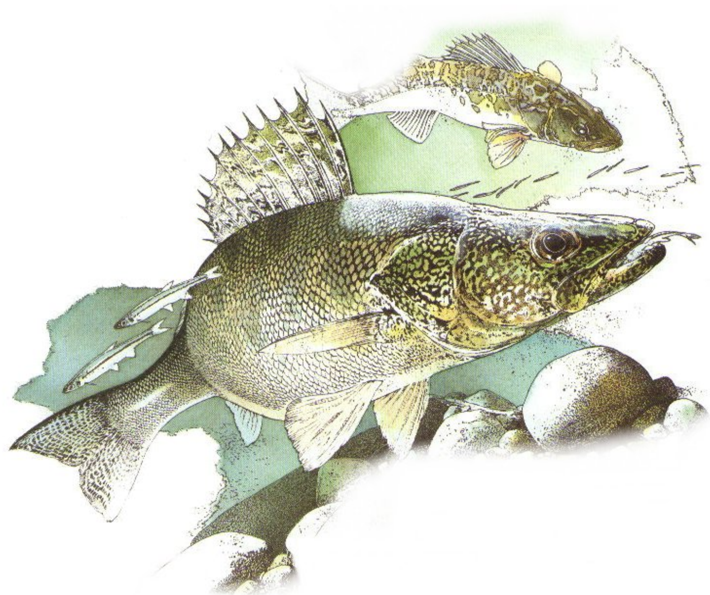
Report for 2009 by the

LAKE ERIE WALLEYE TASK GROUP

March 2010



Prepared by members:

Mike Thomas (co-chair) *Michigan Department of Natural Resources and Environment (MDNRE)*
Don Einhouse *New York Department of Environmental Conservation (NYDEC)*
Kevin Kayle *Ohio Department of Natural Resources (ODNR)*
Mark Turner *Ohio Department of Natural Resources (ODNR)*
Chris Vandergoot *Ohio Department of Natural Resources (ODNR)*
Megan Belore *Ontario Ministry of Natural Resources (OMNR)*
Andy Cook *Ontario Ministry of Natural Resources (OMNR)*
Khahy Ho (co-chair) *Ontario Ministry of Natural Resources (OMNR)*
Tom MacDougall *Ontario Ministry of Natural Resources (OMNR)*
Karen Soper *Ontario Ministry of Natural Resources (OMNR)*
Yingming Zhao *Ontario Ministry of Natural Resources (OMNR)*
Chuck Murray *Pennsylvania Fish and Boat Commission (PFBC)*

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Note*: 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.*

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Charges to the Walleye Task Group, 2009-2010

The charges from the Lake Erie Committee's (LEC) Standing Technical Committee (STC) to the Walleye Task Group (WTG) for the period from March 2009 to February 2010 were to:

1. Maintain and update centralized time series of datasets and methodology required for population models and assessment including;
    a. Tagging and population indices (abundance, growth, maturity).
    b. Fishing harvest and effort by grid.
2. Improve existing population models to produce the most scientifically-defensible method for estimating and forecasting abundance
    a. Establish criteria for model structure: data sources (i.e., pooling), catchability, and lambdas.
    b. Establish protocols for evaluating alternative model configurations.
    c. Using existing data, refine standard catch-age-analysis model by 2010.
3. Report Recommended Allowable Harvest (RAH) levels for 2010.
4. Review jaw and PIT tagging study results and provide guidance and/or recommendations for future tagging strategies to the LEC.
5. Assist the Habitat Task Group with the identification and collection of habitat metrics for the purpose of re-examining the extent of suitable adult walleye habitat in Lake Erie.
6. Assist the STC with a five-year review of the Walleye Management Plan and the Traffic Light approach.

Review of Walleye Fisheries in 2009

Fishery effort and walleye harvest data were combined for all jurisdictions and Management Units (Figure 1) to produce lake-wide estimates. The 2009 total estimated lake-wide harvest of walleye was 2.241 million walleye (Tables 1 and 2), with a total of 2.157 million walleye harvested in the total allowable catch (TAC) area. This harvest represents 88% of the 2009 TAC of 2.450 million walleye and includes walleye harvested in commercial and sport fisheries in Management Units 1, 2, and 3. An additional 83,874 walleye (4% of the lake-wide total) were harvested outside of the TAC area in Management Units 4 and 5 (referred to as Unit 4 in the Tables). The sport fish harvest of 1.166 million walleye was 53% below the long-term (1975-2009) average of 2.495 million, and 14% below the 2008 harvest of 1.354 million. The 2009 Ontario harvest was approximately 1.096 million walleye (Table 1), taken mainly in the commercial fishery, and was 104% of the Ontario TAC allocation of 1.055 million walleye. The Ontario harvest data were not adjusted by the 3.3% which Ontario allows on individual transferable quotas for icing fish, thus indicating that Ontario was slightly over TAC, by 0.415%. The Ontario commercial harvest was 31% lower than the 2008 harvest and 50% of the long-term average (1978-2009; Table 2, Figure 2).

Sport fishing effort decreased 9% in 2009 from 2008, to a total of 2.7 million angler hours (Table 3, Figure 3). Compared to 2008, all Management Units experienced a decrease in effort: Management Unit 1 decreased 3%, Management Unit 2 decreased 4%, Management Unit 3 decreased 19%, and Management Units 4 and 5 (combined) exhibited the highest decrease (35%). Lake-wide commercial gill net effort in 2009 (7,925 km) decreased 25% from 2008 to the lowest effort observed since 1978 (10,590 km; Table 3, Figure 4).

Sport harvest per unit of effort (HUE, walleye/angler hour) in Unit 1 (0.47 walleye/angler hour) increased slightly (4%); however, in Unit 2 (0.37 walleye/angler hour) and Unit 3 (0.44 walleye/angler hour), rates dropped by 10% and 30%, respectively, compared to 2008. Harvest rates in Units 1 and 2 remained slightly above the long-term average (0.46 and 0.32 walleye per angler hour; Table 4, Figure 5). In contrast, the Unit 3 sport harvest rate in 2009 was 20% above the long-term mean (0.35 walleye per angler hour). The 2009 lake-wide average sport HUE of 0.42 walleye/angler hour was 2% lower than the long-term mean of 0.43 walleye/angler hour.

Although total commercial gill net harvest per unit effort (HUE) decreased 8% relative to 2008, the 2009 commercial gill net HUE (136 walleye/kilometer of net) was 13% above the long-term lake-wide average (118 walleye/kilometer; Table 4, Figure 5). Commercial gill net harvest rates in 2009 increased slightly in Unit 1 (4%), but decreased in Unit 2 (7%), Unit 3 (39%), and Unit 4 (18%) from 2008 harvest rates.

Fishing success was largely based on the strong 2003 year class (age-6 walleye), evident from the age composition in the harvest. Age-6 walleye comprised 64% of the lake-wide sport fishery harvest and 49% of the total commercial fishery harvest (Tables 5 and 6). The 2007 year class (age-2 walleye) represented 11% of the total sport harvest and 27% of the total commercial harvest (Table 6). Older walleye (age-7+) represented 10% of the total harvest lake-wide, but were better represented in Units 4 and 5 (28%). Age-7+ walleye contributed 10% to the sport fishery and 9% to the commercial fishery (Tables 5 and 6). The 2003 and 2007 year classes contributed 57% and 19%, respectively, to the total lake-wide harvest. The low contributions from the age 3, 4, and 5 cohorts (2006, 2005, and 2004 year classes, respectively) is an indication of their relatively low abundance.

Across all jurisdictions, the mean age of walleye in the harvest ranged from 4.8 to 6.8 years old in the sport fishery, and from 4.7 to 7.5 years old in Ontario’s commercial fishery (Table 7, Figure 6). The mean age of walleye increased in the sport fishery and decreased in the commercial fishery compared to 2008 values. The mean age in the sport fishery was 5.7 years, above the long-term (1975-2009) mean of 4.1 years, and the highest recorded since at least 1975. In the commercial fishery, the mean age was 4.9 years, higher than the long-term (1975-2009) mean of 3.6 years. The mean age of the total harvest in 2009 (5.3 years) was the second-highest in the time series (1975-2009), following 2008. This reflects the continued dependence of the fisheries on the 2003 year class (age-6) offset by recruitment from the 2007 year class (age 2) in the fisheries.

Walleye Management Plan

In 2005, the Lake Erie Walleye Task Group completed the Lake Erie Walleye Management Plan (WMP; Locke et al. 2005). Within this plan, it was recommended that the actions, and the outcomes of these actions, be reviewed on a five-year basis in order to measure the success of the plan and evaluate its objectives. Recommendations within this review included: 1) review the overall status of the walleye population relative to changes in carrying capacity; 2) evaluate the impact of long-term exploitation policy implementation on population abundance and demographic attributes; and 3) determine if the exploitation policy is working as it was intended to in the plan. If necessary, the review should include recommendations on improvements to the WMP to achieve its objectives.

The STC, with help from the WTG, was charged in 2009-2010 to begin the five-year review of the WMP. The document, still in draft form, contains background information on the WMP, a review of walleye stocks over the past five years (2005-2009), and an evaluation of the performance of the WMP. Initial conclusions found that the WMP performed relatively well in some aspects, in particular achieving harvest and catch rate objectives for the commercial fishery, while other aspects, such as instability in the TAC, caused concern for fisheries managers and stakeholders. Recommendations under consideration include the incorporation of a Traffic Light Approach, the development of a Decision Table for TACs, the consideration of alternate exploitation policies, and the use of age 3+ population thresholds for fishery objectives. The five-year review is expected to be completed during the 2010-2011 reporting cycle.

Catch-at-Age Population Analysis and Relative Abundance

The WTG continued to use the Automatic Differentiation Model Builder (ADMB) catch-at-age analysis used to estimate walleye population abundance from 1978 to 2009 (Walleye Task Group 2001). The model continues to include fishery data from the Ontario commercial fishery (west and central basins) and sport fisheries in Ohio (west and central basins) and Michigan (west basin). In addition to fishery data, this model includes assessment data from three index gill net surveys from Michigan (west basin), Ohio (west and west-central basins combined), and Ontario (west, west-central, and east-central basins combined).

The model assumes log-normal distributions for catch-at-age (ages 2 through 7+, i.e., seven and older) and fishing effort. Natural mortality (M) is fixed in the model for all ages and years at 0.32. The key parameters, including age-2 recruitment and population size in the first year of the model, fisheries catchability, and selectivity, are estimated using a maximum likelihood approach with a concentrated likelihood configuration. The abundances-at-age were derived from the estimated parameters using an exponential survival equation. The methodology for deriving data weights (lambdas) used in the objective function differs this year from the previous reports.

Lambdas were derived based on an expert opinion approach (EO lambda) described in the ***Review of Lambda Weightings*** section**.**

The walleye population in the eastern basin was modeled separately (see section: ***Eastern Basin Catch-At-Age Analysis***) using similar model techniques, and includes fishery and survey data from Ontario, New York and Pennsylvania, but incorporates data from ages 2-11+ with an assumed natural mortality rate of M=0.16. Recent work using walleye tag data suggested that the natural mortality rate of eastern basin walleye may be 0.22 (Zhao, MacDougall, and Einhouse, in preparation).

The 2009 west-central population estimate from the EO lambda model was 39.243 million age-2 and older walleye (Table 8, Figure 7). The age-2 abundance estimate of 26.867 million walleye represented 68% of the total population estimate. The WTG members agreed that this 2007 year class estimate was much higher than initial projections, and not supported by fishery or assessment results, and it was considered to be an outlier. The derivation of an alternate estimate for the 2007 cohort at age-2 used to determine RAH (Tables 10 and 11) is described in the section ***Recruitment Estimator for Incoming Age-2 Walleye and 2010 Population Size Projection***.

There were an estimated 11.481 million age 4 and older walleye in 2009. The strong 2003 year class was estimated to contribute approximately 8.582 million age-6 walleye to the population in 2009. This EO lambda model abundance estimate was slightly higher than the abundance estimate projected last year by the standard ADMB model in the 2009 WTG report (6.559 million). The EO lambda model estimated the abundance of the 2003 year class to be 58.929 million age-2 walleye in the 2010 report model. This represents a 17% increase in the abundance of age-2 walleye (i.e., 50.200 million age-2 walleye) from the 2009 report model estimate for this year class. Despite the model changes (i.e., EO lambda weightings), the abundance of the 2003 year class is still estimated to be higher than the strong 1982 (54.051 million) and 1986 (45.164 million) year classes at age-2 (Table 8).

Recruitment Estimator for Incoming Age-2 Walleye and 2010 Population Size Projection

A linear regression model was used to estimate age-2 walleye recruitment for 2010 and 2011. This regression utilizes estimates of age-2 walleye abundance from the catch-at-age analysis of the EO lambda model (see below in the ***Review of Lambda Weightings*** section) and walleye catches from pooled Ontario and Ohio bottom trawling reported as number of young-of-the-year walleye per hectare (Table 9, Figure 8). Linear regression used by the WTG to predict the abundance of these cohorts excludes the most recent ADMB age-2 estimate (the 2007 year class), as it has the widest estimation error due to the presence of only a single estimate of age in the model time series. The 2010 age-2 population estimate (2008 year class) from linear regression was 3.586 million walleye (Table 9). This cohort and the 2009 year class (3.414 million walleye) appear comparable in strength. Consequently, abundance and RAH forecasts for 2011 are lower than for 2010 (Table 11).

The standard process for projecting age-3 abundance for the year in which RAH is reported (i.e., 2010 in this case) involves applying statistical catch-age analyses (SCAA) survival estimates from the last year in the ADMB model to the abundance estimate of age-2 walleye in the last year (2009). Estimated age-specific survival is a function of estimated instantaneous fishing mortality (F), selectivity, and assumed natural mortality (M, 0.32) during 2009. After running both the standard and new EO lambda ADMB models, the age-2 estimates for 2009 (i.e., the 2007 year class) were assessed to be outliers by the WTG. The age-2 estimate exceeded the young-of-the-year trawl regression estimate for the 2007 year class of 8.3 million age-2 walleye in the 2009 WTG report (Table 9, Walleye Task Group 2009). The standard model estimate was 19.9 million and the EO lambda estimate was 26.9 million age-2 walleye (Table 8). These estimates were both outside of the 95% confidence limits of the linear regression and equal to (standard model) or above (EO lambda model) the 95% confidence limits of the individual predictions for the 2007 year class. One possible cause for the high abundance estimates may be an increase in growth of the 2007 year class which allowed these walleye to recruit to the fishing gear earlier than expected.

