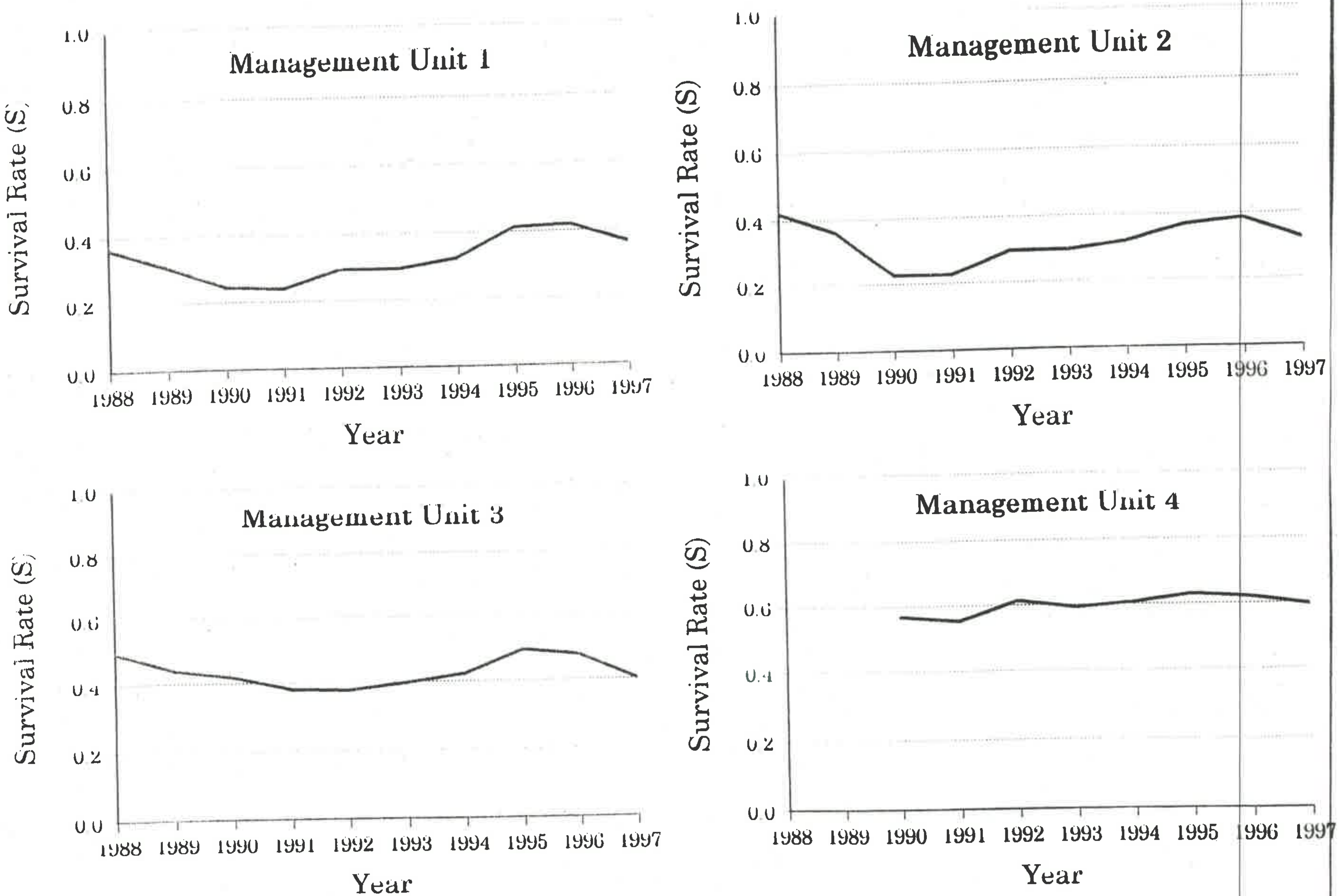

Figure 9. Survival rates of age 3 and older Lake Erie yellow perch, 1988 - 1997. Estimates are derived from CAGEAN.

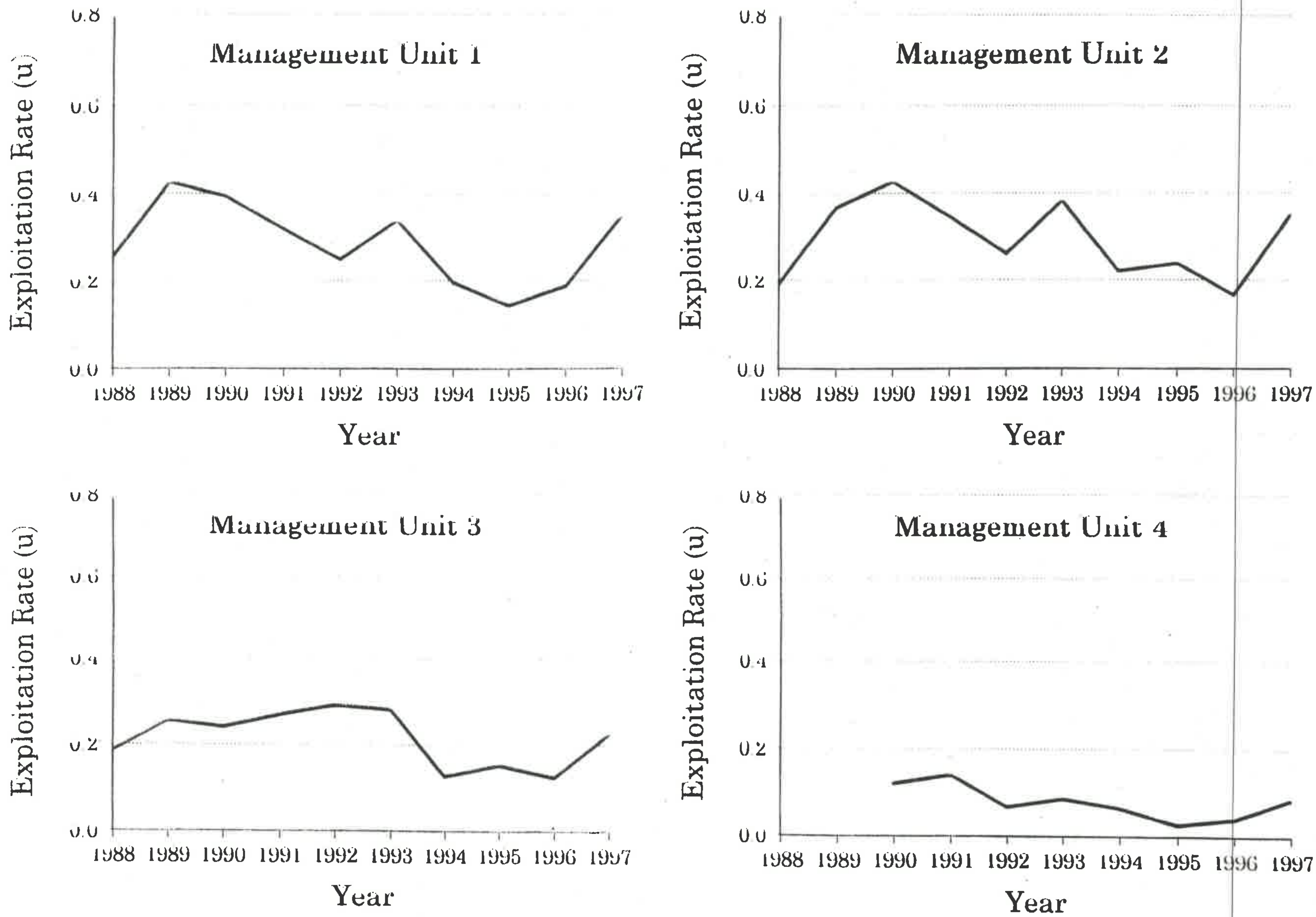

Figure 10. Exploitation rates of age 2 and older yellow perch, Lake Erie, 1988 - 1997. Estimates are derived from CAGEAN.

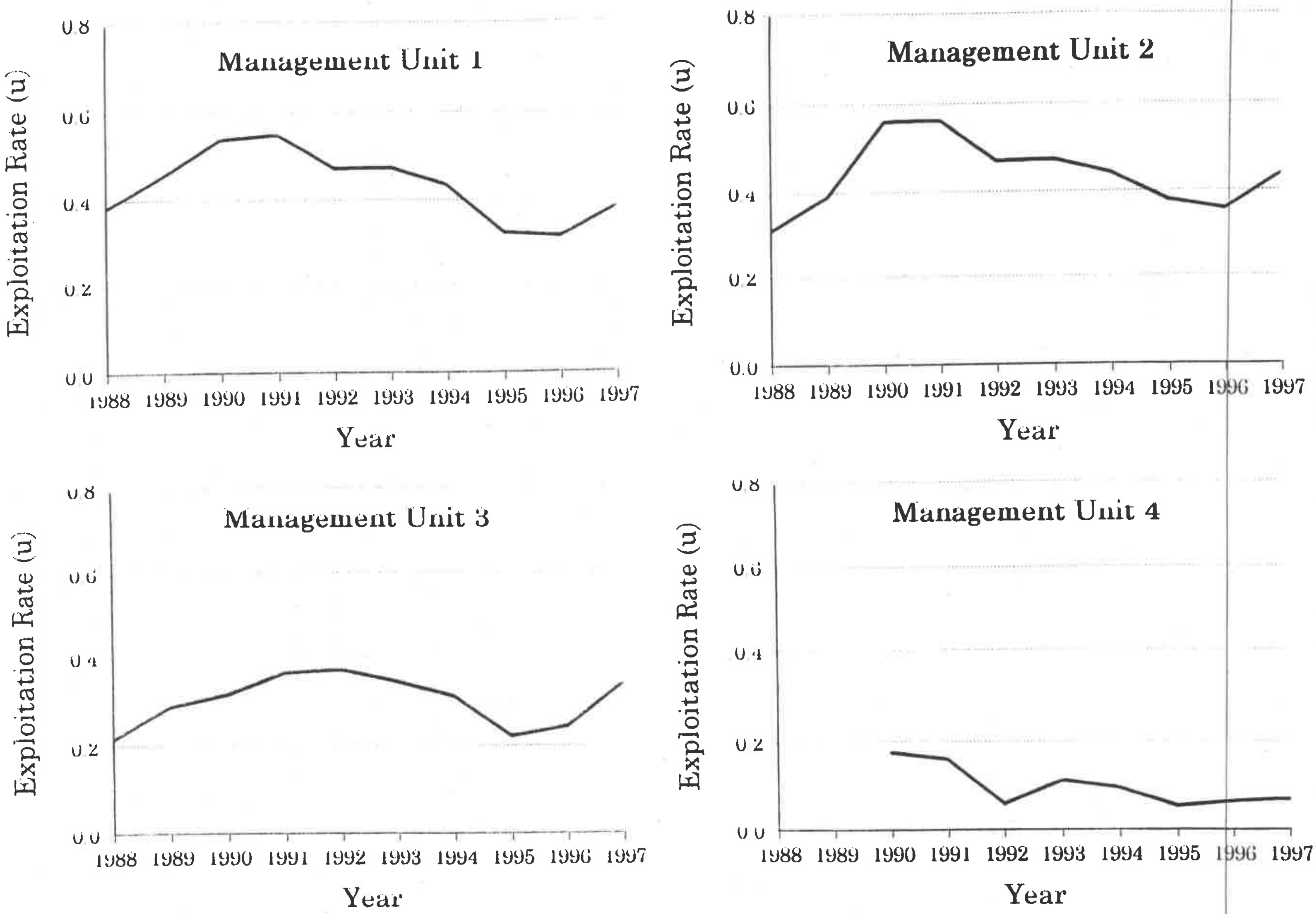

Figure 11. Exploitation rates of age 3 and older yellow perch, Lake Erie, 1988 - 1997. Estimates are derived from CAGEAN.

