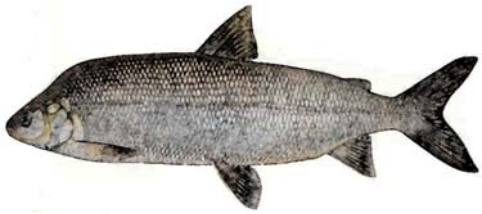
Technical Fisheries Committee Administrative Report 2008: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan, with recommended yield and effort levels for 2008



A Report Submitted by the Modeling Subcommittee to the Technical Fisheries Committee

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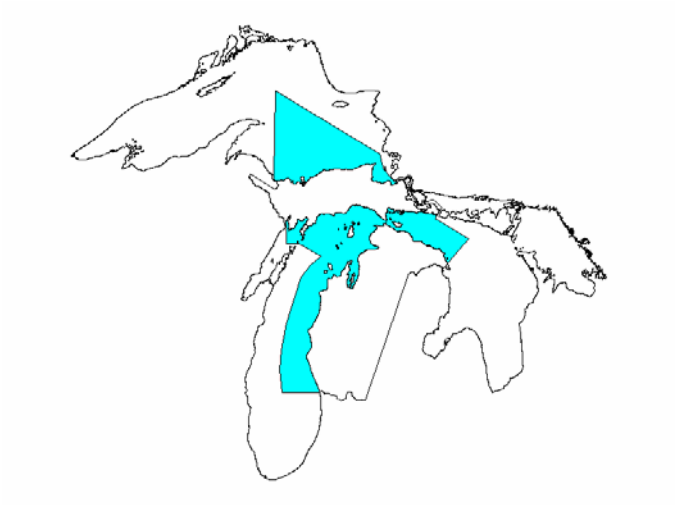

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Table of Contents

EXECUTIVE SUMMARY

Prepared by David C. Caroffino and Stephen J. Lenart

In August 2000, Bay Mills Indian Community, Sault Ste. Marie Tribe of Chippewa Indians, Grand Traverse Band of Ottawa and Chippewa Indians, Little Traverse Bay Bands of Odawa Indians, Little River Band of Ottawa Indians, the United States of America, and the State of Michigan settled upon a negotiated agreement (Consent Decree) to resolve issues of allocation, management, and regulation of fishing in 1836 Treaty-ceded waters of lakes Superior, Michigan, and Huron (U.S. v. Michigan 2000). The provisions of the Consent Decree were to be implemented by the five tribes of the Chippewa/Ottawa Resource Authority (CORA), the United States Department of Interior's U.S. Fish and Wildlife Service (USFWS), and the State of Michigan's Department of Natural Resources (MDNR). The Consent Decree outlines a specific lake trout management regime that regulates the fishery though yield and effort limits established through maximum lake trout mortality rates. In management units where the state and tribes share the commercial whitefish harvest, maximum whitefish mortality rates are regulated with yield limits for each party. The Consent Decree provides specific guidelines on how these yield and effort limits are to be calculated. In management units where the whitefish harvest is not shared, whitefish Harvest Regulation Guidelines (HRG) are established by CORA according to provisions of the Tribal Management Plan for the 1836 Treaty Great Lakes Waters. A Modeling Subcommittee (MSC) of the Technical Fisheries Committee (TFC) was established and charged with developing the annual yield and effort limits required by the Consent Decree.

For 2008, the MSC assessed population status and mortality rates of 18 different stocks of lake whitefish and nine stocks of lake trout that are within 1836 Treaty-ceded waters. The MSC developed and fit statistical catch-at-age (SCAA) models using a nonlinear modeling and statistics program (AD Model Builder, Otter Research Ltd.) to estimate age- and year-specific population abundance and mortality rates. Insufficient data prevented development of reliable SCAA models in three lake whitefish units, so an alternative, descriptive approach was used. The estimates of abundance and mortality were combined with growth and maturity data for whitefish and lake trout in each stock or management unit to project recommended yield levels for the 2008 fishing season. Recommended yield limits were obtained by either limiting mortality to a maximum rate or achieving a minimum spawning potential reduction. The maximum allowable mortality rate (A) on whitefish was 65%, while the maximum mortality rate on lake trout was either 40, 45, or 47%. The target spawning potential reduction for whitefish was 20%. Harvest limits were allocated to State and CORA fisheries for each stock following the percentages for 2008 specified in the Consent Decree.

The 2008 MSC recommended harvest limits for whitefish and lake trout are provided in the table below as are the actual harvest and effort limits that were imposed based on terms of the

Consent Decree or Tribal Management Plan. Details are given in the text of the reports for units where recommended and actual harvest limits differ.

Species	Lake	Management unit	MSC recommended yield limit (lb)	Actual yield limit (lb)	Gill net limit (ft)
Lake trout	Superior	MI-5	126,400	149,345	NA
		MI-6	104,000	104,000	4.34 million
		MI-7	100,700	131,155	5.01 million
	Huron	MH-1	no estimate	230,000	6.31 million
		MH-2	46,000	85,794	NA
	Michigan	MM-1,2,3	*7,900	503,000	9.36 million
		MM-4	*80,350	(No TFC Consensus)	0.49 million
		MM-5	135,100	(No TFC Consensus)	0.74 million
		MM-6,7	567,628	305,239	NA
Lake whitefish	Superior	WFS-04	92,000	92,000	NA
		WFS-05	459,000	459,000	NA
		WFS-06	no estimate	210,000	NA
		WFS-07	535,000	535,000	NA
		WFS-08	195,000	195,000	NA
	Huron	WFH-01	231,000	384,000	NA
		WFH-02	432,000	432,000	NA
		WFH-03	no estimate	150,000	NA
		WFH-04	546,000	546,000	NA
		WFH-05	883,000	883,000	NA
	Michigan	WFM-01	2,261,000	2,261,000	NA
		WFM-02	558,000	558,000	NA
		WFM-03	2,551,000	2,551,000	NA
		WFM-04	945,000	945,000	NA
		WFM-05	342,000	342,000	NA
		WFM-06	201,000	201,000	NA
		WFM-07	no estimate	500,000	NA
		WFM-08	1,335,000	1,335,000	NA

*Calculated based on fully-phased mortality, for comparison only

In April 2008, the TFC could not reach consensus on MSC recommended lake trout harvest limits for MM-4 and MM-5. To date, harvest limits have not been finalized for these units, and negotiations between the parties are ongoing. This is the third consecutive year that harvest limits for these units were not finalized by the parties prior to the fishing season.

