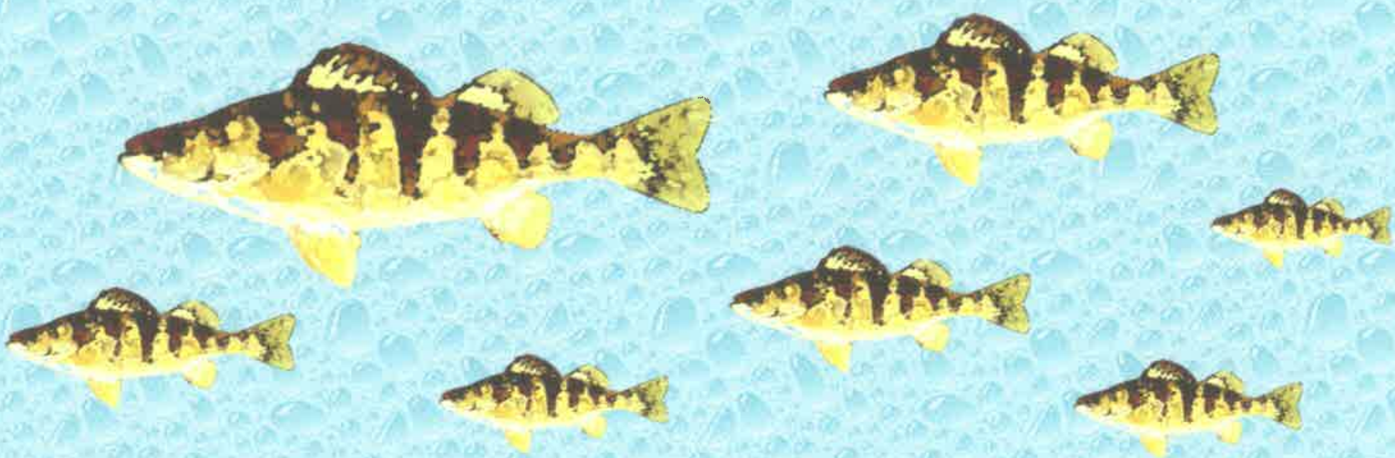
Report of the Lake Erie Yellow Perch Task Group

March 2000



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Presented to: Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Introduction

In 1999, the Lake Erie Committee assigned the Yellow Perch Task Group (YPTG) six charges. 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 and recruitment indices of yellow perch. Another charge assigned to the YPTG, a determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie, was examined in greater detail this year. The fourth charge on which we will report examines the potential for genetic research on Lake Erie yellow perch stocks. Two new charges were given to the task group in 1999: (1) Investigate independent management of yellow perch stocks in the Eastern Basin of Lake Erie (Management Unit 4), and (2) Investigate yellow perch bioenergetics.

1999 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1999 totaled 5.698 million pounds (2,584 metric tonnes or 2.584 million kgs), which was a 3% decrease over the 1998 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 (pounds) increased over 1998 levels for Ohio (+19%) and New York (+2%), but declined for Ontario (-13%), Michigan (-23%), and Pennsylvania (-29%).

In comparison with 1998, each agency's proportion of the lakewide harvest (in pounds) changed only slightly. Ohio's proportion increased from 32% to 39% of the lakewide harvest, Ontario's proportion decreased from 65% to 59%, Michigan's remained at 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 1988-1999 by management unit, year, agency, and gear type in Table 2, parts a through d. Trends over a longer time series (1975-1999) are depicted graphically for harvest (Figure 2), fishing effort (Figure 3), and catch rates (Figure 4) by management unit and gear type. Harvest summed by management unit showed minor decreases in Units 1 (-10%) and 3 (-8%), and a minor increase (+5%) in Unit 2. Unit 4 harvest exhibited an increase for the third consecutive year (+25%, but the actual numerical increase was small). Unit 4 fisheries exhibited the largest harvest since were: Unit 1, 2.3 million pounds; Unit 2, 3.0 million pounds; Unit 3, 1.1 million pounds; Unit 4, 0.1 million pounds. The YPTG RAH mean values from CAGEAN and age-2 regression estimates were identical to the TAC. The 1999 harvest of Lake Erie yellow perch in each management unit did not exceed total allowable catch set by the Lake Erie Committee. The 1999 harvest amounts, in millions of pounds by management unit, were: Unit 1, 2.058 million pounds; Unit 2, 2.547 million pounds; Unit 3, 1.027 million pounds; and Unit 4, 0.065 million pounds. The 1999 Lake Erie yellow perch fisheries attained (calculated from exact harvest values in Table 1) 89% of TAC in Unit 1, 85% of TAC in Unit 2, 93% of TAC in Unit 3 and 65% of TAC in Unit 4.

Stock Assessment

Age and Growth

After years of inconsistent recruitment in the late 1980's and early 1990's, the 1993 and 1994 year classes were strong and helped turn around the declining yellow perch population. These two year classes entered the fisheries strong in 1996, dominated the fisheries in Management Units 1 through 3 during 1997, and remained in the fisheries in 1999. In Unit 1, the 1995 year class still is showing some strength. Poor growth due to shorter growing seasons led to the underestimation of the 1995 year class strength in 1997. The 1996 year class, strong by current measures, did not fully recruit to all the fishery gear even in 1999. This year class rebounded from a weaker showing the previous year due to reduced growth of these fish and selectivity of fishery gear. This trend was apparent again this year and may have led to the underestimation of the strength of the 1996 year class in CAGEAN runs, particularly in the Western Basin. In all Units, the 1996 year class, then the 1995 and 1994 year classes were strong contributors in the harvest (Table 3). The 1997 year class was predicted by our recruitment-regression module to be one of the weakest in recent times. Selectivity by the fisheries to larger and older fish may also have caused a bias in the CAGEAN estimates of this year class. Relatively speaking, it still performed as expected, with low percentages of age 2 fish showing up in the harvest. In all management units, we can point to the contribution of three moderate to strong year classes and potential recruitment of two moderate year classes (1998 and 1999) as a sign that recovery of the yellow perch population continues. We must temper our enthusiasm by the apparent weakness of the 1997 year class.

In examination of the growth of both the 1995 and 1996 year classes, we observed that length and weight across ages were substantially below mean values or recent trends since about 1988 (Appendix A). Concerned that overall lake productivity might be affecting yellow perch growth, condition, maturity and ultimately recruitment into the fishery, we investigated this issue further. There appears to be a downward trend for growth of older yellow perch in Unit 1. However, there was no apparent decreasing trend in condition for Lake Erie yellow perch. This variation may be attributed to abiotic and/or biotic factors associated with the lake and their effects on the food web. Because these fish are sampled in the fall, there may also be strong selection by the fisheries for faster growing individuals for younger age groups. We will monitor this trend in the future and quantify its effect on the population.

The 1997 through 1999 year classes are showing improved growth rates at the early life stages; lengths and weights are at the ten-year mean or higher (Appendix A). Some of the older age groups in the central and eastern basins are also showing some increasing growth trends (at age) for the last two years. Specific age-growth data and the relationship of summer climatic factors were examined again this year. Similar to last year's report (YPTG 1999) summer growth of yellow perch at age 0 and age 1 was positively correlated to summer heat indices such as cooling degree days (sum of daily mean temperature above 65 degrees F).

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 yellow perch growth data and F_{opt} values according to methods previously described (YPTG 1996, 1998), but no changes were made to last year's von Bertalanffy model or F_{opt} values.

Catch-at-Age Analysis (CAGEAN) and Population Estimates

The Yellow Perch Task Group continues to use a version of CAGEAN presented to us by Terry Quinn at a workshop held in the mid 1990s. In an effort to refine these techniques and address new methods for performing this analysis the members of the Yellow Perch Task Group attended an AD model builder workshop held in January 2000 at Cornell University. The workshop taught by Dr. Pat Sullivan and Cliff Kraft examined the use and implementation of catch-at-age analysis using AD Model Builder software and C++ programming language. The advantages of this program are many, including the ability to run models over a longer time series, batch processing of surface response requests, multiple blocking of parameters such as catchability and selectivity, and ability to add survey gear as an additional time series. While the model program is powerful, it is also complex and requires some programming background. To date, the YPTG has begun initial development of an AD Model Builder CAGEAN. Complete data files and a working model run have been completed for each of the four management units; however, there is still some model design, fitting, and ground-truthing to be completed. We will examine this issue in the next year and will build tuned models for all four management units.

CAGEAN 1999/2000

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 harvests in Unit 4 are still valid.

The effort lambda, λ_E , was adjusted for each gear type to equal the ratio of the variance of catch observations to the variance of effort observations. The 1999-2000 CAGEAN model ran efficiently as model iterations were low (usually 3 to 6), no apparent trends were depicted in the residuals, and 40 bootstraps were completed. A three-gear (gill net, trap net and sport angling: harvest-by-age, effort, and weight-at-age) version of the CAGEAN model was used to estimate the 1999 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). A surface response rate exercise to determine the sensitivity of population estimates to variability or error in estimating M showed little variation compared to the overall coefficient of variation (CV) of the population estimate. Growth and recruitment of the slower growing 1995 and 1996 year classes were addressed by blocking selectivity groups for several of the most recent years used in the CAGEAN command files.

Population size and population parameters such as survival and exploitation rates are presented for a stock size estimate that consists of age 2 abundance estimates in 2000 derived from a refined recruitment-regression model (Tables 4 and 5 and Appendix B). Numbers and biomass by management unit are presented for age 2 and older. Population estimates (in numbers of yellow perch) using the regression model are depicted in Figure 5, and biomass estimates are presented in Figure 6.

Backcasting population estimates for 1999 using this year's CAGEAN, and comparing to YPTG (1999) CAGEAN and yield per recruit, stock size estimates of age 3 and older fish were lower than predicted (i.e., they were overestimated last year) in Units 1 (-23%) and 2 (-14%). Estimates of the number of age 3 and older yellow perch in Units 3 (+18%) and 4 (+10%) were higher than values reported last year. Imprecision was due to estimating the 1996 year class and selectivity of fishing gear. In examining backcast estimates of ages 2 and older, last year's CAGEAN and recruitment regression values overestimated the population in all Units (Unit 1, -19%; Unit 2, -27%; Unit 3, -16%; Unit 4, -8%). Error was attributable to overestimates of the 1996 and/or 1997 cohorts. Our original age 2 regression estimates were 13.6 million in Unit 1, 13.0 million in Unit 2, 6.0 million in Unit 3, and 0.8 million in Unit 4. CAGEAN's first read on the 1997 year class estimated 12.544 million in Unit 1, 4.799 million in Unit 2, 1.044 million in Unit 3, and 0.371 million in Unit 4. The 1996 year class, which had exhibited reduced growth early on, became fully recruited to all fishing gear by midyear. Estimates for the 1996 year class declined this year in the latest permutation of CAGEAN. No significant increasing trends in older age groups were apparent.

Age 2+ backcast values of 1999 biomass were slightly lower than last year's YPTG (1999) projections by 7% in Unit 1, 8% in Unit 2, and 13% in Unit 4. Backcast values for 1999 biomass were higher than YPTG (1999) projections by 15% in Unit 3. Backcast estimates decreased the biomass of age 3+ yellow perch in Units 1, 2, and 4; down 11%, 2%, and 14%, respectively. Backcast estimates increased age 3+ biomass in Unit 3 by 36%. Again, most of this imprecision was due to abundance estimates of the not-fully-recruited 1996 year class and a weak 1997 year class. Some differences were apparent due to changes in weight-at-age. Unit 4 imprecision was likely due to the paucity of assessment and experimental samples provided for the model.

In analysis of fishery data, it was apparent that the commercial fishery behaved in a different fashion than the previous few years to capitalize on the larger individuals from the 1995 and 1996 year classes. Fishing pressure early in the season was heavier, and larger mesh sizes (greater than 2¼ inches, but less than 3 inches) were employed to increase selectivity for older fish. This strategy also has effects on the efficiency of CAGEAN. The earlier effort and harvest, larger mesh, and selectivity for older fish during this year would cause an underestimate for age 2 fish that were not as greatly selected. CAGEAN could not account for this within a one-year time block. To remedy this situation, we examined regressions of Ontario Partnership gill nets and Ohio Division of Wildlife bottom trawls against the standing stock of age 2 and age 3 yellow perch from 1988 to 1997 in Management Units 1 through 3 (Figures 7-12). In analysis of these data, we chose to use the model that gave us the best regression model fit (highest R-square for a model with a significant F-test probability of less than .05) between the survey and CAGEAN data within the time series. These estimators would give us an alternate value for age 2 and age 3 yellow perch in each of these management units for 1999. This would provide alternate estimates for age 3 and age 4 yellow perch in 2000 after going through the yield per recruit permutation, as well.

Recruitment Estimator for Incoming Age 2 Yellow Perch

The Yellow Perch Task Group continues 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. The YPTG presents the most significant regression equations used in calculating age 2 yellow perch for the 1998 year class entering the fishery in 2000 in Appendix B, Table B-1. Data from trawl index series for the time period examined are presented in Appendix B, Tables B-2 (geometric means) and B-3 (arithmetic means), while a key summarizing abbreviations used for the trawl series is presented as a Legend in Appendix B. Due to the variability in significant regression indices, the YPTG chose a mean estimator to describe age 2 yellow perch available to the fishery in 2000. Regressions that produced negative slopes or did not have index values for 1998 (age 0) or 1999 (age 1) were also omitted from the analyses.

In general, the 1998 year class is moderately strong, falling between the weaker 1997 year class and the stronger 1996 year class. With improved growth rates *(see Appendix A)*, this year class in the coming two to three years may be a contributor on par with the 1993 through 1995 year classes, in contrast to the poorer year classes of the late 1980's and early 1990's.

2000 Population Size Projection

Stock size estimates for 2000 (age 3 and older) were projected from the CAGEAN 1999 population size estimates and age-specific survival rates in 1999 (Tables 5 and 6). Age 2 recruitment values for the 1998 year class in 2000 (methods described above) were then added into the age 3 and older population size estimates in each unit to give a 2000 population of yellow perch ages 2 and older (Table 6). The YPTG continued to calculate and report standard errors and ranges about our mean estimates for each age similar to the last several years (YPTG 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. Where we employed regression equations for the 1996 and 1997 year class estimates, we calculated the standard errors for the regression equations and entered those values in the corresponding cells in Table 6b.

Stock size abundance estimates for 2000, compared to 1999, using standard CAGEAN estimates and the yield per recruit module for age 2 and older yellow perch show small increases Units 2-4, and small decrease in Unit 1: -5% in Unit 1, +17% in Unit 2, +10% in Unit 3, and +5% in Unit 4 (Tables 4 and 5, Figure 5). Stock size estimates of age 3 and older fish using this same method for 2000 show a moderate to sizable decreases in all management units: -30% in Unit 1, -48% in Unit 2, -46% in Unit 3, and -28% in Unit 4. The estimates changed because of a moderate year class entering at age 2 and a weak year class progressing into age 3, and the possible underestimation of the strength of the 1996 and 1997 year classes (as previously discussed). When examining the alternate stock size projections with the enhanced 1996 and 1997 year class estimates from regressions (Figure 13), populations for 2000 are slightly higher than 1999 in Units 2 (+5%) and 4 (+5%) and lower in Units 1 (-16%) and 3 (-2%).

Biomass estimates for age 2 and older fish using the original CAGEAN and yield per recruit module for the original 2000 projection show declines compared to 1999 levels in all units except a minor increase in Unit 4 (Table 4, Figure 6). This is due to the projections of a moderate 1998 year class, weak 1997 year class, and a not-fully-recruited 1996 year class. Ages 2+ biomass estimates are down 25% in Unit 1, 5% in Unit 2, 16% in Unit 3 and up 3% in Unit 4. Biomass estimates of age 3 and older yellow perch available at the start of 2000 are lower than 1999 in all management units: Unit 1, -37%; Unit 2, -39%; Unit 3, -43%; and Unit 4, -3%. Yellow perch populations in all units will be dominated by fish from the 1996 year class, with the 1995 and 1997 year classes, and to a much smaller extent the 1994 and 1993 year classes persisting in all management units. It is expected that the 1998 year class will contribute about as much as or slightly more than the 1995 year class when it entered the fishery at age 2 several years ago.

Biomass estimates for 2000 using the enhanced estimates of the 1996 and 1997 year classes based on regression estimators in Units 1-3 show declines compared to 1999 levels (Figure 14); however, the magnitude is smaller in Units 1-3. Using this alternate estimator, biomass estimates for ages 2 and older are down 10% in Unit 1, 2% in Unit 2, 10% in Unit 3, and up 3% in Unit 4. Biomass estimates of age 3 and older yellow perch available at the start of 2000 are lower than 1999 in all management units: Unit 1, -22%; Unit 2, -24%; Unit 3, -25%; and Unit 4, -3%.

Survival rates for ages 2 and older perch in 1999 increased in Units 1-3, and declined slightly in Unit 4 (Figure 15). This trend was also exhibited for survival of ages 3 and older yellow perch in Units 2 and 3 (Table 4, Figure 15), but Units 1 and 4 exhibited small declines. Overall survival trends since 1988 show a general (slow) increase in survival across all management units until 1996 when trends show a leveling off (Unit 1) or a decline (Units 2-4).

Exploitation rates for ages 2 and older fish in 1999 decreased substantially in all management units except Unit 4 (Figure 16). This trend is probably due to lower selectivity of age 2 and the slower-growing age 3 fish from the 1997 and 1996 year classes, respectively. Exploitation of age 3 and older yellow perch increased in Units 1 and 4 but decreased in Units 2 and 3 (Figure 16). Overall trends for exploitation showed a slight decreasing trend up until 1996, but are influenced in each management unit independently by periodic spikes that coincide with the entry of strong year classes into the fishery. These values do show annual variation because recruitment is not a steady state entity. There is a concern by the task group that exploitation rates and fishing mortality at age are still above target levels (as specified by mean RAH values calculated under F_{opt} over years of YPTG reports). Exploitation rates must remain under control to sustain recovery in all Units.

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

The basic yield per recruit model used to calculate a recommended harvest in 2000 is similar to that used in 1999. 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 the 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 $F_{0.1}$, is given in previous reports (YPTG 1991, 1995). Without sufficient information that identifies significant growth changes in the last year or in the two-year averages used in yield per recruit calculations, updates to von Bertalanffy inputs and F_{opt} calculations and outputs were not warranted.

The second factor in determining yield per recruit is calculating fishing mortality by age (F_{age}). In previous years (see YPTG 1996, 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. The YPTG again employed the method described in last year's report. 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. Unfortunately, because fisheries act independently (without direct regard to harvest at age) our actual F_{age} seen from the fisheries may be significantly greater than the projected F_{opt}.

The third and fourth factors updated in the yield per recruit calculations are calculating mean weight-at-age in the population (Table 6) and mean weight-at-age in harvest (Table 7). In both cases, the most recent two-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.

The 2000 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 2000 population projection for that age. The harvest in weight is then calculated by multiplying the age specific catch (millions of fish) by mean weight in the harvest (2 year average, 1998-1999).

The 2000 harvest estimates are somewhat lower than those calculated for 1999 and similar to or slightly higher than the observed 1999 harvest. Two dominant factors that will affect the accuracy of the 2000 harvest estimates are: the full recruitment of the 1997 year class (which from our initial CAGEAN indications was very weak) and the entry of a moderate, but faster growing, 1998 year class.

In our exercise of projecting cohorts for 2000, the age structure of yellow perch in Management Units 1-3 have made significant departures from the previous year (1999; see Table 5). This may also point to a discrepancy in selectivity in the 2000 yield per recruit model, since typically we carry over selectivity from that seen in the previous year. The YPTG has chosen to include a selectivity scenario that incorporates a year of similar age structure within the 1975 to 1998 time series independently for each management unit. The years chosen for the analyses were: 1990 for Unit 1, 1988 for Unit 2, 1996 for Unit 3, and 1999 for Unit 4. These values for selectivity are presented in Table 7c.

Recommended Allowable Harvest

In 1999, the Lake Erie Committee adopted a (YPTG recommended) lakewide harvest of 6.5 million pounds of yellow perch. The lakewide RAH range recommended by the YPTG for 1999 was 4.5 to 8.3 million pounds lakewide. The 1999 lakewide harvest was 5.690 million pounds. The YPTG and the LEC presented TAC (Total Allowable Catch) for 1999 by management unit. Allocation for Unit 1 was 2.3 million pounds, and harvest was 2.050 million pounds. Allocation for Unit 2 was 3.0 million pounds, and harvest was 2.547 million pounds. Allocation for Unit 3 was 1.1 million pounds, and harvest was 1.027 million pounds. Allocation for Unit 4 was 0.1 million pounds, and harvest was 0.065 million pounds.

The Yellow Perch Task Group is aware that continued health of yellow perch stocks in all management units hinges on the progression of the 1996 and 1998 year classes to fully reproductive ages and sizes. Recovery signs (increased abundance, biomass and survival, reduced exploitation and production of good year classes) were evident through 1999 in Units 1, 2 and 3, but may be handed a setback with increased exploitation well above F_{opt} and the full recruitment of a weak 1997 year class. Strong year classes are not yet apparent in Unit 4, meaning recovery there has not progressed as well, compared to the other management units. The task group is also aware of the problems of ultraconservative TAC estimates that could be generated by under-representing the age 2 and 3 cohorts and compounding the problem in yield per recruit calculations for the subsequent year. The task group also recognizes and supports plans to rehabilitate the Eastern Basin yellow perch stocks through the OMNR Eastern Basin 5-year management plan.

The Yellow Perch Task Group recommends adopting a 2000 harvest distribution by YPTG Management Unit in the range of values found in Table 8. We have chosen a specific scenario for each management unit independently based on the best fit of indicators and CAGEAN analyses. Indicators like partnership and trawl indices point to moderate 1996, weaker 1997, and moderate 1998 year class estimates. Given the need for sustained recovery, and reduced exploitation to meet F_{opt} and recovery targets, the Yellow Perch Task Group recommends that the LEC choose TAC's that are near to moderately above the mean RAH values in Table 8, Scenario 3 for Units 1-3, and a TAC in the lower end of the Table 8 range for Unit 4. We have pared down the RAH range to an interval that the YPTG prefers the LEC choose a TAC. Presented by management unit these suggested 2000 RAH ranges would be: Unit 1, 1.9-2.3 million pounds; Unit 2, 2.3-3.0 million pounds; Unit 3, 0.9-1.4 million pounds; Unit 4, 0.06-0.10 million 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." Similar biomass models and estimates have been developed for coastal fisheries (Myers and Barrowman 1994, 1995 and 1996, Myers et al. 1995a, Myers et al. 1995b, Gilbert 1997, Myers 1997, and Francis 1997).

