Report of the Lake Erie Yellow Perch Task Group

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Presented to:

Standing Technical Committee of the Lake Erie Committee
Great Lakes Fishery Commission

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Introduction

The Yellow Perch Task Group (YPTG) was charged with describing the status of yellow perch in Lake Erie, producing population estimates and presenting a recommended allowable harvest (RAH) for 1995 in each of the four management units (Figure 1). The results of these charges are presented in this report. The task group was also charged with the completion of the joint YPTG/Statistics and Modelling Task Group (SAM) report, documenting the procedures used to develop a recommendable allowable harvest. Work was done on this additional charge in 1994; however, it is incomplete.

New charges addressed by the YPTG in 1994 include: (1) examination of the effect of increased minimum size limits on yellow perch yield and (2) determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie.

1994 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1994 totalled 2,002 metric tonnes (4.4 million pounds), which was 14% less than the 1993 harvest (Table 1). Perch catches declined for Michigan, Ontario and New York, but increased in Ohio and Pennsylvania. Pennsylvania harvest showed the greatest increase at +127%, but their overall effect on the lakewide harvest was low (1% of the lakewide harvest). Ohio harvest was up 51% to the previous year. Ohio's harvest was realized in sizable increases in management units 2 (+112%) and 3 (+147%), but a decrease in Unit 1 (- 25%). Ohio's harvest represents 42% of the lakewide total. Ontario fisheries saw a 35% decline in reported yellow perch harvest compared to 1993. Ontario harvested 55% of the lakewide reported catch. Michigan had a 46% decline in perch harvest; they represented just over 1% of the lakewide harvest.

In comparison to 1993, Ohio's share of the actual lakewide harvest increased from 24% to 42%, Ontario's share of the harvest decreased from 73% to 55%, and the remaining three jurisdictions, Michigan, Pennsylvania and New York, slid from 3% each to 1% each of the lakewide harvest.

The allowable harvest level recommended by the YPTG for 1993 was 6 million pounds lakewide. The Lake Erie Committee supported a lakewide allocation of 5 million pounds.

Harvest, fishing effort, and catch rate are summarized by Unit, year, agency, and gear type in Table 2. The trends over time (1975-1994) are depicted for harvest (Figure 2), fishing effort (Figure 3), and catch rate (Figure 4) by management unit (Unit) and gear type. Commercial gill net harvest declined in all Units: 1 (- 38 %), 2 (- 33 %), 3 (- 31%) and 4 (- 27%) compared to the 1993 harvest. Harvest from commercial trap nets increased slightly in Unit 1 (+ 4%), with more substantial increases in Units 2 (+ 165%) and 3 (+ 106%). Trap net harvest in Unit 4 remained low and decreased somewhat (- 33%). Sport harvest decreased substantially in Unit 1 (- 38%), stayed approximately the same in Unit 4, and increased greatly in Units 2 (+ 95%) and 3 (+ 183%).

Commercial gill net effort in 1994 declined in all management units: 1 (- 2%), 2 (- 8%), 3 (- 10%) and 4 (- 18%), as compared to 1993. Sizable increases in trap net effort were seen in Units 2 (+ 179%) and 3 (+ 17%). Decreases in trap net effort were seen in Units 1 (- 16%) and 4 (- 27%). Sport fishing effort declined in Units 1 (- 11%) and 4 (- 44%) in 1994, but increased 68% in Unit 2 and 80% in Unit 3.

Catch rates for 1994 commercial gill net fisheries decreased in comparison to 1993 in all management units: 1 (- 36%), 2 (- 26%), 3 (- 23%), and 4 (- 11%). Commercial trap net catch rates increased in Units 1 (+ 24%) and 3 (+ 76%), and decreased slightly in Units 2 (- 5%) and 4 (- 9%). Catch rates from the sport fisheries decreased in Unit 1 (- 31%), but increased in all the other Units: 2 (+ 15%), 3 (+ 58%), and 4 (+ 82%).

Recruitment of year classes since 1990 have been variable but persistent; there have been no missing or failed year classes as was seen in the late 1980s. Without very large year classes akin to those seen in the mid-1970s and mid-1980s, harvest and catch rates have declined to historic lows. Unit 1 sport angler harvest rates (reported herein as a catch rate) were lower this year due to high numbers of age 1 perch from the strong

1993 year class being caught and released; the release rate was nearly as high as the harvest rate (ODNR 1995).

The 1990 year class remained a strong contributor throughout all management units, but the 1992 year class and the 1991 year class also contributed heavily in Units 1 and 2. Older fish (age 6+) continue to dominate the trap net and sport fishing catches from Unit 4 (Table 3).

Stock Assessment

Age and Growth

During the past several years, a trend was noted that yellow perch growth was increasing. In 1994, the YPTG reviewed the available time series of length-at-age data from all the agencies with the purpose of documenting any noticeable trend in growth during recent years. Appendix A (Tables A-1 through A-7) contains the time series of yellow perch length-at-age data available for recent years. A review of these data indicates a positive trend in yellow perch growth, as reflected in mean length-at-age, since the late 1980's. Data for the western basin most clearly illustrate the trend. The Ontario partnership index fishing program, Ohio sport fishery catch sampling, Michigan sport fishery catch sampling, and Michigan trap net survey data all indicate a significant increase in yellow perch growth in the western basin since the late 1980's. The Ontario partnership index fishing data and Pennsylvania commercial harvest data suggest a positive trend in growth may also be present for the eastern central and eastern basins. However, small sample sizes and short time series confound growth trends for these basins.

A positive trend in yellow perch growth at this time is not surprising. The trend may be a direct result of a density dependent response to the documented decline in yellow perch abundance since the late 1980's. Another factor may be an improvement in the forage base. Hayward and Margraf (1987) suggested that yellow perch in the western basin experienced restricted growth due to reduced size structure of the benthic

prey base. Since the colonization of zebra mussels in the late 1980's, the benthic forage base has changed greatly. For example, mounting evidence suggests that recolonization of the western basin by burrowing mayflies is underway. Rautio (1994) found that benthic invertebrates were more abundant and that yellow perch grew faster in the presence of zebra mussels. An improvement in the quality and quantity of benthic forage may be involved in the observed trend in yellow perch growth in Lake Erie.

Trends in growth may have important ramifications for the application of the CAGEAN analysis to yellow perch in Lake Erie. Improved growth over time results in a temporal change in vulnerability to the various gear types involved in the fisheries. If such a change is not somehow accounted for in the CAGEAN model, the CAGEAN analysis will overestimate of the abundance of the cohorts that have experienced that change. In the case of Lake Erie yellow perch, implications are greatest for age 2 due to the fact that previously they were not considered fully vulnerable to the fisheries.

Catch-at-Age-Analysis (CAGEAN) and the 1994 Population Estimate

CAGEAN Workshop

During the last year, the Yellow Perch and Walleye Task Groups stated a need for a workshop on catch-at-age analysis and theory. The YPTG sought out Dr. Terrence Quinn, one of the original authors of the CAGEAN work and literature. A working manual, "Quantitative Fish Dynamics" written by Terrence J. Quinn and Richard B. Deriso, outlined the workshop in Columbus on August 9-11, 1994. Theories of fish mortality, catch-age analysis, cohort analysis, virtual population analysis, and age-based assessment methods were discussed. The CAGEAN model was then simplified with a spreadsheet review of the calculations.

Catch-at-age analysis data alone can not be used to estimate absolute abundance; many parameter estimates are linear combinations of other estimates making catch-at-age analysis useful in only short trends over time. For catch-at-age analysis to produce accurate estimates, auxiliary information must be incorporated. Auxiliary information

stabilizes relative estimates of abundance even when parameters are fixed. If the number of parameters can be reduced, then the least squares and likelihood objective functions can be used to obtain parameter estimates. Reductions in model variability can be achieved by increasing observations within parameters and pooling ages.

Estimates of selectivity relationships are depicted in catch curve analysis and are applied to a particular year class. When selectivity relationships are applied to several year classes in the same year, assumptions of constant recruitment are made. If the assumption of constant recruitment is not made, a different slope to the catch curve results. This would lead to an increase in the recruitment estimate which underestimates Z.

Catchability coefficients are applied under the assumption that each unit of fishing effort operates independently and is additive. The instantaneous change in catch would be proportional to fishing effort per unit time and abundance.

The importance of accurate data (including correct aging techniques) is critical for cohort analysis. This minimizes error in the calculation of terminal fishing mortalities.

The effort lambda, λ_E, is a pre-specified weight term to govern how strongly the catchability relationship should influence the overall fit of the model. As λ_E approaches infinity, then the constant catchability assumption is strictly satisfied. The term λ_E may be thought of as the ratio of the variances of catch observations to effort observations. The smallest value of λ_E that does not exhibit a trend in the effort residuals is used to diminish robustness. By keeping λ_E as small as possible, this keeps the model fit as good as possible. λ_E can be varied over a wide range to test the sensitivity of the model. The effects of λ_E does not vary the results over a wide range. The goal is to get the measurement error down to a point where it is at around 5-10% of the numerical abundance estimate.

CAGEAN 1995

Because of an increase in growth rates of 2 year old yellow perch, selectivity was adjusted for ages 2-6 for gill nets and angling (Unit 1). Also, 1994 provided one more year of data in Lake Erie's current state of high transparency and declining nutrients.

Data was blocked from 1988-1990 and 1991-1994 to distinguish this most recent change in Lake Erie. The accuracy and credibility of the model was improved by reducing parameters, which decreased variability in the shortened data series (Quinn - personal communication). The long term data set (1979-1994) adds higher variability from years prior to 1987, and is therefore less credible as an estimator of current yellow perch populations. The long term data set CAGEAN runs produced mean numerical abundance estimates that were not significantly different from the shortened data set. The long term data set did project significantly lower numerical abundances compared to last year's (1993)CAGEAN runs.

λ_E was adjusted for each gear type as the ratio of the variances of catch observations to effort observations. The 1995 CAGEAN model ran efficiently as model iterations were low (less than 10, usually 3 or 4), no trends were depicted in the residuals, and bootstraps were easily obtained. The 1995 CAGEAN estimates of Lake Erie yellow perch populations are supported by abundance indices within each agency.

A three gear (gill net, trap net and sport harvest and effort) version of the CAGEAN model was used to estimate the 1994 population size. The three gear version allows factors such as catchabilities and selectivities to be gear specific. Population size estimates were based on a natural mortality rate of 0.4 (M=0.4).

Population size, in numbers and biomass, and population parameters such as survival and exploitation rates are presented for two stock size estimates: one that consists of 1995 age 2 abundance estimates derived from the recruitment-regression module (Table 4), and one that consists of 1995 age 2 abundance estimates derived from averaged CAGEAN age 2 estimates from 1992-1994 (Table 5). In both cases numbers and biomass are presented for both age 2 and older and age 3 and older. Population estimates are depicted in Figures 5 and 6, and biomass estimates are presented in Figures 7 and 8. Age 2 fish do contribute considerably to the harvest; however, a cohort contributes more significantly at age 3 and older, when it is fully vulnerable to all gears throughout the year.

In 1994, stock size estimates of age 3 and older fish increased slightly in management units 1 and 4 and decreased slightly in management units 2 and 3 (Tables 4 and 5, Figure 5). Stock size estimates for all management units were at levels typical of the early 1980s, prior to the 1984 year class. Stock size estimates for Unit 1 in 1995 were better than those of 1994 but still near historical low levels. Biomass estimates for age 3 and older fish in 1994 increased or remained near 1993 levels in all Units and the 1994 population consisted primarily of age 2 fish (Tables 6 and 7).

Survival rates for age 3 and older perch declined slightly in Units 2 and 3, and increased slightly in Units 1 and 4 (Figure 9). Survival rates for age 2 and older perch increased slightly in all management units. Exploitation rates for age 3 and older yellow perch decreased in all management units, as did exploitation rates for age 2 and older, except for a modest increase in Unit 1 (Figure 10).

Recruitment

In recent years, age 2 yellow perch recruits have been projected using the respective regressions of annual index trawling values for each management unit and CAGEAN age 2 population size estimates (recruitment-regression module). The 1995 age 2 recruit projections from the 1993 year class are considered by the task group to be unreasonably high (Appendix B). Even though the 1993 year class of yellow perch is thought to be of modest size based upon initial trawl estimates, the recruitment-regression module projecting year class size at age 2 far exceeds assessment observations. Index trawling regression projections from previous years' recruitment-regression modules have continually overestimated the age 2 yellow perch populations as attested by the significantly reduced CAGEAN backcast values of age 2 yellow perch for successive earlier population estimates from the improved CAGEAN runs this year.

Therefore, the 1995 age 2 projection was founded upon a more reasonable expectation of its abundance. This value was calculated from the average value of the last three years (1992-1994) age 2 CAGEAN estimates; it is considered the best

available reference to the abundance of age 2 yellow perch recruiting to the fishable stock during the latest period of yellow perch life history.

1995 Population Size Projection

Stock size estimates for 1995 (age 3 and older) were projected from the CAGEAN 1994 population size estimates and age-specific survival rates in 1994 (Tables 8 and 9). Recruitment of the 1993 year class in 1995 (age 2 fish) was estimated from various agency trawling indices of age 0 and age 1 yellow perch in the recruitment-regression module (Table 8) and by using the averaging method described above (Table 9).

Projections of stock size for 1995 indicate a stabilizing to slightly increasing number of age 2 and older yellow perch in all Units (Tables 6 and 7); most of this increase is due in part to the 1992 and 1993 year classes. Age 3 and older projections show an approximate 10% increase in Units 1 and 4, and an approximate 10% decrease in Units 2 and 3. The Unit 4 yellow perch stock; however, will continue to be at low levels. More importantly, the Unit 4 population projection is no longer expected to be composed of a large proportion of older fish.

Biomass of age 2 and older fish remains the most representative indicator of fishable stock available in 1995 (Tables 4 and 5) . Biomass estimates in the 1995 projection, using the averaging method for age 2 fish, show increases of 2% in Unit 1, 6% in Unit 2, 92% in Unit 4 (but the biomass is relatively small compared to the other Units) and a 7% decrease in Unit 3. Looking at age 3 and older biomass as an indicator of available spawning stock, CAGEAN shows biomass increases of 28% in Unit 1, 21% in Unit 2, 90% in Unit 4 (again the biomass is relatively small compared to the other Units) and a 7% decrease in Unit 3.

Yield per Recruit

The yield per recruit model used to determine a recommended harvest in 1995 is the same as that used in 1994. The basic assumption of the yield per recruit model is that the desired harvest strategy is to optimize the return in weight per recruit. The

optimum harvest rate F_{opt}, is determined by growth rate versus natural mortality rate. For temperate waters, F_{opt} is modified to $F_{0.1}$, which corresponds to 10% of the rate of increase in yield per recruit, which can be obtained by increasing F (fishing mortality) at low levels of fishing. A full description of the model inputs, as well as the steps required to determine a scaled $F_{0.1}$, are given in the YPTG report of 1992.

The 1995 harvest estimates of age 2 and older fish is the sum of the estimates of harvest from each age, derived from scaling $F_{0.1}$ by the selectivity at that age. Catch in weight is calculated by multiplying the age specific catch in millions of fish by the mean weight in the harvest (5 year average, 1990-1994). The harvest estimate is the sum of the harvest for age 2 and older fish (Tables 10 and 11).

Recommended Allowable Harvest

In 1994, a lakewide harvest of 5 million pounds of yellow perch was adopted by the Lake Erie Committee. The 1994 lakewide harvest was 4.4 million pounds.