In Lake Superior there are self-sustaining stocks of lean lake trout, and the SCAA models and target mortality rates apply to these wild fish in three management areas (MI-5, MI-6, and MI-7). Stability of the MI-6 model was

increased in recent years by borrowing catchability parameters for the large-mesh survey in MI-5, in an effort to reduce the parameter load and stabilize the model's solution. Although direct harvest of spawning lake trout has impacted the MI-5 stock, total mortality rates in both MI-5 and MI-7 have been below targets, and increases in yield are possible. There have been no efforts to fit a stock assessment model for lake trout in MI-8 of Lake Superior because this is a deferred area. Weight-at-age of lake trout has declined since the 1970s and 1980s in Lake Superior, and tied to this is a shift toward later maturity. These changes in growth and maturation likely reflect increases in predator fish abundance and declines in the prey fish, most of which are less abundant than 20 years ago. Competitive effects of the abundant siscowet lake trout also likely play a role. Lower growth rates have led to decreases in lake trout biomass in all modeled Lake Superior units. Commercial fishery harvests in MI-5 and MI-7 continue to be low. As a result, commercial monitoring data is lacking for these units. This paucity of data may cause convergence issues for the Lake Superior models. Sea lamprey-induced mortality continues to climb in Lake Superior and is now the greatest individual source of mortality.

In the Lake Huron and Lake Michigan management areas wild lake trout are scarce, and the assessment models and target mortality rates apply to stocked fish. Lake trout mortality rates remain below target in both MH-1 and MH-2; however, rates have recently increased in MH-1. Commercial harvest by Tribal fishers declined in 2007, for the first time since 2003. However, recreational harvest more than doubled due to a declining salmon fishery. The Yield from the Canadian commercial fishery has also tripled since 2003. Lamprey induced mortality rates continue to be relatively low (< 0.10) in both MH-1 and MH-2. These low mortality rates have allowed harvest to increase in these units. Continued control of sea lamprey in MH-1 and MH-2 is necessary to keep mortality rates below target and allow potential increases in lake trout yield in Lake Huron. The MSC is concerned with its abilities to accurately estimate survival and abundance of juvenile lake trout in Lake Huron based on survey catches. The MSC will explore methods to better estimate juvenile lake trout survival, including the implementation of surveys designed to target juvenile lake trout.

In Lake Michigan units MM-123 and MM-4 lake trout mortality is above target rates. In MM-123, substantial rates of sea lamprey-induced mortality are causing the excessive total mortality. Biomass of young fish is growing; however, too few survive to reach spawning age. A Consent Decree Amendment dated 4 April 2007 set the harvest limit in MM-1,2,3 at 453,000 lb for CORA and 50,000 lb for the State. These limits have been imposed because excessive sea lamprey mortality would effectively prevent any commercial or recreational harvest if this species were managed according to the original Consent Decree mortality limits. This unit will remain in a state of excessive mortality until rates of sea lamprey mortality are controlled. In MM-4, total mortality only slightly exceeds target. Lamprey mortality is slightly above baseline 1998 levels, and harvest in this unit nearly doubled from 2006 to 2007. No agreement exists with regard to a harvest limit for this unit.

Total mortality rates are below target for MM-5 and MM-67. In both units,

harvest decreased between 2006 and 2007 and lamprey mortality is below the baseline level. A harvest limit was set for MM-67; however, similar to MM-4, the TFC could not agree on a harvest limit for MM-5, and one was not set for 2008.

In most management units, lake whitefish harvest has been well below established harvest limits, and total mortality rates are below target in all units with functioning stock assessment models. After substantial declines in the 1980s and 1990s, size-at-age for lake whitefish has recently stabilized and even increased in some units. In a number of stocks the decline in size has been accompanied by a decline in fish condition (weight for a given length). These patterns are most evident in the Lake Michigan and Lake Huron management areas. Recruitment has been variable in whitefish stocks, with some experiencing stable recruitment, near historic levels, others experiencing either low or stochastic recruitment.

Modeling efforts to describe the lake whitefish stocks in WFS-06, WFH-03, and WFM-07 have little utility for estimating allowable harvest due to a lack of data. However, descriptions of these units are still included in this document. In 2008, the WFS-06 HRG was set equal to its respective 2007 level. The HRG for WFH-03 was reduced to 150,000 lb from its 2003-2007 level of 306,000 lb. CORA implemented this change in order to be conservative in the face of potential increases in sea lamprey induced mortality on whitefish and declining yield in this unit. The HRG in WFM-07 remained consistent with previous levels.

In addition to providing assessments for each stock, the MSC also provides recommendations to the TFC to improve both data collection and the SCAA models. These recommendations include gathering accurate data on all forms of fishery extractions, continuing to implement fishery-independent surveys to assess abundance of lake whitefish, better delineating stock boundaries and movement patterns of lake whitefish, improving natural mortality estimates, refining estimates of hooking mortality on lake trout, improving the estimation of selectivity, refining our methods of estimating lake trout recruitment, developing methods of estimating time-varying catchability, and evaluating alternate harvest policies. The implementation of all these recommendations is not imminent and will require a significant and increased investment in staff, time, and other resources. The MSC continues to make progress by estimating throwbacks in the commercial fishery (e.g. MH-1), measuring and adding hooking mortalities from the recreational fishery into the models as harvest, continuing to conduct and expand the time series of fishery-independent lake whitefish surveys, performing sensitivity analyses of stock assessment models, performing retrospective analyses of stock assessment models, and completing studies in lakes Huron and Michigan to assess lake whitefish stock boundaries, movement, and mortality.

The MSC also continues to recommend a process that will allow us to provide timely stock assessment results and meet the strict deadlines imposed by the Consent Decree. The TFC has approved use of projected lake trout commercial fishery yield for the last few months of the year based on historic patterns. This has helped the MSC meet deadlines, but further steps

are necessary. The MSC presented a revised proposal for rotation of lake trout stock assessment models to the TFC in fall 2008. The plan calls for doing full stock assessments for the lake trout units in one lake each year, and only updating sea lamprey and harvest information in the other models. This procedure would still result in the calculation of an annual TAC in each unit, and a full assessment would be done once every three years in each unit. This plan will continue to be discussed and the MSC looks forward to resolution of this issue in 2009.