Some of the data that we employed in the spawning stock biomass analyses included yellow perch abundance and biomass estimates (by age) from our CAGEAN exercises for the time period 1975-1999, and measures of percent female by age and maturity-at-age from our experimental sample data. We also incorporated yellow perch fecundity-at-age (Figure 17) from an estimate presented by Sztramko and Teleki (1977) taken in Long Point Bay and recent data taken from Lake Erie's western and central basins (Mike Bur and John Deller, personal communication). Fecundity-at-age-estimates from recent data were compared to average length-at-age information and the mean length-fecundity curve provided by Sztramko and Teleki.

From our fecundity and female abundance estimates, we can gain considerable insight into the relationship between the number of females or spawning stock biomass and the total egg production in a given year. In this review, it was apparent that yellow perch four years old and older are the most important in determining production. Many yellow perch at age 2 are still not mature, and in many years a surprisingly high percentage of age-3 female yellow perch do not spawn. We also can gain insight into yellow perch population characteristics for each management unit from examination of plots of stock abundance (see Figure 5), spawning stock biomass (Figure 18), Age 2 recruits (Table 5), and stock-recruitment and egg production plots (YPTG 1999). It is apparent from these datasets that large numbers of eggs do not necessarily translate into large recruitment numbers. In fact, the better year classes have come from an area to the left of the mean stock size.

A line (mean or maximum) fitted to stock-recruitment distribution is not a normal curve; it is in fact skewed with a majority of the data points to the left of the mean stock size value and a long tail to the right. Rather than presenting a line described about the mean of recruitment data points against a range of values of stock on the x-axis (as in Ricker 1975), it may be better to describe a dome-shaped curve under which all the stock-recruitment points lie. This would represent the maximum amount of recruitment expected given stock and fecundity levels and current biotic and abiotic conditions (see YPTG 1999). Although we do not have an exact equation calculated for R_{max} by management unit yet, we are looking at key components and a technique that can accurately describe it. Myers et al. (1999), describing a similar technique, examined maximum reproductive rates at low population sizes, and found they were relatively constant within species and exhibited only low variation between species.

It is, however, important to note where yellow perch stock estimates reside under that recruitment curve, and along a Ricker stock-recruitment curve, as a statement of potential for the population and as a statement of risk to the population. During the period of the late 1980s, Lake Erie yellow perch stocks were near the x (horizontal) axis out to the far right tail from the origin (high stock, little recruitment). Then in the early 1990's, several years were spent closer to the X-Y origin before the larger 1993, 1994 and 1996 year classes moved us back out and up. Note that in Unit 4, we are still close to the origin and population recovery (exclusive of the inner bays) is not progressing as well as the other management units.

The YPTG would like to see this charge be updated in the future, and assessment of biological reference points should become part of the YPTG charge regarding standard annual time series updates. The YPTG will continue to investigate new hypotheses in stock-recruitment relationships and the use of biological reference points or indicators to assess the associated risk of certain harvest strategies and the health of population levels. The YPTG is ever cautious that the minimum stock size or any other minimum reference point does not become a target for the fishery to overexploit the population.

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). These samples, taken during the post-spawn season, were collected for genetic analysis by Dr. Carol Stepien of Case Western Reserve University at Cleveland, Ohio. She and Catherine Theisler, a student at Case Western Reserve University, have completed the preliminary genetic analyses of our sample fish (Stepien and Theisler 1999). Their results (abstract presented in Appendix C) have shown that significant variability exists in mitochondrial DNA in the western basin samples and nuclear DNA samples were more variable in the eastern basin. Their data suggest that there are differences between the yellow perch population groups in the western and eastern basins.

Dr. Stepien also stated that she is intends to do more work on a larger sample of Lake Erie yellow perch at both the mtDNA level and nuclear DNA level to determine if specific stock lineage can be ascertained for many sites across the lake, including within basin differences. We will continue to assist and promote this important work in stock identification and delineation.

Independent Management of Eastern Basin Yellow Perch Stocks

A new charge for the Yellow Perch Task Group in 1999-2000 was to "investigate the independent management of yellow perch stocks in Lake Erie's Eastern Basin (MU4)." This item was brought to the YPTG by members of the LEC and STC to determine if eastern basin north shore stocks were distinct from south shore stocks, thereby allowing separate quotas and management strategies for the different eastern basin jurisdictions. The eastern basin deep water area is proposed to act as a means of excluding the mixing of the population, based on yellow perch depth preference, activity and spawning in shallower nearshore habitat of the eastern basin.

We examined the spatial distribution of yellow perch by summing the annual yellow perch sport and commercial harvest in New York and Pennsylvania, and the commercial harvest in Ontario waters within the recognized standard 10-minute scale geodetic international grid system. In this summary, we excluded the harvest statistics from within Presque Isle Bay, Pennsylvania, and Inner Long Point Bay, Ontario, as these areas are believed to comprise discrete stocks of yellow perch that are not included with the international quota management area for those jurisdictions. The total annual yellow perch harvest was summed across jurisdiction and fishery type for each 10-minute grid for the period 1997 through 1999 (Figure 19). The spatial distribution of the yellow perch harvest was then visually examined to assess whether geographically separate harvests of yellow perch were apparent within Unit 4.

A visual inspection of the 1997 to 1999 yellow perch harvest data by 10-minute grid suggests two concentrations for the Unit 4 harvest. Long Point Bay and a mid-lake grid approximately between Port Colborne, Ontario and Sturgeon Point, New York, accounted for most of the Unit 4 harvest between 1997 and 1999. The deep, mid-basin region produced a trivial harvest as expected. The concentration of harvest between Port Colborne and Sturgeon Point is located east of the deep-water region and indicates a continuous distribution of yellow perch from north to south. In addition, we recognize there are different regulatory constraints on yellow perch fisheries between jurisdictions. The discontinuous distribution of harvest along the south shore of Unit 4 from New York through Pennsylvania is probably also a reflection of limited access points for anglers, and the existence of small, less-mobile trap net fishery operations.

In the absence of other supporting information, such as genetic stock structure, it remains the view of the Yellow Perch Task Group that Management Unit 4 boundaries remain unchanged at this time. Other efforts by the Yellow Perch Task Group to support genetic studies will hopefully lend further information for assessing YPTG Management Unit boundaries in the future.

Yellow Perch Bioenergetics

A new charge for the Yellow Perch Task Group in 1999-2000 was to "investigate yellow perch bioenergetics." Discussion of task group direction regarding this task centered on data requirements for model implementation and the findings of the previous two YPTG tasks (genetics and eastern basin stocks). We also discussed incorporation of activities in this charge with bioenergetics work currently being addressed by the Lake Erie Forage Task Group (FTG). It was decided that we pursue this charge separately, apart from the FTG work. With preliminary results of the genetics and eastern basin stocks reported above, we will address bioenergetics for each YPTG Management Unit in upcoming years' work.

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 efforts continue to be devoted to understanding the population changes which are occurring. The Yellow Perch Task Group will continue to monitor yellow perch growth rates and compare yellow perch condition throughout the lake.

The YPTG will also continue to address current charges regarding long term data sets, and RAH. The YPTG will continue to explore growth and recruitment, backcasting, selectivities, and calculating F_{opt}. We will continue to track fishing mortalities at specific ages for incorporation into following task group reports to better predict 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 incoming year classes and CAGEAN backcast and forward estimates of them after another fishing year. The YPTG will also look into a broader model using catch-at-age information from both fisheries and survey gears using the AD Model Builder software. The YPTG plans a continued 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 were pleased to work with Dr. Pat Sullivan and Cliff Kraft in the exploration of AD Model Builder, Dr. Carol Stepien addressing the genetics issues, and with Dr. Ransom Myers investigating the spawning stock biomass and stock-recruitment issues. We look forward to working and communicating with researchers on our charges in the coming year.

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Table 1. Lake Erie yellow perch harvest in pounds by management unit (Unit) and agency, 1988-1999.

		Ontario*		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch
Unit 1	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
	1998	1,170,533	52	968,842	43	132,051	6	--	--	--	--	2,271,426
	1999	1,048,100	51	908,548	44	101,549	5	--	--	--	--	2,058,197
Unit 2	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
	1998	1,797,458	74	627,944	26	--	--	--	--	--	--	2,425,402
	1999	1,572,829	62	974,123	38	--	--	--	--	--	--	2,546,952
Unit 3	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
	1998	811,903	73	274,993	25	--	--	28,527	3	--	--	1,115,423
	1999	665,703	65	352,635	34	--	--	8,925	1	--	--	1,027,263
Unit 4	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
	1998	48,457	93	--	--	--	--	538	1	3,175	6	52,170
	1999	59,842	92	--	--	--	--	2,216	3	3,234	5	65,292
Lakewide Totals	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	4,472	<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
	1998	3,828,351	65	1,871,779	32	132,051	2	29,065	<1	3,175	<1	5,864,421
	1999	3,346,474	59	2,235,306	39	101,549	2	11,141	<1	3,234	<1	5,697,704

* 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, 1988-1999.

		Unit 1			
		Ohio		Michigan	Ontario
	Year	Trap Nets	Sport	Sport	Gill Nets
Catch (pounds)	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
	1998	184,142	784,700	132,051	1,170,533
	1999	200,939	707,609	101,549	1,048,100
Catch (Metric) (tonnes)	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
	1998	84	356	60	531
	1999	91	321	46	475
Effort *(a)*	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
	1998	5,446	863,336	183,882	19,095
	1999	5,185	941,350	184,710	12,846
Catch Rates *(b)*	1988	41.2	4.2	0.5	150.3
	1989	46.6	2.8	1.7	112.6
	1990	33.3	1.4	1.3	44.1
	1991	12.3	2.4	1.9	21.6
	1992	8.2	2.8	2.1	33.8
	1993	10.2	2.6	1.9	43.1
	1994	12.6	2.2	1.1	27.4
	1995	9.6	4.3	2.8	21.4
	1996	18.7	4.9	3.3	37.0
	1997	17.2	3.7	2.8	36.1
	1998	15.4	3.8	3.2	27.8
	1999	17.6	3.3	2.1	37.0

(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, 1988-1999.

		Unit 2		
		Ohio		Ontario
	Year	Trap Nets	Sport	Gill Nets
Catch (pounds)	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
	1998	304,661	323,283	1,797,458
	1999	389,973	584,150	1,572,829
Catch (Metric) (tonnes)	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
	1998	138	147	815
	1999	177	265	713
Effort *(a)*	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
	1998	7,943	422,176	23,823
	1999	7,502	563,819	13,179
Catch Rates *(b)*	1988	46.9	2.4	146.6
	1989	64.9	3.4	98.5
	1990	47.3	1.5	41.2
	1991	21.1	2.2	28.4
	1992	13.9	3.0	32.4
	1993	20.3	3.1	34.3
	1994	19.3	3.3	25.2
	1995	18.1	3.5	26.6
	1996	25.1	4.2	40.1
	1997	25.9	2.8	33.2
	1998	17.4	2.6	34.2
	1999	23.6	3.0	54.1

(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, 1988-1999.

		Unit 3					
		Ohio		Ontario	Pennsylvania		
	Year	Trap Nets	Sport	Gill Nets	Gill Nets	Trap Nets	Sport
Catch (pounds)	1988	330,750	196,245	2,487,240	178,605		
	1989	635,040	564,480	2,414,475	211,680		
	1990	447,615	57,330	2,127,825	185,220		
	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
	1998	90,082	184,911	811,903	0	5,291	23,236
	1999	106,258	246,377	665,703	0	2,905	6,020
Catch (Metric) (tonnes)	1988	150	89	1,128	81		
	1989	288	256	1,095	96		
	1990	203	26	965	84		
	1991	84	31	550	69		
	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	2.4	1.7
	1997	25	75	376	0	3.4	7.2
	1998	41	84	368	0	2.4	10.5
	1999	48	112	302	0	1.3	2.7
Effort *(a)*	1988	4,781	172,490	6,203	1,418		
	1989	7,281	248,530	7,098	1,037		
	1990	7,376	31,881	12,472	1,978		
	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
	1998	2,512	111,425	10,809	0	305	30,612
	1999	2,388	176,603	4,338	0	243	28,486
Catch Rates *(b)*	1988	31.4	2.7	181.8	57.1		
	1989	39.6	4.1	154.3	92.6		
	1990	27.5	1.9	77.4	42.5		
	1991	18.6	2.0	44.9	34.2		
	1992	13.7	1.8	37.1	26.5		
	1993	11.9	1.7	27.5	17.7		
	1994	21.0	2.3	21.1	17.3		
	1995	8.9	1.3	30.8	9.6		
	1996	17.2	2.8	37.5		13.0	0.8
	1997	10.2	3.1	39.9		7.6	0.9
	1998	16.3	3.6	34.0		7.9	1.5
	1999	20.2	3.5	69.6		5.4	1.8

(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, 1988-1999.

		Unit 4					
		New York		Ontario	Pennsylvania		
	Year	Trap Nets	Sport	Gill Nets	Gill Nets	Trap Nets	Sport
Catch (pounds)	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
	1998	1,345	1,830	48,457	0	0	538
	1999	694	2,540	59,842	0	0	2,216
Catch (Metric) (tonnes)	1988	4.0		258	1		
	1989	8.0	47.0	199	0		
	1990	9.0	8.0	128	0		
	1991	7.0	4.0	73	0		
	1992	5.0	4.0	52	0		
	1993	3.0	3.0	33	0		
	1994	2.0	3.0	24	0		
	1995	1.4	3.0	15	0		
	1996	1.3	0.7	14	0	0	1.0
	1997	0.6	0.5	16	0	0	1.4
	1998	0.6	0.8	22	0	0	0.2
	1999	0.3	1.2	27	0	0	1.0
Effort *(a)*	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
	1998	178	7,073	1,081	0	0	3,784
	1999	118	5,410	872	0	0	13,623
Catch Rates *(b)*	1988	1.9		94.9	125.0		
	1989	7.0	2.2	75.7			
	1990	9.2	0.4	32.6			
	1991	7.6	0.6	18.9			
	1992	7.9	0.4	15.5			
	1993	3.9	0.4	16.4			
	1994	3.6	0.4	14.6			
	1995	2.7	0.8	10.9			
	1996	2.4	0.5	13.1			0.6
	1997	1.9	0.4	14.9			1.0
	1998	3.4	0.7	20.4			0.5
	1999	2.7	0.8	31.0			0.6

(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 1999 yellow perch harvest in numbers of fish by gear, age and management unit (Unit).

		Unit 1		Unit 2		Unit 3		Unit 4		Lakewide	
Gear	Age	Number	%	Number	%	Number	%	Number	%	Number	%
Gill Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	47,422	1.1	155,206	2.4	11,795	0.5	3,848	2.0	218,271	1.6
	3	1,808,985	40.9	4,995,988	77.9	1,447,368	62.3	109,065	56.3	8,361,407	62.6
	4	1,851,241	41.9	1,019,813	15.9	711,922	30.6	39,763	20.5	3,622,739	27.1
	5	609,184	13.8	229,504	3.6	135,789	5.8	35,441	18.3	1,009,918	7.6
	6+	101,407	2.3	10,605	0.2	16,257	0.7	5,708	2.9	133,978	1.0
	Total	4,418,239		6,411,117		2,323,132		193,825		13,346,313	
Trap Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	0	0.0	1,830	0.1	93	0.03	121	12.2	2,044	0.1
	3	306,923	49.4	993,560	81.4	258,432	88.8	95	9.6	1,559,011	73.0
	4	196,378	31.6	66,406	5.4	18,786	6.5	11	1.1	281,581	13.2
	5	97,627	15.7	107,832	8.8	10,533	3.6	204	20.6	216,196	10.1
	6+	20,618	3.3	50,946	4.2	3,303	1.1	558	56.4	75,426	3.5
	Total	621,546		1,220,574		291,147		989		2,134,256	
Sport	1	25,714	0.7	12,600	0.8	0	0.0	0	0.0	38,314	0.6
	2	328,583	9.0	206,278	12.3	54,576	8.1	3,024	29.8	592,461	9.8
	3	2,463,487	67.3	1,294,939	77.3	490,263	72.8	3,472	34.2	4,252,161	70.7
	4	599,154	16.4	111,882	6.7	37,353	5.5	469	4.6	748,858	12.4
	5	195,635	5.3	37,429	2.2	56,926	8.4	915	9.0	290,905	4.8
	6+	45,980	1.3	12,576	0.8	34,733	5.2	2,270	22.4	95,559	1.6
	Total	3,658,553		1,675,704		673,850		10,150		6,018,257	
All Gear	1	25,714	0.3	12,600	0.1	0	0.0	0	0.0	38,314	0.2
	2	376,005	4.3	363,314	3.9	66,464	2.0	6,992	3.4	812,776	3.8
	3	4,579,395	52.8	7,284,487	78.3	2,196,063	66.8	112,632	55.0	14,172,578	65.9
	4	2,646,773	30.5	1,198,101	12.9	768,061	23.4	40,243	19.6	4,653,178	21.6
	5	902,446	10.4	374,765	4.0	203,248	6.2	36,560	17.8	1,517,018	7.1
	6+	168,005	1.9	74,127	0.8	54,293	1.7	8,537	4.2	304,963	1.4
	Total	8,672,624		9,307,395		3,288,129		204,964		21,498,826	

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 (1990 in MU 4) through 2000 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	74.631	9.020	19.889	0.489	0.226	52.976	7.013	15.464	0.431	0.299
	1989	38.650	5.006	11.039	0.373	0.372	36.476	4.825	10.639	0.359	0.391
	1990	18.866	3.088	6.809	0.389	0.352	14.435	2.506	5.526	0.325	0.434
	1991	17.214	2.185	4.818	0.448	0.277	7.337	1.197	2.640	0.281	0.492
	1992	20.380	2.404	5.300	0.485	0.230	7.717	1.074	2.368	0.304	0.462
	1993	16.154	1.902	4.194	0.395	0.344	9.887	1.474	3.249	0.272	0.505
	1994	19.049	2.180	4.807	0.491	0.223	6.382	0.901	1.986	0.278	0.496
	1995	34.017	3.565	7.861	0.538	0.164	9.352	1.197	2.640	0.354	0.397
	1996	46.842	4.967	10.953	0.515	0.193	18.286	2.178	4.803	0.363	0.386
	1997	41.099	4.337	9.563	0.490	0.224	24.102	2.813	6.202	0.380	0.363
	1998	52.411	5.253	11.583	0.521	0.185	20.146	2.285	5.038	0.327	0.432
	1999	39.845	3.962	8.736	0.481	0.236	27.302	3.167	6.984	0.403	0.334
	2000	37.709	2.973	6.556			19.153	1.981	4.368		
Unit 2	1988	86.242	11.806	26.031	0.520	0.186	49.393	7.592	16.741	0.446	0.280
	1989	48.376	7.669	16.910	0.383	0.360	44.869	7.405	16.328	0.366	0.381
	1990	25.287	4.228	9.322	0.349	0.403	18.511	3.428	7.559	0.275	0.500
	1991	30.650	4.268	9.410	0.466	0.255	8.832	1.686	3.717	0.290	0.480
	1992	40.804	5.074	11.188	0.452	0.272	14.274	2.173	4.792	0.275	0.501
	1993	27.937	3.344	7.373	0.373	0.373	18.445	2.657	5.859	0.279	0.496
	1994	26.746	3.473	7.657	0.490	0.224	10.409	1.703	3.755	0.338	0.418
	1995	26.447	3.549	7.825	0.477	0.240	13.110	1.988	4.384	0.360	0.389
	1996	43.892	5.380	11.863	0.534	0.169	12.614	1.971	4.346	0.372	0.374
	1997	34.628	4.355	9.604	0.364	0.385	23.419	3.287	7.248	0.270	0.506
	1998	59.528	6.904	15.224	0.522	0.183	12.591	1.929	4.254	0.311	0.453
	1999	35.902	4.995	11.013	0.448	0.277	31.103	4.463	9.842	0.423	0.309
	2000	41.903	4.724	10.417			16.096	2.739	6.040		
Unit 3	1988	61.950	11.572	25.516	0.549	0.150	53.562	10.269	22.642	0.531	0.172
	1989	37.820	7.105	15.667	0.467	0.252	34.013	6.721	14.820	0.446	0.279
	1990	22.661	4.805	10.596	0.480	0.237	17.680	4.231	9.329	0.437	0.291
	1991	20.491	3.582	7.899	0.485	0.230	10.879	2.506	5.525	0.376	0.369
	1992	14.491	2.527	5.571	0.418	0.316	9.946	2.033	4.482	0.327	0.432
	1993	8.195	1.468	3.236	0.413	0.321	6.051	1.213	2.674	0.338	0.419
	1994	13.486	1.508	3.325	0.567	0.127	3.389	0.811	1.789	0.359	0.390
	1995	13.126	1.763	3.887	0.568	0.127	7.651	1.131	2.495	0.505	0.205
	1996	17.737	2.356	5.195	0.564	0.132	7.454	1.177	2.595	0.445	0.280
	1997	17.352	2.046	4.512	0.491	0.223	9.998	1.522	3.355	0.380	0.363
	1998	24.475	3.090	6.812	0.561	0.135	8.513	1.360	2.999	0.409	0.326
	1999	14.782	2.251	4.964	0.485	0.231	13.738	2.150	4.741	0.472	0.246
	2000	16.199	1.895	4.179			7.167	1.223	2.696		
Unit 4	1990	9.138	1.896	4.181	0.559	0.137	8.494	1.832	4.040	0.552	0.146
	1991	5.673	1.292	2.848	0.574	0.119	5.112	1.223	2.696	0.566	0.129
	1992	3.637	0.757	1.670	0.621	0.061	3.256	0.746	1.644	0.616	0.067
	1993	2.972	0.584	1.287	0.610	0.075	2.259	0.508	1.120	0.594	0.094
	1994	2.690	0.411	0.906	0.629	0.051	1.811	0.350	0.772	0.616	0.067
	1995	4.441	0.641	1.413	0.656	0.018	1.692	0.395	0.872	0.642	0.035
	1996	5.012	0.547	1.206	0.643	0.033	2.913	0.414	0.913	0.630	0.049
	1997	3.867	0.568	1.252	0.633	0.046	3.224	0.527	1.161	0.627	0.054
	1998	3.638	0.620	1.367	0.634	0.045	2.447	0.506	1.116	0.620	0.062
	1999	2.677	0.567	1.250	0.621	0.061	2.306	0.530	1.168	0.615	0.069
	2000	2.806	0.586	1.293			1.662	0.515	1.136		

