Report of the Lake Erie Yellow Perch Task Group

March 2005

Members:

Megan Belore	Ontario Ministry of Natural Resources
Andy Cook, (Co-chairman)	Ontario Ministry of Natural Resources
Don Einhouse, (Co-chairman)	New York Department of Environmental Conservation
Travis Hartman	Ohio Department of Natural Resources
Kevin Kayle	Ohio Department of Natural Resources
Roger Kenyon	Pennsylvania Fish and Boat Commission
Carey Knight	Ohio Department of Natural Resources
Brian Locke	Ontario Ministry of Natural Resources
Phil Ryan	Ontario Ministry of Natural Resources
Bob Sutherland	Ontario Ministry of Natural Resources
Mike Thomas	Michigan Department of Natural Resources
Elizabeth Wright	Ontario Ministry of Natural Resources

Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Table of Contents

Note: The data and management summaries contained in this report are provisional. Every effort has been made to insure their correctness. Contact individual agencies for complete state and provincial data. Data reported in pounds for 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 2004 through March 2005, the Yellow Perch Task Group (YPTG) addressed the following charges:

1) Maintain centralized time series of data sets required for population models including:
   a) fishery harvest, effort, age composition and biological parameters
   b) survey indices of adult abundance, size at age, and biological parameters
   c) recruitment indices and biological parameters of juvenile yellow perch

2) Support a sustainable harvest policy by:
   a) examining exploitation strategies
   b) recommending an allowable harvest (RAH) for 2005 in each management unit
   c) supporting decision/risk analysis strategies for yellow perch management

3) Contribute to lake-wide genetic research on Lake Erie yellow perch stocks.

4) Examine the issues of Eastern Basin (MU4) sub-populations and explore whether there is support for re-defining boundaries within MU4 to manage as separate stocks.

During the Coordinated Percid Strategy (CPMS) (2001-2003) the yellow perch task group had an independent review conducted by Myers and Bence (2001). AD Model Builder (ADMB) software was adopted for catch-age analysis and was considered a significant improvement over the former CAGEAN approach. This new programming tool offered greater flexibility, allowing integration of survey data in the model which formerly relied exclusively on fishery data. In addition, commercial gill net selectivity became size dependent instead of simply age dependent. The task group explored a number of exploitation models including the Beverton-Holt yield per recruit, spawning stock biomass (Fx% SSB), Thompson-Bell $F_{0.1}$, spawner biomass per recruit and simulation based approaches. The task group, with endorsement from the LEC, concluded that a simulation based approach provided the most meaningful reference points on which to base harvest strategies. Drawbacks to this approach relate to assumptions and uncertainties common to most, if not all, fisheries models. Sensitivity analyses conducted in 2004-2005 quantified the implications of some simulation assumptions and are discussed in this report. New charges recommended for 2005-2006 are expected to address catch-age analysis uncertainties. A formal decision analysis for Lake Erie yellow perch is presently under consideration. Development of a Yellow Perch Management Plan (YPMP) is scheduled to take place this year. More details regarding charges including the most recent status of Lake Erie yellow perch stocks are described herein.

Charge 1: 2004 Fisheries Review and Population Dynamics

The lake-wide total allowable catch (TAC) in 2004 was 11.027 million pounds. This allocation represented an 11% increase from a TAC of 9.906 million pounds in 2003. For yellow perch assessment and allocation, Lake Erie is partitioned into four Management Units (Units, or MUs; Figure 1.1). The 2004 allocation by management unit was 3.890, 4.437, 2.494 and 0.206 million pounds for Units 1 to 4, respectively.

The lake-wide harvest of yellow perch in 2004 was 9.739 million pounds, the highest observed since 1990 (9.6 million lbs). The 2004 harvest was 4% higher than reported in 2003. Harvest by management unit was 2.9, 4.3, 2.4 and 0.2 million pounds for units 1 to 4 respectively (Table 1.1). Harvest was near or below TAC in all management units, except in Management Unit 1, where the 2004 harvest was about one million pounds below the TAC.

The distribution of harvest among jurisdictions in 2004 was similar to 2003 lake-wide, but differed more within management units (Table 1.1, Figure 1.2). Harvest, fishing effort, and catch rates are summarized for the time period 1994-2004 by management unit, year, agency, and gear type in Tables 1.2 to 1.5. Trends over a longer time series (1975-2004) are depicted graphically for harvest (Figure 1.2), fishing effort (Figure 1.4), and catch rates (Figure 1.8) by management unit and gear type. The spatial distributions in 2004 of harvest (all gears), and effort by gear are presented in Figures 1.3 and 1.5 to 1.7 respectively.

Lake-wide, yield in 2004 was almost identical to 2003 for Ohio, but increased in Ontario (5.2%), Michigan (12%), Pennsylvania (34%), and New York (232%). Compared to 2003, harvest totals in 2004 increased by 8% in MU 1, 2% in MU 2, 1% in MU 3 and 42% in MU 4. Ontario's 2004 harvest increased in MU 1 (44%) and MU 4 (17%), but declined in MU 2 (3%), and MU 3 (13%). Michigan's 2004 harvest (Unit 1) increased 12% from 2003. In Ohio waters, harvest decreased in Unit 1 (22%), but increased in Units 2 (6%) and Unit 3 (37%). Pennsylvania's harvest increased in Unit 3 (38%) and Unit 4 (16%). New York's 2004 harvest (MU 4) more than tripled from the previous year.

Harvest from commercial trap nets increased in Units 1-4 (15%, 3%, 53%, and 273% respectively). Trap net effort (lifts) for 2004 increased in Unit 1 (97%), Unit 2 (18%) but decreased in Unit 3 (20%) and Unit 4 (52%).

Within management units, Ontario's yellow perch harvest from large mesh gill nets (3 inch or greater) in 2004 ranged from less than 1% to 8% of the gill net harvest. Harvest, effort and catch per unit effort from *a*) standard yellow perch effort (<3 inch stretched mesh) and *b*) larger mesh sizes, are distinguished in Tables 1.2 to 1.5. Targeted gill net effort increased in MU 1 (62%) but decreased in MU 2 (7%), MU 3 (19%) and MU 4 (5%) compared to 2003. Gill net effort remained generally low in 2004 compared to the 1990's and earlier decades (Figure 1.4).

In 2004, sport harvest decreased in MU 1 (28%) but increased by 12%, 37% and 156% in Units 2, 3 and 4, respectively. Angling effort decreased in MU 1 (20%) but increased in MU 2 (4%), MU 3 (38%) and MU 4 (107%).

Due to the larger size (older age) composition of the sport harvest, angling catch rates expressed as kg harvested /angler hour (Figure 1.8) increased, in contrast to the number of fish harvested /angler hour which decreased in MU 1 (Table 1.2). Both gill net (12%) and trap net (41%) fisheries experienced lower catch rates in 2004 compared to 2003 in Unit 1. In MU 2, catch rates in 2004 were similar to 2003 for all gears with trap net values down 13%, sport success up by 12% and gill net harvest rates virtually unchanged (Table 1.3). In MU 3, sport catch rates contrasted between Ohio and Pennsylvania anglers, with increased fishing success in Ohio (39%), countered by a reduction of 26% in Pennsylvania waters (Table 1.4). Commercial success rates improved in MU 3 for both gill net (8%) and trap net (91%) fisheries. With the exception of the Pennsylvania's sport fishing success down marginally in 2004, catch rates improved dramatically in MU 4; in both New York (sport by 50% and trap net by 8 fold) and Ontario's waters (gill net fishery by 23%).

Ontario uses an ice allowance policy, first implemented in 2002, by which 3.3% was subtracted from commercial landed weight. This step was taken so that ice was not debited from 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 is represented exclusively by the commercial gill net fishery, described above. Reported sport harvests for Michigan, Ohio, Pennsylvania and New York are based on creel survey estimates, however, the sport harvest of yellow perch from Ontario waters is not routinely assessed. Additional fishery documentation is available in annual agency reports.

Age Composition and Growth

The yellow perch harvest in 2004 consisted mostly of the 2001 (age 3) and 1999 (age 5) year classes, with older fish (i.e.: 1998 year class and earlier) more common in the catches of trapnet and sport fisheries farther east (MU 3 and MU 4) (Table 1.6). There was limited, variable contribution from the 2000 year class (age 4) across management units. The harvest of age 2 recruits (2002 year class) was negligible in all Units. Ontario gill net harvest age composition is from targeted yellow perch harvest only. Differences between the age composition of the harvest between areas and gear types reflect different growth rates, factors affecting age interpretation, gear selectivity, and levels of abundance affected by recruitment and survival.

Yellow perch growth trends differ among life stages and between basins (Figure 1.9). An abundance 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 age 1 and older data 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 stable or improving length at age for ages 0-4 in management units 2, 3 and 4. Growth in management unit 1 appears to be stable or decreasing among ages. In the west basin, young-of-the-year yellow perch have been smaller than average for the last three consecutive years: that included two weak and one strong year classes. A general decline in size of YOY was evident since 1990 in the west basin, with recent sizes comparable to the late 1980s (not shown). Factors such as temperature, lake productivity, and invasive species, along with the proliferation of yellow and white perch may have contributed to the reduced size of young-of-the-year yellow perch in the west basin.

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.

ADMB Catch-Age Analysis 2004

Population size for each management unit was estimated by catch-at-age analysis using AD Model Builder, with the Commercial Selectivity Index (CSI) version, updated with 2004 data. The approach was unchanged from last several years' methodology and has been described in a previous Yellow Perch Task Group Report (2002). Estimates of population size, biomass and parameters such as survival and exploitation rates are presented for 1994-2004 in Table 1.7 and for 1975-2004 in Figures 1.10–1.13. Mean weight-at-age from biological surveys was applied to abundance estimates to generate population biomass estimates (Table 1.8 and Figure 1.11). Population 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 2004 implies that the time series are continuous. Lack of data continuity weakens the validity of this assumption. Survey data are represented in the latter part of the time series (generally 1989 to present), while methods of fishery data collection have also varied. Model parameters, constrained to constants, such as natural mortality, catchability and selectivity blocks, lessen our ability to directly compare abundance levels over three decades. In addition, commercial gill net selectivity 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-age analysis, the most recent year's data estimates inherently have wide error bounds. This is to be expected for cohorts that remain at-large in the population.

Population estimates are derived by minimizing an objective function weighted by data sources including fishery effort, 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; until lambdas remain relatively constant. While lambdas within similar parameter groups (i.e.: effort, catch and surveys) are solved and weighted unequally, the groups themselves are given equal weight. This can be problematic, as in the case of MU 1 for which fishery catch lambdas failed to converge. In order to address this lambda calculation process fully, a new charge has been recommended for 2005-2006 to review and examine methods of deriving lambdas. Data weightings are presented in Appendix Table 1. Plots of fishery and survey data residuals from catch-age analysis are presented in the Appendix Figures 1–4.

Recruitment Estimator for Incoming Age 2 Yellow Perch

Age 2 recruitment in 2005 was predicted by linear regression of juvenile yellow perch trawl indices against catch-age analysis estimates of two-year-old abundance. Age 2 recruitment in 2005 was calculated using the mean of values predicted from the indices listed in Appendix Table 2. Data from trawl index series for the time period examined are presented in Appendix Table 3 (geometric means) and Appendix Table 4 (arithmetic means), while a key that summarizes abbreviations used for the trawl series is presented as a legend in the Appendix.

The estimates of age 2 recruitment for 2005 (the 2003 year class) was strong in all management units (Table 1.7, Appendix Table 2). The 2003 year class should contribute to fisheries in 2005 to varying degrees among MUs, based on selectivity of the age 2's in each MU.

They will contribute even more so in 2006, as they become larger and more vulnerable to all harvest methods.

2005 Population Size Projection

Stock size estimates for 2005 (ages 3 and older) were projected from catch-age analysis estimates of 2004 population size and age-specific survival rates in 2004 (Table 1.8). Projected age 2 recruitment from the 2003 year class (method described above) was added to the 2005 population estimate for older fish in each unit, producing the total standing stock in 2005 (Table 1.8). Standard errors and ranges for estimates are provided for each age in 2004, and following estimated survival (from ADMB), for 2005. Descriptions of *min, mean*, and *max* population estimates refer to the estimates minus or plus one age-specific standard error.

Stock size estimates projected for 2005 were among the highest of the time series due to the 2003 year class (Table 1.7 and Figure 1.10). Overall, projected 2005 yellow perch abundance (2+) is 100%, 117%, 60% and 1% greater than 2004 in management units 1 to 4, respectively. Estimates of abundance for age 3 and older yellow perch in 2004, however, were not as favorable by comparison. Abundance of perch ages 3 and older in 2005 was projected to be reduced by 50% or more than estimated for 2004.

As a function of population estimates and mean weight-at-age, biomass estimates in 2005 were among the highest in the time series (Figure 1.11). Total biomass estimates for 2005 increased from 2004, except in MU 4 where biomass was comparable between 2004 and 2005. Yellow perch biomass estimates for 2005 (ages 2 and older) increased 54%, 59% and 6% in MU's 1 to 3, respectively, but decreased slightly by 7% in MU 4. Biomass of ages 3 and older yellow perch decreased significantly- by 35%, 40%, 32% and 22% in Units 1 to 4, respectively.

Estimated survival of yellow perch ages 2 and older in 2003 were 48%, 38%, 56% and 62% in MU 1, 2, 3 and 4, respectively (Figure 1.12). In 2004, estimated survival was 48%, 38%, 55% and 63% in Units 1 through 4. As expected, survival rates were higher for fish ages 2 and older, than ages 3 and older, since new recruits are less vulnerable to fishing mortality. Albeit with fluctuations, estimated survival has improved gradually in all management units since early to mid 1990s**.**

Estimated exploitation rates in 2003 were 23%, 37%, 14% and 6% in Management Units 1–4, respectively, for ages 3 and older. Exploitation rates for 2004 were estimated at 23%, 37%, 15% and 4% for yellow perch ages 3 and older (Figure 1.13). Exploitation rates of yellow perch ages 2 and older are lower since new recruits are less vulnerable to fishing.

Charge 2: Harvest Strategy and RAH

Harvest Strategy Methodology

In 2004, a suite of exploitation strategies was presented to the Lake Erie Committee (LEC) to support TAC determination. This year, the LEC directed the YPTG to present a single yield strategy, the $F_{0.1}$ spawner-recruit (S/R) for management units 1, 2 and 3. The $F_{0.1}$ rates calculated in 2004 remain unchanged this year for MUs 1-3 (Tables 2.1.1-2.1.3, 2.2.1). $F_{0.1}$ values were derived based on the ratio of average yield to average recruitment plotted against fishing rates. $F_{0.1}$ was determined from the fishing rate at which the slope was 10% of the initial slope of the curve. This approach does not rely on the assumption of knife-edge recruitment, and it incorporates a gamma stock-recruitment relationship. Parameters include mean weight-at-age from harvest (recent two-year mean), age specific selectivities (recent two-year mean) from catch-age analysis weighted by sharing formula, and survey maturity data. The simulation assumes that the targeted fishing rates will be realized for all gear types. Simulation methodology and risk assessment is described below.

Stock-Recruitment Simulation

This simulation approach documented in 2004 remains essentially the same this year, although a number of sensitivity analyses were conducted. Spawner-recruit (S/R) relationships were described by gamma functions (Reish et al. 1985 in 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 (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 in 2005 included averaging the results of simulations over 10 multiple runs. This is described in detail under *Sensitivity Analyses* below. Results are presented for each management unit in Tables 2.1.1-2.1.3.

Stock-Recruitment Simulation Sensitivity Analyses

In order to address concerns from the LEC regarding the sensitivity of risk indicators to $F_{0.1}$ S/R model assumptions, the YPTG conducted sensitivity analyses relating to 1) model configuration, 2) time frames used in model (that relate to recruitment potential), 3) stock–recruitment model applied to the data, and 4) single vs. multiple simulations to describe "average" outcomes at different fishing rates.

Simulation results using data input from two different catch at age models were compared. The first inputs used catch-at-age analyses results that solved commercial gill net selectivity, and the second inputs used results from the current catch at age model in which selectivity was calculated independently of catch-age analysis. Using MU 1 as an example, the $F_{0.1}$ rate was higher with selectivity calculated independently, but would have produced a lower TAC in 2004 (21%) due to lower population estimates.

Time frames compared included the entire series (1975-2003) vs. one that began when target phosphorus loading targets were achieve circa 1982, with the belief that conditions were more favorable for recruitment prior to this period. The $F_{0.1}$ rate derived from the shorter (stock-recruit) time series (1982-2003) was lower compared to that derived using the full time series (1975-2003) in MU1, but was higher in MU2. Risk indicators were more apparent at lower fishing rates in the 1982-2003 model.

Gamma, Ricker, and Beverton-Holt stock recruitment relationships were used to calculate $F_{0.1}$ rates with time series of various lengths and risk indicators. The S/R model that triggered risk indicators at the lowest fishing rates was Beverton-Holt, followed by Ricker and Gamma models which alternated between MUs. Derivation of $F_{0.1}$ rates were insensitive to truncating the time series for Ricker or Gamma S/R models (from 1982-2003 down to 1982-1998).

The simulation is driven in part by the environmental factors (EFs) used in the model. The arrangement of these EFs can affect the risk levels associated with different fishing rates. Therefore, it was suggested that an average of results from multiple simulations with different selections of EF's be used to describe the risk associated with each fishing rate.

Although $F_{0.1}$ rates that were derived in 2004 are presented (Tables 2.1.1 – 2.1.3, 2.2.1), the simulations were run again multiple times (10) and averaged to better describe risk associated with various fishing rates. In 2006, following the lambda review and development of the Yellow Perch Management Plan, application of the results of the sensitivity analyses will be given further consideration.

