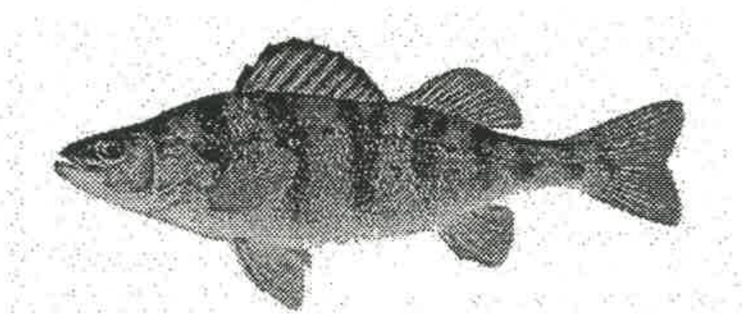
Report of the Lake Erie Yellow Perch Task Group

1997



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Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commmission

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

Introduction

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, $\lambda_{E.}$ 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.