In lieu of the ADMB 2009 age-2 abundance estimate (and subsequent 2010 age-3 estimates), the WTG substituted an alternate estimate for the 2007 year class in 2009. This estimate of the number of age-2 walleye from the 2007 year class was based on the 2009 gill net assessment surveys conducted by the OMNR, MDNRE, and ODNR (Appendix 1). A linear regression model using the age-2 gill net catch rates from the OMNR, MDNRE, and ODNR surveys and the EO lambda model age-2 estimates were used. This method resulted in a mean of 11.782 million age-2 walleye in 2009 with a range of 9.253 to 15.010 million age-2 walleye calculated by averaging the 95% confidence intervals from the regressions. Using survival from the last year in ADMB, these values were projected forward to age-3 in 2010 with a mean of 8.319 million and a range of 6.534 to 10.599 million (Tables 10 and 11).

The 2010 estimated abundance of age-2 and older walleye is approximately 19.627 million (Table 10, Figure 10). It is projected that the 2003 year class (age-7) and older cohorts will represent 31% (6.035 million), whereas the 2007 year class will comprise 42% (8.319 million) of the population in 2010.

Walleye spawner abundance in 2010 (ages-4 and older) remains higher than values in 14 of the 32 previous years modeled (1978-2009). However, the spawner-recruit relationship for Lake Erie walleye is poorly understood, with recruitment influenced by a combination of abiotic and biotic factors.

Harvest Policy and Recommended Allowable Harvest for 2010

The harvest management policy adopted by the LEC in the Walleye Management Plan is a sliding F-scale that has a feedback or state-dependent approach, and varies targeted fishing mortality rate based on population abundance (Figure 11). The policy stipulates that when the walleye abundance is 20-40 million walleye, the targeted fishing mortality rate should be between F=0.20 and F=0.35, and when abundance is between 15-20 million walleye, the fishing rate should be between F=0.1 and F=0.2 (Figure 11; Locke et al. 2005). Using results from the EO lambda model with the adjusted age-2 abundances, the estimated abundance of 19.627 million walleye in 2010, and the sliding-F harvest policy of F=0.193, the calculated mean RAH for 2010 is 2.429 million walleye, with a range from 1.376 (minimum) to 3.597 (maximum) million walleye (Table 11).

The RAH is determined by the exploitation policy, and population and parameter estimates produced by the EO lambda model. In 2010, an alternate WTG estimate of abundance for the 2007 cohort, as described in the ***Recruitment Estimator for Incoming Age-2 Walleye and 2009 Population Size Projection*** section. The Walleye Task Group reviewed alternative model configurations during 2009-2010, described in the ***Review of Lambda Weightings*** section.

Other Walleye Task Group Charges

Centralized Databases

Walleye Task Group members currently manage several databases. These databases consist of harvest and population assessment surveys conducted by the respective agencies that manage the walleye population in Lake Erie. Annually, information from these surveys is compiled to assist WTG members in the decision-making process regarding recommended harvest levels and current status and trends of the walleye population. Use of WTG databases by non-members is only permitted following a specific protocol established in 1994, described in the 1994 WTG Report, and reprinted in the 2003 WTG Report (Walleye Task Group 2003).

The Lake Erie Walleye Tagging database consists of biological information collected from walleye tagged in the tributaries and main lake areas of Lake Erie. The tagging program dates back to 1986, and is maintained at the Lake St. Clair Fisheries Research Station of the MDNRE. Annually, agencies submit information regarding tagging activities in their jurisdictions. In addition to updating the database with new tagging information, the database also maintains a record of the tagged walleye which are reported as harvested in a given year. The information is used to estimate the movements of different spawning stocks within the lake proper and connecting waters of Lake Erie. Estimates of survival and exploitation are also generated with this information.

Fishery harvest and population assessment survey information are annually compiled by the WTG and are used for estimating the population abundance of walleye in Lake Erie via catch-at-age analysis (Deriso et al. 1985). A spatially-explicit version of agency-specific harvest data (e.g., harvest-at-age and fishery effort by management unit) and population assessment (e.g., the interagency trawl program and gill net surveys) databases are maintained by the WTG. Annual population abundance estimates are used to assist LEC members with setting TACs for the upcoming year as well as to evaluate past harvest policy decisions.

Review of Lambda Weightings

Since 2005-2006, the WTG has been charged with reviewing the methodology of assigning weighting factors (lambdas) to data sources in the statistical catch-at-age analysis (SCAA) model. The SCAA model uses a negative log-likelihood process to estimate abundance. This method relies on minimizing the differences between “observed” and estimated fishery harvest-at-age, fishery effort, and survey catch rates-at-age, while simultaneously estimating abundance-at-age over the time series. Population estimates are determined when the sum of the squared differences (“sums of squares”) are smallest. Lambdas specific to each data source weight the sums of squares in the objective function, thereby modifying the degree of influence exerted by each data source on the outcome. The Lake Erie Walleye and Yellow Perch Task Groups have been working with Dr. James Bence and Dr. Travis Brenden of Michigan State University’s Quantitative Fisheries Center (MSU-QFC), Dr. Yingming Zhao of the OMNR, and, more recently, MSU-QFC graduate research assistant Aaron Berger to study lambda weighting and catchability configurations in the ADMB catch-at-age models. Previous external reviews by MSU-QFC modelers and Myers and Bence (2001) have shown the current methods, while adequate, could be improved.

In 2009, the LEC directed the WTG to, with assistance from MSU-QFC, complete the necessary lambda configuration updates to the “west-central” SCAA model for implementation in March 2010. In addition to considering methods for lambda determination, the Task Group felt it necessary to revisit the rationale for catchability configurations. Agency staff described factors that could potentially affect fishery and survey catchability, indicating preferences for configurations that were deemed most applicable.

From 2009-2010, the WTG-QFC group developed a method for determining SCAA lambdas based on an expert opinion approach for evaluating potential sources of bias in data sets that could negatively influence model performance. WTG members supplied background materials for each data source to the working group to facilitate completion of lambda spreadsheet templates. Expert opinions were expressed in a spreadsheet template by evaluating possible sources of bias pertaining to all nine data sources used in the west-central SCAA model. The perceived magnitude of bias in each data set was ranked according to factors associated with spatial, temporal, sampling, modeling assumptions, and fishing methodology. These qualitative selections linked to numeric values were then weighted by the relative importance assigned to each factor, resulting in SCAA model lambda configurations determined by eleven individual WTG members. These values were averaged to determine the final lambdas for use in the model.

Five options for combining eleven completed WTG templates into a single SCAA walleye lambda configuration were evaluated with the assistance of Aaron Berger (MSU-QFC). Various methods for pooling results included simply averaging the eleven completed templates or averaging weighted or unweighted results from each jurisdiction. The single lambda configurations that resulted did not differ greatly among the five methods. The Standing Technical Committee (STC) recommended averaging the results of eleven WTG members. The lambdas for the expert opinion (EO lambda) model are presented in Appendix 2.

The performance of the new expert opinion lambda (EO lambda) configuration was compared to the older standard model according to retrospectivity, total sums of squares, and Akaike's Information Criterion (AIC, AICc). AIC is a model selection method that favors the best model fit with the fewest number of parameters. AICc also takes into account the sample size of data used in the model (Burnham and Anderson, 2002). Retrospective analyses describe how much population estimates change when truncating the time series in successive SCAA model runs. Ideally, population estimates would not vary at all, indicating a robust model configuration. The WTG felt that retrospectivity was the most important criterion for model evaluation, since an expert opinion approach was possibly in conflict with model evaluation approaches that rely entirely on model fit.

The performance of three model configurations was compared: 1) standard model (using the ratio of the variance of observed log-catch to log-effort to determine lambdas); 2) EO lambda with new catchability assumptions (EO lambda new q); and 3) EO lambda with historic catchability blocks (EO lambda old q). According to total sums of squares (TSS), EO lambda new q was best, followed by EO lambda old q and the standard model. AIC and AICc performed best with the standard model, followed by the EO lambda old q and EO lambda new q. Retrospective analyses focused on estimates of abundance and exploitation. Retrospective analyses for abundance (age-2 and total) favored the standard model when 1999 and 2005 were the only reference years. Based on exploitation rate estimates for 1999 and 2005, retrospective results were best for EO lambda old q and EO lambda new q, depending on the reference year. Coefficients of variation of total abundance and age-2 abundance for all years in model runs using multiple truncated time series were marginally better with the EO lambda old q than the standard model. The EO lambda new q configuration performed poorly and was considered too unstable for producing WTG population estimates.

Although the results of model comparisons were variable, the WTG accepted the EO lambda (old q) with the historic catchability configuration as a marginal improvement over the former standard model. Abundance estimates in this report (Table 8) are outputs of the SCAA EO lambda model with historic catchability blocks. The standard model will continue to be used to ensure that the EO lambda model is consistent with abundance thresholds identified within the Walleye Management Plan. A more detailed report describing the model comparisons will be available in 2010.

A doctoral student, Aaron Berger (MSU-QFC) is investigating several alternate walleye models with a focus on how selectivity and catchability assumptions influence model performance and resulting management predictions. Task Group modelers will continue to incorporate model improvements as they become available upon presentation to and discussion with the STC and LEC.

Eastern Basin Catch-At-Age Analysis

Several years ago, the WTG developed an ADMB catch-at-age model for eastern Lake Erie's walleye population. This stock assessment model incorporates walleye harvest-at-age and fishing effort values from Ontario commercial gill nets, New York and Pennsylvania sport fisheries, and survey data from Ontario and New York. A long-term New York walleye tagging study provided the instantaneous natural mortality estimate (M) of 0.16 used for this model.

The current eastern basin model's portrayal of walleye population dynamics is provided in this report simply for illustrative purposes. The current configuration of this eastern basin model does not account for walleye movements into the basin by much larger western basin spawning stocks, which confounds estimates of walleye survival, exploitation, and abundance. This movement dynamic must be recognized in the model for this to become a viable tool for walleye population estimation, and therefore, at this time, it cannot be used for yield calculation and quota determination for eastern basin stocks. However, model results through recent years (Table 12) show reasonable agreement with separate fishery and assessment indices throughout the basin, suggesting that the model is tracking changes in the abundance of harvestable walleye despite not being able to predict future abundance. An important function of the west-central ADMB catch-at-age model, the ability to predict future abundance based on recent year class contributions, is confounded in the eastern basin by an unpredictable contribution to the fishery based on migratory movement rather than recruitment. Until this is resolved, and in the interest of continuity, we continue to present output of the model as it was configured in 2005 rather than introduce changes to the natural mortality estimate (as suggested in the last year) or to the fishery and assessment weightings (lambdas) of effort data (as occurred for the West-Central model this year based on expert opinion; see Charge 1).

The 2009 estimate of walleye abundance from the eastern basin model was 3.6 million walleye (Table 12). The eastern basin model output also estimates that 44% of the eastern basin abundance were age-2 (2007 year class) and 34% were age-6 (2003 year class) walleye. These results portray the 2009 eastern basin walleye resource with above-average abundance relative to the 1993 to 2009 data series, based largely on a strong signal from the 2007 year class. Eastern basin walleye abundance has been somewhat elevated since the emergence of the dominant 2003 year class.

Relative to the more robust western basin walleye stock assessment model, the eastern basin's model is limited by a more truncated data series, and further limited the problematic issue of modeling uneven seasonal movements by western basin walleye into the eastern basin. Additionally, walleye migrating seasonally from the west-central quota management area represent a trivial fraction of the population remaining within the west and central basins; however, this trivial fraction is apparently large in relation to the resident population inhabiting the eastern basin (Einhouse and MacDougall 2010). Uneven distribution of western migrants within the east (greater density on south shore) may further confound estimates. In 2008, the Walleye Task Group began analyzing the inter-agency walleye tagging database to gather an improved understanding of the degree to which western emigrants contribute to individual fisheries spatially and temporally. Preliminary results suggest migration from western stocks is both very large and density-dependent. WTG members continue to examine the walleye resource inhabiting eastern Lake Erie in pursuit of a multi-jurisdictional assessment approach that recognizes both expansive seasonal movements from the west-central quota management area, as well as the dynamics of smaller and localized eastern basin spawning stocks. This may necessarily include a stock assessment approach that does not utilize a catch-at-age modeling of absolute abundance

Lake Erie Walleye Tagging Study

In 2005, a lake-wide research tagging initiative was undertaken by the WTG. The project was funded by the United States Fish and Wildlife Service (USFWS) Restoration Act Program through 2006, and an additional year of funding was provided by the respective LEC agencies. The objectives of the study were to: 1) assess the use of Passive Integrated Transponder (PIT) tags as an alternative to jaw tags in estimating walleye exploitation rates in Lake Erie and Saginaw Bay, Lake Huron, in terms of tag retention, cost/benefit analysis, sample size considerations, and precision of exploitation estimates; 2) assess temporal patterns in loss rates of jaw and PIT tags through double-tagging for use in correcting exploitation estimates; 3) determine walleye exploitation rates for different fishery components (i.e., commercial, private, and charter) and determine individual stock contribution to each fishery; and 4) obtain additional information regarding walleye movement patterns in each lake through recapture of tagged walleye by fishers. Between 2005 and 2007, more than 31,000 walleye were PIT tagged for this study.

The final report to the USFWS was completed in October, 2009 for this project and is available upon request by contacting Chris Vandergoot at the ODNR (christopher.vandergoot@dnr.state.oh.us). Specific recommendations to the LEC with respect to addressing Charge 4 for the WTG (*Review jaw and PIT tagging results and provide guidance and/or recommendations for future tagging strategies to the LEC.*) are forthcoming. A doctoral dissertation is expected to be completed by 2012 which will address tag loss, reporting rates, and natural mortality (M) estimates.

Habitat Metrics for Suitable Walleye Habitat

The current definition of adult walleye habitat, used by the LEC for the purposes of allocating fishery quota, is based on the Scientific Protocol Committee (SPC) 1976 description of: “lake surface area that lies inside of the 7 fathom (~13 m) depth contour.” The inclusion of alternate or additional habitat metrics in the definition (e.g., measures of spawning and nursery habitat), was originally “postponed pending acquisition of more definitive data” (Standing Technical Committee 2007).