Table 5. Yellow perch stock size (millions of fish) at the start of the year, estimated by CAGEAN for the years 1988 to 1999. The 2000 population estimates use age 2 values 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	1999	2000
Unit 1	2	21.655	2.174	4.432	9.877	12.663	6.267	12.667	24.665	28.557	16.997	32.265	12.544	18.556
	3	23.078	13.666	1.344	2.641	5.652	7.539	3.696	7.576	14.976	17.466	10.975	20.715	8.152
	4	23.601	10.053	5.048	0.372	0.608	1.624	2.047	1.059	2.716	5.523	7.420	4.357	9.142
	5	2.584	9.721	3.354	1.309	0.076	0.150	0.379	0.512	0.340	0.890	1.438	1.778	1.196
	6+	3.714	3.037	4.690	3.015	1.381	0.574	0.259	0.204	0.254	0.224	0.313	0.453	0.664
	2 and Older	74.631	38.650	18.866	17.214	20.380	16.154	19.049	34.017	46.842	41.099	52.411	39.845	37.709
	3 and Older	52.976	36.476	14.435	7.337	7.717	9.887	6.382	9.352	18.286	24.102	20.146	27.302	19.153
Unit 2	2	36.849	3.507	6.776	21.818	26.530	9.492	16.337	13.337	31.278	11.208	46.937	4.799	25.807
	3	16.647	22.839	2.079	3.735	11.708	14.524	5.269	9.594	7.892	18.723	6.258	27.184	2.937
	4	31.402	8.105	9.244	0.617	0.988	2.937	3.915	1.866	3.503	3.020	4.906	1.899	11.378
	5	0.752	13.248	2.587	1.723	0.097	0.221	0.739	1.166	0.570	1.137	0.754	1.396	0.771
	6+	0.592	0.677	4.601	2.757	1.480	0.763	0.486	0.483	0.649	0.540	0.672	0.623	1.010
	2 and Older	86.242	48.376	25.287	30.650	40.804	27.937	26.746	26.447	43.892	34.628	59.528	35.902	41.903
	3 and Older	49.393	44.869	18.511	8.832	14.274	18.445	10.409	13.110	12.614	23.419	12.591	31.103	16.096
Unit 3	2	8.388	3.807	4.981	9.612	4.546	2.144	10.098	5.476	10.283	7.354	15.962	1.044	9.033
	3	6.622	5.558	2.495	3.154	5.857	2.795	1.346	6.434	3.591	6.678	4.709	10.254	0.679
	4	44.797	3.811	2.820	0.838	0.679	1.421	0.859	0.481	3.261	1.570	2.493	1.850	4.790
	5	1.329	23.442	1.631	0.507	0.063	0.065	0.226	0.207	0.197	1.426	0.586	0.967	0.854
	6+	0.815	1.203	10.734	6.379	3.346	1.770	0.957	0.529	0.406	0.324	0.725	0.667	0.843
	2 and Older	61.950	37.820	22.661	20.491	14.491	8.195	13.486	13.126	17.737	17.352	24.475	14.782	16.199
	3 and Older	53.562	34.013	17.680	10.879	9.946	6.051	3.389	7.651	7.454	9.998	8.513	13.738	7.167
Unit 4	2			0.644	0.561	0.382	0.713	0.878	2.749	2.099	0.643	1.191	0.371	1.144
	3			0.583	0.420	0.364	0.253	0.470	0.576	1.827	1.387	0.426	0.788	0.245
	4			1.247	0.307	0.211	0.220	0.146	0.265	0.361	1.138	0.861	0.259	0.466
	5			0.184	0.226	0.043	0.085	0.068	0.082	0.165	0.225	0.706	0.524	0.153
	6+			6.480	4.158	2.638	1.701	1.128	0.769	0.560	0.473	0.454	0.735	0.797
	2 and Older			9.138	5.673	3.637	2.972	2.690	4.441	5.012	3.867	3.638	2.677	2.806
	3 and Older			8.494	5.112	3.256	2.259	1.811	1.692	2.913	3.224	2.447	2.306	1.662

Table 6. Projection of the 2000 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN. Age 2 estimates in 2000 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.

			1999 Parameters				Rate Functions					2000 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.		1999	2000	2000
Unit 1		2	12.544	3.424	9.119	15.968	0.031	0.431	0.350	0.025	0.650	2	18.556	8.661	28.451	0.053	0.794	0.992	2.188
	0.273	3	20.715	5.655	15.060	26.370	0.418	0.818	0.559	0.285	0.441	3	8.152	5.926	10.377	0.077	2.279	0.625	1.379
		4	4.357	1.189	3.167	5.546	0.893	1.293	0.726	0.501	0.274	4	9.142	6.646	11.638	0.099	0.526	0.909	2.005
		5	1.778	0.485	1.292	2.263	0.893	1.293	0.726	0.501	0.274	5	1.196	0.869	1.522	0.182	0.263	0.218	0.480
		6+	0.453	0.124	0.329	0.576	0.544	0.944	0.611	0.352	0.389	6+	0.664	0.483	0.845	0.345	0.100	0.229	0.505
		Total	39.845	9.748	30.097	49.594	0.333	0.733	0.519	0.236	0.481	Total	37.709	22.585	52.833		3.962	2.973	6.556
		(3+)	27.302	6.680	19.849	34.755	0.509	0.909	0.597	0.334	0.403	(3+)	19.153	13.924	24.382		3.167	1.981	4.368
Unit 2		2	4.799	1.032	3.767	5.831	0.091	0.491	0.388	0.072	0.612	2	25.807	15.145	36.470	0.077	0.531	1.985	4.377
	0.215	3	27.184	5.845	21.340	33.029	0.471	0.871	0.581	0.314	0.419	3	2.937	2.306	3.569	0.111	3.688	0.325	0.717
		4	1.899	0.408	1.491	2.308	0.502	0.902	0.594	0.331	0.406	4	11.378	8.931	13.824	0.162	0.306	1.847	4.073
		5	1.396	0.300	1.096	1.696	0.347	0.747	0.526	0.244	0.474	5	0.771	0.605	0.936	0.248	0.294	0.191	0.421
		6+	0.623	0.134	0.489	0.756	0.180	0.580	0.440	0.137	0.560	6+	1.010	0.793	1.227	0.372	0.175	0.376	0.828
		Total	35.902	7.719	28.183	43.621	0.402	0.802	0.552	0.277	0.448	Total	41.903	27.780	56.026		4.995	4.724	10.417
		(3+)	31.103	6.687	24.415	37.790	0.460	0.860	0.577	0.309	0.423	(3+)	16.096	12.635	19.556		4.463	2.739	6.040
Unit 3		2	1.044	0.289	0.755	1.333	0.030	0.430	0.349	0.024	0.651	2	9.033	5.679	13.607	0.074	0.101	0.672	1.483
	0.277	3	10.254	2.840	7.413	13.094	0.361	0.761	0.533	0.253	0.467	3	0.679	0.491	0.867	0.113	1.449	0.077	0.169
		4	1.850	0.513	1.338	2.363	0.373	0.773	0.538	0.260	0.462	4	4.790	3.464	6.117	0.153	0.298	0.731	1.613
		5	0.967	0.268	0.699	1.235	0.373	0.773	0.538	0.260	0.462	5	0.854	0.618	1.091	0.202	0.221	0.173	0.381
		6+	0.667	0.185	0.482	0.851	0.120	0.520	0.405	0.094	0.595	6+	0.843	0.609	1.076	0.288	0.182	0.242	0.534
		Total	14.782	4.095	10.687	18.876	0.324	0.724	0.515	0.231	0.485	Total	16.199	10.860	22.758		2.251	1.895	4.179
		(3+)	13.738	3.805	9.932	17.543	0.350	0.750	0.528	0.246	0.472	(3+)	7.167	5.181	9.152		2.150	1.223	2.696
Unit 4		2	0.371	0.128	0.243	0.498	0.016	0.416	0.340	0.013	0.660	2	1.144	0.109	2.179	0.062	0.037	0.071	0.156
	0.344	3	0.788	0.271	0.517	1.060	0.125	0.525	0.408	0.097	0.592	3	0.245	0.161	0.329	0.114	0.121	0.028	0.062
		4	0.259	0.089	0.170	0.349	0.125	0.525	0.408	0.097	0.592	4	0.466	0.306	0.627	0.167	0.047	0.078	0.172
		5	0.524	0.180	0.344	0.704	0.112	0.512	0.401	0.088	0.599	5	0.153	0.101	0.206	0.284	0.102	0.044	0.096
		6+	0.735	0.253	0.482	0.987	0.018	0.418	0.342	0.015	0.658	6+	0.797	0.523	1.072	0.459	0.259	0.366	0.807
		Total	2.677	0.921	1.756	3.598	0.077	0.477	0.379	0.061	0.621	Total	2.806	1.200	4.413		0.567	0.586	1.293
		(3+)	2.306	0.793	1.513	3.099	0.087	0.487	0.385	0.069	0.615	(3+)	1.662	1.090	2.234		0.530	0.515	1.136

Table 6-b. Projection of the 2000 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN*. Age 2 estimates in 2000 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.
****Age 2 and Age 3 values in italics for Units 1-3 have been changed to reflect Partnership and trawl regression estimates and standard errors.***

			1999 Parameters				Rate Functions					2000 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)	**1999**	**2000**	**2000**
Unit 1		2	12.544	3.424	9.119	15.968	0.031	0.431	0.350	0.025	0.650	2	18.556	8.661	28.451	0.053	0.652	0.992	2.188
	0.273	3	***31.780***	***3.276***	***28.504***	***35.056***	0.418	0.818	0.559	0.285	0.441	3	8.152	5.926	10.377	0.077	2.279	0.625	1.379
		4	4.357	1.189	3.167	5.546	0.893	1.293	0.726	0.501	0.274	4	***14.025***	***12.579***	***15.471***	0.099	***0.526***	***1.395***	***3.075***
		5	1.778	0.485	1.292	2.263	0.893	1.293	0.726	0.501	0.274	5	1.196	0.869	1.522	0.182	0.263	0.218	0.480
		6+	0.453	0.124	0.329	0.576	0.544	0.944	0.611	0.352	0.389	6+	0.664	0.483	0.845	0.345	0.100	0.229	0.505
		Total	50.910	12.456	38.455	63.366	0.351	0.751	0.528	0.247	0.472	Total	42.592	28.518	56.666		3.820	3.459	7.627
		(3+)	38.367	9.387	33.293	43.441	0.482	0.882	0.586	0.320	0.414	(3+)	24.036	19.857	28.215		3.167	2.467	5.439
Unit 2		2	***14.754***	***4.139***	***10.615***	***18.894***	0.091	0.491	0.388	0.072	0.612	2	25.807	15.145	36.470	0.077	1.003	1.985	4.377
	0.215	3	27.184	5.845	21.340	33.029	0.471	0.871	0.581	0.314	0.419	3	***9.030***	***6.497***	***11.563***	0.111	***3.688***	***1.000***	***2.205***
		4	1.899	0.408	1.491	2.308	0.502	0.902	0.594	0.331	0.406	4	11.378	8.931	13.824	0.162	0.306	1.847	4.073
		5	1.396	0.300	1.096	1.696	0.347	0.747	0.526	0.244	0.474	5	0.771	0.605	0.936	0.248	0.294	0.191	0.421
		6+	0.623	0.134	0.489	0.756	0.180	0.580	0.440	0.137	0.560	6+	1.010	0.793	1.227	0.372	0.175	0.376	0.828
		Total	45.857	9.859	35.997	55.716	0.326	0.726	0.516	0.232	0.484	Total	47.995	31.970	64.021		5.467	5.399	11.904
		(3+)	31.103	6.687	24.415	37.790	0.460	0.860	0.577	0.309	0.423	(3+)	22.188	16.826	27.551		4.463	3.414	7.527
Unit 3		2	***6.408***	***2.393***	***4.015***	***8.802***	0.030	0.430	0.349	0.024	0.651	2	9.033	5.679	13.607	0.074	0.404	0.672	1.483
	0.277	3	10.254	2.840	7.413	13.094	0.361	0.761	0.533	0.253	0.467	3	***4.168***	***2.612***	***5.726***	0.113	***1.449***	***0.470***	***1.036***
		4	1.850	0.513	1.338	2.363	0.373	0.773	0.538	0.260	0.462	4	4.790	3.464	6.117	0.153	0.298	0.731	1.613
		5	0.967	0.268	0.699	1.235	0.373	0.773	0.538	0.260	0.462	5	0.854	0.618	1.091	0.202	0.221	0.173	0.381
		6+	0.667	0.185	0.482	0.851	0.120	0.520	0.405	0.094	0.595	6+	0.843	0.609	1.076	0.288	0.182	0.242	0.534
		Total	20.146	5.580	14.565	25.726	0.237	0.637	0.471	0.175	0.529	Total	19.689	12.981	27.617		2.554	2.288	5.046
		(3+)	13.738	3.805	9.932	17.543	0.350	0.750	0.528	0.246	0.472	(3+)	10.656	7.302	14.010		2.150	1.616	3.563
Unit 4		2	0.371	0.128	0.243	0.498	0.016	0.416	0.340	0.013	0.660	2	1.144	0.109	2.179	0.062	0.037	0.071	0.156
	0.344	3	0.788	0.271	0.517	1.060	0.125	0.525	0.408	0.097	0.592	3	0.245	0.161	0.329	0.114	0.121	0.028	0.062
		4	0.259	0.089	0.170	0.349	0.125	0.525	0.408	0.097	0.592	4	0.466	0.306	0.627	0.167	0.047	0.078	0.172
		5	0.524	0.180	0.344	0.704	0.112	0.512	0.401	0.088	0.599	5	0.153	0.101	0.206	0.284	0.102	0.044	0.096
		6+	0.735	0.253	0.482	0.987	0.018	0.418	0.342	0.015	0.658	6+	0.797	0.523	1.072	0.459	0.259	0.366	0.807
		Total	2.677	0.921	1.756	3.598	0.077	0.477	0.379	0.061	0.621	Total	2.806	1.200	4.413		0.567	0.586	1.293
		(3+)	2.306	0.793	1.513	3.099	0.087	0.487	0.385	0.069	0.615	(3+)	1.662	1.090	2.234		0.530	0.515	1.136

Table 7. Estimated harvest of Lake Erie yellow perch for 2000. The exploitation rate is derived from optimal yield policy, and the stock size estimate 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.

		Stock Size (numbers)			Exploitation Rate				Catch (millions of fish)			Mean Wt. in Harvest	RAH Catch (millions of kg)			RAH Catch (millions of lbs)		
	Age	**Mean**	**Min.**	**Max.**	**F(opt)**	**s(age)**	**(F)**	**(u)**	**Mean**	**Min.**	**Max.**	(kg)	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Unit 1	2	18.556	8.661	28.451	0.519	0.035	0.018	0.015	0.273	0.128	0.419	0.091	0.025	0.012	0.038	0.055	0.026	0.084
	3	8.152	5.926	10.377	0.519	0.468	0.243	0.179	1.461	1.062	1.860	0.100	0.146	0.106	0.186	0.322	0.234	0.410
	4	9.142	6.646	11.638	0.519	1.000	0.519	0.339	3.103	2.256	3.950	0.113	0.351	0.255	0.446	0.773	0.562	0.984
	5	1.196	0.869	1.522	0.519	1.000	0.519	0.339	0.406	0.295	0.517	0.134	0.054	0.040	0.069	0.120	0.087	0.153
	6+	0.664	0.483	0.845	0.519	0.609	0.316	0.226	0.150	0.109	0.191	0.180	0.027	0.020	0.034	0.059	0.043	0.076
	Total	37.709	22.585	52.833				0.143	5.393	3.850	6.936	0.112	0.603	0.432	0.774	1.330	0.952	1.707
	(3+)	19.153	13.924	24.382				0.267	5.120	3.722	6.517	0.113	0.578	0.420	0.736	1.275	0.927	1.623
Unit 2	2	25.807	15.145	36.470	0.477	0.181	0.086	0.068	1.767	1.037	2.497	0.112	0.198	0.116	0.280	0.436	0.256	0.617
	3	2.937	2.306	3.569	0.477	0.938	0.448	0.302	0.886	0.696	1.077	0.119	0.105	0.083	0.128	0.233	0.183	0.283
	4	11.378	8.931	13.824	0.477	1.000	0.477	0.318	3.614	2.837	4.391	0.137	0.495	0.389	0.602	1.092	0.857	1.326
	5	0.771	0.605	0.936	0.477	0.691	0.330	0.234	0.180	0.142	0.219	0.162	0.029	0.023	0.036	0.064	0.051	0.078
	6+	1.010	0.793	1.227	0.477	0.359	0.171	0.130	0.132	0.103	0.160	0.220	0.029	0.023	0.035	0.064	0.050	0.078
	Total	41.903	27.780	56.026				0.157	6.579	4.815	8.344	0.130	0.857	0.633	1.080	1.889	1.396	2.382
	(3+)	16.096	12.635	19.556				0.299	4.812	3.778	5.847	0.137	0.659	0.517	0.800	1.453	1.140	1.765
Unit 3	2	9.033	5.679	13.607	0.466	0.080	0.037	0.030	0.274	0.172	0.413	0.115	0.032	0.020	0.048	0.070	0.044	0.105
	3	0.679	0.491	0.867	0.466	0.968	0.451	0.304	0.206	0.149	0.263	0.131	0.027	0.020	0.034	0.060	0.043	0.076
	4	4.790	3.464	6.117	0.466	1.000	0.466	0.312	1.493	1.080	1.907	0.154	0.230	0.166	0.294	0.507	0.367	0.648
	5	0.854	0.618	1.091	0.466	1.000	0.466	0.312	0.266	0.193	0.340	0.187	0.050	0.036	0.064	0.110	0.079	0.140
	6+	0.843	0.609	1.076	0.466	0.322	0.150	0.115	0.097	0.070	0.124	0.240	0.023	0.017	0.030	0.051	0.037	0.066
	Total	16.199	10.860	22.758				0.144	2.337	1.664	3.048	0.155	0.362	0.259	0.469	0.797	0.570	1.034
	(3+)	7.167	5.181	9.152				0.288	2.063	1.492	2.635	0.160	0.330	0.239	0.422	0.728	0.526	0.930
Unit 4	2	1.144	0.109	2.179	0.391	0.128	0.050	0.040	0.046	0.004	0.088	0.108	0.005	0.000	0.009	0.011	0.001	0.021
	3	0.245	0.161	0.329	0.391	1.000	0.391	0.270	0.066	0.043	0.089	0.121	0.008	0.005	0.011	0.018	0.012	0.024
	4	0.466	0.306	0.627	0.391	1.000	0.391	0.270	0.126	0.083	0.169	0.141	0.018	0.012	0.024	0.039	0.026	0.053
	5	0.153	0.101	0.206	0.391	0.896	0.350	0.246	0.038	0.025	0.051	0.145	0.005	0.004	0.007	0.012	0.008	0.016
	6+	0.797	0.523	1.072	0.391	0.144	0.056	0.045	0.036	0.024	0.048	0.309	0.011	0.007	0.015	0.025	0.016	0.033
	Total	2.806	1.200	4.413				0.111	0.312	0.179	0.445	0.152	0.047	0.028	0.066	0.104	0.062	0.147
	(3+)	1.662	1.090	2.234				0.160	0.266	0.174	0.357	0.159	0.042	0.028	0.057	0.093	0.061	0.126

Table 7-b. Estimated harvest of Lake Erie yellow perch for 2000*. The exploitation rate is derived from optimal yield policy, and the stock size estimate 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 3 and age 4 values in italics for Units 1-3 have been changed to reflect Partnership and trawl regression estimates.***

		Stock Size (numbers)			Exploitation Rate				Catch (millions of fish)			Mean Wt. in Harvest	RAH					
													Catch (millions of kg)			Catch (millions of lbs)		
	Age	Mean	Min.	Max.	F(opt)	s(age)	(F)	(u)	Mean	Min.	Max.	(kg)	Mean	Min.	Max.	Mean	Min.	Max.
Unit 1	2	18.556	8.661	28.451	0.519	0.035	0.018	0.015	0.273	0.128	0.419	0.091	0.025	0.012	0.038	0.055	0.026	0.084
	3	8.152	5.926	10.377	0.519	0.468	0.243	0.179	1.461	1.062	1.860	0.100	0.146	0.106	0.186	0.322	0.234	0.410
	4	***14.025***	***12.579***	***15.471***	0.519	1.000	0.519	0.339	4.761	4.270	5.252	0.113	0.538	0.483	0.593	1.186	1.064	1.309
	5	1.196	0.869	1.522	0.519	1.000	0.519	0.339	0.406	0.295	0.517	0.134	0.054	0.040	0.069	0.120	0.087	0.153
	6+	0.664	0.483	0.845	0.519	0.609	0.316	0.226	0.150	0.109	0.191	0.180	0.027	0.020	0.034	0.059	0.043	0.076
	Total	37.709	22.585	52.833				0.187	7.051	5.864	8.238	0.112	0.790	0.659	0.921	1.743	1.454	2.031
	(3+)	19.153	13.924	24.382				0.354	6.777	5.736	7.819	0.113	0.765	0.648	0.883	1.688	1.429	1.947
Unit 2	2	25.807	15.145	36.470	0.477	0.181	0.086	0.068	1.767	1.037	2.497	0.112	0.198	0.116	0.280	0.436	0.256	0.617
	3	***9.030***	***6.497***	***11.563***	0.477	0.938	0.448	0.302	2.725	1.961	3.490	0.119	0.324	0.233	0.415	0.715	0.514	0.916
	4	11.378	8.931	13.824	0.477	1.000	0.477	0.318	3.614	2.837	4.391	0.137	0.495	0.389	0.602	1.092	0.857	1.326
	5	0.771	0.605	0.936	0.477	0.691	0.330	0.234	0.180	0.142	0.219	0.162	0.029	0.023	0.036	0.064	0.051	0.078
	6+	1.010	0.793	1.227	0.477	0.359	0.171	0.130	0.132	0.103	0.160	0.220	0.029	0.023	0.035	0.064	0.050	0.078
	Total	41.903	27.780	56.026				0.201	8.418	6.079	10.757	0.128	1.075	0.784	1.367	2.371	1.728	3.015
	(3+)	16.096	12.635	19.556				0.413	6.651	5.042	8.260	0.132	0.878	0.668	1.087	1.935	1.472	2.398
Unit 3	2	9.033	5.679	13.607	0.466	0.080	0.037	0.030	0.274	0.172	0.413	0.115	0.032	0.020	0.048	0.070	0.044	0.105
	3	***4.168***	***2.612***	***5.726***	0.466	0.968	0.451	0.304	1.266	0.793	1.739	0.131	0.166	0.104	0.228	0.366	0.229	0.502
	4	4.790	3.464	6.117	0.466	1.000	0.466	0.312	1.493	1.080	1.907	0.154	0.230	0.166	0.294	0.507	0.367	0.648
	5	0.854	0.618	1.091	0.466	1.000	0.466	0.312	0.266	0.193	0.340	0.187	0.050	0.036	0.064	0.110	0.079	0.140
	6+	0.843	0.609	1.076	0.466	0.322	0.150	0.115	0.097	0.070	0.124	0.240	0.023	0.017	0.030	0.051	0.037	0.066
	Total	16.199	10.860	22.758				0.210	3.397	2.308	4.523	0.147	0.500	0.343	0.662	1.104	0.756	1.461
	(3+)	7.167	5.181	9.152				0.436	3.123	2.136	4.110	0.150	0.469	0.323	0.615	1.034	0.712	1.356
Unit 4	2	1.144	0.109	2.179	0.391	0.128	0.050	0.040	0.046	0.004	0.088	0.108	0.005	0.000	0.009	0.011	0.001	0.021
	3	0.245	0.161	0.329	0.391	1.000	0.391	0.270	0.066	0.043	0.089	0.121	0.008	0.005	0.011	0.018	0.012	0.024
	4	0.466	0.306	0.627	0.391	1.000	0.391	0.270	0.126	0.083	0.169	0.141	0.018	0.012	0.024	0.039	0.026	0.053
	5	0.153	0.101	0.206	0.391	0.896	0.350	0.246	0.038	0.025	0.051	0.145	0.005	0.004	0.007	0.012	0.008	0.016
	6+	0.797	0.523	1.072	0.391	0.144	0.056	0.045	0.036	0.024	0.048	0.309	0.011	0.007	0.015	0.025	0.016	0.033
	Total	2.806	1.200	4.413				0.111	0.312	0.179	0.445	0.152	0.047	0.028	0.066	0.104	0.062	0.147
	(3+)	1.662	1.090	2.234				0.160	0.266	0.174	0.357	0.159	0.042	0.028	0.057	0.093	0.061	0.126