Harvest Strategies and RAH Determination

"*A harvest strategy is a plan that should be robust to the unpredictable and/or uncontrolled biological fluctuations that are expected from the stock. A harvest strategy involves biological, economic, social and political decisions…"* (Hilborn and Walters, 1992). The task group described biological risk associated with various fishing intensities. The YPTG calculated target fishing rates ($F_{0.1}$ S/R) believed to be sustainable based on a simulation approach that is subject to assumptions which overlap with those of catch-age analysis. These may be essential elements of a harvest strategy, but do not by themselves constitute a complete one until economic, social and political considerations have been satisfied. The LEC, supported by the YPTG, deemed that the $F_{0.1}$ harvest projections for 2005, presented in Table 2.2.1, satisfied these elements in the interim, until outstanding uncertainties have been addressed and incorporated into a Yellow Perch Management Plan (YPMP). Since 2000, the Management Unit 4 harvest strategy has been pursued separately from other Units, and established more directly by the LEC as a rehabilitation strategy. Based on the improved status of yellow perch reported in Management Unit 4, the LEC proposes a 50% increase in allowable harvest for MU4 in 2005. This proposal should not impose excessive biological risk to yellow perch or other species, and represents a compromise between diverse economic and social interests. If the proposed TAC were adopted in 2005, the outcomes would be monitored by assessment programs and reported by the YPTG. Further considerations for MU 4 are discussed in *Charge 4*. Also of note, 2005 marks the end of a transition from historic pattern to lake area allocation sharing by jurisdiction which began in 1993. In 2005, lake area-based allocation shares by management unit and jurisdiction are:

Allocation by Management Unit and Jurisdiction, 2005:

MU 1 :	MI 8.1%	OH 49.6%	ONT 42.3%
MU 2:	OH 57.5%	ONT 42.5%	
MU 3:	OH 31.9%	PA 11.9%	ONT 56.1%
MU 4:	NY 27.6%	PA 17.2%	ONT 55.2%

With the advent of geographic information software (GIS) technology, the Standing Technical Committee (STC) is redefining yellow perch management unit delineations using modern approaches. Implications to sharing formulas based on lake surface area have yet to be addressed.

Charge 3: Yellow Perch Genetics

During 2004 the YPTG supported genetic stock discrimination research by collecting yellow perch tissue samples for Dr. Carol Stepien at the University of Toledo. In recent years this support has become an annual endeavor by the YPTG with expectation that this research will expand our understanding of yellow perch genetic stock structure. Ongoing tissue collections from spawning concentrations should assemble a database that represents a stock library for Lake Erie yellow perch. The YPTG thanks Dr. Carol Stepien and her associates for their continued efforts.

Charge 4: Eastern Basin (MU 4) Sub-stock Delineation and Boundaries

Yellow perch in eastern Lake Erie have been treated as a single stock for assessment and allocation purposes since the 1980s. However, MU4 is notable among Lake Erie's yellow perch management units as the area where yellow perch fisheries are more often spatially isolated within the basin, and yellow perch habitat remains more clearly partitioned by lake bathymetry. Also, there has been evidence of differing recruitment patterns within various parts of the basin. Finally, the Myers and Bence (2001) independent review of YPTG stock assessment efforts identified MU4 as a special case where stock definition seemed evident within the basin.

Currently, eastern basin yellow perch stock assessment is being examined as part of a thorough technical review being pursued by the Ontario Ministry of Natural Resources, **Eastern Lake Erie Technical Report – Draft, December 2004**. At present, this draft document supports the YPTG's ongoing practice of treating the east basin yellow perch resource as one unit, i.e. "MU4", for stock assessment purposes. Nevertheless, there remains enough evidence for sub-stocks within MU4 that yellow perch assessments in this area should pursue approaches capable of detecting, describing and managing discrete stocks.

Suggested New Charges for 2005-2006

1) Lambda review- In 2005-2006 the YPTG & STC will initiate a review of methods that can be used to generate data set weighting lambdas for catch-age analysis. The objective of the review is to identify, describe and apply the most scientifically defensible method of generating lambdas that influence population estimation.

2) Yellow Perch Management Plan – In 2005-2006, the LEC, the YPTG, and the STC will formulate, with stakeholder input, a yellow perch management plan that documents historic methods and outlines an appropriate exploitation strategy with measurable performance indicators.

Acknowledgments

The task group wishes to thank the following people for providing support to the task group during the past year:

- Tim Bader (Ohio Department of Natural Resources, Division of Wildlife),
- Mike Bur (US Geological Survey- Biological Resources Division),
- Bruce Morrison (Ontario Ministry of Natural Resources),
- Dr. Carol Stepien (University of Toldeo),
- Jeff Tyson (Ohio Department of Natural Resources, Division of Wildlife), and
- Larry Witzel (Ontario Ministry of Natural Resources)

The YPTG report could not be completed without the contributions of all Lake Erie staff from the Michigan Department of Natural Resources, Ohio Division of Wildlife, Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, US Geological Survey- Biological Resources Division, and the Ontario Ministry of Natural Resources. In addition, the YPTG expresses thanks to the Great Lakes Fishery Commission for their continued support.

Literature Cited

Helser, T.E., J.P. Geaghan and R.E. Condrey. 1998. Estimating gill net selectivity using nonlinear response surface regression. Can. J. Fish. Aquat. Sci. 55: 1328-1337.

Hilborn, R. and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment : Choice, Dynamics and Uncertainty. Routledge, Chapman and Hall, Inc. NY.

MacGregor, R.B. and L.D. Witzel. 1987. A twelve year study of the fish community in the Nanticoke Region of Long Point Bay, Lake Erie: 1971-1983 Summary Report. Lake Erie Fisheries Management Unit. Report 1987-3. 615 pp.

Myers, R.A. and J.R. Bence. 2001. The 2001 assessment of perch in Lake Erie; a review. Presented to the Lake Erie Committee, Great Lakes Fishery Commission.

Ontario Ministry of Natural Resources. 2004. Eastern Lake Erie Technical Report – Draft. Lake Erie Management Unit.

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

Reish, R.L., R.B. Deriso, D. Ruppert, and R.J. Carroll. 1985. An investigation into the population dynamics of Atlantic Menhaden (*Brevoortia tyrannus*). Can. J. Fish. Aquat. Sci. 42: 147-157.

Yellow Perch Task Group (YPTG). 2002. Report of the Yellow Perch Task Group to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission.

Yellow Perch Task Group (YPTG). 2004. Report of the Yellow Perch Task Group to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission.

Table 1.1. Lake Erie yellow perch harvest in pounds by management unit (Unit) and agency, 1994-2004.

		Ontario*		Ohio		Michigan		Pennsylvania		New York		Total
	Year	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch
Unit 1	1994	710,010	59	434,385	36	66,150	5	--	--	--	--	1,210,545
	1995	524,790	38	784,980	57	77,175	6	--	--	--	--	1,386,945
	1996	704,167	36	1,125,716	57	134,810	7	--	--	--	--	1,964,693
	1997	1,091,844	48	1,071,025	47	111,819	5	--	--	--	--	2,274,688
	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
Unit 2	1994	1,300,950	55	1,045,170	45	--	--	--	--	--	--	2,346,120
	1995	1,073,835	57	804,825	43	--	--	--	--	--	--	1,878,660
	1996	1,290,998	61	823,425	39	--	--	--	--	--	--	2,114,423
	1997	1,826,180	63	1,079,882	37	--	--	--	--	--	--	2,906,062
	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
Unit 3	1994	379,260	48	359,415	45	--	--	55,125	7	--	--	793,800
	1995	465,255	80	83,790	14	--	--	30,870	5	--	--	579,915
	1996	512,293	72	186,695	26	--	--	9,041	1	--	--	708,029
	1997	829,353	77	219,664	20	--	--	23,360	2	--	--	1,072,377
	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
Unit 4	1994	52,920	84	--	--	--	--	--	--	10,214	16	63,134
	1995	33,075	80	--	--	--	--	--	--	8,012	20	41,087
	1996	30,495	82	--	--	--	--	2,205	6	4,472	12	37,172
	1997	36,171	87	--	--	--	--	3,049	7	2,387	6	41,607
	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
Lakewide	1994	2,443,140	55	1,838,970	42	66,150	1	55,125	1	10,214	<1	4,413,599
Totals	1995	2,096,955	54	1,673,595	43	77,175	2	30,870	1	8,012	<1	3,886,607
	1996	2,537,953	53	2,135,836	44	134,810	3	11,246	<1	4,472	<1	4,824,317
	1997	3,783,548	60	2,370,571	38	111,819	2	26,409	<1	2,387	<1	6,294,734
	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

* processor weight

Table 1.2. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 1 (Western Basin) by agency and gear type, 1994-2004.

		Unit 1				
		Michigan	Ohio		Ontario Gill Nets	
	Year	Sport	Trap Nets	Sport	Small Mesh	Large Mesh
	1994	66,150	165,375	269,010	710,010	
Catch	1995	77,175	108,045	676,935	524,790	
(pounds)	1996	134,810	200,313	925,403	704,167	
	1997	111,819	211,876	859,149	1,091,844	
	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
	1994	30	75	122	322	
Catch	1995	35	49	307	238	
(Metric)	1996	61	91	420	319	
(tonnes)	1997	51	96	390	495	
	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
	1994	224,744	5,937	469,959	11,734	
Effort	1995	123,616	5,103	598,977	11,136	
(a)	1996	193,733	4,869	772,078	8,614	
	1997	192,605	5,580	834,934	13,704	
	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	686,937	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
	1994	1.1	12.6	2.2	27.4	--
Catch Rates	1995	2.8	9.6	4.3	21.4	--
(b)	1996	3.3	18.7	4.9	37.0	--
	1997	2.8	17.2	3.7	36.1	--
	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	149.1	21.5
	2002	2.5	56.4	3.4	135.7	58.2
	2003	2.4	51.3	3.5	140.1	32.4
	2004	1.6	30.1	3.0	122.7	30.8

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 1.3. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 2 (western Central Basin) by agency and gear type, 1994-2004.

		Unit 2			
		Ohio		Ontario Gill Nets	
	Year	Trap Nets	Sport	Small Mesh	Large Mesh
	1994	304,290	740,880	1,300,950	
Catch (pounds)	1995	257,985	546,840	1,073,835	
	1996	323,334	500,091	1,290,998	
	1997	498,945	580,937	1,826,180	
	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
	1994	138	336	590	
Catch (Metric) (tonnes)	1995	117	248	487	
	1996	147	227	585	
	1997	226	263	828	
	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
	1994	7,139	538,977	23,441	
Effort *(a)*	1995	6,467	388,238	18,337	
	1996	5,834	316,736	14,572	
	1997	8,721	575,365	24,974	
	1998	7,943	422,176	23,823	
	1999	7,502	563,819	13,179	
	2000	5,272	601,712	6,266	
	2001	4,747	581,118	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
	1994	19.3	3.3	25.2	--
Catch Rates *(b)*	1995	18.1	3.5	26.6	--
	1996	25.1	4.2	40.1	--
	1997	25.9	2.8	33.2	--
	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

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 1.4. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 3 (eastern Central Basin) by agency and gear type, 1994-2004.

		Unit 3						
		Ohio		Ontario Gill Nets		Pennsylvania		
	Year	Trap Nets	Sport	Small Mesh	Large Mesh	Gill Nets	Trap Nets	Sport
	1994	141,120	218,295	379,260		55,125		
Catch	1995	63,945	19,845	465,255		30,870		
(pounds)	1996	103,414	83,281	512,293		0	5,292	3,749
	1997	54,776	164,888	829,353		0	7,398	15,962
	1998	90,082	184,911	811,903		0	5,291	23,236
	1999	106,258	246,377	665,703		0	2,905	6,020
	2000	156,510	286,740	771,646		0	5,930	26,683
	2001	4,472	460,339	948,622	50,828	0	2,602	96,946
	2002	0	640,104	1,094,894	97,797	0	2,009	138,812
	2003	0	481,559	1,647,047	20,086	0	5,050	172,467
	2004	0	659,447	1,443,314	10,105	0	7,753	236,310
	1994	64	99	172		25		
Catch	1995	29	9	211		14		
(Metric)	1996	47	38	232		0	2.4	1.7
(tonnes)	1997	25	75	376		0	3.4	7.2
	1998	41	84	368		0	2.4	11
	1999	48	112	302		0	1.3	2.7
	2000	71	130	350		0	2.7	12
	2001	2.0	209	430	23	0	1.2	44
	2002	0	290	497	44	0	0.9	63
	2003	0	218	747	9.1	0	2.3	78
	2004	0	299	655	4.6	0	3.5	107
	1990	7,376	31,881	12,472		1,978		
	1991	4,516	54,607	12,247		2,018		
	1992	3,361	84,445	14,540		1,321		
	1993	2,610	96,619	10,017		620		
	1994	3,053	173,706	8,169		1,442		
Effort	1995	3,258	42,234	6,843		1,465		
(a)	1996	2,730	69,887	6,184		0	185	12,850
	1997	2,455	126,530	9,423		0	441	43,377
	1998	2,512	111,425	10,809		0	305	30,612
	1999	2,388	176,603	4,338		0	243	28,485
	2000	1,640	214,825	2,342		0	231	48,561
	2001	32	257,217	2,451	1,047	0	175	90,214
	2002	0	416,543	2,490	1,055	0	95	123,287
	2003	0	256,890	4,617	316	0	87	138,720
	2004	0	368,537	3,750	268	0	70	175,596
	1994	21.0	2.3	21.1	--	17.3	--	--
Catch Rates	1995	8.9	1.3	30.8	--	9.6	--	--
(b)	1996	17.2	2.8	37.5	--	--	13.0	0.8
	1997	10.1	3.1	39.9	--	--	7.6	0.9
	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

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 1.5. Catch, effort and catch per unit effort summaries for Lake Erie yellow perch fisheries in Management Unit 4 (Eastern Basin) by agency and gear type, 1994-2004.

		Unit 4					
		New York		Ontario Gill Nets		Pennsylvania	
	Year	Trap Nets	Sport	Small Mesh	Large Mesh	Trap Nets	Sport
	1994	4,410	5,804	52,920			
Catch	1995	3,122	4,890	33,075			
(pounds)	1996	2,822	1,650	30,495		0	2,205
	1997	1,241	1,146	36,171		0	3,049
	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
	1994	2.0	2.6	24.0			
Catch	1995	1.4	2.2	15.0			
(Metric)	1996	1.3	0.7	13.8		0	1.0
(tonnes)	1997	0.6	0.5	16.4		0	1.4
	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
	1994	555	14,800	1,642			
Effort	1995	532	12,115	1,375			
(a)	1996	533	6,535	1,063		0	7,292
	1997	292	8,905	1,073		0	13,747
	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	12,451
	2002	89	44,270	224	28	9	61,734
	2003	91	33,162	373	21	0	32,525
	2004	44	73,056	355	3.2	0	62,639
	1994	3.6	0.4	14.6			
Catch Rates	1995	2.7	0.8	10.9			
(b)	1996	2.4	0.5	13.0			0.6
	1997	1.9	0.4	15.3			1.0
	1998	3.4	0.7	20.3			0.3
	1999	2.7	0.8	31.1			0.4
	2000	6.4	0.2	51.5			1.7
	2001	0.3	1.8	121.5	26.0		1.5
	2002	9.9	1.3	174.0	25.0	1.5	2.4
	2003	5.2	0.9	102.9	2.9		1.9
	2004	40.3	1.4	126.1	2.4		1.7

(a) sport effort in angler-hours; gill net effort in km; trap net effort in lifts
(b) catch rates for sport in fish/hr, gill net in kg/km, trap net in kg/lift

Table 1.6. Lake Erie 2004 yellow perch harvest in numbers of fish by gear, age and management unit (Unit).

		Unit 1		**Unit 2**		**Unit 3**		**Unit 4**		**Lakewide**	
Gear	Age	Number	%	Number	%	Number	%	Number	%	Number	%
	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	55,948	1.0	193,366	2.9	14,705	0.4	2,826	1.2	266,845	1.6
	3	2,091,765	36.6	4,295,484	63.4	1,405,705	40.5	101,850	42.4	7,894,803	48.7
Gill Nets	4	1,367,106	23.9	1,008,873	14.9	318,167	9.2	35,697	14.9	2,729,844	16.8
	5	1,526,730	26.7	893,798	13.2	1,116,942	32.2	59,573	24.8	3,597,044	22.2
	6+	680,223	11.9	383,940	5.7	615,649	17.7	40,251	16.8	1,720,062	10.6
	Total	5,721,772		6,775,462		3,471,169		240,196		16,208,599	
	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2	19,768	2.0	0	0.0	0	0.0	0	0.0	19,768	0.4
	3	596,439	61.0	2,397,698	56.1	446	5.7	905	15.5	2,995,488	56.9
Trap Nets	4	119,581	12.2	290,024	6.8	5,655	71.7	975	16.7	416,235	7.9
	5	157,382	16.1	935,866	21.9	893	11.3	1,045	17.9	1,095,186	20.8
	6+	83,833	8.6	650,652	15.2	3,869	49.1	2,924	50.0	741,278	14.1
	Total	977,003		4,274,240		7,887		5,849		5,264,979	
	1	7,690	0.3	1,879	0.1	0	0.0	0	0.0	9,569	0.1
	2	76,209	2.6	19,711	0.8	4,061	0.2	1,295	1.5	101,276	1.3
	3	2,003,348	68.2	1,486,300	57.2	814,409	38.5	15,351	18.1	4,319,408	55.8
Sport	4	161,740	5.5	153,080	5.9	152,537	7.2	17,130	20.2	484,487	6.3
	5	397,231	13.5	425,021	16.3	358,274	16.9	15,022	17.7	1,195,548	15.5
	6+	291,987	9.9	513,573	19.8	786,079	37.2	35,843	42.3	1,627,482	21.0
	Total	2,938,205		2,599,564		2,115,361		84,641		7,737,771	
	1	7,690	0.1	1,879	0.0	0	0.0	0	0.0	9,569	0.0
	2	151,925	1.6	213,077	1.6	18,766	0.3	4,121	1.2	387,889	1.3
	3	4,691,552	48.7	8,179,482	59.9	2,220,561	39.7	118,106	35.7	15,209,700	52.1
All Gear	4	1,648,427	17.1	1,451,977	10.6	476,360	8.5	53,802	16.3	3,630,566	12.4
	5	2,081,343	21.6	2,254,685	16.5	1,476,109	26.4	75,640	22.9	5,887,777	20.2
	6+	1,056,043	11.0	1,548,165	11.3	1,405,597	25.1	79,018	23.9	4,088,823	14.0
	Total	9,629,290		13,649,266		5,597,393		330,686		29,214,325	

Table 1.7. Yellow perch stock size (millions of fish) in each Lake Erie management unit. The years 1994 to 2004 are estimated by ADMB catch-age analysis. The 2005 population estimates use age 2 values derived from regressions of ADMB age 2 abundance against YOY and yearling trawl indices.

	Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Unit 1	2	8.874	21.605	24.433	20.392	39.859	10.663	33.032	35.086	8.106	52.741	6.503	77.997
	3	1.831	5.444	13.309	14.668	12.804	24.734	6.845	21.132	22.724	5.240	33.639	4.216
	4	1.919	0.825	2.471	5.845	7.048	6.484	13.651	3.787	12.622	12.131	2.998	17.520
	5	0.301	0.513	0.232	0.669	1.855	2.497	2.882	6.630	2.062	5.289	5.734	1.300
	6+	0.033	0.086	0.178	0.106	0.173	0.448	1.085	1.731	4.358	2.349	3.351	3.320
	2 and Older	12.958	28.473	40.622	41.680	61.738	44.826	57.495	68.366	49.872	77.750	52.226	104.353
	3 and Older	4.084	6.868	16.190	21.289	21.879	34.163	24.463	33.280	41.766	25.010	45.723	26.356
Unit 2	2	12.385	12.922	27.357	17.864	58.866	14.215	50.005	39.279	8.956	66.138	3.907	90.475
	3	3.078	7.028	7.224	13.098	9.159	30.728	8.741	29.893	22.914	5.501	37.898	2.442
	4	2.879	0.933	2.139	2.218	3.423	3.292	15.729	4.465	15.459	10.335	2.416	14.980
	5	0.481	0.665	0.205	0.509	0.404	0.793	1.603	7.407	2.166	6.075	3.704	0.768
	6+	0.080	0.129	0.176	0.091	0.069	0.076	0.352	0.889	4.023	2.420	3.088	2.001
	2 and Older	18.902	21.677	37.101	33.780	71.921	49.105	76.430	81.933	53.518	90.470	51.013	110.666
	3 and Older	6.518	8.755	9.744	15.916	13.055	34.890	26.425	42.655	44.562	24.332	47.106	20.191
Unit 3	2	5.818	6.421	11.958	8.660	32.933	10.346	37.077	21.580	4.419	23.640	1.271	31.772
	3	1.411	3.374	3.952	7.564	5.374	21.205	6.671	23.762	13.672	2.801	15.109	0.815
	4	0.967	0.753	1.969	2.292	3.947	3.177	13.429	4.159	14.850	8.329	1.676	8.620
	5	0.419	0.336	0.381	0.986	1.086	2.137	1.963	7.970	2.527	8.587	4.614	0.877
	6+	0.201	0.238	0.296	0.334	0.565	0.813	1.770	2.183	6.107	5.017	7.541	6.300
	2 and Older	8.816	11.122	18.557	19.836	43.904	37.679	60.910	59.653	41.575	48.373	30.210	48.385
	3 and Older	2.998	4.701	6.598	11.176	10.971	27.333	23.833	38.073	37.156	24.734	28.939	16.613
Unit 4	2	0.121	0.998	0.632	0.271	3.314	1.142	10.031	2.070	1.584	7.683	0.477	3.575
	3	0.167	0.077	0.656	0.415	0.178	2.219	0.755	6.685	1.387	1.061	5.130	0.315
	4	0.028	0.076	0.044	0.374	0.231	0.116	1.388	0.495	4.457	0.913	0.690	3.255
	5	0.045	0.009	0.037	0.021	0.175	0.144	0.071	0.892	0.328	2.859	0.575	0.422
	6+	0.081	0.037	0.021	0.026	0.022	0.114	0.150	0.140	0.679	0.611	2.106	1.542
	2 and Older	0.442	1.198	1.390	1.108	3.919	3.735	12.395	10.281	8.436	13.128	8.977	9.108
	3 and Older	0.321	0.200	0.758	0.836	0.605	2.593	2.364	8.212	6.852	5.445	8.500	5.533

Table 1.8. Projection of the 2005 Lake Erie yellow perch population. Stock size estimates are derived from ADMB and age 2 estimates for 2005 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.

		2004 Parameters				Rate Functions					2005 Parameters				Stock Biomass			
		Stock Size (numbers)				Mortality Rates				Survival Rate		Stock Size (numbers)			Mean Weight in	millions kg		millions lbs.
	Age	**Mean**	**Std. Err.**	**Min.**	**Max.**	**(F)**	**(Z)**	**(A)**	**(u)**	**(S)**	**Age**	**Mean**	**Min.**	**Max.**	Pop. (kg)	**2004**	**2005**	**2005**
Unit 1	2	6.503	3.843	2.660	10.346	0.033	0.433	0.352	0.027	0.648	2	77.997	55.128	100.866	0.066	0.410	5.148	11.351
	3	33.639	14.534	19.105	48.173	0.252	0.652	0.479	0.185	0.521	3	4.216	1.725	6.708	0.090	3.128	0.379	0.837
	4	2.998	1.119	1.879	4.117	0.435	0.835	0.566	0.295	0.434	4	17.520	9.950	25.089	0.114	0.318	1.997	4.404
	5	5.734	2.186	3.548	7.920	0.553	0.953	0.615	0.357	0.385	5	1.300	0.815	1.785	0.158	0.906	0.205	0.453
	6+	3.351	1.372	1.979	4.723	0.706	1.106	0.669	0.427	0.331	6+	3.320	2.023	4.616	0.222	0.724	0.737	1.625
	Total	52.226	23.054	29.172	75.280	0.284	0.684	0.495	0.206	0.505	Total	104.353	69.641	139.064	0.081	5.486	8.467	18.669
	(3+)	45.723	19.211	26.512	64.934	0.325	0.725	0.516	0.231	0.484	(3+)	26.356	14.513	38.199	0.126	5.076	3.319	7.319
Unit 2	2	3.907	2.201	1.706	6.108	0.070	0.470	0.375	0.056	0.625	2	90.475	65.846	115.103	0.086	0.293	7.807	17.214
	3	37.898	15.276	22.622	53.174	0.528	0.928	0.605	0.344	0.395	3	2.442	1.067	3.818	0.133	4.965	0.325	0.717
	4	2.416	0.863	1.553	3.279	0.746	1.146	0.682	0.444	0.318	4	14.980	8.942	21.019	0.218	0.457	3.261	7.189
	5	3.704	1.340	2.364	5.044	0.831	1.231	0.708	0.478	0.292	5	0.768	0.494	1.042	0.290	1.033	0.223	0.492
	6+	3.088	1.123	1.965	4.211	0.812	1.212	0.702	0.471	0.298	6+	2.001	1.275	2.726	0.314	0.957	0.628	1.384
	Total	51.013	20.803	30.210	71.816	0.527	0.927	0.604	0.343	0.396	Total	110.666	77.623	143.708	0.111	7.705	12.243	26.996
	(3+)	47.106	18.602	28.504	65.708	0.576	0.976	0.623	0.368	0.377	(3+)	20.191	11.777	28.605	0.220	7.412	4.437	9.783
Unit 3	2	1.271	0.735	0.536	2.006	0.044	0.444	0.358	0.035	0.642	2	31.772	22.133	41.411	0.076	0.093	2.425	5.346
	3	15.109	6.480	8.629	21.589	0.161	0.561	0.429	0.123	0.571	3	0.815	0.344	1.287	0.135	1.889	0.110	0.243
	4	1.676	0.635	1.041	2.311	0.247	0.647	0.476	0.182	0.524	4	8.620	4.923	12.318	0.201	0.302	1.730	3.814
	5	4.614	1.686	2.928	6.300	0.267	0.667	0.487	0.195	0.513	5	0.877	0.545	1.210	0.280	1.283	0.246	0.542
	6+	7.541	2.598	4.943	10.139	0.251	0.651	0.479	0.185	0.521	6+	6.300	4.080	8.520	0.339	2.715	2.133	4.703
	Total	30.210		18.076	42.344	0.198	0.598	0.450	0.149	0.550	Total	48.385	32.025	64.745	0.137	6.280	6.644	14.649
	(3+)	28.939		17.540	40.338	0.205	0.605	0.454	0.154	0.546	(3+)	16.613	9.892	23.334	0.254	6.188	4.219	9.303
Unit 4	2	0.477	0.376	0.101	0.853	0.015	0.415	0.340	0.012	0.660	2	3.575	2.040	5.110	0.083	0.046	0.296	0.654
	3	5.130	3.294	1.836	8.424	0.055	0.455	0.366	0.044	0.634	3	0.315	0.067	0.563	0.158	0.780	0.050	0.109
	4	0.690	0.407	0.283	1.097	0.091	0.491	0.388	0.072	0.612	4	3.255	1.165	5.345	0.220	0.151	0.717	1.580
	5	0.575	0.329	0.246	0.904	0.165	0.565	0.432	0.126	0.568	5	0.422	0.173	0.671	0.263	0.145	0.111	0.245
	6+	2.106	1.193	0.913	3.299	0.150	0.550	0.423	0.115	0.577	6+	1.542	0.666	2.417	0.330	0.691	0.508	1.120
	Total	8.977		3.378	14.576	0.084	0.484	0.384	0.067	0.616	Total	9.108	4.111	14.106	0.185	1.813	1.682	3.709
	(3+)	8.500		3.277	13.723	0.088	0.488	0.386	0.070	0.614	(3+)	5.533	2.071	8.996	0.250	1.766	1.385	3.055

Table 2.1.1. Management Unit 1 yellow perch biological references from simulations and projected population size in 2006 for a range of fishing rates. Biological reference points include mean spawner biomass as a fraction of an unfished population, mean survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993-4 for ages 2+ (12.9 million) and 3+ (4.1 million). The harvest strategy applied in the "Harvest 2005" column, is based on the S/R F0.1 stock recruitment simulation from the 2004 YPTG report (using ADMB abundance estimates from 1975-2003). Refer to Table 2.2.1 for summary of F0.1 fishing rates and 2005 recommended harvest by management unit.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest (lbs x 10^6) 2005	Population 2+ (millions) 2006	Population 3+ (millions) 2006	Harvest Strategy Reference
100	67%	67%	0	0	0.000	0.000	71.6	69.9	
86	64%	63%	0	0	0.100	0.604	70.0	68.4	
75	62%	59%	0	0	0.200	1.177	68.5	66.8	
70	61%	58%	0	0	0.250	1.452	67.8	66.1	
66	60%	56%	0.1	0	0.300	1.720	67.1	65.4	
62	59%	55%	0.3	0	0.350	1.980	66.4	64.7	
59	58%	53%	0.4	0	0.400	2.235	65.7	64.0	
56	57%	52%	0.4	0	0.450	2.482	65.0	63.4	
54	56%	50%	0.5	0	0.500	2.724	64.4	62.8	
51	56%	49%	0.6	0	0.550	2.959	63.8	62.1	
49	55%	48%	0.7	0	0.600	3.188	63.2	61.5	
47	54%	47%	1.0	0.2	0.650	3.412	62.6	60.9	
45	53%	46%	1.5	0.3	0.700	3.631	62.0	60.3	
44	**53%**	**45%**	**1.6**	**0.3**	**0.720**	**3.716**	**61.8**	60.1	**F0.1 SR**
43	53%	44%	1.7	0.3	0.750	3.844	61.4	59.8	
42	52%	43%	2.0	0.4	0.800	4.052	60.9	59.2	
40	52%	42%	2.4	0.5	0.850	4.255	60.3	58.7	
39	51%	41%	2.8	0.6	0.900	4.453	59.8	58.1	
37	51%	41%	3.0	0.9	0.950	4.646	59.3	57.6	
36	50%	40%	3.2	1.1	1.000	4.835	58.8	57.1	
32	48%	36%	6.4	2.7	1.200	5.549	56.8	55.2	
29	47%	33%	9.8	5.1	1.400	6.202	55.1	53.4	
26	45%	31%	13.0	9.3	1.600	6.802	53.4	51.8	
24	44%	28%	16.7	14.1	1.800	7.354	51.9	50.3	
22	42%	26%	20.0	19.3	2.000	7.865	50.5	48.9	

Parameters in Computations

Age	s(age)	Weight (kg)
2	0.085	0.104
3	0.388	0.124
4	0.702	0.142
5	0.764	0.172
6	0.851	0.215

2005 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	77.997	55.128	100.866
3	4.216	1.725	6.708
4	17.520	9.950	25.089
5	1.300	0.815	1.785
6+	3.320	2.023	4.616
(2+)	104.353	69.641	139.064
(3+)	26.356	14.513	38.199

2006 Recruitment Millions Age 2s
1.655

Table 2.1.2. Management Unit 2 yellow perch biological references from simulations and projected population size in 2006 for a range of fishing rates. Biological reference points include mean spawner biomass as a fraction of an unfished population, mean survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993-4 for ages 2+ (17.8 million) and 3+ (7.0 million). The harvest strategy applied in the "Harvest 2005" column, is based on the S/R F0.1 stock recruitment simulation from the 2004 YPTG report (using ADMB abundance estimates from 1975-2003). Refer to Table 2.2.1 for summary of F0.1 fishing rates and 2005 recommended harvest by management unit.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest (lbs x 10^6) 2005	Population 2+ (millions) 2006	Population 3+ (millions) 2006	Harvest Strategy Reference
100	67%	67%	0	0	0.000	0.000	76.4	74.2	
90	64%	63%	0.1	0	0.100	0.761	74.5	72.3	
82	61%	59%	0.5	0	0.200	1.483	72.7	70.5	
78	60%	57%	0.8	0	0.250	1.830	71.8	69.6	
75	58%	55%	0.9	0.1	0.300	2.169	71.0	68.8	
72	57%	54%	1.7	0.1	0.350	2.500	70.1	67.9	
69	56%	52%	2.1	0.3	0.400	2.823	69.3	67.1	
67	55%	51%	2.7	0.5	0.450	3.138	68.5	66.4	
64	54%	49%	3.6	0.9	0.500	3.445	67.8	65.6	
62	53%	48%	4.2	1.2	0.550	3.745	67.0	64.8	
60	52%	46%	5.6	2.1	0.600	4.039	66.3	64.1	
58	52%	45%	7.2	3.2	0.650	4.325	65.6	63.4	
58	**51%**	**45%**	**7.4**	**3.4**	**0.661**	**4.387**	**65.4**	**63.2**	**F0.1 SR**
56	51%	44%	8.1	4.2	0.700	4.605	64.9	62.7	
55	50%	43%	8.7	4.9	0.750	4.879	64.2	62.0	
53	49%	42%	10.5	7.0	0.800	5.147	63.5	61.3	
52	49%	41%	12.3	9.2	0.850	5.409	62.8	60.7	
50	48%	40%	13.9	11.4	0.900	5.665	62.2	60.0	
49	47%	39%	15.6	13.2	0.950	5.916	61.6	59.4	
48	47%	38%	16.1	14.9	1.000	6.161	60.9	58.8	
43	44%	34%	20.3	23.2	1.200	7.094	58.6	56.4	
39	42%	31%	28.1	35.3	1.400	7.956	56.4	54.2	
36	40%	28%	34.2	47.4	1.600	8.754	54.4	52.2	
32	38%	26%	41.6	59.6	1.800	9.497	52.5	50.3	
30	36%	23%	47.2	69.8	2.000	10.192	50.7	48.5	

Parameters in Computations

Age	s(age)	Weight (kg)
2	0.141	0.124
3	0.586	0.147
4	0.834	0.161
5	0.865	0.183
6	0.819	0.227

2005 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	90.475	65.846	115.103
3	2.442	1.067	3.818
4	14.980	8.942	21.019
5	0.768	0.494	1.042
6+	2.001	1.275	2.726
(2+)	110.666	77.623	143.708
(3+)	20.191	11.777	28.605

2006 Recruitment Millions Age 2s
2.192

Table 2.1.3. Management Unit 3 yellow perch biological references from simulations and projected population size in 2006 for a range of fishing rates. Biological reference points include mean spawner biomass as a fraction of an unfished population, mean survival of age 2+ and 3+ fish, and the probability of attaining low population levels observed in 1993-4 for ages 2+ (6.9 million) and 3+ (2.9 million). The harvest strategy applied in the "Harvest 2005" column, is based on the S/R F0.1 stock recruitment simulation from the 2004 YPTG report (using ADMB abundance estimates from 1975-2003). Refer to Table 2.2.1 for summary of F0.1 fishing rates and 2005 recommended harvest by management unit.

Simulation					Projections at Different Fishing Rates				
% Spawner Biomass (of Unfished)	Survival 2+	Survival 3+	Prob %. 1993 2+	Prob. % 1994 3+	F	Harvest (lbs x 10^6) 2005	Population 2+ (millions) 2006	Population 3+ (millions) 2006	Harvest Strategy Reference
100	67%	67%	0	0	0.000	0.000	34.6	32.4	
89	64%	63%	0	0	0.100	0.568	33.5	31.3	
79	61%	59%	0	0	0.200	1.102	32.5	30.3	
75	59%	57%	0	0	0.250	1.357	32.0	29.8	
72	58%	55%	0	0	0.300	1.603	31.5	29.3	
69	57%	53%	0.1	0	0.350	1.843	31.0	28.8	
66	55%	52%	0.2	0	0.400	2.075	30.5	28.4	
63	54%	50%	0.7	0	0.450	2.300	30.1	27.9	
60	53%	48%	0.9	0.1	0.500	2.518	29.7	27.5	
58	52%	47%	1.7	0.1	0.550	2.730	29.2	27.1	
56	51%	46%	2.7	0.6	0.600	2.936	28.8	26.7	
54	50%	44%	3.1	0.9	0.650	3.135	28.4	26.3	
52	49%	43%	3.5	1.8	0.700	3.329	28.1	25.9	
52	**49%**	**43%**	**3.7**	**1.8**	**0.703**	**3.340**	**28.0**	**25.9**	**F0.1 SR**
50	49%	42%	4.9	2.7	0.750	3.517	27.7	25.5	
48	48%	41%	6.7	3.3	0.800	3.700	27.3	25.1	
47	47%	40%	7.7	5.7	0.850	3.878	27.0	24.8	
45	46%	38%	9.5	7.4	0.900	4.050	26.6	24.4	
44	46%	37%	11.8	10.1	0.950	4.218	26.3	24.1	
43	45%	36%	14.2	13.1	1.000	4.381	26.0	23.8	
38	42%	33%	21.7	27.0	1.200	4.990	24.7	22.6	
34	40%	29%	31.3	45.8	1.400	5.536	23.6	21.5	
31	38%	27%	43.8	63.4	1.600	6.027	22.6	20.5	
28	36%	24%	52.1	78.0	1.800	6.472	21.7	19.5	
26	34%	22%	61.3	88.4	2.000	6.875	3.5	20.9	

Parameters in Computations

Age	s(age)	Weight (kg)
2	0.134	0.120
3	0.432	0.147
4	0.795	0.179
5	0.823	0.222
6	0.789	0.258

2005 Stock Size (numbers x 10^6)

Age	Mean	Min.	Max.
2	31.772	22.133	41.411
3	0.815	0.344	1.287
4	8.620	4.923	12.318
5	0.877	0.545	1.210
6+	6.300	4.080	8.520
(2+)	48.385	32.025	64.745
(3+)	16.613	9.892	23.334

2006 Recruitment

Millions Age 2s
2.177

Table 2.2.1. Lake Erie yellow perch fishing rate and proposed Total Allowable Catch (TAC; in millions of pounds) in 2005 according to harvest strategies presented. The S/R F0.1 strategy is based on the stock recruitment simulation model produced in 2004 (using ADMB abundance estimates from 1975-2003). An adaptive approach has been applied to MU 4 based on the improved status of yellow perch in eastern Lake Erie, with an increased allowable catch of 50% from 2004.