The WTG is currently working with the Habitat Task Group (HTG) in an effort to produce a more realistic definition of walleye habitat by utilizing additional data describing walleye movements and environmental conditions that have become available since the time of the initial definition. This process will incorporate GIS technology, habitat mapping, and spatial calculations to consider; for example, habitat volume as an alternative to surface area calculations. Consideration of lake-wide habitat will expand upon currently calculated habitat (only Management Units 1 to 3).

It was decided in 2009 that an initial focus would be the constraints placed on habitat by temperature, light, and possibly oxygen. Data to inform this work includes not only measurements taken at the time of fishery surveys but also the large datasets of lower trophic level information as compiled by the Forage Task Group (FTG) and the Lake Erie community at large (e.g., Lake Erie Limnological Synthesis).

This charge is being led by the HTG; however, overlap in membership with the WTG, particularly on the walleye habitat subgroup that formed in 2009, ensures communication between these two Task Groups. Work on this charge to date has involved planning and strategy meetings by conference call and a working meeting in Ann Arbor in January, 2010. Preliminary attempts to model thermal habitat preferences of Lake Erie walleye based on the Ontario Partnership gill net index and Ohio gill net datasets have been encouraging.

For more details on progress and please refer to the 2010 annual report of the HTG at: http://glfc.org/lakecom/lec/HTG.htm

Acknowledgments

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Table 1. Annual Lake Erie walleye total allowable catch (TAC, top) and measured harvest (Har; bottom, bold), in numbers of fish from 1980 to 2009. TAC allocations for 2009 are based on water areas: Ohio, 51.11%; Ontario, 43.06%; and Michigan, 5.83%. New York and Pennsylvania do not have assigned quotas but are included in annual total harvest.

		TAC Area (MU-1, MU-2, MU-3)				Non-TAC Area (MUs 4&5)				All Areas
Year		Michigan	Ohio	Ontario [a]	Total	NY	Penn.	Ontario	Total	Total
1980	TAC	261,700	1,558,600	1,154,100	2,974,400				0	2,974,400
	Har	**183,140**	**2,169,800**	**1,049,269**	**3,402,209**				**0**	**3,402,209**
1981	TAC	367,400	2,187,900	1,620,000	4,175,300				0	4,175,300
	Har	**95,147**	**2,942,900**	**1,229,017**	**4,267,064**				**0**	**4,267,064**
1982	TAC	504,100	3,001,700	2,222,700	5,728,500				0	5,728,500
	Har	**194,407**	**3,015,400**	**1,260,852**	**4,470,659**				**0**	**4,470,659**
1983	TAC	572,000	3,406,000	2,522,000	6,500,000				0	6,500,000
	Har	**145,847**	**1,864,200**	**1,416,101**	**3,426,148**				**0**	**3,426,148**
1984	TAC	676,500	4,028,400	2,982,900	7,687,800				0	7,687,800
	Har	**351,169**	**4,055,000**	**2,178,409**	**6,584,578**				**0**	**6,584,578**
1985	TAC	430,700	2,564,400	1,898,800	4,893,900				0	4,893,900
	Har	**460,933**	**3,730,100**	**2,435,627**	**6,626,660**				**0**	**6,626,660**
1986	TAC	660,000	3,930,000	2,910,000	7,500,000				0	7,500,000
	Har	**605,600**	**4,399,400**	**2,617,507**	**7,622,507**				**0**	**7,622,507**
1987	TAC	490,100	2,918,500	2,161,100	5,569,700				0	5,569,700
	Har	**902,500**	**4,433,600**	**2,688,558**	**8,024,658**				**0**	**8,024,658**
1988	TAC	397,500	3,855,000	3,247,500	7,500,000				0	7,500,000
	Har	**1,996,788**	**4,890,367**	**3,054,402**	**9,941,557**	**85,282**			**85,282**	**10,026,839**
1989	TAC	383,000	3,710,000	3,125,000	7,218,000				0	7,218,000
	Har	**1,091,641**	**4,191,711**	**2,793,051**	**8,076,403**	**129,226**			**129,226**	**8,205,629**
1990	TAC	616,000	3,475,500	2,908,500	7,000,000				0	7,000,000
	Har	**747,128**	**2,282,520**	**2,517,922**	**5,547,570**	**47,443**			**47,443**	**5,595,013**
1991	TAC	440,000	2,485,000	2,075,000	5,000,000				0	5,000,000
	Har	**132,118**	**1,577,813**	**2,266,380**	**3,976,311**	**34,137**			**34,137**	**4,010,448**
1992	TAC	329,000	3,187,000	2,685,000	6,201,000				0	6,201,000
	Har	**249,518**	**2,081,919**	**2,497,705**	**4,829,142**	**14,384**			**14,384**	**4,843,526**
1993	TAC	556,500	5,397,000	4,546,500	10,500,000				0	10,500,000
	Har	**270,376**	**2,668,684**	**3,821,386**	**6,760,446**	**40,032**			**40,032**	**6,800,478**
1994	TAC	400,000	4,100,000	3,500,000	8,000,000				0	8,000,000
	Har	**216,038**	**1,468,739**	**3,431,119**	**5,115,896**	**59,345**			**59,345**	**5,175,241**
1995	TAC	477,000	4,626,000	3,897,000	9,000,000				0	9,000,000
	Har	**107,909**	**1,435,188**	**3,813,527**	**5,356,624**	**26,964**			**26,964**	**5,383,588**
1996	TAC	583,000	5,654,000	4,763,000	11,000,000				0	11,000,000
	Har	**174,607**	**2,316,425**	**4,524,639**	**7,015,671**	**38,728**	**89,087**		**127,815**	**7,143,486**
1997	TAC	514,000	4,986,000	4,200,000	9,700,000				0	9,700,000
	Har	**122,400**	**1,248,846**	**4,072,779**	**5,444,025**	**29,395**	**88,682**		**118,077**	**5,562,102**
1998	TAC	546,000	5,294,000	4,460,000	10,300,000				0	10,300,000
	Har	**114,606**	**2,303,911**	**4,173,042**	**6,591,559**	**34,090**	**124,814**	**47,000**	**205,904**	**6,797,463**
1999	TAC	477,000	4,626,000	3,897,000	9,000,000				0	9,000,000
	Har	**140,269**	**1,033,733**	**3,454,250**	**4,628,252**	**23,133**	**89,038**	**87,000**	**199,171**	**4,827,423**
2000	TAC	408,100	3,957,800	3,334,100	7,700,000				0	7,700,000
	Har	**252,280**	**932,297**	**2,287,533**	**3,472,110**	**28,599**	**77,512**	**67,000**	**173,111**	**3,645,221**
2001	TAC	180,200	1,747,600	1,472,200	3,400,000				0	3,400,000
	Har	**159,186**	**1,157,914**	**1,498,816**	**2,815,916**	**14,669**	**52,796**	**39,498**	**106,963**	**2,922,879**
2002	TAC	180,200	1,747,600	1,472,200	3,400,000				0	3,400,000
	Har	**193,515**	**703,000**	**1,436,000**	**2,332,515**	**18,377**	**22,000**	**36,000**	**76,377**	**2,408,892**
2003	TAC	180,200	1,747,600	1,472,200	3,400,000				0	3,400,000
	Har	**128,852**	**1,014,688**	**1,457,014**	**2,600,554**	**27,480**	**43,581**	**32,692**	**103,753**	**2,704,307**
2004	TAC	127,200	1,233,600	1,039,200	2,400,000				0	2,400,000
	Har	**114,958**	**859,366**	**1,419,237**	**2,393,561**	**8,400**	**19,969**	**29,864**	**58,233**	**2,451,794**
2005	TAC	308,195	2,988,910	2,517,895	5,815,000				0	5,815,000
	Har	**37,599**	**610,449**	**2,933,393**	**3,581,441**	**27,370**	**20,316**	**17,394**	**65,080**	**3,646,521**
2006	TAC	523,958	5,081,404	4,280,638	9,886,000				0	9,886,000
	Har	**305,548**	**1,868,520**	**3,494,551**	**5,668,619**	**37,161**	**151,614**	**68,774**	**257,549**	**5,926,168**
2007	TAC	284,080	2,755,040	2,320,880	5,360,000				0	5,360,000
	Har	**165,551**	**2,160,459**	**2,159,965**	**4,485,975**	**29,134**	**116,671**	**37,566**	**183,371**	**4,669,346**
2008	TAC	209,530	1,836,893	1,547,576	3,594,000				0	3,594,000
	Har	**121,072**	**1,082,636**	**1,574,723**	**2,778,431**	**29,017**	**74,250**	**34,906**	**138,173**	**2,916,604**
2009	TAC	142,835	1,252,195	1,054,970	2,450,000				0	2,450,000
	Har	**94,048**	**967,476**	**1,095,500**	**2,157,024**	**13,727**	**42,422**	**27,725**	**83,874**	**2,240,898**

[a] Ontario sport harvest values were estimated from the most recent creel surveys in each basin; 2008 in Unit 1, 2004 in Units 2 and 3, and 2003 in Unit 4. These values are included in Ontario's total walleye harvest, but are not used in catch-at-age analysis.

Table 2. Annual harvest (thousands of fish) of Lake Erie walleye by gear, management unit, and agency. Means contain data from 1975 to 2009.

	Sport Fishery															Commercial Fishery				
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Unit 1	Unit 2	Unit 3	Unit 4	
Year	OH	MI	ON[a]	Total	OH	ON[a]	Total	OH	ON[a]	Total	ON[a]	PA	NY	Total	Total	ON	ON	ON	ON	Total
1975	77	4	7	88	10	--	10	--	--	--	--	--	--	0	98	--	--	--	--	0
1976	605	30	50	685	35	--	35	--	--	--	--	--	--	0	720	113	44	--	--	157
1977	2,131	107	69	2,307	37	--	37	--	--	--	--	--	--	0	2,344	235	67	--	--	302
1978	1,550	72	112	1,734	37	--	37	--	--	--	--	--	--	0	1,771	274	60	--	--	334
1979	3,254	162	79	3,495	60	--	60	--	--	--	--	--	--	0	3,555	625	30	--	--	655
1980	2,096	183	57	2,336	49	--	49	24	--	24	--	--	--	0	2,409	953	40	--	--	993
1981	2,857	95	70	3,022	38	--	38	48	--	48	--	--	--	0	3,108	1,037	119	3	--	1,159
1982	2,959	194	49	3,202	49	--	49	8	--	8	--	--	--	0	3,259	1,077	134	2	--	1,213
1983	1,626	146	41	1,813	212	--	212	26	--	26	--	--	--	0	2,051	1,129	167	80	--	1,376
1984	3,089	351	39	3,479	787	--	787	179	--	179	--	--	--	0	4,445	1,639	392	108	--	2,139
1985	3,347	461	57	3,865	294	--	294	89	--	89	--	--	--	0	4,248	1,721	432	225	--	2,378
1986	3,743	606	52	4,401	480	--	480	176	--	176	--	--	--	0	5,057	1,651	558	356	--	2,565
1987	3,751	902	51	4,704	550	--	550	132	--	132	--	--	--	0	5,386	1,611	622	405	--	2,638
1988	3,744	1,997	18	5,759	584	--	584	562	--	562	--	--	85	85	6,990	1,866	762	409	--	3,037
1989	2,891	1,092	14	3,997	867	35	902	434	80	514	--	--	129	129	5,542	1,656	621	386	--	2,663
1990	1,467	747	35	2,249	389	14	403	426	23	449	--	--	47	47	3,148	1,615	529	302	--	2,446
1991	1,104	132	39	1,275	216	24	240	258	44	302	--	--	34	34	1,851	1,446	440	274	--	2,160
1992	1,479	250	20	1,749	338	56	394	265	25	290	--	--	14	14	2,447	1,547	534	316	--	2,397
1993	1,846	270	37	2,153	450	26	476	372	12	384	--	--	40	40	3,053	2,488	762	496	--	3,746
1994	992	216	21	1,229	291	20	311	186	21	207	--	--	59	59	1,806	2,307	630	432	--	3,369
1995	1,161	108	32	1,301	159	7	166	115	27	141	--	--	27	27	1,635	2,578	681	489	--	3,748
1996	1,442	175	17	1,634	645	8	653	229	27	256	--	89	39	128	2,671	2,777	1,107	589	--	4,473
1997	929	122	8	1,059	188	2	190	132	5	138	--	89	29	118	1,505	2,585	928	544	--	4,057
1998	1,790	115	34	1,939	215	5	220	299	5	304	19	125	34	178	2,641	2,497	1,166	462	28	4,153
1999	812	140	34	986	139	5	144	83	5	88	19	89	23	131	1,349	2,461	631	317	68	3,477
2000	674	252	34	961	165	5	170	93	5	98	19	78	29	125	1,354	1,603	444	196	48	2,291
2001	941	160	34	1,135	171	5	176	46	5	51	19	53	15	87	1,449	1,004	310	141	20	1,475
2002	516	194	34	744	141	5	146	46	5	51	19	22	18	59	1,000	937	309	146	17	1,409
2003	715	129	34	878	232	5	237	68	5	73	2	44	27	73	1,261	948	283	182	14	1,427
2004	515	115	34	664	272	2	274	72	0	72	2	20	8	30	1,040	866	334	175	11	1,386
2005	374	38	27	438	110	2	112	126	0	126	2	20	27	49	725	1,878	625	401	15	2,920
2006	1,194	306	27	1,526	503	2	505	170	0	170	2	152	37	191	2,392	2,137	784	545	66	3,532
2007	1,414	166	27	1,607	578	2	580	169	0	169	2	116	29	147	2,502	1,348	450	333	35	2,167
2008	524	121	44	689	333	2	335	225	0	225	2	74	29	105	1,354	954	335	241	35	1,565
2009	553	94	44	691	287	2	289	128	0	128	2	42	14	58	1,166	705	212	135	28	1,079
Mean	1,662	293	39	1,994	283	11	290	173	14	183	9	72	36	55	2,495	1,478	457	300	32	2,140

[a] Ontario sport harvest values were estimated from the most recent creel surveys in each basin; 2008 in Unit 1, 2004 in Units 2 and 3, and 2003 in Unit 4. These values are included in Ontario's total walleye harvest, but are not used in catch-at-age analysis.

Table 3. Annual fishing effort for Lake Erie walleye by gear, management unit, and agency. Means contain data from 1975 to 2009.

