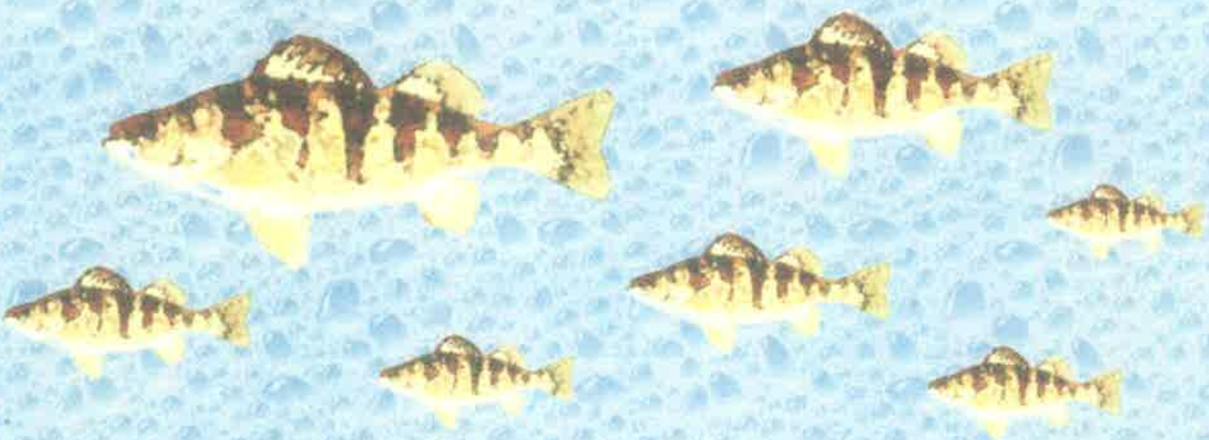
Report of the Lake Erie Yellow Perch Task Group

March 1999



Members:

Kevin Kayle,	Ohio Division of Wildlife, *chairman*
Roger Kenyon,	Pennsylvania Fish & Boat Commission
Carey Knight,	Ohio Division of Wildlife
Phil Ryan,	Ontario Ministry of Natural Resources
Bob Sutherland,	Ontario Ministry of Natural Resources
Mike Thomas,	Michigan Department of Natural Resources

Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Introduction

In 1998, the Lake Erie Committee assigned the Yellow Perch Task Group (YPTG) five charges. As in previous years, the task group was charged with producing a lake-wide Recommended Allowable Harvest (RAH) partitioned by Lake Erie management unit, and to maintain and update the centralized time-series data set of harvest, effort, growth and maturity and agency or interagency abundance indices of yellow perch. Another continuing charge undertaken by the YPTG involves using interagency field data in a regression or other predictive model to estimate the relative strength of the age 2 cohort in each management unit as it recruits into the fishery in the subsequent year. Another charge assigned to the YPTG, a determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie, was examined in greater detail this year. The fifth charge on which we will report examines the potential for genetic research on Lake Erie yellow perch stocks.

1998 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1998 totaled 5.864 million pounds (2,660 metric tonnes or 2.66 million kgs), which was a 7% decrease over the 1997 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 over 1997 levels for Ontario (+1%), Pennsylvania (+10%), Michigan (+18%) and New York (+33%), but declined for Ohio (-21%).

In comparison with 1997, each agency's proportion of the lakewide harvest changed only slightly. Ontario's proportion increased from 60% to 65% of the lakewide harvest, Ohio's proportion decreased from 38% to 32%, Michigan's remained at 2%, while New York's and Pennsylvania's shares remained at less than one percent of the total lakewide harvest.

Harvest, fishing effort, and catch rates are summarized for the time period 1988-1998 by management unit, year, agency, and gear type in Table 2, parts a through d. Trends over a longer time series (1975-1998) are depicted graphically for harvest (Figure 2), fishing effort (Figure 3), and catch rate (Figure 4) by management unit and gear type. Harvest summed by management unit showed minor increases in Units 1-3. Unit 4 (the eastern basin) exhibited a minor increase for the second consecutive year. Ontario experienced increases in Units 1 (+7%)

and 4 (34%) and slight declines in Units 2 (-2%) and 3 (-2%). Michigan's harvest (Unit 1) increased by 18% over 1997. Ohio's yellow perch harvest experienced a small decrease in Unit 1 (-9%), and a sizable decrease in Unit 2 (-42%). Ohio's Unit 3 harvest was up 25% compared to 1997 levels. Pennsylvania's fisheries, albeit small, showed a sizable increase in Unit 3 (up 22%); but a strong decline in Unit 4 (down 82%). New York's small fishery realized a harvest increase for the first time in nine years, up 33% over their 1997 harvest.