The MSC continues to urge the parties to meet Consent Decree and TFC mandated data submission deadlines. Some parties have repeatedly missed data deadlines in the past. Doing so makes it nearly impossible for the MSC to complete stock assessment models prior to its semi-annual meeting. This prevents the entire committee from reviewing the stock assessment and evaluating the current year's model. It also makes it difficult to provide adequately evaluated yield and effort limits to the TFC and the parties by already short Consent Decree deadlines.

The authors would like to recognize past contributions to this section by A. Woldt, J. Bence, and M. Ebener.

STOCK ASSESSMENT MODELS

Prepared by Shawn P. Sitar, James R. Bence, and Aaron P. Woldt

We used age-structured population models in two ways. The first was as a means to generate estimates of lake trout and lake whitefish abundance and mortality rates and describe how these have changed over time. The second was to project yield, harvest amounts, and associated effort that met criteria established as part of the 2000 Consent Decree. The first of these tasks was accomplished through applying statistical catch-at-age analysis (SCAA) as a means of estimating parameters determining fish abundance and mortality. These catch-age models operated with annual time steps and age-specific abundances. Mortality rates were estimated for each year through the last year for which data were available. Models were developed for stocks in each defined management area.

The second task built from the first, by projecting the estimated fish population forward through the 2008 fishing season, accounting for expected fishing and natural mortality and projecting the associated harvest and yield. The fishing mortality rates were adjusted in these projections to match upper bounds on fishing effort, fishery harvest, or total mortality while satisfying state and Tribal allocation as defined in the Consent Decree.

Statistical Catch-Age Analysis

A catch-at-age model was fit to the available data in each unit. Each model consisted of two components. The first was a sub-model that described the population dynamics of the stock. The second was a sub-model that predicted observed data, given the estimated population each year. The agreement between the model predictions and observed data was measured by statistical likelihood. Both the population and observation sub-models included adjustable parameters. Any given set of these parameters corresponded to a specific sequence of stock abundances, mortality rates, and predicted data. The set of such parameters and associated stock dynamics and mortality rates that maximized the likelihood (the maximum likelihood estimates) was taken as the best estimate.

Population sub-model

The basic population model was quite simple. Except for the first age and first year, abundance-at-age at the start of each year was calculated recursively as the proportion of the cohort surviving from the start of the previous year:

$$N_{a+1,y+1} = N_{a,y} P_{a,y}$$

The proportion surviving was modeled as

$$P_{a,y} = e^{-Z_{a,y}},$$

where $Z_{a,y}$ was the instantaneous mortality rate for age a and year y. Total annual mortality ($A = 1 - P$) increases with increasing Z, but asymptotes at 1.0. Mortality targets were usually expressed in terms of A, but could be expressed in terms of the equivalent Z.

A primary challenge in developing the stock assessment models was to break the total instantaneous mortality rate into components of interest that can be calculated from a suite of parameters, which can be estimated from available data. All the models include fishing mortality (F) and background natural mortality (M). All lake trout models and whitefish models for Lake Huron include sea lamprey induced mortality (ML). In addition, fishing mortality was usually broken into two subcomponents. Thus:

$$Za,y = F(1)_{a,y} + F(2)_{a,y} + M_a + ML_{a,y},$$

where $F(1)$ and $F(2)$ represent two fishery components (e.g., gill nets and trap nets, or sport and commercial). It was not possible to estimate all these rates as independent age- and year-specific components. To reduce the number of parameters, for each fishery component, the age- and year-specific fishing mortality rates are products of age-specific "selectivity" and year-specific "fishing intensity". In a purely separable model, selectivity was constant and thus each fishing mortality component was the product of an age (S) and year (f) effect:

$$F(i)a,y = S(i)_a f(i)_y$$

In many of our assessment models we have relaxed the separability assumption, to account for changing selectivity resulting from changes in size-at-age, fishery behavior, or other causes. To do this we modeled the relationship between selectivity and age with a four-parameter double logistic function that provides a flexible dome-shaped relationship between selectivity and age, and includes asymptotic increases with age as a special case. When time-varying selectivity was desired, one of the parameters of this function (that controls selectivity for younger ages) was allowed to vary gradually over time, following a quadratic function in time. Thus, selectivity patterns over time were described by the three parameters of the quadratic function and the three other parameters of the logistic function.

Fishing intensity was the fishing mortality rate for ages that had a selectivity of 1.0. Fishing intensities were not estimated freely, but instead were assumed to be proportional to effort, up to a multiplicative deviation:

$$f(i) = q(i)E(i)_y \zeta(i)_y,$$

where q was catchability (the proportionality constant), E was observed effort, and ζ was the deviation. During model fitting, large estimated deviations were penalized. However, in cases where fishery effort was not considered to be very informative regarding fishing mortality (generally for the lake trout models), this penalty was reduced to near zero making the procedure nearly identical to estimating the *f(i)* directly.

The background natural mortality was assumed to be constant over time. For lake whitefish models and models of wild lake trout in Lake Superior, M was assumed constant for all ages modeled, whereas for other lake trout models, M was allowed to be higher for the younger ages. For the whitefish models M was assumed known based on a published relationship between M and growth model parameters and water temperature (Pauly 1980). For lake trout, while M was estimated during model fitting, deviations from prior estimates, based on

the same relationship used for whitefish, were penalized.

The process for estimating sea lamprey wounding rates was changed in 2005. Previously, mean fall and spring wounding rates were converted to mortality based on the probability of surviving an attack and the average length of a lake trout (Sitar et al. 1999). Now, only spring wounding rates are used and are fit to a logistic curve with an asymptotic wounding rate according to Rutter and Bence (2003). Three parameters are estimated from the logistic curve, α and β, which describe the steepness and position of the curve, and θ, which represents the asympototic wounding rate, or the average wounding rate on large fish. These parameters are then used to convert wounding rates to mortality rates based on survivability of an attack and growth parameters of fish in each unit.