For 1995, we present two harvest scenarios (Table 12). Both strategies employ the unadjusted CAGEAN estimates of population size for ages 3-6+ and a scaled $F_{0.1}$ (or F_{opt}) exploitation strategy. As presented earlier in this report, the difference between the two scenarios is in the treatment of the age 2 recruitment estimate for 1995. One scenario uses the recruitment-regression module from interagency trawls (Tables 8 and 10), the other uses the mean of the 1992-1994 CAGEAN backcast age 2 abundances (Tables 9 and 11).

The recommended allowable harvest (RAH) both lakewide and by management unit is presented in Table 12. The Yellow Perch Task Group is not satisfied with the age 2 estimate from the recruitment-regression module, so it cannot recommend the 5.601 million pounds RAH from the traditional regression method for age 2 and CAGEAN.

The YPTG also is aware that the averaging method for age 2 yellow perch entering the fishery may also be conservative. It still seems to be a robust estimator of the potential of year class strength at age 2 based upon current trophic conditions in

Lake Erie. The YPTG feels confident that CAGEAN estimates have given a better perspective of conditions of age 3 and older populations across all management units, as well as a sharper definition of recent age 2 performance through population backcasting. By relying solely on these methods (age 2 averaging and CAGEAN), the RAH would be 3.374 million pounds.

With this in mind, and also realizing that age 2 yellow perch will continue to be a modest contributor to the 1995 harvest, the Yellow Perch Task Group suggests that the 1995 RAH be a value in the lower half of the range between 3.374 and 5.601 million pounds.

Additional Task Group Charges

Minimum Size Limits

One of the new charges assigned to the Yellow Perch Task Group in 1994 was to "conduct an analysis of the utility and effects of a minimum size limit (MSL) or size specific gear regulation for the exploitation of yellow perch stocks."

Hartman et al. (1980) reviewed the age structure, growth and mortality rates, maturation schedule, and length-fecundity relationship for Lake Erie yellow perch in the 1970's and applied Ricker type equilibrium models to determine the effects of various MSLs on yield, production, average stock weight, potential egg deposition, and the Abrosov spawning frequency indicator. Based on that analysis, Hartman et al. (1980) recommended that a minimum length of at least 8.5 inches be established for all yellow perch fisheries on the lake.

At present, the Ontario small-mesh gill net fishery is restricted by a minimum stretched-mesh size (MMS) of 2.25" (approximating a MSL of 8.0"). The Ohio trap net fishery is regulated by a MSL of 8.5". Lakewide, the sport fisheries are unregulated by any MSL.

In partial response to the 1994 MSL charge from the LEC, a modified yield-per-recruit model was used that accounts for catch and release of legal and sub-legal size fish

(Clark 1983). Clark modified the classical yield-per-recruit model so that the total mortality rate, Z, was partitioned into three components: natural (M), fishing (F), and hooking (H) mortality rates. Inputs to the model include mean length-at-age, age-specific natural mortality rate, size-specific gear vulnerability, percent of annual growth and percent of annual fishing effort by week, and the number of years to be modeled. In addition, estimates of instantaneous catch rate, percent of legal fish caught that are harvested, percent of sub-legal fish caught that are harvested, and percent hooking mortality on those fish caught and released are included. The instantaneous catch rate, Q, is defined as:

$$Q=F/(1-p)$$

where:

F= instantaneous fishing mortality

p = probability that a fish is released when captured.

Note that for p= 0, then the instantaneous catch rate is equal to the instantaneous fishing mortality.

Outputs from the model include the expected population size by inch group at the end of the simulation time period, and the expected numerical catch (including harvest and catch and release) by inch group. Numerical catch was converted to weight caught using a standard length-weight regression.

The Clark model was used to examine the effects of various MSLs on the Lake Erie small-mesh gill net, trap net, and sport fisheries. For each of the gear types, a range in MSLs was considered from 4 inches to 12 inches in total length. Values used in the analyses are shown in Appendix C, Tables C-1 through C-5. Since the gill net fishery is currently regulated by MMS, simulated changes in MMS are presented for this analysis. This approach is reflected in Appendix C, Table C-4, in the range of vulnerabilities by inch group, representing the shift in size selection that would occur with a change in mesh-size fished.

Results of the analysis for the gill net fishery are shown in Appendix C, Figure C-1 and Table C-6. The benefits of increasing MSLs (approximated by changing MMSs) from

4 to 8 inches are clear from the analysis. Stock size increases sharply over this range, with little decline in weight harvested. Above 8 inches, the increase in stock size slows and levels off. Meanwhile, weight harvested changes little for MSLs from 4 to 7 inches, drops about 15% from 7 inches to 8 inches, and much more sharply at MSLs above 8 inches. This analysis indicates that an 8 inch MSL for the gill net fishery provides substantial benefits in stock size, while reducing the harvest weight of 6 inch or larger fish by only 12%. The current MMS for the gill net fishery is designed to approximate a MSL of 8 inches. Based on catch sampling however, from 1990 to 1994, fish measuring less than 8.0" in total length made up 26%, 35%, 49%, 44%, and 46%, respectively, of the small mesh gill net harvest. It appears that the current MMS may more closely approximate a 7" MSL, rather than an 8" MSL.

Results of the sport fishing analysis are shown in Appendix C, Figure C-2 and Table C-7. The greatest increase in stock size occurs between MSLs of 5 inches and 9 inches. Weight harvested declines sharply for MSLs between 6 and 10 inches. This analysis indicates that stock size increases about 5% when a MSL for the sport fishery changes from 6.0 to 8.0 inches. Meanwhile, weight harvested is reduced by about 40%. Currently no MSLs are in place for the Lake Erie yellow perch sport fishery. It is assumed that through the interaction of angler preferences and yellow perch abundance and size structure, some short of "voluntarily" imposed MSL exists for the sport fishery. Catch sampling of the Ohio sport fishery from 1991 to 1994, indicates that fish measuring less than 7.9 inches in total length accounted for 47%, 48%, 41%, and 41%, respectively, of the total Ohio sport harvest. It is suspected that a voluntarily-imposed MSL exists somewhere around 6.0 to 6.5 inches for the sport fishery.

Results for the analysis of the trap net fishery are shown in Appendix C, Figure C-3 and Table C-8. The largest increase in stock size occurs for MSLs between 7 and 10 inches. Similarly, the largest loss of weight harvested occurs for the same range of MSLs. The current MSL of 8.5 inches for the trap net fishery falls in the middle of this range.

This analysis did not include an examination of the effects of changing MSLs on spawning potential or spawning biomass. The various Lake Erie fisheries agencies have

initiated investigations to gather new data on yellow perch length-weight relationships, maturity schedules, and length-fecundity relationships to update Hartman's work, for use by Lake Erie's managers, and for incorporation into other population models. In light of the current concern over the status of Lake Erie yellow perch stocks, this factor may be of equal or greater interest than those discussed above.

Another approach also not investigated, but being pursed at various levels by different agencies, is the effect on harvest of other restrictions such as seasons and sport fishing bag limits. The YPTG will continue work on these aspects within this charge in 1995.

Spawning Stock Biomass

Another new charge addressed by the YPTG was the "determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie." Currently, various spawning stock biomass models have been reviewed and we are collating information concerning fecundity and maturity rates of yellow perch in Lake Erie. Other literature (Henderson and Nepszy 1988) states the relationship between parental stock size and reproductive success of yellow perch in Lake Erie is poor. The YPTG will address this charge further in 1995.

Conclusions

It is the view of the YPTG that the long term time series monitoring of the resource continue and that effort continue to be devoted to understanding the population changes which are occurring. The YPTG will continue to fine tune our use of CAGEAN. Additional information gained at the CAGEAN workshop was highly valuable to our group. The YPTG will continue to explore improvements in the age 2 estimator for incorporation into the successive year's RAH. The YPTG will continue to rely on CAGEAN backcasting as a guide for predicting performance of estimators for year classes entering at age 2.

The YPTG is keenly aware of changing trophic conditions in Lake Erie. Whether harvest (and possibly abundance) differences seen on the north and south shores of the lake are due to yellow perch migration or differential survival need further investigation. Additional work on productivity differences or gradients, and their changes within recent decades, also must be addressed. Are certain areas (like major river outfalls) more productive or have remained more productive than other locations in the lake?

The YPTG is also aware of passing claims that high walleye abundance may have some impact on the yellow perch population. In each of our respective jurisdictions' field work operations, we have not seen yellow perch at any size as an important component of walleye diets. It continues to be a fact that the mainstay of walleye diets are smelt and shiners in the east and east-central basins and shiners and clupeids in the west-central and western basins. Continued work on this aspect of yellow perch-walleye dynamics should bear out any interaction between the two major species of Lake Erie.

The YPTG is also interested in current yellow perch genetic work, which may assist our ability to recognize individual stocks that need more careful management than a lakewide or management unit approach. The YPTG will also continue to address current charges regarding long term data sets, RAH, spawning stock biomass, and minimum size limits.

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Table 1. Summary of total catch (metric tonnes) of yellow perch by management unit and agency, Lake Erie 1985-1994.

		Ontario		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch
Unit 1	1985	1,347	73	476	26	22	1	--	--	--	--	1,845
	1986	1,360	61	775	35	82	4	--	--	--	--	2,217
	1987	1,298	59	785	36	102	5	--	--	--	--	2,185
	1988	1,445	61	846	36	76	3	--	--	--	--	2,367
	1989	1,432	59	862	35	151	6	--	--	--	--	2,445
	1990	808	67	296	24	105	9	--	--	--	--	1,209
	1991	294	46	309	48	43	7	--	--	--	--	646
	1992	312	59	184	35	30	6	--	--	--	--	526
	1993	517	62	262	31	56	7	--	--	--	--	835
	1994	322	59	197	36	30	5	--	--	--	--	549
Unit 2	1985	2,127	87	308	13	--	--	--	--	--	--	2,435
	1986	2,289	89	289	11	--	--	--	--	--	--	2,578
	1987	2,512	88	344	12	--	--	--	--	--	--	2,856
	1988	2,538	93	191	7	--	--	--	--	--	--	2,729
	1989	2,530	84	486	16	--	--	--	--	--	--	3,016
	1990	1,303	75	432	25	--	--	--	--	--	--	1,735
	1991	985	76	310	24	--	--	--	--	--	--	1,295
	1992	1,144	83	227	17	--	--	--	--	--	--	1,371
	1993	877	80	224	20	--	--	--	--	--	--	1,101
	1994	590	55	474	45	--	--	--	--	--	--	1,064
Unit 3	1985	370	81	43	9	--	--	43	9	--	--	456
	1986	1,101	92	60	5	--	--	30	3	--	--	1,191
	1987	908	84	108	10	--	--	64	6	--	--	1,080
	1988	1,128	78	239	17	--	--	81	6	--	--	1,448
	1989	1,095	63	544	31	--	--	96	6	--	--	1,735
	1990	965	76	229	18	--	--	84	7	--	--	1,278
	1991	550	75	115	16	--	--	69	9	--	--	734
	1992	540	82	84	13	--	--	35	5	--	--	659
	1993	275	78	66	19	--	--	11	3	--	--	352
	1994	172	48	163	45	--	--	25	7	--	--	360
Unit 4	1985	190	75	--	--	--	--	14	5	51	20	255
	1986	143	89	--	--	--	--	16	10	2	1	161
	1987	260	90	--	--	--	--	23	8	6	2	289
	1988	258	98	--	--	--	--	1	0	4	2	263
	1989	199	78	--	--	--	--	0	0	55	22	254
	1990	128	88	--	--	--	--	0	0	17	12	145
	1991	73	87	--	--	--	--	0	0	11	13	84
	1992	52	85	--	--	--	--	0	0	9	15	61
	1993	33	85	--	--	--	--	0	0	6	15	39
	1994	24	83	--	--	--	--	0	0	5	17	29
Lakewide Totals	1985	4034	81	827	17	22	<1	57	1	51	1	4991
	1986	4893	80	1124	18	82	1	46	1	2	<1	6147
	1987	4978	78	1237	19	102	2	87	1	6	<1	6410
	1988	5369	79	1276	19	76	1	82	1	4	<1	6807
	1989	5256	71	1892	25	151	2	96	1	55	1	7450
	1990	3204	73	957	22	105	2	84	2	17	<1	4367
	1991	1902	69	734	27	43	2	69	3	11	<1	2759
	1992	2048	78	495	19	30	1	35	1	9	<1	2617
	1993	1702	73	552	24	56	2	11	<1	6	<1	2327
	1994	1108	55	834	42	30	1	25	1	5	<1	2002

Table 2. Catch and effort summaries for Lake Erie yellow perch fisheries by management unit (MU), agency and gear type, 1985-1994.

		Unit 1				Unit 2			Unit 3				Unit 4			
		Ohio		Michigan	Ontario	Ohio		Ontario	Ohio		Ontario	Pennsylvania	New York		Ontario	Pennsylvania
	Year	Trap Nets	Sport	Sport	Gill Nets	Trap Nets	Sport	Gill Nets	Trap Nets	Sport	Gill Nets	Gill Nets	Trap Nets	Sport	Gill Nets	Gill Nets
Catch (tonnes)	1985	27	449	23	1,206	8	300	2,208	2	41	325	43	0		137	14
	1986	71	704	82	1,361	0	289	2,290	0	60	1,101	30	2		143	48
	1987	139	646	102	1,298	10	334	2,512	21	87	908	64	6		260	23
	1988	284	562	76	1,445	21	170	2,538	150	89	1,128	81	4		258	1
	1989	392	470	151	1,432	91	395	2,530	288	256	1,095	96	8	47	199	0
	1990	210	86	105	808	295	137	1,303	203	26	965	84	9	8	128	0
	1991	89	220	43	294	137	173	985	84	31	550	69	7	4	73	0
	1992	56	128	30	312	66	161	1,144	46	38	540	35	5	4	52	0
	1993	72	190	56	517	52	172	877	31	35	275	11	3	3	33	0
	1994	75	122	30	322	138	336	590	64	99	172	25	2	3	24	0
Effort (a)	1985	4,141	935,645	46,782	16,139	212	728,763	34,187	136	144,309	10,635	2,175	0		8,582	486
	1986	5,279	1,404,286	404,514	20,909	0	461,273	30,920	0	122,007	12,440	2,185	3,513		8,797	569
	1987	7,078	1,046,115	452,460	14,730	630	429,239	20,940	668	129,316	6,667	1,538	1,602		4,908	632
	1988	6,900	1,153,182	494,158	9,616	448	402,180	17,315	4,781	172,490	6,203	1,418	2,132		2,719	8
	1989	8,418	1,028,551	696,973	12,716	1,403	572,612	25,679	7,281	248,530	7,098	1,037	1,136	65,370	2,628	0
	1990	6,299	350,000	634,255	18,305	6,238	400,676	31,613	7,376	31,881	12,472	1,978	981	24,463	3,924	0
	1991	7,259	700,719	164,517	13,629	6,480	452,277	34,739	4,516	54,607	12,247	2,018	918	22,090	3,859	0
	1992	6,795	350,433	120,979	9,221	4,753	340,917	35,348	3,361	84,445	14,540	1,321	632	52,398	3,351	0
	1993	7,092	530,012	244,455	12,006	2,558	320,891	25,569	2,610	96,619	10,017	620	761	26,297	2,008	0
	1994	5,937	469,959	224,744	11,734	7,139	538,977	23,441	3,053	173,706	8,169	1,442	555	14,800	1,642	0
Catch Rates (b)	1985	6.52	0.48	0.49	74.73	37.74	0.41	64.59	14.71	0.28	30.56	19.77	0.00		15.96	28.81
	1986	13.45	0.50	0.20	65.09		0.63	74.06		0.49	88.50	13.73	0.57		16.26	84.36
	1987	19.64	0.62	0.23	88.12	15.87	0.78	119.96	31.44	0.67	136.19	41.61	3.75		52.97	36.39
	1988	41.16	0.49	0.15	150.27	46.88	0.42	146.58	31.37	0.52	181.85	57.12	1.88		94.89	125.00
	1989	46.57	0.46	0.22	112.61	64.86	0.69	98.52	39.56	1.03	154.27	92.57	7.04	0.72	75.72	
	1990	33.34	0.25	0.17	44.14	47.29	0.34	41.22	27.52	0.82	77.37	42.47	9.17	0.33	32.62	
	1991	12.26	0.31	0.26	21.57	21.14	0.38	28.35	18.60	0.57	44.91	34.19	7.63	0.18	18.92	
	1992	8.24	0.37	0.25	33.84	13.89	0.47	32.36	13.69	0.45	37.14	26.50	7.91	0.08	15.52	
	1993	10.15	0.36	0.23	43.06	20.33	0.54	34.30	11.88	0.36	27.45	17.74	3.94	0.11	16.43	
	1994	12.63	0.26	0.13	27.44	19.33	0.62	25.17	20.96	0.57	21.06	17.34	3.60	0.20	14.62	

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

Table 3. Lake Erie yellow perch harvest in numbers by age and management unit, 1994.