Commercial gill net harvest (by weight) for 1998 increased in management units 1 and 4, and decreased in management units 2 and 3 compared to 1997 levels. Ontario has the only gill net fishery remaining on Lake Erie for yellow perch. Harvest from commercial trap nets decreased in Units 1 and 2, down 13% and 39%, respectively, but increased in Units 3 and 4, up 53% and 8%, respectively. Sport harvest decreased in Units 1, 2 and 4: -7% in Unit 1, -9% in Unit 2, and -44% in Unit 4. Sport harvest increased by 15% in Unit 3. *Note: Ontario's Lake Erie sport, trap net and large mesh gill net catches and effort are not calculated in Yellow Perch Task Group reporting procedures and analyses. Complete data for these fisheries is unavailable. The task group uses Ontario commercial small mesh gill net fishery data obtained in OMNR fish processor reports (known as processor weight) instead of landed estimates.*

Commercial small mesh gill net effort for 1998 increased in Management Units 1, 2 and 4 over 1997 levels: up 39% in Unit 1, 15% in Unit 3 and 1% in Unit 4. Reported gill net effort declined in Unit 2 by 5%. Trap net effort for 1998 decreased lakewide: Unit 1, down 2%; Unit 2, down 9%; Unit 3, down 3%; and Unit 4, down 39%. Compared to 1997, sport fishing effort for 1998 increased by 2% in Unit 1, but decreased by 27% in Unit 2, 16% in Unit 3, and 52% in Unit 4.

Catch rates (catch per unit of effort, or CPE) for the 1998 commercial gill net fishery decreased in Units 1 and 3: down 23% in Unit 1 and 15% in Unit 3. Small to moderate increases in CPE were realized in Units 2 and 4: up 3% in Unit 2 and 37% in Unit 4. Trap net catch rates for 1998 declined in Unit 1, down 10%, and Unit 2, down 33%; but increased markedly in Units 3 and 4, up 57% and 79%, respectively. Catch rates for anglers targeting yellow perch increased in Unit 1 by 3% and in Unit 3 by 24%, but decreased by 7% in Unit 2 and 18% in Unit 4.

The lakewide RAH range recommended by the YPTG for 1998 was 5.9 to 7.5 million pounds lakewide. The Lake Erie Committee supported a total allowable catch (TAC) lakewide allocation of 7.44 million pounds. Partitioned by YPTG Management Unit, TAC values for 1998 were: Unit 1, 2.6 million pounds; Unit 2, 3.3 million pounds; Unit 3, 1.4 million pounds; Unit 4, 0.14 million pounds. The YPTG RAH mean values from CAGEAN and age-2 regression estimates by Unit from west to east were 2.2, 2.6, 1.1 and 0.1 million pounds, respectively. Using the alternate scenario presented last year that re-evaluated the 1995 year class, the RAH mean value estimates by Unit from west to east were 2.6, 3.3, 1.2 and 0.1 million pounds, respectively. The 1998 harvest of Lake Erie yellow perch in each management unit did not exceed total allowable catch set by the Lake Erie Committee. The 1998 harvest in millions of pounds by MU was: 2.3, 2.4, 1.1, and 0.052. The 1998 Lake Erie yellow perch fisheries attained 88% of TAC in Unit 1, 74% of TAC in Unit 2, 93% of TAC in Unit 3 and 37% of TAC in Unit 4.

Stock Assessment

Age and Growth

After years of inconsistent recruitment in the late 1980's and early 1990's, the 1993 and 1994 year classes were strong and helped turn around the declining yellow perch population. These two year classes entered the fisheries strong in 1996, dominated the fisheries in Management Units 1 through 3 during 1997, and remained in the fisheries in 1998. In Units 1, 2, and 3, the 1995 year class came in at age 3 stronger than expected. Its poor growth in prior years led to the underestimation of year class strength in 1997. The 1996 year class, still strong by current measures, entered the fishery weaker than expected in all Units except Unit 2 (Table 3). Again, reduced growth of these fish and selectivity of fishery gear is the suspected cause. Trawl and gill net surveys still show this is a very strong year class, especially in the west central and east central basins. In Unit 1, the 1994 year class, then the 1995 and 1996 year classes were strong contributors in the harvest. In Unit 2, the 1996 year class was the greatest contributor, primarily due to the high percentage of age 2 fish caught by gill nets and sport anglers. The 1994 and 1995 year classes were also well represented. In Unit 3, the 1995 was the strongest contributor followed by the 1994 then the 1996 year class. In Unit 4, where the fishery has been dominated by older fish, the 1994 year class made up the greatest proportion of harvest, followed by the 1995 and 1993 year classes. In all Units, we can point to the contribution of three moderate to strong year classes as a sign that recovery of the yellow perch population continues.

