Report of the Lake Erie Yellow Perch Task Group

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Presented to:

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

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Introduction

The Yellow Perch Task Group (YPTG) was assigned five 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, and to maintain and update the centralized time-series data set of harvest, effort, growth and maturity and agency abundance indices of yellow perch. The task group was also charged with the completion of the joint YPTG/Statistics and Modeling Task Group (SAM) report, documenting the procedures used to develop a recommendable allowable harvest. Two charges assigned to the YPTG in 1994, an examination of the effect of increased minimum size limits on yellow perch yield, and determination of a minimum spawning stock biomass necessary for sustaining fishable yellow perch stocks in Lake Erie, were repeated in 1995 and are still being addressed by the group.

1995 Fisheries Review

The reported harvest of yellow perch from Lake Erie in 1995 totaled 1,762 metric tonnes (3.88 million pounds), which was 88% of the 1994 harvest (Table 1). As in the recent past, the YPTG partitions Lake Erie into four Management Units, or MUs (Figure 1). Perch catches declined for Ontario, Ohio, Pennsylvania and New York, but increased in Michigan. Ontario experienced a decrease in harvest in all MUs except MU-3, where there was a 23% increase over the 1994 harvest. The Ontario harvest declined by 26% in MU-1, 17% in MU-2, and 38% in MU-4. The Pennsylvania harvest showed the greatest decrease (56% of 1994 harvest). The Ohio yellow perch harvest experienced the smallest decrease among the agencies (91% of 1994 harvest), due largely to the increased harvest in MU-1 (up 81%). The Ohio MU-2 harvest was 77% of the 1994 level. The largest decline in Ohio's fishery occurred in Management Unit 3, where harvest dropped to 23% of the 1994 level. The Michigan harvest increased by 15% over 1994. New York's harvest declined to 60% of the 1994 harvest.

In comparison with 1994, each agency's proportion of the lakewide harvest was largely unchanged. Ohio's proportion increased from 42% to 43% of the lakewide harvest, Michigan's proportion increased from 1% to 2%, Ontario's decreased from 55% to 54%, while New York's and Pennsylvania's shares remained unchanged.

The allowable harvest level range recommended by the YPTG for 1994 was 3.374 to 4.488 million pounds lakewide. The Lake Erie Committee supported a lakewide allocation of 4 million pounds.

Harvest, fishing effort, and catch rates are summarized by Management Unit, year, agency, and gear type in Table 2. The trends over time (1975-1995) are depicted for harvest (Figure 2), fishing effort (Figure 3), and catch rate (Figure 4) by Management Unit and gear type. Commercial gillnet harvest declined in Units 1, 2 and 4, down from the 1994 harvest by 26%, 17% and 38% respectively. The commercial gillnet harvest in Unit 3 increased by 14% over the 1994 level. Harvest from commercial trapnets decreased in all Management Units: MU-1 decreased by 35%, by 15% in MU-2, and by 55% in Unit 3. Trapnet harvest in Unit 4 decreased by 50%. Sport harvest increased substantially in Unit 1 (+ 125%), stayed approximately the same in Unit 4, and decreased in Units 2 and 3, down by 26% and 90% respectively.

Commercial gillnet effort in 1994 declined in all management units: down by 5% in Unit 1, 22% in Unit 2, 14% in Unit 3 and 16% in Unit 4, from 1994 levels. Trapnet effort declined in Units 1, 2 and 4 (down 14%, 9% and 4% respectively), from 1994, but increased by 6% in Unit 3. Sport fishing effort increased by 4% in Unit 1 in 1995, but declined by 28% in Unit 2, 76% in Unit 3, and 18% in Unit 4.

Catch rates for the 1995 commercial gillnet fishery increased by 6% over 1994 in Unit 2 and by 32% in Unit 3. The gillnet catch rates declined by 22% in Unit 1, and by 25% in Unit 4, relative to 1994. Commercial trapnet catch rates decreased in all Management Units. Unit 1 catch rates dropped 24% from 1994, Unit 2 declined by 6%, Unit 3 by 58%, and Unit 4 decreased 48% from 1994. Catch rates from the sport fisheries increased in Unit 1 (up 113%), Unit 2 (up 3%) and Unit 4 (up 25%) from 1994. The sport fishery catch rate from Unit 3 decreased by 63% from 1994.