Table 7-c. Estimated harvest of Lake Erie yellow perch for 2000. The exploitation rate is derived from optimal yield policy*, and the stock size estimate 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.
Selectivity values have been changed in Units 1-3 to mimic harvest patterns under a similar age-stock structure.
****Age 3 and age 4 values in italics for Units 1-3 have been changed to reflect Partnership and trawl regression estimates.***

		Stock Size (numbers)			Exploitation Rate				Catch (millions of fish)			Mean Wt. in Harvest	RAH Catch (millions of kg)			RAH Catch (millions of lbs)		
	Age	**Mean**	**Min.**	**Max.**	**F(opt)**	**s(age)**	**(F)**	**(u)**	**Mean**	**Min.**	**Max.**	(kg)	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Unit 1	2	18.556	8.661	28.451	0.519	***0.124***	0.064	0.051	0.955	0.446	1.465	0.091	0.087	0.041	0.133	0.192	0.090	0.294
	3	8.152	5.926	10.377	0.519	***0.932***	0.484	0.321	2.618	1.903	3.333	0.100	0.261	0.190	0.332	0.575	0.418	0.732
	4	***14.025***	***12.579***	***15.471***	0.519	***1.000***	0.519	0.339	4.761	4.270	5.252	0.113	0.538	0.482	0.593	1.186	1.064	1.308
	5	1.196	0.869	1.522	0.519	***1.000***	0.519	0.339	0.406	0.295	0.517	0.134	0.054	0.040	0.069	0.120	0.087	0.153
	6+	0.664	0.483	0.845	0.519	***0.402***	0.209	0.156	0.104	0.075	0.132	0.180	0.019	0.014	0.024	0.041	0.030	0.052
	Total	37.709	22.585	52.833				0.235	8.844	6.990	10.698	0.108	0.959	0.766	1.152	2.114	1.689	2.540
	(3+)	19.153	13.924	24.382				0.412	7.889	6.544	9.233	0.111	0.872	0.725	1.018	1.922	1.599	2.245
Unit 2	2	25.807	15.145	36.470	0.477	***0.169***	0.081	0.064	1.652	0.969	2.334	0.112	0.185	0.109	0.262	0.409	0.240	0.578
	3	***9.030***	***6.497***	***11.563***	0.477	***1.000***	0.477	0.318	2.868	2.063	3.673	0.119	0.342	0.246	0.437	0.753	0.542	0.964
	4	11.378	8.931	13.824	0.477	***1.000***	0.477	0.318	3.614	2.837	4.391	0.137	0.496	0.390	0.603	1.095	0.859	1.330
	5	0.771	0.605	0.936	0.477	***1.000***	0.477	0.318	0.245	0.192	0.297	0.162	0.040	0.031	0.048	0.087	0.069	0.106
	6+	1.010	0.793	1.227	0.477	***0.211***	0.101	0.079	0.080	0.063	0.097	0.220	0.018	0.014	0.021	0.039	0.030	0.047
	Total	41.903	27.780	56.026				0.202	8.458	6.125	10.792	0.128	1.080	0.789	1.372	2.382	1.740	3.025
	(3+)	16.096	12.635	19.556				0.423	6.807	5.155	8.458	0.132	0.895	0.680	1.110	1.974	1.500	2.448
Unit 3	2	9.033	5.679	13.607	0.466	***0.074***	0.034	0.028	0.253	0.159	0.381	0.115	0.029	0.018	0.044	0.064	0.040	0.097
	3	***4.168***	***2.612***	***5.726***	0.466	***1.000***	0.466	0.312	1.300	0.814	1.785	0.131	0.170	0.107	0.234	0.375	0.235	0.516
	4	4.790	3.464	6.117	0.466	***1.000***	0.466	0.312	1.493	1.080	1.907	0.154	0.230	0.166	0.294	0.508	0.367	0.648
	5	0.854	0.618	1.091	0.466	***1.000***	0.466	0.312	0.266	0.193	0.340	0.187	0.050	0.036	0.064	0.110	0.079	0.140
	6+	0.843	0.609	1.076	0.466	***0.316***	0.147	0.113	0.096	0.069	0.122	0.240	0.023	0.017	0.029	0.051	0.037	0.065
	Total	16.199	10.860	22.758				0.210	3.408	2.315	4.535	0.147	0.502	0.344	0.665	1.108	0.759	1.466
	(3+)	7.167	5.181	9.152				0.440	3.155	2.156	4.154	0.150	0.473	0.326	0.621	1.043	0.718	1.369
Unit 4	2	1.144	0.109	2.179	0.391	0.128	0.050	0.040	0.046	0.004	0.088	0.108	0.005	0.000	0.009	0.011	0.001	0.021
	3	0.245	0.161	0.329	0.391	1.000	0.391	0.270	0.066	0.043	0.089	0.121	0.008	0.005	0.011	0.018	0.012	0.024
	4	0.466	0.306	0.627	0.391	1.000	0.391	0.270	0.126	0.083	0.169	0.141	0.018	0.012	0.024	0.039	0.026	0.053
	5	0.153	0.101	0.206	0.391	0.896	0.350	0.246	0.038	0.025	0.051	0.145	0.005	0.004	0.007	0.012	0.008	0.016
	6+	0.797	0.523	1.072	0.391	0.144	0.056	0.045	0.036	0.024	0.048	0.309	0.011	0.007	0.015	0.025	0.016	0.033
	Total	2.806	1.200	4.413				0.111	0.312	0.179	0.445	0.152	0.047	0.028	0.066	0.104	0.062	0.147
	(3+)	1.662	1.090	2.234				0.160	0.266	0.174	0.357	0.159	0.042	0.028	0.057	0.093	0.061	0.126

Table 8. Lake Erie yellow perch recommended allowable harvest (RAH) estimates for 2000. Estimates are based on the F(opt) fishing strategy. Three harvest strategy scenarios are presented. Scenario 1 (Standard Method) contains the original CAGEAN and selectivity estimates. Scenario 2 employs adjusted 1997 year class strength in Units 1-3. Scenario 3 uses adjusted selectivity values in Units 1-3 to a comparable age structure. All yield models estimate the 1998 year class recruiting into the fishery in 2000 using the standard parametric regression model.

Yield (Millions of Pounds) | **Yield (Millions of Kilograms)**

Scenario 1: Standard Method

	RAH (lb) Min.	Mean	Max.	RAH (kg) Min.	Mean	Max.
Unit 1	0.952	1.330	1.707	0.432	0.603	0.774
Unit 2	1.396	1.889	2.382	0.633	0.857	1.080
Unit 3	0.570	0.797	1.034	0.259	0.362	0.469
Unit 4	0.062	0.104	0.147	0.028	0.047	0.066
Total	**2.981**	**4.120**	**5.269**	**1.352**	**1.869**	**2.390**

Scenario 2: Re-evaluation of 1996 and 1997 Year Classes

	RAH (lb) Min.	Mean	Max.	RAH (kg) Min.	Mean	Max.
Unit 1	1.454	1.743	2.031	0.659	0.790	0.921
Unit 2	1.728	2.371	3.015	0.784	1.075	1.367
Unit 3	0.756	1.104	1.461	0.343	0.500	0.662
Unit 4	0.062	0.104	0.147	0.028	0.047	0.066
Total	**4.001**	**5.322**	**6.653**	**1.814**	**2.414**	**3.017**

Scenario 3: Changing Selectivity for 2000 + Scenario 2

	RAH (lb) Min.	Mean	Max.	RAH (kg) Min.	Mean	Max.
Unit 1	1.689	2.114	2.540	0.766	0.959	1.152
Unit 2	1.740	2.382	3.025	0.789	1.080	1.372
Unit 3	0.759	1.108	1.466	0.344	0.502	0.665
Unit 4	0.062	0.104	0.147	0.028	0.047	0.066
Total	**4.249**	**5.709**	**7.177**	**1.927**	**2.589**	**3.255**

Lake Erie Yellow Perch Task Group Management Units (MUs)

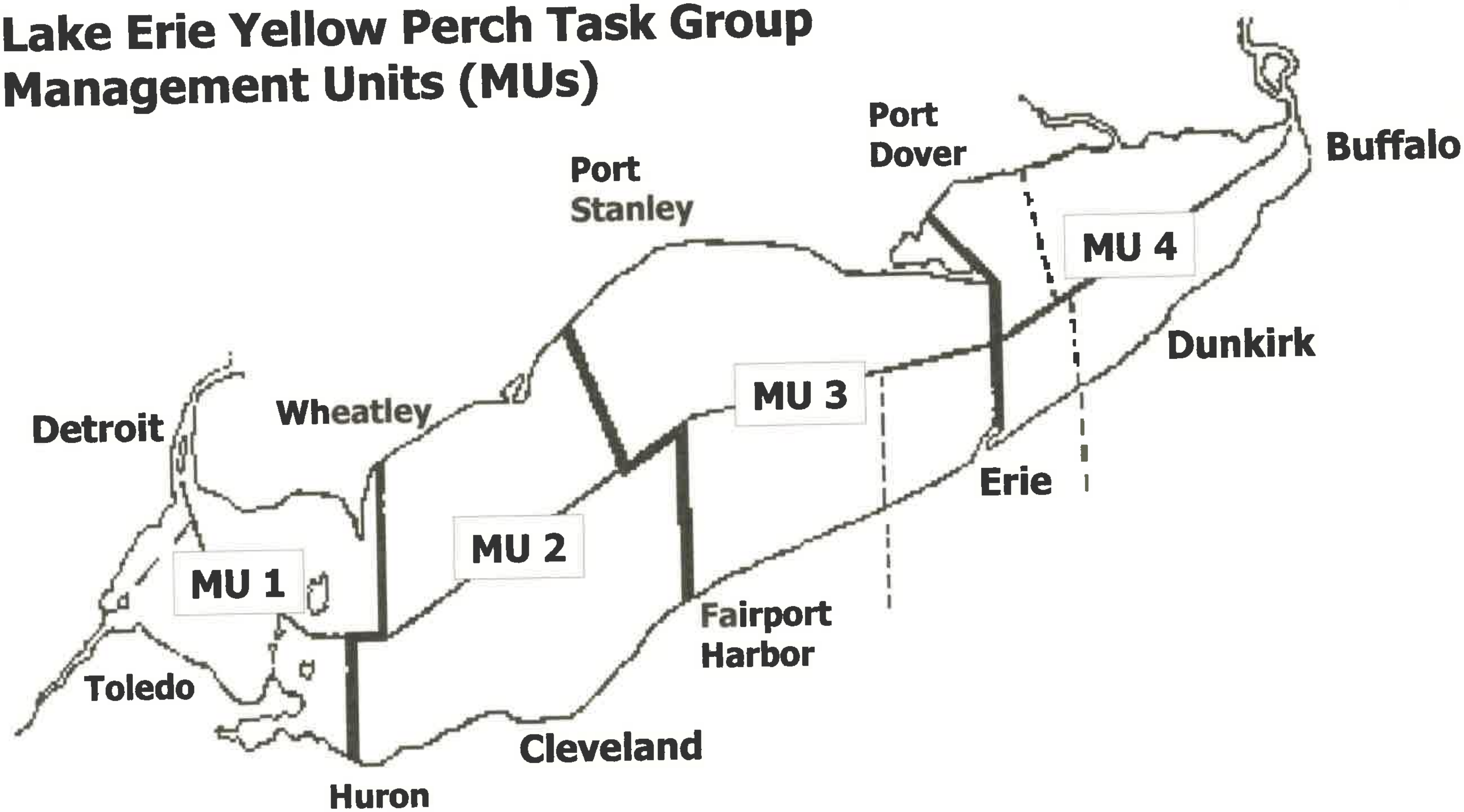


Figure 1. The Yellow Perch Task Group management units (MUs) of Lake Erie.

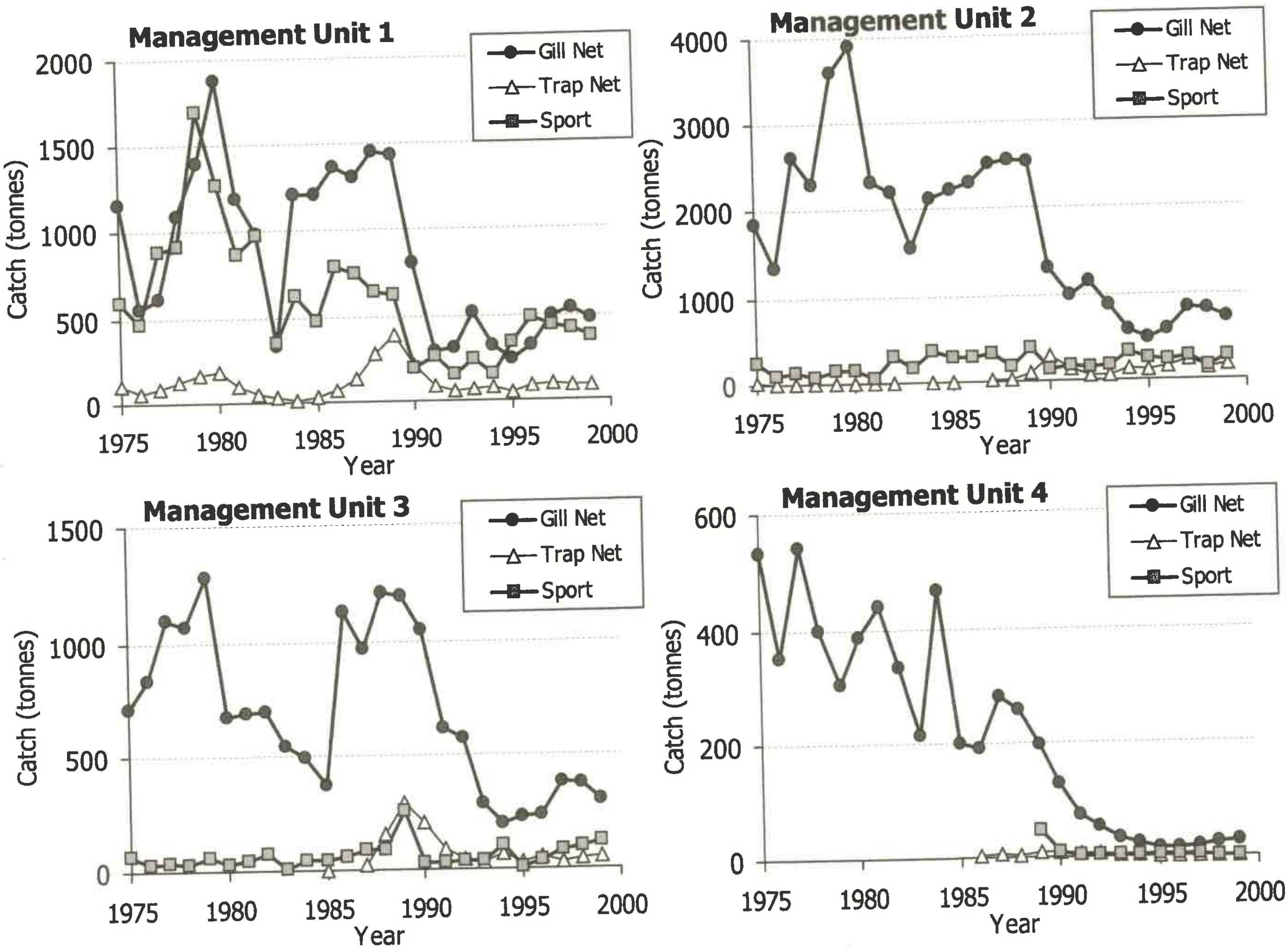


Figure 2. Lake Erie yellow perch harvest by management unit and gear type.

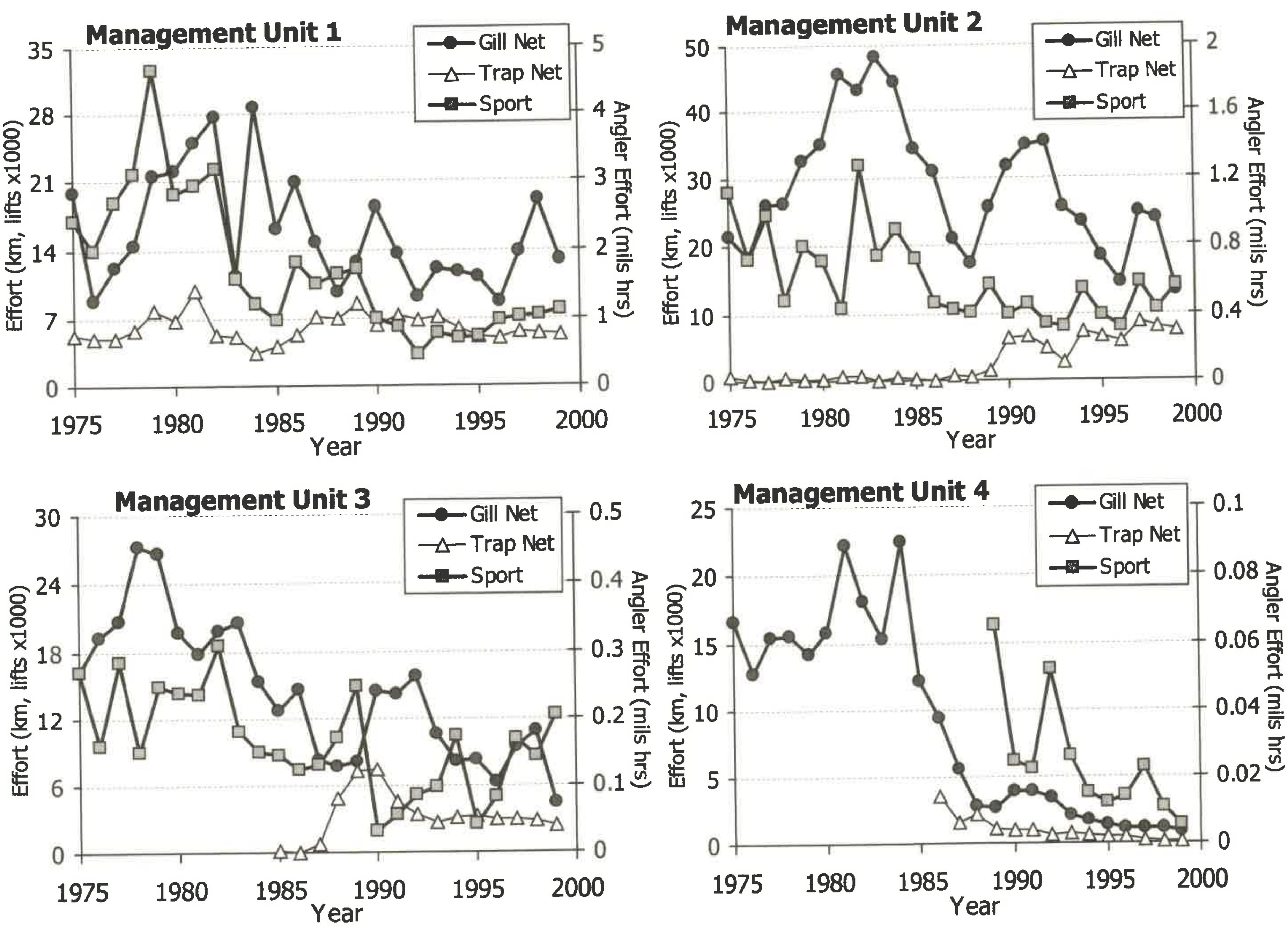


Figure 3. Lake Erie yellow perch effort by management unit and gear type.