Gear	Age	Unit 1 Number	Unit 1 %	Unit 2 Number	Unit 2 %	Unit 3 Number	Unit 3 %	Unit 4 Number	Unit 4 %
Gill Nets	1	0	0	11,856	0	0	0	0	0
	2	880,445	34	2,945,032	57	661,902	50	15,080	14
	3	838,337	32	1,111,551	21	234,921	18	53,310	48
	4	802,190	31	1,015,011	20	240,352	18	10,724	10
	5	77,960	3	81,230	2	112,012	9	18,513	17
	6+	0	0	5,946	0	68,315	5	12,748	12
	Total	2,598,932		5,170,626		1,317,502		110,375	
Trap Nets	1	0	0	0	0	0	0	0	0
	2	43,067	8	38,105	4	0	0	0	0
	3	98,156	19	315,188	37	93,758	27	2,517	24
	4	323,204	63	363,040	42	217,743	62	1,053	10
	5	43,012	8	120,030	14	30,559	9	729	7
	6+	8,529	2	23,479	3	8,778	3	6,287	59
	Total	515,968		859,842		350,838		10,586	
Sport Fishing	1	92,390	7	50,339	3	0	0	0	0
	2	563,392	44	372,318	21	34,054	8	95	1
	3	324,961	26	460,485	26	70,144	17	920	8
	4	226,732	18	717,156	41	185,778	46	2,599	24
	5	49,530	4	80,416	5	45,693	11	602	6
	6+	16,368	1	64,764	4	66,169	16	6,623	61
	Total	1,273,373		1,745,478		401,838		10,839	
All Gear	1	92,390	2	62,195	1	0	0	0	0
	2	1,486,904	34	3,355,455	43	695,956	34	15,175	12
	3	1,261,454	29	1,887,224	24	398,823	19	56,747	43
	4	1,352,126	31	2,095,207	27	643,873	31	14,376	11
	5	170,502	4	281,676	4	188,264	9	19,844	15
	6+	24,897	1	94,189	1	143,262	7	25,658	19
	Total	4,388,273		7,775,946		2,070,178		131,800	

Table 4. Estimates of Lake Erie yellow perch population size, 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 populations consisting of age 2 and older fish , and for age 3 and older fish. 1995 estimates use age 2 abundance estimates derived from CAGEAN estimates regressed against YOY and yearling trawl indices.

		Age 2 and Older				Age 3 and Older			
	Year	Number (millions)	Biomass (millions kg)	S	u	Number (millions)	Biomass (millions kg)	S	u
Unit 1	1988	90.147	10.663	0.498	0.215	60.052	7.874	0.423	0.302
	1989	47.437	6.033	0.390	0.412	44.893	5.821	0.376	0.435
	1990	23.307	3.804	0.388	0.382	18.505	3.174	0.324	0.466
	1991	19.263	2.479	0.369	0.268	9.049	1.458	0.341	0.415
	1992	21.415	2.585	0.453	0.559	7.116	1.083	0.424	0.430
	1993	15.848	1.975	0.436	0.211	9.708	1.555	0.411	0.481
	1994	16.485	1.973	0.471	0.261	6.916	1.006	0.441	0.406
	1995	49.614	4.341			7.768	1.286		
Unit 2	1988	103.147	14.299	0.542	0.206	62.229	9.620	0.487	0.299
	1989	59.197	9.651	0.415	0.362	55.899	9.402	0.404	0.380
	1990	31.439	5.548	0.428	0.348	24.569	4.738	0.387	0.405
	1991	39.160	5.816	0.314	0.258	13.459	2.775	0.388	0.343
	1992	39.269	5.314	0.395	0.297	12.299	2.366	0.428	0.549
	1993	22.952	3.228	0.406	0.406	15.514	2.690	0.412	0.531
	1994	20.588	2.945	0.421	0.375	9.317	1.724	0.407	0.468
	1995	31.415	3.652			8.665	2.082		
Unit 3	1988	63.404	11.698	0.582	0.152	49.218	9.490	0.557	0.245
	1989	40.781	7.485	0.492	0.264	36.869	7.090	0.473	0.292
	1990	24.892	5.256	0.466	0.312	20.050	4.697	0.419	0.384
	1991	21.672	3.757	0.423	0.235	11.591	2.627	0.437	0.342
	1992	17.290	2.915	0.459	0.283	9.162	2.032	0.471	0.439
	1993	10.841	1.923	0.514	0.241	7.942	1.578	0.512	0.298
	1994	9.670	1.594	0.516	0.214	5.575	1.311	0.495	0.247
	1995	16.961	1.931			4.993	1.153		
Unit 4	1990	3.843	0.652	0.458	0.309	3.182	0.586	0.418	0.370
	1991	2.154	0.390	0.434	0.319	1.759	0.341	0.387	0.382
	1992	1.162	0.186	0.572	0.125	0.934	0.179	0.551	0.155
	1993	1.263	0.186	0.554	0.160	0.664	0.123	0.466	0.280
	1994	1.293	0.144	0.592	0.102	0.699	0.103	0.538	0.167
	1995	12.197	2.162			0.766	0.196		

Table 5. Lake Erie yellow perch estimates of population size, 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 populations consisting of age 2 and older fish, and for age 3 and older fish. 1995 estimates use age 2 estimates derived from averaged CAGEAN age 2 estimates from 1992-1994.

		Age 2 and Older				Age 3 and Older			
	Year	Number (millions)	Biomass (millions kg)	S	u	Number (millions)	Biomass (millions kg)	S	u
Unit 1	1988	90.147	10.663	0.498	0.215	60.052	7.874	0.423	0.302
	1989	47.437	6.033	0.390	0.412	44.893	5.821	0.376	0.435
	1990	23.307	3.804	0.388	0.382	18.505	3.174	0.324	0.466
	1991	19.263	2.479	0.369	0.268	9.049	1.458	0.341	0.415
	1992	21.415	2.585	0.453	0.559	7.116	1.083	0.424	0.430
	1993	15.848	1.975	0.436	0.211	9.708	1.555	0.411	0.481
	1994	16.485	1.973	0.471	0.261	6.916	1.006	0.441	0.406
	1995	17.771	2.016			7.768	1.286		
Unit 2	1988	103.147	14.299	0.542	0.206	62.229	9.620	0.487	0.299
	1989	59.197	9.651	0.415	0.362	55.899	9.402	0.404	0.380
	1990	31.439	5.548	0.428	0.348	24.569	4.738	0.387	0.405
	1991	39.160	5.816	0.314	0.258	13.459	2.775	0.388	0.343
	1992	39.269	5.314	0.395	0.297	12.299	2.366	0.428	0.549
	1993	22.952	3.228	0.406	0.406	15.514	2.690	0.412	0.531
	1994	20.588	2.945	0.421	0.375	9.317	1.724	0.407	0.468
	1995	23.891	3.132			8.665	2.082		
Unit 3	1988	63.404	11.698	0.582	0.152	49.218	9.490	0.557	0.194
	1989	40.781	7.485	0.492	0.264	36.869	7.090	0.473	0.292
	1990	24.892	5.256	0.466	0.312	20.050	4.697	0.419	0.384
	1991	21.672	3.757	0.423	0.235	11.591	2.627	0.437	0.342
	1992	17.290	2.915	0.459	0.283	9.162	2.032	0.471	0.439
	1993	10.841	1.923	0.514	0.241	7.942	1.578	0.512	0.298
	1994	9.670	1.594	0.516	0.214	5.575	1.311	0.495	0.247
	1995	10.034	1.481			4.993	1.153		
Unit 4	1990	3.843	0.652	0.458	0.309	3.182	0.586	0.418	0.370
	1991	2.154	0.390	0.434	0.319	1.759	0.341	0.387	0.382
	1992	1.162	0.186	0.572	0.125	0.934	0.179	0.551	0.155
	1993	1.263	0.186	0.554	0.160	0.664	0.123	0.466	0.280
	1994	1.293	0.144	0.592	0.102	0.699	0.103	0.538	0.167
	1995	1.239	0.277			0.766	0.196		

Table 6. Yellow perch stock size (millions of fish) at the start of the year, estimated by CAGEAN for the years 1988-1994. The 1995 population estimates use age 2 estimates derived from regressions of CAGEAN abundance against YOY and yearling trawl indices.

	Age	1988	1989	1990	1991	1992	1993	1994	1995
Unit 1	2	30.095	2.543	4.802	10.214	14.299	6.140	9.569	41.846
	3	27.277	19.507	1.637	3.047	4.031	6.694	2.930	4.722
	4	27.377	12.114	7.826	0.526	0.904	1.575	2.667	1.259
	5	2.377	10.877	4.204	2.237	0.156	0.353	0.628	1.145
	6+	3.022	2.395	4.838	3.240	2.025	1.085	0.691	0.643
	2 and Older	90.147	47.437	23.307	19.263	21.415	15.848	16.485	49.614
	3 and Older	60.052	44.893	18.505	9.049	7.116	9.708	6.916	7.768
Unit 2	2	40.918	3.298	6.870	25.700	26.969	7.437	11.271	22.750
	3	19.224	25.592	1.984	3.959	7.083	10.251	2.926	4.874
	4	41.421	9.350	10.397	0.649	1.012	2.518	3.876	1.125
	5	0.776	20.076	3.711	3.144	0.166	0.360	0.952	1.491
	6+	0.808	0.881	8.478	5.707	4.039	2.385	1.562	1.175
	2 and Older	103.147	59.197	31.439	39.160	39.269	22.952	20.588	31.415
	3 and Older	62.229	55.899	24.569	13.459	12.299	15.514	9.317	8.665
Unit 3	2	14.186	3.912	4.842	10.081	8.128	2.900	4.095	11.968
	3	8.233	9.459	2.597	3.193	4.096	3.627	1.511	2.231
	4	37.987	4.641	4.705	0.934	1.207	1.737	1.792	0.739
	5	1.463	21.065	2.252	1.639	0.353	0.512	0.858	0.876
	6+	1.536	1.704	10.495	5.825	3.506	2.066	1.414	1.146
	2 and Older	63.404	40.781	24.892	21.672	17.290	10.841	9.670	16.961
	3 and Older	49.218	36.869	20.050	11.591	9.162	7.942	5.575	4.993
Unit 4	2			0.661	0.394	0.227	0.599	0.593	11.431
	3			0.643	0.428	0.253	0.150	0.390	0.389
	4			1.161	0.330	0.202	0.150	0.080	0.221
	5			0.260	0.330	0.070	0.095	0.049	0.032
	6+			1.118	0.671	0.409	0.270	0.180	0.123
	2 and Older			3.843	2.154	1.162	1.263	1.293	12.197
	3 and Older			3.182	1.759	0.934	0.664	0.699	0.766

Table 7. Yellow perch stock size (millions of fish) at the start of the year, estimated from CAGEAN for the year 1988-1994. 1995 population estimates use age 2 estimates derived from averaged CAGEAN age 2 estimates from 1992-1994.

	Age	1988	1989	1990	1991	1992	1993	1994	1995
Unit 1	2	30.095	2.543	4.802	10.214	14.299	6.140	9.569	10.003
	3	27.277	19.507	1.637	3.047	4.031	6.694	2.930	4.722
	4	27.377	12.114	7.826	0.526	0.904	1.575	2.667	1.259
	5	2.377	10.877	4.204	2.237	0.156	0.353	0.628	1.145
	6+	3.022	2.395	4.838	3.240	2.025	1.085	0.691	0.643
	2 and Older	90.147	47.437	23.307	19.263	21.415	15.848	16.485	17.771
	3 and Older	60.052	44.893	18.505	9.049	7.116	9.708	6.916	7.768
Unit 2	2	40.918	3.298	6.870	25.700	26.969	7.437	11.271	15.226
	3	19.224	25.592	1.984	3.959	7.083	10.251	2.926	4.874
	4	41.421	9.350	10.397	0.649	1.012	2.518	3.876	1.125
	5	0.776	20.076	3.711	3.144	0.166	0.360	0.952	1.491
	6+	0.808	0.881	8.478	5.707	4.039	2.385	1.562	1.175
	2 and Older	103.147	59.197	31.439	39.160	39.269	22.952	20.588	23.891
	3 and Older	62.229	55.899	24.569	13.459	12.299	15.514	9.317	8.665
Unit 3	2	14.186	3.912	4.842	10.081	8.128	2.900	4.095	5.041
	3	8.233	9.459	2.597	3.193	4.096	3.627	1.511	2.231
	4	37.987	4.641	4.705	0.934	1.207	1.737	1.792	0.739
	5	1.463	21.065	2.252	1.639	0.353	0.512	0.858	0.876
	6+	1.536	1.704	10.495	5.825	3.506	2.066	1.414	1.146
	2 and Older	63.404	40.781	24.892	21.672	17.290	10.841	9.670	10.034
	3 and Older	49.218	36.869	20.050	11.591	9.162	7.942	5.575	4.993
Unit 4	2			0.661	0.394	0.227	0.599	0.593	0.473
	3			0.643	0.428	0.253	0.150	0.390	0.389
	4			1.161	0.330	0.202	0.150	0.080	0.221
	5			0.260	0.330	0.070	0.095	0.049	0.032
	6+			1.118	0.671	0.409	0.270	0.180	0.123
	2 and Older			3.843	2.154	1.162	1.263	1.293	1.239
	3 and Older			3.182	1.759	0.934	0.664	0.699	0.766

Table 8. Projection of the 1995 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN. 1995 age 2 estimates are derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices.