	Sport Fishery [a]															Commercial Fishery [b]				
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Unit 1	Unit 2	Unit 3	Unit 4	
Year	OH	MI	ON[c]	Total	OH	ON[c]	Total	OH	ON[c]	Total	ON[c]	PA	NY	Total	Total	ON	ON	ON	ON	Total
1975	486	30	46	562	61	--	61	--	--	--	--	--	--	0	623	--	--	--	--	--
1976	1,356	84	98	1,538	163	--	163	--	--	--	--	--	--	0	1,701	1,796	1,933	--	--	3,729
1977	2,768	171	130	3,069	151	--	151	--	--	--	--	--	--	0	3,220	4,282	1,572	--	--	5,854
1978	2,880	176	148	3,204	154	--	154	--	--	--	--	--	--	0	3,358	5,253	436	--	--	5,689
1979	4,179	257	97	4,533	169	--	169	--	--	--	--	--	--	0	4,702	5,798	1,798	--	--	7,596
1980	3,938	624	92	4,654	237	--	237	187	--	187	--	--	--	0	5,078	6,229	1,565	--	--	7,794
1981	5,766	447	138	6,351	264	--	264	382	--	382	--	--	--	0	6,997	6,881	2,144	622	--	9,647
1982	5,928	449	108	6,484	223	--	223	114	--	114	--	--	--	0	6,821	10,531	2,913	689	--	14,133
1983	4,168	451	118	4,737	568	--	568	128	--	128	--	--	--	0	5,433	11,205	5,352	5,814	--	22,371
1984	4,077	557	82	4,716	1,322	--	1,322	392	--	392	--	--	--	0	6,430	11,550	6,008	2,438	--	19,996
1985	4,606	926	84	5,616	1,078	--	1,078	464	--	464	--	--	--	0	7,158	7,496	2,800	2,983	--	13,279
1986	6,437	1,840	107	8,384	1,086	--	1,086	538	--	538	--	--	--	0	10,008	7,824	5,637	3,804	--	17,265
1987	6,631	2,193	84	8,908	1,431	--	1,431	472	--	472	--	--	--	0	10,811	6,595	4,243	3,045	--	13,883
1988	7,547	4,362	87	11,996	1,677	--	1,677	1,081	--	1,081	--	--	462	462	15,216	7,495	5,794	3,778	--	17,067
1989	5,246	3,794	81	9,121	1,532	77	1,609	883	205	1,088	--	--	556	556	12,374	7,846	5,514	3,473	--	16,833
1990	4,116	1,803	121	6,040	1,675	33	1,708	869	83	952	--	--	432	432	9,132	9,016	5,829	5,544	--	20,389
1991	3,616	440	144	4,200	1,241	79	1,320	724	155	880	--	--	440	440	6,840	10,418	5,055	3,146	--	18,619
1992	3,955	715	105	4,775	1,169	81	1,249	640	145	786	--	--	299	299	7,109	9,486	6,906	6,043	--	22,435
1993	3,943	691	125	4,759	1,349	70	1,418	1,062	125	1,187	--	--	305	305	7,669	16,283	11,656	7,420	--	35,359
1994	2,808	788	125	3,721	1,025	65	1,090	599	130	729	--	--	355	355	5,894	16,698	9,968	6,459	--	33,125
1995	3,188	277	125	3,589	803	65	868	355	130	485	--	--	259	259	5,201	20,521	12,113	7,850	--	40,484
1996	3,060	521	125	3,706	1,132	65	1,197	495	130	625	--	316	256	572	6,101	19,976	15,685	10,990	--	46,651
1997	2,748	374	88	3,210	864	45	909	492	91	583	--	388	273	661	5,363	15,708	11,588	9,094	--	36,390
1998	3,010	374	103	3,487	635	51	686	409	55	464	217	390	280	887	5,524	19,027	19,397	13,253	818	52,495
1999	2,368	411	--	2,779	603	--	603	323	--	323	--	397	171	568	4,699	21,432	10,955	7,630	1,444	41,461
2000	1,975	540	--	2,516	540	--	540	281	--	281	--	244	177	421	3,757	22,238	11,049	7,896	1,781	43,054
2001	1,952	362	--	2,314	697	--	697	261	--	261	--	241	163	404	3,676	9,372	5,746	5,021	639	20,778
2002	1,393	606	--	1,999	444	--	444	246	--	246	--	130	132	262	2,951	4,431	4,212	4,427	445	13,515
2003	1,719	326	--	2,045	675	--	675	236	--	236	30	159	162	351	3,307	4,476	3,946	3,725	365	12,512
2004	1,257	504	--	1,761	736	27	763	178	7	185	--	88	101	189	2,898	3,875	2,977	2,401	240	9,493
2005	1,180	212	40	1,392	573	--	573	261	--	261	--	109	142	251	2,477	7,083	4,174	4,503	174	15,934
2006	1,757	587	--	2,344	899	--	899	260	--	260	--	239	137	376	3,879	5,689	4,008	3,589	822	14,107
2007	2,076	448	--	2,524	1,147	--	1,147	321	--	321	--	232	135	367	4,358	4,509	2,927	2,665	383	10,484
2008	1,027	392	63	1,419	809	--	809	356	--	356	--	187	156	343	2,927	4,990	3,193	1,909	497	10,590
2009	1,063	310	--	1,373	777	--	777	289	--	289	--	124	100	224	2,663	3,537	2,164	1,746	478	7,925
Mean	3,264	773	102	4,109	797	60	816	443	114	485	124	232	250	257	5,610	9,693	5,919	4,895	674	20,028

[a] Sport units of effort are thousands of angler hours.

[b] Estimated Standard (Total) Effort in kilometers of gill net = (walleye targeted effort x walleye total harvest)/ walleye targeted harvest.

[c] Ontario sport fishing effort was estimated from the most recent creel surveys in each basin; 2008 in Unit 1, 2004 in Units 2 and 3, and 2003 in Unit 4.

Table 4. Annual catch per unit effort for Lake Erie walleye by gear, management unit, and agency. Means contain data from 1975 to 2009.

	Sport Fishery [a]															Commercial Fishery [b]				
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Unit 1	Unit 2	Unit 3	Unit 4	
Year	OH	MI	ON[c]	Total	OH	ON[c]	Total	OH	ON[c]	Total	ON[c]	PA	NY	Total	Total	ON	ON	ON	ON	Total
1975	0.16	0.13	0.16	0.16	0.17	--	0.17	--	--	--	--	--	--		0.16	--	--	--	--	--
1976	0.45	0.36	0.50	0.45	0.22	--	0.22	--	--	--	--	--	--		0.42	63.0	22.9	--	--	42.2
1977	0.77	0.62	0.53	0.75	0.24	--	0.24	--	--	--	--	--	--		0.73	54.9	42.6	--	--	51.6
1978	0.54	0.41	0.76	0.54	0.24	--	0.24	--	--	-	--	--	--		0.53	52.2	138.2	--	--	58.8
1979	0.78	0.63	0.81	0.77	0.36	--	0.36	--	--	--	--	--	--		0.76	107.9	16.7	--	--	86.3
1980	0.53	0.29	0.62	0.50	0.21	--	0.21	0.13	--	0.13	--	--	--		0.47	153.0	25.3	--		127.3
1981	0.50	0.21	0.51	0.48	0.14	--	0.14	0.12	--	0.12	--	--	--		0.44	150.7	55.4	4.9		120.1
1982	0.50	0.43	0.45	0.49	0.22	--	0.22	0.07	--	0.07	--	--	--		0.48	102.2	45.9	2.8		85.8
1983	0.39	0.32	0.34	0.38	0.37	--	0.37	0.20	--	0.20	--	--	--		0.38	100.7	31.2	13.7		61.5
1984	0.76	0.63	0.48	0.74	0.60	--	0.60	0.46	--	0.46	--	--	--		0.69	141.9	65.3	44.4		107.0
1985	0.73	0.50	0.68	0.69	0.27	--	0.27	0.19	--	0.19	--	--	--		0.59	229.6	154.5	75.6		179.1
1986	0.58	0.33	0.49	0.52	0.44	--	0.44	0.33	--	0.33	--	--	--		0.51	211.0	99.0	93.7		148.6
1987	0.57	0.41	0.61	0.53	0.38	--	0.38	0.28	--	0.28	--	--	--		0.50	244.2	146.5	133.1		190.0
1988	0.50	0.46	0.21	0.48	0.35	--	0.35	0.52	--	0.52	--	--	0.18	0.18	0.46	249.0	131.4	108.2		177.9
1989	0.55	0.29	0.17	0.44	0.57	0.45	0.56	0.49	0.39	0.47	--	--	0.23	0.23	0.45	211.1	112.7	111.2		158.3
1990	0.36	0.41	0.29	0.37	0.23	0.42	0.24	0.49	0.28	0.47	--	--	0.11	0.11	0.34	179.1	90.7	54.5		120.0
1991	0.31	0.30	0.27	0.30	0.17	0.30	0.18	0.36	0.28	0.34	--	--	0.08	0.08	0.27	138.8	87.0	87.1		116.0
1992	0.37	0.35	0.19	0.37	0.29	0.69	0.32	0.41	0.18	0.37	--	--	0.05	0.05	0.34	163.1	77.3	52.3		106.8
1993	0.47	0.39	0.30	0.45	0.33	0.37	0.34	0.35	0.09	0.32	--	--	0.13	0.13	0.40	152.8	65.4	66.8		106.0
1994	0.35	0.27	0.17	0.33	0.28	0.31	0.28	0.31	0.16	0.28	--	--	0.17	0.17	0.31	138.2	63.2	66.9		101.7
1995	0.36	0.39	0.25	0.36	0.20	0.12	0.19	0.32	0.21	0.29	--	--	0.10	0.10	0.31	125.7	56.2	62.2		92.6
1996	0.47	0.34	0.13	0.44	0.57	0.13	0.55	0.46	0.21	0.41	--	0.28	0.15	0.22	0.44	139.0	70.6	53.6		95.9
1997	0.34	0.33	0.10	0.33	0.22	0.04	0.21	0.27	0.06	0.24	--	0.23	0.11	0.17	0.28	164.6	80.1	59.8		111.5
1998	0.59	0.31	0.33	0.56	0.34	0.10	0.32	0.73	0.08	0.65	0.09	0.32	0.12	0.18	0.48	131.3	60.1	34.8	34.2	79.1
1999	0.34	0.34	--	0.34	0.23	--	0.23	0.26	--	0.26	--	0.22	0.14	0.18	0.27	114.8	57.6	41.6	47.4	83.9
2000	0.34	0.47	--	0.37	0.31	--	0.31	0.33	--	0.33	--	0.32	0.16	0.24	0.34	72.1	40.2	24.8	27.1	53.2
2001	0.48	0.44	--	0.48	0.25	--	0.25	0.18	--	0.18	--	0.22	0.09	0.16	0.38	107.1	54.0	28.1	32.1	71.0
2002	0.37	0.32	--	0.36	0.32	--	0.32	0.19	--	0.19	--	0.17	0.14	0.15	0.32	211.5	73.4	33.0	37.4	104.3
2003	0.42	0.40	--	0.41	0.34	--	0.34	0.29	--	0.29	0.07	0.28	0.17	0.22	0.37	211.8	71.7	48.9	38.4	114.1
2004	0.41	0.23	--	0.36	0.37	0.06	0.37	0.40	--	0.40	--	0.23	0.08	0.16	0.35	223.5	112.2	73.0	45.3	146.0
2005	0.32	0.18	0.67	0.30	0.19	--	0.19	0.48	--	0.48	--	0.18	0.19	0.19	0.28	265.2	149.8	89.1	86.4	183.2
2006	0.68	0.52	--	0.64	0.56	--	0.56	0.65	--	0.65	--	0.63	0.27	0.45	0.61	375.7	195.6	151.9	80.8	250.4
2007	0.68	0.37	--	0.63	0.50	--	0.50	0.53	--	0.53	--	0.50	0.21	0.36	0.57	298.9	153.8	124.9	91.4	206.7
2008	0.51	0.31	--	0.45	0.41	--	0.41	0.63	--	0.63	--	0.40	0.19	0.29	0.45	191.2	104.9	126.2	70.4	147.8
2009	0.52	0.30	--	0.47	0.37	--	0.37	0.44	--	0.44	--	0.34	0.14	0.24	0.42	199.2	97.9	77.1	58.0	136.1
Mean	0.49	0.37	0.40	0.46	0.32	0.27	0.32	0.36	0.19	0.35	0.08	0.31	0.15	0.19	0.43	166.9	83.8	67.0	54.1	118.3

[a] Sport CPE = Number/angler hour

[b] Commercial CPE = Number/kilometer of gill net

[c] Ontario sport fishing CPE was estimated from the most recent creel surveys in each basin; 2008 in Unit 1, 2004 in Units 2 and 3, and 2003 in Unit 4.

Table 5. Catch at age of walleye harvest by management unit, gear, and agency in Lake Erie during 2009. Units 4 and 5 are combined in Unit 4.

		Commercial	Sport					All Gear
Unit	Age	Ontario	Ohio	Michigan	New York	Pennsylvania	Total	Total
1	1	4,588	0	0	--	--	0	4,588
	2	209,818	60,949	30,960	--	--	91,909	301,727
	3	19,463	42,175	683	--	--	42,858	62,321
	4	57,278	35,619	7,333	--	--	42,952	100,230
	5	25,959	20,035	1,035	--	--	21,070	47,029
	6	342,170	365,759	45,305	--	--	411,064	753,234
	7+	45,303	28,371	8,732	--	--	37,103	82,406
	Total	704,579	552,908	94,048	--	--	646,956	1,351,535
2	1	712	0	--	--	--	0	712
	2	56,144	22,985	--	--	--	22,985	79,129
	3	6,291	10,528	--	--	--	10,528	16,819
	4	15,498	9,265	--	--	--	9,265	24,763
	5	4,618	8,343	--	--	--	8,343	12,961
	6	104,342	195,558	--	--	--	195,558	299,900
	7+	24,300	40,123	--	--	--	40,123	64,423
	Total	211,905	286,802	--	--	--	286,802	498,707
3	1	0	0	--	--	--	0	0
	2	19,826	6,030	--	--	--	6,030	25,856
	3	7,778	5,428	--	--	--	5,428	13,206
	4	19,896	6,610	--	--	--	6,610	26,506
	5	5,090	4,341	--	--	--	4,341	9,431
	6	63,210	79,930	--	--	--	79,930	143,140
	7+	18,736	25,428	--	--	--	25,428	44,164
	Total	134,536	127,767	--	--	--	127,767	262,303
4	1	0	--	--	0	0	0	0
	2	111	--	--	365	1,923	2,288	2,399
	3	385	--	--	2,721	2,397	5,118	5,503
	4	932	--	--	873	2,240	3,113	4,045
	5	0	--	--	142	1,351	1,493	1,493
	6	16,325	--	--	5,198	25,595	30,793	47,118
	7+	9,972	--	--	4,428	8,915	13,343	23,315
	Total	27,725	--	--	13,727	42,422	56,149	83,874
All	1	5,300	0	0	0	0	0	5,300
	2	285,899	89,964	30,960	365	1,923	123,212	409,111
	3	33,917	58,131	683	2,721	2,397	63,932	97,849
	4	93,604	51,494	7,333	873	2,240	61,940	155,544
	5	35,667	32,719	1,035	142	1,351	35,247	70,914
	6	526,047	641,247	45,305	5,198	25,595	717,345	1,243,392
	7+	98,311	93,922	8,732	4,428	8,915	115,997	214,308
	Total	1,078,745	967,477	94,048	13,727	42,422	1,117,674	2,196,419

[a] Ontario sport harvest values were not estimated from creel surveys in 2009; they are not used in catch-at-age analysis.