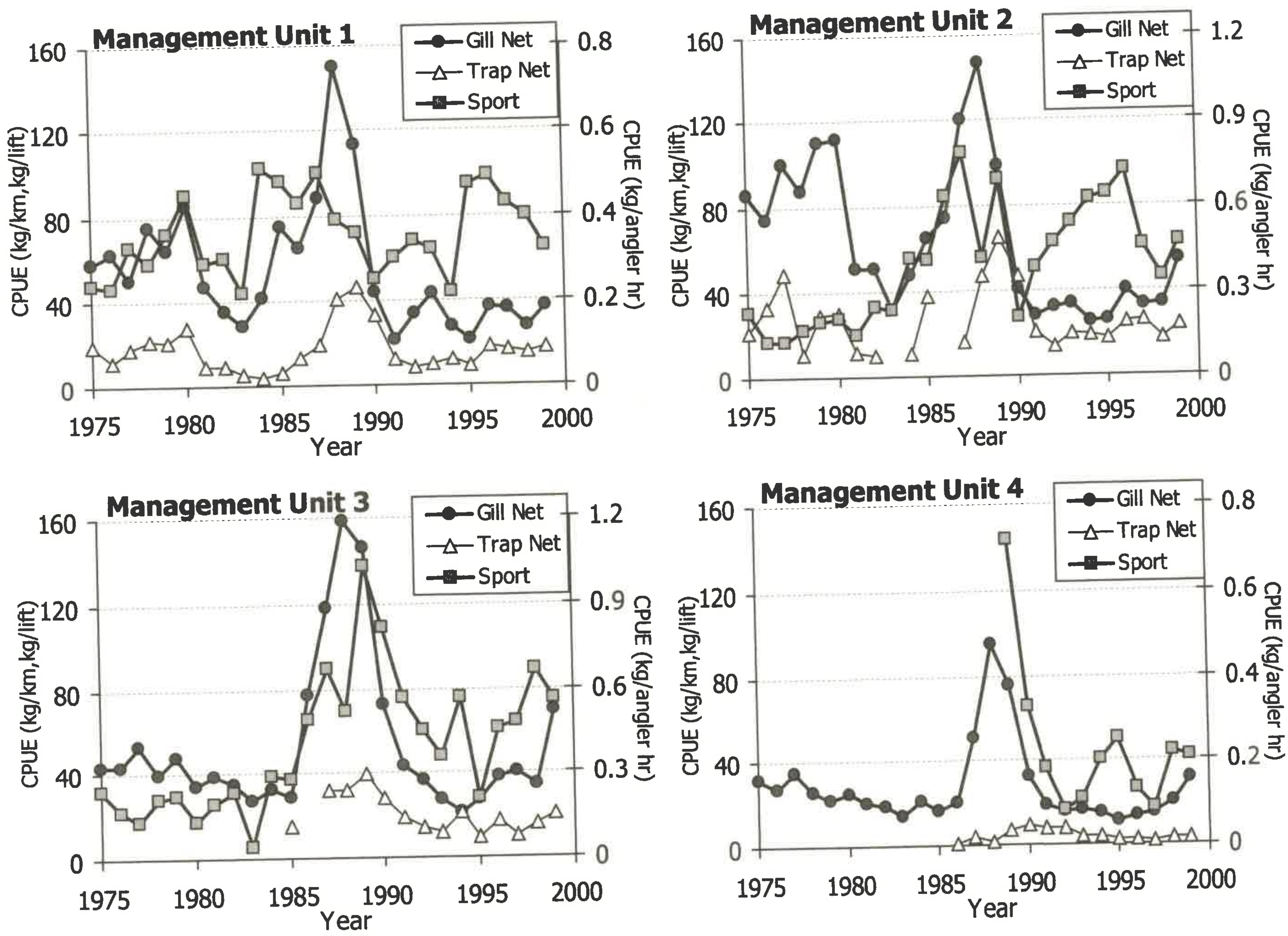


Figure 4. Lake Erie yellow perch catch per unit effort by management unit and gear type.

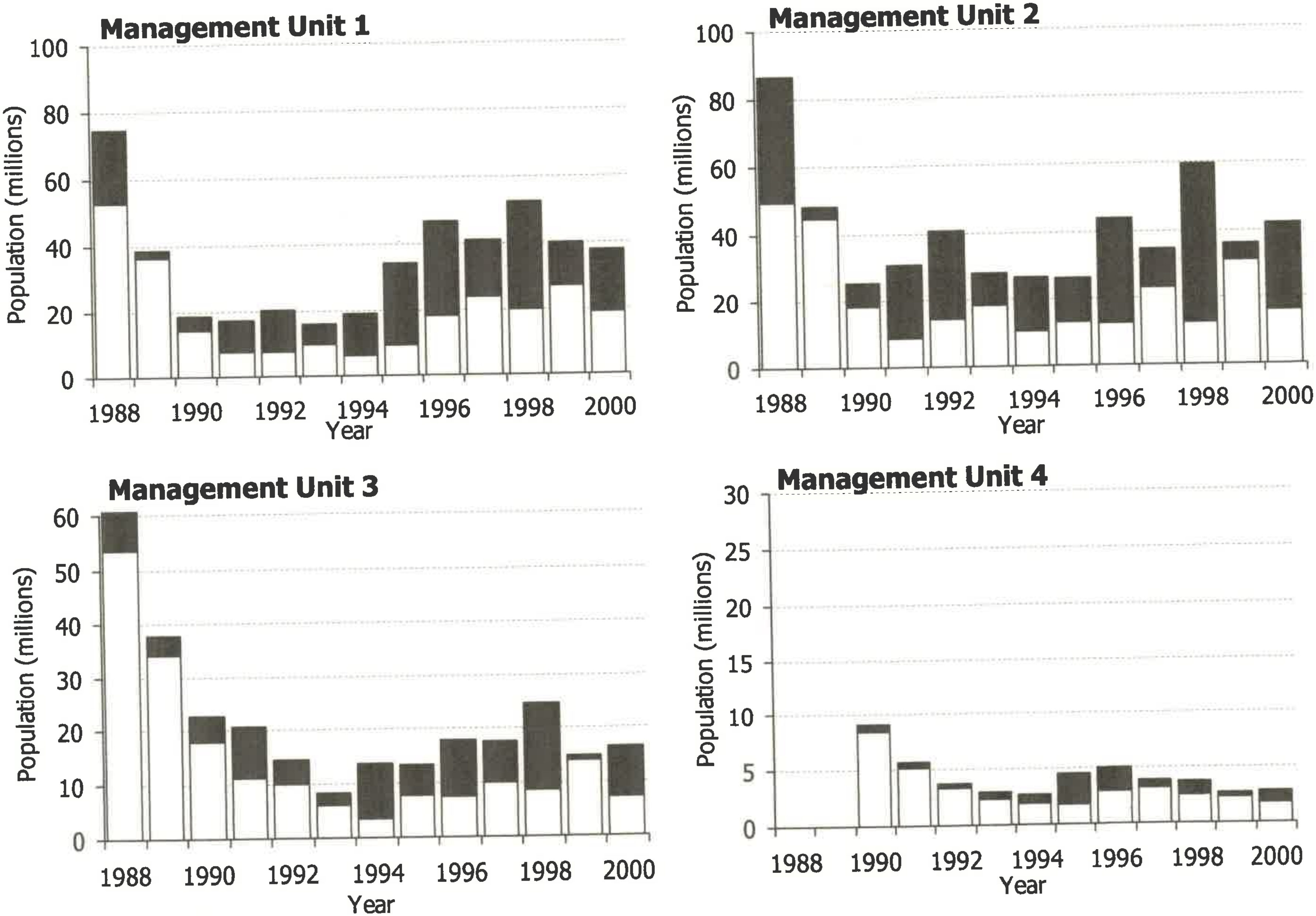


Figure 5. Lake Erie yellow perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2000 are from CAGEAN and parametric regressions for age 2.

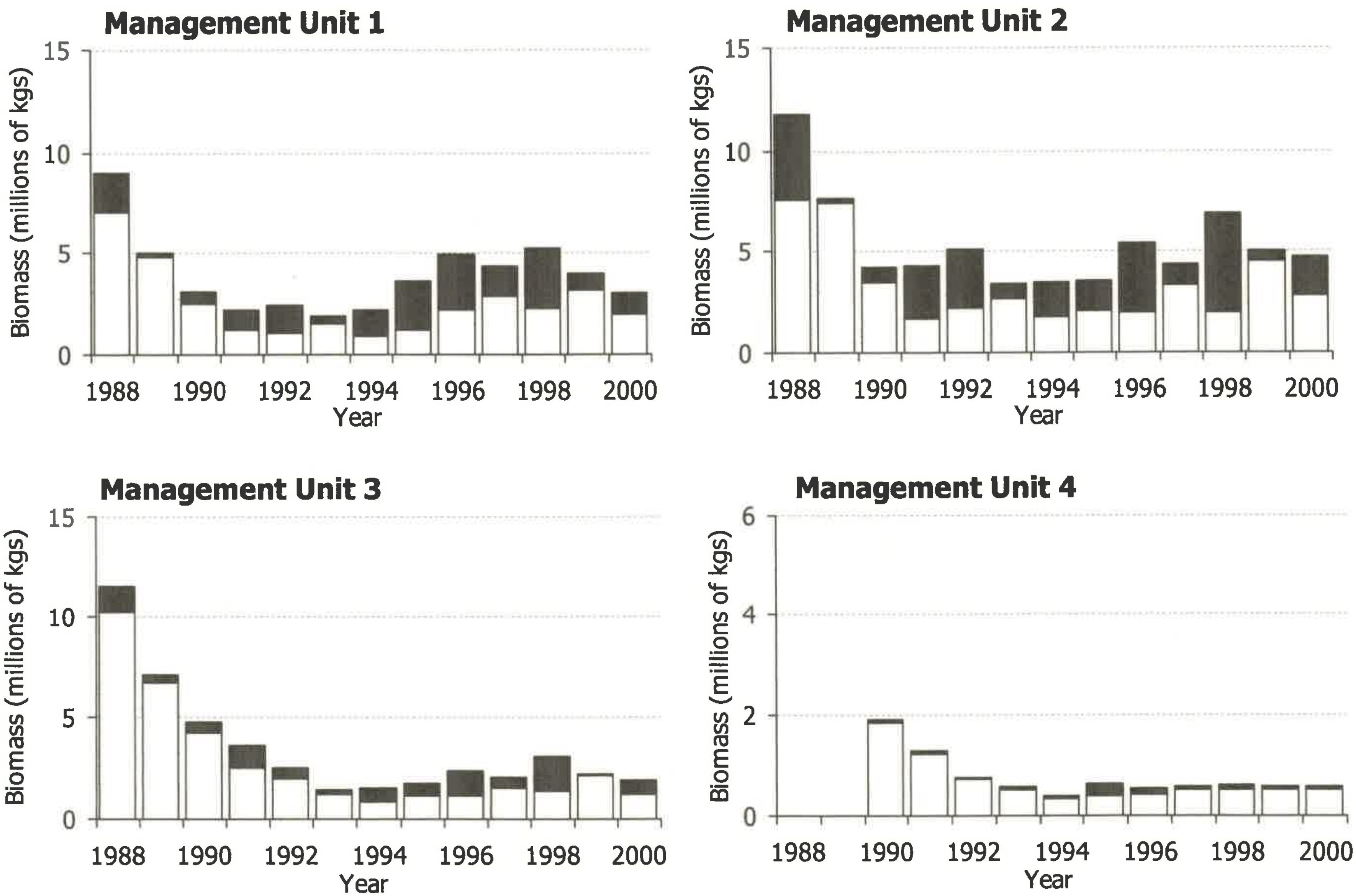
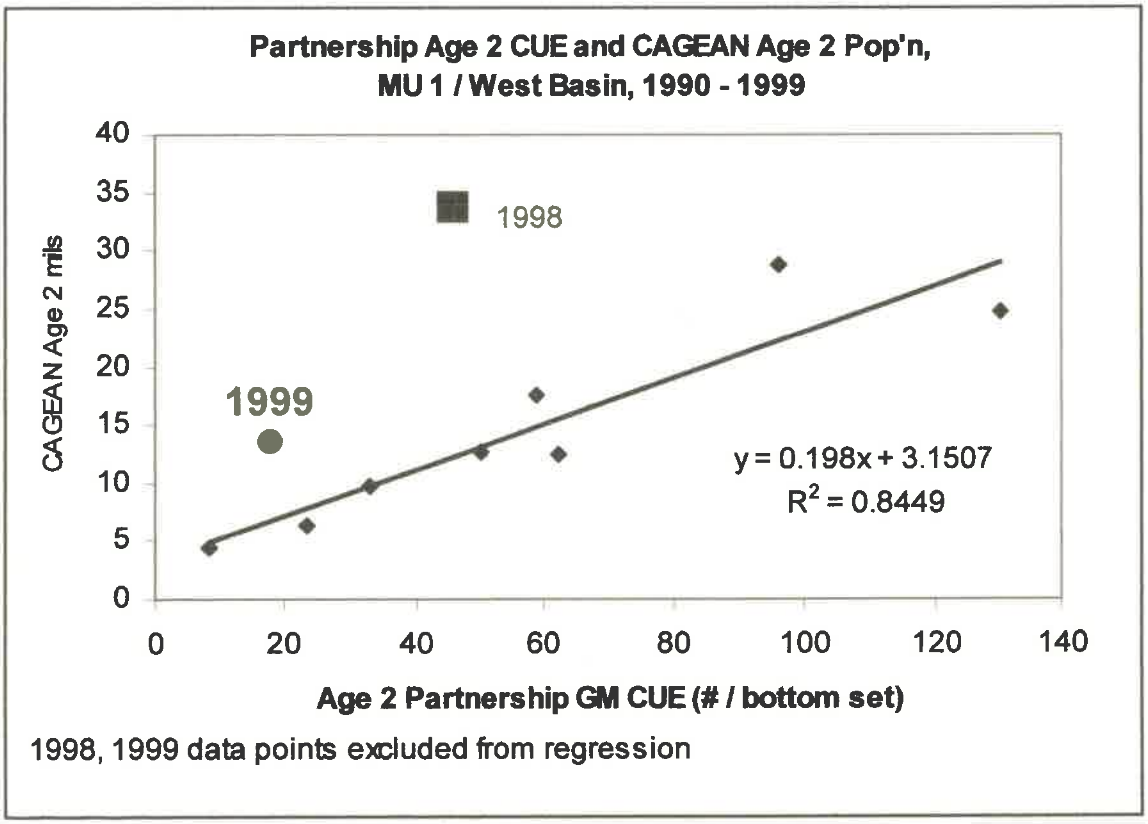


Figure 6. Lake Erie yellow perch biomass estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2000 are from CAGEAN and parametric regressions for age 2.



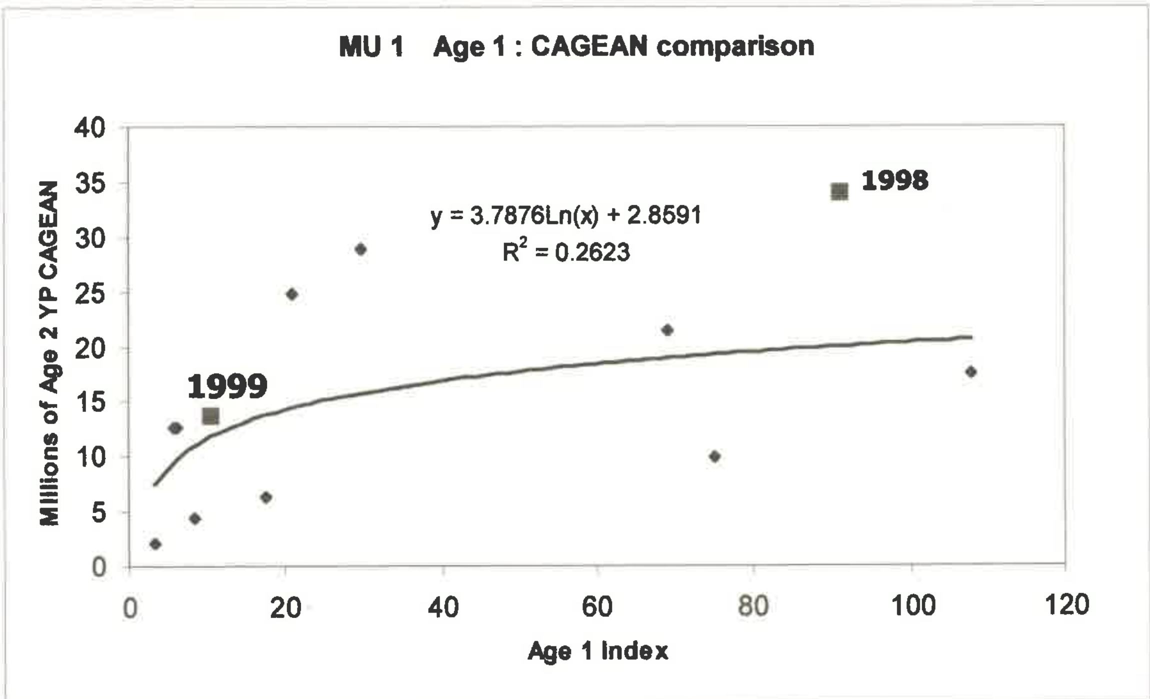
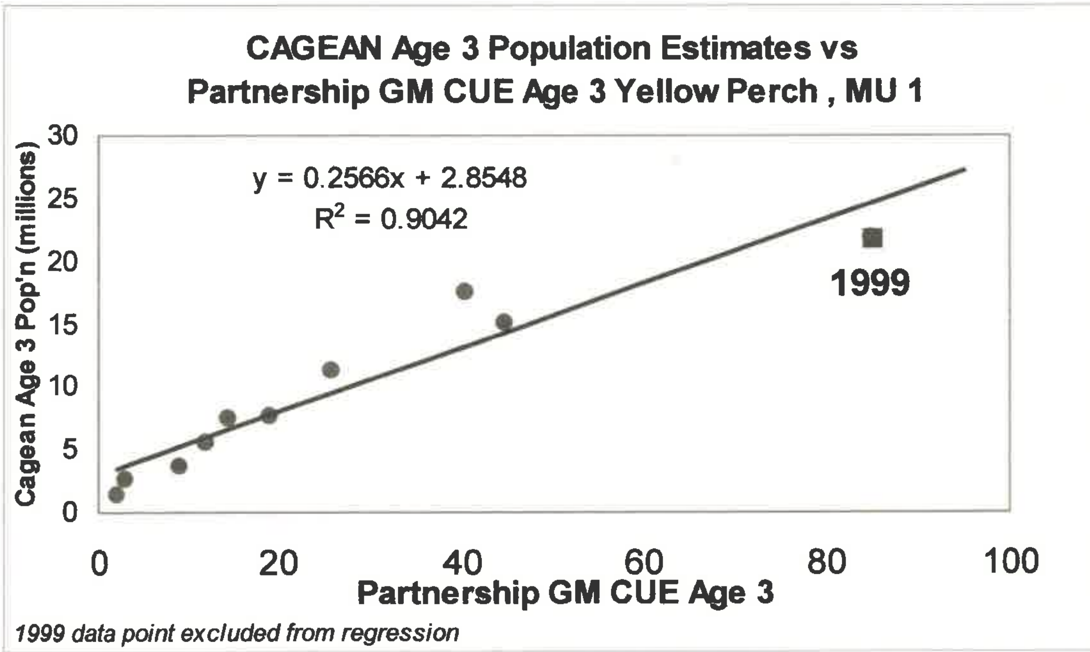


Figure 7. Data plots and regression equations (Ontario Partnership, top, and Ohio trawls, bottom) used to recalculate the 1997 year class as age 2 in 1999, Management Unit 1.



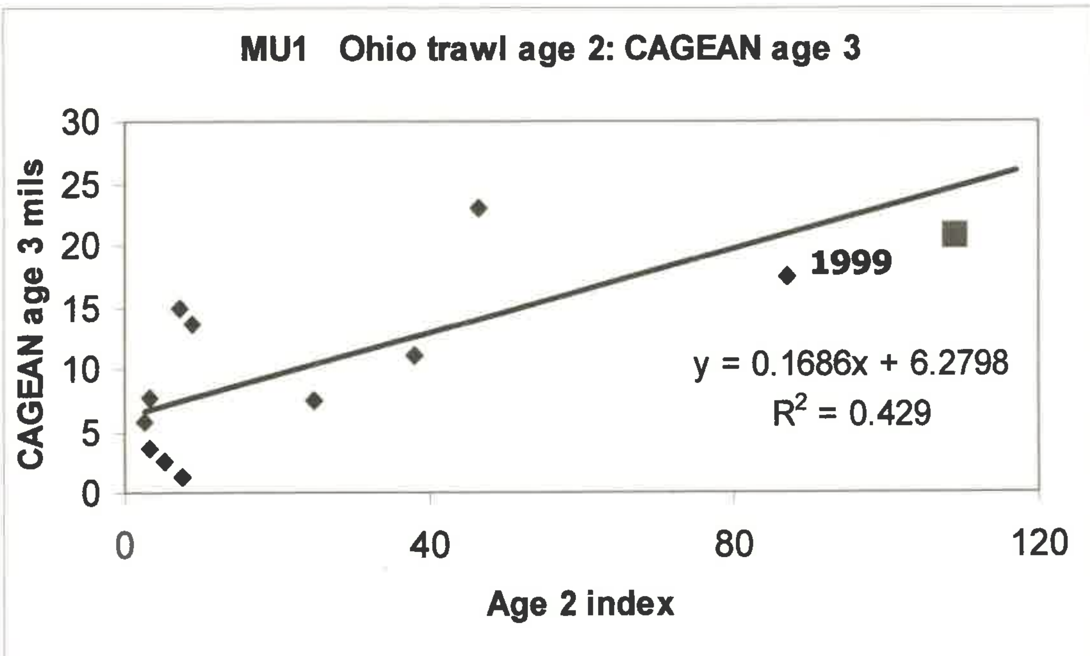


Figure 8. Data plots and regression equations (Ontario Partnership, top, and Ohio trawls, bottom) used to recalculate the 1996 year class as age 3 in 1999, Management Unit 1.

