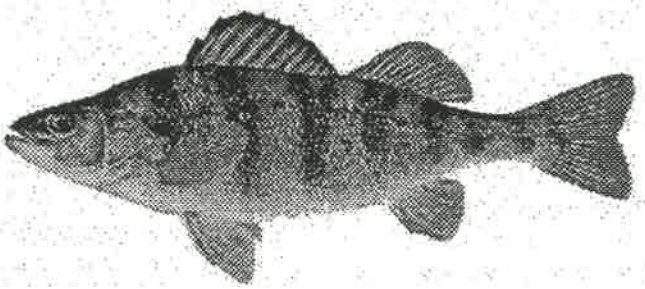
Report of the Lake Erie Yellow Perch Task Group

1997



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Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commmission

Table of Contents

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

Introduction

The Yellow Perch Task Group (YPTG) was assigned four charges by the Lake Erie Committee. As in previous years, the task group was charged with producing a lake-wide Recommended Allowable Harvest (RAH) level by Lake Erie Management Unit, and to maintain and update the centralized time-series data set of harvest, effort, growth and maturity and agency abundance indices of yellow perch. A recent charge undertaken by the YPTG involves using interagency field data in a regression or other predictive model to estimate the relative strength of the age 2 cohort in each management unit as it recruits into the fishery in the subsequent year. One charge assigned to the YPTG in 1994, a determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie, was repeated in 1996 and is still being researched by members of the group. Former members of the YPTG were also responsible for the completion of the joint YPTG and Statistics and Modeling Task Group (SAM) report, documenting the procedures used to develop recommended allowable harvest values.

1996 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1996 totaled 4.990 million pounds (2,263 metric tonnes), which was 128% of the 1995 harvest (Table 1). As in recent years, the YPTG partitioned Lake Erie into four Management Units (Units, or MUs; Figure 1) for harvest, effort, age and population analyses. Yellow perch harvest increased substantially for Ontario (up 29%), Ohio (up 28%) and Michigan (up 75%), but decreased in Pennsylvania (down 63%) and New York (down 32%). Some of Pennsylvania's decrease in harvest was directly attributed to the permanent closing and buyout of their gill net fishery on January 1, 1996. Pennsylvania's trap net and sport fishery data have been included in the summary tables, but without long-term data series no trends or comparisons can be reported.

In comparison with 1995, each agency's proportion of the lakewide harvest was largely unchanged. Ontario's proportion remained at 54% of the lakewide harvest, Ohio's proportion remained at 43%, Michigan's proportion increased from 2% to 3%, while New York's and Pennsylvania's shares decreased to less than one percent of the total lakewide harvest.

Harvest within management units showed strong increases with the exception of Unit 4 (the eastern basin). Ontario experienced sizable harvest increases in all MUs except Unit 4, where they saw a 7% decline compared to the 1995 harvest. Ontario's harvest increased by 45% in Unit 1, 29% in Unit 2, and 15% in Unit 3. Michigan's harvest (Unit 1) increased by 75% over 1995. Ohio's yellow perch harvest experienced large increases in Units 1 and 3, up 43% and 122%, respectively. Ohio's Unit 2 harvest was up 2% compared to the 1995 level. New York's harvest declined to 68% of their 1995 harvest. Pennsylvania's fisheries showed the greatest decrease (37% of 1995 harvest).

Harvest, fishing effort, and catch rates are summarized by Management Unit, year, agency, and gear type in Table 2. The trends over time (1975-1996) are depicted for harvest (Figure 2), fishing effort (Figure 3), and catch rate (Figure 4) by Management Unit and gear type. Commercial gill net harvest increased in all Units except Unit 4. Ontario has the only gill net fishery remaining on Lake Erie for yellow perch. Harvest from commercial trap nets increased in all management units except Unit 4: Unit 1, up 86%; Unit 2, up 25%; Unit 3, up 62%; Unit 4, down 10%. Sport harvest increased 37% in Unit 1, decreased 9% in Unit 2, increased a strong 321% in Unit 3, rebounding after a poor 1995 season. Sport harvest decreased over 42% in Unit 4.

Commercial gill net effort in 1996 declined in all management units: down by 23% in Unit 1, 19% in Unit 2, 26% in Unit 3 and 23% in Unit 4, from 1995 levels. Trap net effort declined in Units 1, 2 and 3 (down 5%, 10% and 16%, respectively), from 1995, but increased by less than 1% in the small trap net fishery in Unit 4. Compared to 1995, sport fishing effort increased by 34% in Unit 1, declined by 18% in Unit 2, increased 65% in Unit 3, and declined 46% in Unit 4.

Catch rates (catch per unit of effort, or CPE) for the 1996 commercial gill net fishery increased in all management units: up 87% in Unit 1, 59% in Unit 2, 27% in Unit 3, and 20% in Unit 4. Catch rates from the sport fisheries increased in Unit 1 (up 5%), Unit 2 (up 12%) and Unit 3 (up 157%) from 1995, but decreased in Unit 4 (down 56%). Trap net catch rates increased in management units 1 through 3: Unit 1, up 94%; Unit 2, up 39%; Unit 3, up 93%. Trap net catch rates for the small Unit 4 fishery declined 9%.

The RAH range recommended by the YPTG for 1996 was 3.254 to 4.914 million pounds lakewide. The Lake Erie Committee supported a total allowable catch (TAC) lakewide allocation of 4.3 million pounds. Partitioned by YPTG management unit, TAC values for 1996 by MU were: Unit 1, 1.4 million pounds; Unit 2, 2.0 million pounds; Unit 3,

0.8 million pounds; Unit 4, 0.1 million pounds. Total allowable catch was exceeded by 44% in Unit 1 and by 10% in Unit 2. In Units 3 and 4, fisheries were under TAC by 9% and 63%, respectively.

Recruitment of yellow perch year classes to the fisheries have been generally low and inconsistent from the late 1980s through 1991. There have been no super-abundant year classes that have recruited into the fishery as large as those seen in 1982, 1984 or 1986 (depending on the MU). The failure to produce large year classes has resulted in yellow perch stock size, harvest and catch rates reaching historic lows from 1991 through 1995. Moderate-sized year classes have persisted since the early 1990s with an occasional strong performer in a specific Unit. This has helped reverse the downward trend and has brought on the sizable increases in harvest realized in 1996.

The 1992 year class has declined from being a strong contributor throughout all management units, whereas the stronger 1993 and now the 1994 year classes made substantial contributions to the lakewide harvest. Older fish (age 6+) continue to be a moderate component of the trap net and sport fishing harvest from Unit 4 (Table 3), but stronger age 2 and 3 cohorts are starting to make an impact in the fishery.

Stock Assessment

Age and Growth

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 also continues to use VonBertalanffy growth model data and F_{opt} values calculated last year (YPTG 1996). The YPTG uses this information to provide model predictors that reflect recent conditions and changes in the Lake Erie environment and yellow perch population response to those conditions.

Catch-at-Age Analysis (CAGEAN) and the 1996 Population Estimate

CAGEAN 1996

As discussed in a previous (YPTG 1995) report, the long-term data series (1975 - present) includes data from a period which the task group feels embodied conditions

significantly different than those found from 1988 to the present. For that reason, only data from 1988 to present were incorporated in the CAGEAN model (YPTG 1996). Data were typically blocked from 1988-1990 and 1991-1996 to distinguish the most recent changes in Lake Erie. 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), which decreased variability in the shortened data series (T. Quinn - personal communication).

The effort lambda, λ_E, was adjusted for each gear type as the ratio of the variances of catch observations to effort observations. The 1996 CAGEAN model ran efficiently, as model iterations were low (usually 3 to 6), no trends were depicted in the residuals, and bootstraps were easily completed. The 1996 CAGEAN estimates of Lake Erie yellow perch populations are supported by abundance indices from all agencies.

A three-gear (gill net, trap net and sport: harvest and effort) version of the CAGEAN model was used to estimate the 1996 population size in numerical abundance and biomass in each management unit. The three-gear version allows factors such as catchabilities and selectivities to be gear specific. Population size estimates were based on a natural mortality rate of 0.4 (M=0.4).

Population size and population parameters such as survival and exploitation rates are presented for one stock size estimate that consists of 1997 age 2 abundance estimates derived from a refined recruitment-regression model (Table 4 and Appendix A). Another age 2 estimator examined by the task group is one that consists of 1997 age 2 abundance estimates derived from non-parametric models (Hollander and Wolfe 1973) developed from Kendall (1938) and Theil (1950b) (Appendix B). Values calculated by non-parametric methods were not significantly different from parametric regression calculations, and are only presented in Appendix B for illustrative purposes pursuant to the charge to the YPTG regarding examination of methods for predicting age 2 recruitment.

Selectivity on all age groups of yellow perch was defined by examining instantaneous fishing mortality, (f), for the last year in the CAGEAN runs independently for each management unit. Age 2 yellow perch selectivity (and other ages not achieving full selectivity) was scaled by the proportion of (f) for that age to (f) for ages at full selectivity. In all cases, the YPTG reports on numbers and biomass for age 2 and older and age 3 and older. Population estimates using the Age-2 regression model and CAGEAN are depicted in Figure 5, and biomass estimates are presented in Figure 6.

Recruitment Estimator for Incoming Age 2 Yellow Perch

In recent years, age 2 yellow perch recruits have been projected using regressions of annual index trawling values for each year class as young-of-the-year and yearlings against CAGEAN estimates of abundance for those year classes as age 2 fish. By using CAGEAN as a method of backcasting age 2 population size and recruitment, it has been shown that our prior methods of calculating age 2 yellow perch entering the fishery using either the old regressions or the three-year, age 2 averaging method (YPTG 1995, 1996) were not robust and did not predict actual magnitude of age 2 entry very well. The age 2 averaging method was an interim method, employed until a more refined method could be defined. In all cases, the old regression model overestimated age 2 severely (YPTG 1995, 1996) and the averaging method underestimated age 2 recruits.

In 1997 the yellow perch task group has refined 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 pooled across season and agency where available. Greater precision was gained by compiling data in arithmetic and/or geometric mean catch per hour tow. The YPTG presents the most significant regression equations used in calculating age 2 yellow perch entering the fishery in Appendix A. The YPTG chose a mean estimator from the significant regression lines to describe age 2 yellow perch available to the fishery beginning in 1997. Area discrepancies across management units were taken into consideration (i.e. Unit 4 data was not applicable in Units 1 and 2). The YPTG also omitted regressions producing negative slopes. As mentioned previously, non-parametric regression models were examined and gave similar results that were not significantly different with wider confidence intervals (Appendix B).

