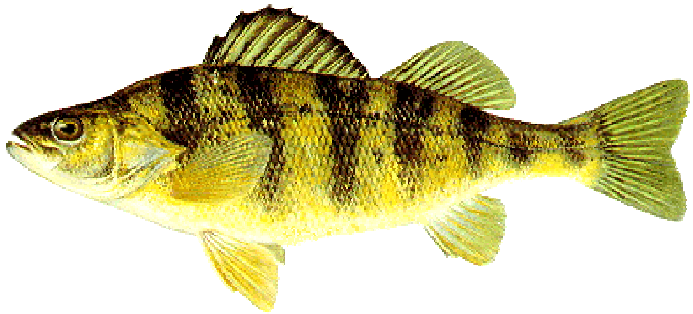
Report of the Lake Erie Yellow Perch Task Group

March 23th, 2009



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Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

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***Note*:** The data and management summaries contained in this report are provisional. Every effort has been made to ensure their correctness. Contact individual agencies for complete state and provincial data. Data reported in pounds for years prior to 1996 have been converted from metric tonnes. Please contact the Yellow Perch Task Group or individual agencies before using or citing data published herein.

Introduction

From April 2008 through March 2009, the Yellow Perch Task Group (YPTG) addressed the following charges:

1. Maintain centralized time series of data required for population models and assessments including:
    a) Fishery harvest, effort, age composition and biological parameters.
    b) Survey indices of juvenile and adult abundance, size at age, and biological parameters.
    c) Examine methods of expressing juvenile indices; *i.e.* area-based trawl catch rates (catch/ha).
    d) Standardize approaches within YPTG and between YPTG/WTG including q blocks and selectivity methods.

2. Support a sustainable harvest policy by:
    a) Examining exploitation strategies.
    b) Recommending an allowable harvest for 2009 for each Management Unit.
    c) Supporting decision/risk analysis strategies for yellow perch management.

3. Prepare a Lake Erie Yellow Perch Management Plan.

4. Review different methods for calculation of lambdas for use in catch-at-age analyses; implement the most scientifically defensible method for weighting data sources used in analyses.

Charge 1: 2008 Fisheries Review and Population Dynamics

The lakewide total allowable catch (TAC) in 2008 was 10.160 million pounds. This allocation represented a 10.8% decrease from a TAC of 11.389 million pounds in 2007. For yellow perch assessment and allocation, Lake Erie is partitioned into four Management Units (Units, or MUs; Figure 1.1). The 2008 allocation by Management Unit was 1.408, 4.227, 4.200, and 0.325 million pounds for Units 1 through 4, respectively. Please note that in 2008, the LEC set the TAC for MU3 higher (4.200 million pounds) than the RAH suggested by the YPTG in March 2008 (3.710 million pounds). The lakewide harvest of yellow perch in 2008 was 8.330 million pounds, 82.0% of the 2008 TAC. This was a 14.0% decrease from the 2007 harvest of 9.684 million pounds. Harvest by Lake Erie Management Units 1 through 4 was 1.038, 3.995, 2.985, and 0.312 million pounds, respectively (Table 1.1). The portion of TAC harvested was 73.7%, 94.5%, 71.1%, and 96.1% in MUs 1 through 4, respectively. In 2008, Ontario harvested 5.011 million pounds, followed by Ohio (3.044 million lbs.), Pennsylvania (186

thousand lbs.), Michigan (48 thousand lbs.), and New York (41 thousand lbs.).

Ontario's fraction of allocation harvested was 101.4% in MU1, 103.3% in MU2, 101.3% in MU3, and 125.1% in MU4. Ontario exceeded the MU4 TAC due to a discrepancy between Ontario quota zone delineation and LEC Management Unit divisions. Overages in the other MUs by Ontario commercial fishers can be explained by adjustments for ice allowance (set by convention at 3.3%). Ohio fishers attained 57.9% of their TAC in the western basin (MU1), 87.2% in the west central basin (MU2), and 45.6% in the east central basin (MU3). Michigan anglers in MU1 attained 37.4% of their TAC. Pennsylvania fisheries achieved 23.9% of their TAC in MU3 and 89.5% of their TAC in MU4. New York fisheries attained 41.6% of their TAC in MU4.

Ontario's portion of the lakewide yellow perch harvest increased slightly to 60% in 2008 from 59% in 2007 (Table 1.1). Ohio's proportion of lakewide harvest was 37% in 2008, remaining unchanged from 2007. Harvest in Michigan, Pennsylvania, and New York combined represented 3.3% of the lakewide harvest in 2008.

Ontario continued to employ a commercial ice allowance policy implemented in 2002, by which 3.3% is subtracted from commercial landed weight. This step was taken so that ice was not debited towards fishers' quotas. Ontario's landed weights in the YPTG report have not been adjusted to account for ice content. Ontario's reported yellow perch harvest in tables and figures is represented exclusively by the commercial gill net fishery. Reported sport harvests for Michigan, Ohio, Pennsylvania, and New York are based on creel survey estimates. Ohio, Pennsylvania, and New York trap net harvest and effort are based on landed catch reports. Additional fishery documentation is available in annual agency reports.

Harvest, fishing effort, and fishery harvest rates are summarized for the time period 1998 to 2008 by Management Unit, year, agency, and gear type in Tables 1.2 to 1.5. Trends over a longer time series (1975 to 2008) are depicted graphically for harvest (Figure 1.2), fishing effort (Figure 1.3), and harvest rates (Figure 1.4) by Management Unit and gear type. The spatial distributions in 2008 of harvest (all gears) and effort by gear type for 2008 in ten-minute interagency grids are presented in Figures 1.5 through 1.8.

Ontario's yellow perch harvest from large mesh (3 inches or greater) gill nets in 2008 ranged from 9.3% to 13.2% of the gill net harvest in MUs 1 and 2, respectively, but was negligible in MU3 and MU4 (<2%). Harvest, effort, and catch per unit effort from (1) standard yellow perch effort (<3 inch stretched mesh) and (2) larger mesh sizes, are distinguished in Tables 1.2 to 1.5. Harvest from targeted small mesh gill nets declined 27.9% in MU1 and

26.6% in MU3, and increased 6.9% in MU2 and 30.5% in MU4. Ontario trap net harvest is minimal and is included in the total harvest of yellow perch in MU1 (Tables 1.1 and 1.2), but is not summarized for catch-age analysis. Incidental catch of yellow perch in Ontario commercial trawls occurs in the central and eastern basin MUs 2-4. Trawl catches are included in the total harvest of yellow perch in Table 1.1 and documented by MU at the bottom of Tables 1.2 to 1.5.

Targeted gill net effort decreased 25.9% in MU1 and 45.4% in MU3, while it increased 5.3% in MU2 and 3.5% in MU4 from 2007. Gill net effort remained lower in 2008 compared to the 1990s and earlier decades (Figure 1.3). Targeted gill net harvest rates increased in 2008 compared to 2007 in all Management Units except MU1 (Figure 1.4). Targeted gill net harvest rates decreased 2.7% in MU1, and increased 1.6% in MU2, 34.6% in MU3, and 26.1% in MU4. Gill net harvest rates in MU2, MU3, and MU4 in 2008 were the highest in the time series.

In 2008, sport harvest in U.S. waters decreased in MU1 (45.7%), and increased in MU2 (15.9%), MU3 (21.6%), and MU4 (44.3%) from 2007 harvest (Figure 1.2). Angling effort in U.S. waters decreased in 2008 from 2007 in MU1 (38.8%), MU2 (9.8%), and MU3 (2.7%), but remained approximately the same in MU4 (Figure 1.3). The sport harvest of yellow perch from Ontario waters is assessed periodically and was assessed for the western basin in 2008. Results indicate that for the strata that were sampled, 16,148 yellow perch were harvested, with an effort of 8,847 angler hours.

Sport fishing harvest rates are commonly expressed as fish harvested per angler hour for those anglers seeking yellow perch. These harvest rates are presented in Tables 1.2 to 1.5. Compared to 2007 rates, harvest per angler hour decreased for Ohio anglers in MU1 by 21%, but angler harvest rates increased in the rest of Ohio waters (up 25% in MU2 and 35% in MU3). Angler harvest rates also increased for all other U.S. jurisdictions: Michigan up 50% in MU1, Pennsylvania up 18% in MU3 and 327% in MU4, and New York up 150% in MU4. Ontario sport fishers surveyed in the western basin had a harvest rate of 2.06 fish per hour.

We also express angler harvest in kg harvested per angler hour graphically for pooled jurisdictions (Figure 1.4). In 2008, the sport harvest rate (in kg/hr) decreased in MU1 (11.3%), and increased in MU2, MU3, and MU4 by 28.1%, 24.2%, and 45.2%, respectively, relative to 2007 rates.

Harvest from Ohio, Pennsylvania, and New York commercial trap nets in 2008 decreased 19.2% in MU2, and increased 121.2% in MU2 and 18.6% in MU4 from 2007. Ohio trap nets continued fishing in 2007 after re-entering the MU3 fishery in 2005, following three years of absence. In 2008, Ohio trap nets were restricted to the central basin, and thus there was no

trap net harvest or effort in the Ohio waters of MU1 in 2008. Trap net effort (lifts) in 2008 decreased in MU2 (56.5%), and MU4 (4.9%), but increased 70.5% in MU3 compared to 2007. Trap net harvest rates increased in MU2 (85.9%), MU3 (32.5%), and MU4 (23.0%) from 2007.

Age Composition and Growth

The yellow perch harvest in 2008 consisted mostly of the 2003 (age 5) and 2005 (age 3) year classes across all MUs, with a fair contribution of the 2006 (age 2) year class in MU1 (Table 1.6). The strong 2003 year class (age 5) was a major contributor to all fisheries across all MUs; however, the 2005 (age 3) year class did represent the second largest proportion (17.6%) of harvest across all MUs, and was the strongest contributor to the harvest in MU4. Overall, the 2003 year class accounted for the majority (70.7%) of the lakewide harvest. A high percentage of age 6 (2002 year class) and older fish were seen in the trap net and sport harvests in MU4 (52.3% and 34.9%, respectively), and in the sport harvest of MU3 (24.0%).

Yellow perch growth differs among life stages and between basins as illustrated by trends in length-at-age (Figure 1.9). A wealth of yellow perch growth data exists among Lake Erie agencies. For simplicity, Figure 1.9 is comprised of young-of-the-year data from summer and fall interagency trawls, while data for age 1 and successive ages to age 4 are from Ontario Partnership gill net surveys (MUs 1 and 4) and Ohio fall trawls (MUs 2 and 3). Size-at-age time series results describe relatively stable length-at-age for ages 0 to 4 across Management Units. Though some recent trends in declining growth seemed evident in the 2007 data, these trends did not persist in the 2008 data; conversely, trends of increasing growth emerged, as seen in most ages since 2005 in MU3. Figure 1.10 is comprised of data from Ontario Partnership gill net surveys (MUs 1 and 4) and Ohio fall trawls (MUs 2 and 3). Additional data from Long Point Bay trawl surveys are used to determine condition of Age 0 yellow perch in MU4. Condition factors (K) of yellow perch of every age class decreased in MUs 2 and 3 in 2008, but K values for most ages increased in MU1 (Figure 1.10). Few recent trends in fish condition were apparent, though condition of age 1 has increased in MU4 since 2005.

The task group continues to update yellow perch growth data in: (1) weight-at-age values recorded annually in the harvest and (2) length and weight-at-age values taken from interagency trawl and gill net surveys. These values are applied in the calculation of population biomass and the forecasting of harvest in the approaching year. Therefore, changes in weight-at-age factor into the changes in overall population biomass and determination of recommended

allowable harvest (RAH). In 2007, the YPTG moved from using a two-year average of weight-at-age to using a three-year average, and this was continued in 2008. This was done to minimize the impacts of weak year classes on determining the mean weight-at-age of yellow perch in the population and in the harvest.

ADMB Catch-at-Age Analysis 2009

Population size for each Management Unit was estimated by catch-at-age analysis using the Auto Differentiation Model Builder computer program (ADMB), with a standard version that incorporates commercial gill net catchability coefficients (the Ontario Commercial Selectivity Index or CSI version) based on the seasonal distribution of harvest and relative catch rates. The approach was identical to methods used in 2008. Estimates of population size, biomass, and parameters such as survival and exploitation rates are presented by Management Unit for 1990 to 2008 in Table 1.7 and graphically for 1975 to 2008 in Figures 1.11 to 1.14. Mean weight-at-age from surveys was applied to abundance estimates to generate population biomass estimates (Table 1.8 and Figure 1.12). Population abundance and biomass estimates are critical to monitoring the status of stocks and determining allowable harvest.

Abundance estimates should be interpreted with several caveats. Inclusion of abundance estimates from 1975 to 2008 implies that the time series are continuous. Lack of data continuity for the entire time series weakens the validity of this assumption. Survey data from multiple agencies are represented only in the latter part of the time series (since the late 1980s), while methods of fishery data collection have also varied. Some model parameters are constrained to constants, such as natural mortality, catchability, and selectivity blocks. This technique lessens our ability to directly compare abundance levels over three decades. In addition, commercial gill net selectivity (CSI) was estimated independently in the latter part of the time series using gill net selectivity curves derived from index gillnet data by the method of Helser (1998), involving back calculation of length-at-age and weightings based on the monthly distribution of harvest-at-age. With catch-at-age analysis, the most recent year's data estimates inherently have the widest error bounds. This is to be expected for cohorts that remain at-large (especially under less than full selectivity) in the population.

Population estimates are derived by minimizing an objective function weighted by data sources including fishery effort, fishery catch, and survey catch rates. The weightings (or lambdas) of effort data are calculated by the ratio of variance of observed log-catch to log-effort (Quinn and Deriso 1999). Weightings of fishery catch and survey catch rates are solved

iteratively until convergence occurs; *i.e.* until lambdas remain relatively constant (they do not change by a factor of 0.1). While lambdas within similar parameter groups (effort, catch, and surveys) are solved and weighted unequally, the groups themselves are given equal weight (the greatest lambda for catch, effort, and surveys is 1.0). Data weightings are presented in Appendix A, Table 1. In order to address this lambda calculation process fully, a new charge was undertaken in 2006 to derive the most scientifically defensible model lambdas. See section below under "*Charge 5: Lambda Review.*"

Recruitment Estimator for Incoming Age 2 Yellow Perch

Age 2 yellow perch recruitment in 2009 was predicted by linear regression of juvenile yellow perch trawl indices against catch-at-age analysis estimates of two-year-old abundance in each Management Unit. Age 2 yellow perch recruitment in 2009 was calculated using the mean of values predicted from the indices that correlate well ($F < 0.01$, $r^2 > 0.50$) with age 2 abundance estimates (Appendix A, Table 2). Data from trawl index series for the time period examined are presented in Appendix A, Table 3, while a key that summarizes abbreviations used for the trawl series is presented as a legend in Appendix A.

Estimates of age 2 yellow perch recruitment for 2009 (the 2007 year class) were well above average across all MUs (Table 1.7, Appendix A, Table 2). The 2007 year class is expected to contribute substantially to fisheries in 2009, as age 2 yellow perch recruitment is well above the levels of poor recruitment portrayed in the early 1990s (1990 to 1994) in MU1 and MU2, but is still below the high levels of recruitment of the 2003 year class. Early 1990s recruitment resulted in minimal stock sizes that were, in many cases, 25% of the magnitude of yellow perch stocks from the late 1990s and early 2000s.

2009 Population Size Projection

Stock size estimates for 2009 (ages 3 and older) were projected from catch-at-age analysis estimates of 2008 population size and age-specific survival rates in 2008 (Table 1.8). Projected age 2 yellow perch recruitment from the 2007 year class (method described above) was added to the 2009 population estimate for older fish in each unit, producing the total standing stock in 2009 (Table 1.8). Standard errors and ranges for estimates are provided for each age in 2008, and following estimated survival from ADMB, for 2009. Descriptions of *min, mean*, and *max* population estimates refer to the estimates minus or plus one age-specific standard error (Table 1.8).

Stock size estimates projected for 2009 were higher than 2008 due primarily to stronger recruitment in all Management Units (Table 1.8, Appendix A Table 2, and Figure 1.11). Abundance estimates of age 2 and older yellow perch in 2009 are 41.8%, 40.5%, 43.7%, and 5.4% higher than the 2008 abundances in Management Units 1 to 4, respectively. Abundance projections for 2009 were 49.6, 100.3, 79.7, and 14.8 million age 2 and older yellow perch in Management Units 1 through 4, respectively. Model estimates of abundance for age 3 and older yellow perch in 2009 are lower compared to the 2008 estimates in MU2 (18.8%) and MU3 (1.3%); however, estimates of abundance were 23.3% higher in MU1 and 10.9% higher in MU4 for 2009 compared to 2008. Age 3 and older yellow perch abundance in 2009 is projected to be 20.9, 41.2, 33.6, and 9.1 million fish in Units 1 through 4, respectively.

As a function of population estimates and mean weight-at-age from surveys, total biomass estimates of age 2 and older yellow perch for 2008 have increased across all Management Units (Figure 1.12). Total biomass in 2009 is estimated to increase from 2008 values in MU1 (14.9%), MU2 (15.4%), MU3 (20.4%) and MU4 (4.9%). The biomass estimates for 2008 are above the historic long-term (1975 to 2008) mean in MU1 (110.0% of the mean value), MU2 (179.9%), MU3 (214.3%), and MU4 (270.7%). Yellow perch ages 6 and older (2003 year class and older) are expected to represent the largest fraction of total biomass in 2009 in MU2 (39.0%), MU3 (39.5%), and MU4 (27.6%). The 2007 year class (at age 2) is expected to comprise the most biomass in 2009 in MU1 (41.0%), surpassed only by fish ages 6 and older in MU2 and MU3. The 2006 year class (at age 3) is also expected to represent a large fraction of total biomass in MU1 (27.4%), MU3 (17.4%), and MU4 (27.2%).

Estimates of yellow perch survival for ages 3 and older in 2007 were 44.9%, 48.8%, 51.1%, and 63.6% in MUs 1 to 4, respectively (Figure 1.13). In 2008, estimated survival rates of age 3 and older were 56.0%, 54.5%, 57.2%, and 63.3% in Units 1 through 4 (Table 1.8 and Figure 1.13). Estimates of yellow perch survival in 2008 for ages 2 and older were 59.8% in MU1, 57.8% in MU2, 60.6% in MU3, and 64.6% in MU4 (Table 1.8 and Figure 1.13). Survival rates increased in MUs 1, 2 and 3 for ages 2 and older, while they were similar in MU4 compared to 2007.