MU	Fishing Rate	Harvest (millions lbs)	Yield Methods
1	0.720	3.716	$F_{0.1\ S/R}$
2	0.661	4.387	$F_{0.1\ S/R}$
3	0.703	3.340	$F_{0.1\ S/R}$
4	0.230*	0.309	**Special Interim Strategy** 50% Increase from 2004 TAC
Total		11.752	

* Note: F=0.230 is the targeted fishing rate that produces a TAC of 309,000 lbs in 2005.
This represents a 50% increase from the 2004 TAC in MU 4

Lake Erie Yellow Perch Management Units (MUs)

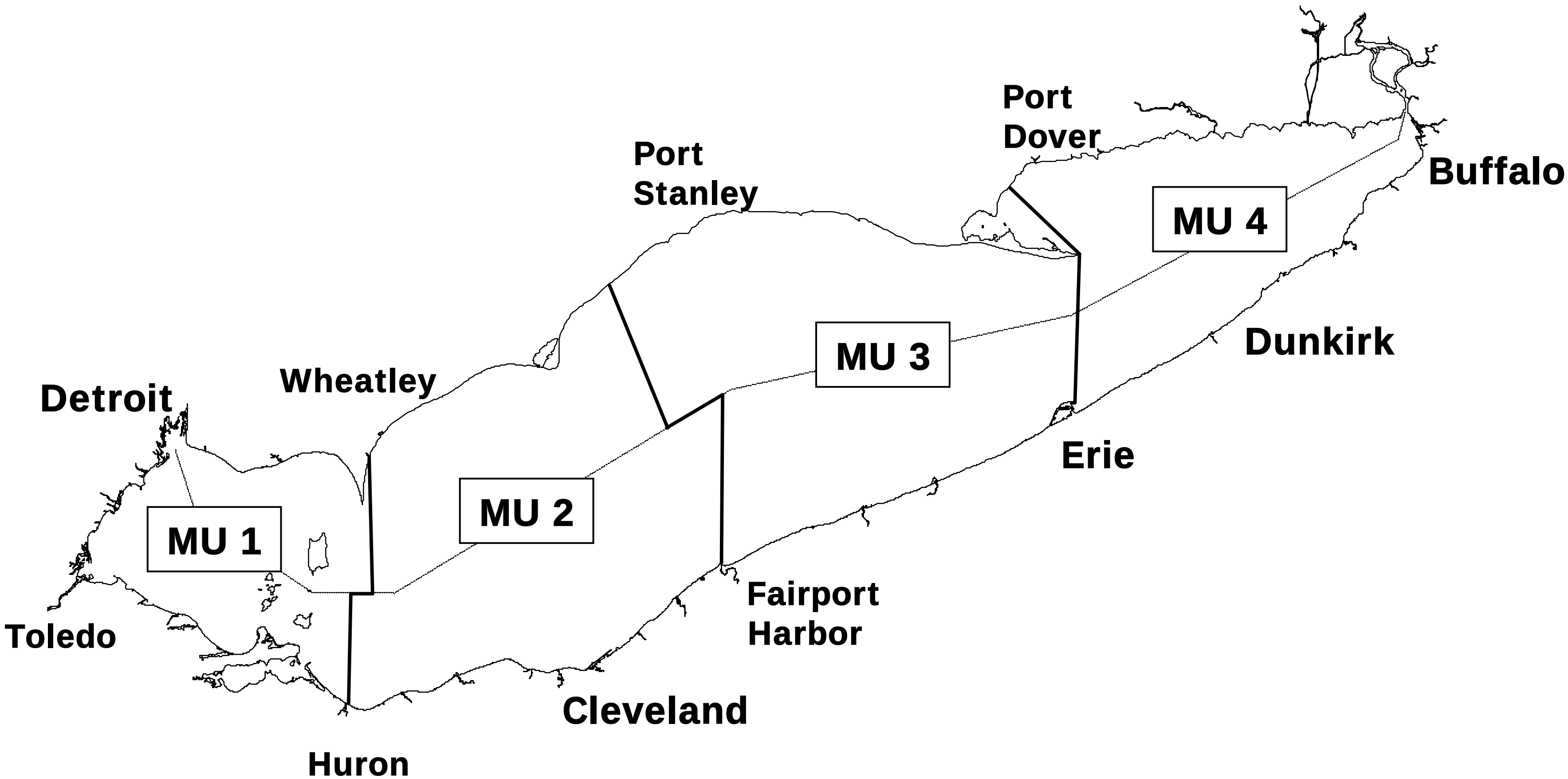


Figure 1.1. Yellow Perch management units (MUs) of Lake Erie; for illustrative purposes only; not to be used for quota determination or border delineation.

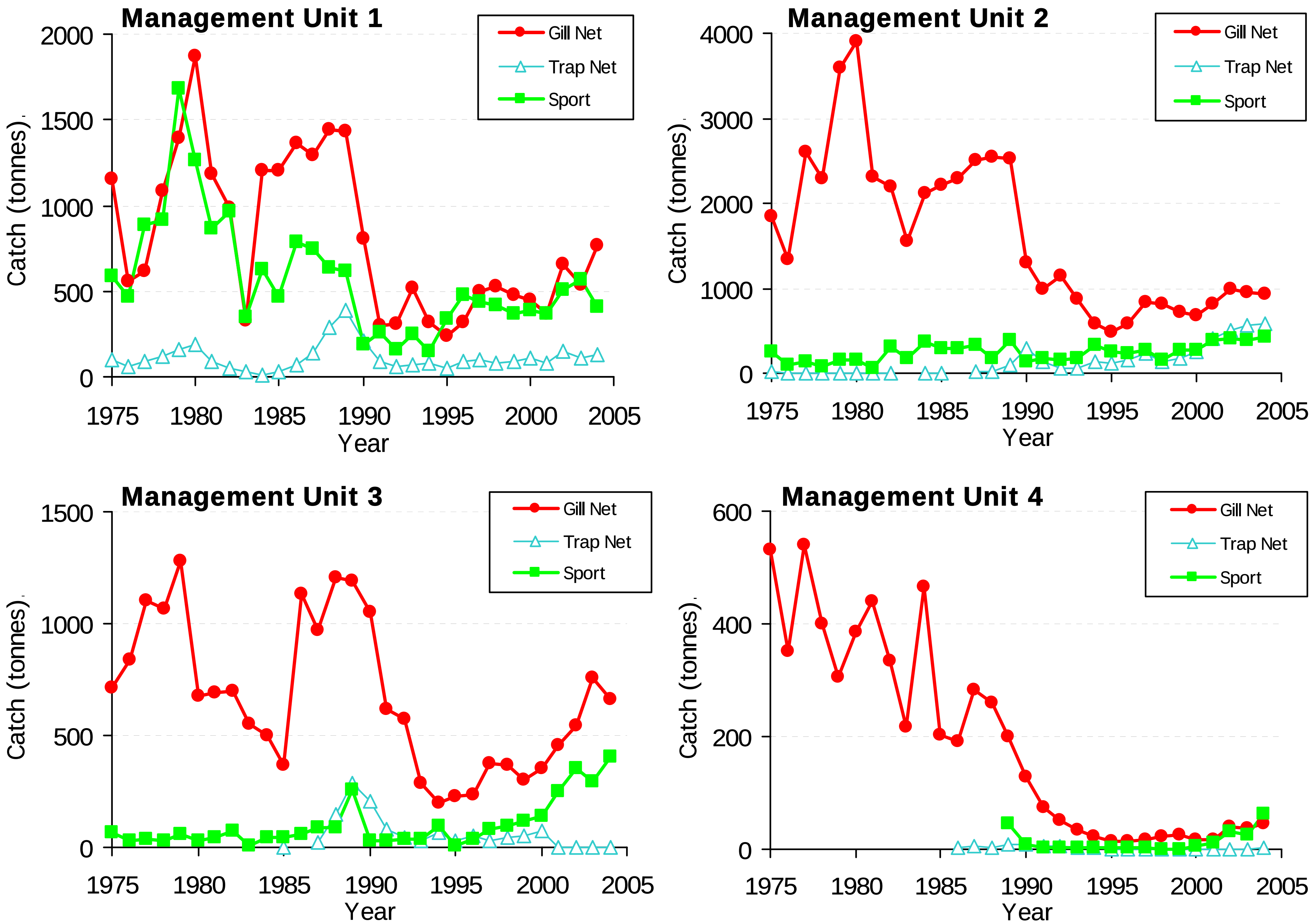


Figure 1.2. Lake Erie yellow perch harvest by management unit and gear type.

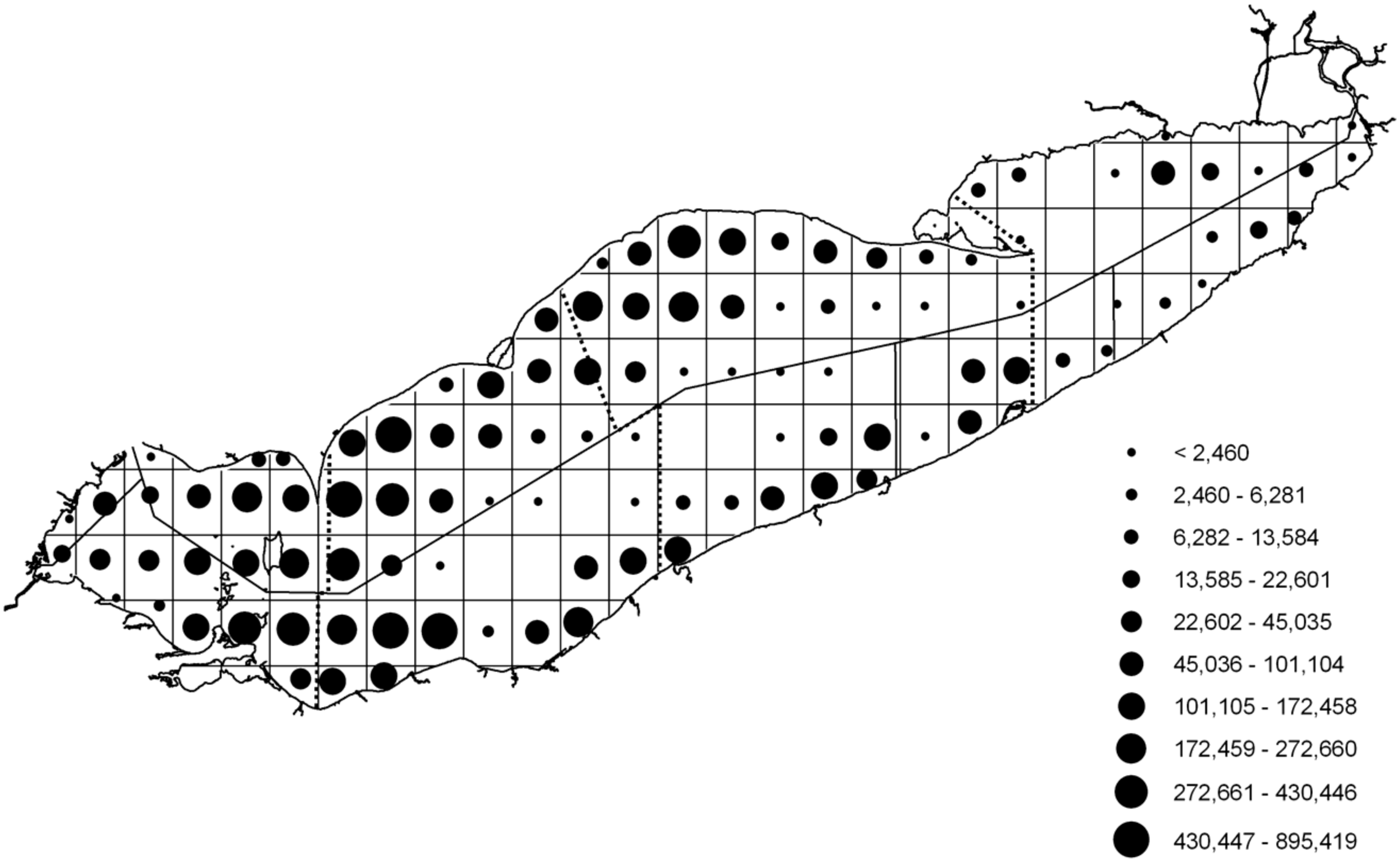


Figure 1.3. Spatial distribution of yellow perch total harvest (lbs.) in 2004 by 10-minute grid.

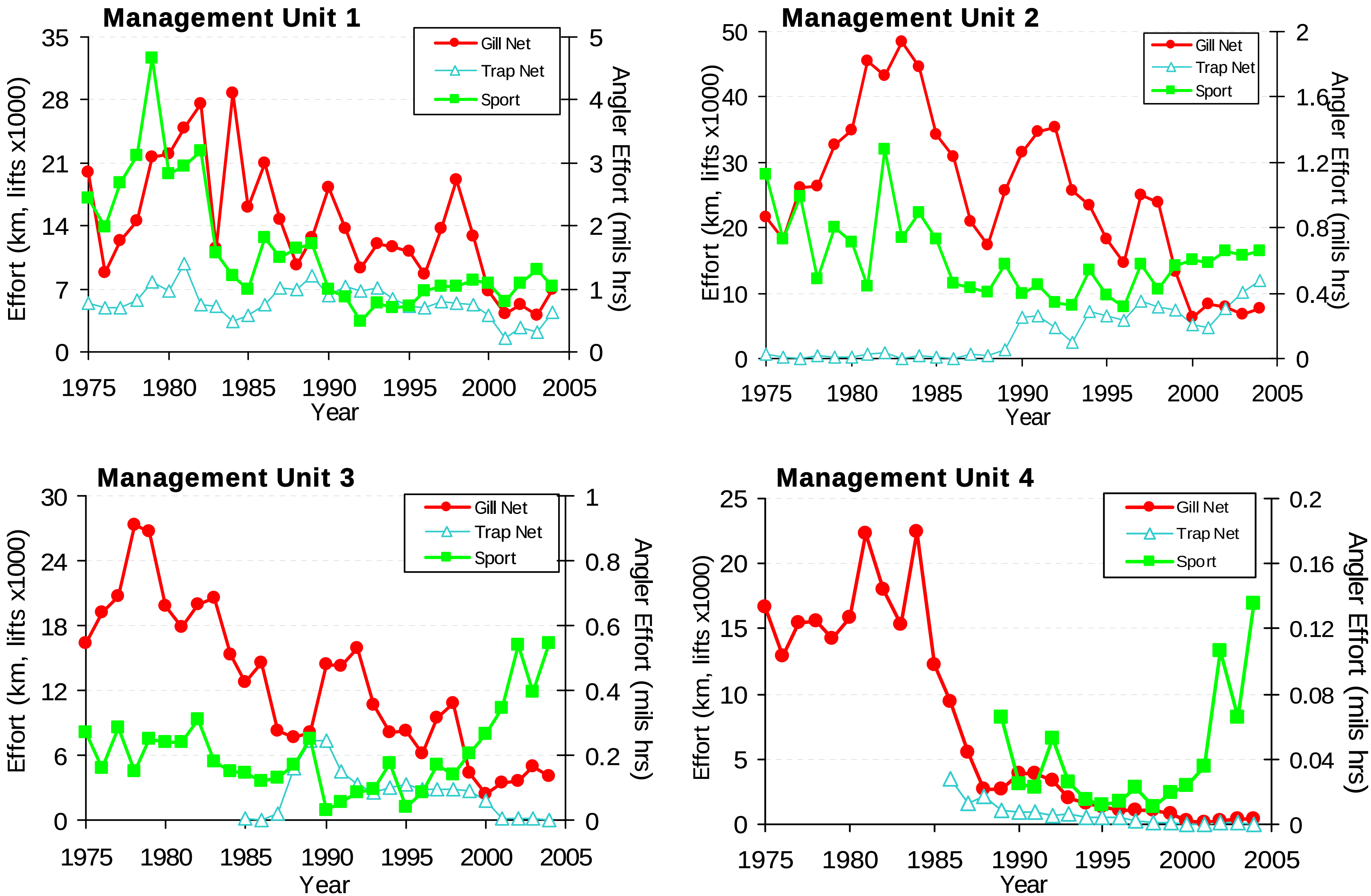


Figure 1.4. Lake Erie yellow perch effort by management unit and gear type. Note: 2001-2004 gill net effort presented contains both small and large mesh.