1997 Population Size Projections

Stock size estimates for 1997 (age 3 and older) were projected from the CAGEAN 1996 population size estimates and age-specific survival rates in 1996 (Tables 5 and 6). Recruitment of the 1995 year class in 1997 (age 2 fish) was estimated from the revised recruitment-regression module (Table 6, Appendix A).

At the request of the Lake Erie Committee (LEC) and the Standing Technical Committee (STC), the YPTG has changed the way it calculates and reports standard errors and ranges about our mean estimates for each age. In the past, the YPTG has used the CAGEAN bootstrap mean-of-means and standard deviation from the time series used in the

model to produce the standard errors. The YPTG members have learned in the last month that the Walleye Task Group (WTG) uses the mean and standard deviation produced in the last year of the CAGEAN run time series to calculate standard errors. The YPTG method would typically produce standard error ranges that were much tighter than the WTG method (i.e., Unit 1: 7% compared to 25%). At the request of LEC and STC, the YPTG has adopted the WTG calculation method, and this year will incorporate it (Table 6). Another net effect will also be to produce wider ranges for the 1997 population estimates and RAHs for each management units.

Backcasting for 1996, and comparing to YPTG (1996) projections, stock size estimates of age 2 and older fish increased (i.e., they were underestimated last year) in all management units (Tables 4 and 5, Figure 5). For 1997, stock size estimates of age 2 and older yellow perch show a decrease of 8% in Unit 1, a increase by 1% in Unit 2, and a 16% decrease in Units 3 and 4 (Table 4, Figure 5). Stock size estimates of age 3 and older fish increased in all management units in 1997, due to the strong recruitment of older year classes and the entry of a weaker age 2 year class.

Biomass estimates for age 2 and older fish in 1996 increased over 1995 levels in all Units (Table 4, Figure 6). Backcast estimates of biomass at the start of 1996 were higher than projected in the YPTG 1996 report. Biomass estimates of age 2 and older yellow perch available at the start of 1997 are lower than 1996 in Management Units 1 through 3, and slightly higher in Management Unit 4 (Table 4, Figure 6). However, substantial increases in biomass of yellow perch ages 3 and older are realized for 1997. Yellow perch populations in all units are dominated by fishes of ages 2 and 3, but 4 year olds are persisting in Unit 1.

Survival rates for age 2 and older perch in 1996 declined slightly in Units 1 and 4, and increased slightly in Units 2 and 3 (Figure 7). Overall survival trends since 1988 show a general (slow) increase in survival across all management units. Exploitation rates for age 2 and older fish in 1996 increased in Units 1 and 4 and decreased in Units 2 and 3 (Figure 8). Overall trends for exploitation show a slight decreasing trend, but are influenced in each management unit independently by periodic spikes that coincide with the entry of strong year classes into the fishery.

Yield per Recruit

The yield per recruit model used to calculate a recommended harvest in 1997 is the same as that used in 1996. The basic assumption of the yield per recruit model is that the

desired harvest strategy is to optimize the return in weight per recruit. The optimum harvest rate, F_{opt}, is determined by growth rate versus natural mortality rate. For temperate waters, F_{opt} is modified to $F_{0.1}$, which corresponds to 10% of the rate of increase in yield per recruit, which can be obtained by increasing F (fishing mortality) at low levels of fishing. A full description of the model inputs, as well as the steps required to determine a scaled $F_{0.1}$, are given in previous reports (YPTG 1991, 1992). As discussed above, the task group reviewed all the model inputs in 1995, and has revised the F_{opt} values.

The 1997 harvest estimates for age 2 and older fish are summarized 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 by scaling the $F_{0.1}$ value by the selectivity for that age, and applying the resulting F_{opt} to the 1996 population projection for that age. The harvest (weight) is then calculated by multiplying the age specific catch (in millions of fish) by the mean weight in the harvest (5 year average, 1992-1996).

Recommended Allowable Harvests

In 1996, a lakewide harvest of 4.3 million pounds of yellow perch was adopted by the Lake Erie Committee. The 1996 lakewide harvest was 4.99 million pounds. The TAC (Total Allowable Catch) for 1996 was presented by management unit by the YPTG and the LEC. Allocation for Unit 1 was 1.4 million pounds, and harvest was 2.0 million pounds. Allocation for Unit 2 was 2.0 million pounds, and harvest was 2.2 million pounds. Allocation for Unit 3 was 0.8 million pounds, and harvest was 0.7 million pounds. Allocation for Unit 4 was 0.1 million pounds, and harvest was 0.04 million pounds.

For 1997, we present harvest scenarios by management unit (Table 8). This strategy employs the unadjusted CAGEAN estimates of population size for ages 3 to 6+ and a scaled $F_{0.1}$ (or F_{opt}) exploitation strategy and uses the updated mean recruitment-regression equation from interagency trawls for incoming age 2 yellow perch (Table 6, Appendix A). The YPTG also has provided a wider min-max harvest range by calculating population-at-age standard errors within management unit, using the same methodology and formula as the WTG.

The recommended allowable harvest (RAH) by management unit, and summed for a lakewide total, is presented in Table 8. The Yellow Perch Task Group is aware that recovery

of yellow perch stocks is well underway in management units 1 and 2, is lagging in unit 3, and is not apparent in unit 4. The Yellow Perch Task Group recommends adopting an approximate harvest distribution by Management Unit within the reported ranges. The YPTG is also aware of recovery of stocks, and the potential of a large 1996 year class in the western and central basins of Lake Erie that should enter the fishery in 1998. With the knowledge of these factors, the YPTG recommends to the LEC that harvest levels in the upper half of the ranges in Units 1 and 2 would be appropriate, while mean values would be more appropriate in Units 3 and 4.

Additional Task Group Charge

Spawning Stock Biomass

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

Several models are under review by the task group. Indicators of spawning stock size have included catch rates for mature yellow perch during or immediately following spawning, and indicators of recruitment have included indices of juvenile abundance or catch rates of 2 year old fish as they become vulnerable to the fisheries. A number of problems in the analysis and interpretation have been considered during the review. For example, the relationship between the size of the spawning stock and the resulting recruitment is confounded by the occurrence of highly variable year class strengths, which is typical for yellow perch and other species which are present in Lake Erie. Also, the changing habitat and the presence of a succession of invading species such as zebra mussels must be considered in the evaluation of the success of yellow perch. Variable signs of recovery of perch stocks across different basins of the lake may also mean that model analyses should be done on a unit-by-unit or basin-by-basin approach.

The task group considered this charge to be of lower priority since other charges were more important to calculating harvest values for the next year, and the urgency of these findings seemed to lessen with the entrance of several good year classes entering the fishery and the presence of a super-abundant year class (1996) potentially entering the fishery in a

few years time. Critical mass and time capacity of present YPTG members has forced a greater degree of focus on specific topics and data generation limited to the most essential. The YPTG will continue to evaluate this method of estimating populations, ever cautious that the minimum stock size does not become a target for the fishery to exploit the population down to on an annual basis. The Yellow Perch Task Group will continue to pursue this topic in 1997-1998.

Update on old charge: Joint YPTG/SAM Report on RAH Procedures

An old charge for two former members of the YPTG was the completion of the joint YPTG/Statistics and Modeling Task Group (SAM) report documenting the procedures used to develop a recommendable allowable harvest. It was on track for a 1996 report date. Parties responsible have left agency employment and for this reason output has been slow. Furthermore, since our recent CAGEAN workshop, many of these techniques have been refined and streamlined, but this document will serve as a good point-in-time reference regarding RAH procedures. The YPTG still wants this document to be published, with a new focus on updated CAGEAN information. It should be completed by existing task group members and possibly published as a GLFC Special Report, rather than incorporating the document into an annual report of the YPTG.

Conclusions

It is the view of the Yellow Perch Task Group that the long term time series monitoring of the yellow perch population and harvest continue, and that effort continue to be devoted to understanding the population changes which are occurring. The YPTG will also continue to address current charges regarding long term data sets, RAH, and spawning stock biomass and age 2 recruitment estimators. The YPTG will more closely examine CAGEAN standard error, scaling F, and F_{opt} calculation practices. We will hold joint meetings with the WTG to insure that CAGEAN and harvest methodologies and calculations for both task groups are identical. The YPTG will continue to explore age 2 selectivities and fishing mortalities at specific ages, for incorporation into following task group reports in order to better track how fisheries will perform in subsequent years with projected yellow perch populations.

The task group is continuing to monitor yellow perch growth rates, as new dry weight data collection was initiated in 1996 and will be continued in 1997. These data will serve as baseline comparisons of yellow perch condition throughout the lake, and will be comparable to dry weight data obtained from 1984-1986 (Heyward and Margraf 1988). This will serve as a good comparison on yellow perch growth and condition during pre-zebra mussel invasion and more eutrophic times versus current status of yellow perch stocks.

The task group is also interested in current yellow perch genetic work, which may assist in our ability to recognize individual stocks which may require a more focused management than at the management unit level. This may also shed light on why recovery has progressed better in some locations than others. The YPTG suggests a minimal collection to gather baseline mtDNA sequencing information on Lake Erie yellow perch substocks with a report on status within two years.

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Table 1. Summary of Lake Erie yellow perch harvest in pounds for 1986-1996, by management unit (Unit) and agency.