	1994 Parameters									1995 Parameters				Stock Biomass		
	Stock Size (numbers)				Mortality Rates				Survival Rate	Stock Size (numbers)				Mean Weight in	Biomass (thousand tonnes)	
	Age	Mean	Std. Err.	Min.	Max.	(F)	(Z)	(A)	(u)	(S)	Age	Mean	Min.	Max.	Pop. (kg)	1994	1995
Unit 1																	
	2	9.569	0.775	8.794	10.344	0.306	0.706	0.507	0.220	0.493	2	41.846	32.634	53.658	0.073	0.966	3.055
	3	2.930	0.237	2.693	3.168	0.445	0.845	0.571	0.301	0.429	3	4.722	4.339	5.104	0.118	0.395	0.557
	4	2.667	0.216	2.451	2.883	0.445	0.845	0.571	0.301	0.429	4	1.259	1.157	1.360	0.198	0.380	0.249
	5	0.628	0.051	0.577	0.678	0.445	0.845	0.571	0.301	0.429	5	1.145	1.053	1.238	0.246	0.106	0.282
	6+	0.691	0.056	0.635	0.747	0.216	0.616	0.460	0.161	0.540	6+	0.643	0.591	0.695	0.308	0.126	0.198
	Total	16.485	1.335	15.150	17.820	0.352	0.752	0.529	0.248	0.471	**Total**	49.614	39.773	62.055		1.973	4.341
	(3+)	6.916	0.560	6.356	7.476	0.420	0.820	0.559	0.286	0.441	**(3+)**	7.768	7.139	8.398		1.006	1.286
Unit 2																	
	2	11.271	1.178	10.094	12.449	0.438	0.838	0.568	0.297	0.432	2	22.750	20.975	24.674	0.069	1.221	1.570
	3	2.926	0.306	2.620	3.232	0.556	0.956	0.615	0.358	0.385	3	4.874	4.364	5.383	0.174	0.419	0.848
	4	3.876	0.405	3.471	4.281	0.556	0.956	0.615	0.358	0.385	4	1.125	1.008	1.243	0.253	0.654	0.285
	5	0.952	0.100	0.853	1.052	0.556	0.956	0.615	0.358	0.385	5	1.491	1.335	1.647	0.315	0.183	0.470
	6+	1.562	0.163	1.399	1.725	0.258	0.658	0.482	0.189	0.518	6+	1.175	1.052	1.298	0.408	0.468	0.480
	Total	20.588	2.151	18.437	22.740	0.465	0.865	0.579	0.311	0.421	**Total**	31.415	28.735	34.244		2.945	3.652
	(3+)	9.317	0.974	8.343	10.290	0.499	0.899	0.593	0.329	0.407	**(3+)**	8.665	7.760	9.571		1.724	2.082
Unit 3																	
	2	4.095	1.086	3.009	5.180	0.207	0.607	0.455	0.155	0.545	2	11.968	10.857	13.192	0.065	0.283	0.778
	3	1.511	0.401	1.110	1.912	0.316	0.716	0.511	0.225	0.489	3	2.231	1.640	2.823	0.101	0.224	0.225
	4	1.792	0.475	1.317	2.267	0.316	0.716	0.511	0.225	0.489	4	0.739	0.543	0.935	0.258	0.325	0.191
	5	0.858	0.227	0.631	1.085	0.471	0.871	0.581	0.314	0.419	5	0.876	0.644	1.108	0.381	0.200	0.334
	6+	1.414	0.375	1.039	1.789	0.186	0.586	0.443	0.140	0.557	6+	1.146	0.842	1.450	0.352	0.562	0.404
	Total	9.670	2.563	7.106	12.233	0.261	0.661	0.484	0.191	0.516	**Total**	16.961	14.526	19.509		1.594	1.931
	(3+)	5.575	1.478	4.097	7.053	0.303	0.703	0.505	0.217	0.495	**(3+)**	4.993	3.669	6.316		1.311	1.153
Unit 4																	
	2	0.593	0.242	0.352	0.835	0.022	0.422	0.344	0.018	0.656	2	11.431	7.070	18.483	0.172	0.041	1.966
	3	0.390	0.159	0.231	0.190	0.166	0.566	0.432	0.127	0.568	3	0.389	0.231	0.548	0.200	0.042	0.078
	4	0.080	0.033	0.047	0.605	0.528	0.928	0.604	0.344	0.396	4	0.221	0.131	0.108	0.247	0.010	0.055
	5	0.049	0.020	0.029	0.621	0.542	0.942	0.610	0.351	0.390	5	0.032	0.019	0.239	0.318	0.008	0.010
	6+	0.180	0.073	0.107	0.158	0.147	0.547	0.421	0.113	0.579	6+	0.123	0.073	0.334	0.433	0.043	0.053
	Total	1.293	0.527	0.766	1.819	0.124	0.524	0.408	0.096	0.592	**Total**	12.197	7.523	19.712		0.144	2.162
	(3+)	0.699	0.285	0.414	1.574	0.219	0.619	0.462	0.163	0.538	**(3+)**	0.766	0.454	1.229		0.103	0.196

Table 9. Projection of the 1995 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN. Age 2 estimates for the 1995 population are derived from averaged CAGEAN age 2 estimates from 1992-1994.

	1994 Parameters									1995 Parameters				Stock Biomass		
	Stock Size (numbers)				Mortality Rates				Survival Rate	Stock Size (numbers)				Mean Weight in	Biomass (thousand tonnes)	
	Age	Mean	Std. Err.	Min.	Max.	(F)	(Z)	(A)	(u)	(S)	Age	Mean	Min.	Max.	Pop. (kg)	1994	1995
Unit 1																	
	2	9.569	0.775	8.794	10.344	0.306	0.706	0.507	0.220	0.493	2	10.003	6.218	13.788	0.073	0.966	0.730
	3	2.930	0.237	2.693	3.168	0.445	0.845	0.571	0.301	0.429	3	4.722	4.339	5.104	0.118	0.395	0.557
	4	2.667	0.216	2.451	2.883	0.445	0.845	0.571	0.301	0.429	4	1.259	1.157	1.360	0.198	0.380	0.249
	5	0.628	0.051	0.577	0.678	0.445	0.845	0.571	0.301	0.429	5	1.145	1.053	1.238	0.246	0.106	0.282
	6+	0.691	0.056	0.635	0.747	0.216	0.616	0.460	0.161	0.540	6+	0.643	0.591	0.695	0.308	0.126	0.198
	Total	16.485	1.335	15.150	17.820	0.352	0.752	0.529	0.248	0.471	**Total**	17.771	13.357	22.185		1.973	2.016
	(3+)	6.916	0.560	6.356	7.476	0.420	0.820	0.559	0.286	0.441	**(3+)**	7.768	7.139	8.398		1.006	1.286
Unit 2																	
	2	11.271	1.178	10.094	12.449	0.438	0.838	0.568	0.297	0.432	2	15.226	5.664	24.788	0.069	1.221	1.051
	3	2.926	0.306	2.620	3.232	0.556	0.956	0.615	0.358	0.385	3	4.874	4.364	5.383	0.174	0.419	0.848
	4	3.876	0.405	3.471	4.281	0.556	0.956	0.615	0.358	0.385	4	1.125	1.008	1.243	0.253	0.654	0.285
	5	0.952	0.100	0.853	1.052	0.556	0.956	0.615	0.358	0.385	5	1.491	1.335	1.647	0.315	0.183	0.470
	6+	1.562	0.163	1.399	1.725	0.258	0.658	0.482	0.189	0.518	6+	1.175	1.052	1.298	0.408	0.468	0.480
	Total	20.588	2.151	18.437	22.740	0.465	0.865	0.579	0.311	0.421	**Total**	23.891	13.424	34.359		2.945	3.132
	(3+)	9.317	0.974	8.343	10.290	0.499	0.899	0.593	0.329	0.407	**(3+)**	8.665	7.760	9.571		1.724	2.082
Unit 3																	
	2	4.095	1.086	3.009	5.180	0.207	0.607	0.455	0.155	0.545	2	5.041	2.510	7.572	0.065	0.283	0.328
	3	1.511	0.401	1.110	1.912	0.316	0.716	0.511	0.225	0.489	3	2.231	1.640	2.823	0.101	0.224	0.225
	4	1.792	0.475	1.317	2.267	0.316	0.716	0.511	0.225	0.489	4	0.739	0.543	0.935	0.258	0.325	0.191
	5	0.858	0.227	0.631	1.085	0.471	0.871	0.581	0.314	0.419	5	0.876	0.644	1.108	0.381	0.200	0.334
	6+	1.414	0.375	1.039	1.789	0.186	0.586	0.443	0.140	0.557	6+	1.146	0.842	1.450	0.352	0.562	0.404
	Total	9.670	2.563	7.106	12.233	0.261	0.661	0.484	0.191	0.516	**Total**	10.034	6.179	13.888		1.594	1.481
	(3+)	5.575	1.478	4.097	7.053	0.303	0.703	0.505	0.217	0.495	**(3+)**	4.993	3.669	6.316		1.311	1.153
Unit 4																	
	2	0.593	0.242	0.352	0.835	0.022	0.422	0.344	0.018	0.656	2	0.473	0.276	0.670	0.172	0.041	0.081
	3	0.390	0.159	0.231	0.549	0.166	0.566	0.432	0.127	0.568	3	0.389	0.231	0.548	0.200	0.042	0.078
	4	0.080	0.033	0.047	0.113	0.528	0.928	0.604	0.344	0.396	4	0.221	0.131	0.312	0.247	0.010	0.055
	5	0.049	0.020	0.029	0.069	0.542	0.942	0.610	0.351	0.390	5	0.032	0.019	0.045	0.318	0.008	0.010
	6+	0.180	0.073	0.107	0.254	0.147	0.547	0.421	0.113	0.579	6+	0.123	0.073	0.174	0.433	0.043	0.053
	Total	1.293	0.527	0.766	1.819	0.124	0.524	0.408	0.096	0.592	**Total**	1.239	0.730	1.747		0.144	0.277
	(3+)	0.699	0.285	0.414	0.984	0.219	0.619	0.462	0.163	0.538	**(3+)**	0.766	0.454	1.078		0.103	0.196

Table 12. Lake Erie yellow perch harvest estimates for 1995. All estimates are based on unadjusted CAGEAN outputs and F(opt) fishing strategy. Traditional method estimates 1993 year class in 1995 with regressions of CAGEAN age 2 estimates against YOY and yearling indices. Averaged method estimates 1993 year class in 1995 by averaging CAGEAN age 2 estimates for 1992-94.

Yield (tonnes)

Age 2+ Estimated RAH - Traditional

	Mean	Min.	Max.
Unit 1	1.181	0.960	1.458
Unit 2	0.963	0.878	1.052
Unit 3	0.361	0.298	0.425
Unit 4	0.036	0.022	0.060
Total	**2.540**	**2.158**	**2.994**

Age 2+ Estimated RAH - Averaged

	Mean	Min.	Max.
Unit 1	0.496	0.392	0.600
Unit 2	0.765	0.475	1.055
Unit 3	0.251	0.165	0.336
Unit 4	0.018	0.011	0.026
Total	**1.530**	**1.043**	**2.017**

Age 3+ Estimated RAH

	Mean	Min.	Max.
Unit 1	0.281	0.258	0.304
Unit 2	0.363	0.325	0.401
Unit 3	0.171	0.125	0.216
Unit 4	0.018	0.010	0.025
Total	**0.833**	**0.720**	**0.946**

Yield (million pounds)

Age 2+ Estimated RAH - Traditional

	Mean	Min.	Max.
Unit 1	2.604	2.117	3.214
Unit 2	2.124	1.937	2.319
Unit 3	0.795	0.656	0.938
Unit 4	0.079	0.048	0.132
Total	**5.601**	**4.758**	**6.603**

Age 2+ Estimated RAH - Averaged

	Mean	Min.	Max.
Unit 1	1.094	0.864	1.324
Unit 2	1.686	1.047	2.326
Unit 3	0.553	0.364	0.741
Unit 4	0.041	0.024	0.057
Total	**3.374**	**2.299**	**4.448**

Age 3+ Estimated RAH

	Mean	Min.	Max.
Unit 1	0.620	0.569	0.670
Unit 2	0.801	0.717	0.885
Unit 3	0.376	0.277	0.476
Unit 4	0.039	0.023	0.055
Total	**1.836**	**1.587**	**2.086**

Table 12. Revised projection of Lake Erie yellow perch harvest estimates for 1995. All estimates are based on unadjusted CAGEAN outputs and F(opt) fishing strategy. Traditional method estimates 1993 year class in 1995 with regressions of CAGEAN age 2 estimates against YOY and yearling indices. Averaged method estimates 1993 year class in 1995 by averaging CAGEAN age 2 estimates for 1992-94.

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Yield (tonnes)

Age 2+ Estimated RAH - Traditional

	Mean	Min.	Max.
Unit 1	1.181	0.960	1.458
Unit 2	0.990	0.903	1.081
Unit 3	0.518	0.428	0.610
Unit 4	0.049	0.030	0.082
Total	**2.737**	**2.320**	**3.231**

Yield (million pounds)

Age 2+ Estimated RAH - Traditional

	Mean	Min.	Max.
Unit 1	2.604	2.117	3.214
Unit 2	2.182	1.990	2.383
Unit 3	1.141	0.943	1.345
Unit 4	0.109	0.066	0.182
Total	**6.036**	**5.116**	**7.124**

MU Harvest Proportions

43.14%
36.15%
18.91%
1.80%

Age 2+ Estimated RAH - Averaged

	Mean	Min.	Max.
Unit 1	0.496	0.392	0.600
Unit 2	0.786	0.488	1.084
Unit 3	0.358	0.236	0.480
Unit 4	0.025	0.015	0.035
Total	**1.665**	**1.130**	**2.200**

Age 2+ Estimated RAH - Averaged

	Mean	Min.	Max.
Unit 1	1.094	0.864	1.324
Unit 2	1.733	1.075	2.390
Unit 3	0.789	0.519	1.059
Unit 4	0.055	0.032	0.077
Total	**3.671**	**2.491**	**4.850**

MU Harvest Proportions

29.80%
47.20%
21.50%
1.49%

Age 3+ Estimated RAH

	Mean	Min.	Max.
Unit 1	0.281	0.258	0.304
Unit 2	0.373	0.334	0.412
Unit 3	0.242	0.178	0.306
Unit 4	0.024	0.014	0.033
Total	**0.920**	**0.784**	**1.055**

Age 3+ Estimated RAH

	Mean	Min.	Max.
Unit 1	0.620	0.569	0.670
Unit 2	0.823	0.737	0.909
Unit 3	0.533	0.392	0.675
Unit 4	0.052	0.031	0.074
Total	**2.028**	**1.729**	**2.327**