In examination of the growth of both the 1995 and 1996 year classes, we observed that length and weight across ages was substantially below the mean value or recent trend since about 1988 (Appendix A). In concern that overall lake productivity might be affecting yellow perch growth, condition, maturity and ultimately recruitment into the fishery, we investigated this issue further. There was no apparent decreasing trend in condition for Lake Erie yellow perch. This variation may be attributed to abiotic and/or biotic factors associated with the lake and their effects on the food web. The 1997 and 1998 year classes are showing improved growth rates-lengths and weights that are at the ten-year mean or higher. Specific age-growth data and the relationship of summer climatic factors to growth of yellow perch at age 0 and age 1 are also presented in Appendix A.

The task group continues to update yellow perch growth in: (1) weight-at-age values recorded annually in the harvest and (2) weight-at-age values taken from interagency trawl and gill net surveys. These values are important in our calculation of available biomass and for calculating harvest in the next year. The task group reviewed yellow perch von Bertalanffy growth model data and F_{opt} values according to methods previously described (YPTG 1996, 1998), but no changes were made to last year's F_{opt} values.

Catch-at-Age Analysis (CAGEAN) and the 1999 Population Estimate

CAGEAN 1998/1999

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

The effort lambda, λ_E , was adjusted for each gear type to equal the ratio of the variance of catch observations to the variance of effort observations. The 1998-99 CAGEAN model ran efficiently as model iterations were low (usually 4 to 8), no apparent trends were depicted in the residuals, and 40 bootstraps were easily completed. A three-gear (gill net, trap net and sport: harvest-by-age, effort, and weight-at-age) version of the CAGEAN model was used to estimate the 1998 population size in numerical abundance and biomass in each management unit. The three-gear version allows factors such as catchabilities and selectivities to be gear specific. Population size estimates were based on a natural mortality rate of 0.4 (M=0.4). A surface response rate exercise to determine the sensitivity of population estimates to variability or error in estimating M showed little variation compared to the overall coefficient of variation (CV) of the population estimate. Growth and recruitment of the slower growing 1995 and 1996 year classes were addressed by blocking selectivity groups for several of the most recent years used in the CAGEAN command files.

Population size and population parameters such as survival and exploitation rates are presented for a stock size estimate that consists of 1999 age 2 abundance estimates derived from a refined recruitment-regression model (Tables 4 and 5 and Appendix B). Numbers and biomass by management unit are presented for age 2 and older. Population estimates using the regression model are depicted in Figure 5, and biomass estimates are presented in Figure 6.

Backcasting population estimates for 1998, and comparing to YPTG (1998) CAGEAN, stock size estimates of age 3 and older fish are higher than predicted (i.e., they were underestimated last year) in Units 1 (+112%), 3 (+19%), and 4 (94%). Estimates of age 3 and older yellow perch in Unit 2 were close to that value reported last year (-2%). The source of the variation was traced to the inability to estimate the 1995 year class strength. As previously discussed, growth declines for Age 2 fish and specific gear selectivity (Appendix A) may have led to their reduced recruitment, which in turn could give an underestimate to CAGEAN's first estimate of the 1995 year class as it entered the fishery in Units 1-3. In an effort to address this perceived underestimate, we used OMNR Partnership gill net regression values to give another estimate of the strength of the 1995 year class. These estimators gave a closer result in Unit 1, but overestimated the age 3 cohort for 1998 in Unit 3 by 22% and severely overestimated the age 3 population in Unit 2 by 176%.

In examining backcast estimates of ages 2 and older, last year's CAGEAN and recruitment regression values overestimated the population in Units 1-3, but underestimated Unit 4. Much of the error was attributed to overestimates of the age 2 cohort. Our original regression estimates were 79.3 million in Unit 1, 71.7 million in unit 2 and 32.4 million in Unit 3. CAGEAN's first read on the 1996 year class estimated 41.7 million in Unit 1, 54.7 million in Unit 2 and 12.1 million in Unit 3. The 1996 year class has also exhibited reduced growth; therefore, it is possible that this cohort had reduced recruitment during this year (and subsequently lower selectivity). If this were the case, then we would expect these estimates to rise again next year when we perform the next permutation of CAGEAN. There are some cautionary notes regarding the strength of the 1996 year class that are also evident. Recent OMNR Partnership surveys show that the 1996 year class may not be as strong as expected in Ontario waters of Units 1-3. Ohio Division of Wildlife trawl surveys in Unit 1 during 1998 also validate this position.