Appendix A. Review of Yellow Perch Growth Rates, Condition and Trends

In this appendix, we present growth and condition data in the form of length, weight and condition (K) trend analyses for Lake Erie yellow perch by management unit. We present figures for length, weight and K values from 1990-1997 by Unit for age 1, age 2 and age 4 yellow perch sampled in Ontario interagency gill net surveys and in Ohio trawl surveys (Figures A-1 through A-4). In these figures, we generalize that growth in both length and weight at age has been reduced for the last two years, but annual condition factor values have not shown a significant declining trend (Figures A-5 and A-6). There is some concern that there may be a declining trend in growth emerging, as is shown in Figure A-7, when a three-year moving average for incremental growth (in mm/year) is calculated. This will warrant future observation to determine if these effects are seen in the fishery as a change in selectivity for specific age groups.

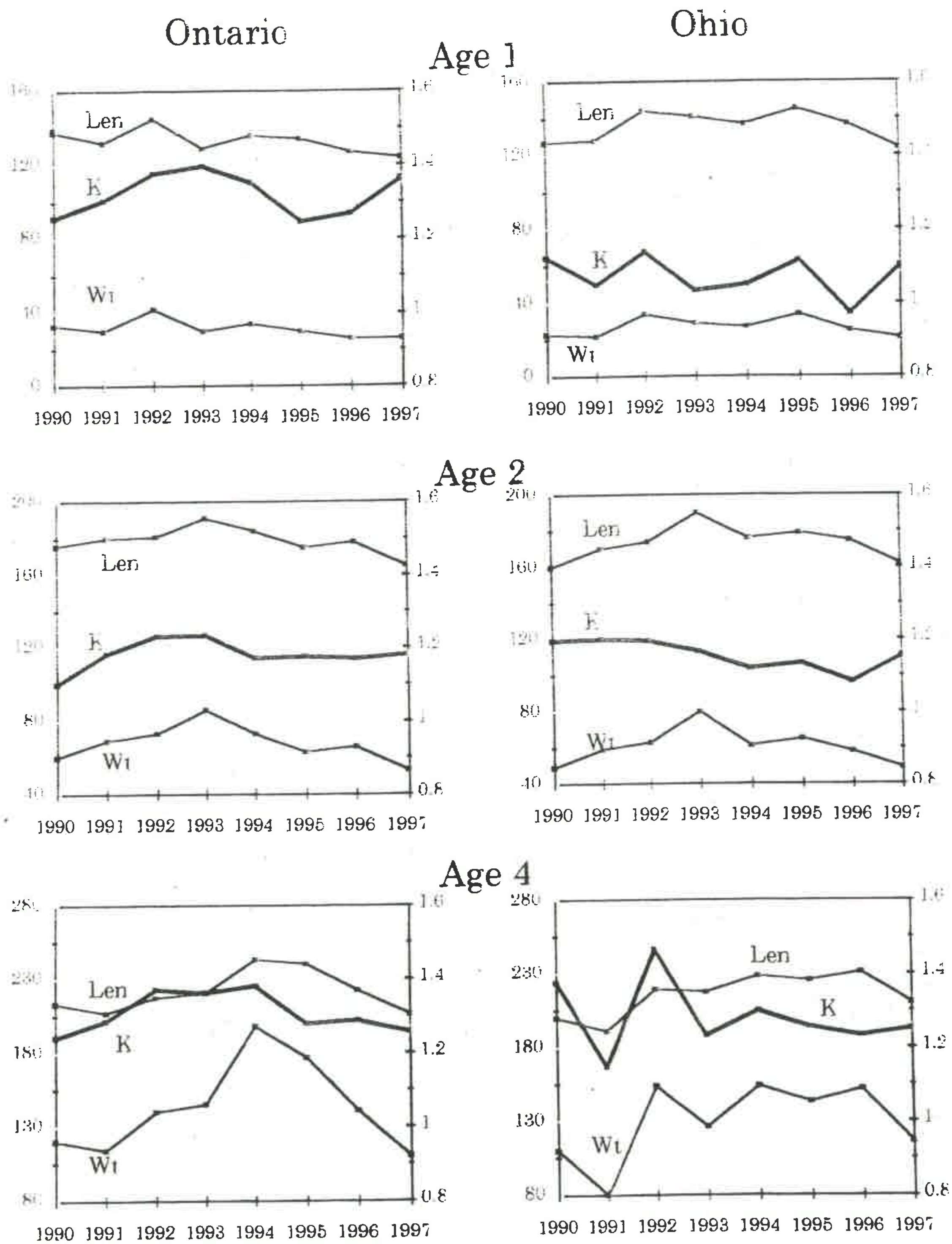

Figure A-1. Length, weight and condition (K) of ages 1, 2 and 4 yellow perch sampled from Ontario interagency gill nets and Ohio trawls in the western basin of Lake Erie. The Y-1 Axis is for length and weight data, the Y-2 axis is for K values.

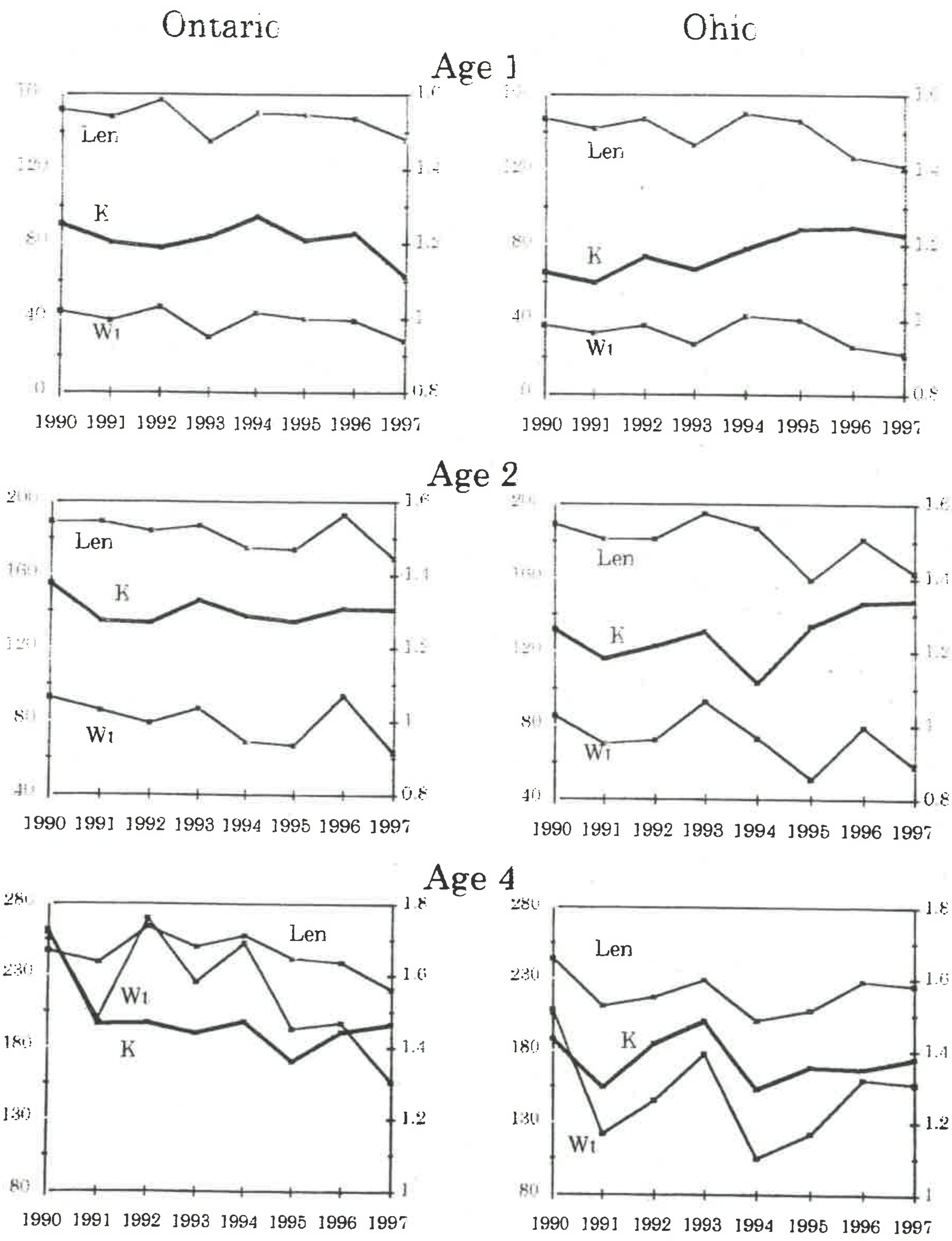

Figure A-2. Length, weight and condition (K) of ages 1, 2 and 4 yellow perch sampled from Ontario interagency gill nets and Ohio trawls in the west central sub-basin of Lake Erie.