Estimated exploitation rates in 2007 were 27.8%, 22.7%, 19.8%, and 4.2% in Management Units 1 to 4, respectively, for age 3 and older. Exploitation rates for yellow perch age 3 and older in 2008 were estimated at 13.7%, 15.5%, 12.2%, and 4.6%, for MUs 1 to 4, respectively (Figure 1.14). Estimates of yellow perch exploitation in 2008 for ages 2 and older were 8.9% in MU1, 11.5% in MU2, 7.9% in MU3, and 3.0% in MU4 (Table 1.8 and Figure 1.14).

Exploitation rates of yellow perch age 2 and older in 2008 were slightly lower than in 2007 in MUs 1, 2 and 3, while they remained steady in MU4.

Yellow Perch Genetics and Stock Discrimination

In 2007 and 2008, the YPTG supported the efforts of Dr. Patrick M. Kocovsky, of the U.S. Geological Survey (USGS), Lake Erie Biological Station, to examine the whole-body morphology of yellow perch as a means of assessing stock structure. This work expanded on genetics work done by Dr. Carol Stepien, of the University of Toledo, which provided evidence that yellow perch Management Units in Lake Erie may not adequately capture population genetic structure. Whole-body morphology has been used successfully to identify stock structure of lake herring (*Coregonus artedi*) in Lake Superior (Hoff 2004) and orange roughy (*Hoplostethus atlanticus*) in Australian waters (Elliott et al. 1995), and to non-lethally discriminate between fall and spring runs of Chinook salmon (*Oncorhynchus tshawytscha*; Tiffan et al. 2000) when genetic discrimination has not been possible or has been unsuccessful. An advantage of morphological measurements for stock identification is that whole-body morphology is a reflection of both the genetic composition of fishes (*i.e.*, the genes that control morphology) and the conditions in which a species lives; thus, morphology integrates genetics and the environment. Accordingly, genetic and morphological analyses complement each other and provide a more holistic assessment of stock structure in Lake Erie.

Preliminary results suggest yellow perch morphology varies distinctly by site. At least six unique morphs were identified. Distinct morphological differences existed between sampling locations within MU1, MU2, and MU3. Complete results are being prepared for a peer-reviewed manuscript. In 2009, the USGS and ODNR are planning a joint research project in collaboration with OMNR to sample Ohio and Ontario waters of MU2 to assess spawning locations and differences in genetics and morphology within MU2. Presently no additional sampling is planned for MU4.

In recent years, tissue collection has become an annual endeavor by the YPTG with the expectation that genetic research will expand our understanding of yellow perch stock structure and assist in defining Management Unit delineation. Recent genetic analyses completed with YPTG samples have been summarized by the University of Toledo's Osvaldo J. Sepulveda-Villet in a progress report to the Yellow Perch Task Group (Sepulveda-Villet 2007). Dr. Stepien and Sepulveda-Villet continue to analyze the genetic stock structure and endeavor to delineate spawning groups of yellow perch. This research is sustained by ongoing tissue collections from

spawning concentrations that will continue to assemble a diverse database representing a thorough stock library for Lake Erie yellow perch. The YPTG will to continue to provide support for genetic stock discrimination research initiatives, as requested.

Charge 2: Harvest Strategy and RAH

Harvest Strategy Methodology

In 2009, fishing rates applied in 2008 (F_{2008}) are presented for MUs 1 to 4 in Tables 2.1.1 to 2.1.4 and in Table 2.2.1 summarized for all management units. These rates are the same as fishing rates presented in the 2005 YPTG report for MUs 1, 2, 3, and 4. In 2004, $F_{0.1}$ values were derived based on the ratio of average yield to average recruitment plotted against fishing rates in simulations that assumed gamma stock-recruitment functions based on 1975 to 2003 stock and recruitment estimates. $F_{0.1}$ was determined from the fishing rate at which the slope was 10% of the initial slope of the curve. This approach does not assume knife-edge recruitment. The simulation assumes that the targeted fishing rates will be realized for all gear types.

Stock-Recruitment Simulation

This simulation approach, documented in the 2004 YPTG report (YPTG 2004), remains the same with the exception that the time series used for the stock-recruitment relationship is shorter (1982 to 2007). The time series was shortened as the task group believes that conditions during the 1970s were more favorable for supporting recruitment compared to the period after, in which municipal phosphorus loading targets were achieved (Dolan 1993). The length of the spawner-recruit (S/R) time series is relevant for assessing the risk associated with fishing rates. Spawner-recruit relationships were described by gamma functions (Reish et al. 1985, Quinn et al. 1999) with the recognition that environmental factors exert major influence on recruitment. The YPTG created population simulations based on gamma stock-recruitment functions, influenced by environmental factors. Environment Factors (EF) were derived from residuals of the S/R relationship as:

EF = (observed recruitment)/(predicted recruitment).

Two years of recent abundance estimates were used to initiate simulations. Recruitment for each year was estimated from the S/R function, and then multiplied by an EF selected

randomly from the observed distribution of residuals (EFs). This process extended over 20 years and 100 replicates under a broad range of fishing mortality rates (F = 0 to 2) to produce measures of risk. Other model parameters included were consistent with ADMB catch-at-age analysis. This process, applied to populations in each Management Unit, allowed the YPTG to quantify risk associated with various fishing rates, while giving consideration to stock-recruitment patterns and environmental influences experienced by yellow perch during recent decades in Lake Erie. Biological reference points including spawner biomass (as a fraction of an unfished population), survival rates, and the probability of attaining low levels of abundance comparable to 1993-94 were included as outputs. A further refinement since the 2005 YPTG report (YPTG 2005) included averaging the results of simulations over ten multiple runs. Updated $F_{0.1}$ reference points were derived based on the fishing rate at which the slope equaled 10% of the initial slope when average yield was plotted against instantaneous fishing mortality rate. Results are presented for Management Units 1 through 4 in Tables 2.1.1 to 2.1.4.

In February 2009, the QFC reviewed a draft of the Yellow Perch Management Plan (YPMP), which included examining the application of the YPTG simulation model to assess biological risk with different fishing policies. Recommendations included improvements to the simulation models to better address uncertainty. To date, simulation performance for each management unit was assessed independently. Future criteria for assessing model performance will include comparisons between management units. Given anticipated improvements to the simulations, measures of biological risk described in the simulation portion (left side) of tables 2.1.1 to 2.1.4 are presented for general reference. More on the status of the YPMP can be found below.

Harvest Strategies and RAH Determination

Risk levels associated with fishing rates are based on simulations updated in 2008, and are presented for MUs 1, 2, 3, and 4 (Tables 2.1.1 to 2.1.4). In MU1 to MU3, target fishing rates used for TACs in 2008 (F_{2008}) are proposed for 2009 TACs, and are presented for Management Units 1 through 3 (Table 2.2.1). An alternative target fishing rate (F_{2009}) of 0.23 was proposed and accepted by the LEC for MU4 (Table 2.1.4 and Table 2.2.1) recognizing the improved recruitment and abundances of the MU4 yellow perch population. Yield rates for $F_{0.1}$ calculated in the same method as last year are presented as biological reference points in Tables 2.1.1 to 2.1.4.

In 2005, an exercise was completed to update the allocation area shares using

geographical information systems (GIS) mapping. In late 2008, the YPTG proposed that the line dividing MUs 3 and 4 be moved 5 minutes to the east in order to be consistent with Ontario's Eastern Basin Management Zone. The Lake Erie Committee (LEC) and Standing Technical Committee (STC) approved the change and new areas and allocation shares by jurisdiction were calculated (Figure 2.1). The change will be implemented in 2009. New allocation shares by Management Unit and jurisdiction for 2009 are:

Allocation of TAC within Management Unit and Jurisdiction, 2009:

MU1:	MI	9.1%	OH	50.3%	ONT	40.6%
MU2:	OH	54.4%	ONT	45.6%		
MU3:	OH	32.4%	PA	15.3%	ONT	52.3%
MU4:	NY	31.0%	PA	11.0%	ONT	58.0%

Charge 3: Lake Erie Yellow Perch Management Plan

With guidance from the STC, the YPTG was charged with the preparation of a Lake Erie Yellow Perch Management Plan (YPMP) as a companion document to the recently completed Walleye Management Plan. A draft YPMP was submitted to Michigan State University's QFC for a technical review of the exploitation strategies and harvest policies. The QFC has returned preliminary comments; however, they indicate that additional time is required to carry out a more thorough review of the harvest strategies and thresholds defined in the management plan. The task group will also require more time for review of comments and implementation of suggested improvements. The YPTG and the LEC will have the YPMP in place by 2010.

Charge 4: Lambda Review – Data Weighting Factors in Catch-at-age Analysis

In 2005-06, the YPTG was charged with reviewing the methodology of assigning weighting factors to data sources in the catch-at-age models. The current weighting methodology is described in Charge 1 of this report. The Lake Erie Walleye and Yellow Perch Task Groups continue to work with Dr. James Bence and Travis Brenden of Michigan State University's QFC and Yingming Zhao of OMNR to resolve the lambda weighting issues in the ADMB catch-at-age models. Previous external reviews by QFC modelers have shown that the current methods, while adequate, could be improved (STC 2007).

At a 2007 QFC-LEC workshop, a Bayesian approach to determine dataset weightings was presented and discussed. A Bayesian approach is able to approximate uncertainty by providing

a posterior distribution of parameters using lengthy runs of Markov Chain Monte Carlo (MCMC) simulations. Since the meeting, the modeling group developed Bayesian models for Lake Erie walleye and yellow perch which weighted datasets based on their relative coefficients of variance. Evaluation of these models using total sums of squares, degree of retrospectivity, and deviance information criteria, revealed that further model refinements and testing are still required.

The QFC has now appointed a Ph.D. student, Aaron Berger, to investigate the structure of the yellow perch and walleye models including an investigation of dataset weightings. Final results of this investigation are not expected for approximately three years; however, the task groups' modelers can incorporate valuable, substantial model improvements as they become available upon presentation and discussion with the STC and LEC. At this time, the YPTG is continuing to utilize the population abundance estimation models which weight data sets by the ratio of variance of observed log-catch to log-effort.

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- Dr. Carol Stepien and Osvaldo J. Sepulveda-Villet of the University of Toledo;
- Mike Bur and Patrick Kocovsky of the U.S. Geological Survey, Biological Resources Division, Sandusky.

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Literature Cited

Dolan, D. M. 1993. Point source loadings of phosphorus to Lake Erie: 1986:1990. Journal of Great Lakes Research 19(2): 212-223.

Elliott, N. G., K. Haskard, and J. A. Koslow. 1995. Morphometric analysis of orange roughy (*Hoplostethus atlanticus*) off the continental slope of southern Australia. Journal of Fish Biology 46: 202-220.

Helser, T. E., J. P. Geaghan, and R. E. Condrey. 1998. Estimating gill net selectivity using nonlinear response surface regression. Canadian Journal of Fisheries and Aquatic Sciences 55: 1328-1337.

Hoff, M. H. 2004. Discrimination among spawning aggregations of lake herring from Lake Superior using whole-body morphometric characters. Journal of Great Lakes Research 30(Supplement 1): 385-394.

Quinn, T. J. and R. B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press.

Reish, R. L., R. B. Deriso, D. Ruppert, and R. J. Carroll. 1985. An investigation into the population dynamics of Atlantic Menhaden (*Brevoortia tyrannus*). Canadian Journal of Fisheries and Aquatic Sciences 42: 147-157.

Sepulveda-Villet, O. J. 2007. Research update for the 2007 Yellow Perch Task Group. Unpublished progress report. Great Lakes Genetics Laboratory, Lake Erie Center, University of Toledo. Toledo, Ohio, USA. 4 pp.

Standing Technical Committee. 2007. Lambda Review Workshop Completion Report to the Lake Erie Committee of the Great Lakes Fishery Commission. 8pp.

Tiffan, K. F., D. W. Rondorf, R. D. Garland, and P. A. Verhey. 2000. Identification of juvenile fall versus spring Chinook salmon migrating through the lower Snake River based on body morphology. Transactions of the American Fisheries Society 129: 1389-1395.

Yellow Perch Task Group (YPTG). 2004. Report of the Yellow Perch Task Group, March 2004. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Yellow Perch Task Group (YPTG). 2005. Report of the Yellow Perch Task Group, March 2005. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Table 1.1. Lake Erie yellow perch harvest in pounds by management unit (Unit) and agency, 1998-2008.

		Ontario*		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest
Unit 1	1998	1,170,533	52	968,842	43	132,051	6	--	--	--	--	2,271,426
	1999	1,048,100	51	908,548	44	101,549	5	--	--	--	--	2,058,197
	2000	980,323	47	1,038,650	50	67,010	3	--	--	--	--	2,085,983
	2001	813,066	45	915,641	51	70,910	4	--	--	--	--	1,799,617
	2002	1,454,105	50	1,316,553	45	147,065	5	--	--	--	--	2,917,723
	2003	1,179,667	44	1,406,385	53	84,878	3	--	--	--	--	2,670,930
	2004	1,698,761	59	1,090,669	38	94,732	3	--	--	--	--	2,884,162
	2005	1,513,890	60	965,231	38	49,485	2	--	--	--	--	2,528,606
	2006	1,325,464	54	1,055,378	43	62,854	3	--	--	--	--	2,443,696
	2007	727,678	41	982,677	55	62,815	4	--	--	--	--	1,773,170
	2008	580,050	56	409,705	39	47,934	5	--	--	--	--	1,037,689
Unit 2	1998	1,797,458	74	627,944	26	--	--	--	--	--	--	2,425,402
	1999	1,572,829	62	974,123	38	--	--	--	--	--	--	2,546,952
	2000	1,484,125	56	1,169,234	44	--	--	--	--	--	--	2,653,359
	2001	1,794,275	51	1,747,069	49	--	--	--	--	--	--	3,541,344
	2002	2,190,621	52	1,986,730	48	--	--	--	--	--	--	4,177,351
	2003	2,107,639	50	2,113,285	50	--	--	--	--	--	--	4,220,924
	2004	2,051,473	48	2,246,264	52	--	--	--	--	--	--	4,297,737
	2005	2,666,231	59	1,843,190	41	--	--	--	--	--	--	4,509,421
	2006	3,102,269	69	1,393,732	31	--	--	--	--	--	--	4,496,001
	2007	1,847,139	45	2,244,656	55	--	--	--	--	--	--	4,091,795
	2008	1,990,237	50	2,005,000	50	--	--	--	--	--	--	3,995,237
Unit 3	1998	811,903	73	274,993	25	--	--	28,527	3	--	--	1,115,423
	1999	665,703	65	352,635	34	--	--	8,925	1	--	--	1,027,263
	2000	771,646	62	443,250	36	--	--	32,613	3	--	--	1,247,509
	2001	999,450	64	464,811	30	--	--	91,211	6	--	--	1,555,472
	2002	1,192,691	60	640,104	32	--	--	140,821	7	--	--	1,973,616
	2003	1,667,133	72	481,558	21	--	--	177,516	8	--	--	2,326,207
	2004	1,453,419	62	659,447	28	--	--	244,063	10	--	--	2,356,929
	2005	1,771,800	75	457,593	19	--	--	142,028	6	--	--	2,371,421
	2006	3,451,499	90	271,144	7	--	--	106,260	3	--	--	3,828,903
	2007	2,997,101	84	391,285	11	--	--	193,065	5	--	--	3,581,451
	2008	2,200,168	74	629,366	21	--	--	155,014	5	--	--	2,984,548
Unit 4	1998	48,457	93	--	--	--	--	538	1	3,175	6	52,170
	1999	59,842	92	--	--	--	--	2,216	3	3,234	5	65,292
	2000	35,686	73	--	--	--	--	10,950	22	2,458	5	49,094
	2001	35,893	60	--	--	--	--	8,337	14	15,319	26	59,549
	2002	87,541	54	--	--	--	--	46,903	29	26,903	17	161,347
	2003	84,772	60	--	--	--	--	39,821	28	16,511	12	141,104
	2004	98,733	49	--	--	--	--	46,344	23	54,862	27	199,939
	2005	195,347	67	--	--	--	--	42,226	15	53,468	18	291,041
	2006	230,226	69	--	--	--	--	57,005	17	48,107	14	335,338
	2007	185,954	78	--	--	--	--	25,859	11	25,935	11	237,748
	2008	240,270	77	--	--	--	--	31,325	10	40,809	13	312,404
Lakewide Totals	1998	3,828,351	65	1,871,779	32	132,051	2	29,065	<1	3,175	<1	5,864,421
	1999	3,346,474	59	2,235,306	39	101,549	2	11,141	<1	3,234	<1	5,697,704
	2000	3,271,780	54	2,651,134	44	67,010	1	43,563	<1	2,458	<1	6,035,945
	2001	3,642,684	52	3,127,521	45	70,910	1	99,548	1	15,319	<1	6,955,982
	2002	4,924,958	53	3,943,387	43	147,065	2	187,724	2	26,903	<1	9,230,037
	2003	5,039,211	54	4,001,228	43	84,878	1	217,337	2	16,511	<1	9,359,165
	2004	5,302,386	54	3,996,380	41	94,732	<1	290,407	3	54,862	<1	9,738,767
	2005	6,147,268	63	3,266,014	34	49,485	1	184,254	2	53,468	<1	9,700,489
	2006	8,109,458	73	2,720,254	24	62,854	<1	163,265	1	48,107	<1	11,103,938
	2007	5,757,872	59	3,618,618	37	62,815	<1	218,924	2	25,935	<1	9,684,164
	2008	5,010,725	60	3,044,071	37	47,934	<1	186,339	2	40,809	<1	8,329,878

*processor weight (quota debit weight) to 2001; fisher/observer weight from 2002 to 2008 (negating ice allowance).

Table 1.2. Harvest, effort and harvest per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 1 (Western Basin) by agency and gear type, 1998-2008.