		Ontario		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch
Unit 1	1986	2,998,800	61	1,708,875	35	180,810	4	--	--	--	--	4,888,485
	1987	2,862,090	59	1,730,925	36	224,910	5	--	--	--	--	4,817,925
	1988	3,186,225	61	1,865,430	36	167,580	3	--	--	--	--	5,219,235
	1989	3,157,560	59	1,900,710	35	332,955	6	--	--	--	--	5,391,225
	1990	1,781,640	67	652,680	24	231,525	9	--	--	--	--	2,665,845
	1991	648,270	46	681,345	48	94,815	7	--	--	--	--	1,424,430
	1992	687,960	59	405,720	35	66,150	6	--	--	--	--	1,159,830
	1993	1,139,985	62	577,710	31	123,480	7	--	--	--	--	1,841,175
	1994	710,010	59	434,385	36	66,150	5	--	--	--	--	1,210,545
	1995	524,790	38	784,980	57	77,175	6	--	--	--	--	1,386,945
	1996	759,292	38	1,125,716	56	134,810	7	--	--	--	--	2,019,818
Unit 2	1986	5,047,245	89	637,245	11	--	--	--	--	--	--	5,684,490
	1987	5,538,960	88	758,520	12	--	--	--	--	--	--	6,297,480
	1988	5,596,290	93	421,155	7	--	--	--	--	--	--	6,017,445
	1989	5,578,650	84	1,071,630	16	--	--	--	--	--	--	6,650,280
	1990	2,873,115	75	952,560	25	--	--	--	--	--	--	3,825,675
	1991	2,171,925	76	683,550	24	--	--	--	--	--	--	2,855,475
	1992	2,522,520	83	500,535	17	--	--	--	--	--	--	3,023,055
	1993	1,933,785	80	493,920	20	--	--	--	--	--	--	2,427,705
	1994	1,300,950	55	1,045,170	45	--	--	--	--	--	--	2,346,120
	1995	1,073,835	57	804,825	43	--	--	--	--	--	--	1,878,660
	1996	1,380,749	63	823,425	37	--	--	--	--	--	--	2,204,174
Unit 3	1986	2,427,705	92	132,300	5	--	--	66,150	3	--	--	2,626,155
	1987	2,002,140	84	238,140	10	--	--	141,120	6	--	--	2,381,400
	1988	2,487,240	78	526,995	17	--	--	178,605	6	--	--	3,192,840
	1989	2,414,475	63	1,199,520	31	--	--	211,680	6	--	--	3,825,675
	1990	2,127,825	76	504,945	18	--	--	185,220	7	--	--	2,817,990
	1991	1,212,750	75	253,575	16	--	--	152,145	9	--	--	1,618,470
	1992	1,190,700	82	185,220	13	--	--	77,175	5	--	--	1,453,095
	1993	606,375	78	145,530	19	--	--	24,255	3	--	--	776,160
	1994	379,260	48	359,415	45	--	--	55,125	7	--	--	793,800
	1995	465,255	80	83,790	14	--	--	30,870	5	--	--	579,915
	1996	532,662	73	186,695	26	--	--	9,041	1	--	--	728,398
Unit 4	1986	315,315	89	--	--	--	--	35,280	10	4,410	1	355,005
	1987	573,300	90	--	--	--	--	50,715	8	13,230	2	637,245
	1988	568,890	98	--	--	--	--	2,205	<1	8,820	2	579,915
	1989	438,795	78	--	--	--	--	0	0	121,275	22	560,070
	1990	282,240	88	--	--	--	--	0	0	37,485	12	319,725
	1991	160,965	87	--	--	--	--	0	0	24,255	13	185,220
	1992	114,660	85	--	--	--	--	0	0	19,845	15	134,505
	1993	72,765	85	--	--	--	--	0	0	13,230	15	85,995
	1994	52,920	83	--	--	--	--	0	0	11,025	17	63,945
	1995	33,075	83	--	--	--	--	0	0	6,615	17	39,690
	1996	30,716	82	--	--	--	--	2,205	6	4,472	12	37,393
Lakewide Totals	1986	10,789,065	80	2,478,420	18	180,810	1	101,430	1	4,410	<1	13,554,135
	1987	10,976,490	78	2,727,585	19	224,910	2	191,835	1	13,230	<1	14,134,050
	1988	11,838,645	79	2,813,580	19	167,580	1	180,810	1	8,820	<1	15,009,435
	1989	11,589,480	71	4,171,860	25	332,955	2	211,680	1	121,275	1	16,427,250
	1990	7,064,820	73	2,110,185	22	231,525	2	185,220	2	37,485	<1	9,629,235
	1991	4,193,910	69	1,618,470	27	94,815	2	152,145	3	24,255	<1	6,083,595
	1992	4,515,840	78	1,091,475	19	66,150	1	77,175	1	19,845	<1	5,770,485
	1993	3,752,910	73	1,217,160	24	123,480	2	24,255	<1	13,230	<1	5,131,035
	1994	2,443,140	55	1,838,970	42	66,150	1	55,125	1	11,025	<1	4,414,410
	1995	2,096,955	54	1,673,595	43	77,175	2	30,870	1	6,615	<1	3,885,210
	1996	2,703,418	54	2,135,836	43	134,810	3	11,246	<1	4,472	<1	4,989,782

Table 2. Catch and effort summaries for Lake Erie yellow perch fisheries by management unit (Unit), agency and gear type, 1986-1996.

		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
	1986	156,555	1,552,320	180,810	3,001,005	0	637,245	5,049,450	0	132,300	2,427,705	66,150	4,410		315,315	105,840
	1987	306,495	1,424,430	224,910	2,862,090	22,050	736,470	5,538,960	46,305	191,835	2,002,140	141,120	13,230		573,300	50,715
	1988	626,220	1,239,210	167,580	3,186,225	46,305	374,850	5,596,290	330,750	196,245	2,487,240	178,605	8,820		568,890	2,205
	1989	864,360	1,036,350	332,955	3,157,560	200,655	870,975	5,578,650	635,040	564,480	2,414,475	211,680	17,640	103,635	438,795	0
Catch	1990	463,050	189,630	231,525	1,781,640	650,475	302,085	2,873,115	447,615	57,330	2,127,825	185,220	19,845	17,640	282,240	0
(pounds)	1991	196,245	485,100	94,815	648,270	302,085	381,465	2,171,925	185,220	68,355	1,212,750	152,145	15,435	8,820	160,965	0
	1992	123,480	282,240	66,150	687,960	145,530	355,005	2,522,520	101,430	83,790	1,190,700	77,175	11,025	8,820	114,660	0
	1993	158,760	418,950	123,480	1,139,985	114,660	379,260	1,933,785	68,355	77,175	606,375	24,255	6,615	6,615	72,765	0
	1994	165,375	269,010	66,150	710,010	304,290	740,880	1,300,950	141,120	218,295	379,260	55,125	4,410	6,615	52,920	0
	1995	108,045	676,935	77,175	524,790	257,985	546,840	1,073,835	63,945	19,845	465,255	30,870	3,122	6,615	33,075	0
	1996	200,313	925,403	134,810	759,292	323,334	500,091	1,380,749	103,414	83,281	532,662	t=5,292;s=3,749*	2,822	1,650	30,716	s=2,205
	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
Catch	1990	210	86	105	808	295	137	1,303	203	26	965	84	9	8	128	0
(Metric)	1991	89	220	43	294	137	173	985	84	31	550	69	7	4	73	0
(tonnes)	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
	1995	49	307	35	238	117	248	487	29	9	211	14	1.4	3	15	0
	1996	91	420	61	344	147	227	626	47	38	242	t=1.7;s=2.4	1.3	0.8	14	s=1.0
	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
Effort	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
(a)	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
	1995	5,103	598,977	123,616	11,136	6,467	388,238	18,337	3,258	42,234	6,843	1,465	532	12,115	1,375	0
	1996	4,869	772,078	193,733	8,617	5,834	316,736	14,850	2,730	69,887	6,184	t=185;s=12,850	533	6,535	1,063	s=7,292
	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	
Catch Rates	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	
(b)	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	
	1995	9.60	0.51	0.28	21.37	18.09	0.64	26.56	8.90	0.21	30.83	9.56	2.63	0.25	10.91	
	1996	18.66	0.54	0.31	39.96	25.13	0.72	42.17	17.18	0.54	39.06		2.40	0.11	13.10	

(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

(*)- t=trap, s=sport

Table 3. Lake Erie 1996 yellow perch harvest (numbers of fish) by gear, age and management unit (Unit).

Gear	Age	Unit 1 Number	Unit 1 %	Unit 2 Number	Unit 2 %	Unit 3 Number	Unit 3 %	Unit 4 Number	Unit 4 %	Lakewide Number	Lakewide %
Gill Nets	1	4,719	0.1	0	0.0	0	0.0	0	0.0	4,719	0.0
	2	436,732	13.5	2,291,032	41.0	283,253	14.3	15,837	13.3	3,026,854	27.7
	3	2,192,305	67.6	1,980,494	35.4	674,858	34.2	66,627	55.9	4,914,285	45.0
	4	529,991	16.3	1,231,261	22.0	978,827	49.6	27,592	23.2	2,767,671	25.3
	5	60,141	1.9	74,700	1.3	31,565	1.6	6,886	5.8	173,292	1.6
	6+	20,724	0.6	17,047	0.3	5,497	0.3	2,163	1.8	45,432	0.4
	Total	3,244,612		5,594,535		1,974,000		119,106		10,932,253	
Trap Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	72,670	11.0	78,772	8.0	20,918	6.3	0	0.0	172,360	8.7
	3	348,139	52.8	370,620	37.8	123,795	37.5	4,541	46.9	847,095	42.8
	4	184,067	27.9	414,643	42.3	137,244	41.6	2,143	22.1	738,097	37.3
	5	28,480	4.3	77,179	7.9	13,515	4.1	675	7.0	119,849	6.1
	6+	26,331	4.0	39,255	4.0	34,608	10.5	2,324	24.0	102,518	5.2
	Total	659,687		980,469		330,080		9,683		1,979,919	
Sport	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	1,773,522	38.1	846,663	58.4	58,242	28.1	2,974	29.1	2,681,401	42.4
	3	2,498,162	53.7	372,611	25.7	64,116	31.0	3,117	30.5	2,938,006	46.5
	4	270,167	5.8	152,543	10.5	47,570	23.0	366	3.6	470,646	7.4
	5	80,982	1.7	48,210	3.3	18,480	8.9	1,521	14.9	149,194	2.4
	6+	33,420	0.7	30,313	2.1	18,692	9.0	2,256	22.0	84,681	1.3
	Total	4,656,254		1,450,339		207,100		10,234		6,323,927	
All Gear	1	4,719	0.1	0	0.0	0	0.0	0	0.0	4,719	0.0
	2	2,282,924	26.7	3,216,467	40.1	362,413	14.4	18,811	13.5	5,880,615	30.6
	3	5,038,607	58.9	2,723,725	33.9	862,769	34.4	74,285	53.4	8,699,386	45.2
	4	984,225	11.5	1,798,448	22.4	1,163,641	46.3	30,101	21.7	3,976,414	20.7
	5	169,603	2.0	200,088	2.5	63,560	2.5	9,083	6.5	442,335	2.3
	6+	80,475	0.9	86,615	1.1	58,797	2.3	6,743	4.9	232,631	1.2
	Total	8,560,553		8,025,343		2,511,180		139,023		19,236,099	

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. 1997 estimates use age 2 abundance estimates derived from CAGEAN estimates regressed against YOY and yearling trawl indices.