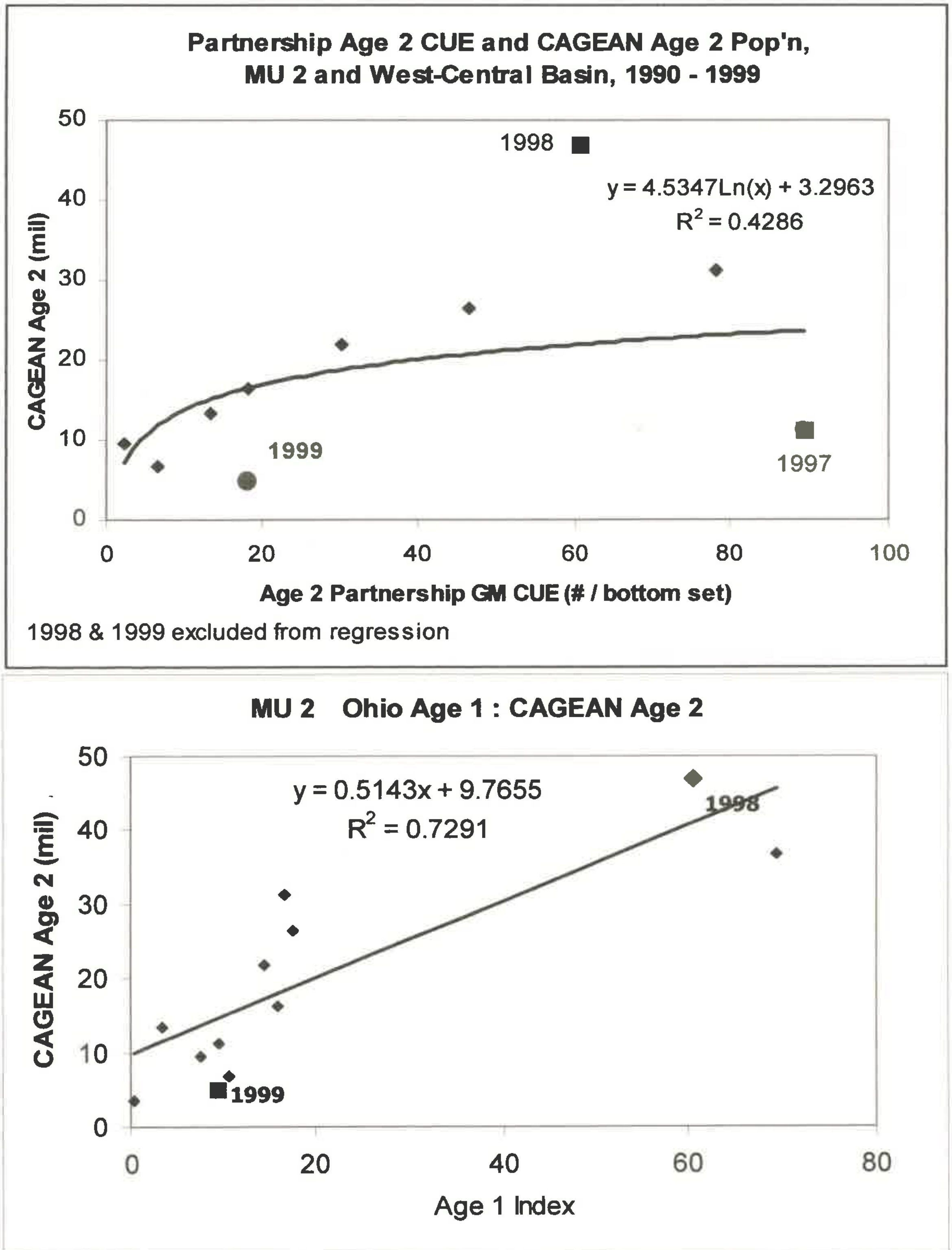


Figure 9. Data plots and regression equations (Ontario Partnership, top, and Ohio trawls, bottom) used to recalculate the 1997 year class as age 2 in 1999, Management Unit 2.

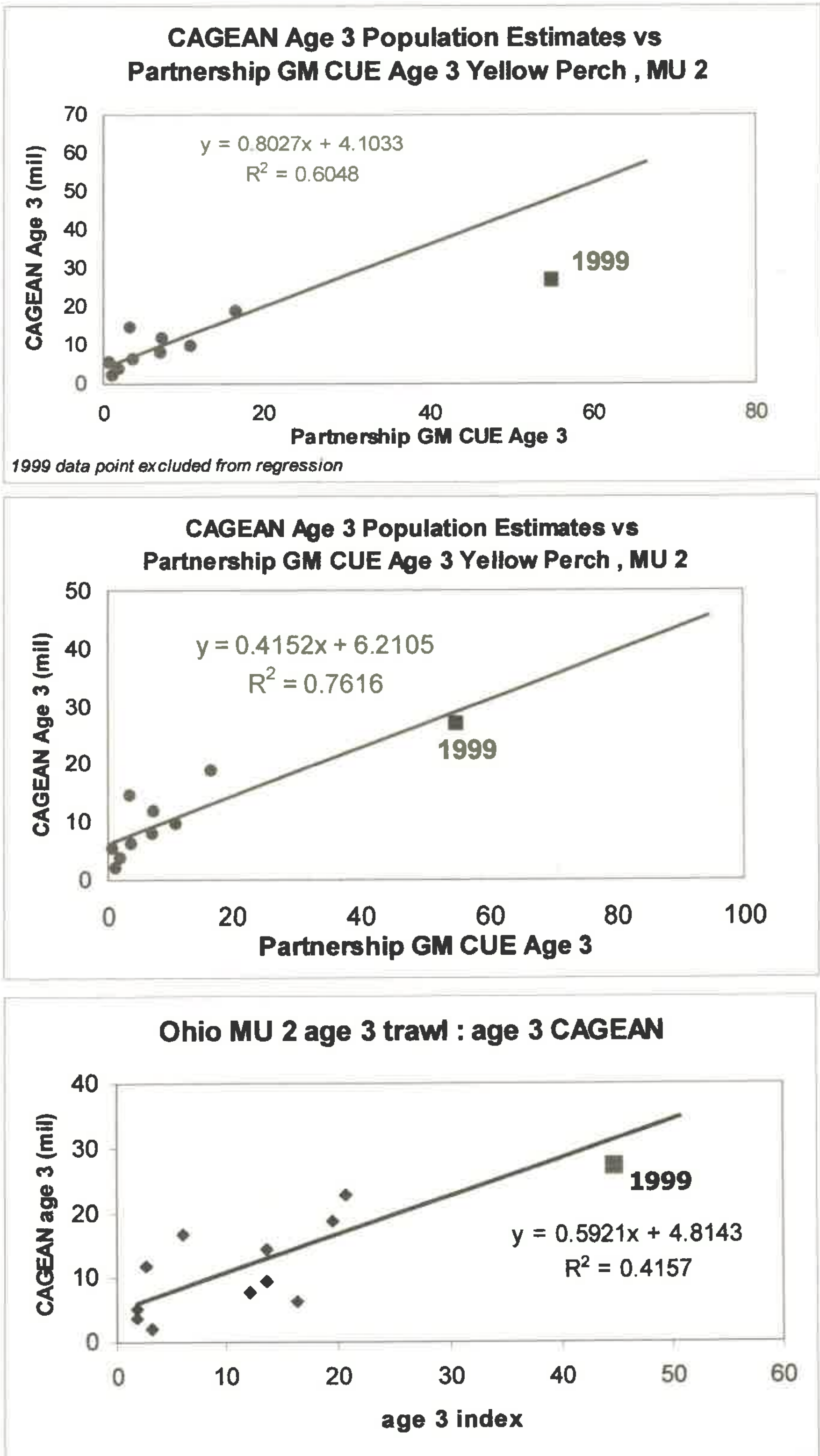
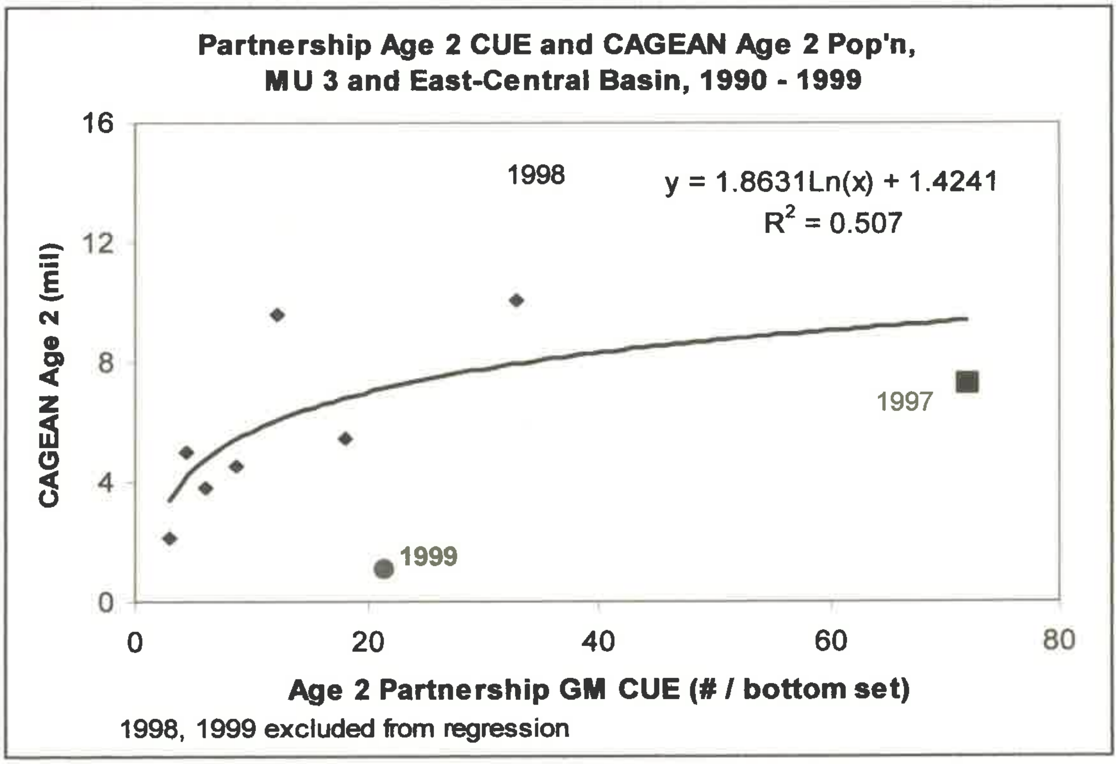


Figure 10. Data plots and regression equations (Ontario Partnership, top and middle, and Ohio trawls, bottom) used to recalculate the 1996 year class as age 3 in 1999, Management Unit 2.



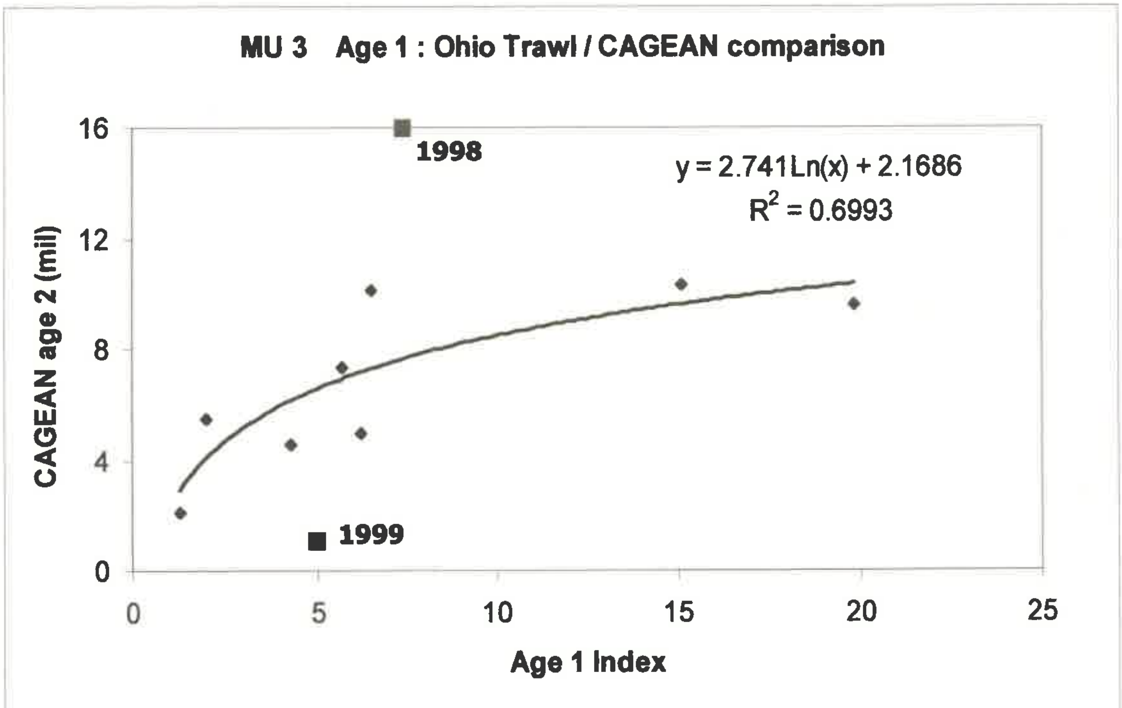
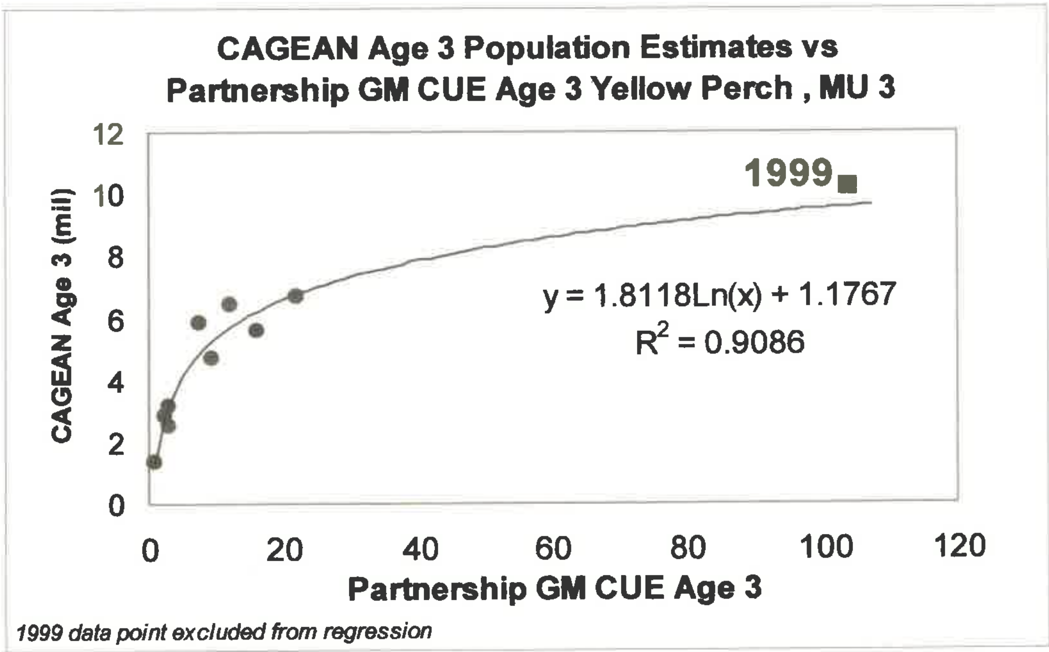


Figure 11. Data plots and regression equations (Ontario Partnership, top, and Ohio trawls, bottom) used to recalculate the 1997 year class as age 2 in 1999, Management Unit 3.



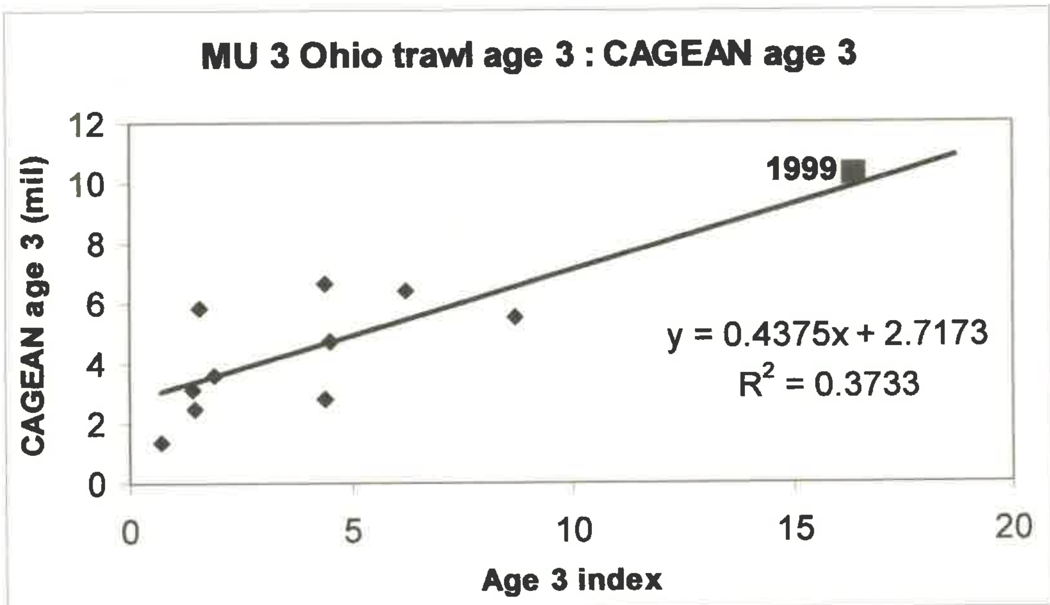


Figure 12. Data plots and regression equations (Ontario Partnership, top, and Ohio trawls, bottom) used to recalculate the 1996 year class as age 3 in 1999, Management Unit 3.

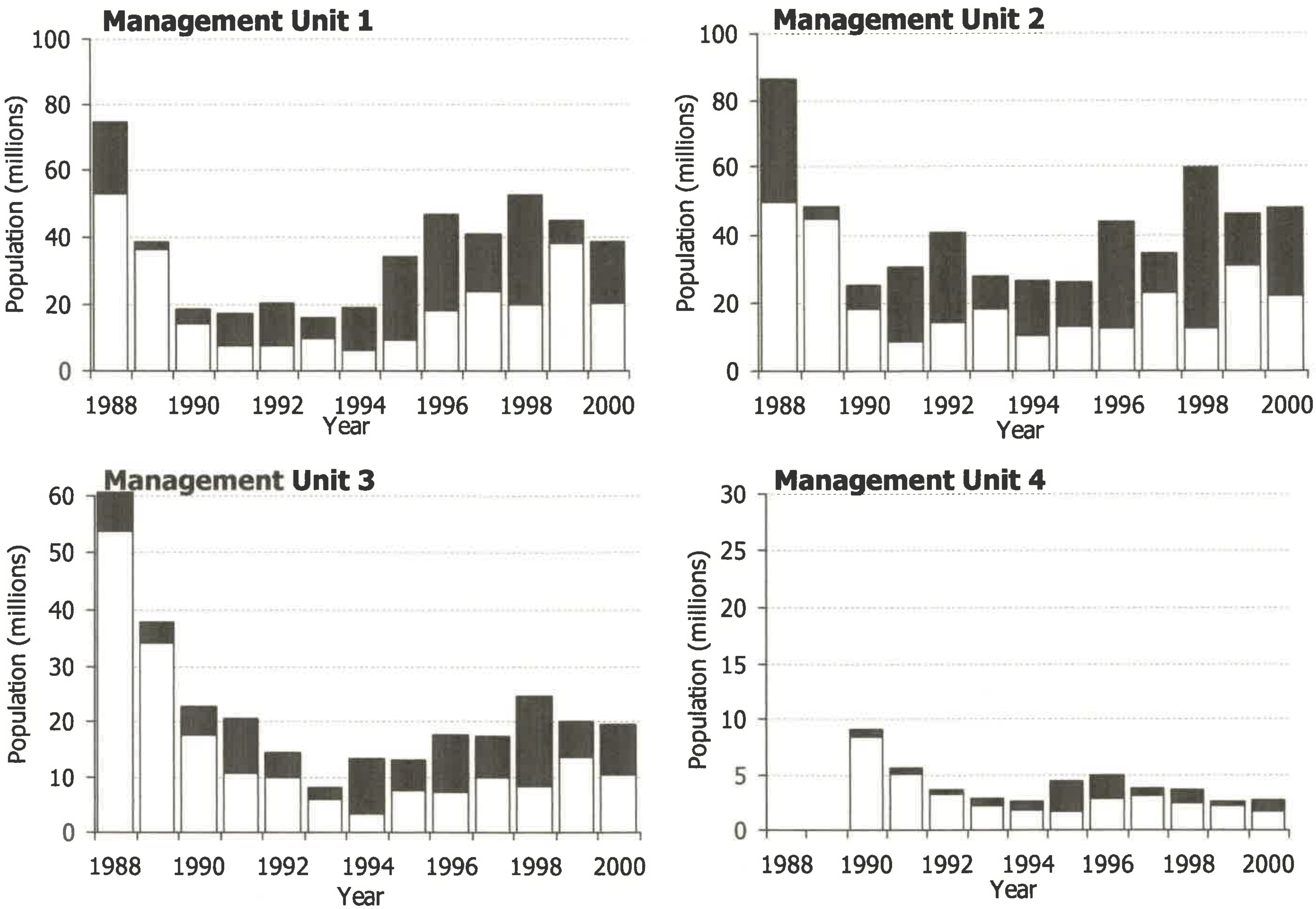


Figure 13. Lake Erie yellow perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 1999 and 2000 in Units 1-3 are adjusted for interagency regression estimates of the 1997 year class otherwise estimates are from CAGEAN and parametric regressions for age 2.

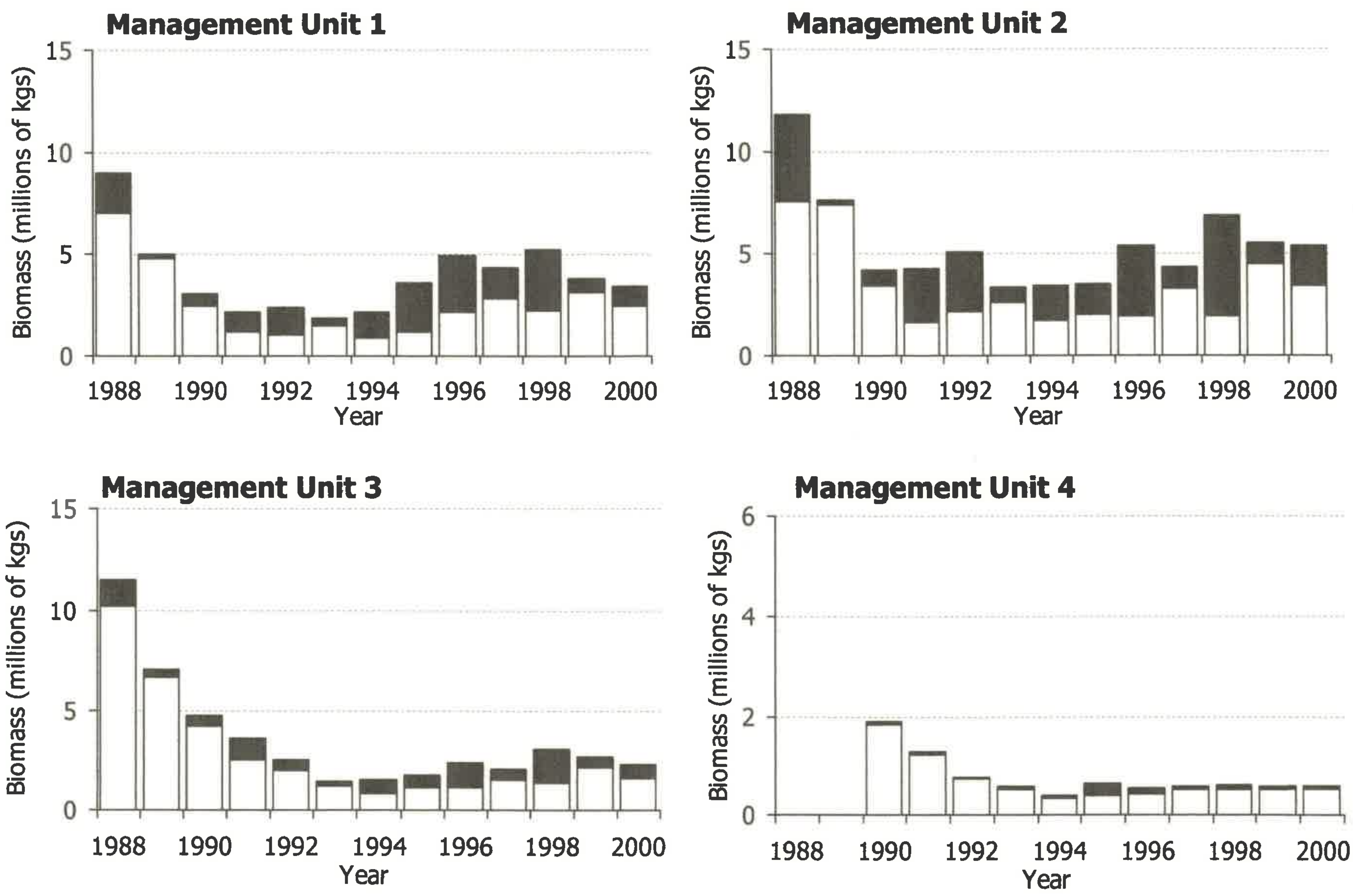


Figure 14. Lake Erie yellow perch biomass estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 1999 and 2000 in Units 1-3 are adjusted for interagency regression estimates of the 1996 and 1997 year classes. Otherwise estimates are from CAGEAN and parametric regressions for age 2.