MU Harvest Proportions

30.55%
40.57%
26.29%
2.58%

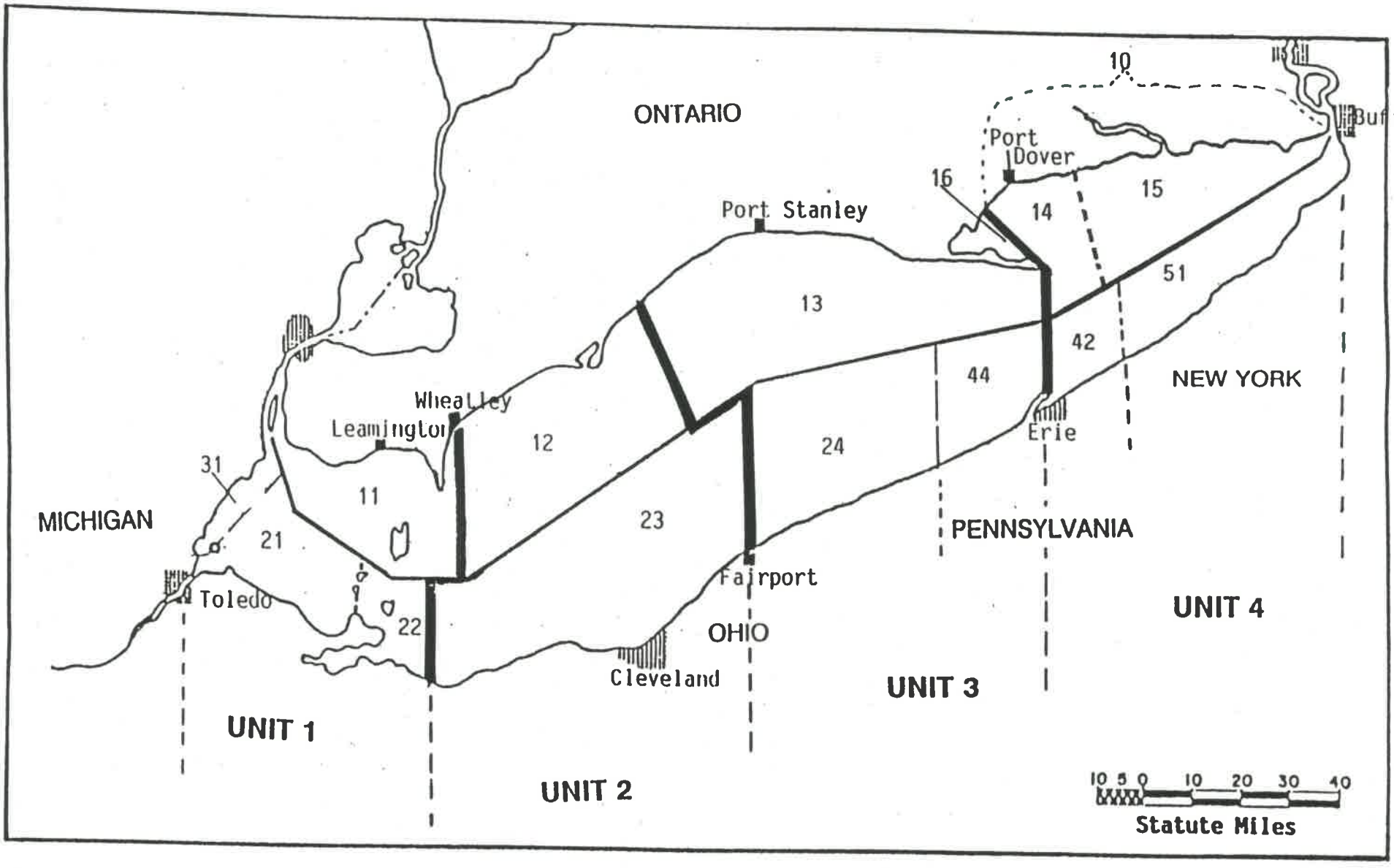
ONTARIO
10
Buffalo
Port Dover
16
15
14
Port Stanley
13
51
42
44
NEW YORK
Wheatley
Leamington
12
24
Erie
31
11
MICHIGAN
21
23
PENNSYLVANIA
Fairport
Toledo
22
OHIO
UNIT 4
Cleveland
UNIT 3
UNIT 1
UNIT 2
10 5 0 10 20 30 40
Statute Miles

Figure 1

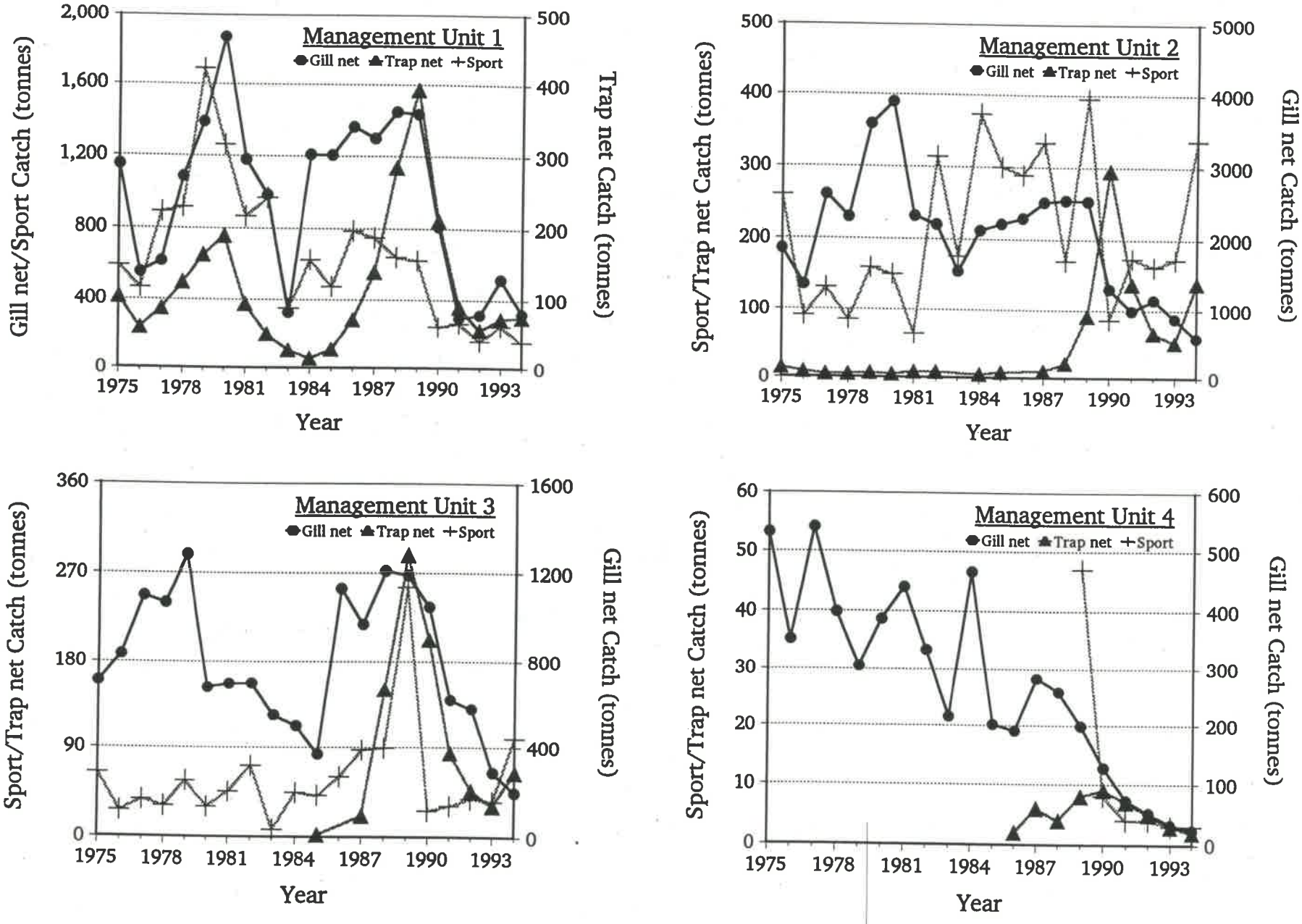

Figure 2. Lake Erie yellow perch harvest by management unit and gear type.

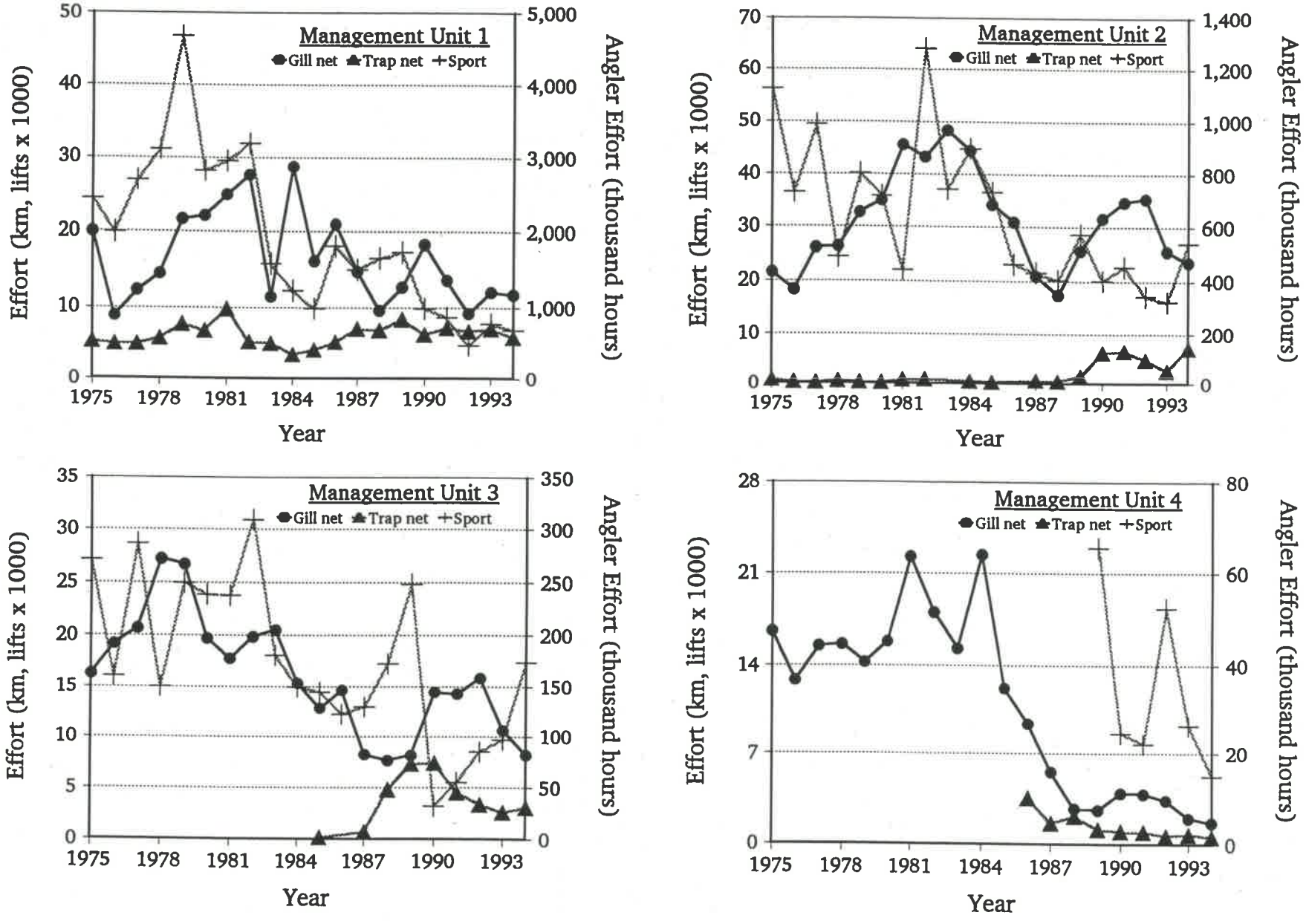

Figure 3. Lake Erie yellow perch effort by management unit and gear type.

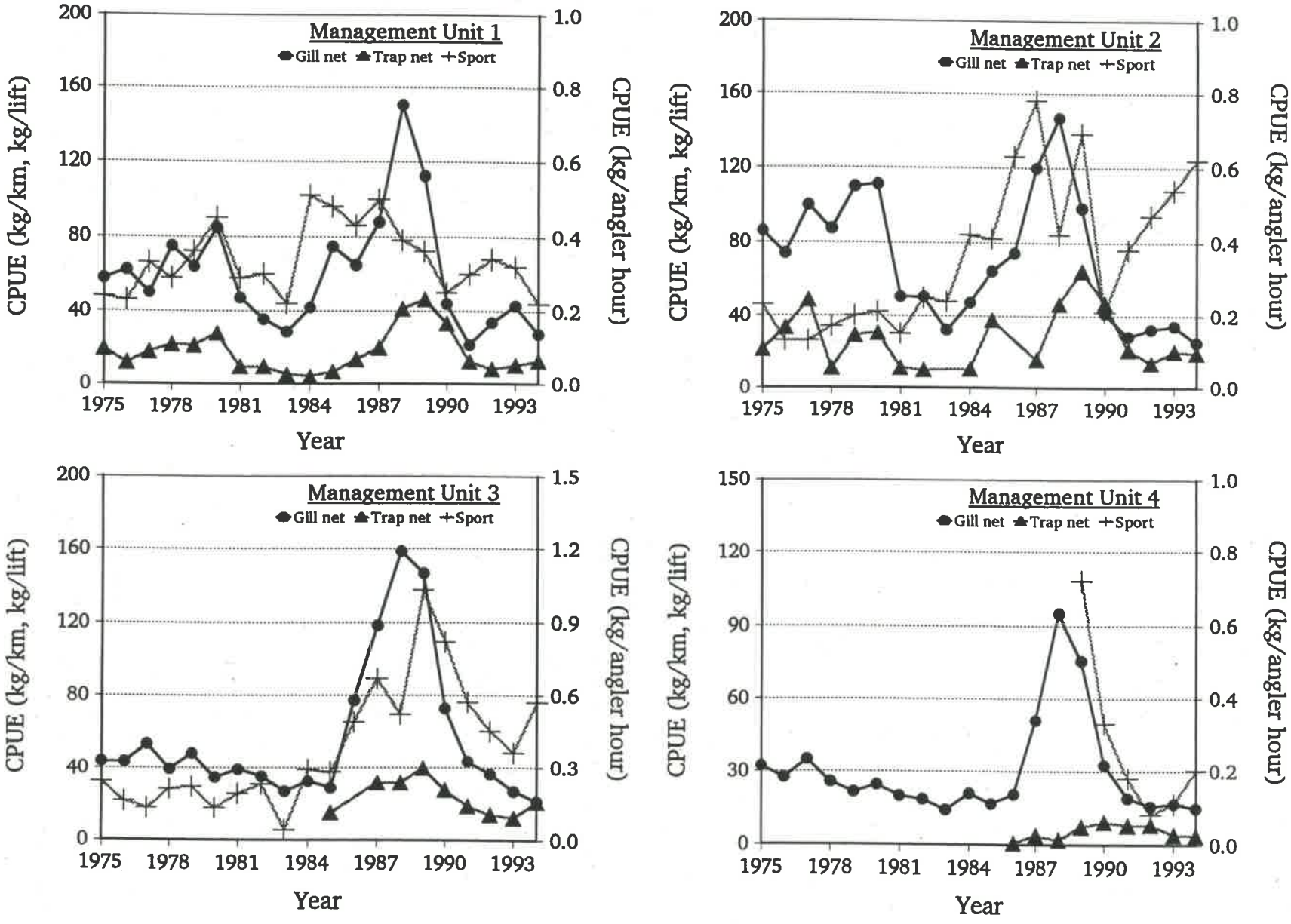

Figure 4. Lake Erie yellow perch catch per unit effort by management unit and gear type.