		Unit 1				
		Michigan	Ohio		Ontario Gill Nets*	
	Year	Sport	Trap Nets	Sport	Small Mesh	Large Mesh
Harvest (pounds)	1998	132,051	184,142	784,700	1,170,533	--
	1999	101,549	200,939	707,609	1,048,100	--
	2000	67,010	240,541	798,109	980,323	--
	2001	70,910	179,234	736,407	711,745	101,321
	2002	147,065	337,829	978,724	1,359,637	94,468
	2003	84,879	250,456	1,155,929	1,151,358	28,309
	2004	94,732	289,136	801,533	1,637,488	61,273
	2005	49,485	357,182	608,049	1,402,523	111,082
	2006	62,854	235,852	819,526	1,264,370	61,094
	2007	62,815	200,818	781,859	671,536	56,142
	2008	47,934	0	409,705	484,409	49,378
Harvest (Metric) (tonnes)	1998	60	84	356	531	--
	1999	46	91	321	475	--
	2000	30	109	362	445	--
	2001	32	81	334	323	46
	2002	67	153	444	617	43
	2003	38	114	524	522	13
	2004	43	131	364	743	28
	2005	22	162	276	636	50
	2006	29	107	372	573	28
	2007	28	91	355	305	25
	2008	22	0	186	220	22
Effort *(a)*	1998	183,882	5,446	863,336	19,095	--
	1999	184,710	5,185	941,350	12,846	--
	2000	122,447	4,026	965,628	6,741	--
	2001	97,761	1,518	720,923	2,167	2,142
	2002	190,573	2,715	900,289	4,546	739
	2003	121,638	2,213	1,182,694	3,725	395
	2004	206,902	4,351	833,690	6,052	901
	2005	98,429	3,903	816,959	5,170	1,182
	2006	118,628	3,517	683,994	5,194	787
	2007	181,698	2,951	823,624	2,230	1,125
	2008	95,925	0	519,050	1,653	899
Harvest Rates *(b)*	1998	3.2	15.3	3.8	27.8	--
	1999	2.1	17.6	3.3	37.0	--
	2000	2.2	27.1	3.0	66.0	--
	2001	2.9	53.5	3.4	149.0	21.5
	2002	2.5	56.4	3.4	135.6	58.0
	2003	2.4	51.3	3.5	140.2	32.5
	2004	1.6	30.1	3.0	122.7	30.8
	2005	1.7	41.5	3.1	123.0	42.6
	2006	1.7	30.4	4.2	110.4	35.2
	2007	1.0	30.9	3.4	136.6	22.6
	2008	1.5	--	2.7	132.9	24.9

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts

(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

(*) Ontario commercial trap netters harvested 46,263 pounds of yellow perch in MU1 in 2008.

Table 1.3. Harvest, effort and harvest per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 2 (western Central Basin) by agency and gear type, 1998-2008.

		Unit 2			
		Ohio		Ontario* Gill Nets	
	Year	Trap Nets	Sport	Small Mesh	Large Mesh
Harvest (pounds)	1998	304,661	323,283	1,797,458	--
	1999	389,973	584,150	1,572,829	--
	2000	565,009	604,225	1,484,125	--
	2001	905,088	841,891	1,593,704	200,571
	2002	1,099,971	886,759	1,892,070	298,551
	2003	1,255,205	858,080	2,019,617	88,022
	2004	1,287,747	958,517	1,893,871	157,602
	2005	1,162,746	680,444	2,446,007	219,723
	2006	744,452	649,280	2,981,793	120,476
	2007	1,701,552	543,104	1,561,287	173,699
	2008	1,376,588	628,412	1,669,682	253,984
Harvest (Metric) (tonnes)	1998	138	147	815	--
	1999	177	265	713	--
	2000	256	274	673	--
	2001	410	382	723	91
	2002	499	402	858	135
	2003	569	389	916	40
	2004	584	435	859	71
	2005	527	309	1,109	100
	2006	338	294	1,352	55
	2007	772	246	708	79
	2008	624	285	757	115
Effort *(a)*	1998	7,943	422,176	23,823	--
	1999	7,502	563,819	13,179	--
	2000	5,272	601,712	6,266	--
	2001	4,747	594,741	3,445	4,975
	2002	7,675	658,799	4,786	3,209
	2003	10,214	632,813	5,311	1,555
	2004	12,023	659,454	4,929	2,787
	2005	9,103	784,942	9,716	2,173
	2006	7,544	499,412	11,692	1,925
	2007	9,158	498,843	2,966	2,826
	2008	3,983	450,060	3,124	2,629
Harvest Rates *(b)*	1998	17.4	2.6	34.2	--
	1999	23.6	3.0	54.1	--
	2000	48.6	2.9	107.4	--
	2001	86.5	3.2	209.9	18.3
	2002	65.0	3.1	179.3	42.1
	2003	55.7	3.3	172.5	25.7
	2004	48.6	3.7	174.3	25.6
	2005	57.9	2.8	114.2	45.9
	2006	44.8	3.7	115.7	28.4
	2007	84.3	2.8	238.7	27.9
	2008	156.7	3.5	242.4	43.8

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(*) Ontario commercial trawlers harvested 112,153 pounds of yellow perch in MU2 in 2007.
(*) Ontario commercial trawlers harvested 66,203 pounds of yellow perch in MU2 in 2008.

Table 1.4. Harvest, effort and harvest per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 3 (eastern Central Basin) by agency and gear type, 1998-2008.

		Unit 3					
		Ohio		Ontario* Gill Nets		Pennsylvania	
	Year	Trap Nets	Sport	Small Mesh	Large Mesh	Trap Nets	Sport
Harvest (pounds)	1998	90,082	184,911	811,903	--	5,291	23,236
	1999	106,258	246,377	665,703	--	2,905	6,020
	2000	156,510	286,740	771,646	--	5,930	26,683
	2001	4,472	460,339	948,622	50,828	2,602	96,946
	2002	0	640,104	1,094,894	97,797	2,009	138,812
	2003	0	481,559	1,647,047	20,086	5,050	172,467
	2004	0	659,447	1,443,314	10,105	7,753	236,310
	2005	43,253	414,340	1,657,498	113,969	15,228	126,800
	2006	70,310	200,834	3,332,037	119,461	20,467	85,793
	2007	48,286	342,999	2,941,451	42,570	23,471	169,594
	2008	139,023	490,343	2,160,041	32,673	22,927	132,087
Harvest (Metric) (tonnes)	1998	41	84	368	--	2.4	11
	1999	48	112	302	--	1.3	2.7
	2000	71	130	350	--	2.7	12
	2001	2.0	209	430	23	1.2	44
	2002	0	290	497	44	0.9	63
	2003	0	218	747	9.1	2.3	78
	2004	0	299	655	4.6	3.5	107
	2005	20	188	752	52	6.9	58
	2006	32	91	1,511	54	9.3	39
	2007	22	156	1,334	19	10.6	77
	2008	63	222	980	15	10.4	60
Effort *(a)*	1998	2,512	111,425	10,809	--	305	30,612
	1999	2,388	176,603	4,338	--	243	28,485
	2000	1,640	214,825	2,342	--	231	48,561
	2001	32	269,062	2,451	1,047	175	90,214
	2002	0	416,543	2,490	1,055	95	123,287
	2003	0	256,890	4,617	316	87	138,720
	2004	0	368,537	3,750	268	70	175,596
	2005	947	305,885	5,098	743	129	127,462
	2006	881	139,536	11,130	1,030	124	60,612
	2007	713	218,683	6,115	614	88	135,611
	2008	1288	234,179	3,336	417	78	110,403
Harvest Rates *(b)*	1998	16.3	3.6	34.0	--	7.9	1.4
	1999	20.2	3.5	69.6	--	5.4	1.3
	2000	43.3	3.0	149.4	--	11.6	1.9
	2001	63.4	2.9	175.4	22.0	6.7	2.6
	2002	--	2.7	199.6	41.7	9.6	3.6
	2003	--	3.1	161.8	28.8	26.3	5.3
	2004	--	4.3	174.6	17.1	50.2	3.9
	2005	20.7	3.1	147.4	69.6	53.5	2.9
	2006	36.2	3.3	135.8	52.6	74.9	3.7
	2007	30.7	3.4	218.2	31.4	121.0	3.8
	2008	49.0	4.6	293.6	35.5	133.3	4.5

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(*) Ontario commercial trawlers harvested 13,080 pounds of yellow perch in MU3 in 2007.
(*) Ontario commercial trawlers harvested 7,454 pounds of yellow perch in MU3 in 2008.

Table 1.5. Harvest, effort and harvest per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 4 (Eastern Basin) by agency and gear type, 1998-2008.

		Unit 4					
		New York		Ontario* Gill Nets		Pennsylvania	
	Year	Trap Nets	Sport	Small Mesh	Large Mesh	Trap Nets	Sport
Harvest (pounds)	1998	1,345	1,830	48,457	--	0	538
	1999	694	2,540	59,842	--	0	2,216
	2000	625	1,833	35,686	--	0	10,950
	2001	27	15,292	34,284	1,608	0	8,337
	2002	1,951	24,952	85,935	1,606	29	46,874
	2003	1,048	15,464	84,648	124	0	39,822
	2004	3,907	50,955	98,716	17	0	90,514
	2005	7,726	45,742	195,258	52	0	42,226
	2006	9,423	38,684	229,063	1,163	0	57,005
	2007	9,511	16,424	179,595	3,076	0	25,859
	2008	11,136	29,673	234,366	2,689	0	31,325
Harvest (Metric) (tonnes)	1998	0.6	0.8	22.0	--	0	0.2
	1999	0.3	1.2	27.1	--	0	1.0
	2000	0.3	0.8	16.2	--	0	5.0
	2001	0.01	6.9	15.5	0.7	0	3.8
	2002	0.9	11.3	39.0	0.7	0.01	21.3
	2003	0.5	7.0	38.4	0.06	0	18.1
	2004	1.8	23.1	44.8	0.01	0	41.0
	2005	3.5	20.7	88.6	0.02	0	19.2
	2006	4.3	17.5	103.9	0.53	0	25.9
	2007	4.3	7.4	81.4	1.40	0	11.7
	2008	5.1	13.5	106.3	1.22	0	14.2
Effort *(a)*	1998	178	7,073	1,081	--	0	3,784
	1999	118	5,410	872	--	0	13,623
	2000	44	2,606	314	--	0	21,146
	2001	39	22,950	128	28.0	0	12,451
	2002	89	44,270	224	28.0	9	61,734
	2003	91	33,162	373	21.0	0	32,525
	2004	44	73,056	355	3.2	0	62,639
	2005	179	58,667	782	7.8	0	70,921
	2006	208	46,174	1,007	31.8	0	47,274
	2007	144	29,999	550	62.1	0	31,545
	2008	137	34,511	569	69.2	0	27,041
Harvest Rates *(b)*	1998	3.4	0.46	20.3	--	--	0.3
	1999	2.7	0.44	31.1	--	--	0.4
	2000	6.4	0.20	51.5	--	--	1.7
	2001	0.3	1.65	121.5	26.0	--	1.5
	2002	9.9	1.13	174.0	25.0	1.5	2.4
	2003	5.2	0.76	102.9	2.9	--	1.9
	2004	40.3	1.14	126.1	2.4	--	1.7
	2005	19.6	1.23	113.2	3.0	--	1.8
	2006	20.5	1.36	103.2	16.6	--	2.9
	2007	30.0	0.97	148.1	22.5	--	1.5
	2008	36.9	1.68	186.8	17.6	--	6.4

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) harvest rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift
(*) Ontario commercial trawlers harvested 3,283 pounds of yellow perch in MU4 in 2007.
(*) Ontario commercial trawlers harvested 3,215 pounds of yellow perch in MU4 in 2008.

Table 1.6. Estimated 2008 Lake Erie yellow perch harvest by age and numbers of fish by gear and management unit (Unit).

		Unit 1		Unit 2		Unit 3		Unit 4		Lakewide	
Gear	Age	Number	%	Number	%	Number	%	Number	%	Number	%
Gill Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	185,598	10.4	50,342	0.8	35,415	0.5	9,007	1.4	280,361	1.9
	3	532,150	29.7	773,075	12.4	1,290,086	20.0	470,511	74.8	3,065,822	20.3
	4	36,239	2.0	139,976	2.2	133,477	2.1	18,312	2.9	328,005	2.2
	5	975,326	54.4	5,182,299	82.9	4,867,594	75.4	122,863	19.5	11,148,082	73.7
	6+	62,821	3.5	106,119	1.7	133,346	2.1	8,452	1.3	310,738	2.1
	Total	1,792,135		6,251,811		6,459,918		629,145		15,133,009	
Trap Nets	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	0	0.0	33,963	0.8	18,292	4.3	153	0.7	52,408	1.1
	3	0	0.0	280,886	6.4	59,361	13.9	460	2.0	340,707	7.1
	4	0	0.0	221,089	5.1	30,193	7.1	153	0.7	251,435	5.2
	5	0	0.0	3,697,745	84.8	281,851	65.9	10,124	44.3	3,989,720	82.9
	6+	0	0.0	128,404	2.9	38,127	8.9	11,964	52.3	178,495	3.7
	Total	0		4,362,087		427,824		22,854		4,812,765	
Sport	1	45,736	2.9	9,166	0.6	0	0.0	0	0.0	54,902	1.2
	2	465,495	29.9	136,883	8.6	50,832	3.6	3,265	2.4	656,474	14.0
	3	400,888	25.7	307,539	19.3	213,286	15.0	15,962	11.8	937,675	19.9
	4	51,333	3.3	72,824	4.6	58,271	4.1	9,118	6.8	191,546	4.1
	5	522,885	33.6	946,591	59.4	754,537	53.2	59,582	44.1	2,283,594	48.5
	6+	72,131	4.6	121,526	7.6	340,325	24.0	47,111	34.9	581,093	12.3
	Total	1,558,468		1,594,529		1,417,251		135,037		4,705,285	
All Gear	1	45,736	1.4	9,166	0.1	0	0.0	0	0.0	54,902	0.2
	2	651,093	19.7	221,188	1.8	104,539	1.3	12,424	1.6	989,244	4.0
	3	933,038	28.2	1,361,500	11.2	1,562,733	18.8	486,932	61.9	4,344,204	17.6
	4	87,573	2.6	433,889	3.6	221,941	2.7	27,583	3.5	770,986	3.1
	5	1,498,211	45.3	9,826,635	80.5	5,903,982	71.1	192,569	24.5	17,421,397	70.7
	6+	134,952	4.1	356,049	2.9	511,798	6.2	67,527	8.6	1,070,326	4.3
	Total	3,304,867		12,208,427		8,304,993		787,036		24,651,059	

Table 1.7. Yellow perch stock size (millions of fish) in each Lake Erie management unit. The years 1990 to 2008 are estimated by ADMB catch-age analysis. The 2009 population estimates use age-2 yellow perch estimates derived from regressions of ADMB age-2 abundance values against YOY and yearling trawl index values.

	Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Unit 1	2	3.656	10.749	14.185	4.475	10.192	22.846	26.254	21.453	41.419	10.244	32.701	31.822	8.302	39.564	3.244	55.093	2.178	14.578	17.993	28.634
	3	1.346	1.936	5.668	7.890	1.815	6.219	13.987	15.661	13.372	25.621	6.567	20.884	20.568	5.344	25.023	2.073	34.315	1.409	8.969	11.427
	4	5.340	0.517	0.603	2.030	2.082	0.814	2.824	6.135	7.465	6.836	14.254	3.655	12.467	10.904	3.002	11.885	1.045	14.276	0.803	5.123
	5	2.071	1.537	0.120	0.142	0.313	0.520	0.226	0.753	1.916	2.729	3.118	7.053	1.990	5.180	4.965	1.136	4.356	0.430	6.285	0.463
	6+	1.540	0.671	0.317	0.074	0.025	0.081	0.177	0.103	0.184	0.487	1.223	1.928	4.679	2.405	3.175	2.418	1.062	1.695	0.902	3.905
	2 and Older	13.952	15.408	20.894	14.611	14.427	30.480	43.468	44.104	64.356	45.917	57.863	65.342	48.006	63.397	39.409	72.605	42.957	32.388	34.953	49.552
	3 and Older	10.297	4.660	6.709	10.136	4.235	7.634	17.214	22.651	22.937	35.672	25.161	33.520	39.704	23.833	36.165	17.512	40.778	17.810	16.959	20.918
Unit 2	2	5.431	15.804	22.734	7.398	12.387	13.526	28.140	16.886	61.034	14.587	49.203	39.464	10.044	80.523	6.126	168.373	5.282	24.054	20.587	59.049
	3	1.591	2.246	6.301	10.862	3.494	7.097	7.435	13.773	9.102	32.493	9.069	29.854	23.340	6.294	48.084	3.984	108.241	3.475	15.664	13.554
	4	7.888	0.583	0.726	2.248	4.121	1.267	2.555	3.023	4.989	4.006	18.271	5.043	16.858	12.273	3.478	25.188	2.295	61.141	2.079	9.425
	5	2.315	2.058	0.122	0.194	0.616	0.891	0.241	0.580	0.642	1.127	1.961	8.741	2.433	7.301	4.972	1.580	10.907	1.311	29.512	1.074
	6+	1.965	0.919	0.461	0.157	0.085	0.151	0.200	0.100	0.099	0.119	0.519	1.149	4.769	3.105	4.267	4.008	2.436	6.106	3.542	17.182
	2 and Older	19.190	21.610	30.344	20.859	20.704	22.932	38.571	34.362	75.867	52.332	79.023	84.250	57.443	109.495	66.927	203.133	129.160	96.087	71.384	100.283
	3 and Older	13.758	5.806	7.610	13.461	8.317	9.406	10.431	17.476	14.833	37.745	29.820	44.787	47.399	28.972	60.801	34.760	123.879	72.033	50.797	41.234
Unit 3	2	4.069	8.125	4.980	2.715	6.130	6.549	11.995	9.858	35.510	11.157	41.465	23.550	6.580	36.043	3.406	100.531	3.887	20.567	21.391	46.047
	3	1.601	2.469	3.478	2.217	1.331	3.485	4.009	7.507	6.058	22.878	7.209	26.645	15.003	4.203	23.302	2.227	66.618	2.564	12.321	14.139
	4	3.726	0.752	0.803	1.237	0.928	0.692	2.024	2.323	3.796	3.585	14.542	4.518	16.778	9.269	2.583	14.198	1.349	34.377	1.474	7.413
	5	1.241	1.305	0.281	0.238	0.410	0.288	0.347	1.007	1.050	2.044	2.214	8.655	2.758	9.814	5.322	1.478	7.854	0.677	17.486	0.817
	6+	4.468	1.737	0.718	0.313	0.187	0.207	0.253	0.297	0.523	0.769	1.688	2.290	6.618	5.509	8.801	8.033	5.307	4.908	2.776	11.234
	2 and Older	15.106	14.388	10.261	6.720	8.986	11.221	18.628	20.992	46.936	40.432	67.117	65.658	47.737	64.838	43.413	126.467	85.015	63.093	55.448	79.650
	3 and Older	11.037	6.263	5.280	4.005	2.856	4.672	6.632	11.134	11.426	29.276	25.652	42.108	41.156	28.795	40.007	25.936	81.128	42.526	34.057	33.604
Unit 4	2	0.564	0.409	0.100	0.267	0.134	1.152	0.744	0.323	3.879	1.468	12.121	2.637	2.188	7.017	1.282	9.425	0.963	6.168	5.853	5.713
	3	0.722	0.365	0.261	0.067	0.170	0.086	0.760	0.490	0.212	2.598	0.973	8.088	1.768	1.466	4.688	0.850	6.236	0.642	4.082	3.888
	4	0.996	0.362	0.165	0.168	0.029	0.081	0.051	0.444	0.281	0.140	1.649	0.641	5.398	1.169	0.958	3.024	0.531	3.673	0.415	2.637
	5	0.413	0.376	0.111	0.094	0.047	0.010	0.040	0.026	0.222	0.177	0.087	1.067	0.426	3.487	0.741	0.599	1.833	0.302	2.335	0.264
	6+	0.937	0.507	0.265	0.211	0.083	0.042	0.025	0.031	0.028	0.149	0.196	0.181	0.825	0.778	2.635	2.035	1.544	1.807	1.334	2.268
	2 and Older	3.631	2.018	0.902	0.807	0.463	1.371	1.619	1.314	4.623	4.532	15.025	12.614	10.604	13.917	10.304	15.932	11.107	12.590	14.019	14.770
	3 and Older	3.068	1.609	0.802	0.540	0.328	0.219	0.876	0.991	0.744	3.064	2.904	9.977	8.417	6.899	9.022	6.508	10.144	6.423	8.166	9.057

Table 1.8. Projection of the 2008 Lake Erie yellow perch population. Stock size estimates are derived from ADMB and age 2 estimates for 2008 are derived from regressions of ADMB age-2 abundance against YOY and yearling trawl indices. Standard errors are produced from the ADMB catch-age analysis report.