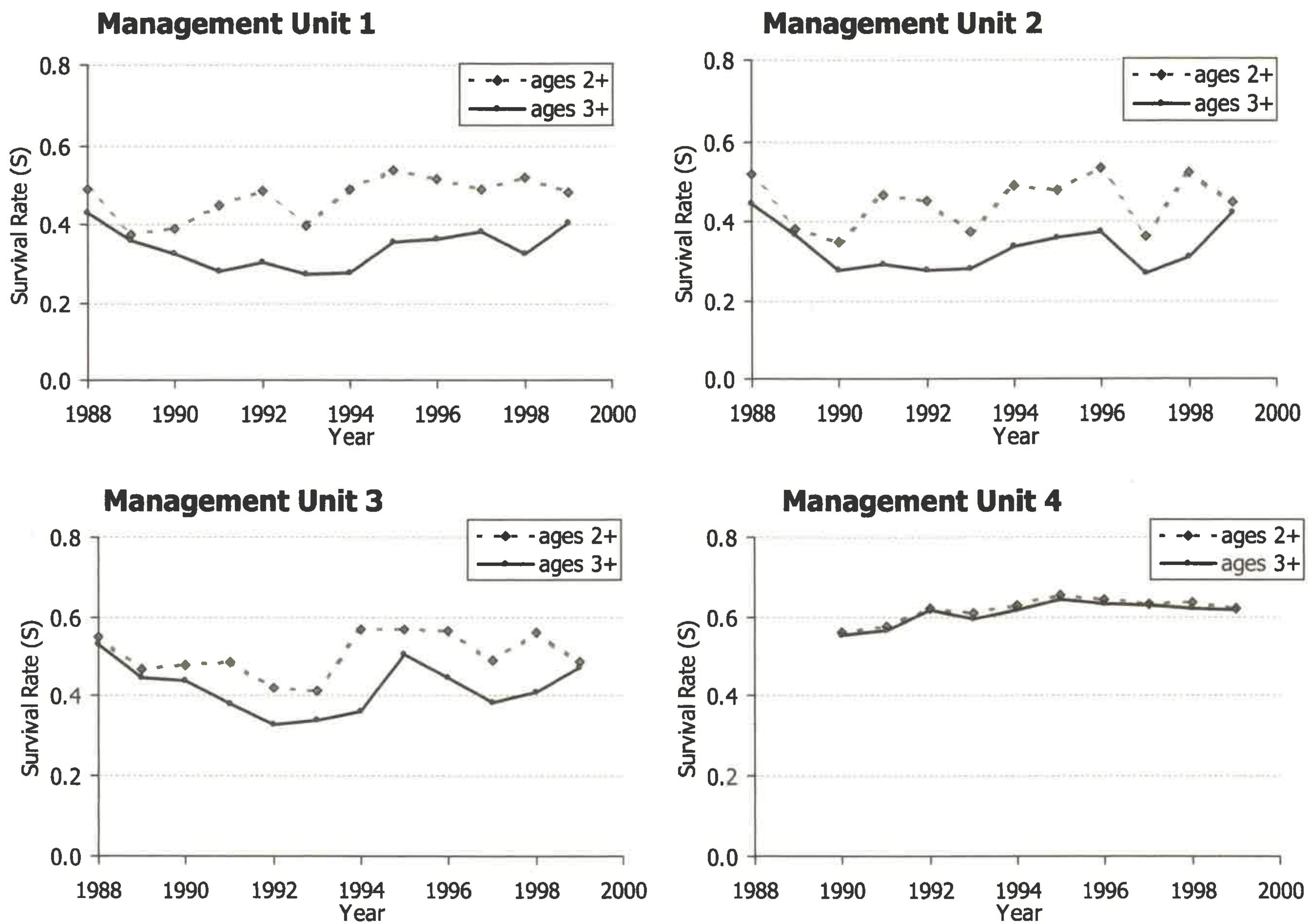


Figure 15. Lake Erie yellow perch survival rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from CAGEAN.

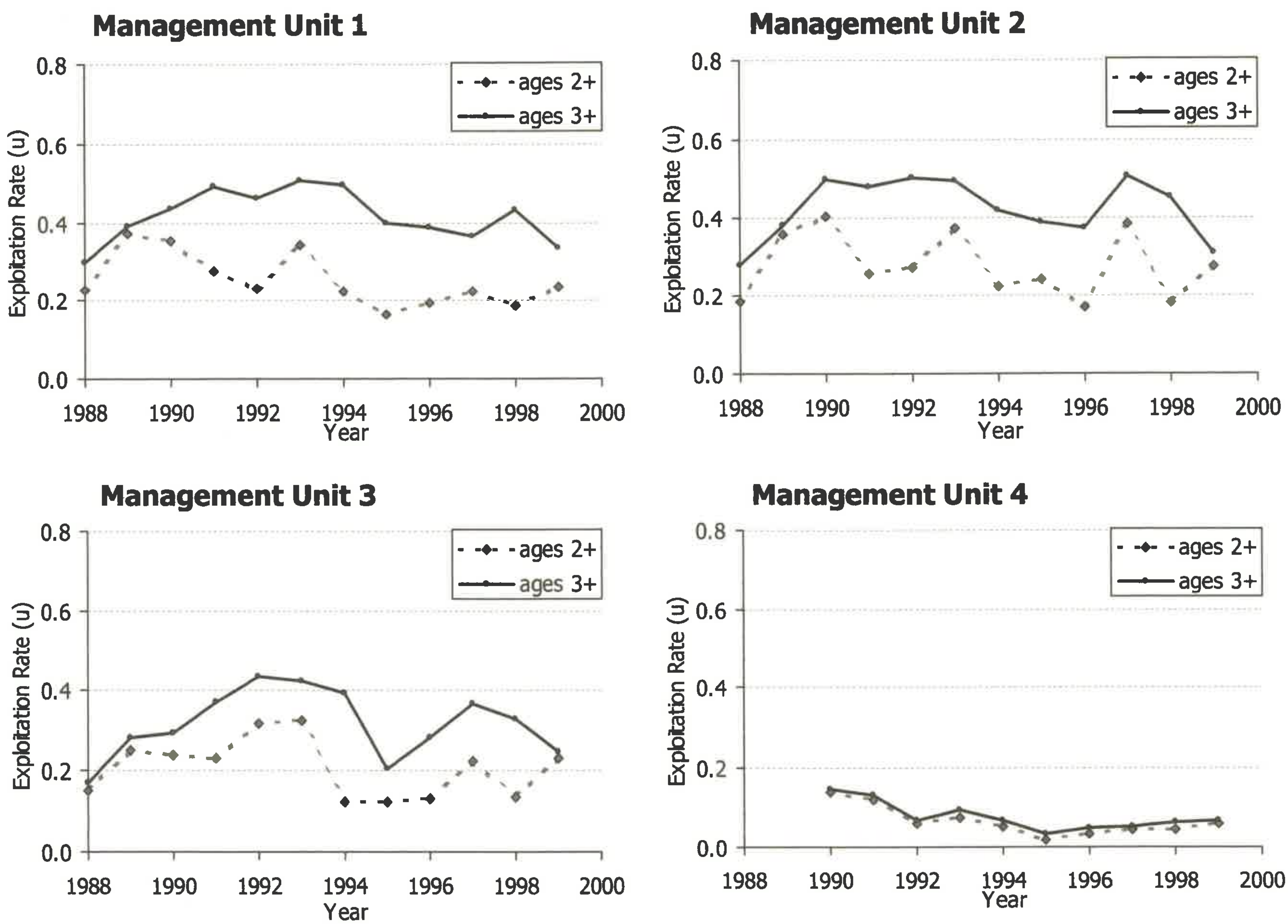


Figure 16. Lake Erie yellow perch exploitation rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from CAGEAN.

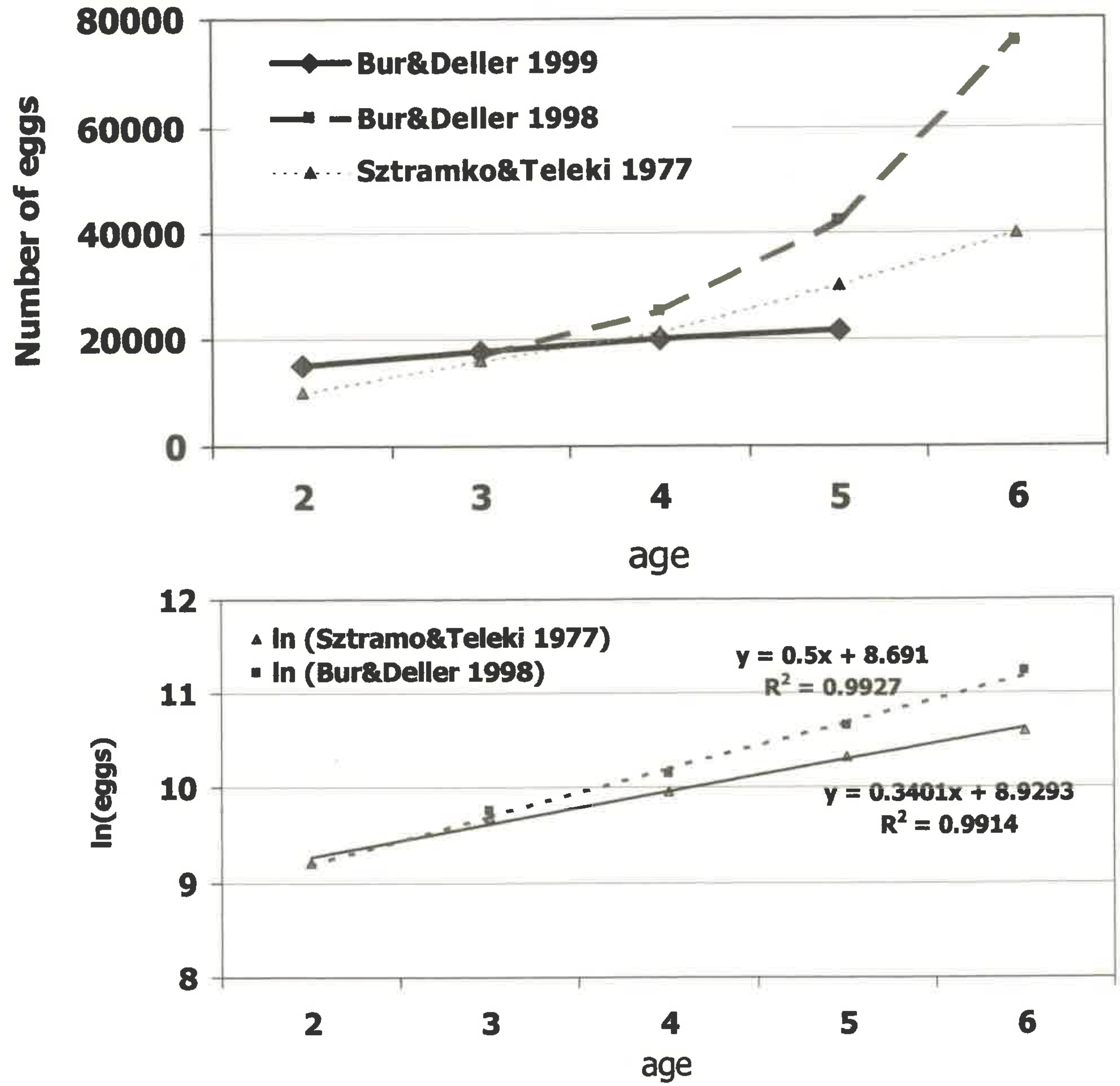


Figure 17. (Top) Lake Erie yellow perch fecundity rates for 1999 (solid line) and 1998 (heavy dashed line) from Bur and Deller, personal communication, compared to values from Sztramko and Teleki, 1977 (light dashed line). (Bottom) Sztramko and Teleki (1977) and Bur and Deller fecundity data by age fitted to a log function line.

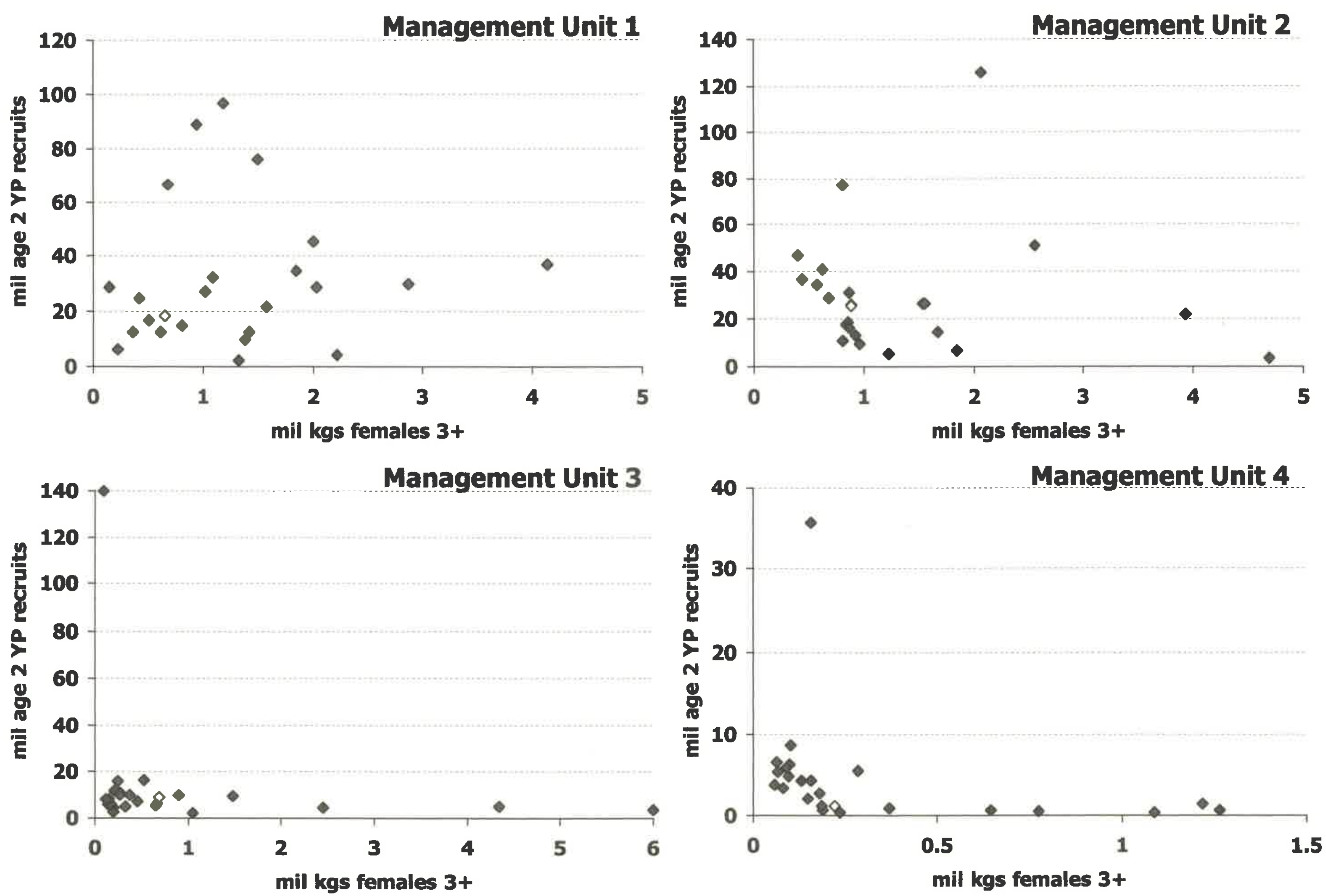


Figure 18. Yellow Perch Spawning Stock Biomass (millions of kgs, females ages 3 and older) versus age 2 recruits for each management unit. The white diamond in each graph represents the stock-recruit point for the 1998 year class.

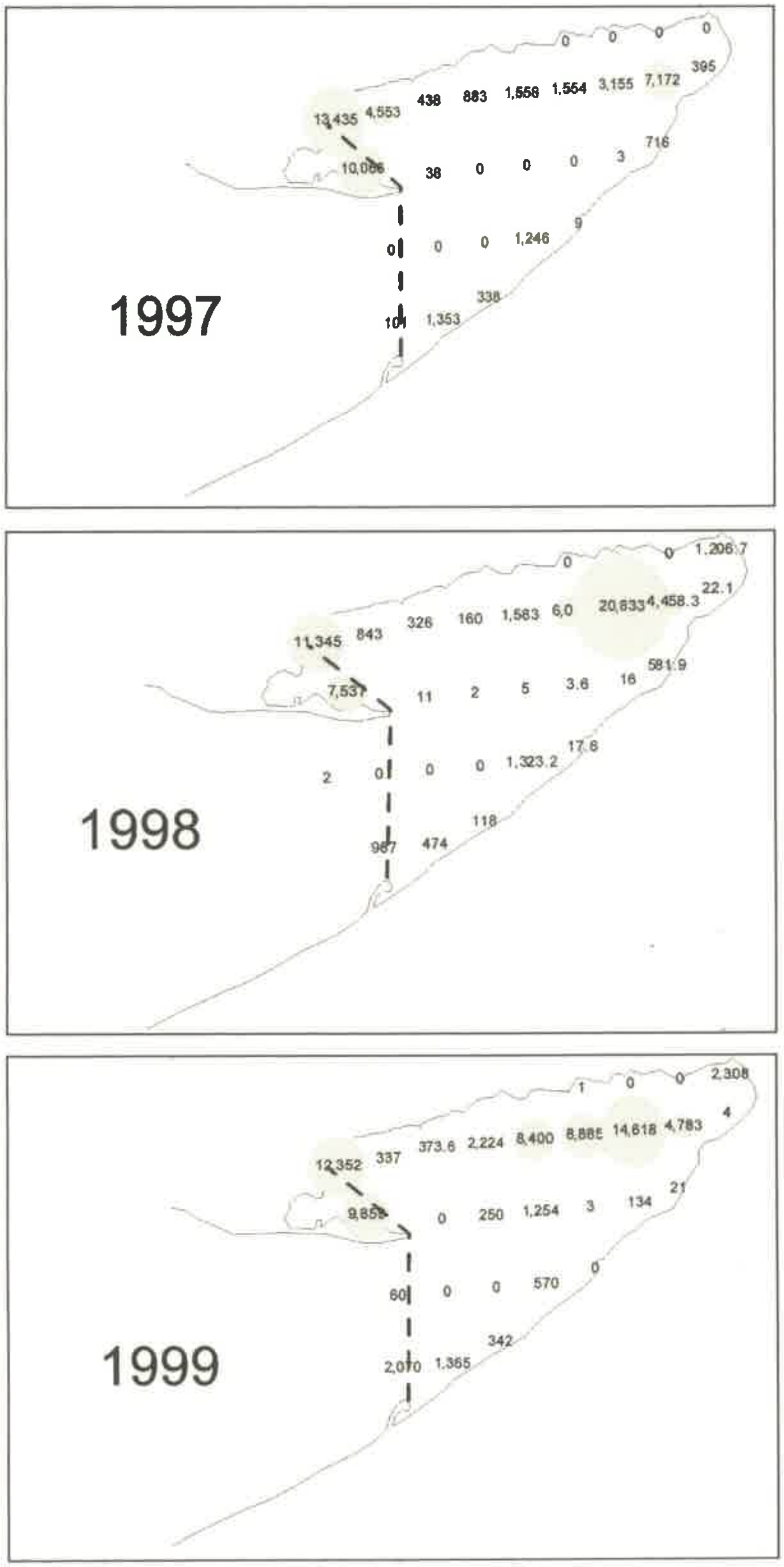


Figure 19. Comparison of Eastern Basin yellow perch harvests by standard ten minute grid, 1997-1999.