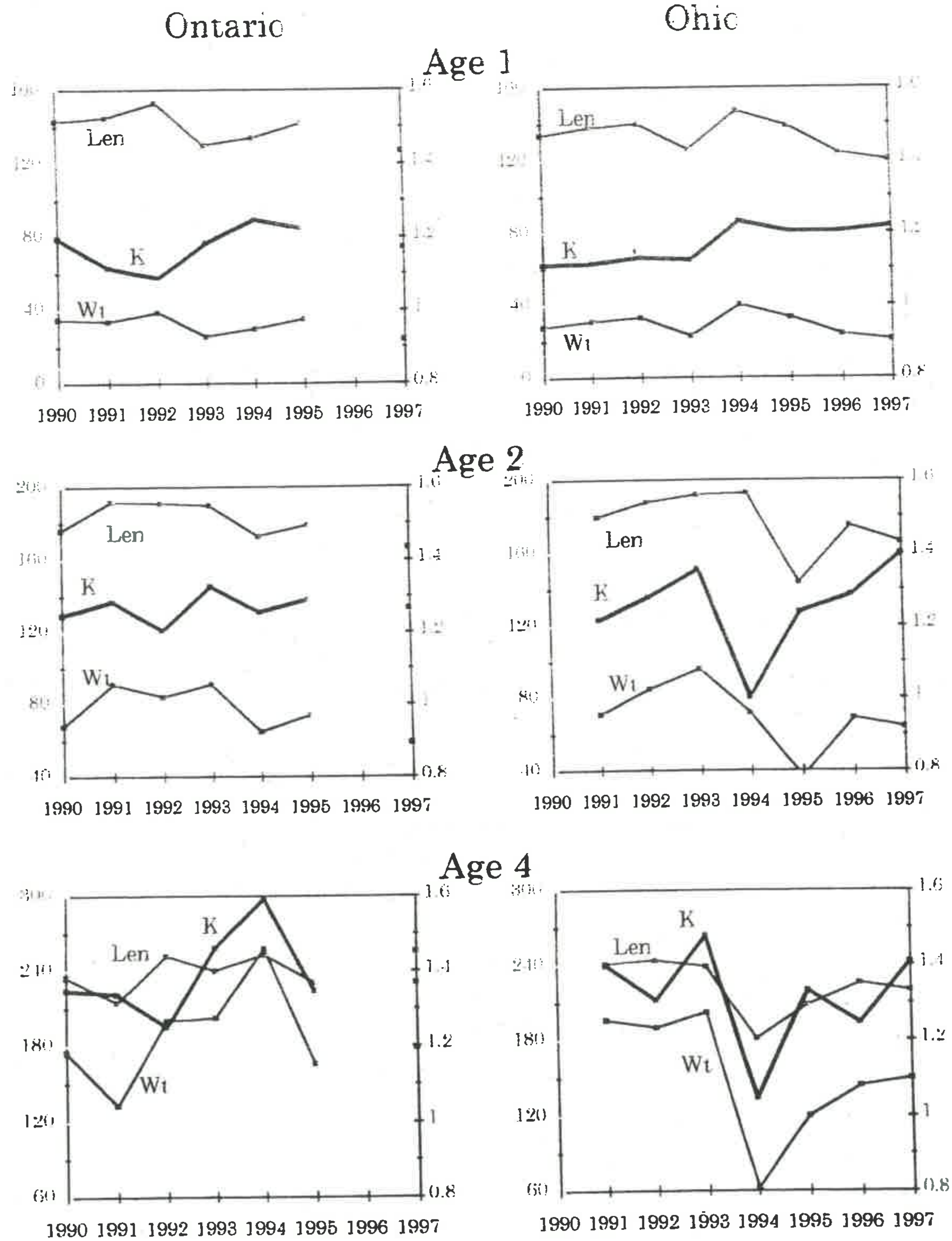

Figure A-3. Length, weight and condition (K) of ages 1, 2 and 4 yellow perch sampled from Ontario interagency gill nets and Ohio trawls in the east central sub-basin of Lake Erie.

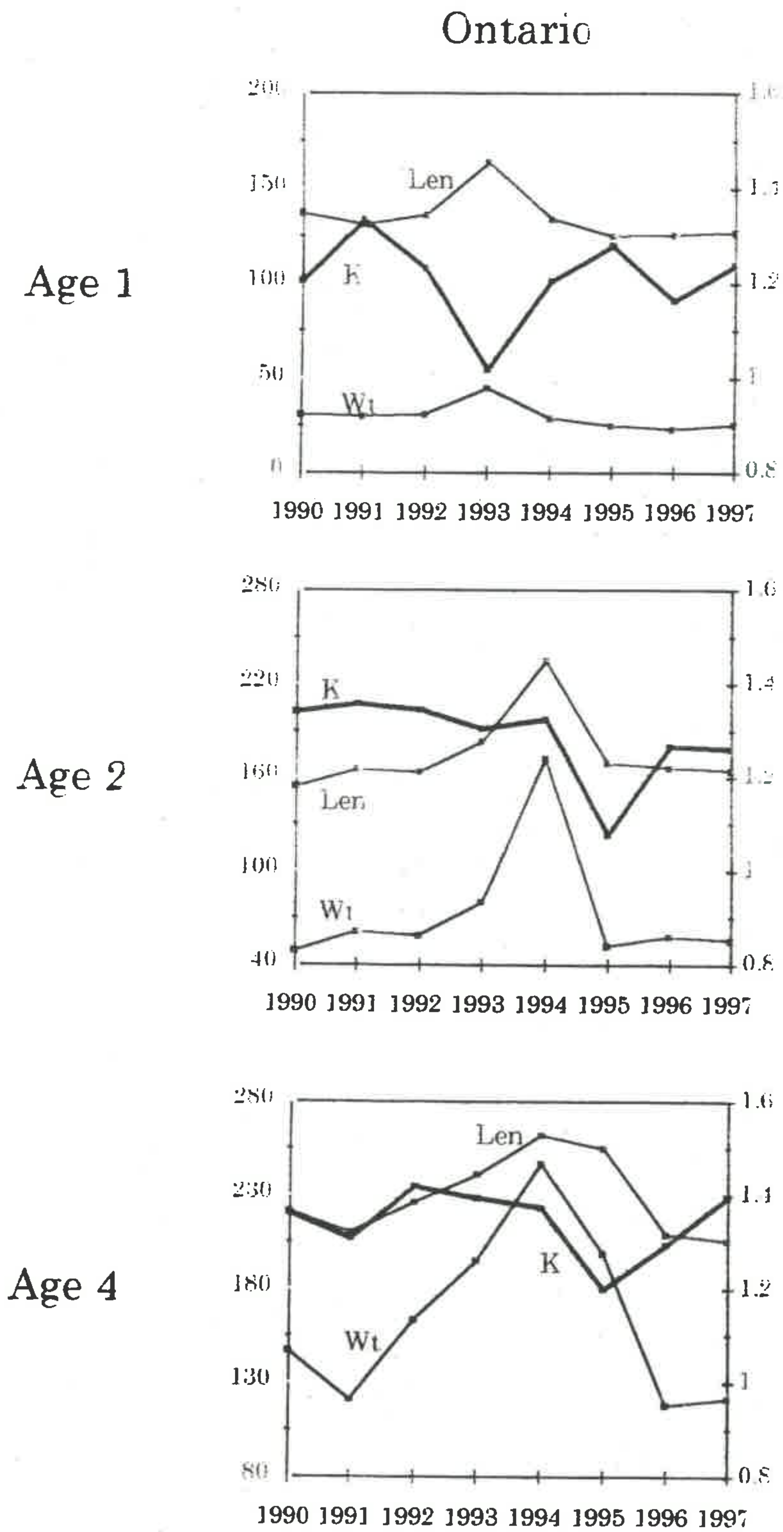

Figure A-4. Length, weight and condition (K) of ages 1, 2 and 4 yellow perch sampled from Ontario interagency gill nets in the eastern basin of Lake Erie.

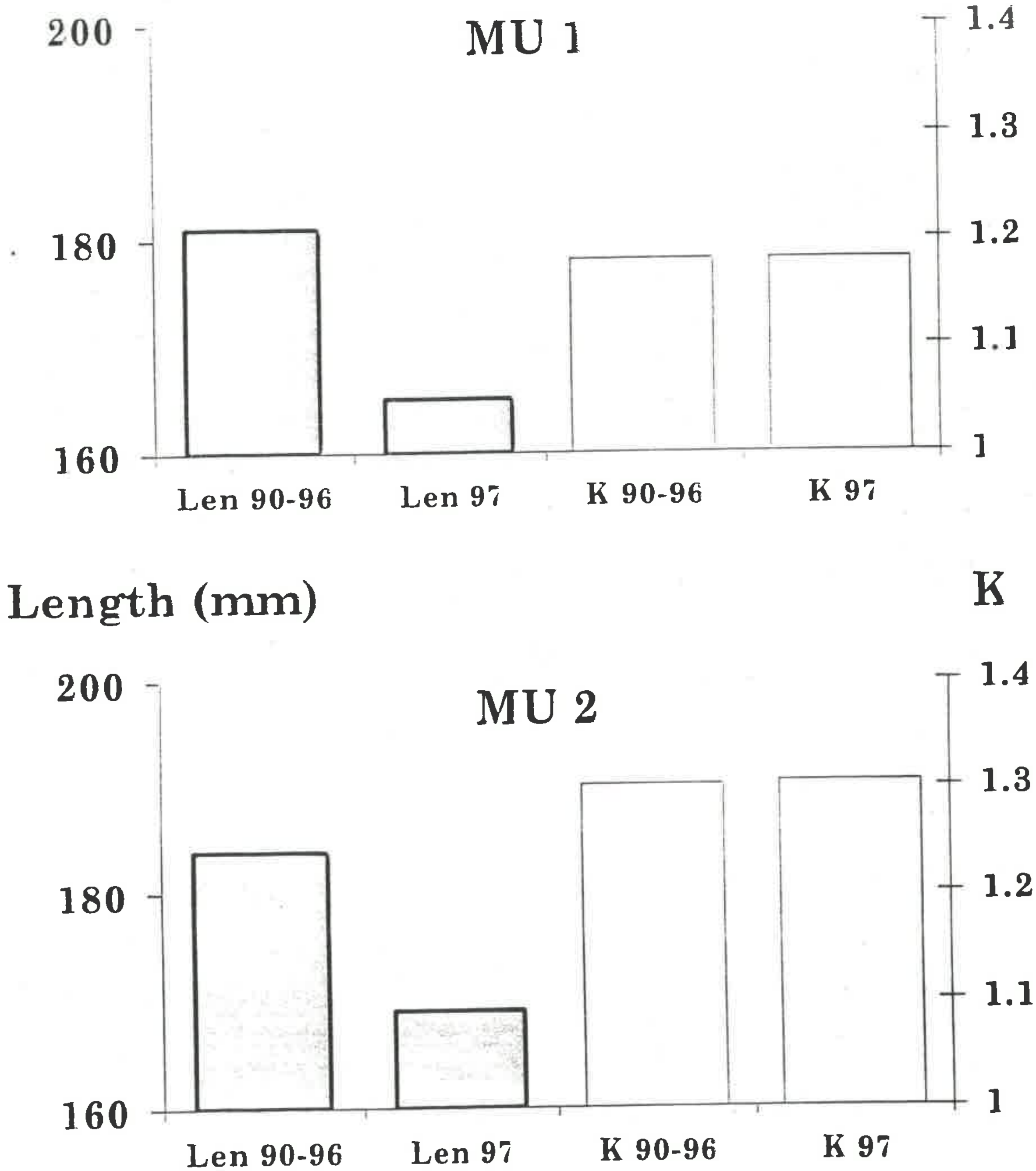

Figure A-5. Age 2 yellow perch length and condition factor (K) calculated for a mean value for 1990-96 and for 1997 in the western basin (MU 1) and the west central sub-basin (MU 2) of Lake Erie.