	2008 Parameters					Rate Functions					2009 Parameters				Stock Biomass			
		Stock Size (numbers)				Mortality Rates				Survival Rate		Stock Size (mils. of fish)			3-yr Mean Weight in	millions kg		millions lbs.
	Age	**Mean**	**Std. Err.**	**Min.**	**Max.**	**(F)**	**(Z)**	**(A)**	**(u)**	**(S)**	**Age**	**Mean**	**Min.**	**Max.**	Pop'n. (kg)	**2008**	**2009**	**2009**
Unit 1	2	17.993	11.755	6.238	29.748	0.054	0.454	0.365	0.043	0.635	2	28.634	22.240	35.028	0.073	1.511	2.090	4.609
	3	8.969	4.215	4.754	13.184	0.160	0.560	0.429	0.123	0.571	3	11.427	3.962	18.893	0.122	1.354	1.394	3.074
	4	0.803	0.322	0.481	1.125	0.150	0.550	0.423	0.115	0.577	4	5.123	2.716	7.531	0.121	0.107	0.620	1.367
	5	6.285	2.676	3.609	8.961	0.210	0.610	0.457	0.157	0.543	5	0.463	0.278	0.649	0.176	1.232	0.082	0.180
	6+	0.902	0.412	0.490	1.313	0.211	0.611	0.457	0.158	0.543	6+	3.905	2.227	5.582	0.231	0.224	0.902	1.989
	Total	34.953		15.573	54.332	0.113	0.513	0.402	0.089	0.598	Total	49.552	31.423	67.682	0.103	4.428	5.088	11.219
	(3+)	16.959		9.335	24.583	0.180	0.580	0.440	0.137	0.560	(3+)	20.918	9.182	32.654	0.143	2.917	2.998	6.610
Unit 2	2	20.587	10.908	9.679	31.495	0.018	0.418	0.342	0.015	0.658	2	59.049	45.984	72.114	0.073	1.523	4.311	9.505
	3	15.664	6.094	9.570	21.759	0.108	0.508	0.398	0.085	0.602	3	13.554	6.372	20.735	0.124	2.287	1.681	3.706
	4	2.079	0.692	1.388	2.771	0.261	0.661	0.484	0.191	0.516	4	9.425	5.758	13.092	0.150	0.397	1.414	3.117
	5	29.512	9.792	19.720	39.304	0.253	0.653	0.480	0.186	0.520	5	1.074	0.717	1.431	0.172	5.696	0.185	0.407
	6+	3.542	1.249	2.292	4.791	0.265	0.665	0.486	0.194	0.514	6+	17.182	11.443	22.921	0.282	0.871	4.845	10.684
	Total	71.384		42.650	100.119	0.149	0.549	0.422	0.115	0.578	Total	100.283	70.274	130.292	0.124	10.775	12.435	27.419
	(3+)	50.797		32.971	68.624	0.207	0.607	0.455	0.155	0.545	(3+)	41.234	24.290	58.178	0.197	9.251	8.124	17.914
Unit 3	2	21.391	11.615	9.776	33.006	0.014	0.414	0.339	0.011	0.661	2	46.047	33.169	58.924	0.058	1.198	2.671	5.889
	3	12.321	5.077	7.244	17.398	0.108	0.508	0.398	0.085	0.602	3	14.139	6.462	21.817	0.110	1.700	1.555	3.429
	4	1.474	0.529	0.946	2.003	0.190	0.590	0.446	0.144	0.554	4	7.413	4.359	10.468	0.137	0.246	1.016	2.239
	5	17.486	6.312	11.174	23.798	0.189	0.589	0.445	0.143	0.555	5	0.817	0.524	1.110	0.197	3.445	0.161	0.355
	6+	2.776	1.140	1.636	3.916	0.195	0.595	0.448	0.147	0.552	6+	11.234	7.103	15.365	0.313	0.822	3.516	7.753
	Total	55.448		30.776	80.119	0.101	0.501	0.394	0.079	0.606	Total	79.650	51.617	107.684	0.112	7.411	8.919	19.666
	(3+)	34.057		21.000	47.114	0.159	0.559	0.428	0.122	0.572	(3+)	33.604	18.447	48.760	0.186	6.213	6.248	13.777
Unit 4	2	5.853	4.207	1.646	10.060	0.009	0.409	0.336	0.007	0.664	2	5.713	3.600	7.826	0.091	0.615	0.520	1.146
	3	4.082	2.408	1.674	6.490	0.037	0.437	0.354	0.030	0.646	3	3.888	1.094	6.683	0.185	0.833	0.719	1.586
	4	0.415	0.226	0.189	0.641	0.053	0.453	0.364	0.043	0.636	4	2.637	1.081	4.192	0.230	0.087	0.606	1.337
	5	2.335	1.266	1.069	3.601	0.081	0.481	0.382	0.064	0.618	5	0.264	0.120	0.408	0.280	0.588	0.074	0.163
	6+	1.334	0.770	0.564	2.104	0.081	0.481	0.382	0.064	0.618	6+	2.268	1.009	3.527	0.322	0.403	0.730	1.610
	Total	14.019		5.142	22.896	0.037	0.437	0.354	0.030	0.646	Total	14.770	6.905	22.636	0.179	2.525	2.650	5.843
	(3+)	8.166		3.496	12.836	0.057	0.457	0.367	0.046	0.633	(3+)	9.057	3.305	14.809	0.235	1.911	2.130	4.697

Table 2.1.1. Management Unit 1 yellow perch biological references from simulations and projected population size in 2010 for a range of fishing rates (F). Biological reference points include mean spawner biomass as a fraction of an unfished population, survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993 for ages 2+ (14.5 million) and 1994 for ages 3+ (4.2 million). The "Harvest 2009" column is based on fishing rates in the "F" column and 2009 abundance estimates at the bottom of the page. Simulations are based on ADMB abundance estimates from 1982-2007 and were used to determine $F_{0.1}$. F_{2008} was the fishing rate used for setting TAC in 2004-2008.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest 2009 (lbs x 10^6)	Population 2+ in 2010 (millions)	Population 3+ in 2010 (millions)	Harvest Strategy Reference
100	67%	67%	0.0	0.0	0.000	0.000	42.892	33.215	
99	67%	67%	0.0	0.0	0.010	0.038	42.786	33.109	
93	65%	65%	0.0	0.0	0.050	0.186	42.368	32.691	
87	64%	63%	1.0	0.0	0.100	0.367	41.856	32.179	
82	63%	61%	1.0	0.0	0.150	0.543	41.357	31.680	
77	61%	59%	2.0	0.0	0.200	0.715	40.871	31.194	
73	60%	57%	5.0	0.0	0.250	0.883	40.397	30.720	
69	59%	56%	6.0	0.0	0.300	1.047	39.934	30.257	
65	58%	54%	8.0	0.0	0.350	1.206	39.482	29.805	
62	57%	53%	9.0	0.0	0.400	1.362	39.041	29.365	
59	56%	51%	15.0	0.0	0.450	1.513	38.611	28.935	
57	55%	50%	15.0	1.0	0.500	1.662	38.191	28.515	
54	54%	48%	21.0	1.0	0.550	1.806	37.781	28.105	
52	53%	47%	24.0	1.0	0.600	1.947	37.381	27.704	
50	53%	46%	25.0	5.0	0.650	2.085	36.990	27.313	
48	52%	45%	29.0	8.0	0.700	2.220	36.608	26.931	
47	52%	44%	30.0	8.0	0.710	2.246	36.533	26.856	
47	52%	44%	31.0	8.0	**0.720**	2.272	36.458	26.781	F_{2008}
46	51%	43%	33.0	8.0	0.750	2.351	36.235	26.558	
44	50%	42%	33.0	8.0	0.800	2.479	35.870	26.193	
42	50%	41%	36.0	10.0	0.850	2.605	35.513	25.837	
41	49%	40%	38.0	14.0	0.900	2.727	35.165	25.488	
39	48%	39%	41.0	21.0	0.950	2.847	34.824	25.147	
38	48%	38%	44.0	25.0	1.000	2.964	34.491	24.814	
35	47%	36%	51.0	29.0	1.100	3.190	33.846	24.169	
33	46%	35%	59.0	33.0	1.200	3.406	33.229	23.552	
31	45%	33%	65.0	39.0	1.300	3.613	32.638	22.961	$F_{0.1}$
29	44%	32%	71.0	49.0	1.400	3.811	32.071	22.394	
27	43%	30%	73.0	56.0	1.500	4.001	31.527	21.851	

Parameters in Computations

Age	sel (age)	Weight (kg)
2	0.130	0.097
3	0.431	0.125
4	0.705	0.138
5	0.789	0.156
6	0.827	0.167

2009 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	28.634	22.240	35.028
3	11.427	3.962	18.893
4	5.123	2.716	7.531
5	0.463	0.278	0.649
6+	3.905	2.227	5.582
(2+)	49.552	31.423	67.682
(3+)	20.918	9.182	32.654

2010 Recruitment Millions Age 2s
9.677

Table 2.1.2. Management Unit 2 yellow perch biological references from simulations and projected population size in 2010 for a range of fishing rates (F). Biological reference points include mean spawner biomass as a fraction of an unfished population, survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993 for ages 2+ (18.2 million) and 1994 for ages 3+ (7.1 million). The "Harvest 2009" column is based on fishing rates in the "F" column and 2009 abundance estimates at the bottom of the page. Simulations are based on ADMB abundance estimates from 1982-2007 and were used to determine $F_{0.1}$. F_{2008} was the fishing rate used for setting TAC in 2004-2008.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest 2009 (lbs x 10^6)	Population 2+ in 2010 (millions)	Population 3+ in 2010 (millions)	Harvest Strategy Reference
100	67%	67%	0.0	0.0	0.000	0.000	94.452	67.223	
99	67%	67%	0.0	0.0	0.010	0.098	94.221	66.991	
94	65%	65%	0.0	0.0	0.050	0.482	93.307	66.078	
89	64%	63%	1.0	0.0	0.100	0.948	92.195	64.966	
85	62%	61%	3.0	0.0	0.150	1.401	91.116	63.887	
80	61%	59%	3.0	0.0	0.200	1.839	90.068	62.839	
77	60%	57%	6.0	0.0	0.250	2.264	89.051	61.822	
73	59%	55%	9.0	0.0	0.300	2.677	88.064	60.834	
70	58%	54%	11.0	0.0	0.350	3.077	87.104	59.875	
67	56%	52%	17.0	1.0	0.400	3.465	86.172	58.943	
64	56%	51%	19.0	1.0	0.450	3.842	85.266	58.037	
62	55%	49%	21.0	1.0	0.500	4.207	84.386	57.157	
59	54%	48%	26.0	2.0	0.550	4.562	83.530	56.301	
57	53%	47%	29.0	2.0	0.600	4.906	82.698	55.468	
55	52%	45%	33.0	3.0	0.650	5.241	81.888	54.659	
55	52%	45%	34.0	3.0	**0.661**	5.313	81.713	54.484	F_{2008}
54	51%	44%	35.0	3.0	0.700	5.566	81.101	53.871	
52	51%	43%	39.0	5.0	0.750	5.882	80.334	53.105	
50	50%	42%	41.0	10.0	0.800	6.188	79.588	52.359	
50	50%	41%	42.0	11.0	0.823	6.327	79.252	52.023	
49	49%	41%	44.0	12.0	0.850	6.486	78.862	51.633	$F_{0.1}$
47	49%	40%	50.0	15.0	0.900	6.776	78.155	50.926	
46	48%	39%	50.0	17.0	0.950	7.058	77.467	50.238	
45	48%	38%	52.0	18.0	1.000	7.332	76.796	49.567	
42	46%	36%	54.0	29.0	1.100	7.858	75.506	48.276	
40	45%	34%	60.0	36.0	1.200	8.356	74.279	47.050	
38	44%	33%	64.0	39.0	1.300	8.828	73.113	45.883	
36	44%	31%	66.0	44.0	1.400	9.276	72.002	44.773	
34	43%	30%	66.0	54.0	1.500	9.701	70.943	43.714	

Parameters in Computations

Age	sel (age)	Weight (kg)
2	0.115	0.093
3	0.426	0.132
4	0.729	0.136
5	0.794	0.151
6	0.839	0.203

2009 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	59.049	45.984	72.114
3	13.554	6.372	20.735
4	9.425	5.758	13.092
5	1.074	0.717	1.431
6+	17.182	11.443	22.921
(2+)	100.283	70.274	130.292
(3+)	41.234	24.290	58.178

2010 Recruitment

Millions Age 2s
27.229

Table 2.1.3. Management Unit 3 yellow perch biological references from simulations and projected population size in 2010 for a range of fishing rates (F). Biological reference points include mean spawner biomass as a fraction of an unfished population, survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993 for ages 2+ (7.5 million) and 1994 for ages 3+ (0.31 million). The "Harvest 2009" column is based on fishing rates in the "F" column and 2009 abundance estimates at the bottom of the page. Simulations are based on ADMB abundance estimates from 1982-2007 and were used to determine $F_{0.1}$. F_{2007} was the fishing rate used for setting TAC in 2004-2007.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest 2009 (lbs x 10^6)	Population 2+ in 2010 (millions)	Population 3+ in 2010 (millions)	Harvest Strategy Reference
100	67%	67%	0.0	0.0	0.000	0.000	72.288	53.392	
98	67%	67%	0.0	0.0	0.010	0.067	72.135	53.240	
93	66%	65%	0.0	0.0	0.050	0.333	71.532	52.637	
86	64%	63%	0.0	0.0	0.100	0.656	70.797	51.902	
80	63%	61%	0.0	0.0	0.150	0.971	70.082	51.187	
75	62%	59%	0.0	0.0	0.200	1.276	69.386	50.491	
70	60%	58%	0.0	0.0	0.250	1.574	68.710	49.814	
66	59%	56%	0.0	0.0	0.300	1.863	68.051	49.155	
62	58%	55%	0.0	0.0	0.350	2.145	67.409	48.514	
59	58%	53%	0.0	0.0	0.400	2.419	66.785	47.889	
56	57%	52%	1.0	0.0	0.450	2.686	66.176	47.281	
53	56%	51%	1.0	0.0	0.500	2.946	65.584	46.689	
50	55%	49%	1.0	1.0	0.550	3.199	65.007	46.112	
48	54%	48%	1.0	1.0	0.600	3.445	64.444	45.549	
46	54%	47%	1.0	1.0	0.650	3.685	63.896	45.001	
45	53%	47%	1.0	1.0	0.658	3.723	63.810	44.915	
43	53%	46%	1.0	1.0	0.700	3.919	63.362	44.467	
43	53%	46%	1.0	1.0	**0.703**	3.933	63.330	44.435	F_{2008}
42	52%	45%	1.0	1.0	0.750	4.147	62.841	43.946	
40	52%	44%	1.0	1.0	0.800	4.369	62.333	43.438	
38	51%	43%	1.0	1.0	0.850	4.585	61.838	42.943	
37	50%	42%	2.0	1.0	0.900	4.796	61.354	42.459	
35	50%	41%	4.0	2.0	0.950	5.002	60.883	41.988	
34	49%	40%	5.0	2.0	1.000	5.203	60.423	41.527	$F_{0.1}$
31	48%	38%	6.0	4.0	1.100	5.590	59.535	40.640	
29	47%	37%	7.0	7.0	1.200	5.958	58.688	39.793	
27	47%	35%	9.0	8.0	1.300	6.309	57.880	38.985	
25	46%	34%	10.0	9.0	1.400	6.644	57.108	38.213	
24	45%	32%	15.0	14.0	1.500	6.964	56.371	37.476	

Parameters in Computations

Age	sel (age)	Weight (kg)
2	0.076	0.118
3	0.343	0.130
4	0.711	0.147
5	0.776	0.165
6	0.766	0.208

2009 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	46.047	33.169	58.924
3	14.139	6.462	21.817
4	7.413	4.359	10.468
5	0.817	0.524	1.110
6+	11.234	7.103	15.365
(2+)	79.650	51.617	107.684
(3+)	33.604	18.447	48.760