		Number	Biomass			
	Year	(millions)	(millions kg)	(millions lbs)	S	u
Unit 1	1988	86.285	10.139	22.356	0.466	0.225
	1989	43.006	5.386	11.875	0.334	0.455
	1990	19.782	3.142	6.929	0.356	0.450
	1991	16.917	2.026	4.468	0.409	0.306
	1992	18.608	2.150	4.742	0.472	0.243
	1993	15.218	1.728	3.810	0.412	0.373
	1994	18.823	2.152	4.744	0.499	0.228
	1995	35.047	3.678	8.111	0.547	0.164
	1996	38.927	4.234	9.337	0.501	0.210
	1997	35.937	3.542	7.810		
Unit 2	1988	93.803	12.710	28.026	0.518	0.227
	1989	52.396	8.186	18.049	0.385	0.409
	1990	28.277	4.599	10.140	0.325	0.387
	1991	30.787	4.206	9.274	0.392	0.328
	1992	35.240	4.345	9.580	0.446	0.331
	1993	24.179	2.852	6.288	0.364	0.385
	1994	28.639	3.576	7.884	0.498	0.269
	1995	26.910	3.573	7.879	0.459	0.238
	1996	46.391	5.607	12.363	0.532	0.171
	1997	47.107	4.870	10.739		
Unit 3	1988	67.850	12.572	27.722	0.522	0.137
	1989	40.233	7.433	16.390	0.462	0.256
	1990	24.546	5.069	11.177	0.463	0.297
	1991	19.886	3.457	7.624	0.451	0.239
	1992	13.239	2.359	5.203	0.434	0.358
	1993	7.716	1.436	3.166	0.435	0.330
	1994	15.820	1.722	3.796	0.571	0.124
	1995	12.130	1.702	3.752	0.527	0.176
	1996	14.538	2.005	4.422	0.559	0.138
	1997	12.263	1.857	4.095		
Unit 4	1990	7.925	1.629	3.592	0.579	0.150
	1991	4.925	1.130	2.492	0.572	0.139
	1992	3.002	0.665	1.465	0.627	0.048
	1993	2.215	0.479	1.056	0.607	0.091
	1994	1.766	0.314	0.692	0.616	0.075
	1995	2.964	0.452	0.996	0.647	0.036
	1996	3.584	0.386	0.851	0.634	0.044
	1997	3.015	0.469	1.035		

Table 5. Yellow perch stock size (millions of fish) at the start of the year, estimated by CAGEAN for the years 1988 to 1996. The 1997 population estimates use age 2 estimates derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices.

	Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Unit 1	2	29.598	2.812	5.403	9.867	11.695	6.441	12.550	25.663	19.740	16.426
	3	26.999	19.241	1.814	3.438	5.171	6.619	3.629	7.300	15.317	11.753
	4	25.092	10.584	6.516	0.463	0.802	1.594	2.035	1.256	3.067	6.298
	5	2.018	8.608	2.983	1.450	0.094	0.211	0.419	0.619	0.476	1.138
	6+	2.579	1.761	3.067	1.699	0.845	0.353	0.190	0.209	0.327	0.322
	2 and Older	86.285	43.006	19.782	16.917	18.608	15.218	18.823	35.047	38.927	35.937
	3 and Older	56.688	40.194	14.379	7.050	6.913	8.777	6.273	9.384	19.187	19.511
Unit 2	2	42.679	3.791	8.115	21.586	23.176	8.451	19.829	12.634	34.047	22.427
	3	17.269	26.961	2.327	4.721	10.089	12.333	4.502	11.413	7.331	20.092
	4	32.927	8.571	11.617	0.738	0.767	2.684	3.334	1.575	4.127	2.877
	5	0.590	12.654	2.426	1.781	0.105	0.179	0.667	0.967	0.466	1.361
	6+	0.337	0.419	3.791	1.960	1.103	0.531	0.307	0.321	0.420	0.350
	2 and Older	93.803	52.396	28.277	30.787	35.240	24.179	28.639	26.910	46.391	47.107
	3 and Older	51.124	48.605	20.162	9.200	12.064	15.728	8.809	14.276	12.345	24.680
Unit 3	2	9.448	4.797	5.978	8.525	4.267	1.970	12.462	3.093	8.144	4.136
	3	7.682	6.297	3.188	3.941	4.761	2.473	1.168	7.645	1.981	5.173
	4	49.558	4.031	2.882	0.921	0.748	1.179	0.714	0.415	3.652	0.892
	5	0.943	24.517	1.720	0.767	0.175	0.185	0.340	0.254	0.198	1.644
	6+	0.219	0.592	10.779	5.731	3.288	1.908	1.136	0.724	0.562	0.419
	2 and Older	67.850	40.233	24.546	19.886	13.239	7.716	15.820	12.130	14.538	12.263
	3 and Older	58.402	35.436	18.569	11.360	8.971	5.746	3.358	9.037	6.394	8.127
Unit 4	2			0.590	0.337	0.184	0.333	0.422	1.876	1.666	0.742
	3			0.529	0.378	0.211	0.120	0.213	0.272	1.237	1.101
	4			1.088	0.262	0.167	0.117	0.059	0.111	0.163	0.751
	5			0.341	0.368	0.068	0.074	0.039	0.022	0.059	0.089
	6+			5.377	3.581	2.372	1.570	1.034	0.682	0.459	0.333
	2 and Older			7.925	4.925	3.002	2.215	1.766	2.964	3.584	3.015
	3 and Older			7.335	4.588	2.819	1.881	1.344	1.088	1.918	2.273

Table 6. Projection of the 1997 Lake Erie yellow perch population. Stock size estimates are derived from CAGEAN. 1997 age 2 estimates are derived from regressions of CAGEAN age 2 abundance against YOY and yearling trawl indices. CV is coefficient of variation by Unit in the last year of CAGEAN runs.

		1996 Parameters				Rate Functions					1997 Parameters				Stock Biomass		
		Stock Size (numbers)				Mortality Rates				Survival Rate		Stock Size (numbers)			Mean Weight in	(thousand tonnes)		(millions lbs.)
	CV Age	Mean	Std. Err.	Min.	Max.	(F)	(Z)	(A)	(u)	(S)	Age	Mean	Min.	Max.	Pop. (kg)	1996	1997	1997
Unit 1	2	19.740	4.830	14.911	24.570	0.119	0.519	0.405	0.092	0.595	2	16.426	12.407	20.445	0.063	1.928	1.043	2.299
0.245	3	15.317	3.747	11.570	19.064	0.489	0.889	0.589	0.324	0.411	3	11.753	8.878	14.629	0.091	1.726	1.065	2.348
	4	3.067	0.750	2.316	3.817	0.592	0.992	0.629	0.375	0.371	4	6.298	4.757	7.838	0.171	0.418	1.075	2.371
	5	0.476	0.117	0.360	0.593	0.592	0.992	0.629	0.375	0.371	5	1.138	0.859	1.416	0.221	0.084	0.251	0.554
	6+	0.327	0.080	0.247	0.407	0.412	0.812	0.556	0.282	0.444	6+	0.322	0.243	0.401	0.335	0.078	0.108	0.238
	Total	38.927	9.524	29.403	48.451	0.291	0.691	0.499	0.210	0.501	Total	35.937	27.144	44.729		4.234	3.542	7.810
	(3+)	19.187	4.694	14.493	23.881	0.506	0.906	0.596	0.333	0.404	(3+)	19.511	14.737	24.284		2.306	2.499	5.511
Unit 2	2	34.047	8.494	25.552	42.541	0.127	0.527	0.410	0.099	0.590	2	22.427	16.832	28.022	0.071	3.711	1.595	3.518
0.249	3	7.331	1.829	5.502	9.161	0.535	0.935	0.608	0.348	0.392	3	20.092	15.079	25.105	0.109	0.997	2.185	4.818
	4	4.127	1.030	3.098	5.157	0.709	1.109	0.670	0.428	0.330	4	2.877	2.159	3.595	0.191	0.659	0.551	1.214
	5	0.466	0.116	0.349	0.582	0.709	1.109	0.670	0.428	0.330	5	1.361	1.022	1.701	0.282	0.098	0.384	0.846
	6+	0.420	0.105	0.315	0.525	0.363	0.763	0.534	0.254	0.466	6+	0.350	0.262	0.437	0.444	0.141	0.155	0.342
	Total	46.391	11.574	34.817	57.965	0.231	0.631	0.468	0.171	0.532	Total	47.107	35.355	58.860		5.607	4.870	10.739
	(3+)	12.345	3.080	9.265	15.424	0.590	0.990	0.628	0.374	0.372	(3+)	24.680	18.523	30.838		1.896	3.275	7.221
Unit 3	2	8.144	4.165	3.980	12.309	0.054	0.454	0.365	0.043	0.635	2	4.136	2.021	6.251	0.073	0.934	0.301	0.663
0.511	3	1.981	1.013	0.968	2.994	0.398	0.798	0.550	0.274	0.450	3	5.173	2.528	7.818	0.108	0.267	0.559	1.232
	4	3.652	1.868	1.785	5.520	0.398	0.798	0.550	0.274	0.450	4	0.892	0.436	1.348	0.160	0.590	0.143	0.315
	5	0.198	0.101	0.097	0.300	0.398	0.798	0.550	0.274	0.450	5	1.644	0.803	2.485	0.408	0.040	0.670	1.478
	6+	0.562	0.287	0.275	0.850	0.135	0.535	0.414	0.104	0.586	6+	0.419	0.205	0.633	0.441	0.174	0.185	0.407
	Total	14.538	7.434	7.104	21.972	0.182	0.582	0.441	0.138	0.559	Total	12.263	5.992	18.534		2.005	1.857	4.095
	(3+)	6.394	3.270	3.124	9.663	0.372	0.772	0.538	0.259	0.462	(3+)	8.127	3.971	12.283		1.071	1.556	3.432
Unit 4	2	1.666	1.001	0.664	2.667	0.014	0.414	0.339	0.012	0.661	2	0.742	0.296	1.188	0.069	0.092	0.051	0.113
0.601	3	1.237	0.744	0.493	1.981	0.100	0.500	0.393	0.079	0.607	3	1.101	0.439	1.762	0.096	0.114	0.105	0.232
	4	0.163	0.098	0.065	0.262	0.208	0.608	0.456	0.156	0.544	4	0.751	0.299	1.202	0.205	0.023	0.154	0.340
	5	0.059	0.035	0.023	0.094	0.208	0.608	0.456	0.156	0.544	5	0.089	0.035	0.142	0.318	0.009	0.028	0.062
	6+	0.459	0.276	0.183	0.735	0.021	0.421	0.343	0.017	0.657	6+	0.333	0.133	0.534	0.392	0.129	0.131	0.288
	Total	3.584	2.155	1.429	5.739	0.055	0.455	0.366	0.044	0.634	Total	3.015	1.202	4.828		0.366	0.469	1.035
	(3+)	1.918	1.153	0.765	3.072	0.092	0.492	0.389	0.073	0.611	(3+)	2.273	0.906	3.640		0.275	0.418	0.922