CAGEAN estimates have generally followed a pattern of increasing abundance of the year class represented by the age 2 cohort for the first few years after successive annual CAGEAN runs. This process improves precision of the cohort estimate with time. Even the 1994 year class exhibited substantial gains (similar to the 1995 year class), again due to the reduced growth factor and now that cohort had full recruitment into all fishery gears. After that year class though, and further back into past years, no increasing trends were apparent.

With the overestimates of the 1996 year class and the underestimates of the 1995 year class, the age 2 and older estimates for 1998 in this year's report were generally at the lowest end of the given range from our YPTG 1998 reported population estimates. Unit 4's age 2 and older estimate for 1998 in this year's report was higher due to improved precision of the 1993 through 1995 year classes.

Backcast estimates of biomass for ages 2+ at the start of 1998 were slightly higher than projected in the YPTG 1998 report for Units 1 and 2, somewhat lower than projected in Unit 3, and much higher in Unit 4 (using the standard CAGEAN and regression estimators). This is primarily due to the difference in abundance estimates but may also be due to reduction in growth and weight-at-age values. Age 2+ backcast values of biomass were higher than YPTG 1998 projections by 3% in Unit 1 and 2% in Unit 2, but lower than YPTG 1998 projections by 11% in Unit 3. The biomass estimate was increased by 98% in Unit 4. Backcast estimates increased the biomass of age 3+ yellow perch in Units 1, 3, and 4, up 59%, 33%, and 120%, respectively. Backcast estimates reduced age 3+ biomass in Unit 2 by 6%. Again most of this imprecision was due to changes in the abundance estimates of the 1995 year class, but Unit 4 imprecision was likely due to the paucity of experimental samples provided for the model.

Recruitment Estimator for Incoming Age 2 Yellow Perch

The Yellow Perch Task Group continues to refine the recruitment module and has improved the trawl data series that goes into calculating the least-squares regression values against calculated CAGEAN age 2 values. Trawl values were also pooled across season and agency where available to gather additional index series. Greater precision was gained by compiling data in arithmetic and geometric mean catch per hour tow. The YPTG presents the most significant regression equations used in calculating age 2 yellow perch from the 1997 year class entering the fishery in 1999 in Appendix B, Table B-1. Raw data from trawl index series for the time period examined are presented in Appendix B, Tables B-2 (geometric means) and B-3 (arithmetic means), while a key summarizing abbreviations used for the trawl series is presented as a Legend in Appendix B. Due to the variability in significant regression indices, the YPTG chose a mean estimator to describe age 2 yellow perch available to the fishery beginning in 1999. Regressions that produced negative slopes or did not have index values for 1998 were also omitted from the analyses.

In general, the 1997 year class is moderately weak compared to the last four years, but still may be a factor compared to the poor year classes of the late 1980's and early 1990's.

1999 Population Size Projection

Stock size estimates for 1999 (age 3 and older) were projected from the CAGEAN 1998 population size estimates and age-specific survival rates in 1998 (Tables 5 and 6). Age 2 recruitment values for the 1997 year class in 1999 (methods described above) were then added into the age 3 and older population size estimates in each unit to give a 1999 population of yellow perch ages 2 and older (Table 6). The YPTG continued to calculate and report standard errors and ranges about our mean estimates for each age as in the last two years (YPTG 1997). This method calculates the coefficient of variation (CV, Table 6), using the mean and standard deviation from the last year in the time series of CAGEAN in each management unit, instead of the bootstrap mean of means that was used in the past. This method was again employed to calculate the CV and the population ranges.

For 1999, stock size estimates of age 2 and older yellow perch compared to 1998 show a sizable decrease of 23% in Unit 1, 28% in Unit 2, 16% in Unit 3, and 13% in Unit 4 (Tables 4 and 5, Figure 5). Stock size estimates of age 3 and older fish show a sizable increase in all management units in 1999 except Unit 4: up 58% in Unit 1, 171% in Unit 2, 33% in Unit 3, but down 23% in Unit 4. The estimates changed so drastically because of a relatively weak year class entering at age 2 and a strong year class progressing into age 3.

Biomass estimates for age 2 and older fish for 1999 decrease over 1998 levels in all Units except Unit 4 (Table 4, Figure 6) due to the weaker incoming 1997 year class. Ages 2+ biomass estimates are down 34% in Unit 1, 31% in Unit 2, 29% in Unit 3 and up 2% in Unit 4. Biomass estimates of age 3 and older yellow perch available at the start of 1999 are higher than 1998 in all management units: Unit 1, +36%; Unit 2, +115%; Unit 3, +10%; and Unit 4, +6%. Yellow perch populations in all units will be dominated by fish from the 1996 year class, but the 1995 and 1994 year classes and to a smaller extent the 1993 year class are persisting in all management units. It is expected that the 1997 year class will contribute less than the 1995 year class when it entered the fishery at age 2 a couple of years ago.