Recruitment of year classes to the fisheries has been variable since 1990; however, there have been no year classes as large as those seen in the mid 1980s. The failure to produce large year classes has resulted in yellow perch stock size, harvest and catch rates reaching historic lows.

The 1992 year class remained a strong contributor throughout all management units, but the 1993 year class made a marked contribution to the harvest in Units 1 and 4. Older fish (age 6+) continue to dominate the trapnet and sport fishing harvest from Unit 4 (Table 3).

Stock Assessment

Age and Growth

In response to an apparent trend of increasing growth of yellow perch, noted in the 1995 YPTG report, the task group reviewed the growth model to compare with the work done previously. Trends in growth may have important ramifications for the application of the CAGEAN analysis to yellow perch in Lake Erie. Improved growth over time results in a temporal change in vulnerability to the various gear types involved in the fisheries. If such a change is not accounted for in the CAGEAN model, the CAGEAN analysis will overestimate the abundance of the cohorts that have experienced that change.

The task group uses growth data in a Beverton-Holt yield-per-recruit model to determine F_{opt}. The inputs required for this model are derived from the VonBertalanffy growth formula (VBGF). The data used for this exercise were from Ontario's partnership index gillnetting program. These data were selected for several reasons: the survey was conducted consistently in all areas of the lake, it occurred in the fall (the end of the growing season), and it provided an unbiased estimate for all size and age groups.

The data from each Management Unit were pooled from 1990 to 1994. The model parameters were derived using the VonBertalanffy regression method (Pauly, 1984) over the more popular Ford-Walford (Everhart and Youngs 1981) method, as these estimates were deemed more realistic, and were not subject to the biases inherent in the Ford-Walford method.

When the revised VBGF values were entered into the yield-per-recruit model, the task group found there was little change in the resulting F_{opt} values. The results of the VBGF models and the yield-per-recruit models are summarized in Appendix A.

Catch-at-Age Analysis (CAGEAN) and the 1995 Population Estimate

CAGEAN 1995

As discussed in the 1995 YPTG 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 on. The introduction of zebra and quagga mussels, combined with reduced nutrient loadings have resulted in a system which exhibits dynamics different than those experienced prior to 1988. In addition, the large 1984 year class altered the behaviour of all Lake Erie's fisheries, raising catches and catch rates, and persisting in large numbers into the early 1990's. Indeed, the 1984 year class is still the largest component of New York's fisheries. The task group felt that the 1984 year class had a strong influence over the CAGEAN model, masking the true dynamics of the population. For that reason, the data from 1988 to present were incorporated in the CAGEAN model. Data was blocked from 1988-1990 and 1991-1994 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 1995 CAGEAN model ran efficiently, as model iterations were low (less than 10, usually 3 or 4), no trends were depicted in the residuals, and bootstraps were easily completed. The 1995 CAGEAN estimates of Lake Erie yellow perch populations are supported by abundance indices from all agencies.

A three-gear (gillnet, trapnet and sport: harvest and effort) version of the CAGEAN model was used to estimate the 1995 population size. The three-gear version allows factors such as catchabilities and selectivities to be gear specific. Population size estimates were based on a natural mortality rate of 0.4 (M=0.4).

Population size, in numbers and biomass, and population parameters such as survival and exploitation rates are presented for two stock size estimates: one that consists of 1996 age 2 abundance estimates derived from the recruitment-regression module (Table 4), and one that consists of 1996 age 2 abundance estimates derived from averaged CAGEAN age 2 estimates from 1993-1995 (Table 5). In both cases numbers and biomass are presented for both age 2 and older and age 3 and older. Population estimates are depicted in Figures 5 and 6, and biomass estimates are presented in Figures 7 and 8. Age 2 fish do contribute considerably to the harvest; however, a cohort contributes more significantly at age 3 and older, when it is fully vulnerable to all gears throughout the year.

In 1995, stock size estimates of age 3 and older fish increased in Management Units 1, 2 and 3, while decreasing slightly in Unit 3 (Tables 4 and 5, Figure 5). Biomass estimates for age 3 and older fish in 1995 increased over 1994 levels in all Units except Unit 4. Nearly half the population (by numbers) in Unit 1 in 1995 consisted of age 2 fish. Age 2 fish are a smaller component of the population in Units 2 and 3 (35% and 16%, respectively). In Unit 4, age 2 fish comprise 64% of the population.