Table 7. Estimated harvest of Lake Erie yellow perch for 1997. 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	Catch (millions of kg) - RAH			Catch (millions of lbs) - RAH		
	Age	Mean	Min.	Max.	F(opt)	s(age)	(F)	(u)	Mean	Min.	Max.	(kg)	Mean	Min.	Max.	Mean	Min.	Max.
Unit 1	2	16.426	12.407	20.445	0.000	0.200	0.091	0.072	1.181	0.892	1.471	0.100	0.118	0.089	0.147	0.261	0.197	0.324
	3	11.753	8.878	14.629	0.423	0.826	0.375	0.261	3.070	2.319	3.821	0.123	0.378	0.285	0.470	0.833	0.629	1.036
	4	6.298	4.757	7.838	0.423	1.000	0.455	0.306	1.924	1.454	2.395	0.149	0.287	0.217	0.357	0.632	0.478	0.787
	5	1.138	0.859	1.416	0.423	1.000	0.455	0.306	0.348	0.263	0.433	0.173	0.060	0.045	0.075	0.133	0.100	0.165
	6+	0.322	0.243	0.401	0.423	0.696	0.316	0.226	0.073	0.055	0.091	0.246	0.018	0.014	0.022	0.039	0.030	0.049
	Total	35.937	27.144	44.729	1.692	3.723	1.692	0.184	6.597	4.983	8.210	0.130	0.861	0.650	1.071	1.898	1.433	2.362
	(3+)	19.511	14.737	24.284	1.692			0.278	5.415	4.090	6.740	0.137	0.742	0.561	0.924	1.637	1.237	2.038
Unit 2	2	22.427	16.832	28.022	0.000	0.180	0.107	0.084	1.889	1.418	2.360	0.113	0.213	0.160	0.267	0.471	0.353	0.588
	3	20.092	15.079	25.105	0.515	0.755	0.451	0.304	6.105	4.582	7.628	0.131	0.800	0.600	0.999	1.763	1.323	2.203
	4	2.877	2.159	3.595	0.515	1.000	0.598	0.378	1.088	0.817	1.360	0.153	0.166	0.125	0.208	0.367	0.276	0.459
	5	1.361	1.022	1.701	0.515	1.000	0.598	0.378	0.515	0.386	0.643	0.207	0.107	0.080	0.133	0.235	0.176	0.294
	6+	0.350	0.262	0.437	0.515	0.512	0.306	0.219	0.077	0.058	0.096	0.304	0.023	0.017	0.029	0.051	0.039	0.064
	Total	47.107	35.355	58.860	2.060	3.446	2.060	0.205	9.674	7.260	12.087	0.135	1.310	0.983	1.636	2.888	2.167	3.608
	(3+)	24.680	18.523	30.838	2.060			0.315	7.785	5.842	9.727	0.141	1.096	0.823	1.370	2.417	1.814	3.020
Unit 3	2	4.136	2.021	6.251	0.000	0.135	0.075	0.060	0.247	0.121	0.374	0.116	0.029	0.014	0.043	0.063	0.031	0.096
	3	5.173	2.528	7.818	0.482	1.000	0.555	0.358	1.849	0.904	2.795	0.133	0.246	0.120	0.372	0.542	0.265	0.820
	4	0.892	0.436	1.348	0.482	1.000	0.555	0.358	0.319	0.156	0.482	0.186	0.059	0.029	0.090	0.131	0.064	0.198
	5	1.644	0.803	2.485	0.482	1.000	0.555	0.358	0.588	0.287	0.888	0.225	0.132	0.065	0.200	0.292	0.142	0.441
	6+	0.419	0.205	0.633	0.482	0.339	0.188	0.142	0.059	0.029	0.090	0.286	0.017	0.008	0.026	0.038	0.018	0.057
	Total	12.263	5.992	18.534	1.928	3.474	1.928	0.250	3.063	1.497	4.629	0.158	0.483	0.236	0.730	1.066	0.521	1.610
	(3+)	8.127	3.971	12.283	1.928			0.346	2.815	1.376	4.255	0.161	0.455	0.222	0.687	1.002	0.490	1.515
Unit 4	2	0.742	0.296	1.188	0.000	0.069	0.041	0.033	0.025	0.010	0.040	0.109	0.003	0.001	0.004	0.006	0.002	0.010
	3	1.101	0.439	1.762	0.398	0.479	0.288	0.208	0.229	0.091	0.367	0.119	0.027	0.011	0.044	0.060	0.024	0.096
	4	0.751	0.299	1.202	0.398	1.000	0.601	0.380	0.285	0.114	0.457	0.130	0.037	0.015	0.059	0.082	0.033	0.131
	5	0.089	0.035	0.142	0.398	1.000	0.601	0.380	0.034	0.013	0.054	0.159	0.005	0.002	0.009	0.012	0.005	0.019
	6+	0.333	0.133	0.534	0.398	0.100	0.060	0.048	0.016	0.006	0.026	0.257	0.004	0.002	0.007	0.009	0.004	0.015
	Total	3.015	1.202	4.828	1.592	2.648	1.592	0.195	0.589	0.235	0.943	0.130	0.077	0.031	0.123	0.169	0.067	0.270
	(3+)	2.273	0.906	3.640	1.592			0.248	0.564	0.225	0.903	0.131	0.074	0.029	0.118	0.163	0.065	0.261

Table 8. Lake Erie yellow perch harvest estimates for 1997. All estimates are based on CAGEAN outputs and the F(opt) fishing strategy. The model estimates the 1995 year class recruiting into the fishery in 1997 by parametric regression (Regression Model). Values are rounded from Table 7 to the nearest one hundred thousand pounds and one hundred thousand kilograms.

Yield (Millions of Pounds)				Yield (Millions of Kilograms)			
	RAH				RAH		
	Mean	Min.	Max.		Mean	Min.	Max.
Unit 1	1.9	1.4	2.4	Unit 1	0.9	0.7	1.1
Unit 2	2.9	2.2	3.6	Unit 2	1.3	1.0	1.6
Unit 3	1.1	0.5	1.6	Unit 3	0.5	0.2	0.7
Unit 4	0.2	0.1	0.3	Unit 4	0.1	0.0	0.1
Total	6.0	4.2	7.9	Total	2.7	1.9	3.6

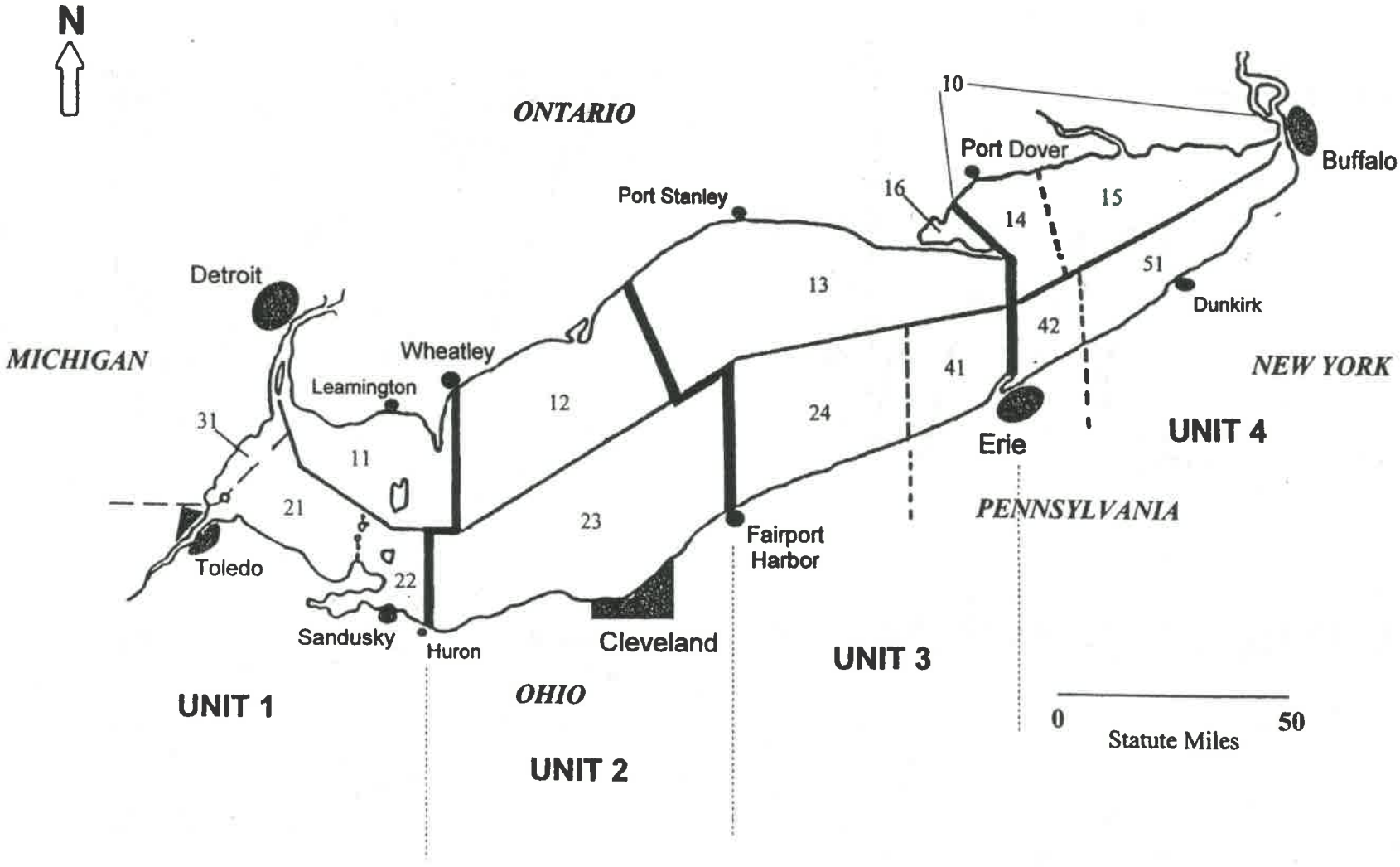

Figure 1. Lake Erie Management Units defined and used by the Yellow Perch Task Group.