Survival rates for ages 2 and older perch in 1998 increased in Units 1-3, and declined slightly in Unit 4 (Figure 7). This trend was also exhibited for survival of ages 3 and older yellow perch in Units 2 and 3 (Table 4, Figure 7), but Units 1 and 4 exhibited small declines. Overall survival trends since 1988 show a general (slow) increase in survival across all management units until 1996 when trends show a leveling off (Unit 1) or a decline (Units 2-4). Exploitation rates for ages 2 and older fish in 1998 decreased substantially in all management units except unit 4 (Figure 8). This trend is probably due to lower selectivity of the slower-growing strong 1996 year class. Exploitation of age 3 and older yellow perch increased in Units 1 and 4 but decreased in Units 2 and 3 (Figure 8). Overall trends for exploitation showed a slight decreasing trend up until 1996, but are influenced in each management unit independently by periodic spikes that coincide with the entry of strong year classes into the fishery. There is a concern by the task group that exploitation rates are still above target levels (as specified by mean RAH values calculated under F_{opt} over years of YPTG reports). Exploitation rates must remain under control to sustain recovery in all Units.

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

The yield per recruit model used to calculate a recommended harvest in 1999 is similar to that used in 1998. 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 $F_{0.1}$, is given in previous reports (YPTG 1991, 1995). Since we have updated our growth information, the YPTG determined updates to von Bertalanffy inputs and F_{opt} calculations and outputs were also necessary. For Management Units 1, 2 and 4, knife-edge full recruitment in the F-OPTMAXX model (YPTG 1995, 1996) was set at age equal to 3.5 years, whereas in unit 3 it was set to 3.0 years based on recent selectivity and CAGEAN information. Updated F_{opt} values are presented in Table 7. F_{opt} values in general decreased slightly for Management Units 2 through 4, but increased in Unit 1.

The second factor in determining yield per recruit is calculating fishing mortality by age (F_{age}). In previous years (see YPTG 1996 or 1997, for example), a method of calculating F_{age} was employed that resulted in values of F for specific ages being greater than F_{opt} for that age. The YPTG again employed the method described in last year's report. F_{age} is equal to F_{opt} (not greater) and for those ages where full recruitment is not attained F_{age} is calculated by the equation: $F_{age} = F_{opt} * s_{(age)}$, where $s_{(age)}$ is the selectivity for that age. Selectivity at a specific age is calculated from the last year of the CAGEAN run (or a similar year's conditions in CAGEAN runs if the new year is expected to differ significantly from the previous year's fishery), based on the ratio of F for that age to F for the age of full recruitment (see "F" column from Table 6 and "s(age)" column from Table 7). This method produces a more conservative estimate of F_{age}, more akin to a Ricker method, and will result in a lower estimate of harvest (and RAH) than the previous method. This is also a more desirable calculation in that at no time do we recommend an F value for any age group that is higher than F_{opt}. This is the same method of calculating F_{opt} that has been adopted by the WTG.

The third and fourth factors updated in the yield per recruit calculations are calculating mean weight-at-age in the population (Table 6) and mean weight-at-age in harvest (Table 7). In both cases, a two-year time series average was used in each management unit for these calculations. Because of the recent changes and variability seen in growth, the YPTG determined that shortening the time series used in calculating these averages to just two years would be more appropriate in reflecting current conditions seen across the lake and would be more responsive to changes in each unit. These values are based on a high number of samples taken from interagency surveys by all agencies.

The 1999 harvest estimates for age 2 and older fish are summarized by management unit in Table 7. These values are the sum of the estimates of the harvest in numbers of each age group. The harvest estimates are derived (as described above) by scaling the F_{opt} value by the selectivity for that age, s(age), and applying the resulting F and exploitation (u) to the 1999 population projection for that age. The harvest in weight is then calculated by multiplying the age specific catch (millions of fish) by mean weight in the harvest (2 year average, 1997-1998).

The 1999 harvest estimates are somewhat lower than those calculated for 1998 and similar to or slightly higher than the observed 1998 harvest. Two dominant factors that will affect the accuracy of the 1999 harvest estimates are: the full recruitment of the 1996 year class (which from our initial indications was very strong, and may be underestimated in this year's CAGEAN due to poor growth) and the entry of the weak 1997 year class, one of the smallest seen in our interagency trawl and gill net surveys for at least a decade.