Lake Huron sea lamprey-induced mortality on lake whitefish

In past stock assessments for Lake Huron lake whitefish, sea lamprey-induced mortality was calculated for specific length classes of whitefish in the spring, then an age-length distribution was applied to the length-specific mortality rates to estimate age-specific sea lamprey mortality of whitefish (Bence 2002). These age-specific mortality rates were assumed to be constant across years and constant across management units and input as data to the stock assessments in Lake Huron as a matrix of age- and year-specific sea lamprey mortality rates.

The method for calculating sea lamprey-induced mortality of whitefish in Lake Huron changed during calculations of the 2003 harvest limit. Marking rate data collected during August through December was used to estimate sea lamprey mortality, because the probability of survival used to estimate sea lamprey mortality of whitefish was collected during late summer and fall (Spangler et al. 1980). Age-specific marking rates for whitefish were estimated from year-specific marking rates and a long-term average marking rate in each management unit as:

$$m_{a,t} = \frac{m_{a,y}}{1 - \left(\frac{m_t - m_y}{m_t} \right)},$$

where m is the average number of sea lamprey marks per fish, a is age class, t is year, and y is the time series under consideration. The time series varied somewhat by management unit but typically covered 1980-2003 in Lake Huron units. Essentially, the average marking rate on an age class was a function of the annual deviation in sea lamprey marking in a management unit from the long-term average marking rate in that unit and the average long-term marking rate on each age class. Sea lamprey-induced mortality was then calculated as in past years (Bence 2002) given that 25% of lake whitefish survived a sea lamprey attack.

In summary, 4 to 6 parameters were estimated during the fitting of the SCAA models to describe each fishery's selectivity pattern, and a year-specific parameter was estimated associated with each fishery's fishing intensity. We estimated from zero parameters (whitefish) up to two parameters (stocked lake trout) to describe background natural mortality. No additional parameters were estimated during model fitting to describe sea

lamprey mortality, as these rates were calculated directly from wounding data.

In order to complete the population model and describe stock dynamics over time it was necessary to specify the initial numbers at age in the first year and the recruitment of the youngest age in each subsequent year. In the simplest cases each of these would be estimated as a free parameter during model fitting. We deviated from this simplest case in various ways. For stocked lake trout stocks, we modeled recruitment as the number of yearling equivalents actually stocked and calculated to move into an area (see Movement Matrices) multiplied by a year-specific "survival adjustment" factor. In this case the "survival adjustment" factors were estimated as parameters, with values deviating from 1.0 being penalized. Wild lake trout recruitment was modeled as a random walk function which was the product of the prior year's recruitment and a multiplicative deviation. The recruitment in the starting year of the model was estimated as a formal model parameter. Lake whitefish recruitment was estimated for each year based on a Ricker stock-recruitment function (with parameters estimated during model fitting). Deviations from calculated recruitment were expected and penalized. For stocked lake trout stocks, when age composition data was limited in earlier years, initial age compositions were based on the known number of lake trout that were stocked and a rough estimate of annual mortality, rather than being estimated during model fitting. For all the hatchery lake trout stocks, initial numbers for year classes known not to be stocked were set to zero.

Movement Matrices and the calculation of yearling equivalents stocked

Assessment models for lake trout on lakes Michigan and Huron were for hatchery-reared lake trout stocked into the lakes. The effective number of yearling lake trout stocked into a management unit was calculated as follows. First, we assumed that lake trout recruitment was based on stocked yearlings or fall fingerlings. The numbers of yearling equivalents were calculated as the number of yearlings stocked that year plus 0.40 times the number of fall fingerlings stocked the year before. Next the numbers stocked at various locations were adjusted for movement soon after stocking (before substantial spatially-varying mortality comes into play). This was done by apportioning fixed proportions of the numbers stocked at each location as being effectively stocked into each of the management areas (recruitment location) on the lake. These translations of numbers from stocking location to recruitment location were in the form of a "movement matrix." The numbers effectively stocked to a management unit (recruitment location) were then summed over the stocking locations. These effective numbers stocked were the input that was then adjusted upward or downward to account for year-specific variations (see above).

The observation sub-model

The observation sub-model predicts numbers of lake trout or lake whitefish killed by each fishing component by age. For the lake trout models survey catch per unit effort (CPUE) by age is also provided. Fishery kill was then converted into proportions-at-age and total number killed for comparison with data. Likewise, age-specific CPUE was

converted into proportions-at-age and total CPUE for comparison with observed data.

Fishery kill was predicted using Baranov's catch equation:

$$C(i)a,y = \frac{F(i)_{a,y}}{Z_{a,y}} N_{ay} A(i)_{ay},$$

note that no additional parameters needed to be estimated.

Survey CPUE was predicted assuming proportionality between population abundance and expected CPUE, with selectivity following a logistic or double logistic function of age:

$$CPUE_{a,y} = q(s)S(s)_a N_{a,y},$$

where $q(s)$ was survey catchability, and $S(s)$ was survey selectivity. In some cases survey selectivity was allowed to vary over time in the same way as was fishery selectivity. The parameters of the survey selectivity function and survey catchability were new parameters that needed to be estimated which were not needed for the population sub-model.

The Likelihood (defining the best fit)

For numerical and coding reasons it was convenient to maximize the likelihood by minimizing the negative log likelihood. Let L stand for the total log-likelihood. This was calculated as the sum of a set of K independent components:

$$L = L_1 + L_2 + L_3 + \ldots + L_K$$

Each component represents a data source or penalty, and the number of components varied among stocks and species. For each fishery that was included in the model there were three components: one for the total fishery kill each year, one for the fishery age composition each year, and one for the effort deviations for each year. These likelihood components were calculated under the assumption that total fishery kill and effort deviations were lognormal and that the proportions-at-age were determined by a multinomial distribution. When a survey was available, this provided two likelihood components: one for the total CPUE (lognormal) and one for the age composition (multinomial). An additional component came from variation about stock-recruit functions or numbers based on stocking. In the calculation of this penalty term, the deviations were treated as lognormal. When variation about a prior estimate of M was allowed, this contributed another term to the likelihood, and these variations were also assumed to be lognormal.