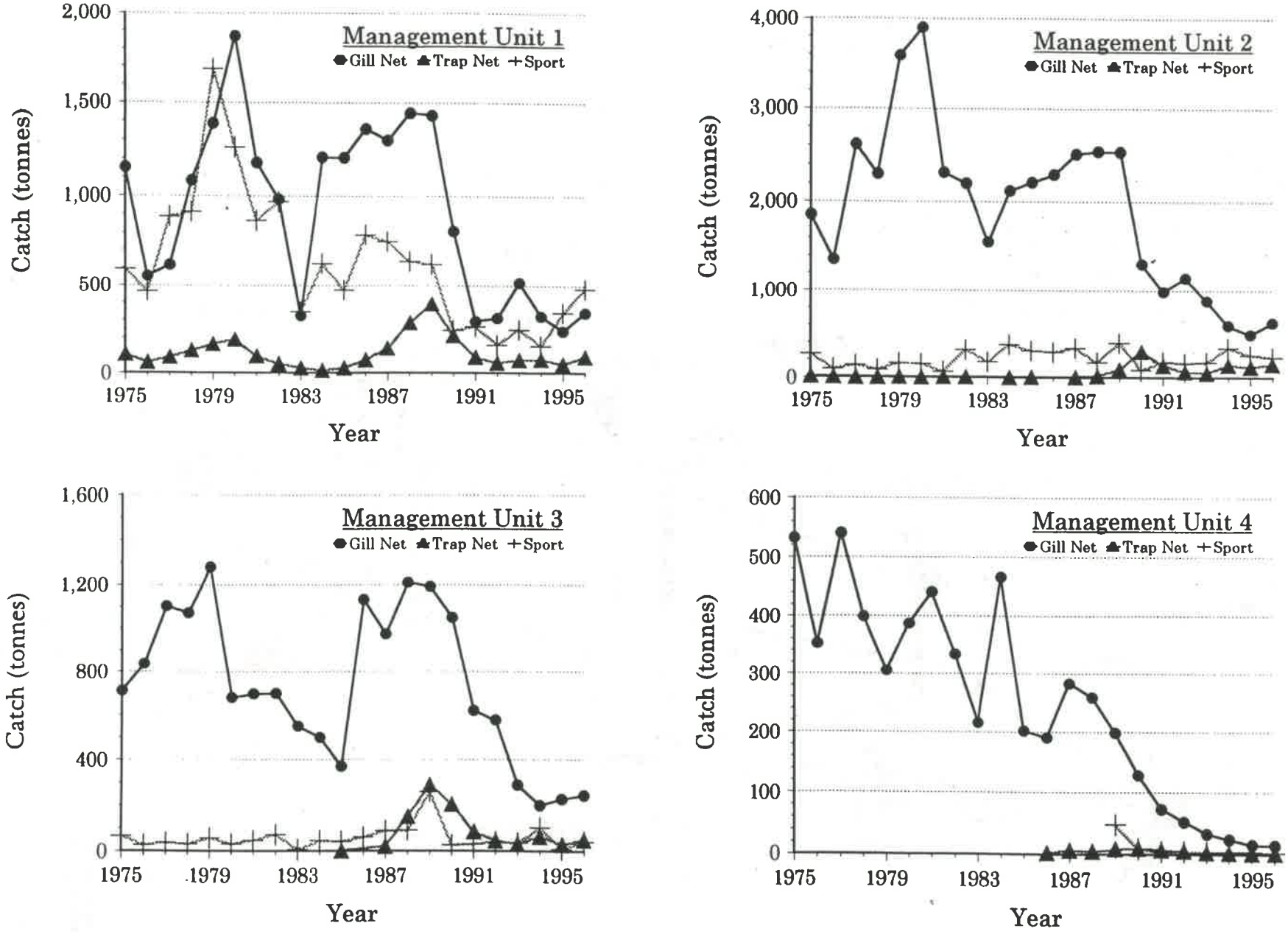

Figure 2. Lake Erie yellow perch harvest by management unit and gear type.

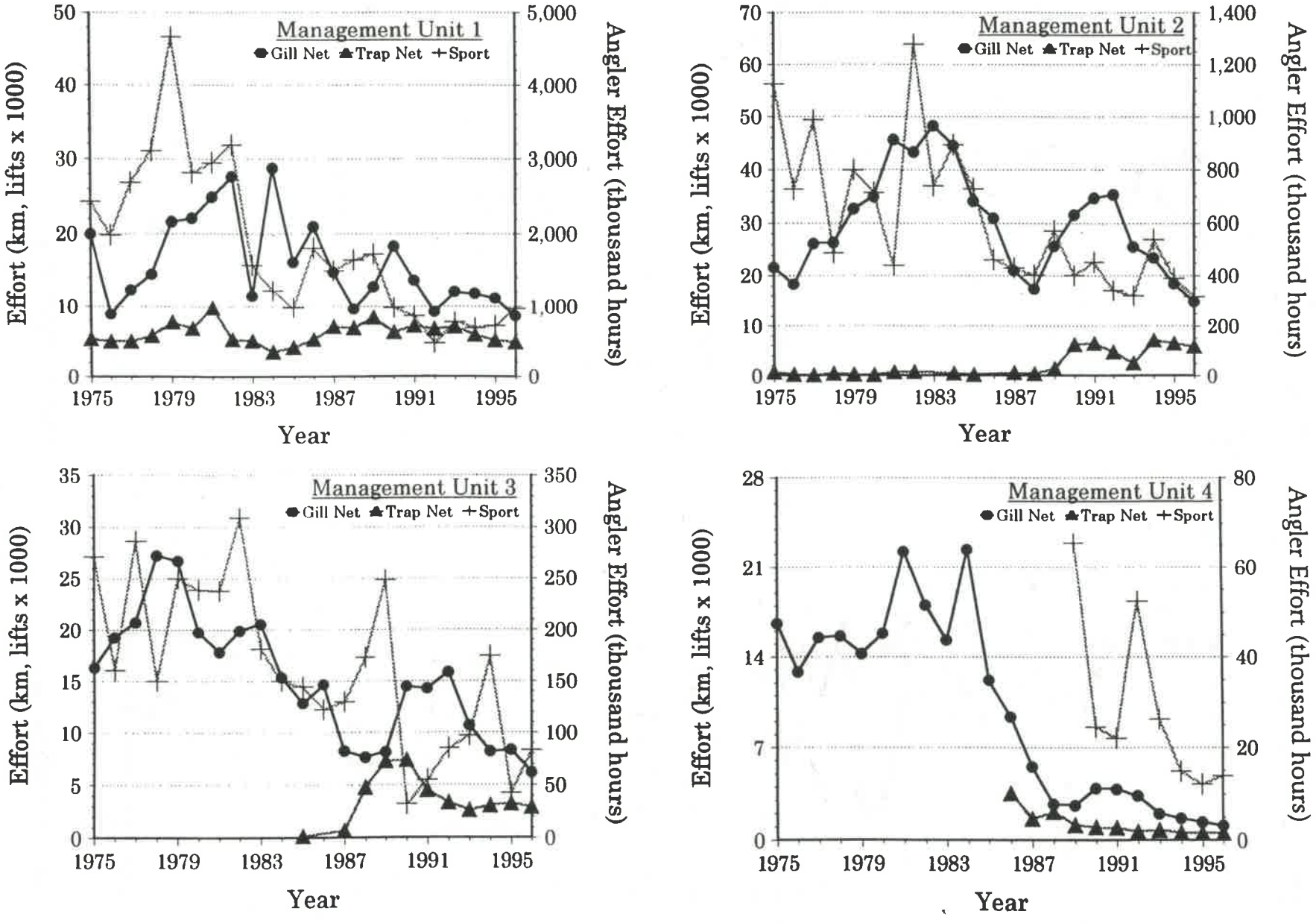

Figure 3. Lake Erie yellow perch effort by management unit and gear type.

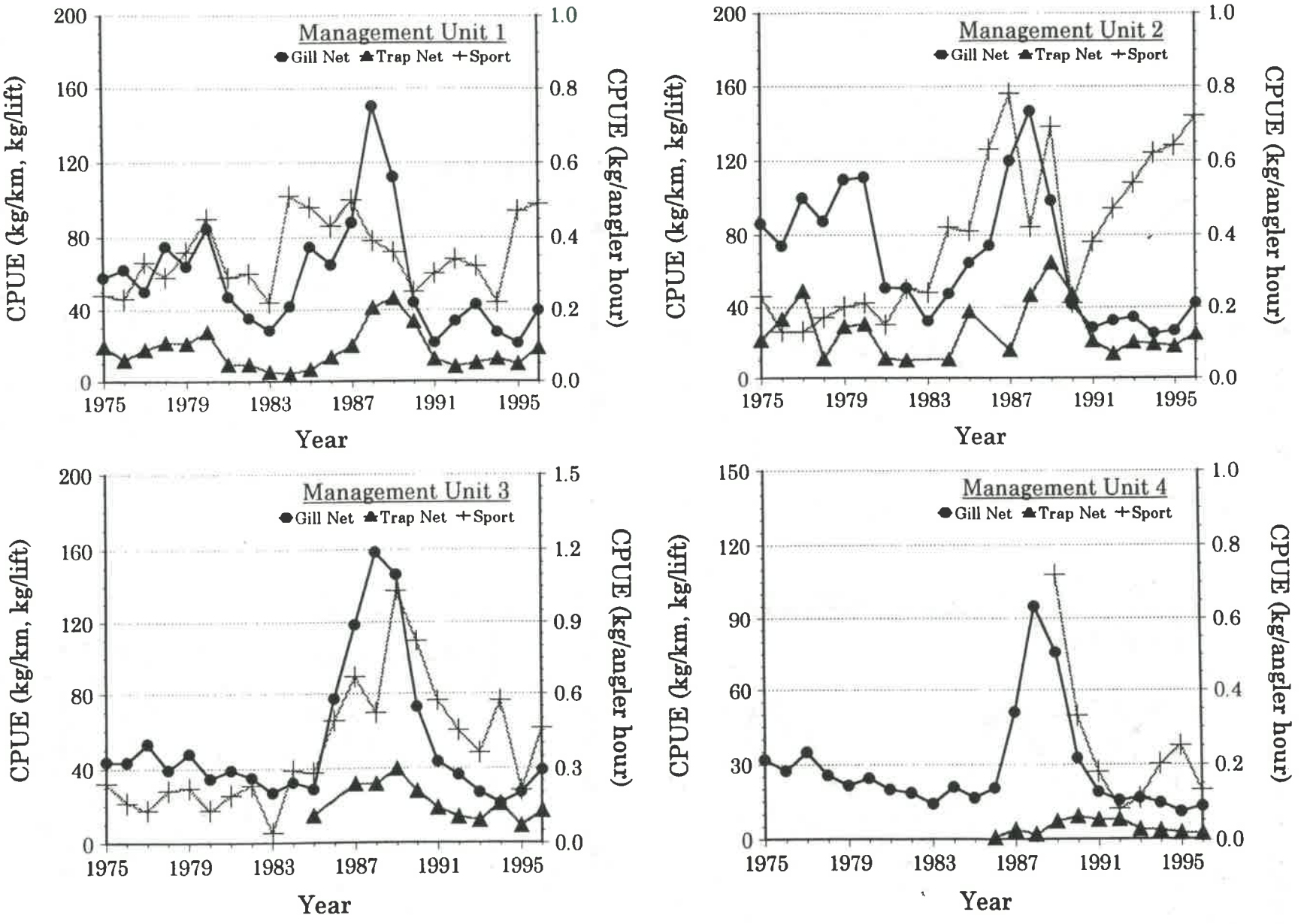

Figure 4. Lake Erie yellow perch catch per unit effort by management unit and gear type.