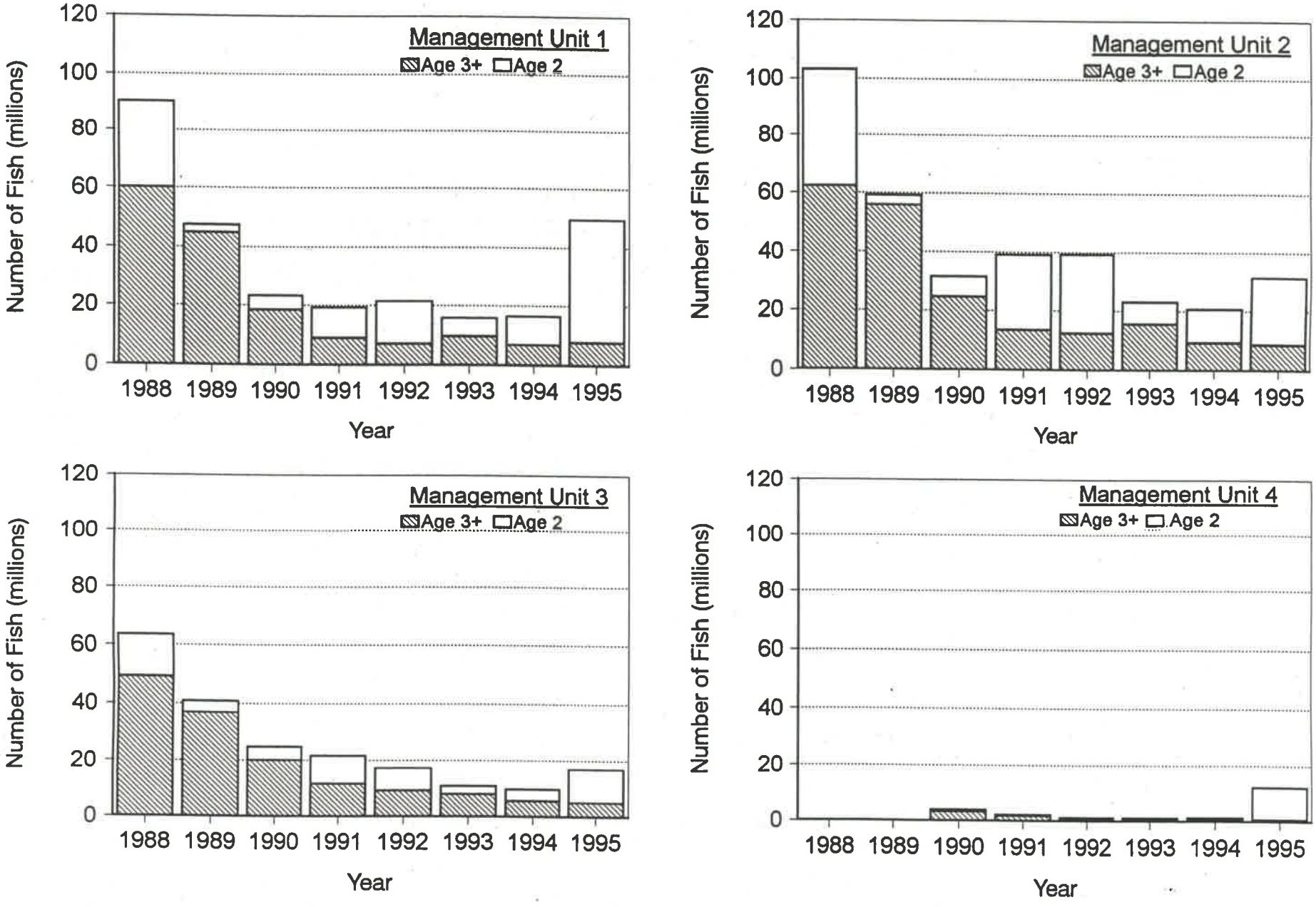

Figure 5. Lake Erie yellow perch population estimates by management unit. 1995 age 2 estimates are from regressions of CAGEAN estimates against YOY and yearling trawl indices.

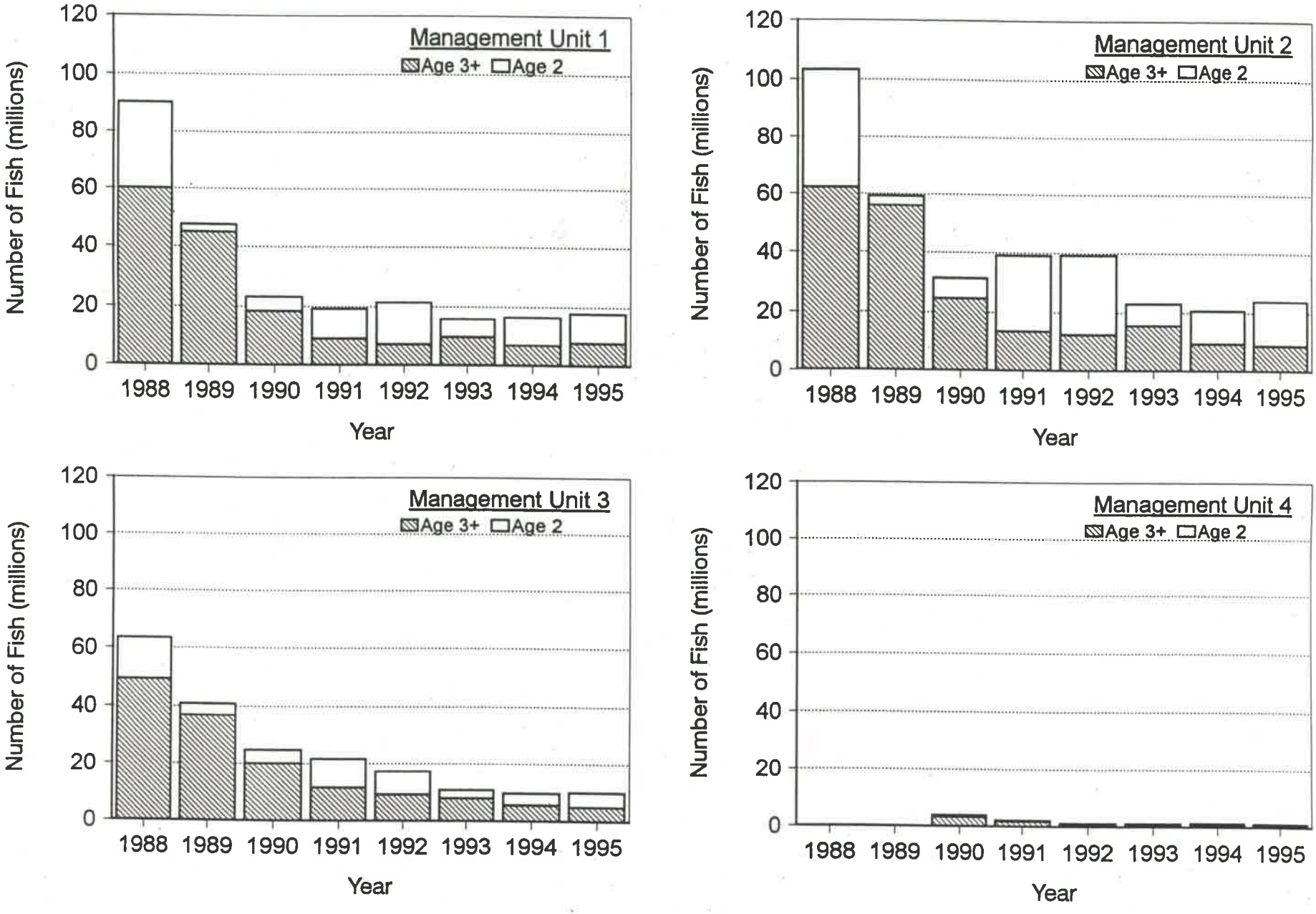

Figure 6. Lake Erie yellow perch population estimates by management unit. 1995 age 2 estimates are the average of CAGEAN age 2 estimates 1992-94.

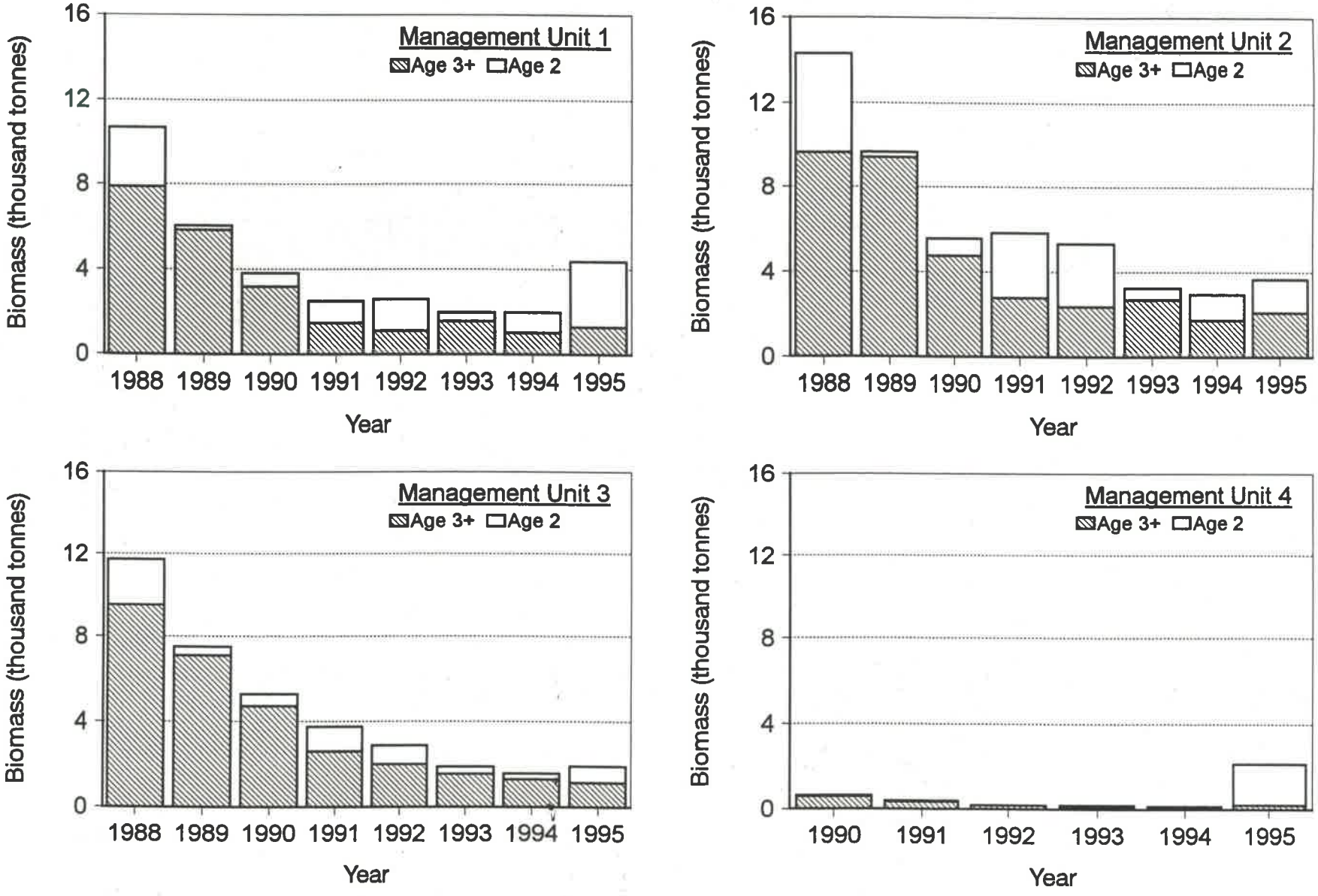

Figure 7. Lake Erie yellow perch biomass estimates by management unit. 1995 age 2 estimates are from regressions of CAGEAN estimates against YOY and yearling trawl indices.

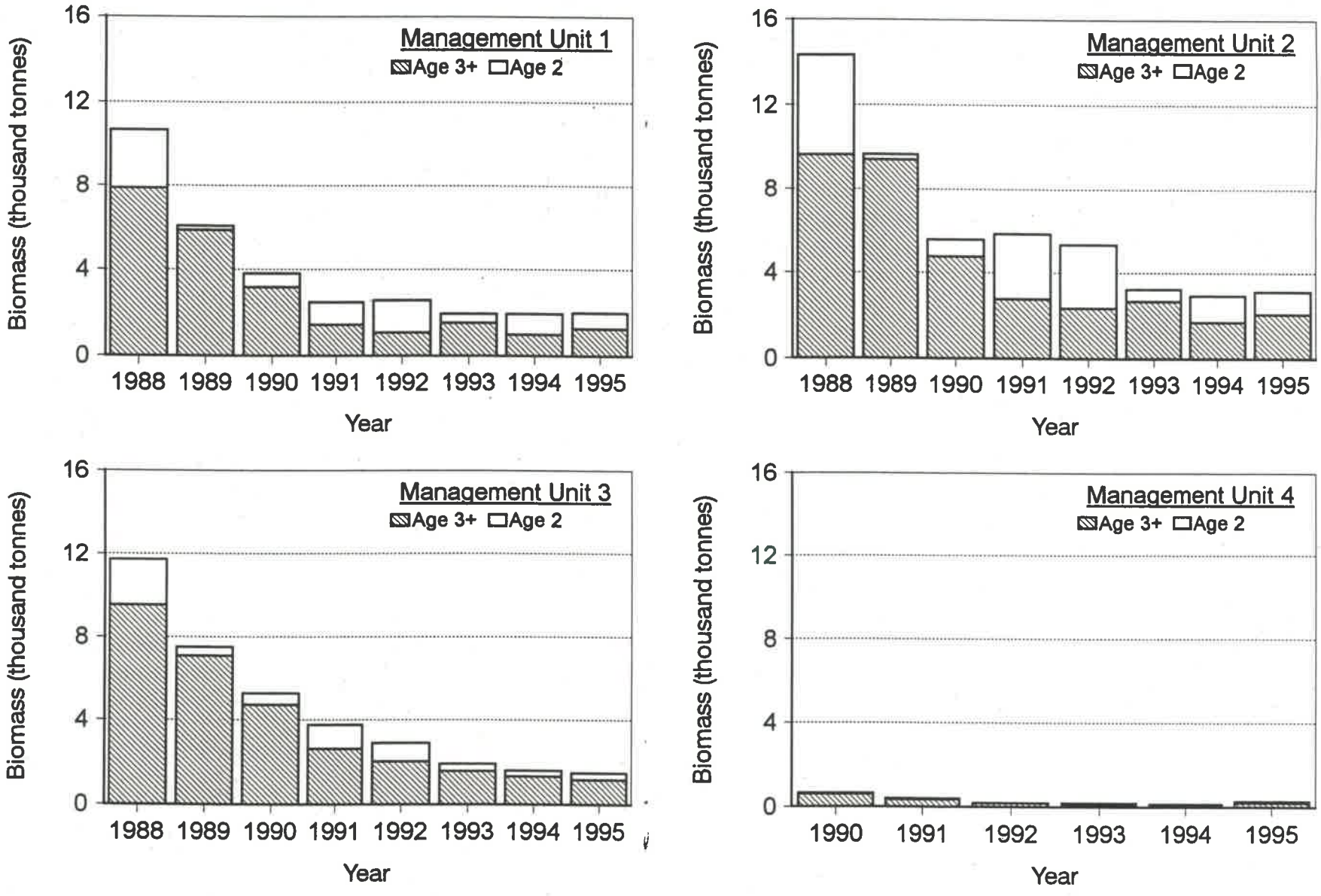

Figure 8. Lake Erie yellow perch biomass estimates by management unit. 1995 age 2 estimates are the average of CAGEAN age 2 estimates 1992-94.