2010 Recruitment Millions Age 2s
18.895

Table 2.1.4. Management Unit 4 yellow perch biological references from simulations and projected population size in 2010 for a range of fishing rates (F). Biological reference points include mean spawner biomass as a fraction of an unfished population, survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993 for ages 2+ (0.82 million) and 1994 for ages 3+ (0.33 million). The "Harvest 2009" column is based on fishing rates in the "F" column and 2009 abundance estimates at the bottom of the page. Simulations are based on ADMB abundance estimates from 1982-2007 and were used to determine $F_{0.1}$. F_{2006} was the fishing rate used for setting TAC in 2006-2008.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest 2009 (lbs x 10^6)	Population 2+ in 2010 (millions)	Population 3+ in 2010 (millions)	Harvest Strategy Reference
100	67%	67%	0.0	0.0	0.000	0.000	22.407	9.901	
99	67%	67%	0.0	0.0	0.010	0.018	22.373	9.868	
94	66%	65%	0.0	0.0	0.050	0.087	22.241	9.736	
89	64%	63%	0.0	0.0	0.100	0.172	22.081	9.575	
84	63%	62%	0.0	0.0	0.150	0.254	21.924	9.418	
80	62%	60%	0.0	0.0	0.200	0.335	21.771	9.265	
77	62%	60%	0.0	0.0	0.230	0.382	21.681	9.175	**F_{2006}**
76	61%	58%	0.0	0.0	0.250	0.413	21.622	9.116	
73	61%	58%	0.0	0.0	**0.280**	0.459	21.534	9.028	**F_{2009}**
72	60%	57%	0.0	0.0	0.300	0.490	21.476	8.971	
70	60%	57%	0.0	0.0	0.340	0.550	21.362	8.857	
69	59%	56%	0.0	0.0	0.350	0.564	21.334	8.829	
66	58%	54%	1.0	0.0	0.400	0.637	21.196	8.691	
63	57%	53%	1.0	0.0	0.450	0.708	21.061	8.556	
61	56%	52%	1.0	0.0	0.500	0.777	20.929	8.424	
59	55%	50%	1.0	0.0	0.550	0.845	20.801	8.295	
56	55%	49%	1.0	1.0	0.600	0.911	20.675	8.170	
54	54%	48%	1.0	1.0	0.650	0.975	20.553	8.048	
53	53%	47%	1.0	1.0	0.700	1.038	20.434	7.928	
51	53%	46%	1.0	1.0	0.750	1.099	20.317	7.811	
49	52%	45%	1.0	1.0	0.800	1.159	20.203	7.698	
48	51%	44%	1.0	1.0	0.850	1.218	20.092	7.586	
46	51%	43%	1.0	1.0	0.900	1.275	19.983	7.478	
45	50%	42%	1.0	1.0	0.950	1.331	19.877	7.372	
44	50%	41%	1.0	1.0	1.000	1.385	19.774	7.268	$F_{0.1}$
41	49%	40%	1.0	3.0	1.100	1.490	19.573	7.068	
39	48%	38%	2.0	3.0	1.200	1.591	19.382	6.877	
37	47%	37%	3.0	8.0	1.300	1.687	19.200	6.694	
35	46%	35%	6.0	8.0	1.400	1.778	19.026	6.520	
34	45%	34%	6.0	10.0	1.500	1.866	18.859	6.353	

Parameters in Computations

Age	sel (age)	Weight (kg)
2	0.075	0.139
3	0.353	0.157
4	0.501	0.184
5	0.748	0.196
6	0.735	0.247

2009 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	5.713	3.600	7.826
3	3.888	1.094	6.683
4	2.637	1.081	4.192
5	0.264	0.120	0.408
6+	2.268	1.009	3.527
(2+)	14.770	6.905	22.636
(3+)	9.057	3.305	14.809

2010 Recruitment

Millions Age 2s
12.505

Table 2.2.1. Lake Erie yellow perch fishing rates and the Recommended Allowable Harvest (RAH; in millions of lbs) for 2009 by Management Unit (MU) and yield strategy employed (Tables 2.1.1-2.1.4).

MU	Fishing Rate	Recommended Allowable Harvest (millions lbs.)	Yield Methods
1	0.720	2.272	F_{2008}
2	0.661	5.313	F_{2008}
3	0.703	3.933	F_{2007}
4	0.280	0.459	F_{2009}
Total		11.978	

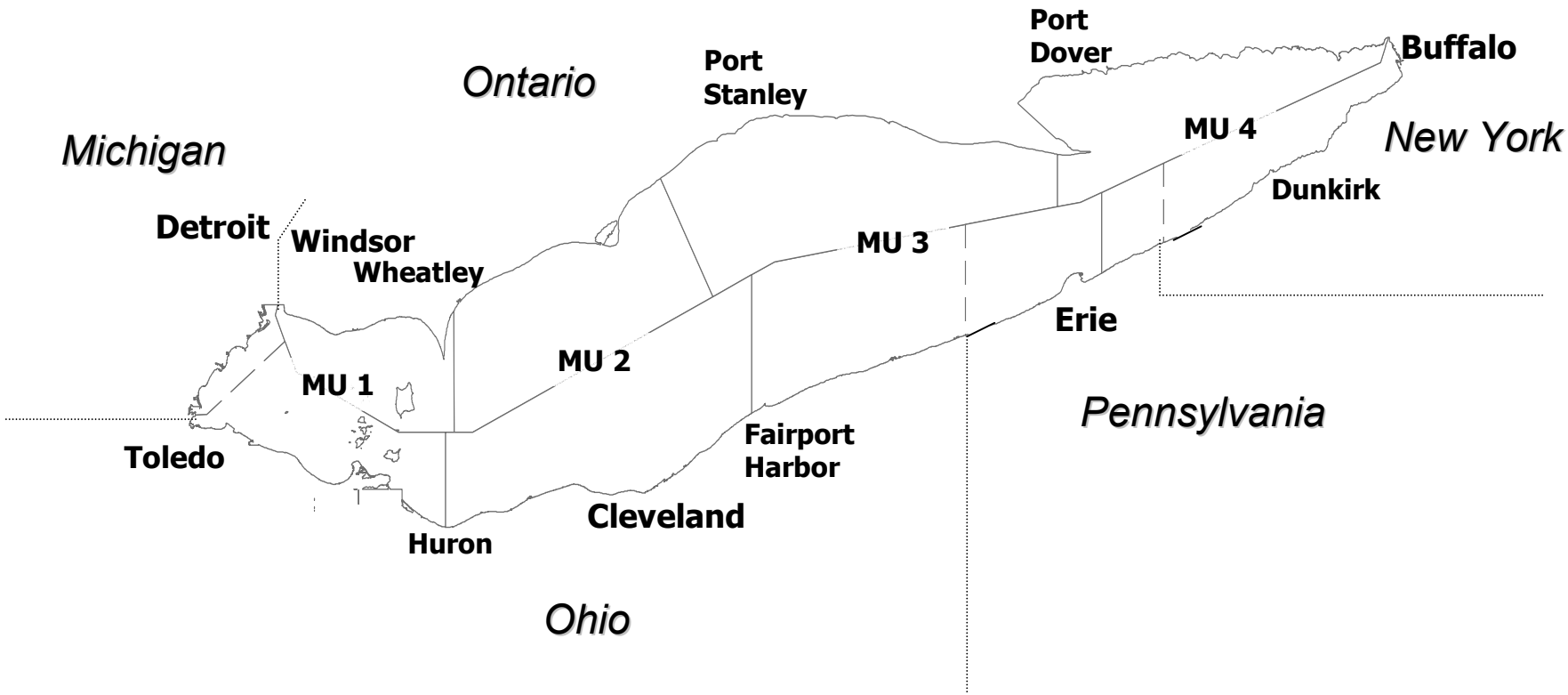


Figure 1.1. Yellow Perch Management Units (MUs) of Lake Erie. For illustrative purposes only, this map should not be used for quota determination or border delineation.

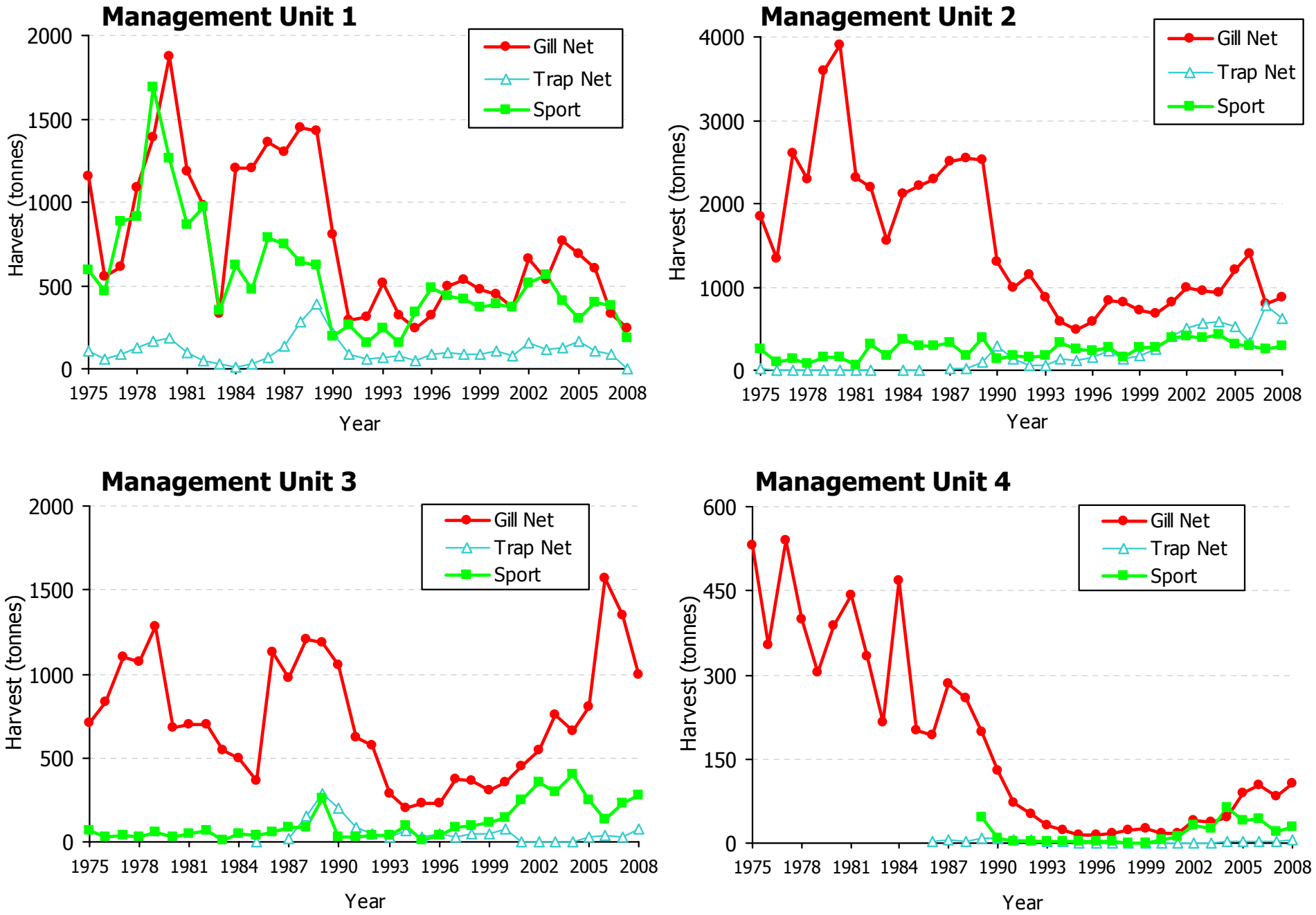


Figure 1.2. Historic Lake Erie yellow perch harvest by management unit and gear type.

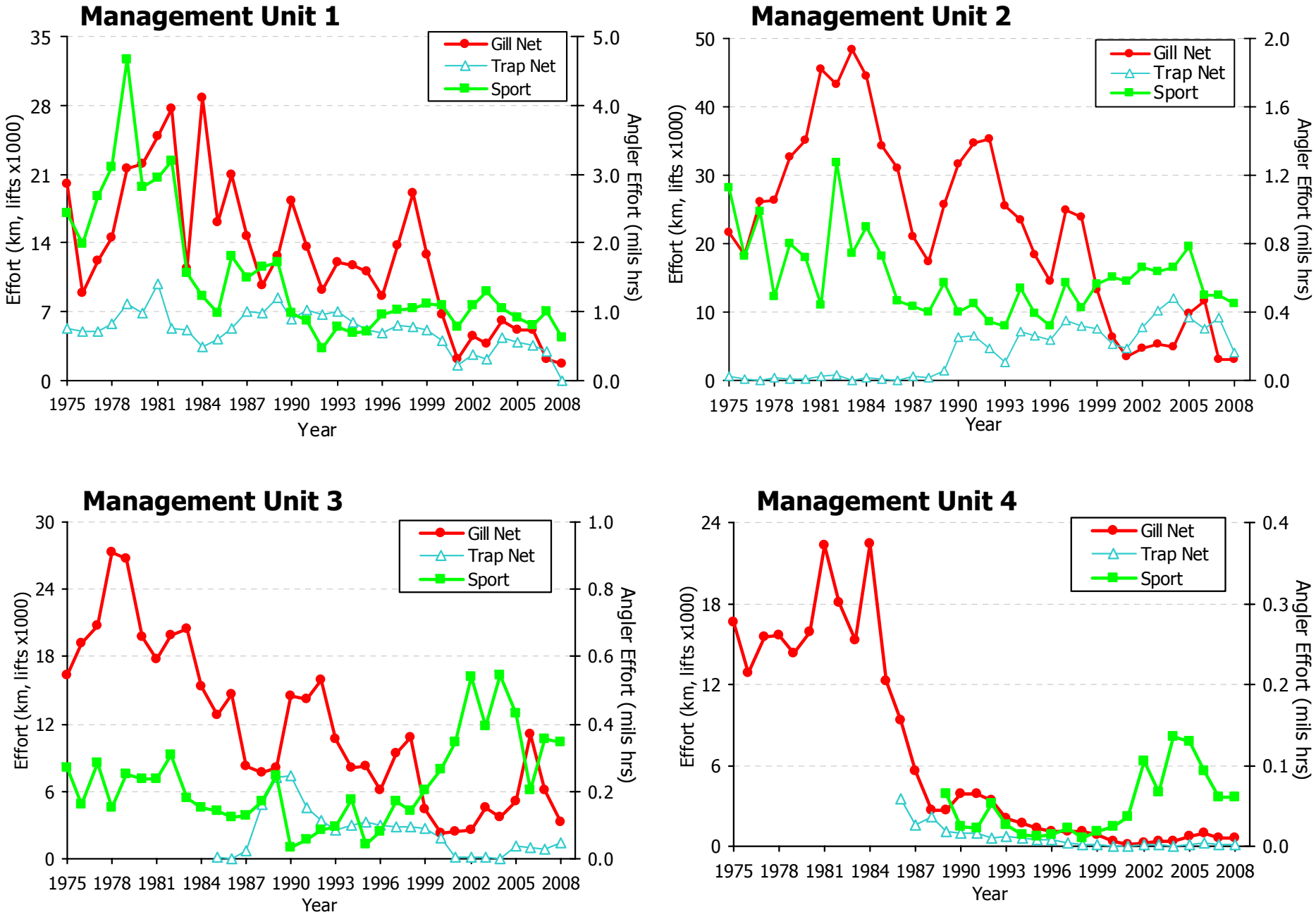


Figure 1.3. Historic Lake Erie yellow perch effort by management unit and gear type. Note: gill net effort presented is targeted effort with small mesh (<3") only.

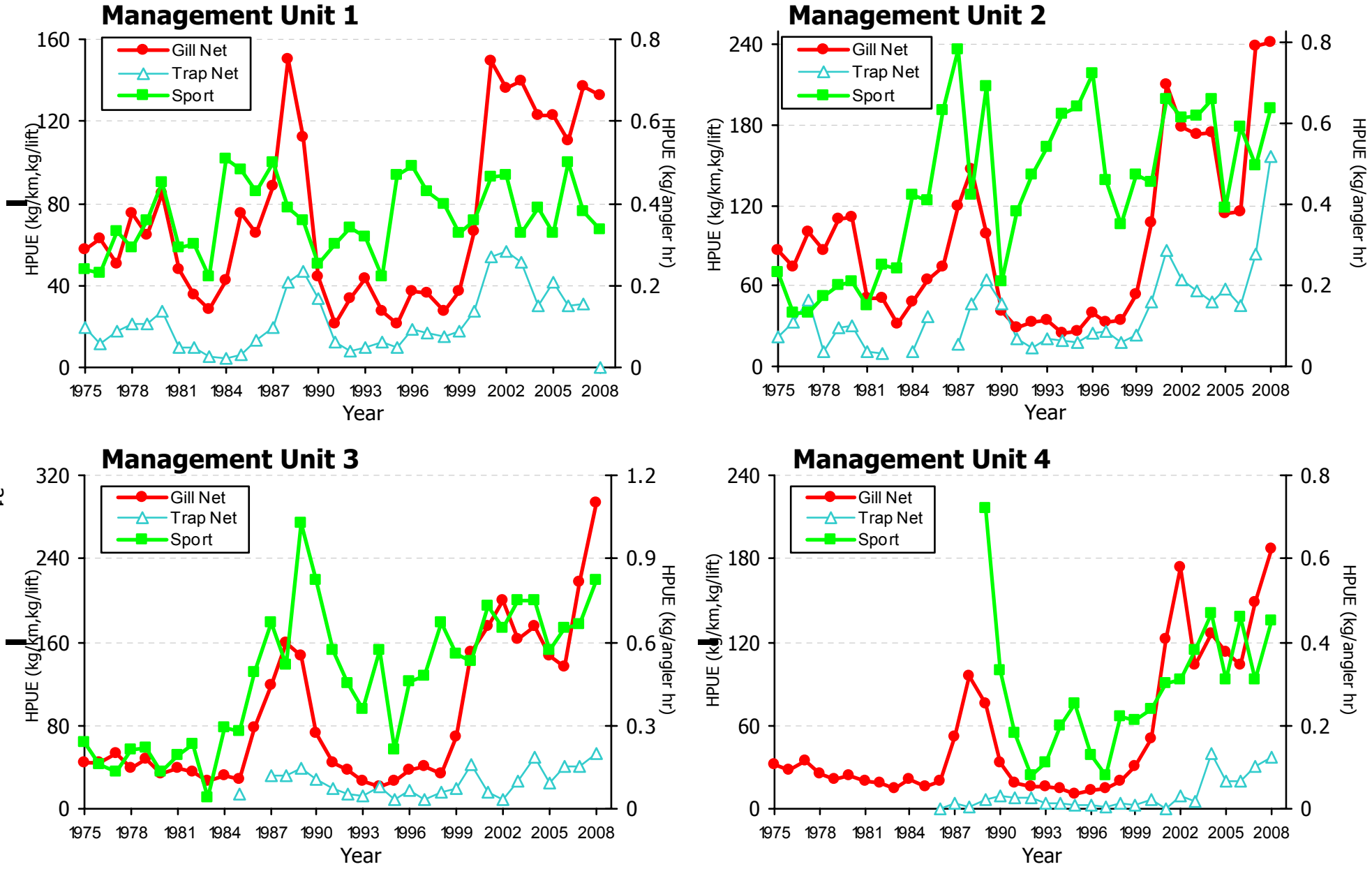


Figure 1.4. Historic Lake Erie yellow perch harvest per unit effort (HPUE) by management unit and gear type. Note: 2001 to 2008 gill net CPUE is for small mesh (< 3") only.