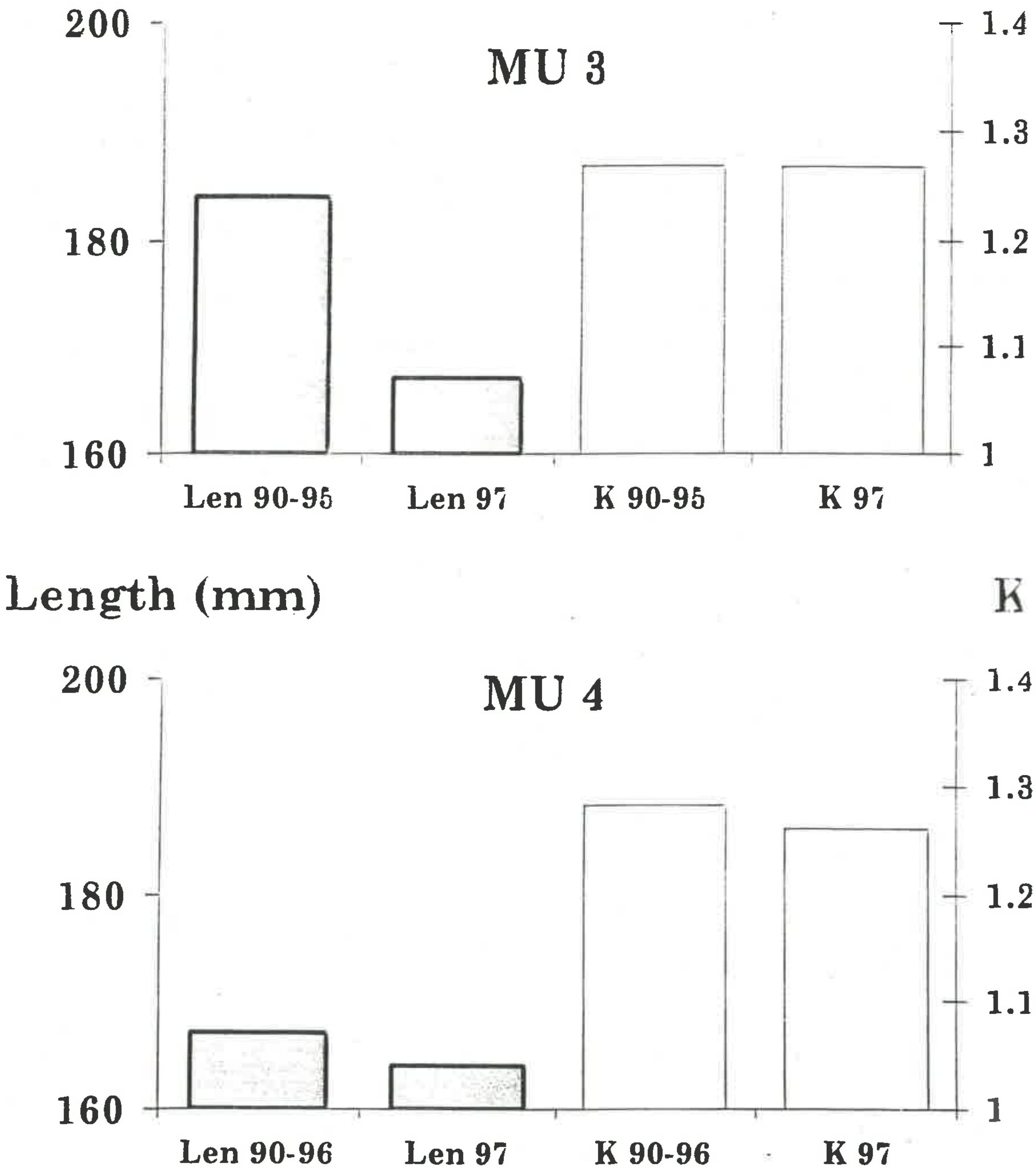

Figure A-6. Age 2 yellow perch length and condition factor (K) calculated for a mean value for 1990-96 and for 1997 in the east central sub-basin (MU 3) and the eastern basin (MU 4) of Lake Erie.

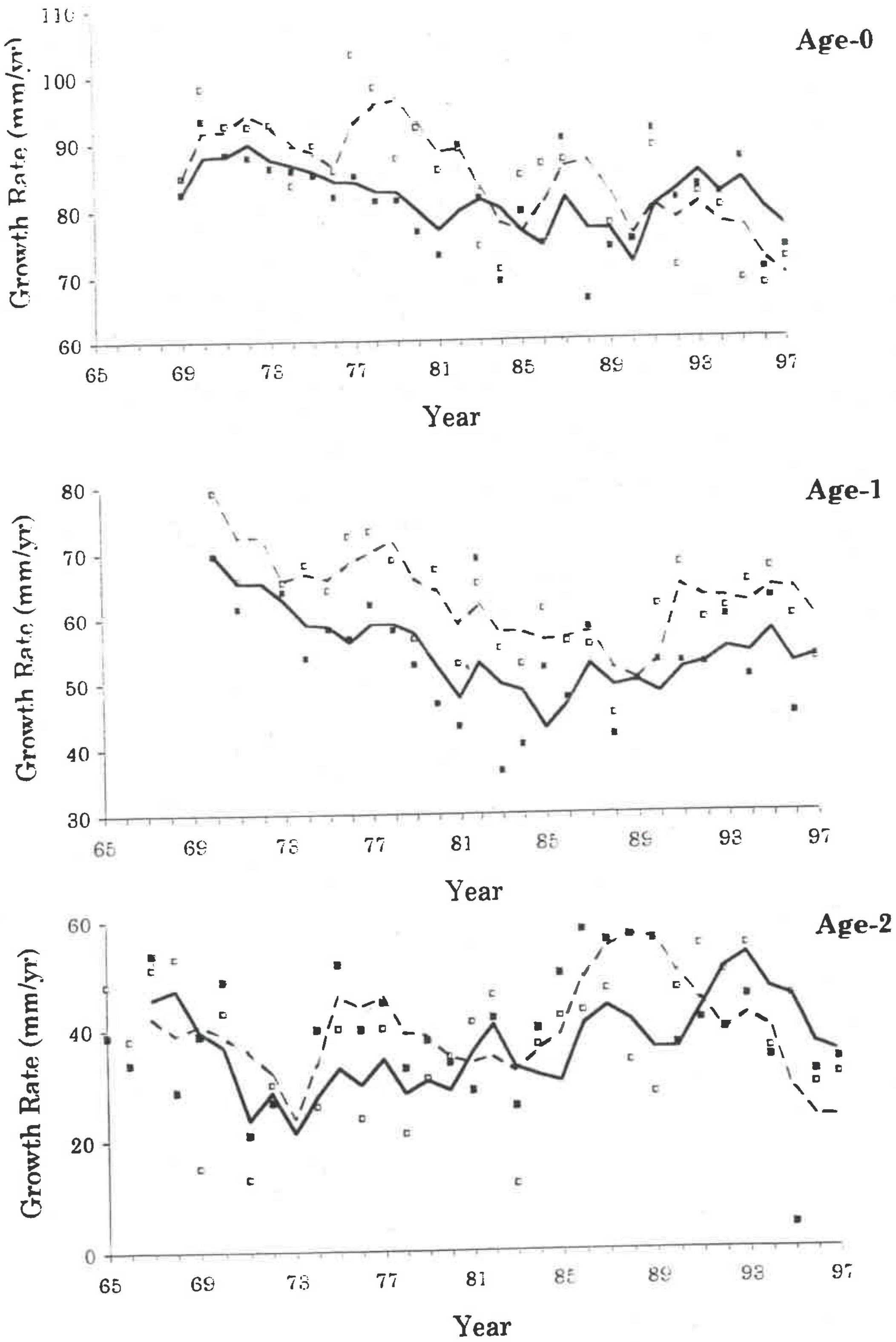

Figure A-7. Growth rates (mm/yr) of age-0, age-1, and age-2 yellow perch from western (— and open boxes) and central (- - and filled boxes) basin sites of Lake Erie. Line fit is a three-year moving average.

Appendix B. Age 2 Recruitment Regressions and Index Trawl Data Series

In this appendix, the YPTG presents significant regressions that result in the estimation of the number of age 2 yellow perch entering the fishery in 1998. The 1996 cohort was very strong in many of our trawl series, giving rise to a significantly larger number of age 2 yellow perch recruiting next year. The YPTG continues to use parametric regression analysis to predict age 2 yellow perch by management unit from interagency trawl surveys. Age 2 mean value estimates and standard error estimates are then incorporated into Tables 6 and 7 in the main body of the report to complete yield per recruit and RAH projections for 1998. Table B-1 presents by management unit those regressions found significant for predicting age 2 yellow perch. Table B-2 contains trawl data series in arithmetic mean catch per trawl hour. Table B-3 contains trawl data series in geometric mean catch per trawl hour. Definition of trawl series abbreviations used in Tables B-2 and B-3 can be found in the Legend which follows these tables.

Appendix B: Table B-1. Agency trawl regression indices (from geometric means) found statistically significant for projecting estimates of age 2 yellow perch by Management Unit.