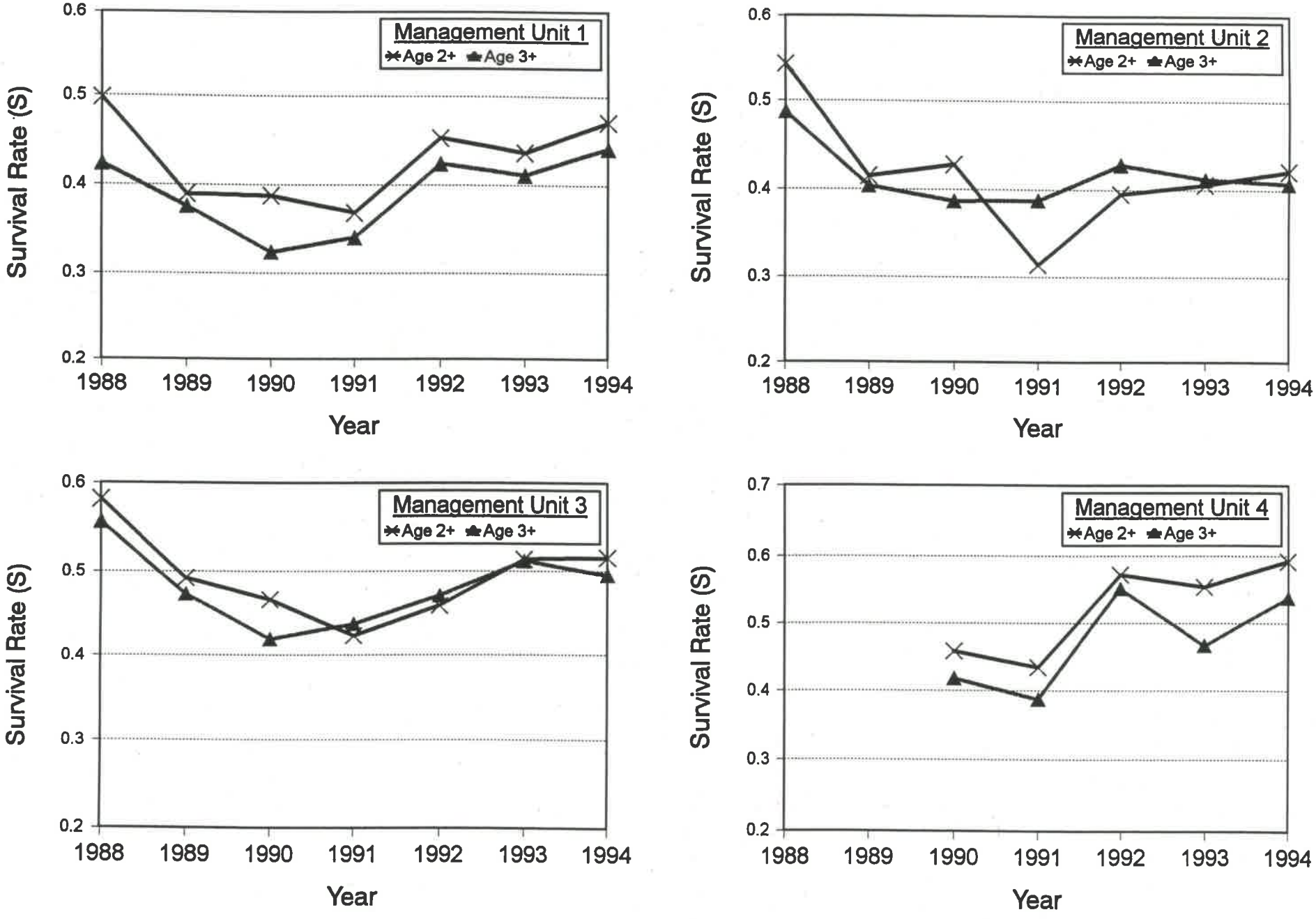

Figure 9. Survival rates of age 2 and older and age 3 and older yellow perch, Lake Erie, 1988 - 1994. Estimates are derived from CAGEAN.

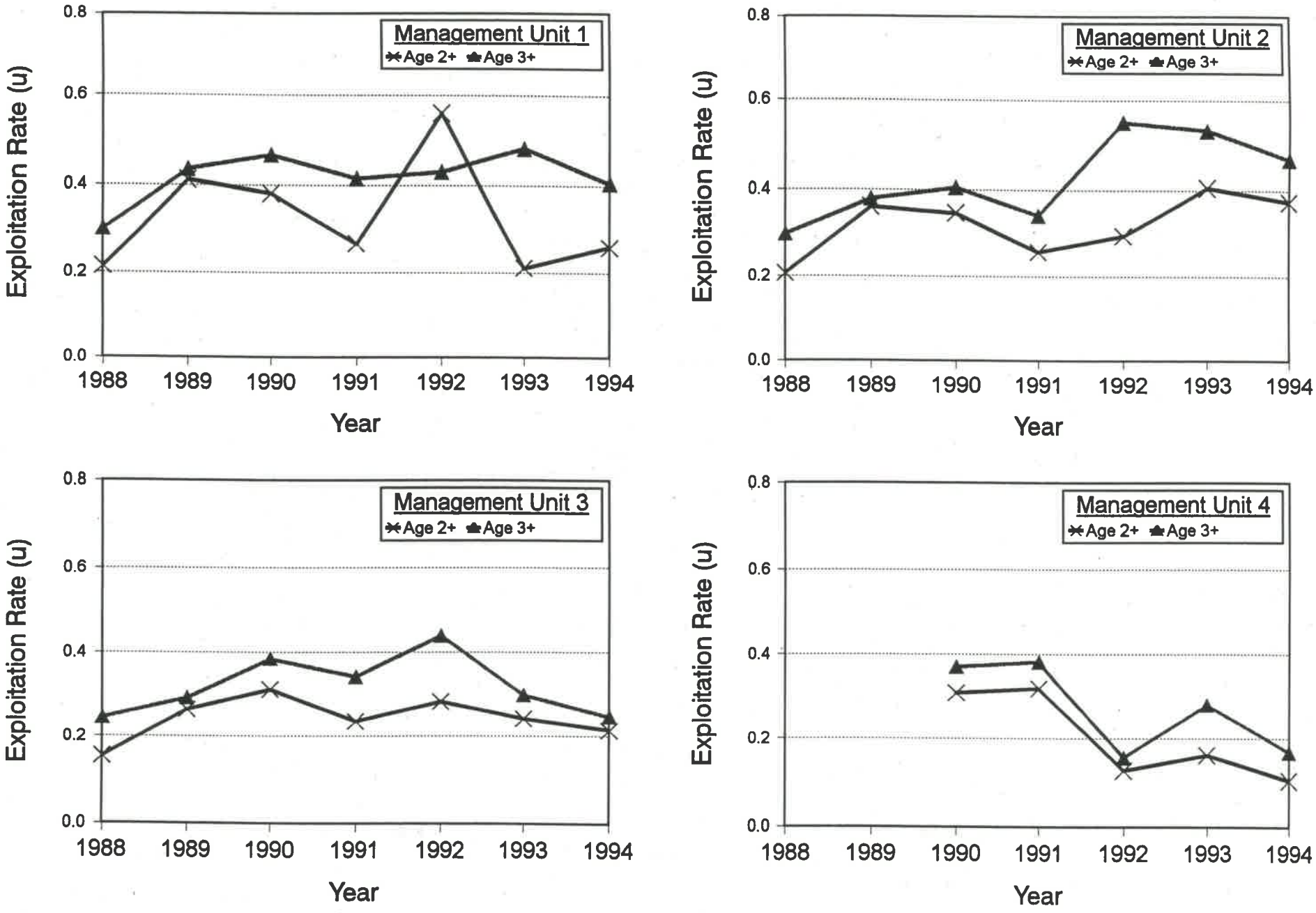

Figure 10. Exploitation rates of age 2 and older and age 3 and older yellow perch, Lake Erie, 1988 - 1994. Estimates are derived from catch data and CAGEAN estimates

Appendix A. Yellow Perch age and growth data from Lake Erie's management agencies.

Table A-1. Lake Erie yellow perch mean length-at-age (mm), 1990-1993 by basin. Data are from Ontario partner index fishing, unadjusted for gear and unweighted by strata. Length expressed as fork length.

Age	1990	1991	1992	1993	1994
			Western basin		
1	137	133	145	129	136
2	167	174	174	183	174
3	189	191	194	194	201
4	201	202	208	211	232
5	228	219	220	224	249
			West-central basin		
1	144	141	149	128	143
2	178	183	181	184	167
3	210	203	210	200	219
4	239	232	252	241	247
5	265	262	273	258	265
			East-central basin		
1	136	137	145	124	128
2	169	184	184	183	165
3	189	203	212	199	180
4	226	206	241	230	244
5	261	260	257	250	279
			Eastern basin		
1	131	124	128	156	126
2	146	155	156	178	224
3	183	187	194	202	235
4	204	213	216	229	253
5	243	234	238	273	262

Table A-2. Mean length at age (mm) for yellow perch harvested by the sport fishery in Ohio water's of Lake Erie, 1988-1993. Data from Ohio catch sampling. Length expressed as total length.

Age	1988	1989	1990	1991	1992	1993
			District 1			
1	___	___	168	166	164	165
2	191	180	189	191	191	198
3	204	209	216	199	204	211
4	219	215	222	205	215	223
5	226	227	229	226	239	239
6	233	231	236	243	249	281
			District 2			
1	___	196	167	167	193	___
2	206	212	207	206	201	206
3	224	236	215	230	222	223
4	254	257	248	243	250	247
5	269	261	259	271	275	271
6	277	261	275	295	300	304
			District 3			
2	213	204	210	204	200	205
3	230	233	238	230	227	220
4	261	248	266	243	265	241
5	276	277	290	273	256	262
6	276	271	299	276	293	301

Table A-3. Mean length-at-age (mm) by sex for yellow perch collected in Ohio October trawls, from 1988-1993. Mean length expressed as total length.

Age	1988		1989		1990		1991		1992		1993	
	Length	N	Length	N	Length	N	Length	N	Length	N	Length	N
District 1												
					Males							
1	135	6	116	59	125	220	128	19	143	29	138	21
2	165	32	153	21	157	18	161	8	171	80	187	10
3	188	37	185	111	174	14	176	5	188	28	207	8
4	204	40	202	97	196	23	199	2	187	1	217	1
5	208	3	208	27	194	7	228	3	201	3	___	___
6	223	6	213	9	202	3	235	1	223	7	___	___
					Females							
1	130	9	117	60	130	156	128	26	148	31	144	17
2	167	23	160	21	163	14	182	6	178	52	199	4
3	192	23	195	52	180	8	188	12	203	16	___	___
4	214	33	210	36	213	8	174	1	236	2	___	___
5	216	1	233	9	211	2	238	1	___	___	___	___
6	309	3	223	4	298	1	213	1	214	2	___	___
District 2												
					Males							
1	___	___	135	16	142	73	141	158	148	34	132	45
2	186	34	190	8	186	12	179	57	176	96	189	6
3	208	10	214	31	208	6	214	8	201	28	195	28
4	211	12	232	10	223	25	178	4	217	1	217	1
5	___	___	234	1	238	7	228	3	___	___	___	___
6	___	___	___	___	254	1	___	___	260	1	___	___
					Females							
1	132	1	136	14	144	91	144	140	149	41	133	50
2	199	43	191	8	190	32	185	47	186	90	198	15
3	223	14	233	17	227	9	219	8	200	9	217	20
4	259	14	261	7	259	37	225	3	___	___	241	1
5	___	___	316	1	279	9	287	11	___	___	___	___
6	___	___	___	___	293	8	292	2	297	2	___	___
District 3												
					Males							
1	___	___	132	7	131	32	132	33	146	10	129	16
2	___	___	183	7	196	15	186	20	182	33	194	2
3	___	___	219	15	216	3	197	7	212	9	205	10
4	___	___	244	6	240	11	236	5	227	1	237	3
5	___	___	256	2	266	3	253	15	___	___	261	1
6	___	___	___	___	264	4	___	___	267	1	___	___
					Females							
1	___	___	143	15	139	36	134	65	154	5	135	16
2	___	___	193	1	189	17	187	23	193	33	192	7
3	___	___	246	5	240	7	222	8	234	15	220	11
4	___	___	278	8	263	23	242	5	248	4	240	3
5	___	___	___	___	274	4	285	20	227	1	285	2
6	___	___	___	___	308	15	296	4	___	___	___	___

Table A-4. Mean length-at-age(mm) and standard error (SE) for yellow perch caught in Michigan trap nets during spring surveys, from 1989-1994. Sample size in parentheses. Length expressed as total length.

	1989		1990		1991		1992		1993		1994	
Age	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
						Males						
2	–	–	–	–	–	–	159 (7)	9.7	177 (4)	2.5	168 (11)	3.5
3	169 (29)	2.9	175 (3)	6.7	189 (12)	4.7	181 (31)	2.3	185 (48)	2.1	189 (24)	3.9
4	190 (24)	3.3	185 (38)	3.4	196 (11)	6.6	208 (16)	7.0	212 (25)	3.6	207 (45)	2.8
5	215 (21)	3.4	205 (29)	3.3	210 (31)	4.7	221 (8)	6.7	233 (10)	7.2	217 (26)	5.7
6	221 (20)	4.4	230 (25)	4.9	229 (21)	4.8	243 (34)	4.1	238 (8)	3.9	239 (8)	6.2
7	251 (14)	7.3	233 (10)	5.7	244 (21)	5.0	238 (25)	4.2	250 (23)	5.4	252 (8)	3.4
8	248 (4)	5.2	252 (22)	2.7	258 (8)	5.5	247 (13)	7.2	258 (6)	7.5	277 (1)	–
9	–	–	266 (4)	9.8	255 (6)	4.4	278 (4)	12.9	260 (10)	4.2	257 (3)	4.1
10	–	–	–	–	–	–	–	–	248 (3)	14.4	250 (1)	–
						Females						
3	189 (10)	4.5	–	–	237 (4)	13.0	233 (13)	6.8	224 (31)	4.4	216 (25)	3.7
4	207 (28)	2.1	213 (17)	7.1	255 (3)	10.2	243 (22)	6.7	239 (32)	3.8	239 (47)	3.4
5	236 (39)	4.5	233 (36)	3.3	250 (21)	5.8	254 (14)	6.8	267 (24)	5.7	248 (19)	5.6
6	272 (32)	5.2	252 (28)	5.5	253 (18)	5.5	276 (23)	4.3	281 (14)	5.0	286 (16)	5.8
7	279 (15)	4.8	278 (22)	6.7	272 (24)	4.4	283 (23)	5.8	290 (12)	6.8	297 (3)	8.0
8	284 (15)	4.3	290 (17)	3.9	279 (7)	13.4	296 (21)	6.0	311 (13)	6.6	306 (4)	8.0
9	–	–	292 (15)	6.2	300 (6)	8.8	294 (3)	8.1	307 (10)	5.8	308 (3)	20.0
10	–	–	279 (3)	28.1	–	–	–	–	305 (5)	4.8	–	–

Table A-5. Mean length (mm) of yellow perch sampled from Michigan's Lake Erie sport fishery. Sample size in parentheses. Length expressed as total length.

	Survey Year									
Age	1989		1991		1992		1993		1994	
1	—	—	157	(2)	18	(3)	166	(7)	159	(21)
2	165	(2)	180	(74)	19	(310)	194	(120)	200	(202)
3	191	(124)	185	(285)	19	(246)	205	(369)	224	(88)
4	208	(168)	198	(223)	20	(74)	214	(113)	231	(125)
5	216	(88)	216	(189)	22	(29)	226	(32)	242	(40)
6	234	(15)	229	(162)	23	(47)	230	(3)	251	(7)
7	236	(8)	241	(67)	25	(17)	244	(5)	248	(9)
8	262	(1)	264	(22)	25	(15)	267	(2)	269	(5)
9	—	—	300	(6)	28	(3)	246	(1)	302	(1)
10	—	—	—	—	31	(1)	323	(1)	287	(1)
Mean	206	(407)	206	(1,030)	20	(745)	206	(653)	216	(499)

Table A-6. Mean length-at-age (mm) for yellow perch commercially harvested from Pennsylvania's waters of Lake Erie. Mean length expressed as total length.

	1990		1992		1994	
Age	Spring	Fall	Spring	Fall	Spring	Fall
3	217	—	218	231	225	245
4	232	—	235	246	248	247
5	255	—	250	253	255	259
6	261	—	259	262	257	264
7	—	—	264	277	274	266

Table A-7. Mean length-at-age for yellow perch from the commercial trap net fishery in New York's waters of Lake Erie, 1993 and 1994.