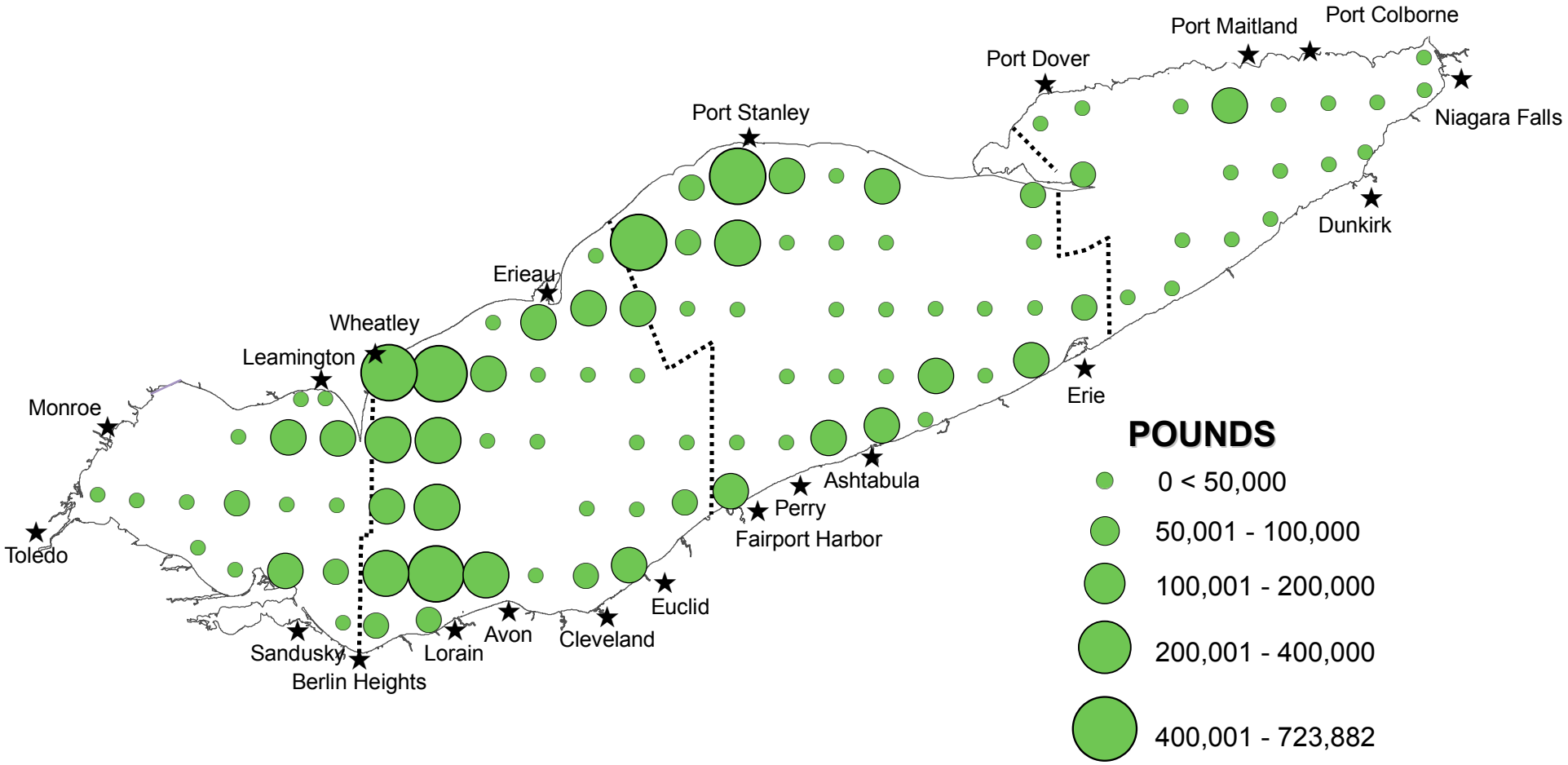


Figure 1.5. Spatial distribution of yellow perch total harvest (lbs.) in 2008 by 10-minute grid.

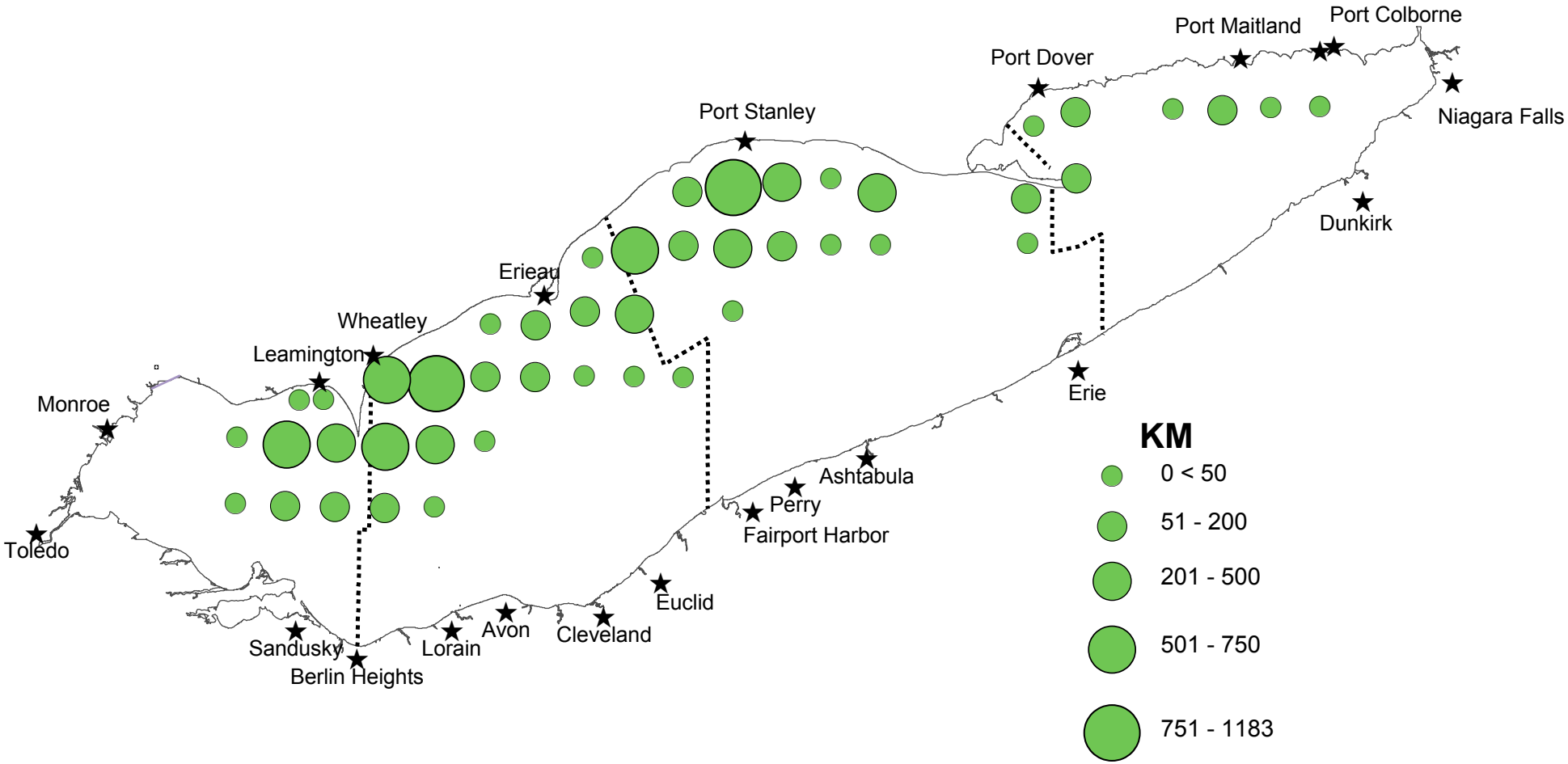


Figure 1.6. Spatial distribution of yellow perch gill net effort (km) in 2008 by 10-minute grid.

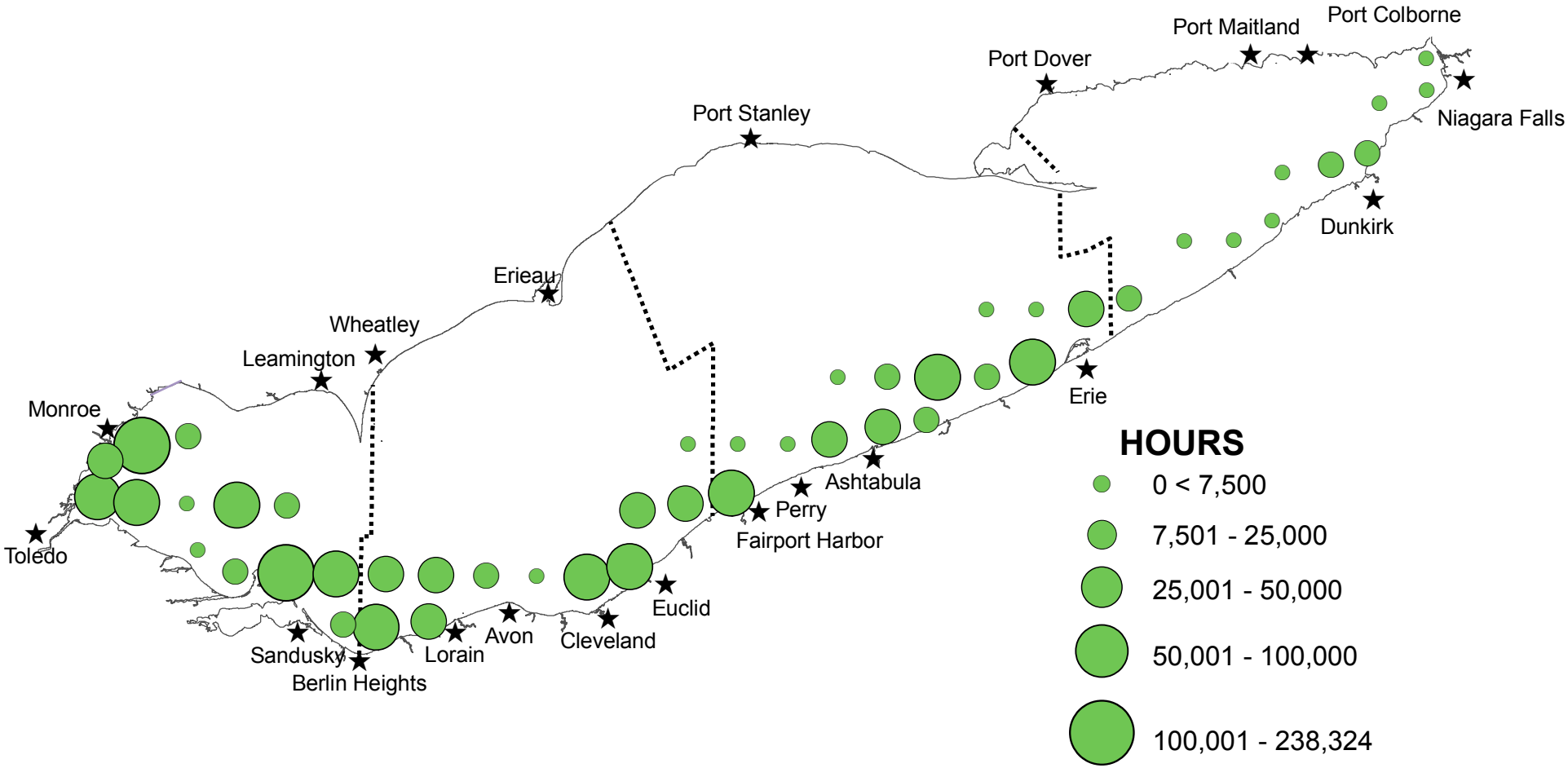


Figure 1.7. Spatial distribution of yellow perch sport angling effort (angler hours) in 2008 by 10-minute grid.

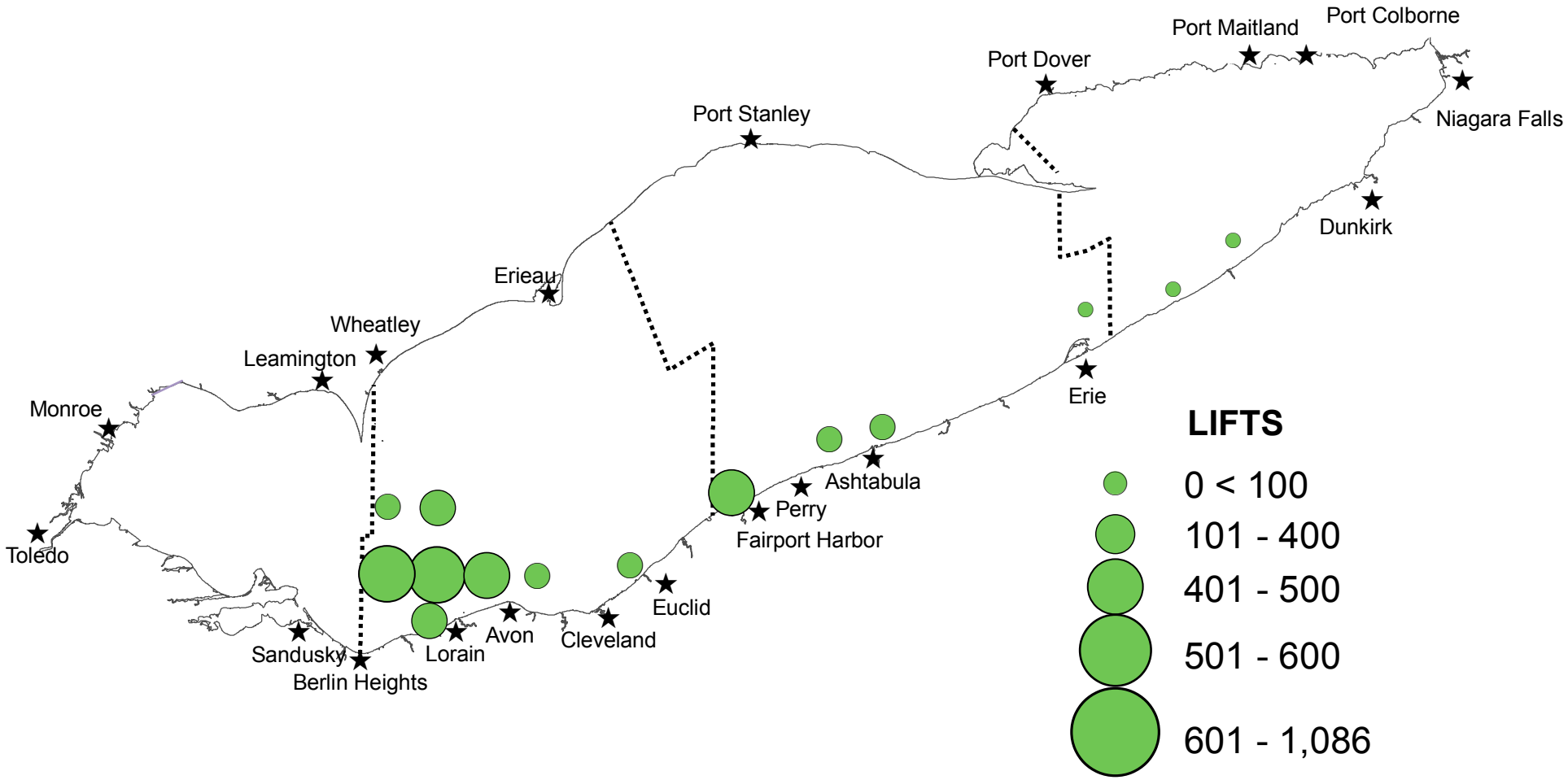


Figure 1.8. Spatial distribution of yellow perch trap net effort (lifts) in 2008 by 10-minute grid.

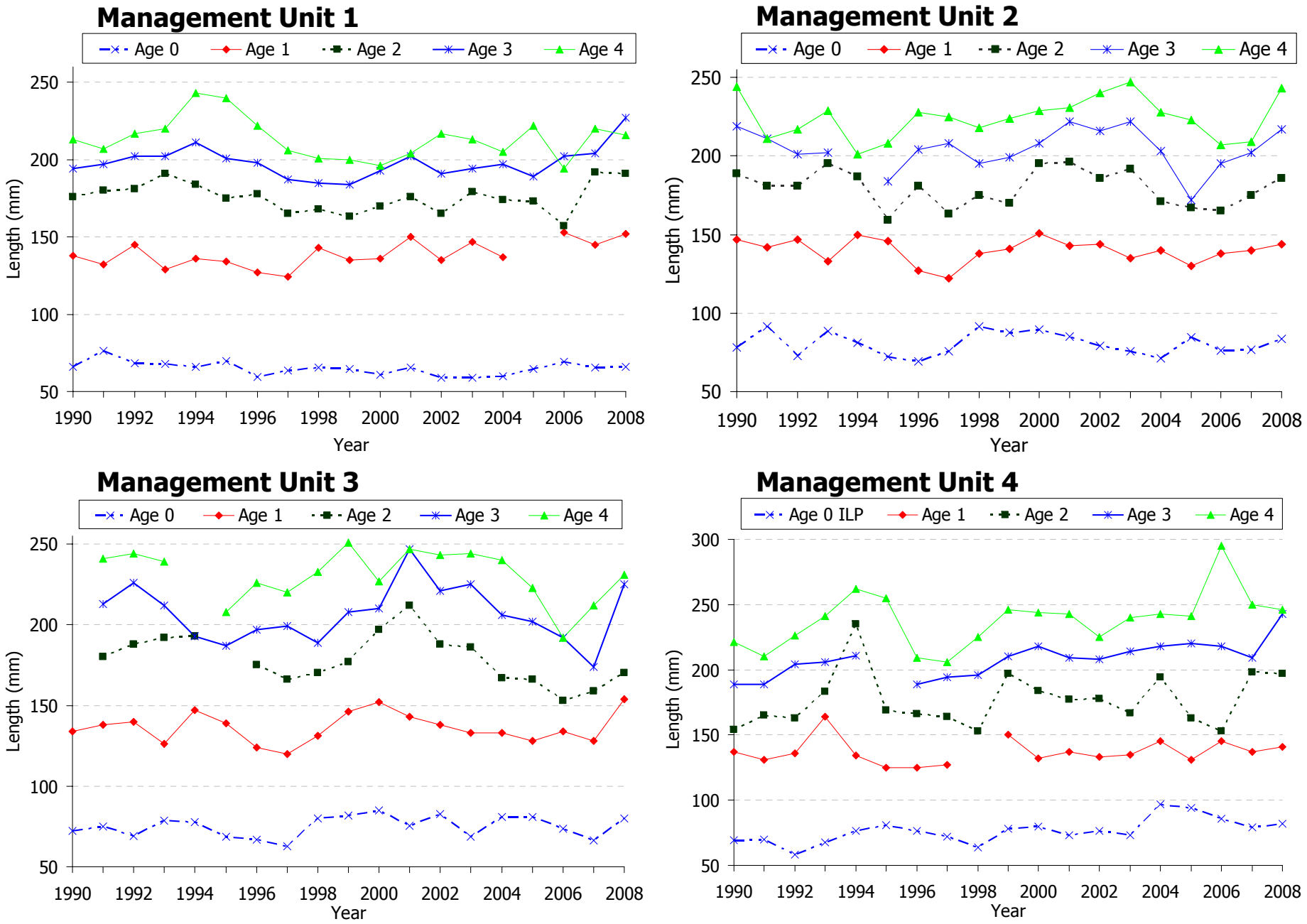


Figure 1.9. Yellow perch length-at-age from 1990-2008 fall interagency experimental samples for ages 0-4 by management unit.