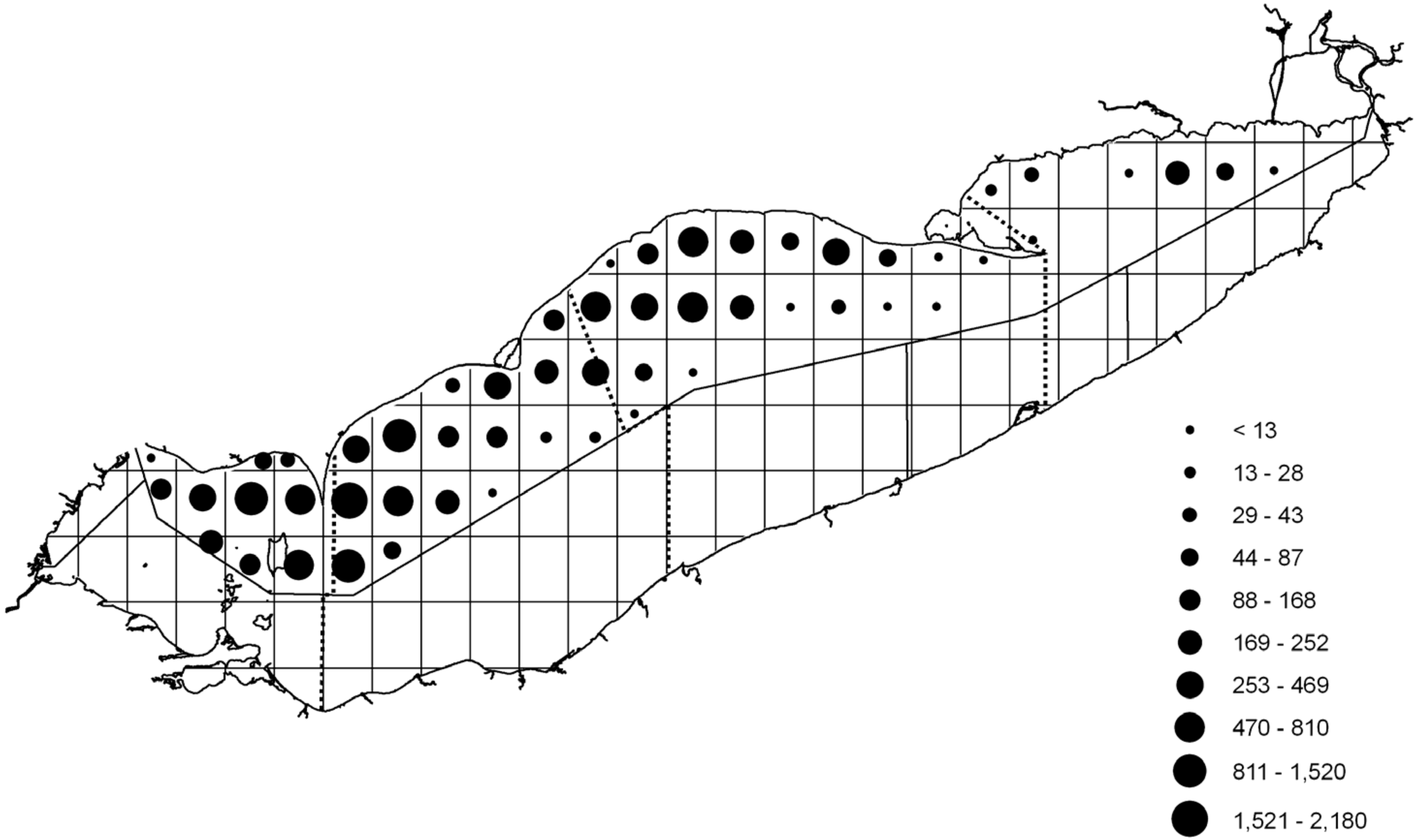


Figure 1.5. Spatial distribution of yellow perch gill net effort (km) in 2004 by 10-minute grid.

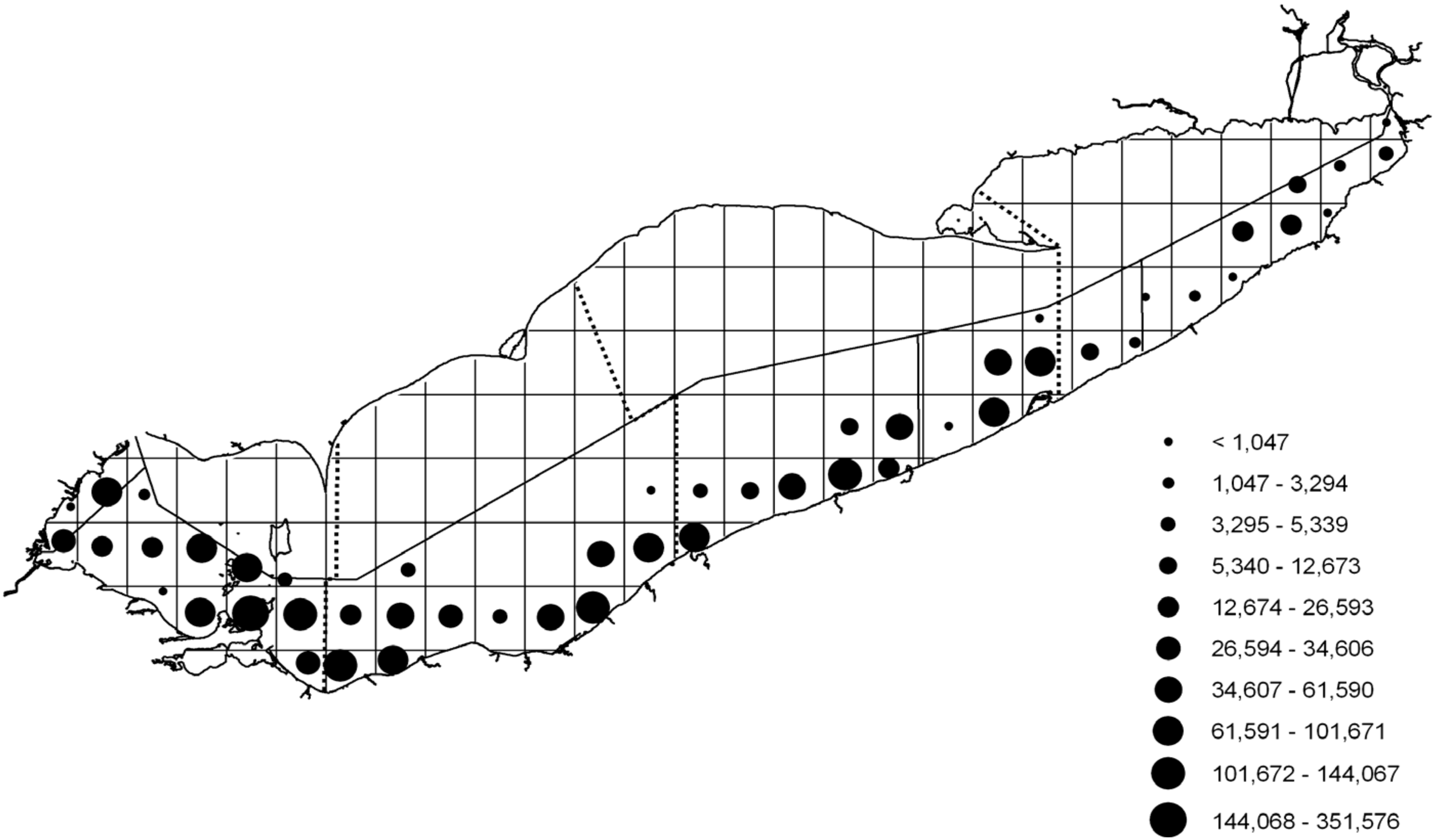


Figure 1.6. Spatial distribution of yellow perch sport angling effort (angler hours) in 2004 by 10-minute grid.

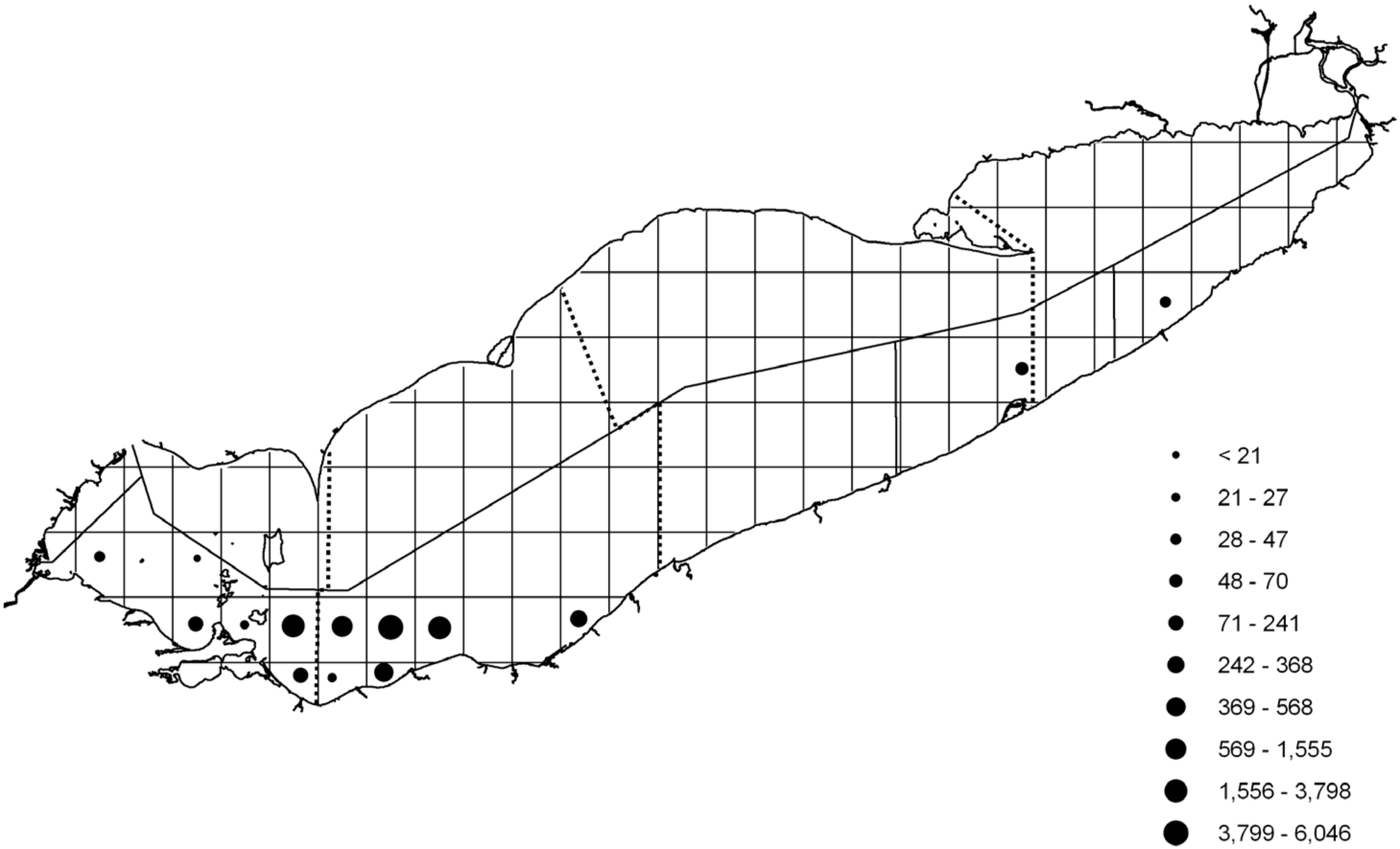


Figure 1.7. Spatial distribution of yellow perch trap net effort (lifts) in 2004 by 10-minute grid.

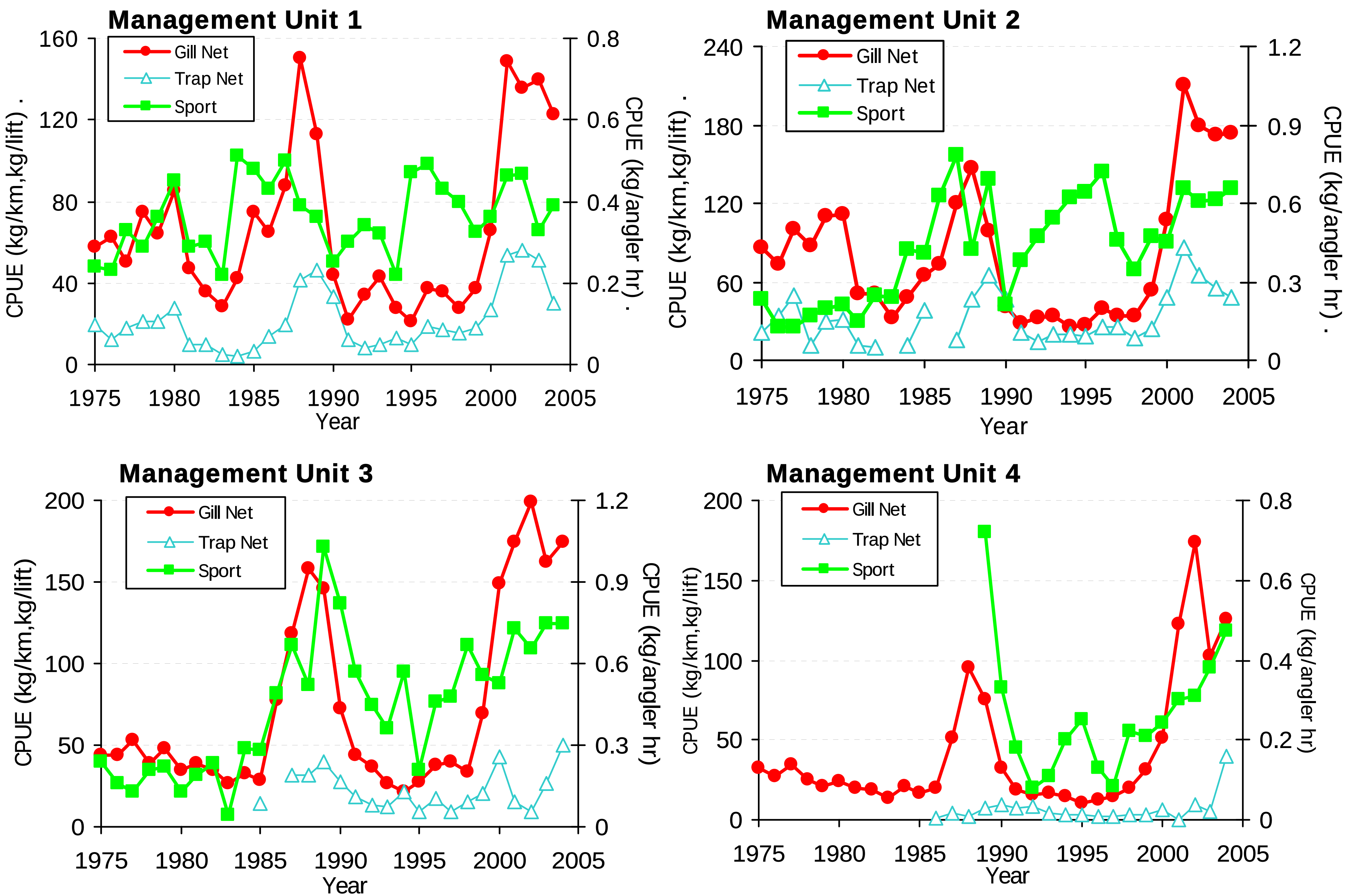


Figure 1.8. Lake Erie yellow perch catch per unit effort (CPUE) by management unit and gear type. Note: 2001 to 2004 gill net CPUE is for small mesh only.

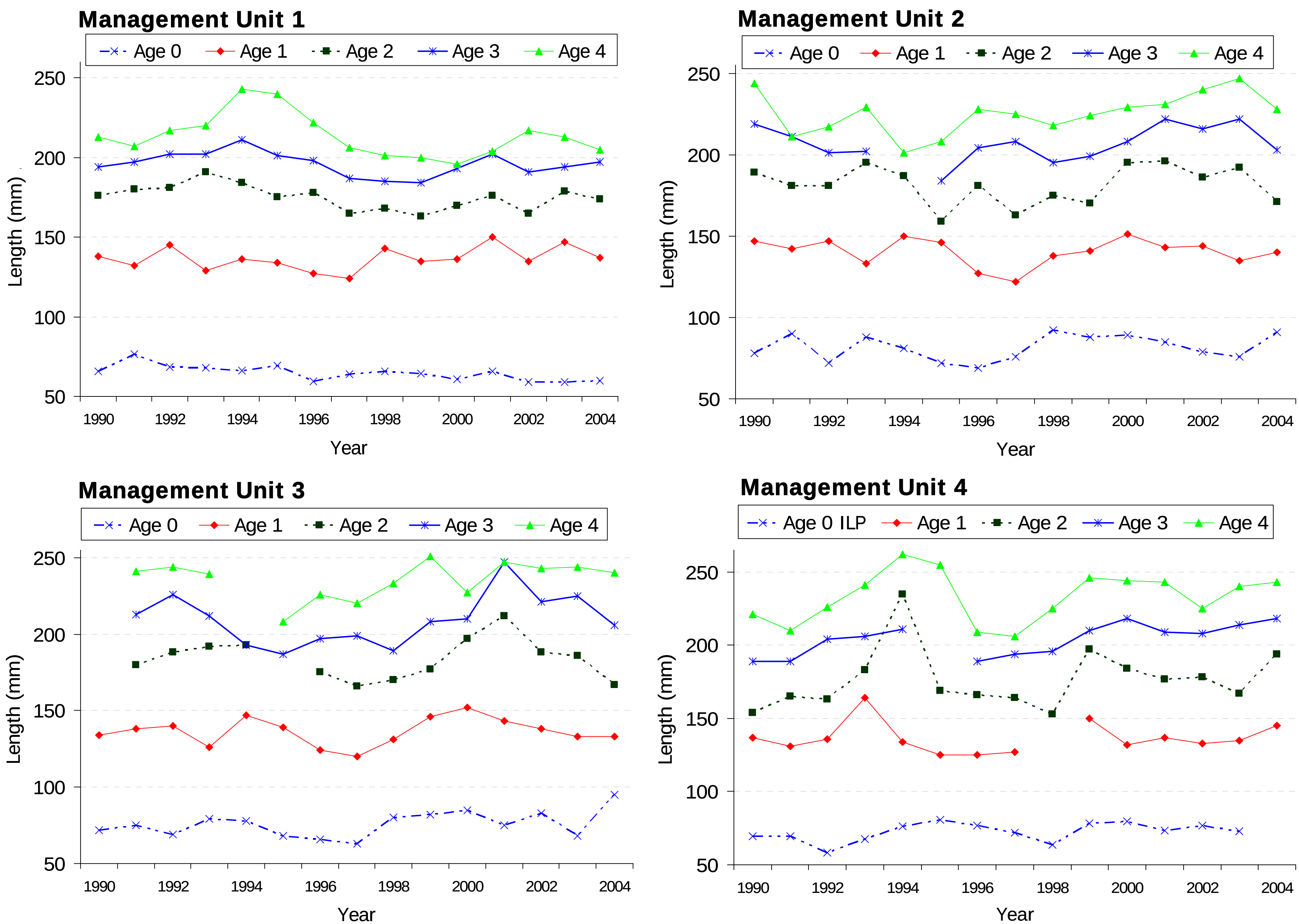


Figure 1.9. Yellow perch length-at-age from 1990-2004 fall interagency experimental samples for ages 0-4 by management unit.