Management Unit 1

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age 2 estimate	R-squared	Upper Age 2 estimate	Lower Age 2 estimate	SE
Ohio Management Unit 1	Summer	YOY	313,501	1,362,452	575	0.002	181,688,227	0.79	181,926,542	181,449,913	119,157
Ohio Management Unit 2	Summer	YOY	1,592,399	5,909,441	61	0.008	103,051,672	0.66	104,750,344	101,353,000	849,336
USGS Management Unit 1	Summer	Yearling	360,739	5,179,174	19	0.025	12,153,341	0.54	12,648,584	11,658,098	247,621
Ohio Management Unit 2	Fall	YOY	883,402	5,852,824	95	0.053	89,790,678	0.44	91,277,507	88,303,850	743,414
USGS Management Unit 1	Fall	Yearling	690,482	3,699,183	9	0.072	9,863,668	0.39	11,139,808	8,587,528	638,070
Mean			768,105	4,400,615	152	0.032	79,309,517	0.56	80,348,557	78,270,478	519,520
Standard Error							32,005,965				

Management Unit 2

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age 2 estimate	R-squared	Upper Age 2 estimate	Lower Age 2 estimate	SE
* Ohio Management Unit 2	Fall	YOY	1,189,766	5,984,701	113	0.001	140,160,562	0.95	140,699,665	139,621,458	269,552
Ohio Management Unit 2	Fall	Yearling	613,202	8,993,981	42	0.001	34,871,105	0.80	35,324,042	34,418,169	226,468
USGS Management Unit 1	Summer	Yearling	428,538	8,423,322	19	0.006	16,708,247	0.68	17,145,093	16,271,401	218,423
Ohio Management Unit 2	Fall	YOY	1,157,952	8,514,586	95	0.007	118,539,248	0.67	119,741,842	117,336,654	601,297
* Ohio Management Unit 2	Fall	Yearling	722,739	9,885,822	40	0.009	38,804,199	0.78	39,483,093	38,125,305	339,447
* Ohio Management Unit 3	Fall	Yearling	603,760	14,597,894	6	0.032	17,953,049	0.64	18,754,100	17,151,997	400,526
Ohio Management Unit 1	Fall	YOY	432,195	6,696,432	262	0.035	119,953,132	0.49	120,600,189	119,306,074	323,529
Ontario Management Unit 1	Summer	YOY	83,870	9,825,934	679	0.074	66,773,664	0.39	66,930,532	66,616,796	78,434
* Ohio Management Unit 2	Summer	YOY	1,242,115	12,109,953	64	0.091	91,545,319	0.55	93,745,338	89,345,300	1,100,009
Mean			719,349	9,448,069	147	0.028	71,700,947	0.66	72,491,544	70,910,351	395,298
Standard Error							15,801,970				

Management Unit 3

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age 2 estimate	R-squared	Upper Age 2 estimate	Lower Age 2 estimate	SE
Ohio Management Unit 2	Summer	Yearling	93,298	4,206,418	855	0.025	83,986,657	0.54	84,115,508	83,857,807	64,425
Inner Long Point Bay Management Unit 4	Fall	Yearling	727,166	2,329,821	2	0.024	3,493,287	0.54	3,584,947	3,401,627	45,830
* Ohio Management Unit 2	Summer	YOY	332,730	3,619,428	64	0.048	24,898,077	0.67	25,360,890	24,435,265	231,406
Ontario Management Unit 1	Summer	YOY	19,425	4,048,551	679	0.097	17,238,126	0.34	17,277,839	17,198,413	19,857
Mean			293,155	3,551,055	400	0.048	32,404,037	0.52	32,584,796	32,223,278	90,380
Standard Error							17,755,146				

Management Unit 4

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age 2 estimate	R-squared	Upper Age 2 estimate	Lower Age 2 estimate	SE
New York Management Unit 4	Fall	YOY	18,098	608,618	24	0.076	1,044,780	0.38	1,080,357	1,009,202	17,074
Mean			18,098	608,618	24	0.076	1,044,780	0.38	1,080,357	1,009,202	17,074
Regression Model Standard Error							17,074				

* This data was blocked by depth stratum

Appendix B Table B-2 Arithmetic index values from lakewide trawl surveys

Arithmetic

Year	nbs10a	nbf10a	onts10a	Nyf4oa	Ohs1oa	Ohs20a	Ohs30a	Ohf10a	Ohf20a	Ohf30a	pal30a	Ohi10a	onti10a	inTwb0a	nbs11a	nbf11a	onts11a	Nyf41a
1980	-	-	-	-	122.0	-	-	663.7	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	29.5	-	-	110.6	-	-	-	-	-	-	-	-	-	-
1982	-	-	905.6	-	359.1	-	-	854.0	-	-	-	-	-	-	-	-	25.1	-
1983	26.4	24.0	3.3	-	30.5	-	-	5.8	-	-	3104.0	-	-	-	50.7	37.1	120.8	-
1984	32.6	48.8	3020.8	-	138.3	-	-	110.0	-	-	256.0	-	-	-	8.3	18.2	0.6	-
1985	49.4	61.0	521.7	-	26.1	-	-	39.0	-	-	508.0	-	-	-	32.2	24.4	769	-
1986	1285.7	81.9	1754.5	-	1143.7	-	-	61.5	-	-	276.0	-	-	-	151.4	67.9	7.9	-
1987	0.0	13.3	0.7	-	20.0	-	-	18.0	-	-	12536.0	20.0	0.7	10.8	-	49.8	21.4	-
1988	0.0	90.5	328.7	-	145.9	-	-	35.0	-	-	48.0	145.8	328.7	224.5	-	12.4	15.6	-
1989	143.6	24.8	788.4	-	107.2	-	-	113.5	-	-	1436.0	107.2	788.7	447.9	13.9	7.1	11.6	-
1990	61.8	121.5	739.9	-	145.5	13.4	5.1	330.0	69.9	42.5	20.0	145.5	739.8	458.8	24.7	9.1	62.5	-
1991	741.9	108.6	111.4	-	139.3	25.3	20.6	61.8	22.3	2.7	3520.0	141.2	111.4	126.1	29.3	20.6	89.6	-
1992	28.0	93.3	271.7	23.0	65.4	37.5	131.5	91.5	71.4	51.8	332.0	65.4	271.7	164.4	6	25.3	34.8	5
1993	321.7	137.7	766.9	222.4	1261.0	475.0	412.5	274.5	20.0	31.6	396.0	1261.0	766.9	1052.5	20.6	4	126	6.2
1994	3284.6	111.4	887.7	102.9	526.5	658.6	807.3	289.4	124.5	28.3	5904.0	526.5	887.7	702.5	44	40.8	105.6	18.7
1995	2046.4	25.4	1337.8	12.0	348.0	16.5	55.3	81.6	8.0	26.7	524.0	348.0	1337.8	815.4	221.8	22.9	162.5	30.9
1996	8257.8	501.4	3309.9	232.1	3284.9	2721.8	5211.4	644.2	347.0	330.1	7292.0	3284.9	3309.9	3296.2	4.9	4.7	352.3	0.7
1997	190.7	42.7	109.9	0.4	58.2	79.0	-	37.2	24.6	7.9	0.0	58.2	109.9	81.2	43.6	44.7	63.9	12.4

Year	Ohs11a	Ohs21a	Ohs31a	Ohf11a	Ohf21a	Ohf31a	Ohi11a	onti11a	indexwb1a	bohmu2s0a	bohmu2f0a	bohmu3s0a	bohmu3f0a	bohmu2s1a	bohmu2f1a	bohmu3s1a	bohmu3f1a
1980	-	-	-	191	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	121.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	104.4	-	-	-	-	-	105.9	21.4	64.5	-	-	-	-	-	-	-	-
1988	12.6	-	-	-	-	-	12.6	15.6	13.9	-	-	-	-	-	-	-	-
1989	15.7	-	-	-	-	-	15.7	11.6	13.7	-	-	-	-	-	-	-	-
1990	26.4	352.2	43.5	-	23.3	7.5	26.4	62.5	45.4	13.4	69.9	5.1	42.5	352.2	23.3	43.5	7.5
1991	31.1	156.6	195.4	0.0	33.5	15.6	35	89.6	63	13.5	18.4	23.4	3.1	148.5	31.0	209.0	16.4
1992	12.9	28.1	21.4	1	20.8	0.6	12.9	34.8	23.4	37.5	72.5	156.3	47.3	28.1	20.6	16.8	0.5
1993	19.6	213.1	102.1	4.8	22.8	6.8	19.6	126	65.4	318.8	22.0	546.9	32.9	179.6	23.5	125.6	7.0
1994	78.2	36.2	98.4	97.4	5.8	2.2	78.2	105.0	91.8	743.3	126.8	992.1	24.3	31.0	5.9	121.1	2.6
1995	167.8	111	105.4	0.2	180.4	87.5	167.8	162.5	165.3	18.3	8.4	70.6	32.9	101.1	160.2	119.7	75.4
1996	105.5	31.6	8.8	121.5	35	9.9	105.5	352.3	216.8	2826.4	368.6	2396.0	233.5	40.4	36.3	4.3	7.2
1997	175.4	1848		156.9	402.1	129.4	174.6	63.9	125.4	93.0	12.8	-	7.1	2116.8	481.1	-	131.0

Appendix B: Table B-5 Geometric index values from lakewide trawl surveys

Geometric year	nbs10g	nbf10g	onts10g	Nyf40g	Ohs10g	Ohs20g	Ohs30g	Ohf10g	Ohf20g	Ohf30g	paf30g	alp0g	ilp0g	alp1g	ilp1g	nbs11g	nbf11g	onts11g
1980	-	-	-	-	10.5	-	-	69	-	-	-	11.8	77.5	25.7	69.0	-	-	-
1981	-	-	-	-	3	-	-	7.9	-	-	23	21.6	357.4	1.7	29.9	-	-	-
1982	-	-	49.4	-	30	-	-	31.6	-	-	26	7.9	229.5	4.1	16.0	-	-	4.2
1983	15.9	16.2	1.4	-	2	-	-	2.2	-	-	0.9	-	25.6	-	-	25.1	27.6	16.1
1984	23.1	32.7	118.5	-	16.3	-	-	5.3	-	-	385	57	414.8	1.4	16.0	7.3	14.5	0.2
1985	23	47.1	36	-	7	-	-	3.9	-	-	4	0.7	6	5.6	32.7	15.8	20.3	38.2
1986	891.7	63.8	66.5	-	155.8	-	-	7.6	-	-	125	38.5	465.4	0.3	3.8	118.9	44.9	1.1
1987	-	10.8	0.5	-	4.3	-	-	4.1	-	-	25	1.1	0.7	10.8	2.6	0.0	35.0	3.6
1988	-	58.5	88.6	-	17.1	-	-	3.6	-	-	40	47.3	73.4	0.4	0.8	0.0	9.6	7.2
1989	104.7	17.8	126.5	-	20.4	-	-	18.8	-	-	0.9	18	70	6.8	6.4	12.0	6.0	5.4
1990	39.3	62.2	11.5	-	42.8	1.4	0.2	54.1	16.8	5	3	8.2	27.2	3.4	8.9	19.4	7.1	29.6
1991	120.2	98.6	41.3	-	20.1	0.9	0.9	14.4	3.9	0.8	5	2	8	0.5	2.8	16.4	13.4	36.9
1992	18.2	52.3	27.4	4.4	12.2	7.3	9.6	10.2	8.4	16.2	50	6.1	46.5	1.4	3.3	5.7	19.1	17.9
1993	108.9	52	80.2	54.9	86.8	8.1	14.2	24	8.1	11.7	38	6.2	19.2	1.2	5.8	16.2	4.0	29.0
1994	748.2	68.3	243.2	12.8	64.6	13.5	4.8	35.6	18.7	7.5	172	26.4	13.2	3.3	3.8	23.6	30.1	42.7
1995	495.5	16.2	51.9	4.9	26.3	1.1	6.8	30.6	2.9	11.6	20	2.4	1.2	10.4	5.4	65.1	11.5	28.3
1996	7545.1	100.7	679	24.1	575.2	61	53.4	262.1	95	76.7	215	36.8	12.6	1.0	2.0	2.4	2.5	72.8
1997	15	7.5	11.4	0.1	10.8	3.5	0	5.9	2.1	2	-	2.6	3.1	4.5	1.6	19.3	8.9	21.5