Age	1993 Spring		1993 Fall		1994 Spring		1994 Fall	
				Males				
2	—	—	185	(3)	—	—	—	—
3	188	(5)	214	(2)	180	(16)	221	(3)
4	208	(11)	252	(2)	197	(8)	206	(1)
5	210	(15)	246	(4)	210	(2)	233	(3)
6	222	(17)	250	(3)	218	(7)	248	(1)
7	251	(9)	258	(5)	219	(4)	236	(1)
8	221	(6)	287	(2)	243	(10)	254	(2)
9	272	(34)	277	(18)	270	(1)	—	—
10+	268	(18)	280	(7)	278	(32)	278	(4)
				Females				
2	—	—	218	(6)	—	—	—	—
3	—	—	261	(4)	198	(4)	242	(5)
4	212	(2)	280	(2)	200	(1)	237	(1)
5	247	(3)	297	(8)	—	—	—	—
6	219	(1)	272	(3)	—	—	269	(2)
7	—	—	317	(4)	—	—	330	(1)
8	—	—	—	—	312	(1)	323	(2)
9	312	(8)	320	(15)	—	—	—	—
10+	327	(6)	308	(5)	—	—	320	(3)

Appendix B. Recruitment-regression module calculations by management unit for determining age 2 abundance in 1995.

Management Unit 1

(MU-1 indices) Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ont.	11	Summer	YOY	47.4	0.6588	17.2710	0.0564	17.1409	17.4011	31,673,787	27,809,827	36,074,615
USFW	21	Fall	YOY	18.9	0.2887	17.1350	0.0527	17.0227	17.2473	27,646,232	24,709,541	30,931,944
USFW	21	Fall	YRL	36.0	0.2647	18.6947	0.3250	18.0021	19.3873	131,524,013	65,798,000	262,904,130
Comb.				**35.9**	**1.2122**	**17.5495**		**17.3009**	**17.7981**	**41,845,582**	**32,633,762**	**53,657,704**

Management Unit 2

(MU-2 indices) Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ohio	23	Fall	YOY	13.2	0.6497	16.7373	0.0603	16.6088	16.8658	18,574,496	16,334,663	21,121,457
Ohio	23	Fall	YRL	51.1	0.7149	17.1243	0.0178	17.0861	17.1625	27,351,994	26,326,853	28,417,054
Comb.				**26.8**	**1.3646**	**16.9401**		**16.8589**	**17.0213**	**22,749,545**	**20,975,376**	**24,673,779**

(MU-1 indices) Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ont.	11	Summer	YOY	47.4	0.6588	17.2710	0.0564	17.1409	17.4011	31,673,787	27,809,827	36,074,615
USFW	21	Fall	YOY	18.9	0.2887	17.1350	0.0527	17.0227	17.2473	27,646,232	24,709,541	30,931,944
USFW	21	Fall	YRL	36.0	0.2647	18.6947	0.3250	18.0021	19.3873	131,524,013	65,798,000	262,904,130
Ohio	23	Fall	YOY	13.2	0.6497	16.7373	0.0603	16.6088	16.8658	18,574,496	16,334,663	21,121,457
Ohio	23	Fall	YRL	51.1	0.7149	17.1243	0.0178	17.0861	17.1625	27,351,994	26,326,853	28,417,054
Comb.				**30.7**	**2.5768**	**17.2268**		**17.0668**	**17.3867**	**30,302,904**	**25,823,313**	**35,559,573**

Continued on next page

Appendix B (continued). Recruitment-regression module calculations by management unit for determining age 2 abundance in 1995.

Management Unit 3

(MU-3 indices)

Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ohio	24	Fall	YOY	28.3	0.1111	17.0649	0.2378	16.5513	17.5785	25,774,598	15,421,913	43,077,010
Ohio	24	Fall	YRL	22.2	0.7610	16.1858	0.0168	16.1492	16.2224	10,700,489	10,315,931	11,099,382
Comb.				**22.9**	**0.8721**	**16.2978**		**16.2003**	**16.3951**	**11,968,478**	**10,857,005**	**13,192,225**

(MU-1 indices)

Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ont.	11	Summer	YOY	47.4	0.7232	17.1201	0.0469	17.0119	17.2283	27,237,357	24,444,114	30,349,785
Ont.	11	Summer	YRL	25.9	0.3649	17.7560	0.2099	17.2812	18.2308	51,443,774	31,998,513	82,705,776
Ohio	21	Summer	YOY	1476.0	0.3613	20.8282	0.7676	19.1924	22.4640	1,110,637,487	216,348,264	5,701,527,738
Ohio	21	Fall	YOY	480.3	0.3592	17.6630	0.1192	17.4090	17.9170	46,875,232	36,360,733	60,430,228
Ohio	21	Fall	YRL	72.2	0.2811	17.1508	0.0402	17.0651	17.2365	28,086,511	25,779,754	30,599,677
USFW	21	Fall	YOY	18.9	0.3399	17.0130	0.0416	16.9244	17.1016	24,471,017	22,396,158	26,738,098
USFW	21	Summer	YRL	8.0	0.2392	16.4676	0.1509	16.1460	16.7892	14,183,644	10,282,973	19,563,967
USFW	21	Fall	YRL	36.0	0.4216	18.4307	0.2610	17.8745	18.9869	101,006,962	57,915,754	176,159,431
Ohio	24	Fall	YOY	28.3	0.1111	17.0649	0.2378	16.5513	17.5785	25,774,598	15,421,913	43,077,010
Ohio	24	Fall	YRL	22.2	0.7610	16.1858	0.0168	16.1492	16.2224	10,700,489	10,315,931	11,099,382
Comb.				**53.5**	**3.9625**	**17.4780**		**17.1287**	**17.8274**	**38,959,435**	**27,471,404**	**55,250,155**

Management Unit 4

(MU-1 indices)

Agency	Area	Season	Group	Geometric Mean #/ Trawl.hr	R-Squared	Estimated Pop. Size (ln)	Std. Err. Estimate (ln)	Lower 95% CI Estimate (ln)	Upper 95% CI Estimate (ln)	Pop. Estimate (numbers)	Lower Pop. Estimate (numbers)	Upper Pop. Estimate (numbers)
Ont.	11	Summer	YOY	47.4	0.5590	16.3334	0.0619	16.1907	16.4761	12,402,393	10,753,050	14,304,718
Ont.	11	Summer	YRL	25.9	0.4710	16.8672	0.1749	16.4716	17.2628	21,151,048	14,240,492	31,415,124
Ohio	21	Summer	YOY	1476.0	0.3873	18.7939	0.7901	17.1102	20.4776	145,240,275	26,969,037	782,183,558
Ohio	21	Fall	YOY	480.3	0.2549	15.4673	0.1368	15.1758	15.7588	5,216,306	3,897,321	6,981,679
Ohio	21	Fall	YRL	72.2	0.4771	14.9291	0.0325	14.8598	14.9984	3,045,270	2,841,379	3,263,791
USFW	21	Summer	YRL	8.0	0.2444	14.2111	0.1586	13.8731	14.5491	1,485,259	1,059,280	2,082,542
USFW	21	Fall	YRL	36.0	0.4371	16.2744	0.2707	15.6975	16.8513	11,691,820	6,566,556	20,817,406
Comb.				**74.6**	**2.8308**	**16.2519**		**15.7713**	**16.7324**	**11,431,374**	**7,069,508**	**18,483,195**

Appendix C. Parameters used with the Clark model for assessing the effects of various minimum size limits for yellow perch in Lake Erie.

Table C-1. Values used for various parameters for three gear types in Lake Erie fishery.

Parameter	Gill nets	Sport fishing	Trap nets
Q - instantaneous catch rate	.2000	.3720	.2000
h - % mortality from catch & release	0.00	30.00	15.00
PL % legal fish harvested	100.00	80.00	100.00
PS % sublegal fish harvested	100.00	0.00	0.00
Initial year (IYR)	1994	1994	1994
Number of years modeled	15	15	15
TP (week of data collection)	40	40	40
TE (week of spawning)	18	18	18
TF (week of fry hatching)	20	20	20
MA (maximum age)	10	10	10

Table C-2. Length at age and instantaneous natural mortality rates (m) used to model the effects of possible regulation changes in Lake Erie.

Age	Mean length	Natural mortality
0	3.5	1.60
1	5.0	0.40
2	6.5	0.40
3	7.3	0.40
4	8.0	0.40
5	8.6	0.40
6	9.0	0.40
7	9.5	0.40
8	10.0	0.40
9	10.5	0.40
10	11.0	0.40

Table C-3. Vulnerability coefficients by inch group used in modeling of Lake Erie yellow perch for sport fishing and trap nets.

	Inch Group														
Gear	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sport	0.0	0.0	0.0	0.2	0.4	0.8	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.0	0.0
Traps	0.0	0.0	0.0	0.0	0.0	0.3	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table C-4. Vulnerability coefficients by inch group used in modeling of Lake Erie yellow perch for gill nets.

	Inch Group														
MSL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	0.0	0.0	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.1	0.1	0.1	0.1	0.1
5	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.1	0.1	0.1	0.1
6	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.1	0.1	0.1
7	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.1	0.1
8	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5	0.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8	0.5
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9	0.8
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.0	1.0	1.0	0.9

Table C-5. Percent of annual yellow perch growth and fishing effort by gear type for Lake Erie.

Week	Annual Growth	Gill net effort	Sport fish. effort	Trap net effort
1	0	0.0	0.0	0.0
2	0	0.0	0.0	0.0
3	0	0.0	0.0	0.0
4	0	0.0	0.0	0.0
5	0	0.0	0.0	0.0
6	0	0.0	0.0	0.0
7	0	0.0	0.0	0.0
8	0	0.0	0.0	0.0
9	0	0.25	0.0	0.0
10	0	0.25	0.0	0.0
11	0	0.25	0.0	0.0
12	0	0.25	0.0	0.0
13	0	2.8	0.0	0.0
14	0	2.8	0.0	0.0
15	0	2.8	0.0	0.0
16	0	2.8	0.0	0.0
17	1	2.8	0.0	0.0
18	1	2.5	0.0	4.7
19	2	2.5	0.1	4.7
20	2	2.5	0.1	4.7
21	3	2.5	0.1	4.7
22	3	0.6	0.1	2.5
23	4	0.6	0.3	2.5
24	4	0.6	0.3	2.5
25	5	0.6	0.3	2.5
26	5	0.6	0.3	2.5
27	5	2.7	0.3	4.4
28	5	2.7	0.0	4.4
29	5	2.7	0.0	4.4
30	5	2.7	0.0	4.4
31	5	4.0	0.0	2.5
32	5	4.0	0.9	2.5
33	4	4.0	0.9	2.5
34	4	4.0	0.9	2.5
35	3	4.0	0.9	2.5
36	3	4.0	16.0	4.1
37	3	4.0	16.0	4.1
38	3	4.0	16.0	4.1
39	3	4.0	16.0	4.1
40	3	3.8	6.1	3.6
41	3	3.8	6.1	3.6
42	3	3.8	6.1	3.6
43	3	3.8	6.1	3.6
44	2	2.2	6.1	1.9
45	2	2.2	0.0	1.9
46	1	2.2	0.0	1.9
47	1	2.2	0.0	1.9
48	1	0.3	0.0	0.1
49	0	0.3	0.0	0.1
50	0	0.3	0.0	0.0
51	0	0.3	0.0	0.0
52	0	0.0	0.0	0.0

Table C-6. Weight harvested and stock size for various MSLs on the small mesh gill net fishery for yellow perch in Lake Erie.

MSL	Harvest	Total harvest	6" + harvest	Stock size
4	1,197	68	44	13,821
5	859	71	54	14,170
6	664	72	65	14,516
7	445	68	66	14,946
8	291	58	58	15,323
9	170	43	43	15,621
10	82	26	26	15,820
11	31	12	12	15,917
12	8	4	4	15,950

Table C-7. Weight harvested and stock size for various MSLs on the sport fishery for Lake Erie yellow perch.

MSL	Stock size	Harvest	Harvest	C&R	Total catch
4	13,789	845	121	30	151
5	13,837	779	120	33	153
6	14,010	657	116	45	161
7	14,360	426	98	83	181
8	14,666	220	68	136	204
9	14,848	93	39	184	223
10	14,933	29	16	218	234
11	14,956	6	4	233	237
12	14,959	0	0	237	238

Table C-8. Weight harvested and stock size for various MSLs on the trap net fishery for Lake Erie yellow perch.

MSL	Stock size	Harvest	Harvest	C&R	Total catch
4	15,177	345	76	0	76
5	15,177	345	76	0	76
6	15,177	345	76	0	76
7	15,297	288	72	8	80
8	15,503	186	58	31	89
9	15,701	83	34	67	102
10	15,790	27	14	94	109
11	15,809	4	3	108	111
12	15,810	0	0	111	111

Figure C-1. Gill net fishery harvest and stock size

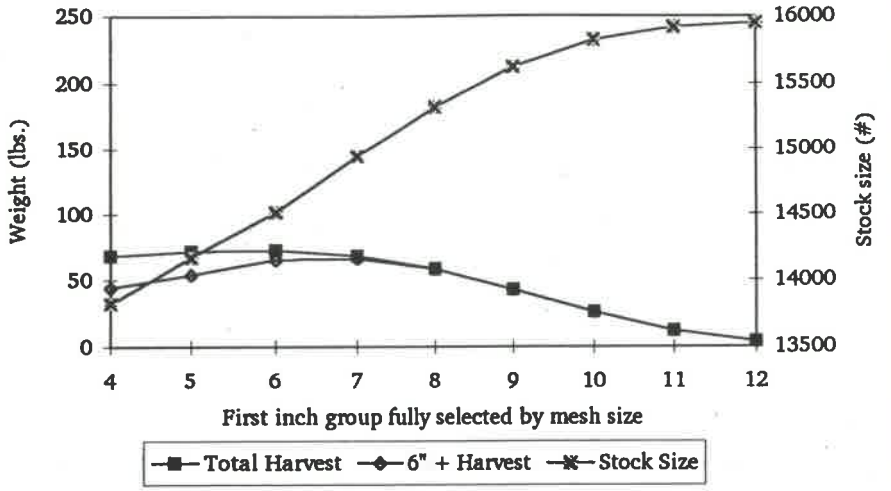

Figure C-2. Sport fishery harvest, total catch, and stock size

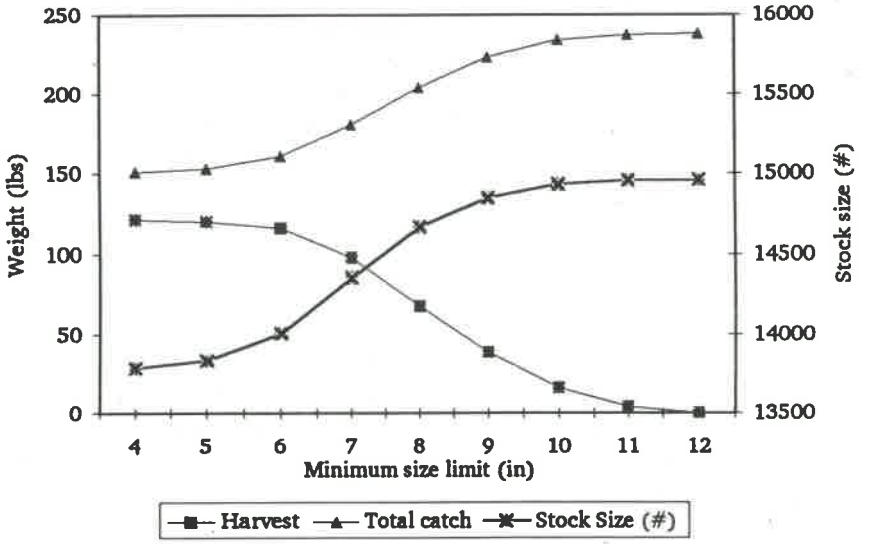

Figure C-3. Trap net fishery harvest, total catch, and stock size