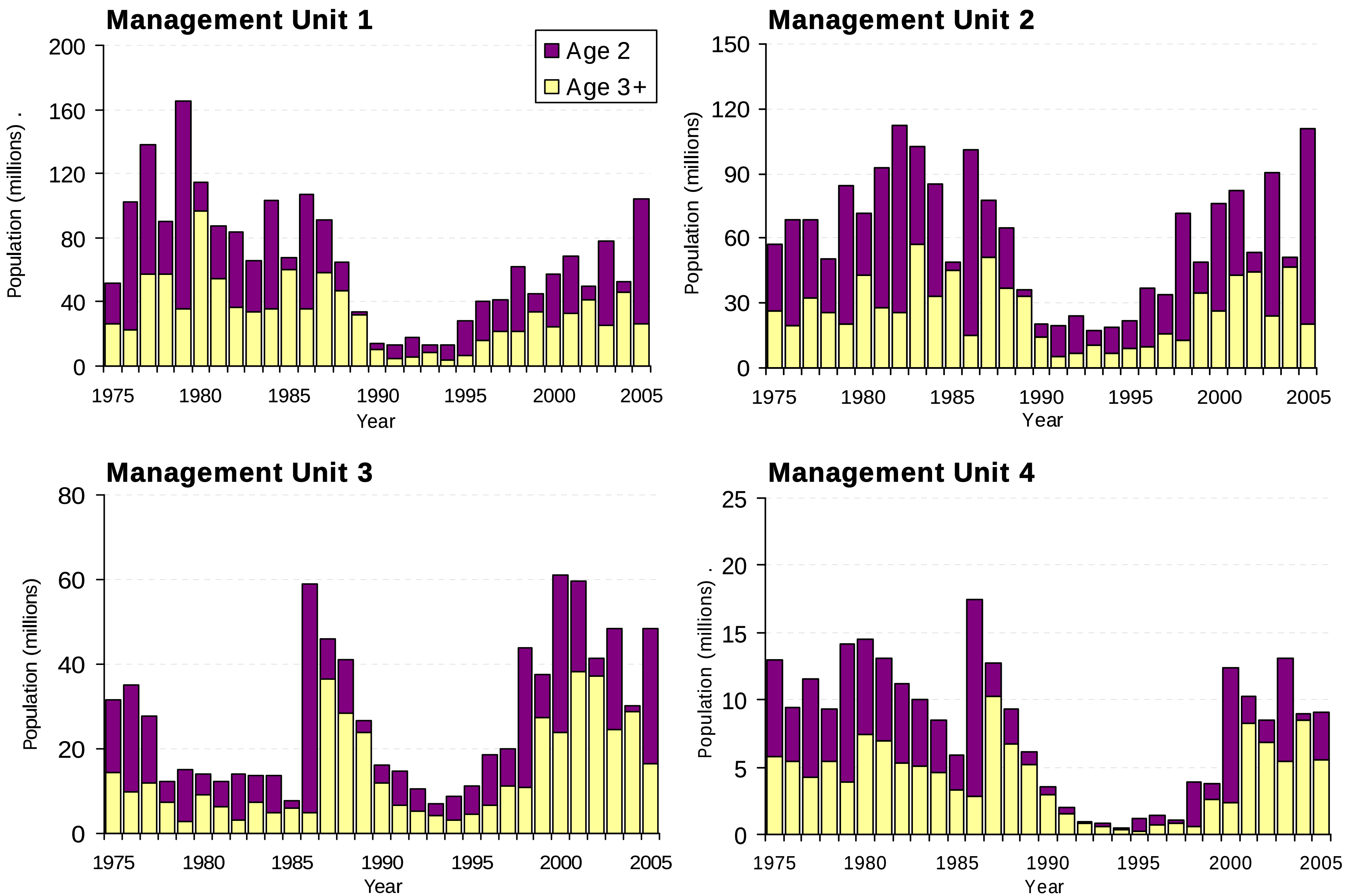


Figure 1.10. Lake Erie yellow perch population estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2005 are from ADMB and parametric regressions for age 2 from survey gears.

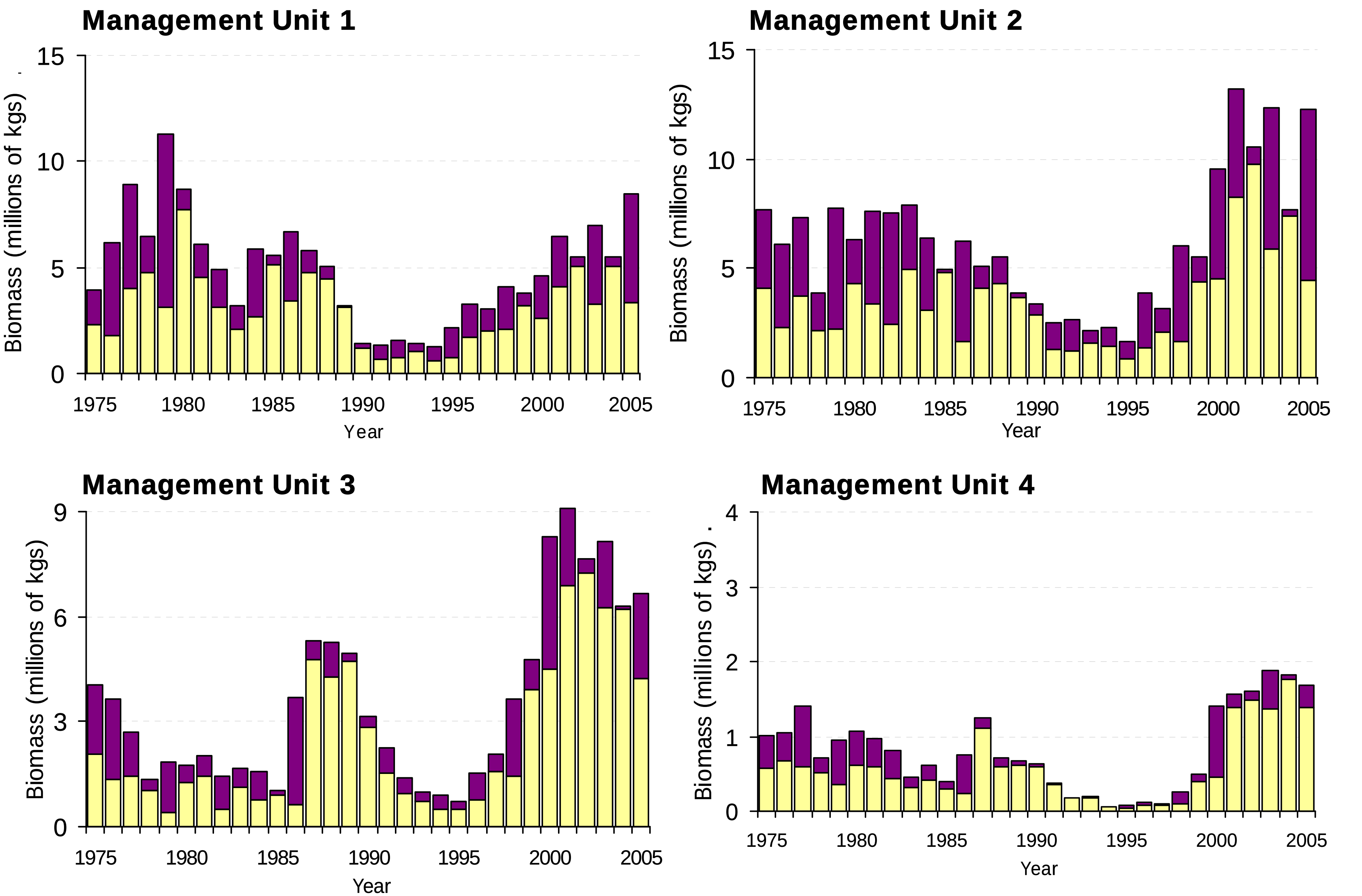


Figure 1.11. Lake Erie yellow perch biomass estimates by management unit for age 2 (dark bars) and ages 3+ (light bars). Estimates for 2005 are from ADMB and parametric regressions for age 2 from survey gears.

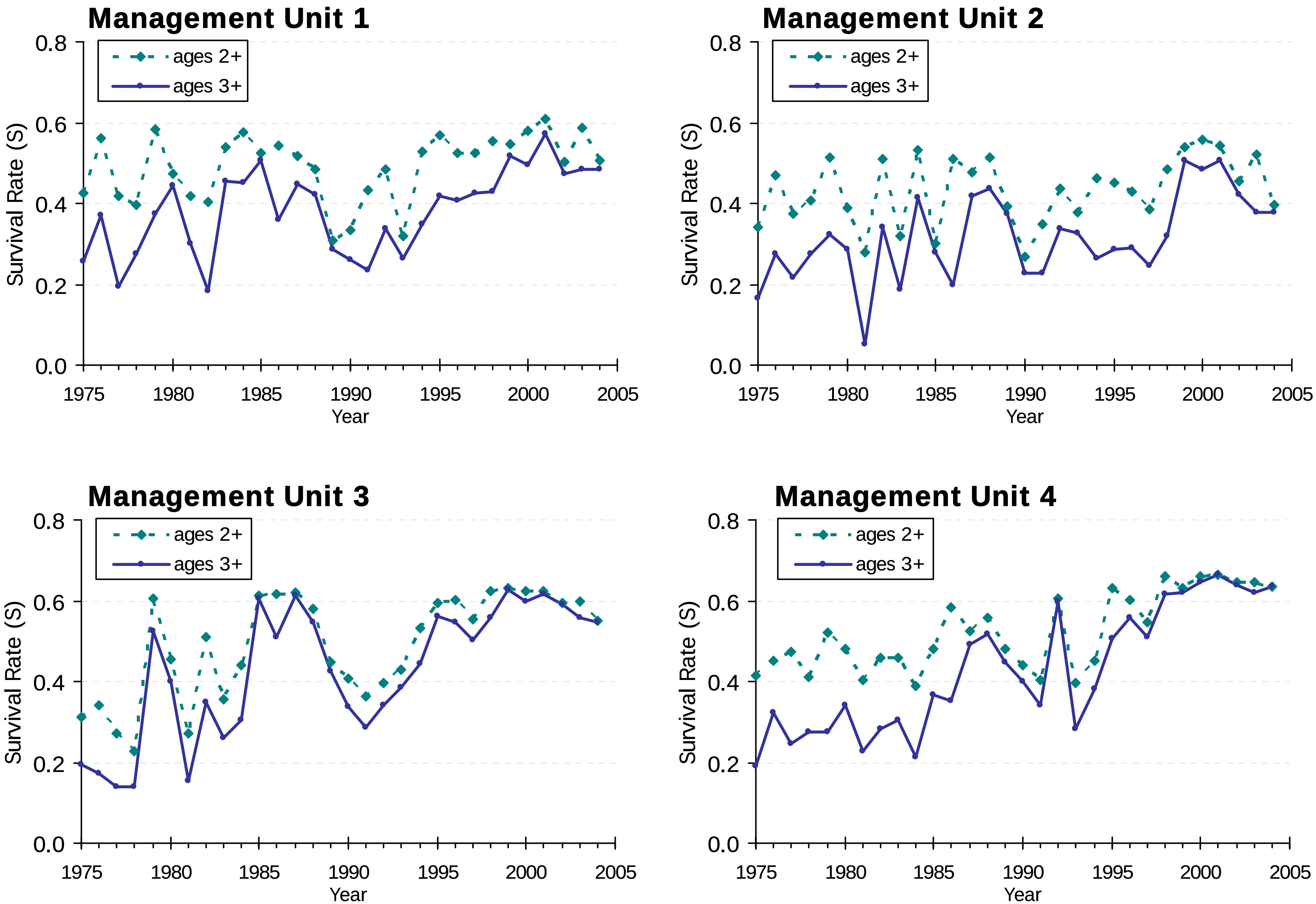


Figure 1.12. Lake Erie yellow perch survival rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from ADMB.

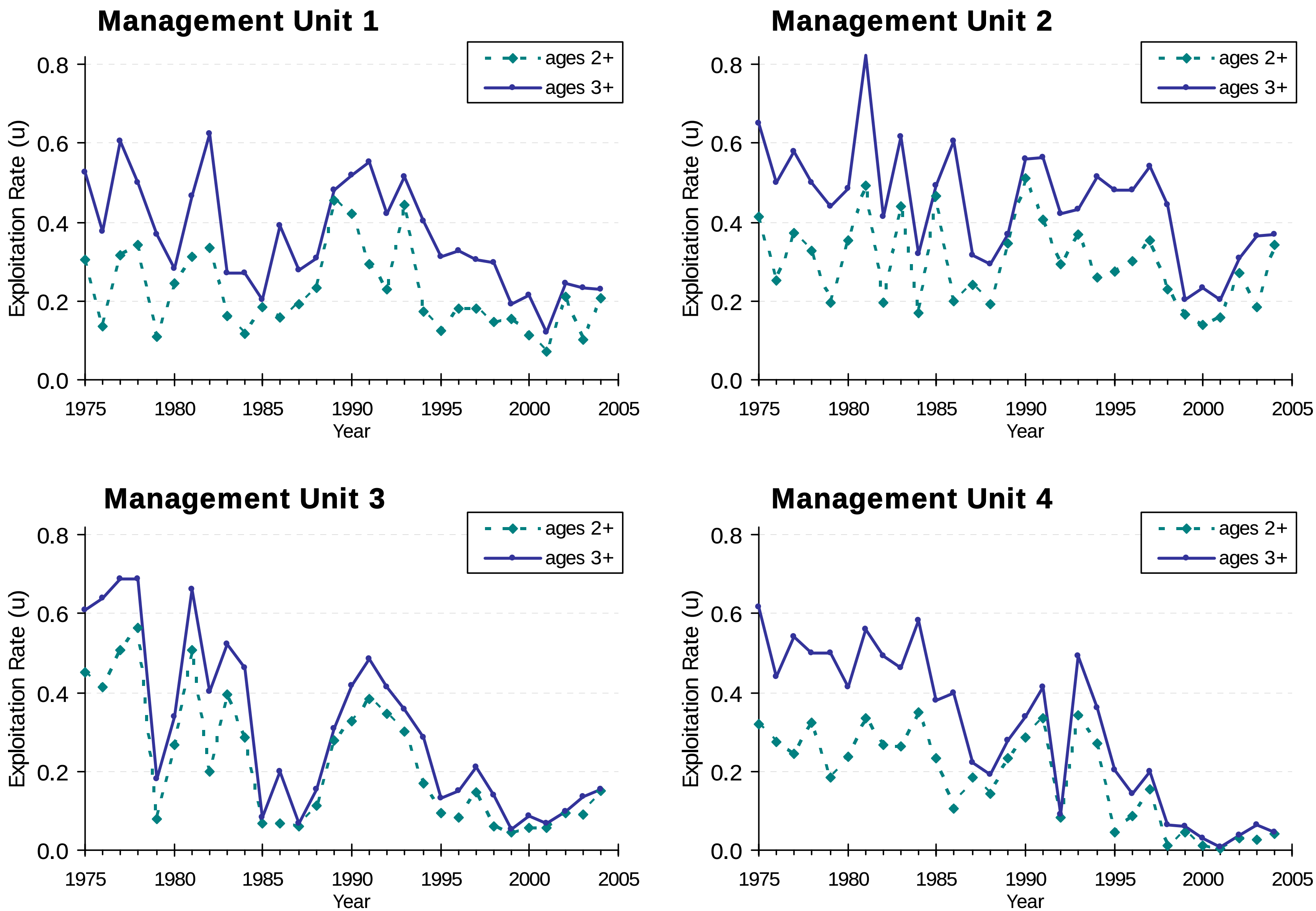


Figure 1.13. Lake Erie yellow perch exploitation rates by management unit for ages 2+ (dashed line) and ages 3+ (solid line). Estimates are derived from ADMB.

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

MU	Data Source	λ	Relative Number of Terms
1*	Commercial Gill Net Effort	0.37	1
	Sport Effort	0.42	1
	Commercial Trap Net Effort	1.00	1
	Commercial Gill Net Harvest	0.60	5
	Sport Harvest	1.00	5
	Commercial Trap Net Harvest	0.31	5
	Trawl Survey Catch Rates	0.42	3
	Partnership Gill Net Index Catch Rates	1.00	5
2	Commercial Gill Net Effort	0.34	1
	Sport Effort	1.00	1
	Commercial Trap Net Effort	0.78	1
	Commercial Gill Net Harvest	1.00	5
	Sport Harvest	0.48	5
	Commercial Trap Net Harvest	0.30	5
	Trawl Survey Catch Rates	1.00	4
	Partnership Gill Net Index Catch Rates	0.90	5
3	Commercial Gill Net Effort	0.28	1
	Sport Effort	1.00	1
	Commercial Trap Net Effort	0.57	1
	Commercial Gill Net Harvest	0.64	5
	Sport Harvest	1.00	5
	Commercial Trap Net Harvest	0.38	5
	Trawl Survey Catch Rates	1.00	4
	Partnership Gill Net Index Catch Rates	0.90	5
4	Commercial Gill Net Effort	0.31	1
	Sport Effort	1.00	1
	Commercial Trap Net Effort	0.51	1
	Commercial Gill Net Harvest	1.00	5
	Sport Harvest	0.95	5
	Commercial Trap Net Harvest	0.80	5
	NY Gill Net Survey Catch Rates	0.48	5
	ONT Partnership Gill Net Index Catch Rates	1.00	5

* Harvest lambdas did not converge according to standard procedure.

Appendix Table 2. Agency trawl regression indices found statistically significant for projecting estimates of age 2 yellow perch recruiting in 2005 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.
OHS11G	0.9174	0.76128	145.4	110.690	0.06105	92.937	128.443
BOHF20A	0.8249	0.14154	345.6	48.916	0.02062	34.664	63.169
OHF11G	0.7885	0.97452	107.5	104.761	0.15963	70.440	139.081
OHF10A	0.7852	0.07658	1540.8	117.994	0.01071	84.991	150.998
BOHF21A	0.7540	0.13022	562.8	73.288	0.02243	48.041	98.535
USF10A	0.6782	0.07406	298.4	22.100	0.01363	13.965	30.234
ONS10G	0.6566	0.09079	751.9	68.229	0.01821	40.859	95.598
			mean	**77.997**		**55.128**	**100.866**

Management Unit 2

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
BOHF20A	0.9251	0.19201	345.6	66.359	0.01728	54.415	78.303
OHS31G	0.9204	2.16232	20.7	44.760	0.22909	35.276	54.244
BOHF31A	0.9093	0.44748	121.2	54.235	0.04262	43.903	64.566
OHS11G	0.8425	0.95302	145.4	138.569	0.10718	107.401	169.737
BOHF21A	0.8295	0.17564	562.8	98.850	0.02401	71.825	125.876
OHF10A	0.7962	0.10032	1540.8	154.573	0.01507	108.133	201.013
OHF11G	0.7470	1.21942	107.5	131.088	0.22123	83.523	178.652
BOHF30A	0.7453	0.22963	154.0	35.363	0.04244	22.292	48.435
			mean	**90.475**		**65.846**	**115.103**

Management Unit 3

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
OHF20G	0.9145	0.42702	59.4	25.365	0.04129	20.460	30.270
OHS31G	0.8789	1.31245	20.7	27.168	0.15408	20.789	33.547
BOHF31A	0.8665	0.25995	121.2	31.506	0.03077	24.047	38.965
BOHF21A	0.7124	0.09687	562.8	54.518	0.01856	33.627	75.410
BOHF30A	0.6924	0.13184	154.0	20.303	0.02779	11.744	28.863
			mean	**31.772**		**22.133**	**41.411**

Management Unit 4

Index	R-SQUARE	Slope	Index Value	Age-2 estimate	SE of slope	Lower Age 2 CI.	Upper Age 2 CI.
NYF41A	0.7988	0.12501	59.1	7.388	0.02092	4.915	9.861
ILP41G	0.6416	0.38744	1.3	0.504	0.07739	0.302	0.705
OHS31G	0.6339	0.24111	20.7	4.991	0.05794	2.592	7.390
OHF31A	0.5703	0.03960	121.2	4.800	0.01036	2.288	7.311
ILP40G	0.5596	0.01386	13.9	0.193	0.00329	0.101	0.284
			mean	**3.575**		**2.040**	**5.110**

Appendix Table 3. Geometric index values from lakewide trawl surveys.