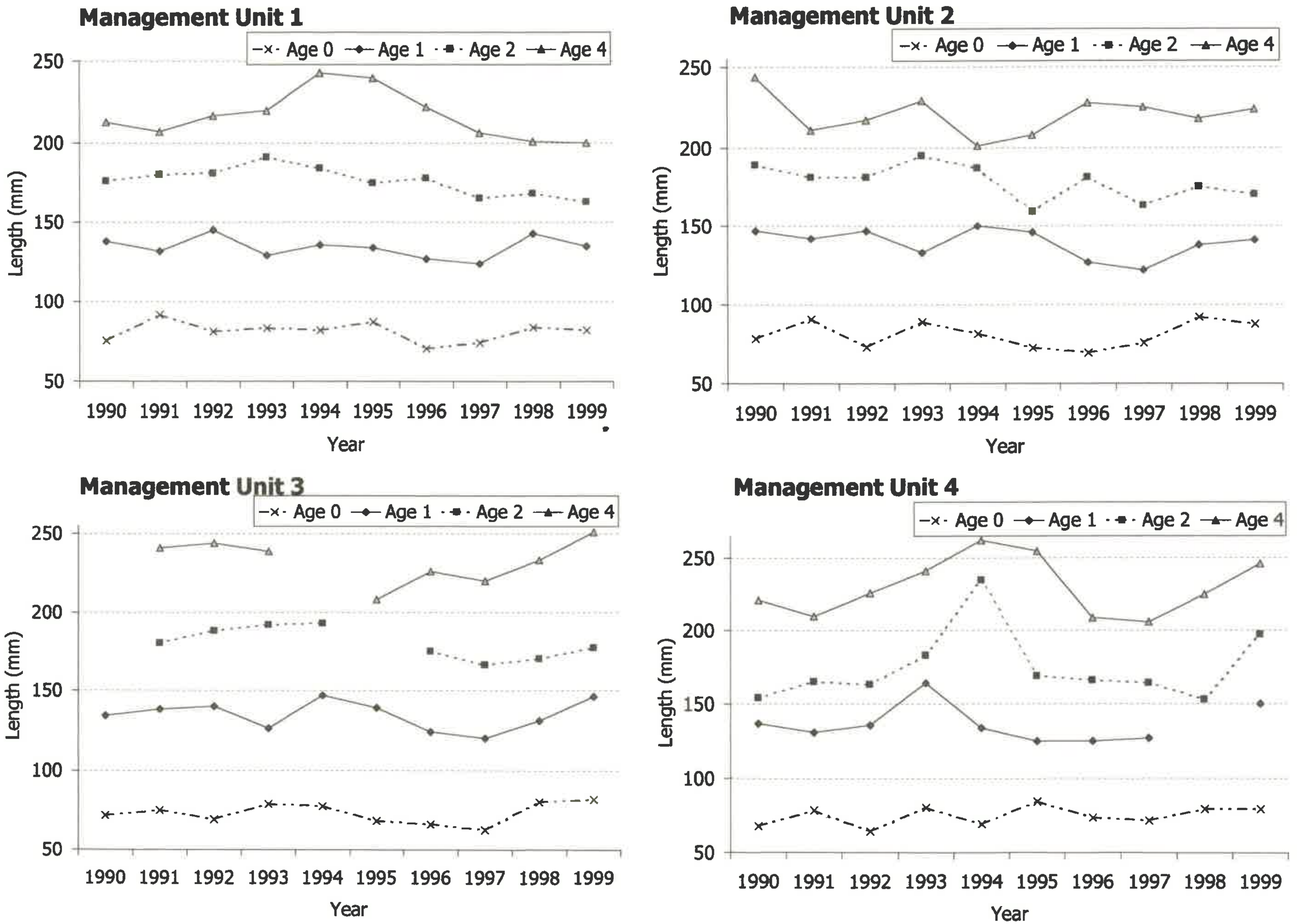
Appendix A. Review of Lake Erie Yellow Perch Growth Rates, Trends and Factors Affecting Growth

In this appendix, we present growth data (in length) for ages 0, 1, 2 and 4 by management unit. These ages are presented because:

- Age 0 lengths give us a good first look at year class performance and may set trends for cohorts in future.
- Age 1 length in the fall is a determining factor of size of fish as they recruit into fishery gear the next spring at age 2. Smaller fish will not recruit highly, and will not be selected for by gear such as gill nets and trap nets.
- Age 2 length is also important for the same reason, a determinant in timing of entry and higher recruitment and selectivity by the fishery.
- Age 4 length is important as showing size of fish being taken at full recruitment by all gears.

The general short-term trend shows smaller lengths-at-age achieved for these ages during 1996 and 1997, but since 1998 the trend reverses itself (Figure A-1). There are some long-term trends, though, that may be cautionary. These include the decline in length of Age 2 and Age 4 yellow perch in Unit 1. There were also variations in weight-at-age, as described in YPTG 1998, but our analyses again determined no trends or significant differences in yellow perch condition factor across any Unit or age group. We cannot directly attribute these trends in length to trophic changes or exotic expansion in Lake Erie, and certainly more analyses will be valuable in these regards.

The YPTG has also performed some analyses on abiotic and biotic factors that can affect growth of yellow perch to the end of age 0 and age 1 (YPTG 1999). Cooling degree days (CDD) is a daily mean temperature calculation, and can be a factor in describing the thermal energy input into Lake Erie during the growing season. In general, there was an increasing trend to growth rates with increasing heat input as evident from a higher sum of CDDs during the growing season. We will continue this analysis to determine factors that may be affecting yellow perch growth.



Appendix A: Figure A-1. Yellow perch length-at-age from October interagency experimental samples for ages 0, 1, 2, and 4 in Management Units 1 through 4.

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 available to the fishery in 2000. The YPTG continues to use parametric regression analysis to predict age 2 yellow perch abundance by management unit from interagency trawl surveys. Age 2 mean value estimates and their standard error estimates are then incorporated into Tables 6 and 7 in the main body of this report to complete abundance estimates, yield per recruit, and RAH projections for 2000.

Trawl series data was updated again this year with interagency data. The 1998 cohort was a moderate one in all management units compared to the strong year class produced in 1996 and the weak year class of 1997. These estimates are substantiated from many trawl series giving significant relationships in each management unit. The Unit 4 estimate is considered less robust due to the low number of significant regression models contributing to the estimate.

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 geometric mean catch per trawl hour. Table B-3 contains trawl data series in arithmetic mean catch per trawl hour. Definitions of the trawl series abbreviations used in Tables B-2 and B-3 can be found in the Legend that follows these tables.

Appendix B: Table B-1. Agency trawl regression indices found statistically significant for projecting estimates of age 2 yellow perch by management unit.

Management Unit 1

Index	Slope	Intercept	Index Value	P value	Age-2 estimate	R-SQUARE	Upper Age 2 CI.	Lower Age 2 CI.	Std Error of Est.
OHS11G	532,620	5,565,530	27.8	0.0001	20,372,366	0.815	28,889,095	11,855,637	4,345,270
PAF30G	108,950	8,789,440	0.2	0.003	8,811,230	0.640	13,874,545	3,747,915	2,583,324
OHS10A	7,980	10,441,490	195.4	0.005	12,000,782	0.600	17,686,080	6,315,484	2,900,662
ONTS10A	8,220	7,963,480	285.4	0.005	10,309,468	0.600	17,292,164	3,326,772	3,562,600
USF11A	321,860	8,908,900	28.8	0.006	18,178,468	0.590	28,610,007	7,746,929	5,322,214
USS11G	845,880	6,636,090	29.2	0.006	31,335,786	0.590	51,299,174	11,372,398	10,185,402
OHF10A	40,020	8,375,570	281.7	0.008	19,649,204	0.570	31,966,575	7,331,833	6,284,373
USS10A	2,130	11,611,400	138.7	0.010	11,906,831	0.540	16,962,283	6,851,379	2,579,312
OHF31A	170,150	12,843,620	112.4	0.014	31,968,480	0.660	47,913,068	16,023,892	8,134,994
OHF21A	53,490	13,478,060	123.8	0.027	20,100,122	0.590	29,996,546	10,203,698	5,049,196
OHS20A	8,640	14,633,450	561.6	0.035	19,485,674	0.620	28,474,893	10,496,455	4,586,336
				mean	**18,556,219**		**28,451,312**	**8,661,127**	5,048,517

Management Unit 2

Index	Slope	Intercept	Index Value	P value	Age-2 estimate	R-SQUARE	Upper Age 2 CI.	Lower Age 2 CI.	Std Error of Est.
OHF21G	825,710	8,678,660	56.8	0.0002	55,578,988	0.912	71,619,275	39,538,701	8,183,820
OHF20A	112,120	10,736,260	199.7	0.001	33,126,624	0.924	42,950,301	23,302,947	5,012,080
OHF10A	59,500	7,708,400	281.7	0.001	24,469,550	0.822	36,061,676	12,877,424	5,914,350
OHS10G	56,590	14,970,200	71.8	0.001	19,033,362	0.640	27,473,083	10,593,641	4,305,980
ONTS10G	55,880	11,412,010	112.5	0.001	17,698,510	0.793	25,394,646	10,002,374	3,926,600
USS11G	1,180,400	7,769,140	12.7	0.002	22,760,220	0.773	35,400,158	10,120,282	6,448,948
USF10G	158,590	11,691,620	100.9	0.002	27,693,351	0.762	40,003,182	15,383,520	6,280,526
OHF31A	248,940	14,580,390	112.4	0.003	42,561,246	0.795	59,176,440	25,946,052	8,477,140
USS10A	2,750	14,415,650	138.7	0.007	14,797,075	0.665	21,039,000	8,555,150	3,184,656
PAF30G	129,410	12,600,780	0.2	0.012	12,626,662	0.622	19,768,980	5,484,344	3,644,040
OHS21G	39,760	17,253,800	11.6	0.013	17,715,016	0.674	23,994,229	11,435,803	3,203,680
OHS30A	6,240	15,912,460	751.3	0.014	20,600,572	0.736	29,657,948	11,543,196	4,621,110
OHF30A	125,920	14,180,270	100.5	0.018	26,835,230	0.703	41,574,822	12,095,638	7,520,200
				mean	**25,807,416**		**36,470,288**	**15,144,544**	5,440,241

Management Unit 3

Index	Slope	Intercept	Index Value	P value	Age-2 estimate	R-SQUARE	Upper Age 2 CI.	Lower Age 2 CI.	Std Error of Est.
OHF30G	316,650	3,913,570	18.3	0.009	9,708,265	0.771	15,105,968	4,310,562	2,753,930
USS10A	865	5,944,200	138.7	0.011	6,064,176	0.631	8,186,767	3,941,584	1,082,955
ONTS10G	15,960	5,257,050	112.5	0.012	7,052,550	0.620	10,413,656	3,691,444	1,714,850
PAF30G	41,560	5,319,370	0.2	0.012	5,327,682	0.615	7,655,927	2,999,437	1,187,880
BOHF21G	193,570	4,646,820	54.8	0.016	15,254,456	0.648	24,326,238	20,826,952	4,628,460
OHF20A	32,950	4,623,440	199.7	0.019	11,203,555	0.702	17,755,874	4,651,236	3,343,020
OHS30A	2,040	5,937,000	751.3	0.020	7,469,652	0.692	10,738,305	4,200,999	1,667,680
OHF31A	73,490	5,959,310	112.4	0.024	14,219,586	0.599	22,139,240	6,299,932	4,040,640
OHS10G	16,650	6,227,120	71.8	0.026	7,422,590	0.531	10,528,641	4,316,539	1,584,720
OHS20A	4,280	5,741,350	561.6	0.026	8,144,998	0.660	12,271,464	4,018,532	2,105,340
OHF10G	37,050	5,962,080	104.4	0.028	9,830,100	0.522	14,973,062	4,687,138	2,623,960
OHS21G	1,230	6,680,150	11.6	0.034	6,694,418	0.557	9,185,970	4,202,866	1,271,200
				mean	**9,032,669**		**13,606,759**	**5,678,935**	2,333,720

Management Unit 4

Index	Slope	Intercept	Index Value	P value	Age-2 estimate	R-SQUARE	Upper Age 2 CI.	Lower Age 2 CI.	Std Error of Est.
NYF41A	63,080	601,980	13.5	0.048	1,453,560	0.664	2,746,964	160,156	659,900
NYF40G	34,510	814,430	0.6	0.091	835,136	0.668	1,611,610	58,662	396,160
				mean	**1,144,348**		**2,179,287**	**109,409**	709,618

Appendix B. Table B-2. Geometric index values from lakewide trawl surveys.

Year	ONTS10G	OHS10G	OHS11G	OHF10G	OHF11G	USS10G	USS11G	USF10G	USF11G	ONOHP10G	OHS20G	OHS21G	OHF20G	OHF21G
1980	-	10.5	0.0	69.0	10.4	-	-	-	-	-	-	-	-	-
1981	-	3.0	7.9	7.9	-	-	-	-	-	-	-	-	-	-
1982	49.4	30.0	13.8	31.6	-	-	-	-	-	-	-	-	-	-
1983	1.4	2.0	0.0	2.2	-	4.0	16.0	2.8	17.5	-	-	-	-	-
1984	118.5	16.3	0.3	5.3	-	7.1	1.9	10.9	2.9	-	-	-	-	-
1985	36.0	7.0	0.0	3.9	-	6.5	8.4	28.8	12.8	-	-	-	-	-
1986	56.5	155.8	0.0	7.6	-	141.7	34.1	8.8	22.7	-	-	-	-	-
1987	0.5	4.3	31.6	4.1	-	1.4	17.3	4.3	12.3	3.9	-	-	-	-
1988	88.6	17.1	2.3	3.6	-	43.3	3.6	1.0	0.1	45.4	-	-	-	-
1989	126.5	20.4	2.9	18.8	-	32.6	8.1	20.0	1.0	61.9	-	-	-	-
1990	111.5	42.8	9.6	54.1	-	29.2	6.7	59.2	2.0	81.0	0.7	47.7	21.5	14.2
1991	41.3	20.1	10.8	14.4	0.2	16.9	17.1	63.4	4.9	33.6	2.8	66.6	4.4	19.6
1992	27.4	12.2	2.0	10.2	0.2	4.3	0.1	17.3	0.3	23.1	68.3	14.4	8.1	4.5
1993	80.2	86.8	6.6	24.0	0.2	28.8	0.9	17.3	0.2	107.5	8.1	59.9	8.6	8.7
1994	243.2	64.6	18.2	35.6	22.7	499.2	8.0	78.7	36.1	148.5	11.6	4.9	15.4	2.4
1995	51.9	26.3	46.4	30.6	0.1	475.2	23.1	9.3	4.4	51.1	0.8	20.0	2.7	35.8
1996	679.0	575.2	32.7	262.1	32.1	10633.1	5.3	228.7	3.9	649.2	47.8	2.7	94.5	4.9
1997	11.4	10.8	45.3	5.9	42.9	18.3	27.1	5.6	9.9	15.0	5.7	762.4	2.1	40.1
1998	112.5	71.8	2.8	104.4	6.8	74.4	3.8	100.9	6.7	100.5	12.9	2.0	70.4	3.1
1999	171.0	102.8	27.8	79.4	31.2	943.4	12.7	50.2	14.7	148.3	11.3	11.6	44.1	56.8

Year	BOHF21G	OHS30G	OHS31G	OHF30G	OHF31G	BOHF31G	PAF30G	PAF31G	ILP40G	ILP41G	OLP40G	OLP41G	NYF40G	NYF41G
1980	-	-	-	-	-	-	-	-	77.5	69.0	11.8	25.7	-	-
1981	-	-	-	-	-	-	23.0	-	357.4	29.9	21.6	1.7	-	-
1982	-	-	-	-	-	-	26.0	-	229.5	16.0	7.9	4.1	-	-
1983	-	-	-	-	-	-	0.5	-	25.6	-	0.0	0.0	-	-
1984	-	-	-	-	-	-	385.0	-	414.8	16.0	57.0	1.4	-	-
1985	-	-	-	-	-	-	4.0	-	6.0	32.7	0.7	5.6	-	-
1986	-	-	-	-	-	-	125.0	-	465.4	3.8	38.5	0.3	-	-
1987	-	-	-	-	-	-	25.0	-	0.7	2.6	1.1	10.8	-	-
1988	-	-	-	-	-	-	40.0	-	73.4	0.8	47.3	0.4	-	-
1989	-	-	-	-	-	-	0.5	-	70.0	6.4	18.0	6.8	-	-
1990	14.5	0.7	8.4	6.1	4.5	19.8	3.0	-	27.2	8.9	8.2	3.4	-	-
1991	17.7	3.1	20.8	0.8	4.9	4.3	5.0	-	8.0	2.8	2.0	0.5	-	-
1992	7.6	80.6	2.5	14.7	1.2	1.3	50.0	-	46.5	3.3	6.1	1.4	4.4	1.8
1993	16.0	13.0	7.5	10.5	3.6	6.5	38.0	-	19.2	5.8	6.2	1.2	54.9	2.1
1994	3.5	6.6	2.4	7.0	0.7	2.0	172.0	-	13.2	3.8	26.4	3.3	12.8	2.6
1995	16.7	4.5	9.2	10.9	36.3	15.1	20.0	-	1.2	5.4	2.4	10.4	4.9	9.6
1996	9.6	50.0	1.1	39.9	2.4	5.7	214.8	-	12.6	1.5	36.8	1.2	24.1	0.2
1997	60.6	-	-	1.8	5.5	7.4	0.0	-	3.1	1.6	2.6	4.5	0.1	1.5
1998	9.7	7.9	1.2	18.3	1.1	5.0	0.2	-	383.3	3.6	14.3	0.7	0.6	0.1
1999	54.8	11.0	22.2	11.8	21.9	22.0	15.0	9.0	5.1	17.6	0.6	8.8	5.6	2.1

Appendix C. Stepien and Theisler (1999) abstract.

Genetic variability of yellow perch (*Perca flavescens*) in Lake Erie from mitochondrial and nuclear DNA sequences

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Abstract

The primary objective is to determine the levels of mitochondrial and nuclear DNA genetic variability and to assess the population genetic structure of the yellow perch *Perca flavescens* (Percidae: Teleostei) in Lake Erie. There have been few analyses of the population genetics of yellow perch and none have examined DNA sequences. The yellow perch is an environmentally important carnivore and comprises a top commercial and sport fishery. The second objective is to test whether there may be significant differences between yellow perch population groups in the western versus eastern basins of Lake Erie. We are sequencing the entire mitochondrial (mt) DNA control region (about 1100 bp) and the nuclear LDH-A6 (lactate dehydrogenase) intron (about 250 bp), which are both believed to be selectivity neutral. Thirdly we are testing whether both the mtDNA control region and the LdhA6 intron reveal similar amounts of genetic variability, similar evolutionary rates, and if both are appropriate for addressing this problem. The data were analyzed with various evolutionary and population genetics statistics, including chi square tests to check for Hardy Weinberg equilibrium, heterozygosity tests, and nucleotide diversity, and divergence calculations. We found that DNA sequences from the mitochondrial DNA control region and nuclear LdhA6 intron both reveal significant variability in the yellow perch from Lake Erie. The data suggest that there are differences between yellow perch population groups in the western versus eastern basins of Lake Erie. The mtDNA revealed greater population variability in the western basin and the nuclear DNA was more variable in the eastern basin, suggesting possible sex differences.

Appendix B. Legend. Lakewide trawl index series names and codes used in Appendix B.

Geometric Means	
ONTS10G	Ontario Management Unit 1 summer age 0 geometric
OHS10G	Ohio Management Unit 1 summer age 0 geometric
OHS11G	Ohio Management Unit 1 summer age 1 geometric
OHF10G	Ohio Management Unit 1 fall age 0 geometric
OHF11G	Ohio Management Unit 1 fall age 1 geometric
USS10G	USGS Management Unit 1 summer age 0 geometric
USS11G	USGS Management Unit 1 summer age 1 geometric
USF10G	USGS Management Unit 1 fall age 0 geometric
USF11G	USGS Management Unit 1 fall age 1 geometric
ONOHP10G	Ontario/Ohio Management Unit 1 summer age 0 geometric
OHS20G	Ohio Management Unit 2 summer age 0 geometric
OHS21G	Ohio Management Unit 2 summer age 1 geometric
OHF20G	Ohio Management Unit 2 fall age 0 geometric
OHF21G	Ohio Management Unit 2 fall age 1 geometric
BOHF21G	Ohio Management Unit 2 fall age 1 geometric (blocked by depth strata)
OHS30G	Ohio Management Unit 3 summer age 0 geometric
OHS31G	Ohio Management Unit 3 summer age 1 geometric
OHF30G	Ohio Management Unit 3 fall age 0 geometric
OHF31G	Ohio Management Unit 3 fall age 1 geometric
BOHF31G	Ohio Management Unit 3 fall age 1 geometric (blocked by depth strata)
PAF30G	Pennsylvania Management Unit 3 fall age 0 geometric
PAF31G	Pennsylvania Management Unit 3 fall age 1 geometric
ILP40G	Inner Long Point Bay Management Unit 4 age 0 geometric
ILP41G	Inner Long Point Bay Management Unit 4 age 1 geometric
OLP40G	Outer Long Point Bay Management Unit 4 age 0 geometric
OLP41G	Outer Long Point Bay Management Unit 4 age 1 geometric
NYF40G	New York Management Unit 4 fall age 0 geometric
NYF41G	New York Management Unit 4 fall age 1 geometric

(continued)

Appendix B. Legend (continued)

Arithmetic Means	
ONTS10A	Ontario Management Unit 1 summer age 0 arithmetic
OHS10A	Ohio Management Unit 1 summer age 0 arithmetic
OHS11A	Ohio Management Unit 1 summer age 1 arithmetic
OHF10A	Ohio Management Unit 1 fall age 0 arithmetic
OHF11A	Ohio Management Unit 1 fall age 1 arithmetic
USS10A	USGS Management Unit 1 summer age 0 arithmetic
USS11A	USGS Management Unit 1 summer age 1 arithmetic
USF10A	USGS Management Unit 1 fall age 0 arithmetic
USF11A	USGS Management Unit 1 fall age 1 arithmetic
ONOHP10A	Ontario/Ohio Management Unit 1 summer age 0 arithmetic
OHS20A	Ohio Management Unit 2 summer age 0 arithmetic
OHS21A	Ohio Management Unit 2 summer age 1 arithmetic
OHF20A	Ohio Management Unit 2 fall age 0 arithmetic
OHF21A	Ohio Management Unit 2 fall age 1 arithmetic
OHS30A	Ohio Management Unit 3 summer age 0 arithmetic
OHS31A	Ohio Management Unit 3 summer age 1 arithmetic
OHF30A	Ohio Management Unit 3 fall age 0 arithmetic
OHF31A	Ohio Management Unit 3 fall age 1 arithmetic
PAF30A	Pennsylvania Management Unit 3 fall age 0 arithmetic
PAF31A	Pennsylvania Management Unit 3 fall age 1 arithmetic
ILP40A	Inner Long Point Bay Management Unit 4 age 0 arithmetic
ILP41A	Inner Long Point Bay Management Unit 4 age 1 arithmetic
OLP40A	Outer Long Point Bay Management Unit 4 age 0 arithmetic
OLP41A	Outer Long Point Bay Management Unit 4 age 1 arithmetic
NYF40A	New York Management Unit 4 fall age 0 arithmetic
NYF41A	New York Management Unit 4 fall age 1 arithmetic