These various components were weighted by either the inverse of the variance associated with them (lognormal components) or the effective sample size (multinomial components). Here if X was lognormally distributed, variance refers to the variance of $\ln(X)$. In the case of effort deviations, in those cases where effort was assumed to provide little information on fishing mortality these components were down-weighted by an arbitrarily small value. The square root of the log-scale variances for the lognormal variables was approximately equal to the coefficient of variation (CV) on the arithmetic scale. In the case of a multinomial variable:

$$CV(p) = \sqrt{\frac{p(1-p)}{N}}$$

With these relationships in mind the modeling group considered information on the likely measurement error associated with the various data sources and specified default variances for each type of data, which were adjusted in cases where additional information was available on data quality.

In the case of variations about recruitment expected based on either the stock-recruit function or the numbers stocked, an iterative approach was followed during model fitting. An initial value for the standard deviation for variations about expected values was specified and the model was fit. Then the standard deviation of the resulting deviations was calculated. The model was refit, adjusting the value of the input standard deviation until the deviation between the standard deviation value specified prior to model fitting and the value calculated after model fitting was minimized. A minimum deviation was defined when the ratio of pre- to post-standard deviation was closest to 1.0.

Calculation of Recommended Harvest Regulation Guidelines, Total Allowable Catch (TAC), and Total Allowable Effort (TAE)

In general, upper bound recommendations on yield and effort were calculated by first estimating population abundance-at-age at the start of the year and then adjusting fishing mortality either to meet mortality targets or to follow guidelines established in the Consent Decree for phasing in the targets. The resulting projection of yield or the effort associated with the fishing mortality then formed the basis of the recommendations.

We start by describing how we determined the maximum amount of yield that could be taken, consistent with a specific upper bound on total mortality. This was the procedure that underlies the modeling group's recommendations regarding harvest regulation guidelines, TACs, and TAEs. We then describe how the procedures were modified to account for specific details that only apply to some areas. For some areas these details include how the target mortality rates were "phased-in" as documented in the Consent Decree.

Target Mortality Rates

The Consent Decree specifies a "fully-phased in" upper bound target for total mortality (i.e., A = the proportion of the population that dies in a year). These rates were either 40-45% (depending on area) for lake trout or 65% for lake whitefish. As demonstrated by the Interagency Modeling Group (IMG) during the period that the Consent Decree was negotiated, these target rates require additional structure in order to be uniquely defined. This occurs because mortality rates vary among ages, so whether or not a population was above a mortality target depends upon what ages were considered and how the mortality rates for the different ages were combined.

Following the procedure of the IMG, we uniquely define mortality rates by making use of the idea of spawning stock biomass per recruit (SSBR). For lake trout, we first calculate spawning stock biomass for a default target mortality schedule. Any age-specific mortality schedule that produces as much spawning stock biomass as the default schedule was considered to be at or below the target mortality rate. The default schedule was to have only natural mortality (excluding sea

lamprey-induced mortality) for ages below a specified age, and mortality equal to the target rate for ages equal to or above the specified age. The specified age at which the target rate first applied varied among areas depending upon maturity schedules and precedent.

For whitefish a somewhat different procedure was used to ensure both that an adequate amount of spawning stock was achieved per recruit and that more than one age was contributing substantially to the spawning population. This was done following a two-stage approach. First, overall fishing mortality rates were adjusted so that during the projection period total annual mortality on the age experiencing the highest projected fishing mortality rate was equal to 65%. Then the spawning stock biomass per recruit was calculated for that scenario. Spawning potential reduction (SPR) was calculated by dividing this by the spawning stock biomass per recruit, calculated assuming only background natural mortality. If SPR was less than 0.2, fishing mortality was decreased until SPR was equal to 0.2. The approach was developed by examining various different "rules" and ascertaining that this approach generally ensured more than one age class was contributing substantially to spawning. A SPR of 0.2 was aggressive by standards applied in other fisheries and reflects a perception that lake whitefish was generally robust to fairly high fishing rates.

Population at the Start of the 2008 Fishing Year

The SCAA stock assessment models for lake trout directly estimate population abundance at the start of the year and mortality rates. As a result these estimates can be used in a straightforward fashion to project abundance for all ages other than the age of recruitment (the youngest age in the model) at the start of next year. Recruitment was set at a value reflecting recent levels of recruitment (Lake Superior) or expected stocking. Note that assumed recruitment has little influence on calculations of harvest during the next year, as these fish are either not selected or only weakly selected by the fishery.

Lake whitefish SCAA stock assessment models were similar to lake trout models except that the estimates were based on data two years behind the year for which a harvest limit was being calculated. Thus for lake whitefish there was one additional step, which was projecting the population for two years. For this projection, age-specific mortality rates by source (i.e., trap-net and gill-net fishing mortality, sea lamprey-induced mortality, natural mortality) were set equal to rates averaged over the last three years for which estimates were made. Recruitment of lake whitefish for the two projection years was set to the average recruitment during the last 10 years for which SCAA estimates were available.

Projections during the 2008 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2008, the population was projected forward over the year accounting for age-specific mortality rates by source, using the same equations described above for the SCAA models. Numbers harvested-at-age were calculated by application of the Baranov catch equation. Harvest-at-age was

converted to yield by multiplying numbers harvested-at-age by weight-at-age for the fishery and summing over ages.

In these calculations, background natural mortality (*M*) was left at the same value as was used or estimated in the SCAA assessments. Currently *M* was assumed constant over time in the assessment models. Likewise, sea lamprey-induced mortality was set to the average of the values in the last three years of the SCAA.

Fishing mortality rates by type (either sport and commercial or trap net and gill net for lake trout and lake whitefish, respectively) were based on average rates in recent years. These average rates were adjusted to account for changes stipulated in the Consent Decree or known changes in fishing activity by multiplying the baseline age-specific rates by an appropriate multiplier. For example, if a gill-net fishery existed in an area prior to 2008, but did not in 2008, then in projecting whitefish yield the multiplier for gill-net fishery was set to zero. When fishing mortality was adjusted to account for a specified change in fishing effort, or when fishing effort was calculated to correspond with a specific level of fishing mortality rate, effort and fishing mortality were treated as being directly proportional. This basic approach to fishing mortality assumes that selectivity and catchability for each source will remain the same as it was on average in recent years. Detail on how fishing mortality rates were adjusted is covered in the next section.