Survival rates for age 3 and older perch declined slightly in Unit 2, and increased slightly in Units 1, 3 and 4 (Figure 9). Survival rates for age 2 and older perch increased in all Management Units 1 and 4, but decreased in Units 2 and 3. Exploitation rates for age 3 and older yellow perch decreased in all management units; however, exploitation rates for age 2 and older fish increased in all areas except Unit 4 (Figure 10).

Recruitment

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. The 1996 age 2 recruit projections from the 1994 year class are considered by the task group to be unreasonably high. Although the 1994 year class of yellow perch is thought to be of modest size based upon initial trawl estimates, the recruitment-regression module projecting year class size at age 2 far exceeds assessment observations. Population projections from previous years' recruitment-regression modules have continually overestimated the age 2 yellow perch populations. With this in mind, the task group feels the 1996 age 2 projection should be founded upon a more reasonable expectation of its abundance. This value was calculated from the average value of the last three years (1993-1995) age 2 CAGEAN estimates; it is considered the best available reference to the abundance of age 2 yellow perch recruiting to the fishable stock during the latest period of yellow perch life history.

1996 Population Size Projection

Stock size estimates for 1996 (age 3 and older) were projected from the CAGEAN 1995 population size estimates and age-specific survival rates in 1994 (Tables 8 and 9). Recruitment of the 1994 year class in 1996 (age 2 fish) was estimated from various agency trawling indices of young-of-the-year and yearling yellow perch in the recruitment-regression module (Table 8) and by using the averaging method described above (Table 9).

Projections of stock size for 1996 initially appear to be at a level similar to 1995; however, this is due to the predicted estimate of age 2 abundance (Tables 6 and 7). In Unit 1, the projection of age 3 and older abundance is close to the 1995 level. In all other Units, the number of age 3 and older fish is lower than in 1995, but within the range experienced in recent years.

Biomass of age 2 and older fish remains another representative indicator of fishable stock available in 1995 (Tables 4 and 5). Biomass estimates in the 1996 projection, using the averaging method for age 2 fish, show slight declines in all Management Units (down by 11% in Unit 1, by 11% in Unit 2, and by 3% in Unit 3). The biomass of age 3 and older fish represents the spawning stock biomass for 1996. The projections of age 3 and older biomass shows a slight increase from 1995 in Units 1 and 4 (2% and 7%, respectively), and a decline of 8% in Unit 2 and 17% in Unit 3.

Yield per Recruit

The yield per recruit model used to determine a recommended harvest in 1996 is the same as that used in 1995. The basic assumption of the yield per recruit model is that the desired harvest strategy is to optimize the return in weight per recruit. The optimum harvest rate F_{opt}, is determined by growth rate versus natural mortality rate. For temperate waters, F_{opt} is modified to $F_{0.1}$, which corresponds to 10% of the rate of increase in yield per recruit, which can be obtained by increasing F (fishing mortality) at low levels of fishing. A full description of the model inputs, as well as the steps required to determine a scaled $F_{0.1}$, are given in the YPTG report of 1992. As discussed above, the task group reviewed all the model inputs in 1995, and has revised the F_{opt} values.

The 1996 harvest estimates for age 2 and older fish are summarized in Tables 10 and 11. 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 in weight is then calculated by multiplying the age specific catch (in millions of fish) by the mean weight in the harvest (5 year average, 1991-1995).

Recommended Allowable Harvest

In 1995, a lakewide harvest of 4 million pounds of yellow perch was adopted by the Lake Erie Committee. The 1995 lakewide harvest was 3.88 million pounds.

For 1995, we present two harvest scenarios (Table 12). Both strategies employ the unadjusted CAGEAN estimates of population size for ages 3 to 6+ and a scaled $F_{0.1}$ (or F_{opt}) exploitation strategy. As presented earlier in this report, the difference between the two scenarios is in the treatment of the age 2 population estimates for 1996. One scenario uses the "traditional" recruitment-regression module from interagency trawls (Tables 8 and 10), the other uses the mean of the CAGEAN age 2 abundance estimates from 1993 to 1995 (Tables 9 and 11).

The recommended allowable harvest (RAH) both lakewide and by management unit is presented in Table 12. The Yellow Perch Task Group is not satisfied with the age 2 estimate from the recruitment-regression module, so it cannot recommend the 6.269 million pounds RAH from the traditional regression method. The YPTG is also aware that the averaging method for age 2 yellow perch entering the fishery may be conservative; however, the task group feels that these estimates are closer to reality than the regression estimates are. The 1995 CAGEAN estimates of age 2 and older fish are representative of the populations in all Management Units. By relying solely on these methods (age 2 averaging and CAGEAN), the RAH would be 3.300 million pounds.