Table 6. Age composition (in percent) of walleye harvest by management unit, gear, and agency in Lake Erie during 2009. Units 4 and 5 are combined in Unit 4.

		Commercial	Sport					All Gears
Unit	Age	Ontario	Ohio	Michigan	New York	Pennsylvania	Total	Total
1	1	0.7	0.0	0.0	--	--	0.0	0.3
	2	29.8	11.0	32.9	--	--	14.2	22.3
	3	2.8	7.6	0.7	--	--	6.6	4.6
	4	8.1	6.4	7.8	--	--	6.6	7.4
	5	3.7	3.6	1.1	--	--	3.3	3.5
	6	48.6	66.2	48.2	--	--	63.5	55.7
	7+	6.4	5.1	9.3	--	--	5.7	6.1
	Total	100.0	100.0	100.0	--	--	100.0	100.0
2	1	0.3	0.0	--	--	--	0.0	0.1
	2	26.5	8.0	--	--	--	8.0	15.9
	3	3.0	3.7	--	--	--	3.7	3.4
	4	7.3	3.2	--	--	--	3.2	5.0
	5	2.2	2.9	--	--	--	2.9	2.6
	6	49.2	68.2	--	--	--	68.2	60.1
	7+	11.5	14.0	--	--	--	14.0	12.9
	Total	100.0	100.0	--	--	--	100.0	100.0
3	1	0.0	0.0	--	--	--	0.0	0.0
	2	14.7	4.7	--	--	--	4.7	9.9
	3	5.8	4.2	--	--	--	4.2	5.0
	4	14.8	5.2	--	--	--	5.2	10.1
	5	3.8	3.4	--	--	--	3.4	3.6
	6	47.0	62.6	--	--	--	62.6	54.6
	7+	13.9	19.9	--	--	--	19.9	16.8
	Total	100.0	100.0	--	--	--	100.0	100.0
4	1	0.0	--	--	0.0	0.0	0.0	0.0
	2	0.4	--	--	2.7	4.5	4.1	2.9
	3	1.4	--	--	19.8	5.7	9.1	6.6
	4	3.4	--	--	6.4	5.3	5.5	4.8
	5	0.0	--	--	1.0	3.2	2.7	1.8
	6	58.9	--	--	37.9	60.3	54.8	56.2
	7+	36.0	--	--	32.3	21.0	23.8	27.8
	Total	100.0	--	--	100.0	100.0	100.0	100.0
All	1	0.5	0.0	0.0	0.0	0.0	0.0	0.2
	2	26.5	9.3	32.9	2.7	4.5	11.0	18.6
	3	3.1	6.0	0.7	19.8	5.7	5.7	4.5
	4	8.7	5.3	7.8	6.4	5.3	5.5	7.1
	5	3.3	3.4	1.1	1.0	3.2	3.2	3.2
	6	48.8	66.3	48.2	37.9	60.3	64.2	56.6
	7+	9.1	9.7	9.3	32.3	21.0	10.4	9.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 7. Annual mean age (years) of Lake Erie walleye by gear, management unit, and agency. Means include data from 1975 to present.

	Sport Fishery															Commercial Fishery					All Gears
	Unit 1				Unit 2			Unit 3			Units 4 & 5					Unit 1	Unit 2	Unit 3	Unit 4		
Year	OH	MI	ON	Total	OH	ON	Total	OH	ON	Total	ON	PA	NY	Total	Total	ON	ON	ON	ON	Total	Total
1975	2.53	2.53	3.26	2.59	1.53	--	1.53	--	--	--	--	--	--	--	2.48	--	--	--	--	--	2.42
1976	2.49	2.49	2.35	2.48	2.05	--	2.05	--	--	--	--	--	--	--	2.46	1.51	1.51	--	--	1.51	2.29
1977	3.29	3.29	2.64	3.27	2.44	--	2.44	--	--	--	--	--	--	--	3.26	2.74	2.74	--	--	2.74	3.21
1978	3.50	3.62	3.07	3.48	3.33	--	3.33	--	--	--	--	--	--	--	3.48	2.69	2.69	--	--	2.69	3.37
1979	2.71	2.71	2.67	2.71	2.29	--	2.29	--	--	--	--	--	--	--	2.70	2.83	2.83	--	--	2.83	2.72
1980	3.00	3.00	2.84	3.00	2.92	--	2.92	2.65	--	2.65	--	--	--	--	2.99	2.96	2.96	--	--	2.96	2.98
1981	3.61	2.97	3.47	3.59	2.62	--	2.62	2.72	--	2.72	--	--	--	--	3.56	3.00	3.00	2.99	--	3.00	3.41
1982	3.25	3.25	2.76	3.24	2.58	--	2.58	2.51	--	2.51	--	--	--	--	3.23	2.81	2.81	2.81	--	2.81	3.12
1983	3.03	3.03	3.17	3.03	2.25	--	2.25	2.07	--	2.07	--	--	--	--	2.94	3.47	3.47	3.47	--	3.47	3.15
1984	2.64	2.64	2.90	2.64	2.61	--	2.61	2.68	--	2.68	--	--	--	--	2.64	2.89	2.89	2.89	--	2.89	2.72
1985	3.36	3.36	3.17	3.36	3.24	--	3.24	3.58	--	3.58	--	--	--	--	3.35	3.04	3.04	3.04	--	3.04	3.24
1986	3.73	3.61	3.54	3.71	3.69	--	3.69	4.08	--	4.08	--	--	--	--	3.72	3.61	3.70	4.22	--	3.71	3.72
1987	3.83	3.32	3.78	3.73	3.68	--	3.68	4.10	--	4.10	--	--	--	--	3.73	3.71	3.47	3.40	--	3.61	3.69
1988	3.97	3.43	4.58	3.78	3.81	--	3.81	5.37	--	5.37	--	--	4.87	4.87	3.93	3.27	3.15	3.89	--	3.32	3.74
1989	4.48	3.75	4.29	4.28	4.65	4.29	4.64	5.13	4.29	5.00	--	--	5.59	5.59	4.44	3.49	3.51	4.22	--	3.60	4.16
1990	4.44	4.64	5.00	4.52	5.31	5.41	5.31	6.41	5.41	6.36	--	--	5.70	5.70	4.90	3.91	3.90	4.60	--	3.99	4.49
1991	4.91	5.29	5.01	4.95	6.22	6.03	6.20	6.70	5.91	6.58	--	--	6.36	6.36	5.41	4.21	4.63	5.14	--	4.41	4.85
1992	4.60	3.49	3.45	4.43	4.89	6.72	5.15	5.67	6.42	5.73	--	--	6.35	6.35	4.71	4.03	4.23	5.49	--	4.27	4.46
1993	4.60	4.41	4.09	4.57	5.79	6.45	5.83	5.98	6.17	5.99	--	--	6.15	6.15	4.96	3.64	4.38	5.21	--	4.00	4.42
1994	4.53	4.19	5.84	4.49	5.38	6.41	5.45	6.22	6.85	6.28	--	--	6.49	6.49	4.93	3.65	4.36	5.60	--	4.03	4.32
1995	4.04	3.55	4.74	4.02	6.07	7.29	6.12	6.08	7.17	6.33	--	--	6.80	6.80	4.48	3.38	4.63	5.92	--	3.94	4.08
1996	3.98	3.46	4.31	3.93	4.22	7.22	4.26	6.06	7.57	6.22	--	--	6.47	6.47	4.35	3.57	3.36	5.21	--	3.73	3.91
1997	4.21	3.99	4.21	4.18	5.30	5.30	5.30	6.27	6.27	6.22	--	--	6.25	6.25	4.67	3.87	3.68	4.83	--	3.96	4.11
1998	3.74	3.13	3.15	3.69	4.66	8.09	4.74	4.64	7.81	4.69	9.55	--	10.13	9.92	4.32	3.26	4.00	5.26	7.00	3.72	3.82
1999	3.72	3.16	3.43	3.63	5.35	9.17	5.48	5.95	10.00	6.18	8.15	--	10.29	9.32	4.55	3.41	4.29	5.28	6.76	3.81	3.89
2000	3.94	3.27	--	3.76	4.12	--	4.12	6.36	--	6.36	--	--	9.75	9.75	4.55	3.69	4.67	5.65	6.46	4.11	4.12
2001	3.66	3.02	--	3.57	4.09	--	4.09	6.14	--	6.14	--	7.70	9.09	8.01	3.99	3.19	3.77	5.52	6.00	3.57	3.75
2002	3.80	3.83	--	3.81	4.57	--	4.57	5.46	--	5.46	--	6.59	8.05	7.25	4.21	3.22	3.50	5.37	5.80	3.54	3.78
2003	4.67	4.16	--	4.59	4.67	--	4.67	5.87	--	5.87	3.35	7.50	10.01	8.45	4.90	3.68	4.36	5.58	6.59	4.09	4.46
2004	4.77	4.41	--	4.70	5.11	6.56	5.11	6.42	--	6.42	--	5.86	11.11	7.41	5.01	2.96	2.59	3.49	6.07	2.96	3.82
2005	5.33	4.26	3.35	5.23	4.21	--	4.21	5.53	--	5.53	--	6.61	6.72	6.68	5.22	3.61	3.16	4.64	4.70	3.66	3.96
2006	3.86	3.24	--	3.73	3.68	--	3.68	4.57	--	4.57	--	4.10	6.38	4.55	3.85	3.19	3.19	3.44	4.82	3.26	3.50
2007	4.64	4.42	--	4.62	4.79	--	4.79	4.89	--	4.89	--	4.89	6.80	5.27	4.71	4.20	4.29	4.25	6.55	4.26	4.50
2008	5.42	5.60	--	5.46	5.90	--	5.90	5.21	--	5.21	--	5.67	7.21	6.10	5.57	5.21	5.38	5.06	8.28	5.29	5.42
2009	5.39	4.78	--	5.30	6.14	--	6.14	6.43	--	6.43	--	6.47	6.84	6.56	5.70	4.67	5.17	5.40	7.45	4.93	5.33
Mean	3.93	3.64	3.66	3.89	4.12	6.58	4.14	5.06	6.72	5.07	7.02	6.16	7.43	6.83	4.11	3.43	3.63	4.55	6.37	3.58	3.80

Table 8. Estimated abundance at age, survival (S), fishing mortality (F) and exploitation (u) for Lake Erie walleye, 1980-2009 (from ADMB-EO model catch at age analysis, M=0.32). Projected 2010 ages 3 to 7+ population is based on survival from 2009, and 2010 age-2 projection is from the regression of pooled trawl YOY data and ADMB age-2 walleye abundance (see Table 9).

	Age							Ages 2+		
Year	2	3	4	5	6	7+	Total	S	F	u
1980	11,693,000	10,200,100	419,818	1,005,950	166,154	28,556	23,513,578	0.575	0.233	0.179
1981	7,159,700	7,591,620	5,122,720	209,212	501,308	97,220	20,681,780	0.444	0.492	0.337
1982	11,802,500	4,234,180	2,789,450	1,864,490	76,146	218,415	20,985,181	0.535	0.306	0.227
1983	7,727,240	7,307,190	1,815,170	1,184,700	791,862	126,576	18,952,738	0.574	0.236	0.181
1984	54,051,100	5,060,330	3,801,090	931,597	608,022	472,861	64,925,000	0.634	0.136	0.109
1985	4,952,830	35,483,000	2,647,650	1,966,640	481,999	563,905	46,096,024	0.611	0.172	0.136
1986	19,418,800	3,396,290	21,383,600	1,585,980	1,178,050	629,970	47,592,690	0.609	0.176	0.139
1987	18,082,400	13,050,700	1,934,970	12,076,800	895,711	1,026,400	47,066,981	0.610	0.174	0.138
1988	45,164,000	12,161,100	7,473,870	1,100,800	6,870,470	1,100,050	73,870,290	0.617	0.163	0.130
1989	11,960,800	29,877,600	6,667,760	4,067,750	599,126	4,345,550	57,518,586	0.586	0.215	0.167
1990	9,628,470	7,997,950	16,865,200	3,736,480	2,279,490	2,801,020	43,308,610	0.612	0.170	0.135
1991	5,669,340	6,552,500	4,762,720	9,971,540	2,209,190	3,023,950	32,189,240	0.625	0.150	0.119
1992	13,596,500	3,904,100	4,026,920	2,903,280	6,078,500	3,215,510	33,724,810	0.619	0.159	0.126
1993	19,786,900	9,208,710	2,277,930	2,325,950	1,676,940	5,400,190	40,676,620	0.592	0.204	0.159
1994	3,606,890	13,008,100	4,893,550	1,191,470	1,216,590	3,778,230	27,694,830	0.564	0.254	0.193
1995	13,709,800	2,396,080	7,156,630	2,648,320	644,807	2,760,700	29,316,337	0.583	0.219	0.169
1996	14,912,400	8,980,960	1,259,760	3,687,810	1,364,680	1,803,910	32,009,520	0.535	0.306	0.228
1997	1,986,940	9,349,900	4,110,110	561,425	1,643,510	1,448,930	19,100,815	0.518	0.337	0.247
1998	15,046,300	1,286,010	4,738,070	2,036,870	278,229	1,560,070	24,945,549	0.558	0.263	0.199
1999	6,888,840	9,446,720	590,221	2,120,800	911,722	852,965	20,811,268	0.546	0.284	0.213
2000	5,949,160	4,440,610	4,726,050	288,640	1,037,150	879,314	17,320,924	0.544	0.288	0.216
2001	17,091,400	3,823,430	2,210,470	2,301,890	140,586	949,468	26,517,244	0.618	0.161	0.128
2002	1,484,970	11,309,700	2,071,860	1,182,100	1,230,990	594,378	17,873,998	0.614	0.168	0.133
2003	12,650,000	1,018,270	6,883,530	1,250,610	713,535	1,106,880	23,622,825	0.627	0.147	0.118
2004	290,531	8,533,180	586,844	3,921,550	712,473	1,049,490	15,094,068	0.622	0.155	0.123
2005	58,928,800	204,556	5,304,030	362,264	2,420,810	1,095,250	68,315,710	0.649	0.112	0.091
2006	1,809,600	39,443,300	109,108	2,771,260	189,276	1,857,380	46,179,924	0.621	0.156	0.124
2007	3,233,860	1,277,440	24,376,900	67,047	1,702,940	1,268,740	31,926,927	0.605	0.183	0.143
2008	1,282,590	2,261,450	764,786	14,474,900	39,812	1,775,070	20,598,608	0.601	0.189	0.148
2009	26,867,400	894,968	1,352,920	453,454	8,582,420	1,092,110	39,243,272	0.680	0.065	0.054
2010	3,586,001	18,971,041	561,038	843,045	282,561	6,035,330	30,279,015			

Table 9. Data used to estimate the recruitment of age-2 walleye by linear regression. Y is the ADMB EO model estimate of age-2 walleye and X is the mean catch per hectare of age-0 walleye for combined Ohio and Ontario August trawls. Values in bold are the regression estimates and are used for RAH projections in 2010 and forecast estimates of recruits in 2010 and 2011. Regression statistics are given at the bottom of the page.