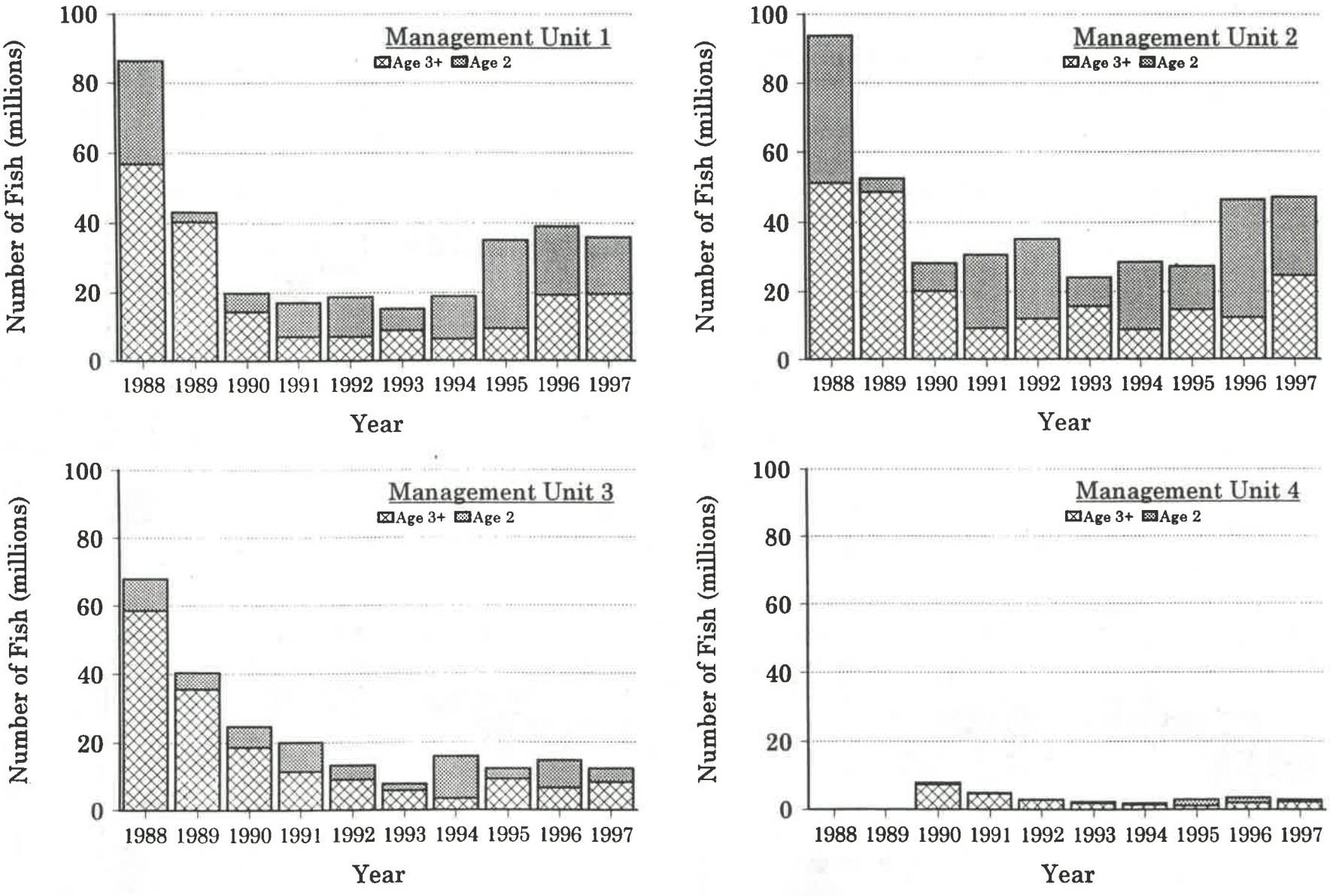

Figure 5. Lake Erie yellow perch population estimates by management unit. Age 2 estimates for 1997 are from regressions of CAGEAN estimates against YOY and yearling trawl indices.

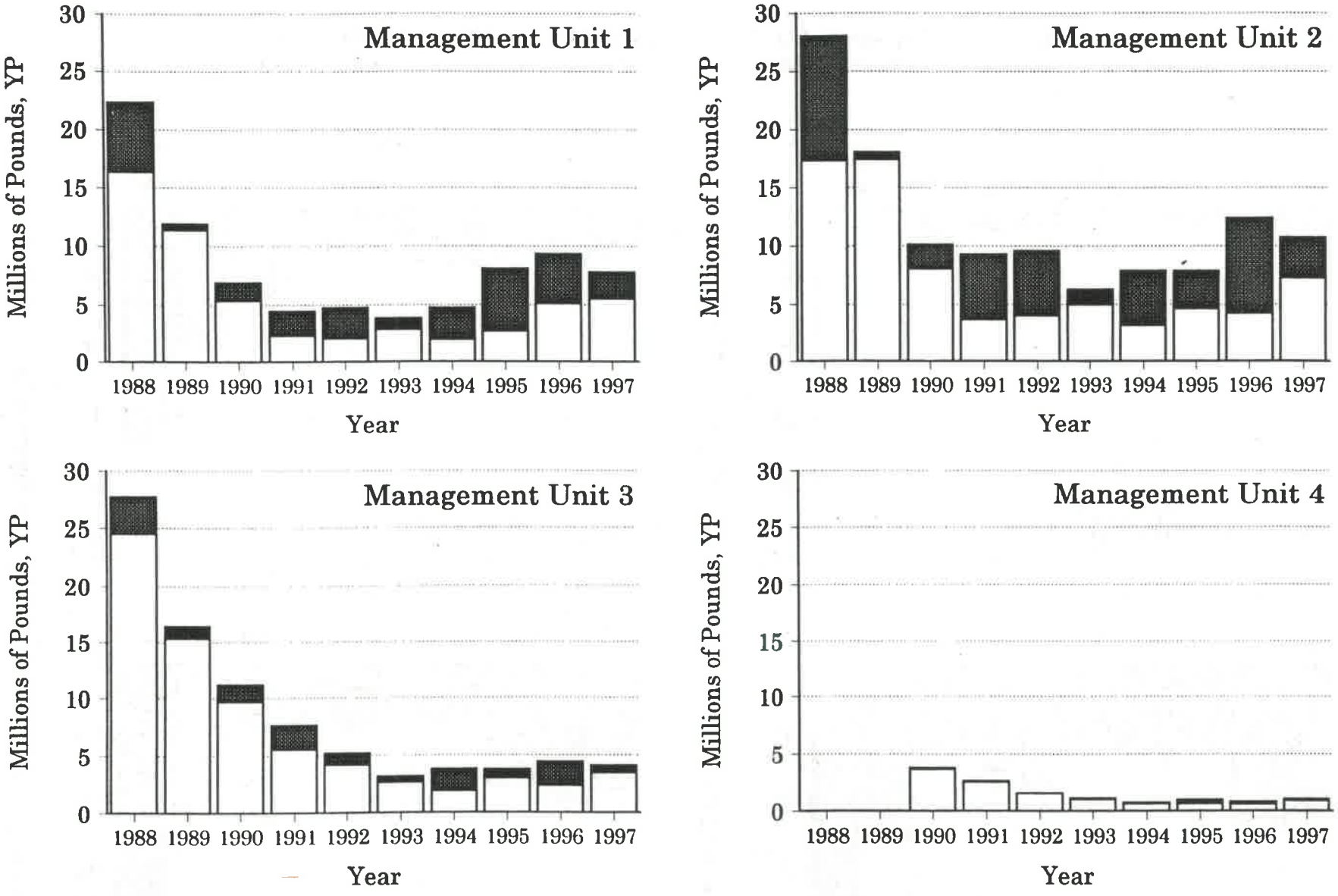

Figure 6. Lake Erie yellow perch biomass estimates by management unit for ages 2 (dark bars) and 3+ (light bars). Estimates for 1997 are from CAGEAN and parametric regressions.