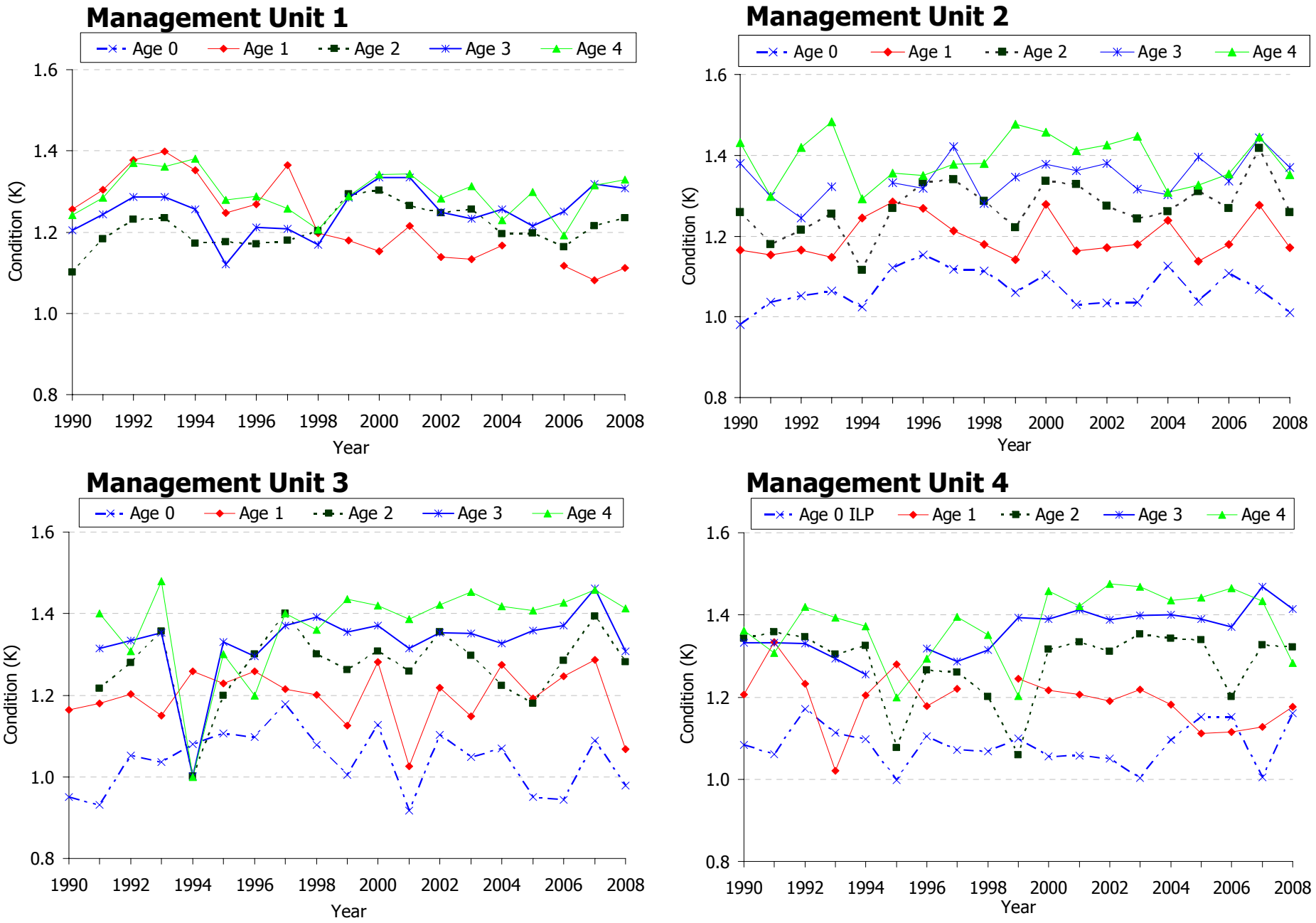


Figure 1.10. Yellow perch condition (K) at age from 1990-2008 fall interagency experimental samples for ages 0 through 4 by management unit.

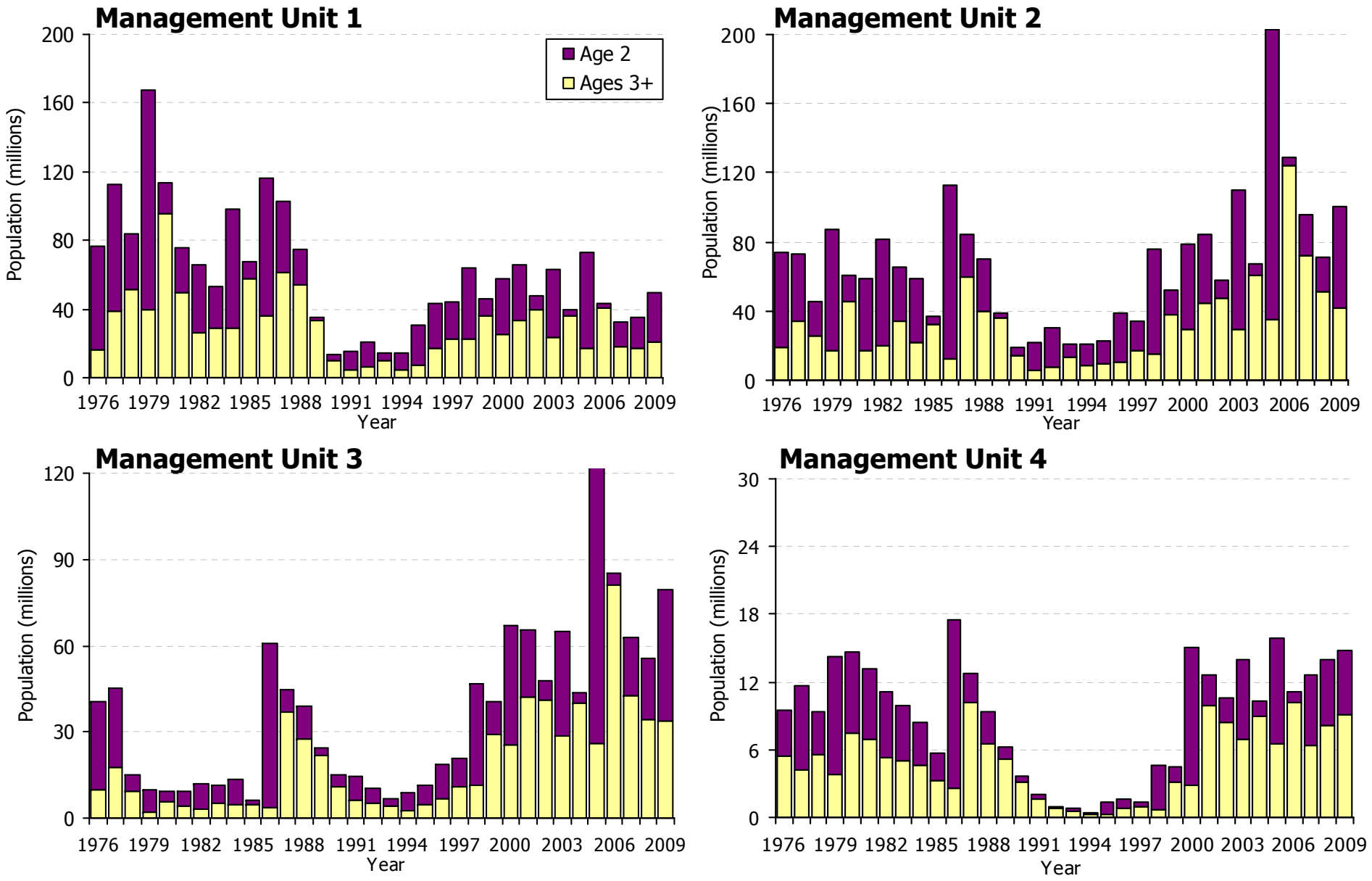


Figure 1.11. Lake Erie yellow perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2009 are from ADMB and parametric regressions for age 2 from survey gears.

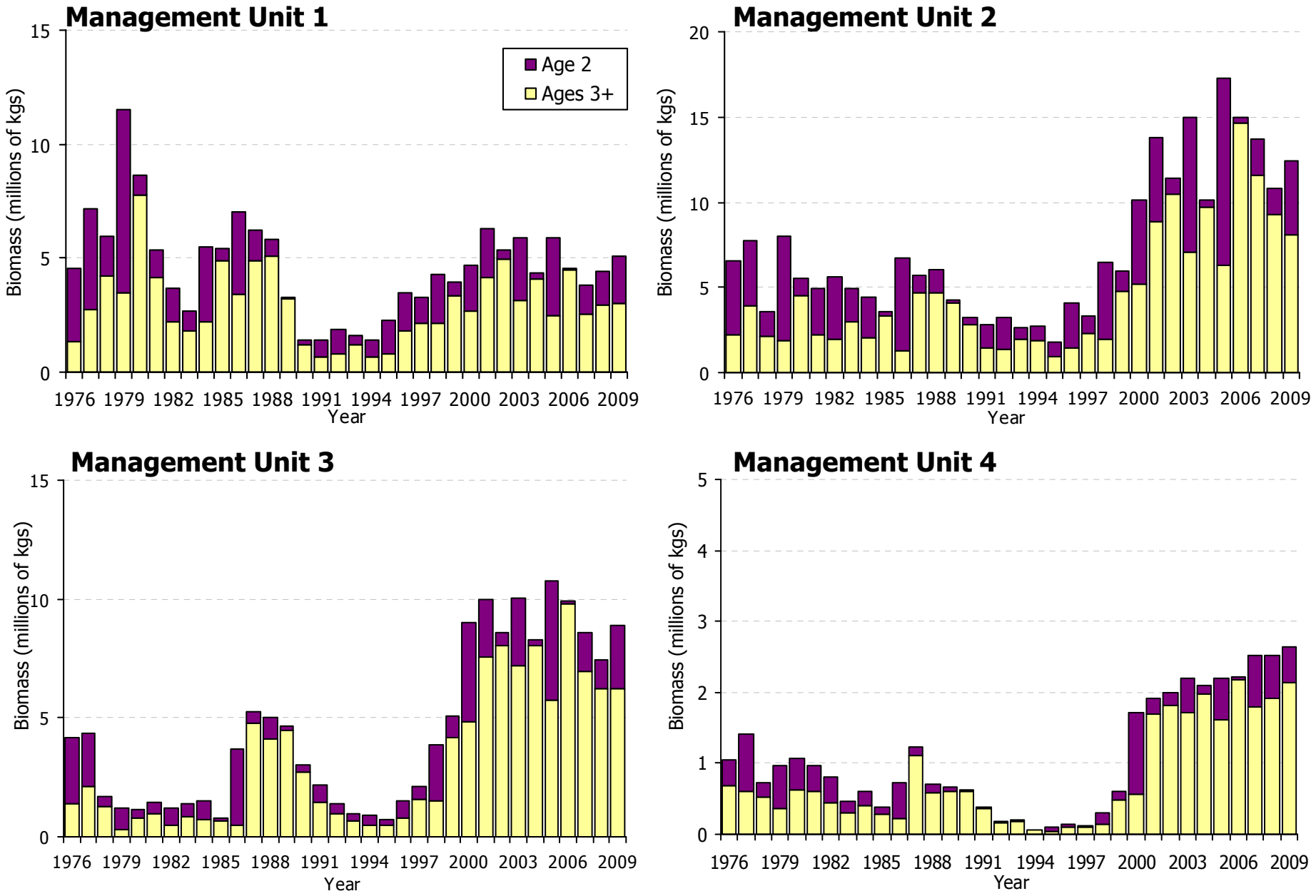


Figure 1.12. Lake Erie yellow perch biomass estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2009 are from ADMB and parametric regressions for age 2 from survey gears.

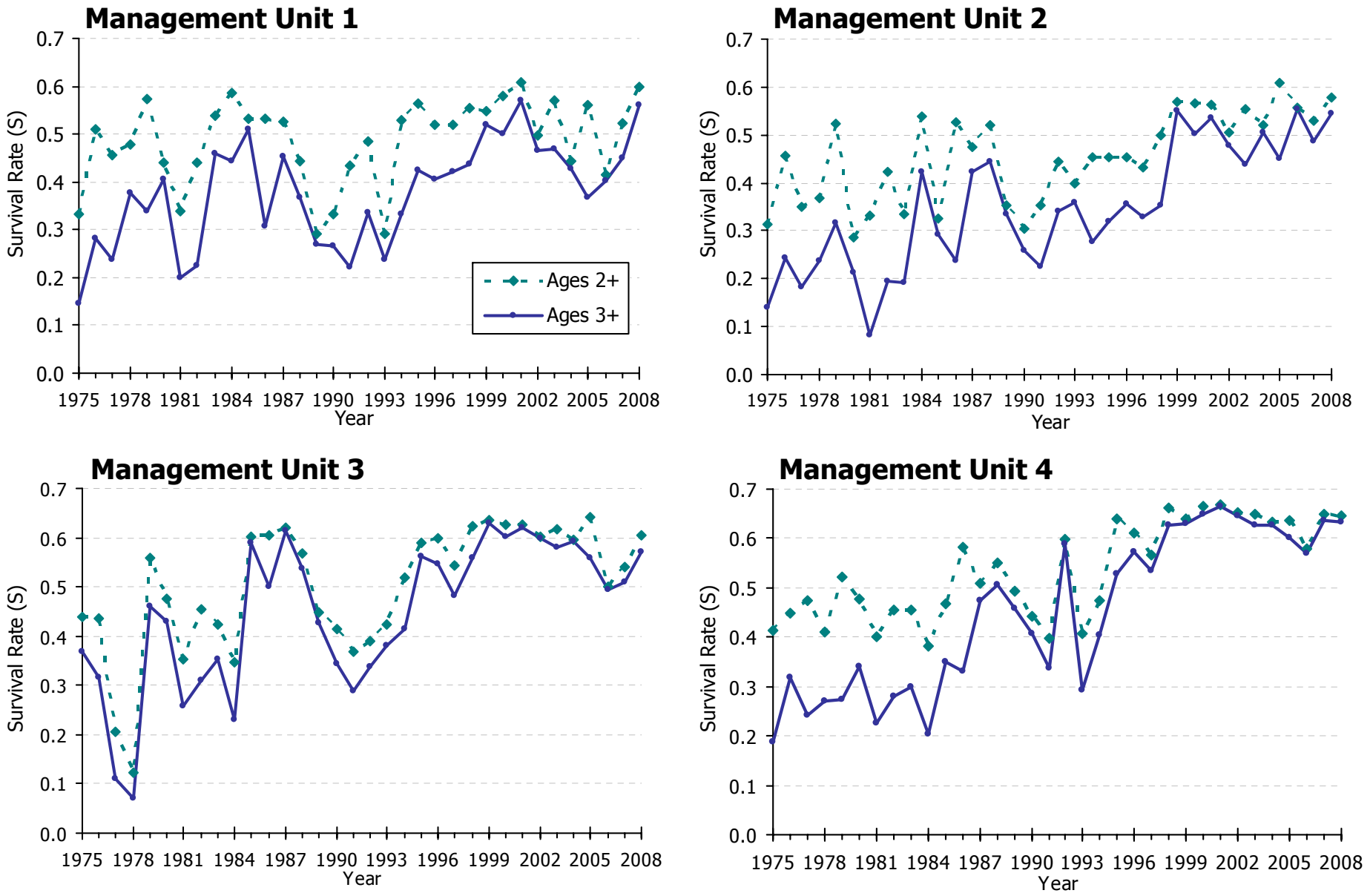


Figure 1.13. Lake Erie yellow perch survival rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from ADMB.