Setting Fishing Mortality Rates for 2008

Fishing mortality rates were adjusted depending on specific details of how an area was designated in the Consent Decree. We begin by considering lake trout. The simplest case was for areas calculated under the assumption of no phase-in (also called 'fully phased-in' areas) and meeting Consent Decree mortality rate and allocation standards: MM-67, MH-2, MI-5, MI-6, and MI-7. Additionally, MH-1 was considered partially phased-in. This was accomplished by setting the multipliers for the recreational and commercial fisheries so as to simultaneously meet the mortality target (expressed in terms of SSBR) and the designated allocation. The process of finding the correct multipliers was expedited by making use of the Solver utility within Microsoft Excel spreadsheets. In MM-67 the target mortality rate was 40% and the allocation was 90% state, 10% Tribal. Although a stipulation governed the TAC in MH-1, the model calculated TAC was based on an interim target mortality rate of 47%, and the allocation was 9% state and 91% Tribal. In MH-2 the target mortality rate was 40% and the allocation was 95% state and 5% Tribal. In MI-5 the target mortality rate was 45% and the allocation was 95% state and 5% Tribal. In MI-6 the target mortality rate was 45% and the allocation was 50% state and 50% Tribal. In MI-7, the target mortality rate was 45% and the allocation was 30% state and 70% Tribal.

In the Lake Superior units adjustments were made as appropriate when reporting yield limits to account for the harvest of hatchery lake trout since tabled yield limits were taken as applying to all lean lake trout (wild and hatchery). This was necessary because hatchery lake trout, which were not part of the modeled population, do constitute a small proportion of the yield. The recommended yield limits do not include

siscowet lake trout. Sport fishery harvest was reported for lean lake trout. In MI-5, commercial yield was reported separately for lean lake trout. In MI-6 and MI-7 reported commercial yield included both lean and siscowet lake trout. The lean-siscowet composition was measured in commercial monitoring. (Note that the harvest and survey data were adjusted so it reflected only lean, wild fish before they were compared with model predictions.)

The Final 2008 TACs for MH-1 and MM-1,2,3 were set in accordance with Court Orders and agreements between the Parties reached at Executive Council Meetings or other negotiations. Final harvest limits for MM-4 and MM-5 were not set and negotiations are ongoing.

The Final 2008 TACs for MI-5, MI-7, and MH-2 were calculated per the Consent Decree. However, the 2008 TACs for these units decreased by more than 15% compared to the 2007 TACs. The TFC agreed to accept higher estimated TACs for these units in 2008 limited by a 15% decline from the 2007 TACs. In MM-67, the TAC increased by more than 15% over the 2007 limit. The TFC did not waive the 15% rule, and limited the increase in harvest limit in this unit to 15% greater than 2007.

Lake whitefish recommended yields were calculated generally following the approach used for fully phased-in lake trout areas. Details differed because of the different way that target mortality was defined for whitefish, and because for most areas there was no specified allocation between state and Tribal fisheries (WFS-05 was an exception). In cases where there was no specified allocation, the first step was to adjust the multipliers for trap nets and gill nets to account for known changes in fishing effort (generally changes expected to arise from conversions or movement of operations). This step merely adjusts the relative contributions of the two gears. Then an overall multiplier (that is applied to both gears) was adjusted until the target mortality rate was reached for the fully-selected age. When an allocation was specified the multipliers for the two gears were adjusted simultaneously (as was the case for lake trout) to match both mortality and allocation targets. At this point SPR was examined, and if it was below 0.20 the fishing multiplier was reduced until SPR reached 0.20.

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RECOMMENDATIONS AND FUTURE DIRECTIONS TO IMPROVE ASSESSMENTS

Prepared by the Modeling Subcommittee

We annually revise our list of recommendations to improve stock assessments. The revised list reflects improvements made in recent years, ongoing work, and future plans to address assessment needs. Items that we consider high priority are noted.

Data collection and processing

- Accurate and complete data on extractions and other deaths caused by fishing is essential if SCAA models are to produce reliable estimates. We assigned a HIGH priority to determining the following:

  i. Evaluating the importance of including recreational harvest in the stock assessment models

     Harvest is large enough in WFM-05, WFS-05, and WFS-06 to warrant inclusion into the assessment models. In addition, harvest in WFH-03 is highly variable, but in years of good ice conditions, extractions in this unit can also be large. The State of Michigan should plan and execute winter creel surveys in these units to ensure an accurate estimate of lake whitefish harvest and we need to evaluate if adding these extractions to the model improves its performance.

  ii. the magnitude of hooking mortality from recreational catch and release fishing

     Currently the models use a hooking mortality rate of 15%, based on a 1986 study. The State of Michigan creel program quantifies released lake trout of both legal and non-legal size. In 2003, an MSC subcommittee drafted a study design to quantify hooking mortality in the recreational fisheries in lakes Superior and Huron. This project was approved for MDNR funding, but due to budget reductions, it has been placed on hold until at least 2010. If completed, this study would allow us to better estimate hooking mortality rates.

- Accurate prior estimates of *M* (natural mortality) are essential in SCAA models. Existing tagging information and current estimates of natural mortality for lake trout and lake whitefish need to be reviewed and revised as necessary. We assigned a HIGH priority to this recommendation.

  Two basin-wide lake whitefish tagging studies in lakes Michigan and Huron were conducted between 2003 and 2005. Empirical estimates of natural

mortality, derived from these results, indicated that natural mortality may be higher than what is currently estimated by the Pauly equation in the whitefish SCAA models. The empirically derived estimates of natural mortality may be incorporated into future assessments.

- The basis for stock boundaries and assumed movement or lack of movement between stocks needs further study. For lake trout the assumption that stocked fish move to an area and then become resident needs to be evaluated. We assigned a HIGH priority to this recommendation.

  The lake whitefish tagging studies conducted in lakes Michigan and Huron demonstrated that current stock boundaries likely do not contain discrete populations of whitefish, as movement across management units was common. A new Lake Huron assessment model incorporating multiple management units will be developed in the future to compare and contrast to models from each individual unit.

  For lake trout, the movement matrix, which represents assumed movement of hatchery lake trout from stocking sites to their resident location may soon be updated. Researchers from the University of Michigan are evaluating juvenile and adult lake trout movement in Lake Michigan. Once available, these results will be evaluated for their utility as an update to the current methodology.