Year Class	Year of Recruitment to Fisheries	OH+ONT Trawl Age-0 CPHa	ln (OH+ONT Trawl CPHa)	ADMB-estimated Age-2 walleye recruits (in millions)	ln (ADMB-estimated Age-2 walleye recruits in millions)
1988	1990	18.28	2.906	9.628	2.265
1989	1991	6.09	1.807	5.669	1.735
1990	1992	39.43	3.675	13.597	2.610
1991	1993	59.86	4.092	19.787	2.985
1992	1994	6.71	1.904	3.607	1.283
1993	1995	105.91	4.663	13.710	2.618
1994	1996	63.92	4.158	14.912	2.702
1995	1997	2.96	1.087	1.987	0.687
1996	1998	85.34	4.447	15.046	2.711
1997	1999	24.18	3.186	6.889	1.930
1998	2000	14.31	2.661	5.949	1.783
1999	2001	44.19	3.788	17.091	2.839
2000	2002	4.11	1.414	1.485	0.395
2001	2003	28.67	3.356	12.650	2.538
2002	2004	0.14	-1.965	0.291	-1.236
2003	2005	183.02	5.210	58.929	4.076
2004	2006	5.33	1.673	1.810	0.593
2005	2007	12.67	2.539	3.234	1.174
2006	2008	2.05	0.718	1.283	0.249
2007 [1]	2009	25.41	3.235		
2008 [2]	2010	7.24	1.979	**3.586**	
2009 [3]	2011	6.75	1.910	**3.414**	

[1] The latest ADMB age-2 estimate has the widest error bounds and is not used in the recruitment estimator.
[2] This regression estimate is for 2010 age-2 recruitment projection.
[3] This regression estimate is for 2011 age-2 recruitment projection.

Note: The regression equation, with standard errors in parentheses, was,

$Y = 0.7055\ (0.0496)\ X - 0.1194\ (0.1573)$

with $n = 19$, $F = 202$, $p < 0.0001$ and $r^2 = 0.9225$.

Table 10. Estimated population of Lake Erie walleye for 2010 based on fishing mortality (F) and survival (S) at age from ADMB EO model. An alternate age-2 estimate for 2009 is presented based on regression of age-2 CUEs in survey gear and ADMB estimates. Age-2 walleye estimates for 2010 are from regressions presented in Table 9.

	2009 Parameters				Rate Functions					2010 Parameters			
	Stock Size (numbers)				Mortality Rates				Survival		2010 Stock Size (mils of fish)		
Age	**Mean**	**Std. Err.**	**Min.**	**Max.**	**(F)**	**(Z)**	**(A)**	**(u)**	**(S)**	**Age**	**Mean**	**Min.**	**Max.**
2*	11.782		9.253	15.010	0.028	0.348	0.294	0.024	0.706	2	3.586	2.778	4.630
3	0.895	0.229	0.666	1.124	0.147	0.467	0.373	0.117	0.627	3	8.319	6.534	10.599
4	1.353	0.300	1.053	1.653	0.153	0.473	0.377	0.122	0.623	4	0.561	0.418	0.704
5	0.453	0.093	0.360	0.547	0.153	0.473	0.377	0.122	0.623	5	0.843	0.656	1.030
6	8.582	1.689	6.894	10.271	0.153	0.473	0.377	0.122	0.623	6	0.283	0.225	0.341
7+	1.092	0.205	0.887	1.297	0.143	0.463	0.371	0.114	0.629	7+	6.035	4.854	7.216
Total	24.158		19.114	29.901	0.089	0.409	0.336	0.073	0.664	Total	19.627	15.464	24.520
(3+)	12.376		9.861	14.891	0.152	0.472	0.376	0.121	0.624	(3+)	16.041	12.686	19.890

* Age-2 estimates presented here are based on a regression of age-2 CUE in survey gear and ADMB estimates. Please see text for further details.

Table 11. Estimated harvest of Lake Erie walleye for 2010 and population projection for 2011. Fishing mortality for the fully-selected age groups is derived from the regression equation described in the Harvest Policy section of this report. Abundance of age 2 and older walleye is from ADMB-EO model catch-age results, adjustment to the 2007 cohort estimate in 2009, and trawl regressions. Stock size and catch in numbers are in millions of fish.

	2010 Stock Size (millions)					Rate Functions					2010 RAH (millions of fish)			Projected 2011 Stock Size (millions)
Age	**Min**	**Mean**	**Max**	**F**	**sel(age)**	**(F)**	**(Z)**	**(S)**	**(u)**		**Min**	**Mean**	**Max**	**Mean**
2	2.778	3.586	4.630		0.183	0.035	0.355	0.701	0.030		0.055	0.107	0.166	3.414
3	6.534	8.319	10.599		0.961	0.185	0.505	0.603	0.146		0.684	1.211	1.837	2.514
4	0.418	0.561	0.704		1.000	0.193	0.513	0.599	0.151		0.046	0.085	0.127	5.018
5	0.656	0.843	1.030		1.000	0.193	0.513	0.599	0.151		0.072	0.127	0.185	0.336
6	0.225	0.283	0.341		1.000	0.193	0.513	0.599	0.151		0.024	0.043	0.061	0.505
7+	4.854	6.035	7.216		0.935	0.180	0.500	0.606	0.142		0.495	0.857	1.221	3.828
Total	15.464	19.627	24.520	0.193					0.124	**RAH 2+**	1.376	2.429	3.597	15.615
(3+)	12.686	16.041	19.890							**RAH 3+**	1.321	2.323	3.431	12.201
										F	0.109	0.193	0.234	

	2011 Stock Size (millions)			Rate Functions				Projected 2011 RAH (millions of fish)	Projected 2012 Stock Size (millions)
Age	**Mean**	**F**	**sel(age)**	**(F)**	**(Z)**	**(S)**	**(u)**	**Mean**	**Mean**
2	3.414		0.183	0.020	0.340	0.711	0.017	0.059	*
3	2.514		0.961	0.108	0.428	0.652	0.088	0.220	2.429
4	5.018		1.000	0.112	0.432	0.649	0.091	0.456	1.639
5	0.336		1.000	0.112	0.432	0.649	0.091	0.031	3.258
6	0.505		1.000	0.112	0.432	0.649	0.091	0.046	0.218
7+	3.828		0.935	0.105	0.425	0.654	0.085	0.327	2.831
Total	15.615	0.112					0.073	1.139	--
(3+)	12.201								10.375

* No estimate of the 2010 cohort recruiting in 2012 is available.

Table 12. Eastern basin walleye ADMB catch-at-age 2009 model results in numbers of fish (a) and biomass (b) by age, based on PA, NY and ONT Units 4 and 5 data; M=0.16.

(a)

Abundance	Age										
Year	2	3	4	5	6	7	8	9	10	11+	Total
1993	221,069	370,521	166,548	270,448	63,643	200,408	106,008	142,455	18,890	39,077	1,599,068
1994	92,221	188,115	307,576	122,968	193,097	45,440	143,089	75,688	101,711	42,166	1,312,072
1995	326,313	78,362	151,746	187,432	73,106	114,799	27,015	85,068	44,998	87,378	1,176,217
1996	626,037	277,648	65,119	117,091	133,262	51,978	81,621	19,207	60,483	94,864	1,527,310
1997	46,212	531,820	224,023	42,755	68,212	77,633	30,280	47,549	11,189	92,923	1,172,596
1998	389,799	39,320	440,858	164,121	30,242	48,248	54,912	21,418	33,632	75,577	1,298,127
1999	99,757	331,615	32,509	319,662	113,899	20,987	33,484	38,108	14,864	77,402	1,082,287
2000	510,195	84,832	272,638	23,560	211,670	75,420	13,897	22,172	25,234	62,378	1,301,995
2001	395,633	433,555	68,709	176,584	14,230	127,851	45,554	8,394	13,392	54,929	1,338,832
2002	41,104	336,487	356,534	48,102	118,379	9,540	85,709	30,539	5,627	47,229	1,079,249
2003	569,455	34,982	280,113	268,255	34,969	86,060	6,935	62,309	22,201	39,234	1,404,513
2004	29,528	484,505	28,951	201,403	188,234	24,538	60,388	4,866	43,722	44,074	1,110,210
2005	5,645,580	25,147	408,483	23,272	159,676	149,235	19,454	47,877	3,858	70,000	6,552,582
2006	19,301	4,808,920	21,270	333,860	18,865	129,440	120,977	15,770	38,811	60,340	5,567,555
2007	368,759	16,425	3,991,610	15,590	238,710	13,489	92,550	86,498	11,276	72,216	4,907,122
2008	438,373	312,327	12,431	1,608,430	6,142	94,042	5,314	36,461	34,077	37,905	2,585,501
2009	1,596,170	373,242	261,840	9,570	1,232,080	4,705	72,037	4,071	27,930	55,777	3,637,421

(b)

Biomass (kgs)	Age										
Year	2	3	4	5	6	7	8	9	10	11+	Total
1993	126,231	397,198	179,039	397,830	104,629	453,724	251,557	422,664	62,640	135,989	2,531,501
1994	63,264	197,332	381,702	235,115	511,513	103,513	387,770	219,950	306,048	146,739	2,552,946
1995	225,809	83,690	201,063	364,555	130,641	236,255	77,344	260,309	135,398	295,601	2,010,665
1996	400,038	258,213	103,279	211,935	265,592	106,971	210,745	55,817	181,993	330,127	2,124,710
1997	29,529	494,592	355,300	77,386	135,947	159,769	78,184	138,177	33,669	323,371	1,825,924
1998	249,081	36,567	699,201	297,059	60,271	99,295	141,782	62,240	101,200	263,009	2,009,706
1999	86,290	358,476	53,672	627,497	229,506	44,661	88,364	104,988	37,784	253,954	1,885,192
2000	368,361	112,996	425,316	39,816	441,755	173,767	35,160	72,236	72,144	193,997	1,935,547
2001	272,987	492,519	97,979	338,512	22,726	271,683	144,499	25,459	43,832	180,935	1,891,131
2002	23,100	414,888	505,208	85,044	247,886	18,631	213,930	86,364	14,805	154,817	1,764,674
2003	397,480	49,289	431,094	417,404	65,287	215,494	19,474	147,610	54,060	116,445	1,913,638
2004	19,813	565,418	36,739	386,694	397,926	55,161	150,306	12,215	107,600	109,481	1,841,353
2005	3,122,010	25,022	554,720	43,146	334,201	335,629	50,347	127,160	9,495	183,259	4,784,989
2006	26,173	8,689,720	39,435	850,007	42,428	256,810	527,216	55,874	202,244	223,559	10,913,466
2007	221,624	17,065	4,482,580	22,122	358,781	26,762	227,581	172,218	20,657	167,974	5,717,364
2008	286,696	315,762	16,595	2,557,410	7,849	205,670	13,067	96,877	88,702	92,904	3,681,533
2009	1,016,760	356,820	343,796	16,594	2,121,630	10,148	186,072	10,482	78,510	150,710	4,291,521

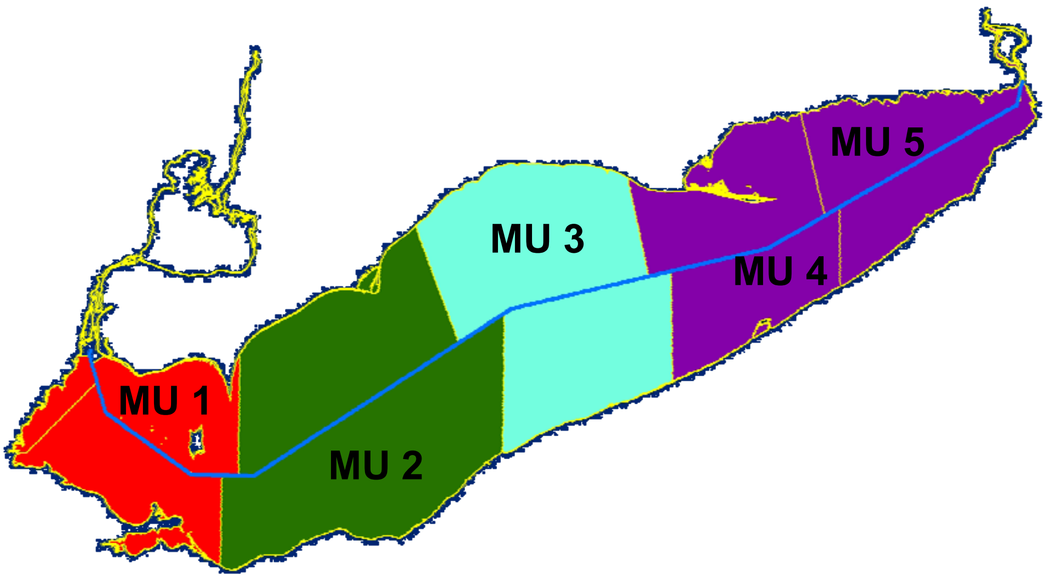

Figure 1. Map of Lake Erie with management units recognized by the Walleye Task Group for interagency management of walleye.