year	Nyf41g	Ohs11g	Ohs21g	Ohs31g	Ohf11g	Ohf21g	Ohf31g	bolunu2s0g	bolunu2f0g	bolunu3s0g	bolunu3f0g	bolunu2s1g	bolunu2f1g	bolunu3s1g	bolunu3f1g
1980	-	-	-	-	10.4	-	-	-	-	-	-	-	-	-	-
1981	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	9.6	25.2	4.4	-	18.2	3.6	4.4	16.6	0.2	5.0	25.2	18.2	4.4	3.8
1991	-	10.6	9.4	1.6	0.2	19.6	6.6	0.4	3.1	1.2	0.9	7.6	17.2	1.3	6.5
1992	1.6	2.0	2.9	3.1	0.2	6.8	0.2	7.3	7.6	29.6	14.2	2.9	6.9	2.3	0.2
1993	2.1	6.6	59.9	8.8	0.2	6.9	2.7	4.4	9.3	20.1	12.0	66.1	5.7	12.2	2.7
1994	2.6	18.2	4.9	2.4	22.7	1.3	0.4	16.5	24.0	6.6	6.9	3.8	1.3	3.4	0.5
1995	9.6	16.4	19.5	18.5	0.1	15.8	35.1	1.1	2.4	9.7	16.1	14.2	34.4	17.2	35.1
1996	0.2	32.7	2.7	1.2	32.1	5.4	3.2	61.0	112.6	26.5	42.5	2.5	4.7	0.6	2.4
1997	1.5	45.3	655.1	-	42.9	42.2	7.5	3.6	2.1	-	2.0	1069.2	40.0	-	5.6

Appendix E: Legend. Lakewide trawl indices and codes used in Appendix E

Arithmetic Trawl Series	Abbreviation
USGS Management Unit 1 summer age 0 arithmetic	nbs10a
USGS Management Unit 1 fall age 0 arithmetic	nbf10a
Ontario Management Unit 1 summer age 0 arithmetic	onts10a
New York Management Unit 4 fall age 0 arithmetic	Nyf4oa
Ohio Management Unit 1 summer age 0 arithmetic	Ohs1oa
Ohio Management Unit 2 summer age 0 arithmetic	Ohs20a
Ohio Management Unit 3 summer age 0 arithmetic	Ohs30a
Ohio Management Unit 1 fall age 0 arithmetic	Oh1f0a
Ohio Management Unit 2 fall age 0 arithmetic	Ohf20a
Ohio Management Unit 3 fall age 0 arithmetic	Ohf30a
Pennsylvania Management Unit 3 fall age 0 arithmetic	paf30a
Ohio Management Unit 1 Interagency age 0 arithmetic	Ohi10a
Ontario Management Unit 1 Interagency age 0 arithmetic	onti10a
Ontario-Ohio pooled Management Unit 1 Interagency age 0 arithmetic	inTwb0a
USGS Management Unit 1 summer age 1 arithmetic	nbs11a
USGS Management Unit 1 fall age 1 arithmetic	nbf11a
Ontario Management Unit 1 summer age 1 arithmetic	onts11a
New York Management Unit 4 fall age 1 arithmetic	Nyf41a
Ohio Management Unit 1 summer age 1 arithmetic	Ohs11a
Ohio Management Unit 2 summer age 1 arithmetic	Ohs21a
Ohio Management Unit 3 summer age 1 arithmetic	Ohs31a
Ohio Management Unit 1 fall age 1 arithmetic	Ohf11a
Ohio Management Unit 2 fall age 1 arithmetic	Ohf21a
Ohio Management Unit 3 fall age 1 arithmetic	Ohf31a
Ohio Management Unit 1 Interagency age 1 arithmetic	Ohi11a
Ontario Management Unit 1 Interagency age 1 arithmetic	onti11a
Ontario-Ohio pooled Management Unit 1 Interagency age 1 arithmetic	indexwb1a
Ohio Management Unit 2 summer age 0 arithmetic block depth strata	bohmu2s0a
Ohio Management Unit 2 fall age 0 arithmetic block depth strata	bohmu2f0a
Ohio Management Unit 3 summer age 0 arithmetic block depth strata	bohmu3s0a
Ohio Management Unit 3 fall age 0 arithmetic block depth strata	bohmu3f0a
Ohio Management Unit 2 summer age 1 arithmetic block depth strata	bohmu2s1a
Ohio Management Unit 2 fall age 1 arithmetic block depth strata	bohmu2f1a
Ohio Management Unit 3 summer age 1 arithmetic block depth strata	bohmu3s1a
Ohio Management Unit 3 fall age 1 arithmetic block depth strata	bohmu3f1a

Appendix C. An Alternative Assessment of the Yellow Perch 1995 Cohort

The YPTG, STC and LEC discussed the issue of assessment of the strength of the 1995 year class of yellow perch in Unit 1, Unit 2 and Unit 3. Documentation and statistical analysis are presented in accompanying text, table and figures.

1. In 1996, from agency trawl regressions, the 1995 cohort was predicted to be 16.426, 22.427, and 4.136 million fish for Unit 1, Unit 2 and Unit 3 respectively.

After the '95 year class appeared in the fishery in 1997, CAGEAN estimated the age 2 population to be 2.924, 9.988, and 5.975 million fish for Unit 1, Unit 2, and Unit 3, respectively. The estimations are much less than predicted from trawl index regression models of recruitment for Unit 1 and Unit 2. When the 1998 CAGEAN estimate is plotted on graphs with trawl indices (combined interagency) it shows up as being an outlier. When the 1997 data are included, the interagency regression is no longer significant. CAGEAN age 2 estimates are known to be less precise; after the cohort has been in the fishery, the accuracy of the cohort estimate at age 2 improves as more fishing history develops. For these reasons, the most recent CAGEAN age 2 estimates have not been used in regressions to project 2-year-old abundance.

2. Index fishing surveys have been used in the past to develop recruitment forecasts for walleye and perch.

In 1998, we are in a unique position of having a time series of index fishing data for age 2 yellow perch that we can calibrate as an estimator of year class strength by regression of CAGEAN age 2 estimates on the index fishery CPUE. These data are related according to the catch equation:

$$\text{Catch} = N * q * E,$$

where N = population size, q = catchability and E = effort, organized as

$$N = \text{Catch}/(q*E) \quad \text{or} \quad N = (1/q)* C/E$$

where C/E = catch per effort for age 2 fish (as geometric mean) from the Partnership index surveys,

and N = CAGEAN estimates of age 2 cohort size.

Appendix E: Legend (continued). Lakewide trawl indices and codes used in Appendix E.

Geometric Trawl Series	Abbreviation
USGS Management Unit 1 summer age 0 geometric	nbs10g
USGS Management Unit 1 fall age 0 geometric	nbf10g
Ontario Management Unit 1 summer age 0 geometric	onts10g
New York Management Unit 4 fall age 0 geometric	Nyf4og
Ohio Management Unit 1 summer age 0 geometric	Ohs10g
Ohio Management Unit 2 summer age 0 geometric	Ohs20g
Ohio Management Unit 3 summer age 0 geometric	Ohs30g
Ohio Management Unit 1 fall age 0 geometric	Oh1f0g
Ohio Management Unit 2 fall age 0 geometric	Ohf20g
Ohio Management Unit 3 fall age 0 geometric	Ohf30g
Pennsylvania Management Unit 3 fall age 0 geometric	paf30g
Outer Long Point Bay Mangement Unit 4 age 0 geometric	olp0g
Inner Long Point Bay Mangement Unit 4 age 0 geometric	ilp0g
Outer Long Point Bay Mangement Unit 4 age 0 geometric	olp1g
Inner Long Point Bay Mangement Unit 4 age 0 geometric	ilp1g
USGS Management Unit 1 summer age 1 geometric	nbs11g
USGS Management Unit 1 fall age 1 geometric	nbf11g
Ontario Management Unit 1 summer age 1 geometric	onts11g
New York Management Unit 4 fall age 1 geometric	Nyf41g
Ohio Management Unit 1 summer age 1 geometric	Ohs11g
Ohio Management Unit 2 summer age 1 geometric	Ohs21g
Ohio Management Unit 3 summer age 1 geometric	Ohs31g
Ohio Management Unit 1 fall age 1 geometric	Ohf11g
Ohio Management Unit 2 fall age 1 geometric	Ohf21g
Ohio Management Unit 3 fall age 1 geometric	Ohf31g
Ohio Management Unit 2 summer age 0 geometric block depth strata	bohmu2s0g
Ohio Management Unit 2 fall age 0 geometric block depth strata	bohmu2f0g
Ohio Management Unit 3 summer age 0 geometric block depth strata	bohmu3s0g
Ohio Management Unit 3 fall age 0 geometric block depth strata	bohmu3f0g
Ohio Management Unit 2 summer age 1 geometric block depth strata	bohmu2s1g
Ohio Management Unit 2 fall age 1 geometric block depth strata	bohmu2f1g
Ohio Management Unit 3 summer age 1 geometric block depth strata	bohmu3s1g
Ohio Management Unit 3 fall age 1 geometric block depth strata	bohmu3f1g

8. Relationships between Partnership indices and CAGEAN age 2 population estimates

The relationship between Partnership index fishing values for age 2 yellow perch and CAGEAN estimates of 2-year-old yellow perch was examined by least squares regression. The geometric mean catch of age 2 perch per bottom set from the western basin index was compared to CAGEAN population estimates (long run series) of 2-year-olds for Unit 1 from 1990-1996. The same comparison was done for the west-central basin index and Unit 2 while the east-central basin index was compared to CAGEAN estimates for Unit 3 from 1989 to 1995 (the study was not done in 1996). This process was repeated, using the geometric mean CPUEs, geometric mean CPUEs fitted through the origin, and arithmetic mean catch per set (canned & bottom).