- Summer lake whitefish surveys

  i. The lake whitefish models continue to need "indices of abundance" based on fishery independent survey data. A sampling protocol for lake whitefish was implemented on all lakes in 2002 and has been carried out each year since. These data were not immediately incorporated into the stock assessment models because of the short time series available; however, as that time series lengthens their inclusion should be evaluated. This continues to be a HIGH priority for us.

  ii. The lake whitefish summer surveys in Lake Huron may have value for the lake trout models. Their use as a separate index of abundance or as a source for population age composition data should be evaluated.

- For lake trout, calculations of the effects of recreational fishery size limit regulations and conversions of length-specific sea lamprey mortality to age-specific rates both depend upon the coefficient of variation (CV) in lengths about the mean length at age. Currently this CV is assumed to be the same for all ages and stocks, but it is not

applied consistently and disparate data sources are sometimes used in calculating the variance. The validity of this assumption (equal variance across stocks and ages) needs to be assessed. This is an ongoing Dingell-Johnson funded project within MDNR. We assigned a HIGH priority to this recommendation.

- The lake trout relative abundance indices (CPUE) used in SCAA models are pre-processed outside the models using mixed-model analysis. The current models and alternatives have been evaluated by a student at Michigan State University, and we are currently in the process of implementing changes to the mixed model methodology. An MDNR Research Report that describes the evaluation is in press.

Models

- Estimates of uncertainty for data used in the models and our assumptions about uncertainty should be evaluated when possible. The way uncertainty is used in model fitting needs to be reviewed based upon research completed at Michigan State University. We assigned a HIGH priority to this recommendation.

- The need to assess fishery selectivity has been recognized since early in this modeling process. Such an evaluation has been completed by researchers at Michigan State University, and changes to selectivity (e.g., utilizing a random walk) will be implemented in the near future.

- The assumption that fishery and survey catchability is constant in the SCAA models needs to be changed. Based on research completed at Michigan State University, fishery catchability should be allowed to vary over time following a random walk. This change represents a small task but is a HIGH priority.

- Current approaches to modeling and estimating recruitment need to be reviewed, including how we project recruitment forward into the future. We should also evaluate adding environmental variables that could influence recruitment based on research completed at Purdue University.

- Current harvest policies and possible alternatives have been evaluated for general lake whitefish stocks. Results from this work need to be considered on a unit specific basis to determine if an alternate policy will better meet the needs of both managers and the fishery.

Reporting and Time Frames

The current time frame for calculating lake trout harvest limits is very narrow and does not allow adequate time for model evaluation given the constraints of data availability. The time frame for lake whitefish quotas is a year longer than for lake trout and is sufficient. The timing of data

availability and target dates for delivery can be summarized as:

Lake Trout

The Consent Decree sets the overall deadline for data availability for lake trout at March 1. We moved this date to February 15 to allow additional time to run the SCAA models and calculate harvest limits; however, some parties still do not submit all the required data by the deadline. We set the second full week in March for our annual meeting to produce preliminary lake trout harvest limits. This allows time for group discussion of model output and diagnostics before the March 31 deadline for preliminary harvest limits.

There is some difficulty with the data submission deadline as sometimes data needs extensive processing before it can be used in the models. Parties need to make better efforts to meet the data submission deadlines. Issues associated with individual data sources and plans for improving timeliness of assessments include:

1. Harvest/Yield:
   a. Commercial yield – Final CORA commercial harvest data cannot be ready by February 15. Preliminary data is projected to account for catch reports not filed by the deadline. Improvements have been made in recent years, but these numbers need to be made available in a more timely fashion.

   b. Recreational harvest – the State can provide these data by February 15.

2. Biological data-commercial:
   a. These data can be available by February 15. We use age composition, mean weight in harvest, mean length at age, and composition of siscowets, wild, and hatchery fish.

   b. Biological data from the Canadian commercial fisheries is not readily available, and better access to these data would improve the Lake Huron lake trout models.

3. Biological data-recreational:
   These data can be available by February 15. Occasionally, data from Tribal fisheries (Keweenaw Bay Indian Community) in 1842 Waters of MI-5 are not available by the deadline. If not ready by March 1 we will proceed without it and use the data the next year. We use age composition, mean weight of harvested fish, and composition of wild and hatchery fish.

4. Stocking data:
   These data are provided by the USFWS and are available by February 15.

5. Survey data:
   a. Survey CPUE – These data can be ready by February 15. Often the mixed model analysis can be completed by February 15.

   b. Age composition – These data can be ready by February 15, except occasionally in Lake Superior. If not ready by February 15, we will proceed without the most recent year's data.

c. Mean length and weight at age – These data can be ready by February 15 and the estimates of von Bertalanffy model can be updated by February 15.

d. Sea lamprey marking – These data can be ready by February 15 and estimates of mortality, processed outside of the model, should be ready by February 15.

e. Maturity at age – These data can be ready by February 15. These are constants in lakes Huron and Michigan and vary in Lake Superior.

Lake whitefish

The Consent Decree sets October 1 as the deadline for the previous year's data. We moved this deadline to August 1 to allow additional time for calculating harvest limits. Because of the one year time lag, data are usually available by the data submission deadline. We set the third full week in September for our annual meeting to produce preliminary lake whitefish harvest limits. This allows for group discussion of model output and diagnostics before the November 1 deadline for preliminary harvest limits.

More general comments

- Given the life history of lake trout, it may be reasonable to either update the lake trout models every 2-3 years or update them with a one-year lag for some data sources. This issue continues to be discussed both internally and with the TFC.

Alternative harvest policies have been evaluated by a graduate student at Michigan State University. We, in conjunction with the TFC, will be evaluating their implementation in some lake whitefish units in the coming years. If implemented, these policies may provide some stability in the annual harvest limit while still providing protection for the stock. There are currently no plans to apply these policies to lake trout management.

- We continue to review fall lake trout data from all agencies. The utility of these data for inclusion in the stock assessment models should be carefully evaluated. Fall age composition data may be particularly useful in characterizing population age structure.