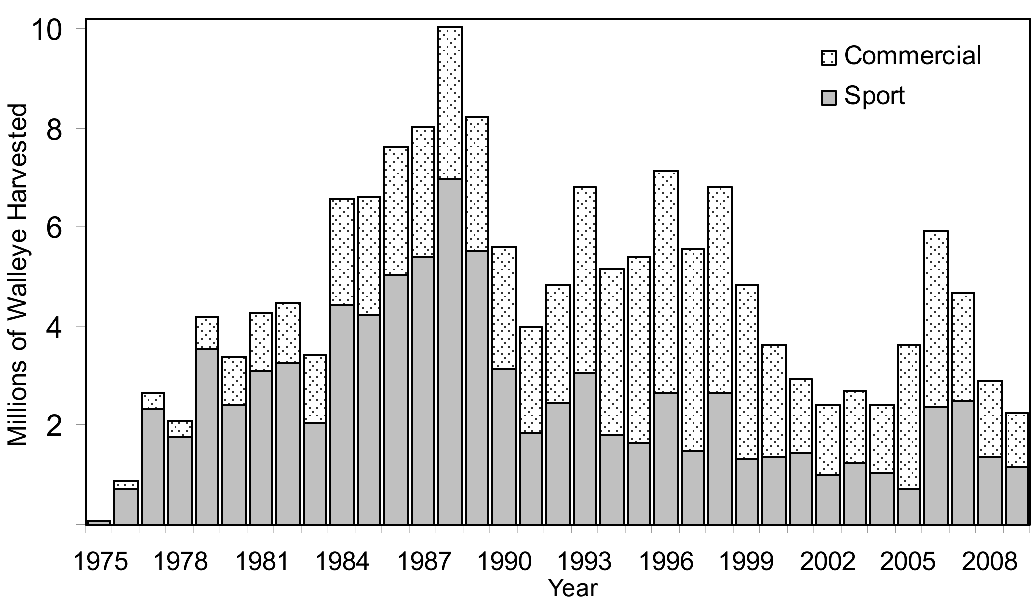

Figure 2. Lake-wide harvest of Lake Erie walleye by sport and commercial fisheries, 1975-2009.

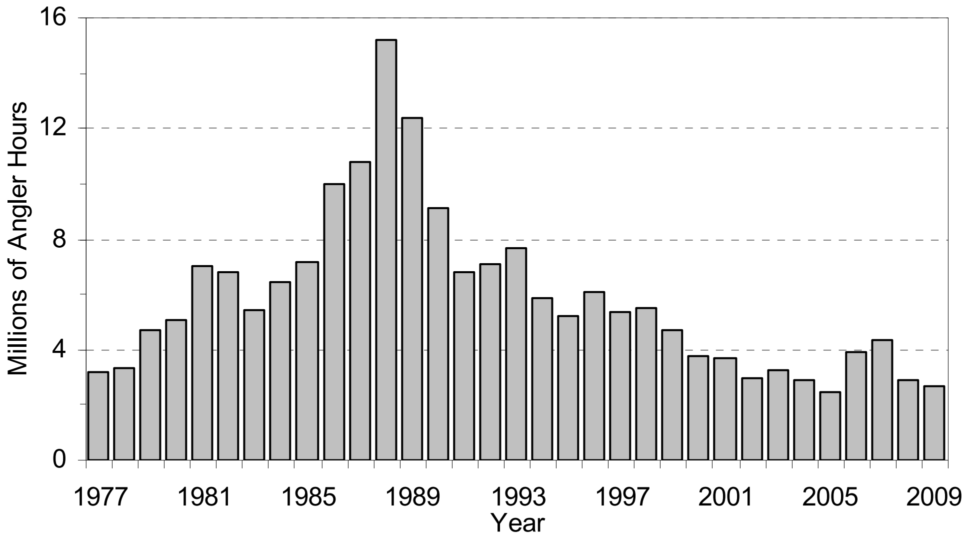

Figure 3. Lake-wide total effort (angler hours) by sport fisheries for Lake Erie walleye, 1975-2009. Years 1999-2009 exclude Ontario sport effort.

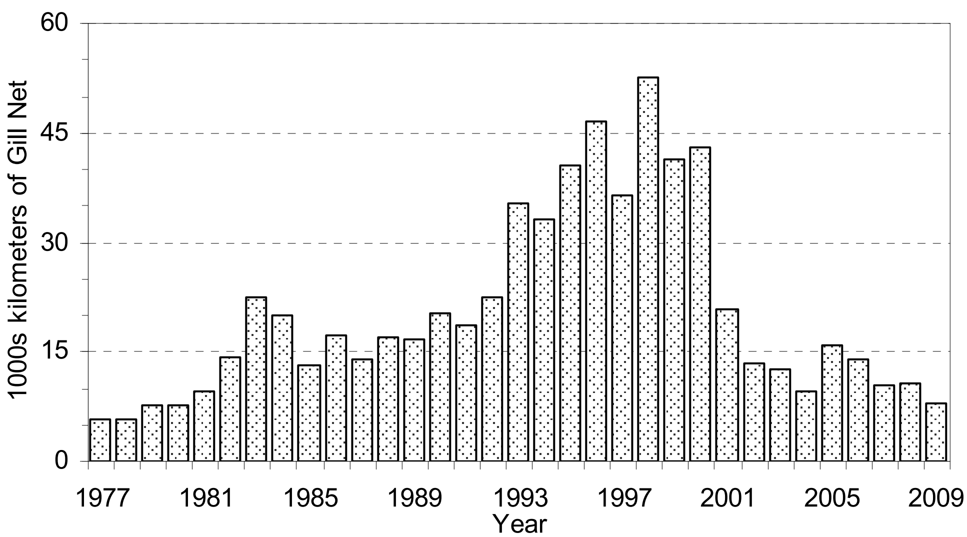

Figure 4. Lake-wide total effort (kilometers of gill net) by commercial fisheries for Lake Erie walleye, 1975-2009.

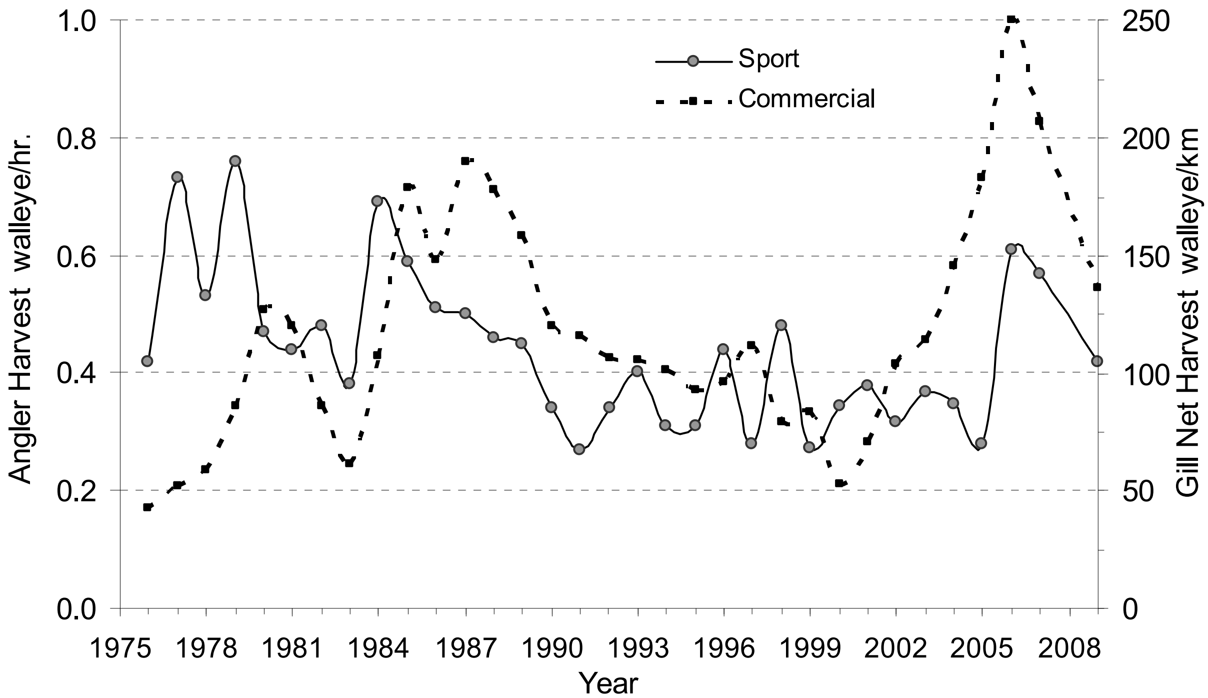

Figure 5. Lake-wide harvest per unit effort (HPE) for Lake Erie sport and commercial walleye fisheries, 1975-2009.

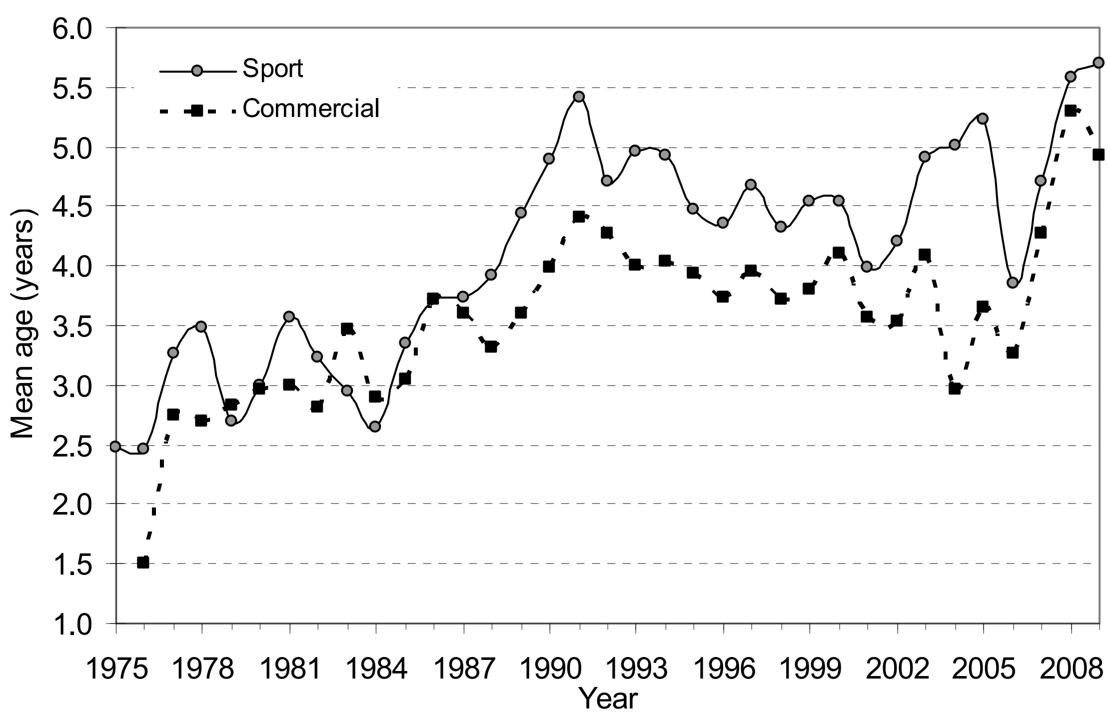

Figure 6. Lake-wide mean age of Lake Erie walleye in sport and commercial harvests, 1975-2009.

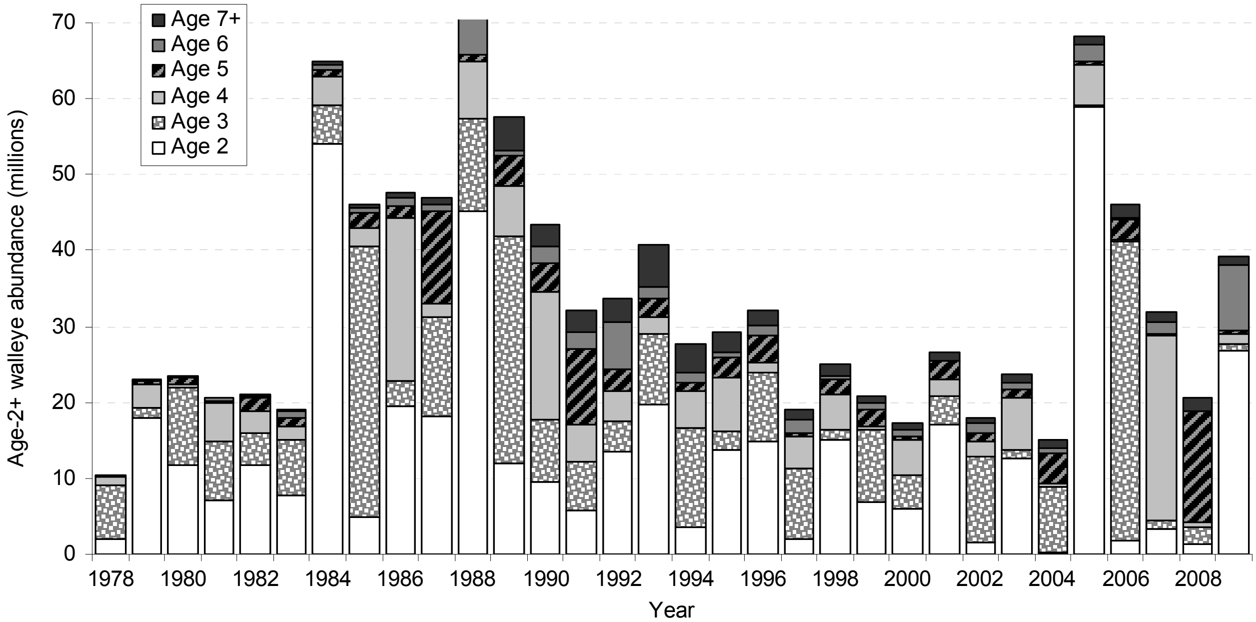

Figure 7. Estimates of abundance by age of Lake Erie walleye 1978-2009. Data are from Table 8.