There was a strong correlation between the geometric mean catch (numbers) per bottom set and the CAGEAN (long run) estimates for age 2 yellow perch for the western basin/Unit 1 (r^2=0.98, P=0.00003) and the west-central basin/Unit 2 (r^2=0.93, P=0.0004). The relationship between the age 2 index from the east-central basin and Unit 3 CAGEAN estimates was not as strong (r^2=0.40, P=0.125).

Confidence intervals for predictions from regressions are closest near the data means, and become wider moving away from the means. The estimate of recruitment of the age 2 cohort in Unit 1 is made using an index that is near the middle of the regression model, and is estimated at 14.555 million age 2 yellow perch (Figure C-1). The estimate for Unit 2 is made from an index value that is larger than any used in the regression. If the regression was refitted as a curvilinear model, it likely shows asymptotic behavior approximating a cohort size of 25-30 million age 2 yellow perch (Figure C-2). We have used curvilinear fitting instead of linear because they tend to give more conservative estimates and have used the midpoint of this range as a cohort estimate. The estimate for Unit 3 is made from an index of 71.9 that is much outside the range of the data (maximum ~ 32). In addition, the data show indication of an asymptotic relationship, such that the cohort size may be leveling off around 8.0 million fish (Figure C-3).

We can then take these new calculated values for 1995 cohorts in Units 1-3 and input them into our spreadsheet tables of population abundance and biomass for 1997, and project an alternate scenario for the 1998 population in the yield per recruit spreadsheet table. We have provided Tables 6C and 7C to present this scenario's information that would parallel Tables 6 and 7 in the main body of the report. In Table 7C, we have used age 2 selectivity values of the previous year (as is the typical procedure) because they represent a value in the range of current trends and also are in the range of expected selectivity values when a particularly strong, dominating year class is entering the fishery. We have also calculated new RAH ranges based on this information and they have been presented as Table 8C.

Figure C-1. CAGEAN AGE 2 POPULATION VS PARTNERSHIP DATA
YELLOW PERCH, WESTERN BASIN, SAME YEAR

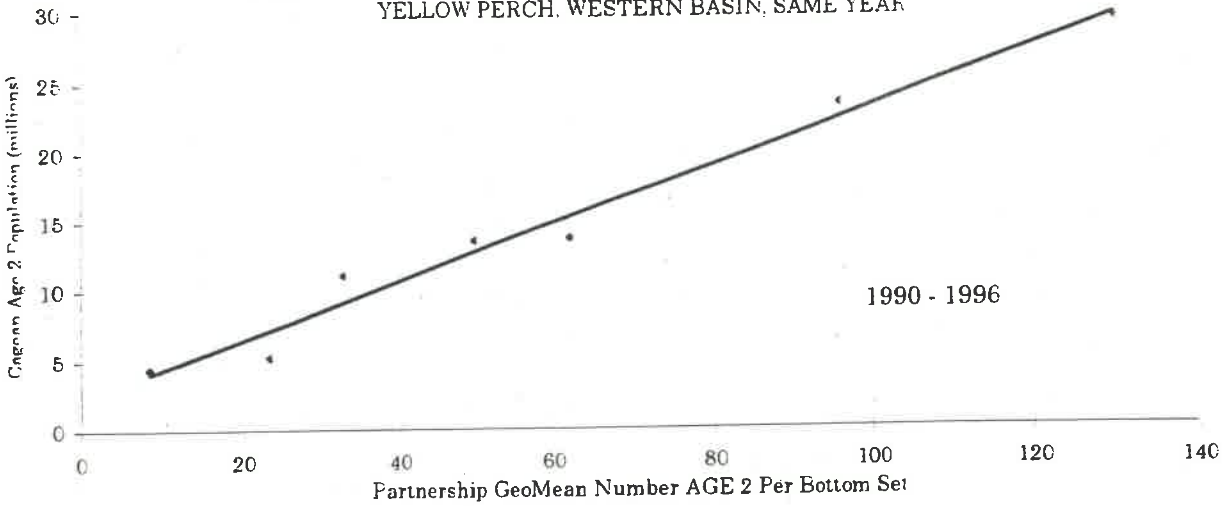

Figure C-2. CAGEAN AGE 2 POPULATION VS PARTNERSHIP DATA
YELLOW PERCH, WEST-CENTRAL BASIN, SAME YEAR

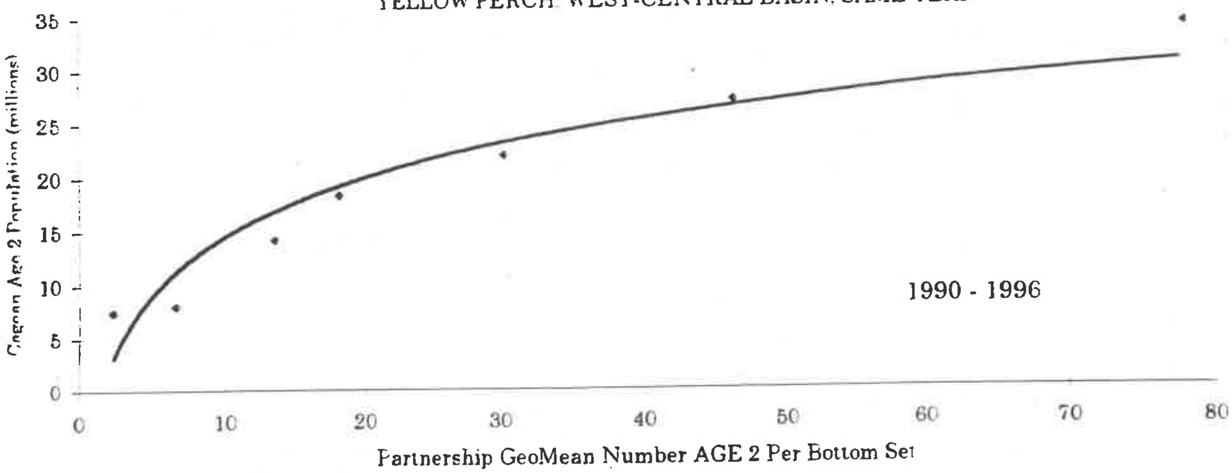

Figure C-3. CAGEAN AGE 2 POPULATION VS PARTNERSHIP DATA
YELLOW PERCH, EAST-CENTRAL BASIN, SAME YEAR

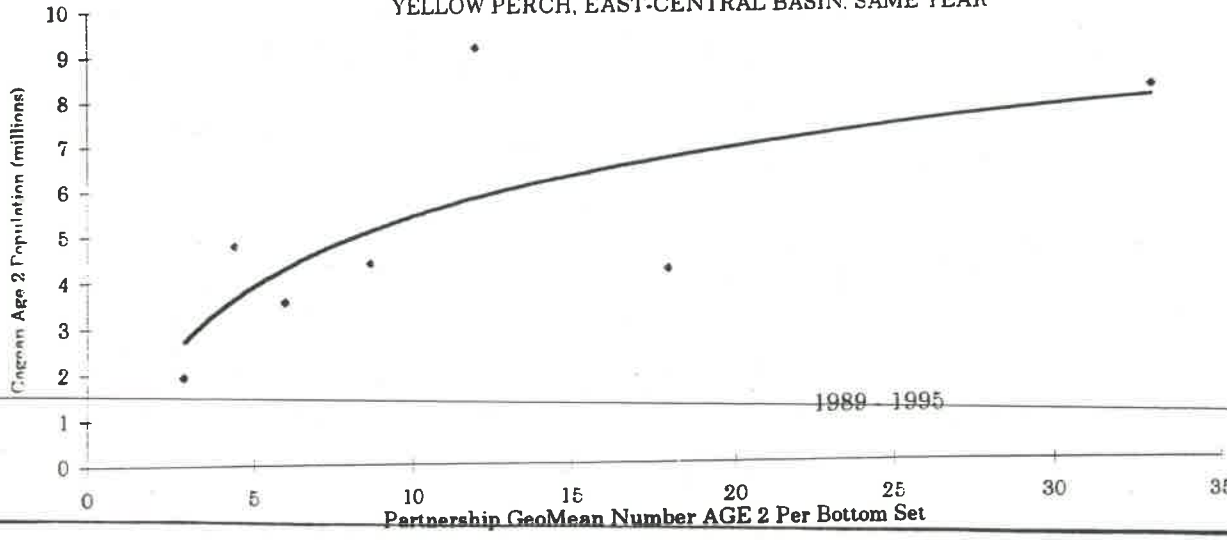

Table 6C: Projection of the 1998 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN*. 1998 age 2 estimates are derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices. CV is coefficient of variation in stock size for the last year of CAGEAN runs.
* The age 2 cohorts in 1997 parameters for Units 1-3 are estimated from Partnership gill net regressions.