Year	ONTS10G	OHS10G	OHS11G	OHF10G	OHF11G	USS10G	USS11G	USF10G	USF11G	ONOHP10G	OHS20G	OHS21G	OHF20G	OHF21G	BOHS20G	BOHS21G	BOHF20G	BOHF21G
1980	-	10.5	0.0	69.0	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	3.0	7.9	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	320.4	30.0	13.8	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	2.4	2.0	0.0	2.2	-	4.0	16.0	2.8	17.5	-	-	-	-	-	-	-	-	-
1984	428.3	16.3	0.3	5.3	-	7.1	1.9	10.9	2.9	-	-	-	-	-	-	-	-	-
1985	132.0	7.0	0.0	3.9	-	6.5	8.4	28.8	12.8	-	-	-	-	-	-	-	-	-
1986	127.2	155.8	0.0	7.6	-	141.7	34.1	8.8	22.7	-	-	-	-	-	-	-	-	-
1987	0.5	4.3	31.6	4.1	-	1.4	17.3	4.3	12.3	3.9	-	-	-	-	-	-	-	-
1988	88.6	17.1	2.3	3.6	-	43.3	3.6	1.0	0.1	45.4	-	-	-	-	-	-	-	-
1989	127.0	20.4	2.9	18.8	-	32.6	8.1	20.0	1.0	61.9	-	-	-	-	-	-	-	-
1990	109.4	42.8	9.6	54.1	-	29.2	6.7	59.2	2.0	80.2	1.0	28.4	19.2	55.2	1.0	28.4	32.5	52.7
1991	38.2	20.1	10.8	14.4	0.2	16.9	17.1	63.4	4.9	32.5	1.9	28.5	4.3	57.2	1.9	28.5	3.3	54.1
1992	23.8	12.2	2.0	10.2	0.2	4.3	0.1	17.3	0.3	21.6	15.0	6.7	8.7	11.7	15.0	6.7	6.7	9.5
1993	80.2	86.8	6.6	24.0	0.2	28.8	0.9	17.3	0.2	107.5	4.0	24.3	9.4	28.7	4.0	24.3	9.1	34.1
1994	285.8	64.6	18.2	35.6	22.7	419.9	8.0	78.7	36.1	160.8	6.5	2.8	20.0	6.8	6.5	2.8	21.4	8.4
1995	51.9	26.3	46.4	30.6	0.1	475.2	23.1	9.3	4.4	51.1	0.8	20.0	2.9	45.8	0.7	26.1	2.4	66.1
1996	679.0	575.2	32.7	262.1	32.1	10633.1	5.3	228.7	3.9	649.2	61.0	2.7	95.0	5.4	55.9	2.9	91.7	5.7
1997	11.4	10.8	45.3	5.9	42.9	18.3	27.1	5.6	9.0	15.0	3.5	855.1	2.1	42.2	3.5	855.1	2.5	33.9
1998	112.4	71.8	2.8	104.4	6.8	74.4	3.8	100.9	6.4	100.5	16.9	1.8	70.4	3.1	13.8	1.6	56.0	3.1
1999	171.0	102.8	27.8	79.4	31.2	943.4	12.7	50.2	14.7	148.3	10.6	14.1	47.6	48.3	10.3	13.9	51.3	50.8
2000	16.5	44.0	46.1	13.3	19.5	11.1	5.4	4.9	9.0	32.4	0.3	27.8	5.6	39.2	0.3	27.8	8.6	45.9
2001	243.5	144.0	9.5	128.5	5.7	22.2	1.1	16.8	0.6	202.4	40.7	2.6	52.1	5.2	40.7	2.6	54.1	5.9
2002	10.3	8.2	52.7	9.0	63.8	1.4	20.1	3.5	10.5	12.1	0.3	181.4	1.2	20.8	0.3	181.4	2.0	30.5
2003	751.5	451.1	1.2	529.0	3.5	708.0	0.8	57.4	0.2	619.6	146.7	1.5	59.4	1.1	208.5	1.9	79.9	1.3
2004	29.1	14.6	145.4	3.6	107.5	14.2	110.8	0.5	34.2	25.7	3.5	67.7	8.5	159.3	4.2	75.4	8.0	185.0

Year	OHS30G	OHS31G	OHF30G	OHF31G	BOHS30G	BOHS31G	BOHF30G	BOHF31G	PAF30G	PAF31G	ILP40G	ILP41G	OLP40G	OLP41G	NYF40G	NYF41G
1980	-	-	-	-	-	-	-	-	-	-	77.5	69.0	11.8	25.7	-	-
1981	-	-	-	-	-	-	-	-	23.0	-	357.4	29.9	21.6	1.7	-	-
1982	-	-	-	-	-	-	-	-	26.0	-	229.5	16.0	7.9	4.1	-	-
1983	-	-	-	-	-	-	-	-	0.5	-	25.6	-	0.0	0.0	-	-
1984	-	-	-	-	-	-	-	-	385.0	-	414.8	16.0	57.0	1.4	-	-
1985	-	-	-	-	-	-	-	-	4.0	-	6.0	32.7	0.7	5.6	-	-
1986	-	-	-	-	-	-	-	-	125.0	-	465.4	3.8	38.5	0.3	-	-
1987	-	-	-	-	-	-	-	-	25.0	-	0.7	2.6	1.1	10.8	-	-
1988	-	-	-	-	-	-	-	-	40.0	-	73.4	0.8	47.3	0.4	-	-
1989	-	-	-	-	-	-	-	-	0.5	-	70.0	6.4	18.0	6.8	-	-
1990	0.3	5.3	6.9	15.8	0.2	3.4	5.5	18.5	3.0	-	27.2	8.9	8.2	3.4	-	-
1991	2.0	6.3	0.9	18.7	2.4	13.6	0.8	14.9	5.0	-	8.0	2.8	2.0	0.5	-	-
1992	11.4	2.5	20.4	3.6	21.3	1.4	26.9	4.1	50.0	-	46.5	3.3	6.1	1.4	4.4	1.8
1993	6.6	4.7	13.8	12.6	6.6	4.7	22.0	15.0	38.0	-	19.2	5.8	6.2	1.2	54.9	2.1
1994	3.0	1.6	9.5	1.5	3.0	1.6	12.2	2.0	172.0	-	13.2	3.8	26.4	3.3	12.8	2.6
1995	4.5	9.2	11.6	35.1	3.5	7.3	13.1	22.9	20.0	-	1.2	5.4	2.4	10.4	4.9	9.6
1996	53.4	1.2	76.7	3.2	66.6	1.1	96.7	3.3	214.8	-	12.6	1.5	36.8	1.2	24.1	0.2
1997	-	-	2.0	7.5	-	-	1.7	6.4	0.0	-	3.1	1.6	2.6	4.5	0.1	1.5
1998	7.9	1.2	21.8	1.1	7.4	0.9	24.9	1.1	0.2	-	383.3	3.6	14.3	0.7	0.6	0.1
1999	11.0	22.2	12.0	22.2	11.0	22.2	12.6	21.6	15.0	9.0	5.1	17.6	0.6	8.8	5.6	3.9
2000	0.0	22.3	0.8	6.9	0.0	22.3	1.0	6.5	14.4	1.8	0.7	0.8	2.6	1.1	5.3	1.9
2001	38.5	5.3	35.0	0.5	38.5	5.3	36.1	0.4	35.8	1.5	169.7	1.6	26.1	0.5	112.3	13.8
2002	0.9	82.3	1.4	9.7	0.9	82.3	1.4	9.1	20.8	28.3	1.5	9.6	0.2	5.1	3.3	10.0
2003	102.0	0.6	23.0	0.9	73.5	0.3	18.3	0.9	2160.0	42.0	13.9	0.4	7.9	0.1	417.1	1.4
2004	2.6	20.7	1.6	24.8	2.6	20.4	1.4	28.4	1.3	2.2	0.04	1.3	0.09	1.2	1.3	17.5

Appendix Table 4. Arithmetic index values from lakewide trawl surveys.

Year	ONTS10A	OHS10A	OHS11A	OHF10A	OHF11A	USS10A	USS11A	USF10A	USF11A	ONOHP10A	OHS20A	OHS21A	OHF20A	OHF21A	BOHS20A	BOHS21A	BOHF20A	BOHF21A
1980	-	122.0	0.0	663.7	191.0	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	29.5	56.0	110.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	1952.4	359.1	124.3	854.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	5.4	30.5	0.0	5.8	-	19.8	59.2	15.0	43.3	-	-	-	-	-	-	-	-	-
1984	2493.5	138.3	0.8	110.0	-	28.5	5.8	46.4	11.8	-	-	-	-	-	-	-	-	-
1985	885.0	26.1	0.0	39.0	-	42.0	34.0	71.4	27.2	-	-	-	-	-	-	-	-	-
1986	2503.6	1143.7	0.0	61.5	-	1295.0	162.3	63.7	76.3	-	-	-	-	-	-	-	-	-
1987	0.7	20.0	104.4	18.0	-	5.0	41.0	12.8	61.2	10.8	-	-	-	-	-	-	-	-
1988	328.7	145.9	12.6	35.0	-	129.0	10.3	5.8	0.3	224.5	-	-	-	-	-	-	-	-
1989	788.7	107.2	15.7	113.5	-	149.8	15.7	34.2	3.3	448.0	-	-	-	-	-	-	-	-
1990	739.7	145.5	26.4	330.0	-	81.0	22.2	176.2	6.3	458.7	3.7	152.5	108.8	59.9	3.7	152.5	108.8	59.9
1991	109.3	139.3	34.1	61.8	0.6	185.2	35.0	210.8	18.0	124.3	10.7	95.7	27.0	120.8	10.7	95.7	27.0	120.8
1992	262.0	65.4	12.9	91.5	1.0	21.0	0.5	75.3	2.5	159.8	16.4	19.2	92.1	34.7	16.4	19.2	92.1	34.7
1993	766.9	1261.0	19.6	274.5	4.8	321.7	6.0	137.7	0.5	1052.5	104.0	72.5	23.9	92.7	104.0	72.5	23.9	92.7
1994	950.4	526.5	78.2	289.4	97.4	4281.8	40.3	162.0	57.8	733.0	144.2	12.3	155.7	26.9	144.2	12.3	155.7	26.9
1995	1337.8	348.0	167.8	81.6	0.2	2866.6	223.4	27.5	20.0	815.4	8.7	278.7	8.0	180.4	8.7	278.7	8.0	180.4
1996	3309.9	3284.9	105.5	644.2	121.5	11444.0	13.2	737.2	9.2	3296.2	2721.8	31.6	347.0	35.0	2721.8	31.6	347.0	35.0
1997	109.9	58.2	175.4	37.2	156.9	293.7	85.3	39.3	51.0	81.2	79.0	1848.0	24.2	402.1	79.0	1848.0	24.2	402.1
1998	285.4	195.4	7.4	281.7	23.3	138.7	11.0	246.2	19.4	236.0	641.1	7.2	199.7	7.4	641.1	7.2	199.7	7.4
1999	816.0	299.3	96.8	180.2	70.6	1234.8	29.2	176.5	28.8	534.2	85.7	52.9	172.1	113.8	85.7	52.9	172.1	113.8
2000	75.6	180.8	112.0	39.7	46.8	115.8	23.8	42.2	30.8	126.5	1.7	236.1	50.5	155.6	1.7	236.1	50.5	155.6
2001	998.0	361.6	18.8	262.9	14.3	63.5	3.3	57.3	2.8	703.5	854.0	21.0	321.8	14.6	854.0	21.0	321.8	14.6
2002	23.6	51.4	90.0	43.4	127.1	8.7	37.7	25.2	38.2	36.5	0.8	520.9	10.3	125.2	0.8	520.9	10.3	125.2
2003	3677.8	2059.6	4.2	1540.8	9.8	1238.5	5.0	298.4	0.8	2846.3	3204.1	10.3	345.6	6.9	3204.1	10.3	345.6	6.9
2004	89.9	53.1	293.5	11.8	169.4	62.8	232.8	0.4	3.6	72.1	95.8	853.5	22.3	562.0	95.8	853.5	21.5	562.8

Year	OHS30A	OHS31A	OHF30A	OHF31A	BOHS30A	BOHS31A	BOHF30A	BOHF31A	PAF30A	PAF31A	ILP40A	ILP41A	OLP40A	OLP41A	NYF40A	NYF41A
1980	-	-	-	-	-	-	-	-	-	-	191.0	207.5	38.1	59.7	-	-
1981	-	-	-	-	-	-	-	-	-	-	607.2	98.9	109.8	5.3	-	-
1982	-	-	-	-	-	-	-	-	-	-	840.2	142.3	54.4	18.7	-	-
1983	-	-	-	-	-	-	-	-	-	-	142.6	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	1167.9	73.7	275.7	7.6	-	-
1985	-	-	-	-	-	-	-	-	-	-	24.6	138.7	3.6	71.3	-	-
1986	-	-	-	-	-	-	-	-	-	-	1324.5	41.2	122.8	0.9	-	-
1987	-	-	-	-	-	-	-	-	-	-	2.8	30.0	2.6	206.4	-	-
1988	-	-	-	-	-	-	-	-	-	-	269.5	3.6	476.1	0.7	-	-
1989	-	-	-	-	-	-	-	-	-	-	359.4	66.9	201.7	37.8	-	-
1990	1.9	22.7	52.5	33.6	1.9	22.7	52.5	33.6	-	-	181.6	31.6	36.4	12.6	-	-
1991	11.3	166.2	3.2	48.0	11.3	166.2	3.2	48.0	-	-	106.2	25.7	10.5	1.1	-	-
1992	45.5	10.4	68.2	7.8	45.5	10.4	68.2	7.8	-	-	428.4	24.3	39.6	7.9	23.0	5.0
1993	96.9	34.7	38.3	29.4	96.9	34.7	38.3	29.4	-	-	180.7	15.4	24.5	3.8	222.4	6.2
1994	176.7	33.5	35.0	9.8	176.7	33.5	35.0	9.8	-	-	67.0	22.9	114.6	12.7	102.9	18.7
1995	69.1	61.2	26.7	87.5	69.1	61.2	26.7	87.5	-	-	3.5	42.6	5.6	27.9	12.0	30.9
1996	5214.4	8.8	330.1	9.9	5214.4	8.8	330.1	9.9	-	-	48.6	5.5	167.0	2.7	232.1	0.7
1997	-	-	7.9	129.4	-	-	7.9	129.4	-	-	18.8	6.5	14.1	38.2	0.4	12.4
1998	751.3	8.5	105.6	3.0	751.3	8.5	105.6	3.0	32.5	-	1054.3	17.2	130.8	1.4	2.7	0.4
1999	122.3	173.3	60.1	110.7	122.3	173.3	60.1	110.7	30.6	47.4	23.8	104.4	1.9	41.9	73.3	62.3
2000	0.0	231.3	2.7	54.4	0.0	231.3	2.7	54.4	31.2	4.2	2.1	3.1	9.8	3.1	46.8	14.1
2001	3500.8	27.8	36.0	1.2	3500.8	27.8	36.0	1.2	177.0	4.3	483.2	5.3	54.1	1.1	207.5	24.4
2002	4.5	2044.1	8.4	134.9	4.5	2044.1	8.4	134.9	26.5	48.8	6.8	36.5	0.4	11.8	19.2	32.0
2003	3191.3	6.2	154.0	3.1	3191.3	6.2	154.0	3.1	2196.0	87.0	118.8	1.0	56.3	0.4	942.2	3.9
2004	9.9	168.3	5.5	121.2	9.9	168.3	5.5	121.2	8.3	26.6	0.08	17.9	0.3	3.8	3.0	59.1

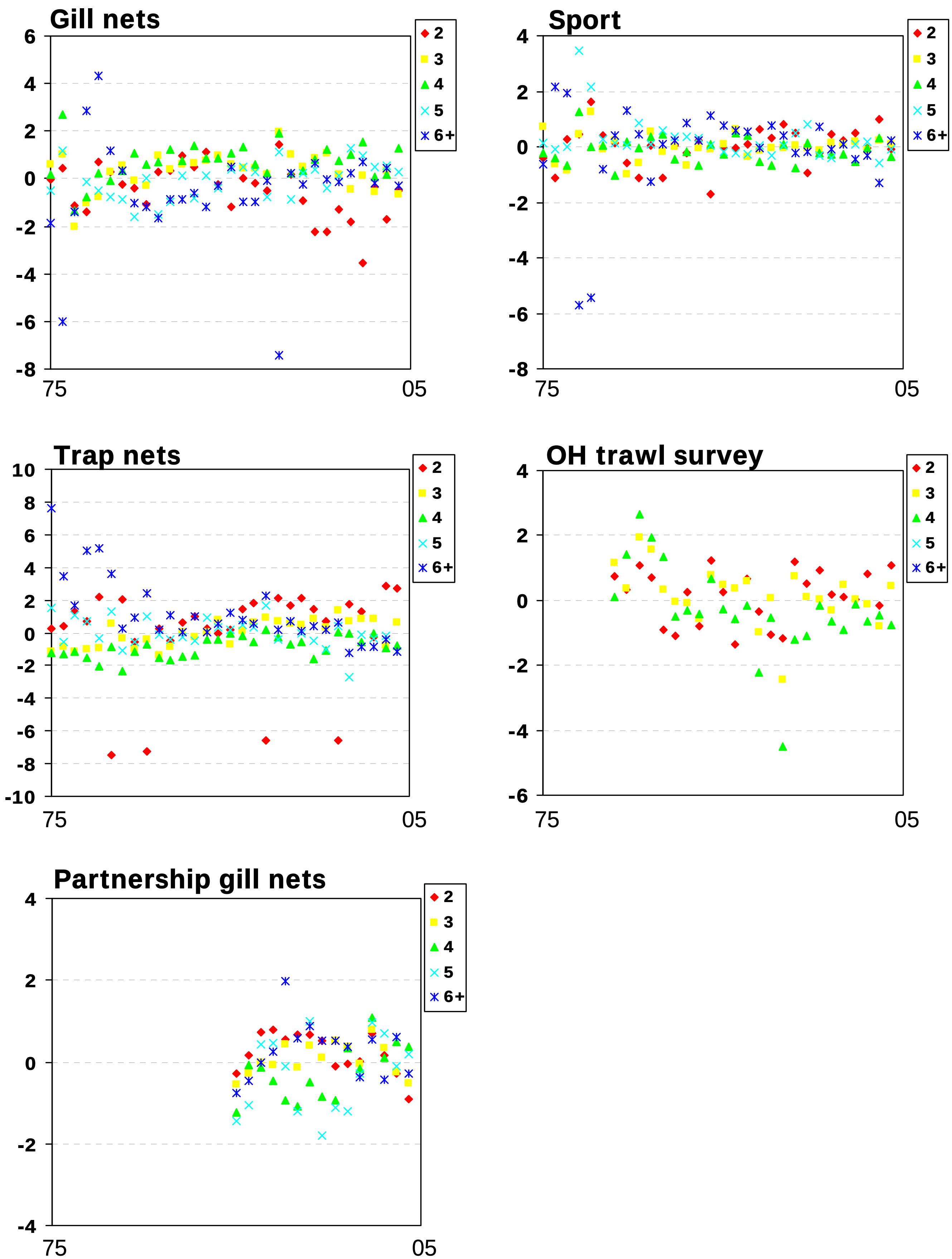
Appendix Legend. Lakewide trawl index series names and codes used in the Appendix.