The Yellow Perch Task Group recognizes that the 1994 year class appears to be of moderate size, based on interagency trawl indices. With this in mind, the task group recommends the lakewide Recommended Allowable Harvest for 1996 be in the range between 3.30 and 4.80 million pounds. Harvest scenarios for specific management units should be based on proportions seen within the range of percentages of the regression (traditional) and averaging models. Averaging method proportions based on a 4 million pounds total allocation: MU-1, 1.372 million lbs. (34.3%); MU-2, 1.817 million lbs. (45.4%); MU-3, 715,000 lbs.

(17.8%); MU-4, 96,000 lbs. (2.4%). Traditional, regression method proportions based on a 4 million pounds total allocation: MU-1, 1.723 million lbs. (43.1%); MU-2, 1.718 million lbs. (43.0%); MU-3, 460,000 lbs. (11.5%); MU-4, 98,000 lbs. (2.4%). The Yellow Perch Task Group recommends adopting a distribution by Management Unit within these ranges.

Additional Task Group Charges

Minimum Size Limits

One of the charges assigned to the Yellow Perch Task Group in 1994, and again in 1995 was to "conduct an analysis of the utility and effects of a minimum size limit (MSL) or size specific gear regulation for the exploitation of yellow perch stocks."

This charge was addressed in the 1995 report of the Yellow Perch Task Group. Using a model developed by Clark (1983), the task group found that the MSL of 8.0" approximated by the minimum mesh size of the gillnet fishery provided a good balance between weight harvested and change in stock size. The number of fish less than 8.0" in total length harvested by the gillnet fishery suggests the effective MSL is closer to 7". By imposing an effective 8.0" MSL on the gillnet fishery, it would impose a considerable expense in retooling the fishery's gear, and only result in a 2% gain in stock size while reducing harvest 15%. An effective MSL of 6.0" to 6.5" was estimated for the sport fishery; however increasing the MSL from 6.0" to 8.0" would only result in a 5% increase in the stock size yet would yield a 40% decline in harvest. The trapnet fishery is currently the only fishery on Lake Erie with an enforced MSL: 8.5". As with the gillnet MSL, this provides the best balance between stock size and harvest.

Another approach, not investigated by the task group but being implemented at various levels by different agencies, is the effect on harvest of other restrictions such as seasons and sport fishing bag limits. Currently, Ohio and Ontario have imposed a restriction on the spring commercial harvest of yellow perch to delay harvest until after spawning. Most agencies have regulated their sport fisheries to some degree: Ohio, Michigan and Pennsylvania have imposed bag limits for yellow perch, and Ontario has banned the sale of angler caught fish. The YPTG feels that work on these various aspects within this charge should render it completed at the present time.

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. The Yellow Perch Task Group will continue to pursue this topic in 1996.

Joint YPTG/SAM Report on RAH Procedures

The completion of the joint YPTG/Statistics and Modeling Task Group (SAM) report, documenting the procedures used to develop a recommendable allowable harvest is on track for a 1996 report date. Since our recent CAGEAN workshop, many of these techniques have been refined and streamlined, and this document will serve as a good point-in-time reference regarding RAH procedures. It will be published, possibly as a Great Lakes Fishery Commission Special Report rather than incorporating the report into the YPTG annual report.

Factors Affecting Recruitment

In 1992, the Yellow Perch Task Group was charged with "... review factors affecting the recruitment of yellow perch ...". The review of these factors the YPTG thinks are important in affecting yellow perch recruitment is summarized in table form as Appendix B.

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 continue to explore alternatives to the present age 2 estimator for incorporation into following task group reports.

The task group is keenly aware of changing trophic conditions in Lake Erie. Whether harvest (and possibly abundance) differences seen on the north and south shores of the lake are due to yellow perch migration or differential survival is in need of further investigation. Additional work on productivity differences or gradients, and their changes within recent decades, should also be addressed.

We are also aware of claims that high walleye abundance may have some negative impact on the yellow perch population. Diet studies conducted basinwide by several agencies conclude that the effect of walleye predation on yellow perch populations is negligible at this time. Further diet work will continue to provide insight into this interaction between predators and their prey.

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. The YPTG will also continue to address current charges regarding long term data sets, RAH, and spawning stock biomass.

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