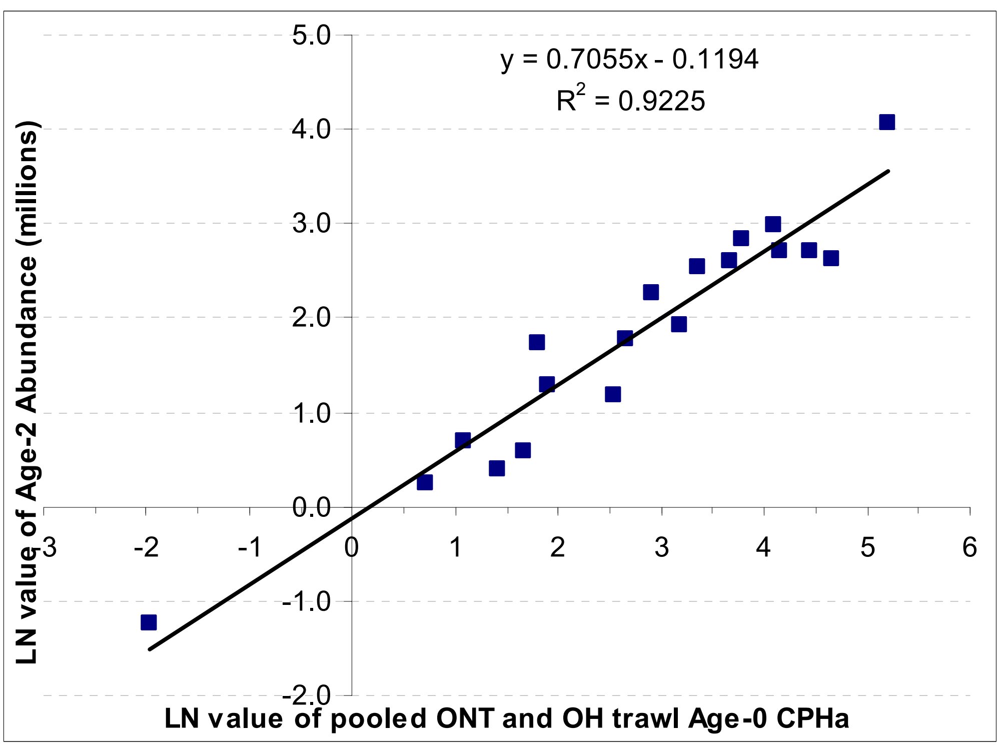

Figure 8. Regression estimates of abundance for age-2 Lake Erie walleye using natural logarithm transformed ADMB 2010 model catch-at-age estimates (y) and pooled Ontario and Ohio young-of-the-year trawl indices (x).

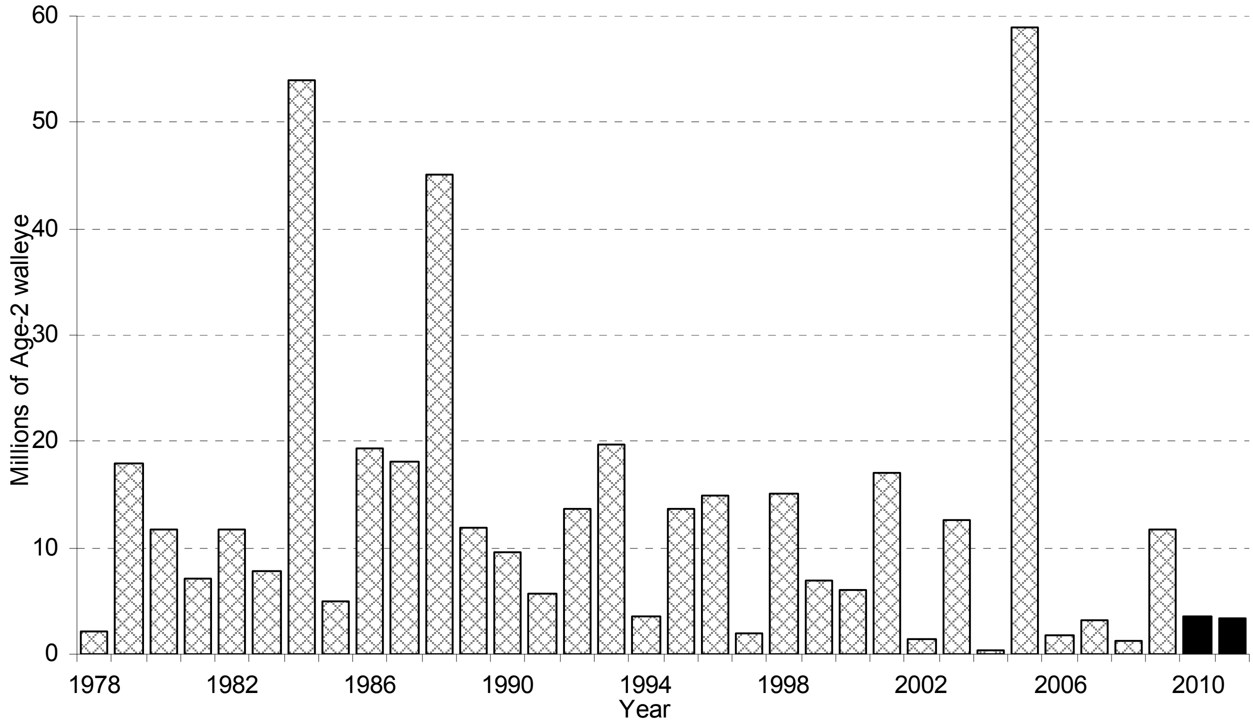

Figure 9. Catch-at-age estimates (from the ADMB EO model using the adjusted age-2 estimate) of age-2 Lake Erie walleye for 1978 to 2009. Estimates for 2010-2011 are from the regression of YOY catch per hectare and numbers of age-2 from catch-at-age analysis (see Table 9).

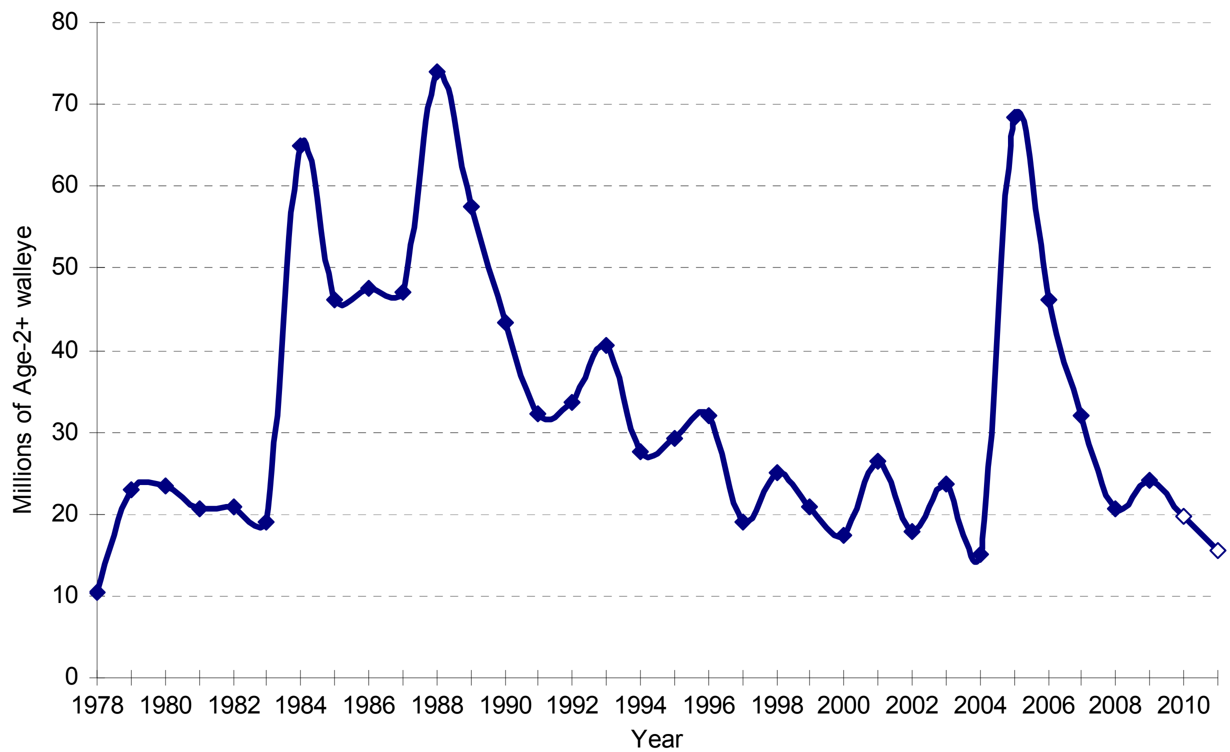

Figure 10. Abundance of Lake Erie walleye (from the ADMB EO model using the adjusted age-2 estimate) from 1978-2011, forecasting two years of population abundance from regressions (open diamonds).

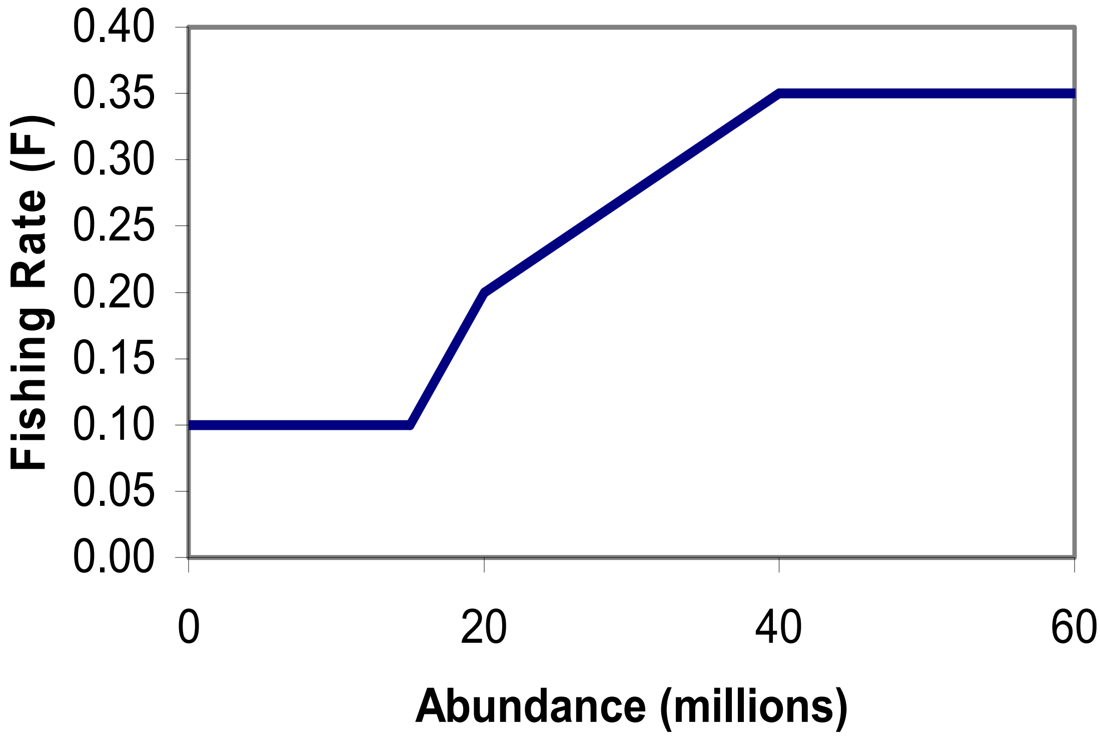

Figure 11. Lake Erie walleye harvest policy for age-2 and older walleye: below 15 million fish, F=0.1; between 15 and 20 million fish, F= 0.02(N)-0.02 (N is abundance in millions of fish); between 20 and 40 million fish, F= 0.0075(N)+0.05; and at 40 million fish and above, F=0.35.

Appendix 1. Abundance estimates of the 2007 year class at age 2 by assessment group using age-specific CUEs in regressions with ADMB estimates. *

Group	Age-2 estimate (mils of fish)
Age 0	10.6
Age 1	8.8
Age 2	16.3
All Ages and Gear	12.0
All Surveys	10.0
All Trawl Surveys	9.4
All Index Gill Net Surveys	11.4
Age 2 in All Index Gill Net Surveys	11.8 **
Age 2 in All Fisheries	20.9
ADMB-EO 2009 Run	26.9

* Fisheries catch rates were standardized by dividing by ADMB age 2 selectivity estimates.
** Value used to provide estimate of 2007 cohort in 2009.

Appendix 2. Lambda (λ) values and relative number of terms associated with catch-at-age analysis data sources.

Model	Data Source	λ	Relative Number of Terms
West/Central Basin	Commercial Gill Net Effort	0.7	1
Variance Ratio Lambdas	Ohio Sport Effort	1.0	1
(results not presented;	Michigan Sport Effort	0.8	1
Walleye Task Group 2009)	Commercial Gill Net Harvest	1.0	6
	Ohio Sport Harvest	0.4	6
	Michigan Sport Harvest	0.1	6
	Partnership Gill Net Index Catch Rates	1.0	6
	Ohio Index Survey Catch Rates	0.4	6
	Michigan Index Survey Catch Rates	0.7	6
West/Central Basin	Commercial Gill Net Effort	0.89	1
Expert Opinion Lambdas	Ohio Sport Effort	0.86	1
(results presented in Table 8)	Michigan Sport Effort	0.80	1
	Commercial Gill Net Harvest	0.91	6
	Ohio Sport Harvest	0.85	6
	Michigan Sport Harvest	0.76	6
	Partnership Gill Net Index Catch Rates	1.00	6
	Ohio Index Survey Catch Rates	0.87	6
	Michigan Index Survey Catch Rates	0.75	6
East Basin	Sport Effort (New York + Pennsylvania)	1.0	1
Variance Ratio Lambdas	Commercial Gill Net Effort	0.4	1
(results presented in Table 12)	Sport Harvest (New York + Pennsylvania)	0.9	10
	Commercial Gill Net Harvest	1.0	10
	Partnership Gill Net Index Catch Rates	1.0	10
	New York Index Survey Catch Rates	0.4	10