			1997 Parameters				Rate Functions					1998 Parameters					Stock Biomass		
			Stock Size (numbers)				Mortality Rates				Survival Rate		Stock Size (numbers)			Mean Weight in	(millions kg)		(millions lbs.)
	CV	Age	Mean	Std. Err.	Min.	Max.	(F)	(Z)	(A)	(u)	(S)	Age	Mean	Min.	Max.	Pop. (kg)	1997	1998	1998
Unit 1		2	14.556	5.563	8.993	20.119	0.122	0.522	0.407	0.095	0.593	2	79.310	47.304	111.316	0.058	1.310	4.600	10.143
	0.242	3	15.152	3.707	11.445	18.859	0.569	0.969	0.621	0.364	0.379	3	8.637	5.336	11.937	0.086	1.657	0.743	1.638
		4	7.640	1.869	5.771	9.509	0.676	1.076	0.659	0.414	0.341	4	5.749	4.343	7.156	0.124	0.975	0.713	1.572
		5	1.316	0.322	0.994	1.637	0.676	1.076	0.659	0.414	0.341	5	2.605	1.968	3.242	0.214	0.203	0.557	1.229
		6+	0.299	0.073	0.226	0.372	0.471	0.871	0.581	0.314	0.419	6+	0.574	0.433	0.714	0.395	0.081	0.227	0.500
		Total	38.962	9.532	29.430	48.494	0.397	0.797	0.549	0.273	0.451	Total	96.875	59.384	134.366		4.226	6.840	15.082
		(3+)	24.406	5.971	18.435	30.377	0.606	1.006	0.634	0.382	0.366	(3+)	17.565	12.080	23.050		2.916	2.240	4.939
Unit 2		2	27.500	7.402	20.098	34.902	0.187	0.587	0.444	0.141	0.556	2	71.701	55.899	87.503	0.077	2.612	5.521	12.174
	0.202	3	20.118	4.066	16.052	24.184	0.710	1.110	0.670	0.429	0.330	3	15.290	11.174	19.405	0.117	2.682	1.789	3.945
		4	3.394	0.686	2.708	4.079	0.854	1.254	0.715	0.487	0.285	4	6.630	5.290	7.970	0.169	0.509	1.120	2.471
		5	1.352	0.273	1.079	1.626	0.854	1.254	0.715	0.487	0.285	5	0.968	0.773	1.164	0.280	0.247	0.271	0.598
		6+	0.377	0.076	0.301	0.454	0.373	0.773	0.538	0.260	0.462	6+	0.560	0.447	0.673	0.407	0.091	0.228	0.503
		Total	52.742	10.659	42.083	63.401	0.411	0.811	0.555	0.281	0.445	Total	95.150	73.583	116.716		6.142	8.930	19.690
		(3+)	25.242	5.101	20.140	30.343	0.729	1.129	0.677	0.437	0.323	(3+)	23.449	17.684	29.213		3.530	3.409	7.516
Unit 3		2	8.000	6.682	1.318	14.682	0.074	0.474	0.377	0.059	0.623	2	32.404	14.649	50.159	0.062	0.568	2.009	4.430
	0.234	3	5.781	1.352	4.429	7.133	0.541	0.941	0.610	0.351	0.390	3	4.980	0.820	9.140	0.102	0.784	0.508	1.120
		4	1.339	0.313	1.026	1.651	0.541	0.941	0.610	0.351	0.390	4	2.255	1.728	2.782	0.155	0.222	0.350	0.771
		5	1.418	0.332	1.087	1.750	0.541	0.941	0.610	0.351	0.390	5	0.522	0.400	0.644	0.178	0.275	0.093	0.205
		6+	0.478	0.112	0.366	0.590	0.124	0.524	0.408	0.097	0.592	6+	0.836	0.641	1.032	0.305	0.117	0.255	0.562
		Total	17.015	3.979	13.037	20.994	0.283	0.683	0.495	0.205	0.505	Total	40.998	18.238	63.757		1.966	3.215	7.088
		(3+)	9.015	2.108	6.907	11.123	0.514	0.914	0.599	0.337	0.401	(3+)	8.594	3.589	13.598		1.398	1.206	2.658
Unit 4		2	0.205	0.098	0.108	0.303	0.016	0.416	0.340	0.013	0.660	2	1.045	1.009	1.080	0.057	0.013	0.060	0.132
	0.176	3	0.959	0.457	0.502	1.416	0.098	0.498	0.392	0.077	0.608	3	0.135	0.071	0.200	0.092	0.137	0.013	0.028
		4	0.752	0.358	0.394	1.110	0.180	0.580	0.440	0.137	0.560	4	0.583	0.305	0.860	0.120	0.119	0.070	0.154
		5	0.120	0.057	0.063	0.178	0.180	0.580	0.440	0.137	0.560	5	0.421	0.220	0.622	0.173	0.022	0.073	0.161
		6+	0.301	0.143	0.157	0.444	0.021	0.421	0.344	0.017	0.656	6+	0.265	0.139	0.391	0.412	0.068	0.109	0.241
		Total	2.337	1.114	1.224	3.451	0.110	0.510	0.399	0.086	0.601	Total	2.449	1.744	3.153		0.359	0.325	0.716
		(3+)	2.132	1.016	1.116	3.148	0.119	0.519	0.405	0.093	0.595	(3+)	1.404	0.735	2.073		0.346	0.265	0.584

Table 7C. Estimated harvest of Lake Erie yellow perch for 1998. The exploitation rate is derived from optimal yield policy, and the stock size estimates are from CAGEAN and trawl regressions. Stock size and catch in numbers are in millions of fish. Catch weight is presented in millions of kilograms and pounds. Age 3s in Units 1-3 are projected from age 2 cohorts estimated from Partnership gill net regressions.

		Stock Size (numbers)			Exploitation Rate				Catch (millions of fish)			Mean Wt. in Harvest	Catch (millions of kg) - RAH			Catch (millions of lbs) - RAH		
	Age	Mean	Min.	Max.	F(opt)	s(age)	(F)	(u)	Mean	Min.	Max.	(kg)	Mean	Min.	Max.	Mean	Min.	Max.
Unit 1	2	79.310	47.304	111.316	0.519	0.180	0.094	0.074	5.863	3.497	8.229	0.084	0.492	0.294	0.691	1.086	0.648	1.524
	3	8.637	5.336	11.937	0.519	0.842	0.437	0.296	2.556	1.579	3.533	0.104	0.266	0.164	0.367	0.586	0.362	0.810
	4	5.749	4.343	7.156	0.519	1.000	0.519	0.339	1.952	1.474	2.429	0.128	0.250	0.189	0.311	0.551	0.416	0.686
	5	2.605	1.968	3.242	0.519	1.000	0.519	0.339	0.884	0.668	1.101	0.161	0.142	0.108	0.177	0.314	0.237	0.391
	6+	0.574	0.433	0.714	0.519	0.697	0.362	0.253	0.145	0.110	0.181	0.258	0.037	0.028	0.047	0.083	0.062	0.108
	Total	96.875	59.384	134.366					11.400	7.328	15.472	0.104	1.188	0.782	1.593	2.619	1.725	3.518
	(3+)	17.565	12.080	23.050					5.537	3.831	7.243	0.126	0.695	0.489	0.902	1.533	1.078	1.989
Unit 2	2	71.701	55.899	87.503	0.477	0.219	0.104	0.082	5.881	4.585	7.178	0.102	0.600	0.468	0.732	1.323	1.031	1.614
	3	15.290	11.174	19.405	0.477	0.831	0.397	0.273	4.180	3.055	5.305	0.126	0.527	0.385	0.668	1.161	0.849	1.474
	4	6.630	5.290	7.970	0.477	1.000	0.477	0.318	2.106	1.680	2.531	0.143	0.301	0.240	0.362	0.664	0.530	0.798
	5	0.968	0.773	1.164	0.477	1.000	0.477	0.318	0.308	0.245	0.370	0.186	0.057	0.046	0.069	0.126	0.101	0.152
	6+	0.560	0.447	0.673	0.477	0.437	0.208	0.156	0.087	0.070	0.105	0.255	0.022	0.018	0.027	0.049	0.039	0.059
	Total	95.150	73.583	116.716					12.562	9.636	15.489	0.120	1.507	1.156	1.858	3.323	2.550	4.097
	(3+)	23.449	17.684	29.213					6.681	5.050	8.311	0.136	0.907	0.689	1.126	2.001	1.518	2.483
Unit 3	2	32.404	14.649	50.159	0.466	0.137	0.064	0.051	1.652	0.747	2.556	0.113	0.187	0.084	0.289	0.412	0.186	0.637
	3	4.980	0.820	9.140	0.466	1.000	0.466	0.312	1.553	0.256	2.849	0.127	0.197	0.032	0.362	0.435	0.072	0.798
	4	2.255	1.728	2.782	0.466	1.000	0.466	0.312	0.703	0.539	0.867	0.141	0.099	0.076	0.122	0.219	0.167	0.270
	5	0.522	0.400	0.644	0.466	1.000	0.466	0.312	0.163	0.125	0.201	0.167	0.027	0.021	0.034	0.060	0.046	0.074
	6+	0.836	0.641	1.032	0.466	0.229	0.107	0.084	0.070	0.054	0.086	0.246	0.017	0.013	0.021	0.038	0.029	0.047
	Total	40.998	18.238	63.757					4.140	1.719	6.561	0.127	0.527	0.227	0.828	1.163	0.500	1.825
	(3+)	8.594	3.589	13.598					2.488	0.973	4.004	0.137	0.341	0.142	0.539	0.751	0.314	1.188
Unit 4	2	1.045	1.009	1.080	0.391	0.089	0.035	0.028	0.029	0.028	0.030	0.106	0.003	0.003	0.003	0.007	0.007	0.007
	3	0.135	0.071	0.200	0.391	0.544	0.213	0.159	0.022	0.011	0.032	0.121	0.003	0.001	0.004	0.006	0.003	0.008
	4	0.583	0.305	0.860	0.391	1.000	0.391	0.270	0.157	0.082	0.232	0.130	0.020	0.011	0.030	0.045	0.024	0.067
	5	0.421	0.220	0.622	0.391	1.000	0.391	0.270	0.114	0.060	0.168	0.137	0.016	0.008	0.023	0.034	0.018	0.051
	6+	0.265	0.139	0.391	0.391	0.117	0.046	0.037	0.010	0.005	0.014	0.161	0.002	0.001	0.002	0.003	0.002	0.005
	Total	2.449	1.744	3.153					0.332	0.187	0.477	0.131	0.043	0.024	0.063	0.096	0.053	0.188
	(3+)	1.404	0.735	2.073					0.303	0.158	0.447	0.133	0.040	0.021	0.059	0.089	0.046	0.131

Table 8C. Lake Erie yellow perch harvest estimates for 1998. All estimates are based on CAGEAN outputs, the Partnership gill net regression for 1997 age 2s in Units 1-3, and the F(opt) fishing strategy. The model estimates the 1996 year class recruiting into the fishery in 1998 by parametric regression (Regression Model). Harvest and TAC from 1997 is included for comparative purposes.

1998 Yield (Millions of Pounds)

	RAH		
	Mean	Min.	Max.
Unit 1	2.6	1.7	3.5
Unit 2	3.3	2.5	4.1
Unit 3	1.2	0.5	1.8
Unit 4	0.10	0.05	0.14
Total	7.2	4.8	9.6

1997 fishery (mil lbs.)

Harvest	TAC	RAH	RAH Range
2.274	2.4	1.9	1.4 - 2.4
2.906	3.6	2.9	2.2 - 3.6
1.072	1.2	1.1	0.5 - 1.6
0.042	0.2	0.2	0.1 - 0.3
6.294	7.4	6.1	4.2 - 7.9

1998 Yield (Millions of Kilograms)

	RAH		
	Mean	Min.	Max.
Unit 1	1.2	0.8	1.6
Unit 2	1.5	1.2	1.9
Unit 3	0.5	0.2	0.8
Unit 4	0.04	0.02	0.06
Total	3.3	2.2	4.3