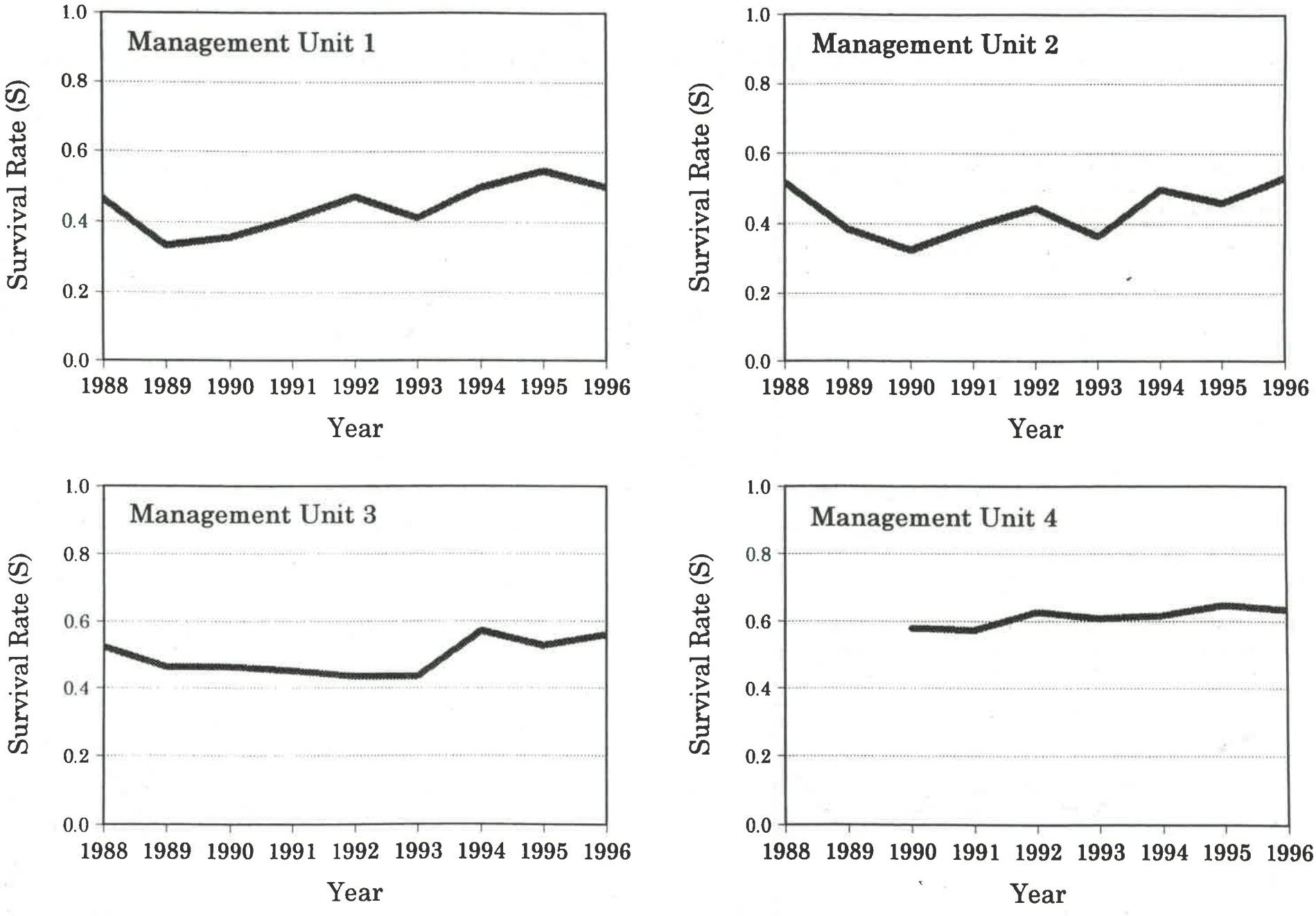

Figure 7. Survival rates of age 2 and older yellow perch, Lake Erie, 1988 - 1996. Estimates are derived from CAGEAN.

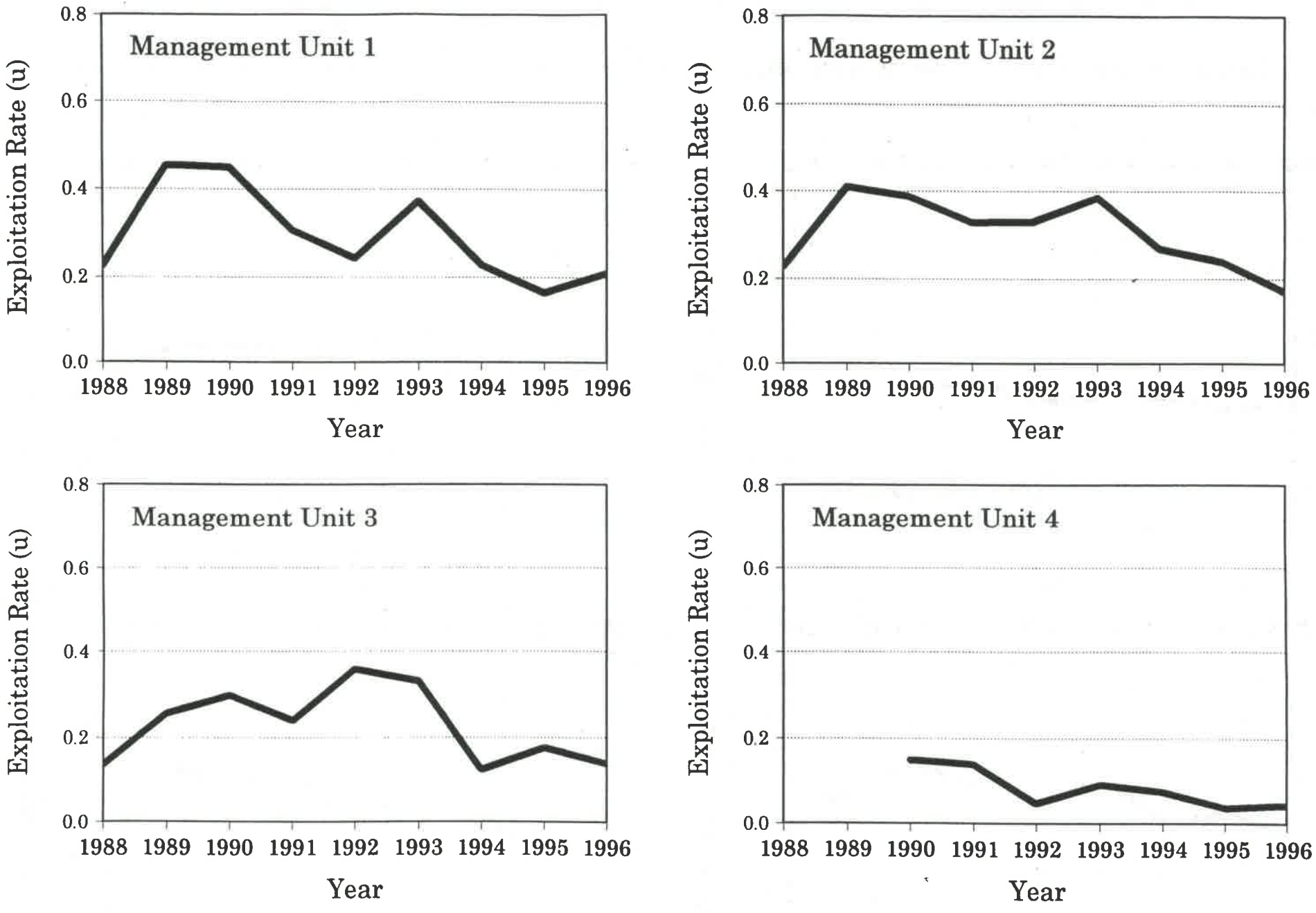

Figure 8. Exploitation rates of age 2 and older yellow perch, Lake Erie, 1988 - 1996. Estimates are derived from CAGEAN.

Appendix A. Agency trawl regression indicies found statistically significant for projecting estimates of age 2 yellow perch by Management Unit.

Management Unit 1

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age-2 estimate	R-Squared	Upper Age-2 estimate	Lower Age-2 estimate	SE
Ontario/Ohio (OMNR calc.)	August	YOY	0.017	5.194	812	0.003	18,657,760	0.86	24,671,380	12,644,140	3.01
Ohio-MU1-interagency	Summer	YOY	0.232	4.298	26	0.004	10,332,381	0.83	16,858,321	3,806,441	3.26
Ohio (OMNR calc.)	August	YOY	0.022	6.409	339	0.030	13,972,093	0.64	23,501,233	4,442,953	4.76
Ontario/Ohio/NBS	Summer	YOY	0.003	12.866	665	0.039	15,114,006	0.05	28,756,986	1,471,026	6.82
Ohio-MU3-Index	Fall	YOY	0.621	7.288	27	0.061	24,054,401	0.63	33,733,121	14,375,681	4.84
Combination			**0.179**	**7.211**	**374**	**0.027**	**16,426,128**	**0.60**	**25,504,208**	**7,348,048**	**4.54**

Management Unit 2

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age-2 estimate	R-Squared	Upper Age-2 estimate	Lower Age-2 estimate	SE
Ohio-MU2-Index	Fall	YOY	0.194	7.784	1	0.003	7,977,569	0.85	15,896,569	58,569	3.96
Ontario-MU1-(OMNR calc.)	August	YOY	0.022	9.406	1370	0.007	39,130,918	0.80	48,243,438	30,018,398	4.56
Ontario/Ohio (OMNR calc.)	Summer	YOY	0.004	17.348	665	0.042	20,171,057	0.05	37,565,897	2,776,217	8.70
Combination			**0.073**	**11.513**	**679**	**0.017**	**22,426,515**	**0.57**	**33,901,968**	**10,951,061**	**5.74**

Management Unit 3

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age-2 estimate	R-Squared	Upper Age-2 estimate	Lower Age-2 estimate	SE
* Ontario Outer Long Point Bay	Fall	YOY	0.322	3.363	2	0.090	4,136,000	0.55	6,010,000	2,260,000	2.91
Combination			**0.322**	**3.363**	**2**	**0.090**	**4,136,000**	**0.55**	**6,010,000**	**2,260,000**	**2.91**

Management Unit 4

Index	Season	Group	Slope	Intercept	Index Value	P-value	Age-2 estimate	R-Squared	Upper Age-2 estimate	Lower Age-2 estimate	SE
Ohio (OMNR calc.)	August	YOY	0.002	0.046	339	0.001	799,000	0.92	1,175,080	422,920	0.19
Ohio-MU1-interagency	Summer	YOY	0.018	0.016	26	0.012	492,594	0.75	1,156,934	0	0.33
Ontario/Ohio (OMNR calc.)	August	YOY	0.001	0.122	812	0.021	1,125,346	0.69	1,866,646	384,046	0.37
Ontario/Ohio/NBS	Summer	YOY	0.000	0.673	665	0.025	878,064	0.06	992,734	763,394	0.06
Ohio-Fixed-Inshore	August	YOY	0.204	0.211	1	0.041	415,308	0.60	1,253,788	0	0.42
Combination			**0.045**	**0.214**	**369**	**0.020**	**742,062**	**0.60**	**1,289,036**	**314,072**	**0.27**

* This regression was based on current age-2 estimates

Appendix B. Non-parametric regression calculations from trawl data for estimates of age 2 yellow perch recruiting into the fishery in 1997. The regression slope line (Theil's B) is calculated by the median of (N-1) pairwise slope calculations from trawl data and CAGEAN age 2 estimates (Hollander and Wolfe 1973). Significance (P-value) is presented for Kendall's K statistic.

			1997 Age 2 estimates			Confidence interval estimates			
Management Unit		P-value	cpht	slope	age 2 est.	slope	age 2 min	slope	age 2 max
Unit 1	Ohio Age 0 Aug MU1	0.022	1823	0.008	15.060	0.002	4.327	0.018	33.066
	OH/ONT pooled	0.007	812	0.024	19.165	0.016	13.109	0.030	24.665
Unit 2	Ohio Age 1 Oct MU2	0.001	30.9	0.444	13.719	0.142	4.400	0.589	18.195
	OH/ONT pooled	0.031	812	0.042	33.935	0.008	6.891	0.050	40.558
Unit 3	Ohio Age 0 MU3	0.242	73	0.020	1.468	0.000	0.000	0.056	4.052
Unit 4	NY Age 0 MU4	0.167	12	0.007	0.088	0.002	0.021	0.016	0.187
	NY Age 1 MU4	0.167	1	0.070	0.070	0.050	0.050		0.110
	ONT Age 0 Outer Long P	0.167	2.4	0.058	0.139	0.006	0.013		0.367

Note: Theil's B calculations of regression lines do not include y-intercept (a) values for the equation: $y = a + B(x)$.