Geometric Means Abbreviation	Series
ONTS10G	Ontario Management Unit 1 summer age 0 geometric
OHS10G	Ohio Management Unit 1 summer age 0 geometric
OHS11G	Ohio Management Unit 1 summer age 1 geometric
OHF10G	Ohio Management Unit 1 fall age 0 geometric
OHF11G	Ohio Management Unit 1 fall age 1 geometric
USS10G	USGS Management Unit 1 summer age 0 geometric
USS11G	USGS Management Unit 1 summer age 1 geometric
USF10G	USGS Management Unit 1 fall age 0 geometric
USF11G	USGS Management Unit 1 fall age 1 geometric
ONOHP10G	Ontario/Ohio Management Unit 1 summer age 0 geometric
OHS20G	Ohio Management Unit 2 summer age 0 geometric
OHS21G	Ohio Management Unit 2 summer age 1 geometric
OHF20G	Ohio Management Unit 2 fall age 0 geometric
OHF21G	Ohio Management Unit 2 fall age 1 geometric
BOHS20G	Ohio Management Unit 2 summer age 0 geometric (blocked by depth strata)
BOHS21G	Ohio Management Unit 2 summer age 1 geometric (blocked by depth strata)
BOHF20G	Ohio Management Unit 2 fall age 0 geometric (blocked by depth strata)
BOHF21G	Ohio Management Unit 2 fall age 1 geometric (blocked by depth strata)
OHS30G	Ohio Management Unit 3 summer age 0 geometric
OHS31G	Ohio Management Unit 3 summer age 1 geometric
OHF30G	Ohio Management Unit 3 fall age 0 geometric
OHF31G	Ohio Management Unit 3 fall age 1 geometric
BOHS30G	Ohio Management Unit 3 summer age 0 geometric (blocked by depth strata)
BOHS31G	Ohio Management Unit 3 summer age 1 geometric (blocked by depth strata)
BOHF30G	Ohio Management Unit 3 fall age 0 geometric (blocked by depth strata)
BOHF31G	Ohio Management Unit 3 fall age 1 geometric (blocked by depth strata)
PAF30G	Pennsylvania Management Unit 3 fall age 0 geometric
PAF31G	Pennsylvania Management Unit 3 fall age 1 geometric
ILP40G	Inner Long Point Bay Management Unit 4 age 0 geometric
ILP41G	Inner Long Point Bay Management Unit 4 age 1 geometric
OLP40G	Outer Long Point Bay Management Unit 4 age 0 geometric
OLP41G	Outer Long Point Bay Management Unit 4 age 1 geometric
NYF40G	New York Management Unit 4 fall age 0 geometric
NYF41G	New York Management Unit 4 fall age 1 geometric

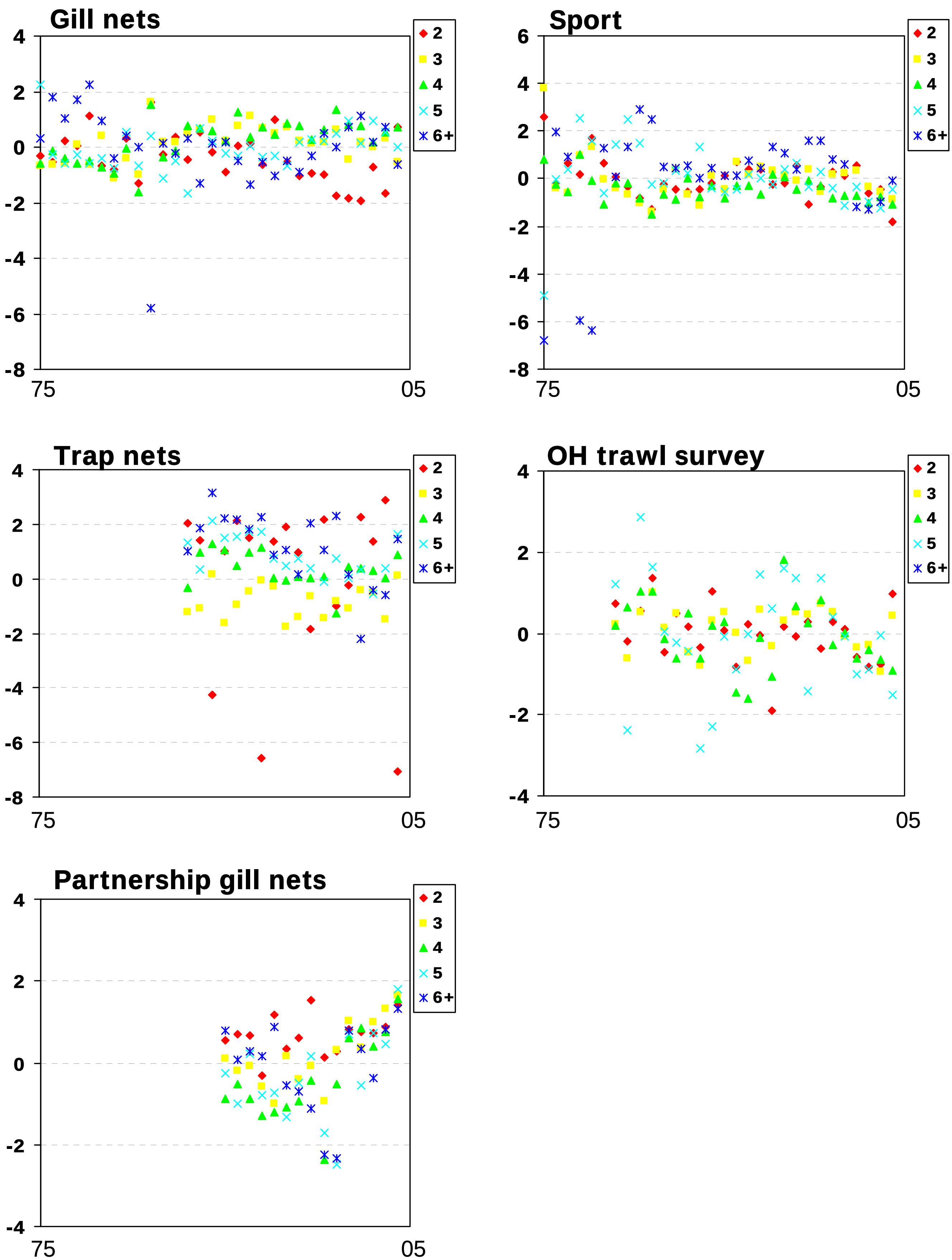
continued

Appendix Legend (continued)

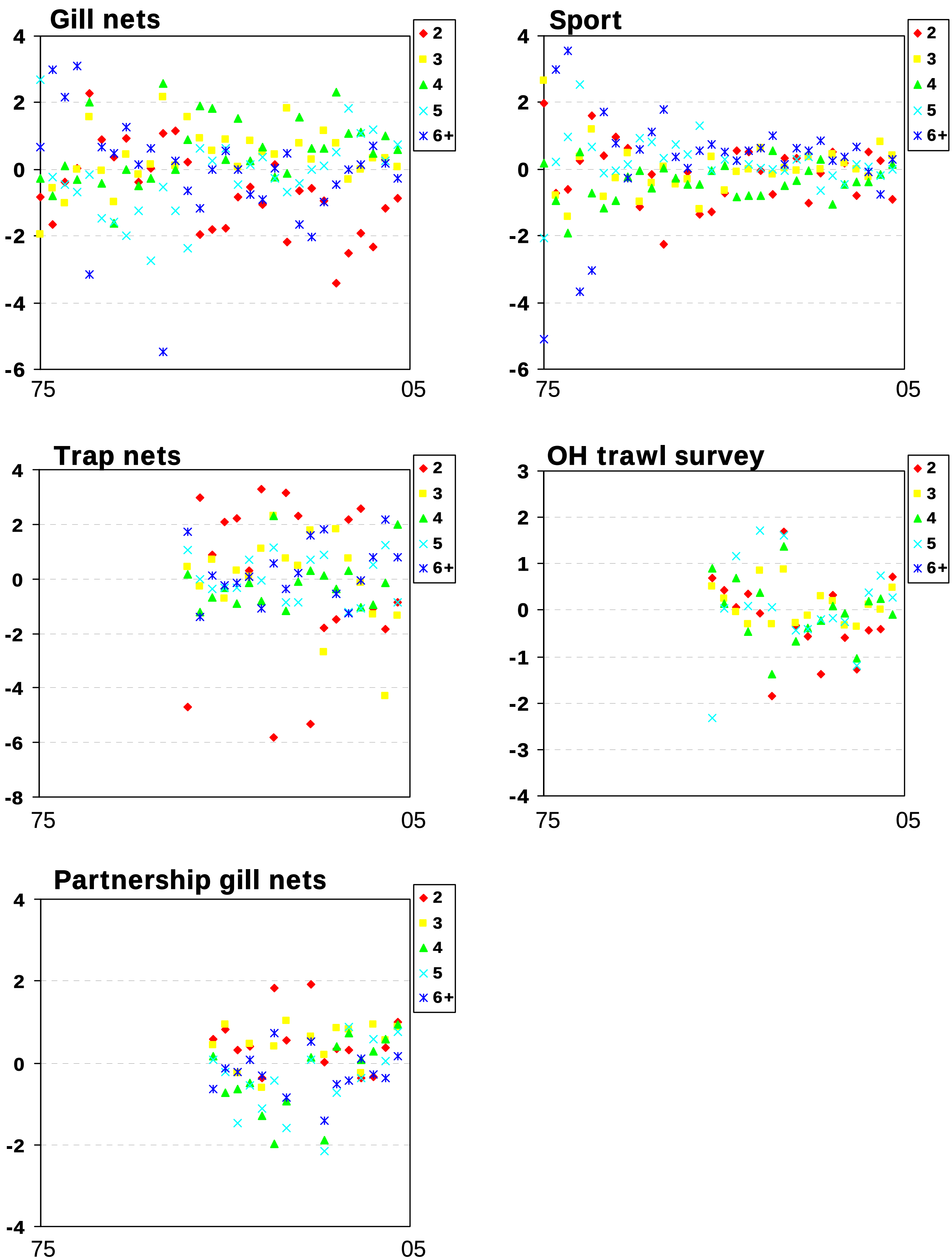
Arithmetic Means	
Abbreviation	Series
ONTS10A	Ontario Management Unit 1 summer age 0 arithmetic
OHS10A	Ohio Management Unit 1 summer age 0 arithmetic
OHS11A	Ohio Management Unit 1 summer age 1 arithmetic
OHF10A	Ohio Management Unit 1 fall age 0 arithmetic
OHF11A	Ohio Management Unit 1 fall age 1 arithmetic
USS10A	USGS Management Unit 1 summer age 0 arithmetic
USS11A	USGS Management Unit 1 summer age 1 arithmetic
USF10A	USGS Management Unit 1 fall age 0 arithmetic
USF11A	USGS Management Unit 1 fall age 1 arithmetic
ONOHP10A	Ontario/Ohio Management Unit 1 summer age 0 arithmetic
OHS20A	Ohio Management Unit 2 summer age 0 arithmetic
OHS21A	Ohio Management Unit 2 summer age 1 arithmetic
OHF20A	Ohio Management Unit 2 fall age 0 arithmetic
OHF21A	Ohio Management Unit 2 fall age 1 arithmetic
BOHS20A	Ohio Management Unit 2 summer age 0 arithmetic (blocked by depth strata)
BOHS21A	Ohio Management Unit 2 summer age 1 arithmetic (blocked by depth strata)
BOHF20A	Ohio Management Unit 2 fall age 0 arithmetic (blocked by depth strata)
BOHF21A	Ohio Management Unit 2 fall age 1 arithmetic (blocked by depth strata)
OHS30A	Ohio Management Unit 3 summer age 0 arithmetic
OHS31A	Ohio Management Unit 3 summer age 1 arithmetic
OHF30A	Ohio Management Unit 3 fall age 0 arithmetic
OHF31A	Ohio Management Unit 3 fall age 1 arithmetic
BOHS30A	Ohio Management Unit 3 summer age 0 arithmetic (blocked by depth strata)
BOHS31A	Ohio Management Unit 3 summer age 1 arithmetic (blocked by depth strata)
BOHF30A	Ohio Management Unit 3 fall age 0 arithmetic (blocked by depth strata)
BOHF31A	Ohio Management Unit 3 fall age 1 arithmetic (blocked by depth strata)
PAF30A	Pennsylvania Management Unit 3 fall age 0 arithmetic
PAF31A	Pennsylvania Management Unit 3 fall 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
OLP40A	Outer Long Point Bay Management Unit 4 age 0 arithmetic
OLP41A	Outer 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



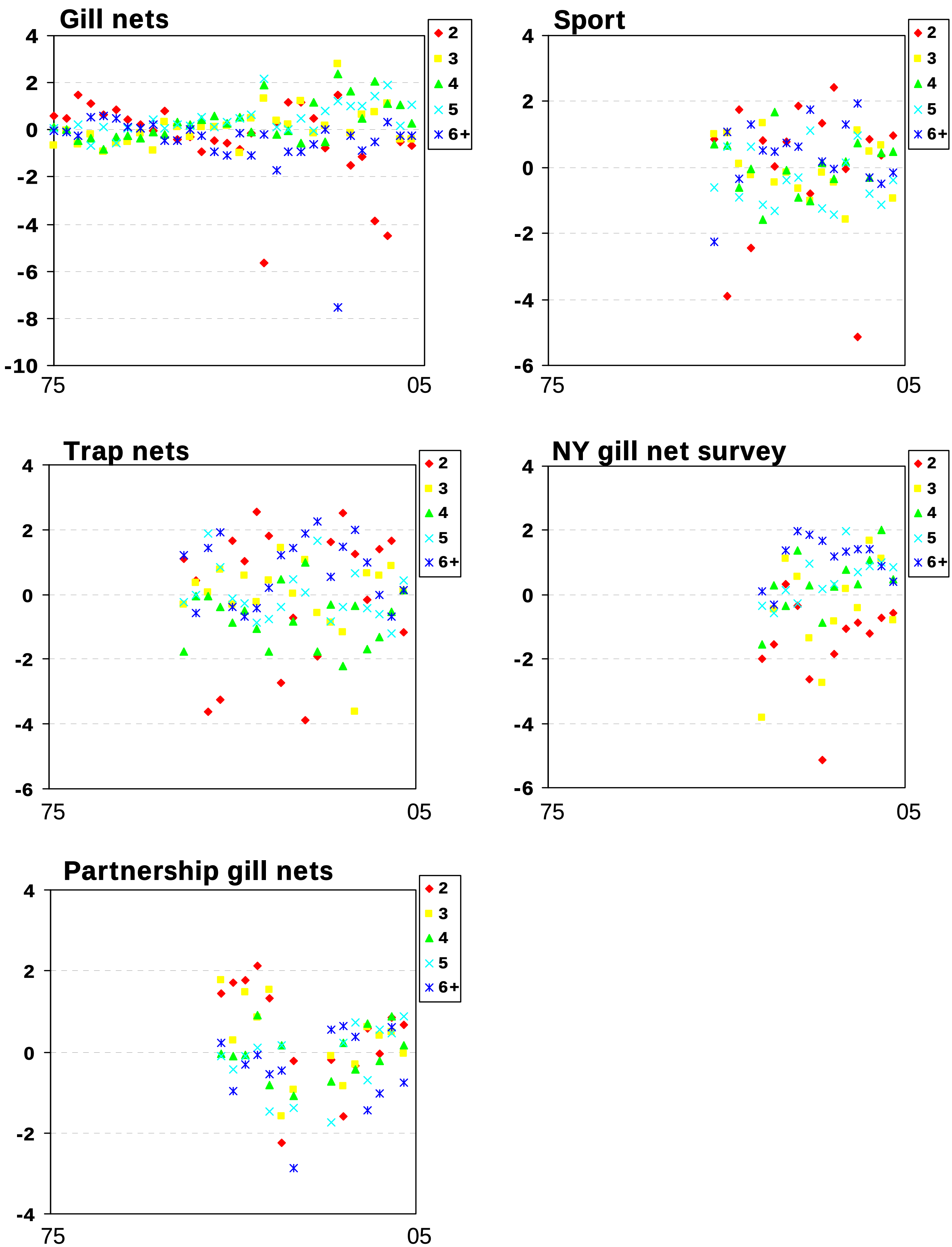
Appendix Figure 1. Patterns of residuals by gear and age from ADMB for Management Unit 1.



Appendix Figure 2. Patterns of residuals by gear and age from ADMB for Management Unit 2.



Appendix Figure 3. Patterns of residuals by gear and age from ADMB for Management Unit 3.



Appendix Figure 4. Patterns of residuals by gear and age from ADMB for Management Unit 4.