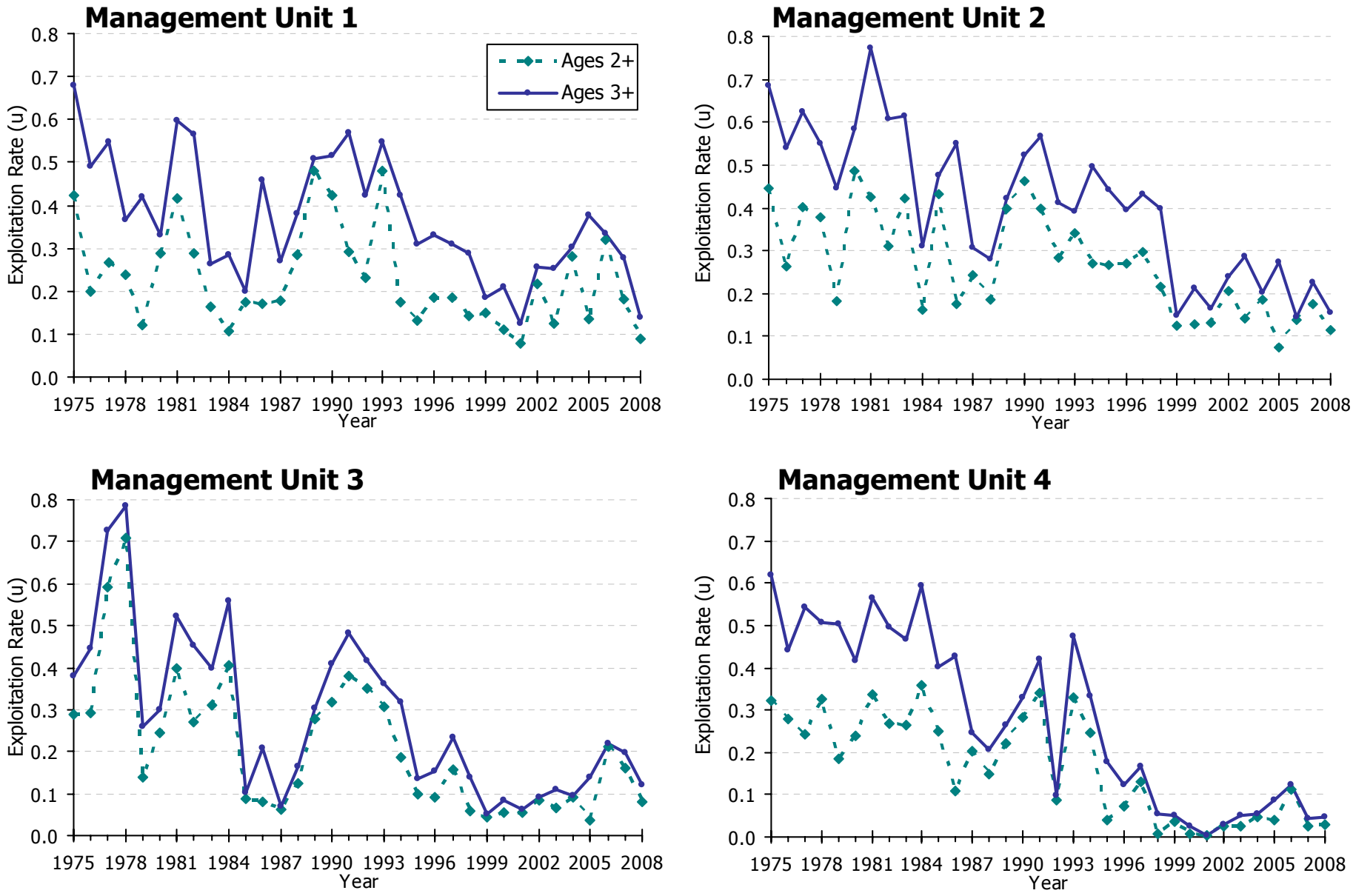
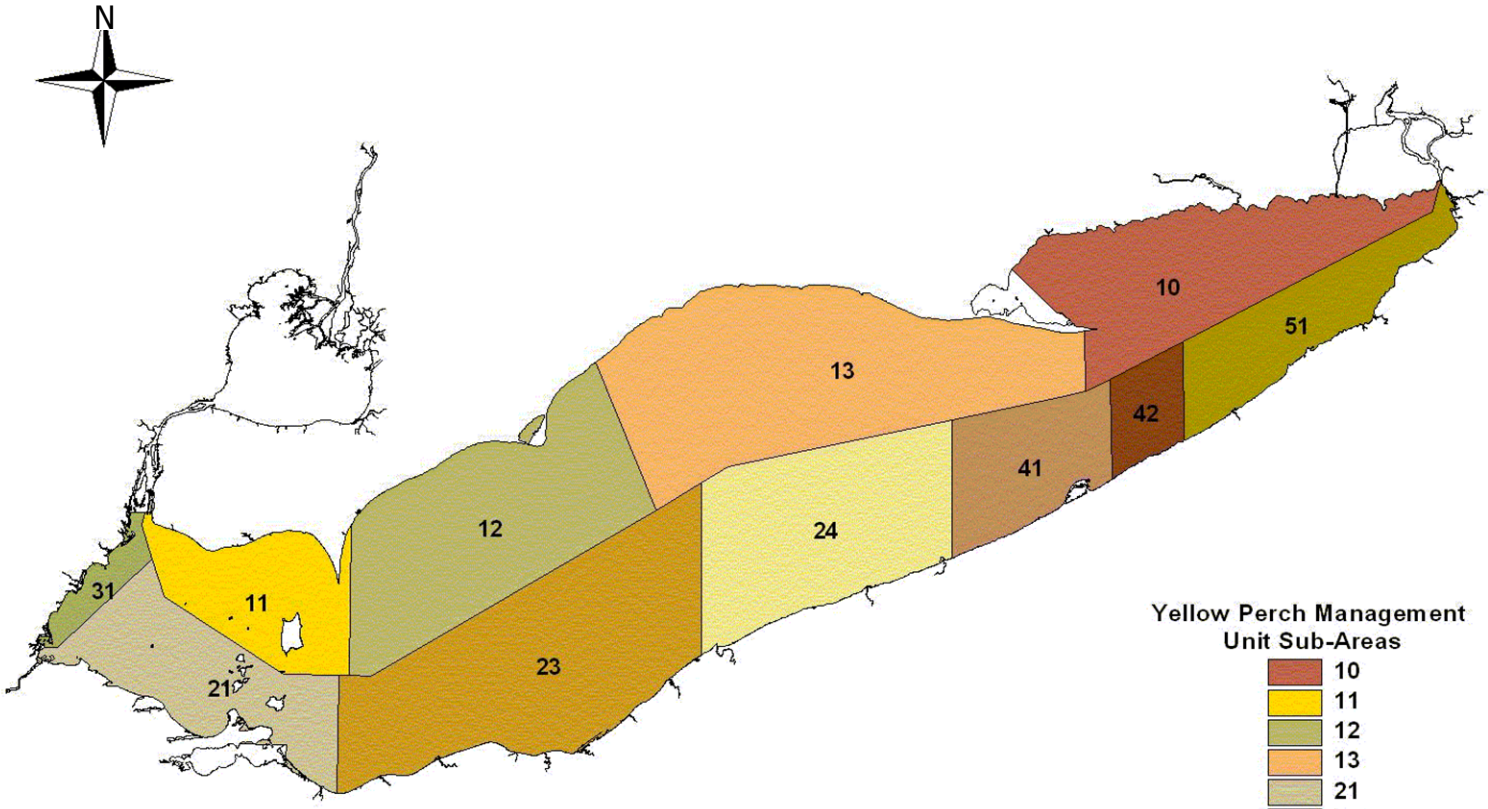


Figure 1.14. Lake Erie yellow perch exploitation rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from ADMB.



Management Unit	Sub-Area	Jurisdiction	Area Estimate (km2)	New Relative Surface Area
MU1	11	Ontario	1537.1	**40.6%**
	31	Michigan	344.8	**9.1%**
	21	Ohio	1905.6	**50.3%**
		MU1 Total	**3787.5**	
MU2	12	Ontario	3497.4	**45.6%**
	23	Ohio	4175.3	**54.4%**
		MU2 Total	**7672.7**	
MU3	13	Ontario	4749.9	**52.3%**
	24	Ohio	2943.7	**32.4%**
	41	Pennsylvania	1385.8	**15.3%**
		MU3 Total	**9079.4**	
MU4	10	Ontario	2818.7	**58.0%**
	42	Pennsylvania	535.6	**11.0%**
	51	New York	1507.2	**31.0%**
		MU4 Total	**4861.4**	

Figure 2.1 Area calculations by subunit area for Yellow Perch Task Group Management Units

Appendix A Table 1. Lambda (λ) values and relative number of terms associated with catch-at-age analysis data sources by management unit.

MU	Data Source	λ	Relative Number of Terms
1	Commercial Gill Net Effort	0.3	1
	Sport Effort	0.4	1
	Commercial Trap Net Effort	1.0	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.9	5
	Commercial Trap Net Harvest	0.5	5
	Trawl Survey Catch Rates	0.4	3
	Partnership Gill Net Index Catch Rates	1.0	5
2	Commercial Gill Net Effort	0.3	1
	Sport Effort	1.0	1
	Commercial Trap Net Effort	1.0	1
	Commercial Gill Net Harvest	1.0	5
	Sport Harvest	0.6	5
	Commercial Trap Net Harvest	0.3	5
	Trawl Survey Catch Rates	1.0	4
	Partnership Gill Net Index Catch Rates	0.5	5
3	Commercial Gill Net Effort	0.3	1
	Sport Effort	1.0	1
	Commercial Trap Net Effort	0.6	1
	Commercial Gill Net Harvest	0.6	5
	Sport Harvest	1.0	5
	Commercial Trap Net Harvest	0.3	5
	Trawl Survey Catch Rates	0.9	4
	Partnership Gill Net Index Catch Rates	1.0	5
4	Commercial Gill Net Effort	0.3	1
	Sport Effort	1.0	1
	Commercial Trap Net Effort	0.5	1
	Commercial Gill Net Harvest	0.8	5
	Sport Harvest	1.0	5
	Commercial Trap Net Harvest	0.6	5
	NY Gill Net Survey Catch Rates	0.7	5
	ONT Partnership Gill Net Index Catch Rates	1.0	5

Appendix A Table 2. Trawl regression indices used for projecting estimates of age-2 yellow perch recruiting in 2009 by management unit.

Management Unit 1

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
OHF20A	0.898	0.37375	167.0	62.416	0.03155	51.879	72.954
OHS11A	0.891	0.30605	23.5	7.192	0.02396	6.066	8.318
OHF11A	0.839	0.25992	44.6	11.592	0.02761	9.130	14.055
OHF10A	0.791	0.06625	631.5	41.837	0.00851	31.089	52.585
OHF21A	0.780	0.29769	124.7	37.122	0.03839	27.547	46.696
OOS10A	0.663	0.02619	444.6	11.644	0.00440	7.732	15.557
			mean	**28.634**		**22.240**	**35.028**

Management Unit 2

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
OHF10A	0.899	0.14345	631.5	90.589	0.01205	75.370	105.808
OHF20A	0.870	0.74767	167.0	124.861	0.07218	100.753	148.969
OHF11A	0.862	0.53398	44.6	23.816	0.05179	19.196	28.435
OHF21A	0.842	0.62709	124.7	78.198	0.06586	61.773	94.624
OHS11A	0.828	0.59177	23.5	13.907	0.06041	11.067	16.746
OHS20A	0.821	0.13516	244.5	33.047	0.01576	25.340	40.753
OHF31A	0.742	1.79638	51.3	92.154	0.25679	65.808	118.501
OHS30A	0.559	0.06675	237.0	15.820	0.01531	8.563	23.077
			mean	**59.049**		**45.984**	**72.114**

Management Unit 3

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
OHF20A	0.809	0.43037	167.0	71.872	0.05235	54.387	89.357
OHF21A	0.804	0.36568	124.7	45.600	0.04377	34.684	56.517
OHS20A	0.804	0.07985	244.5	19.523	0.00986	14.702	24.345
OHF31A	0.743	1.07275	51.3	55.032	0.15292	39.342	70.722
NYF40A	0.742	0.18762	401.3	75.292	0.02961	51.527	99.057
OHS30A	0.504	0.03781	237.0	8.961	0.00968	4.373	13.549
			mean	**46.047**		**33.169**	**58.924**

Management Unit 4

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
NY41A	0.795	0.22758	44.3	10.082	0.02982	7.440	12.724
OHF31A	0.755	0.16683	51.3	8.558	0.02302	6.197	10.920
ILP41A	0.616	0.09652	3.0	0.290	0.01589	0.194	0.385
ILP40A	0.499	0.00911	45.5	0.415	0.00195	0.237	0.592
NY40A	0.465	0.02298	401.3	9.222	0.00659	3.933	14.511
			mean	**5.713**		**3.600**	**7.826**

Appendix A Table 3. Interagency trawl surveys indices. All series are reported in arithmetic mean catch per hectare.

year	OHS10A	OHF10A	OHS11A	OHF11A	OOS10A	OOS11A	OHS20A	OHF20A	OHS21A	OHF21A
1984	.	.	.	.	.	.	.	.	.	.
1985	.	.	.	.	.	.	.	.	.	.
1986	.	.	.	.	.	.	.	.	.	.
1987	16.3	.	74.9	.	.	.	.	.	.	.
1988	188.6	.	11.2	.	212.6	13.3	.	.	.	.
1989	106.1	.	11.8	.	265.4	12.5	.	.	.	.
1990	144.4	310.1	20.7	82.0	259.2	35.2	1.9	52.2	74.1	23.8
1991	146.9	58.1	27.6	10.7	113.2	42.1	5.4	9.3	43.5	39.4
1992	60.7	90.9	9.5	27.7	94.1	16.5	7.2	35.8	8.0	16.5
1993	1164.2	256.4	14.4	16.9	862.5	39.5	41.7	10.6	29.1	29.7
1994	508.5	287.1	57.7	50.9	469.7	62.9	73.3	71.9	5.0	14.6
1995	348.9	82.4	128.8	83.2	478.7	113.5	2.2	2.5	151.1	97.0
1996	3290.8	579.3	79.9	136.4	2544.9	122.8	843.3	119.1	15.7	14.0
1997	52.2	33.7	121.8	102.4	55.2	93.8	29.0	12.3	677.7	161.6
1998	174.5	250.9	4.8	17.5	170.6	8.2	223.8	69.8	2.9	4.7
1999	270.1	155.3	68.5	77.0	330.0	75.0	26.8	73.6	19.4	39.2
2000	186.4	41.5	85.3	50.1	102.5	113.6	0.6	21.9	86.6	63.7
2001	322.1	246.3	12.8	21.7	398.4	11.3	341.9	114.6	6.4	5.4
2002	33.1	30.4	77.1	119.3	26.4	59.5	0.3	6.0	191.0	48.1
2003	1509.9	1111.6	3.0	4.1	1620.8	12.3	1077.5	149.0	4.2	3.5
2004	40.9	9.3	210.7	261.4	39.5	240.2	39.7	8.7	323.7	225.3
2005	124.2	62.3	5.2	0.5	114.8	5.2	118.8	37.8	25.0	7.6
2006	180.2	121.9	6.4	21.0	222.8	12.4	4.9	10.0	2.2	7.4
2007	592.9	631.5	14.5	28.5	444.6	18.8	244.5	167.0	25.1	28.0
2008	267.0	74.7	23.5	44.6	387.2	142.1	290.0	37.3	66.6	124.7

year	OHS30A	OHF30A	OHS31A	OHF31A	OLP40A	OLP41A	ILP40A	ILP41A	NYF40A	NYF41A
1984	.	.	.	.	237.8	6.6	1031.3	65.1	.	.
1985	.	.	.	.	3.1	61.5	21.8	122.5	.	.
1986	.	.	.	.	105.9	0.7	1169.5	36.4	.	.
1987	.	.	.	.	2.3	178.0	2.5	26.5	.	.
1988	.	.	.	.	410.6	0.6	238.0	3.1	.	.
1989	.	.	.	.	174.0	32.6	317.4	59.1	.	.
1990	0.6	20.5	7.2	8.4	31.4	10.0	160.3	27.9	.	.
1991	6.4	1.3	103.4	13.8	9.0	0.9	93.7	22.7	.	.
1992	24.3	31.8	2.7	3.2	34.1	6.9	378.3	21.5	10.4	2.3
1993	39.7	27.3	16.0	10.2	21.1	3.3	159.5	13.6	110.1	3.0
1994	77.2	16.1	16.7	2.0	98.8	10.9	59.2	20.3	47.7	8.4
1995	30.5	12.4	18.7	11.0	5.0	24.0	3.5	41.2	5.7	14.2
1996	1785.8	128.4	2.7	3.3	130.0	2.2	37.5	4.2	106.3	0.3
1997	.	2.6	.	48.8	12.6	34.1	18.1	6.3	0.2	5.5
1998	298.9	38.1	3.5	1.6	84.1	1.2	854.2	14.3	1.5	0.2
1999	44.8	21.0	63.5	40.9	1.7	41.3	23.2	105.5	36.1	33.5
2000	0.0	1.3	84.8	19.7	8.7	2.8	1.9	3.0	23.1	6.6
2001	1283.7	13.6	10.2	0.6	55.9	1.2	479.3	5.0	97.9	11.5
2002	1.7	2.5	749.6	47.9	0.3	10.8	6.5	36.7	9.3	15.5
2003	844.6	47.5	1.5	0.8	48.8	0.4	117.0	0.9	472.5	1.9
2004	3.6	1.9	61.9	44.1	0.3	3.5	0.1	15.5	1.5	28.7
2005	278.2	156.2	82.3	24.8	10.3	0.1	8.8	0.2	57.8	5.4
2006	60.7	18.9	10.8	15.7	2.0	1.0	0.6	3.9	283.2	39.9
2007	237.0	177.8	40.9	23.6	4.0	0.5	45.5	1.8	401.3	41.2
2008	558.3	52.8	150.2	51.3	3.1	4.1	0.2	3.0	1088.3	44.3

Appendix A Table 4. Legend. Lakewide trawl index codes and series names used in Appendix A Tables 2 and 3. All series are reported in arithmetic mean catch per hectare.

Abbreviation	Series
OHS10A	Ohio Management Unit 1 summer age 0 arithmetic
OHS11A	Ohio Management Unit 1 summer age 1 arithmetic
OHF10A	Ohio Management Unit 1 fall age 0 arithmetic
OHF11A	Ohio Management Unit 1 fall age 1 arithmetic
OOS10A	Ontario/Ohio Management Unit 1 summer age 0 arithmetic
OOS11A	Ontario/Ohio Management Unit 1 summer age 1 arithmetic
OHS20A	Ohio Management Unit 2 summer age 0 arithmetic
OHF20A	Ohio Management Unit 2 fall age 0 arithmetic
OHS21A	Ohio Management Unit 2 summer age 1 arithmetic
OHF21A	Ohio Management Unit 2 fall age 1 arithmetic
OHS30A	Ohio Management Unit 3 summer age 0 arithmetic
OHF30A	Ohio Management Unit 3 fall age 0 arithmetic
OHS31A	Ohio Management Unit 3 summer age 1 arithmetic
OHF31A	Ohio Management Unit 3 fall age 1 arithmetic
OLP40A	Outer Long Point Bay Management Unit 4 age 0 arithmetic
OLP41A	Outer Long Point Bay Management Unit 4 age 1 arithmetic
ILP40A	Inner Long Point Bay Management Unit 4 age 0 arithmetic
ILP41A	Inner Long Point Bay Management Unit 4 age 1 arithmetic
NYF40A	New York Management Unit 4 fall age 0 arithmetic
NYF41A	New York Management Unit 4 fall age 1 arithmetic