STATUS OF LAKE TROUT POPULATIONS

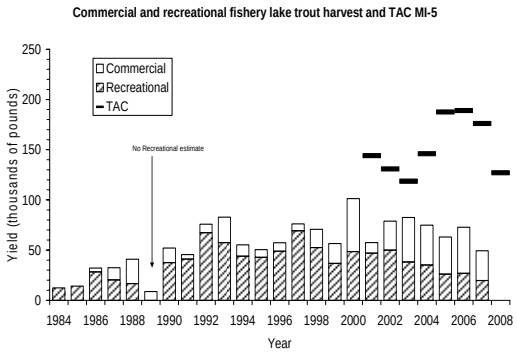
Lake Superior

MI-5 (Marquette - Big Bay)

Prepared by Shawn P. Sitar and John K. Netto

Lake trout management unit MI-5 extends from Pine River Point (west of Big Bay) to Laughing Fish Point (east of Marquette) covering 924,408 acres. This management unit includes Stannard Rock, an offshore shoal about 45 miles north of Marquette, and is in both the 1836 (618,614 acres) and 1842 Treaty waters (305,794 acres). The 1836 Treaty area extends east from the north-south line established by the western boundaries of grids 1130, 1230, 1330, 1430, and 1530. This unit has a wide bathymetric range with some depths past 780 feet and 186,811 acres shallower than 240 feet.

The only Tribal commercial fishery is a large-mesh gill-net fishery that is centered around Marquette and Big Bay in 1842 Treaty waters. This fishery mainly targets lake whitefish with lake trout as bycatch. However, lake trout have been targeted near spawning reefs in Marquette during recent fall fisheries. There have been some low levels of Tribal subsistence gill-net fishing in 1836 treaty waters. Tribal commercial yield of wild lake trout (in 1842 treaty waters) has ranged from 3,800 round lb in 1986 to a peak of 52,700 round lb in 2000. During 2003 to 2007, Tribal yield averaged 39,200 round lb and Tribal large-mesh gill-net effort averaged 670,000 ft per year.



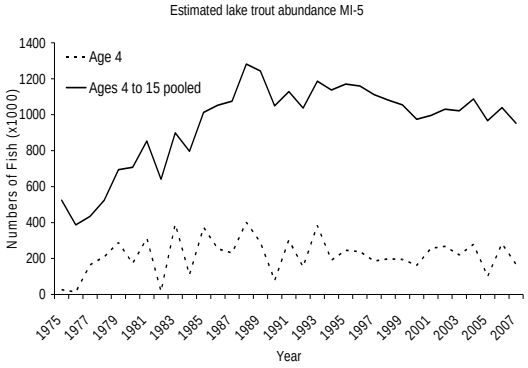
Generally, the fishery is conducted from late winter through early October, with a dome shaped selectivity with peak age between 7 and 10. The commercial fishery operates in various grids near Marquette, and the overall impacts on the MI-5 population are nominal. However, in 2000 and 2003 through 2007, the commercial fishers were allowed to harvest lake trout through the end of October during the lake trout spawning season. During these years, total annual yield increased and in many years nearly 50% of the yield was from October. The concentration of commercial fishing during the spawning period has had a localized impact on lake trout in MI-5. Essentially all of the lake trout harvested in October were from the Presque Isle Harbor area of Marquette.

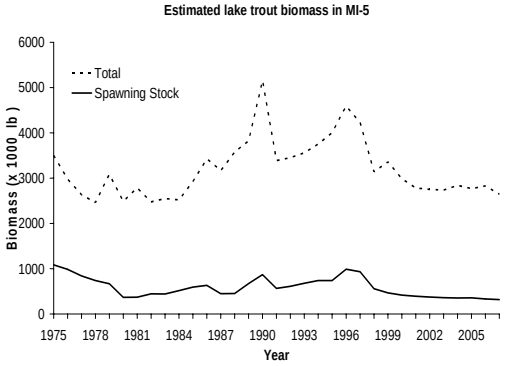
The commercial fishery age composition during the years that spawning lake trout were allowed to be harvested was skewed right with peak age being 15 years or older. During the years with commercial harvest during the spawning season at this site,

instantaneous commercial fishing mortality rates (F_C) on age 15 and older fish ($F_{C,2000}$=0.20 y^{-1}; $F_{C,2003}$=0.12 y^{-1}; $F_{C,2004}$=0.11 y^{-1}; $F_{C,2006}$=0.15 y^{-1}; $F_{C,2007}$=0.11 y^{-1}) were higher than all younger ages and were more than 10-fold higher than all other years. The increased fishing mortality on spawners has affected the size-structure of the Presque Isle Harbor reefs lake trout. The proportion of large lake trout (> 700 mm) collected in MIDNR fall surveys at the Presque Isle Harbor reefs has progressively declined from 44% in 2003 to 25.5% in 2007. Furthermore, relative abundance based on sampling of spawning lake trout by MIDNR has declined since 2000 in Presque Isle Harbor.

Recreational harvest of lake trout comprises both charter and sport angler fisheries. Most of this activity is centered around the port of Marquette, though some lake trout are harvested at Stannard Rock. There are no seasonal restrictions on the sport fishery, though most of the fishery occurs during the months of May through October. Recreational harvest of wild lake trout has increased from 4,400 fish (12,400 round lb) in 1984 to a peak of 15,000 fish (69,200 lb) in 1997 and has been declining since 2003. Average harvest during 2003 to 2007 was 8,400 fish (29,300 lb) per year. Recreational effort has declined from 146,000 angler hours in 1986 to 34,100 angler hours in 2007.

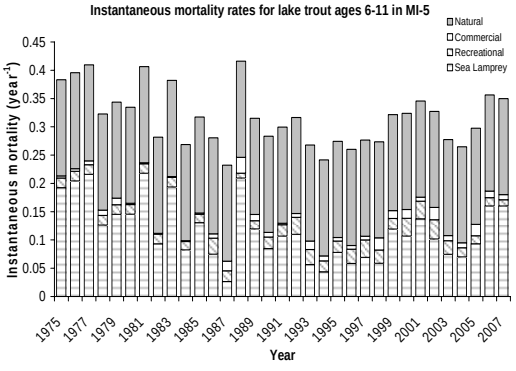
Abundance of wild lake trout increased more than two-fold since 1975 and has averaged about 1 million fish (age 4 and older) during 1998 to 2007. Total biomass of age-4 and older lake trout averaged 2.9 million lb during 1998-2007. Lake trout biomass declined from 4.6 million lb in 1996 to 2.6 million lb in 2007. Spawning stock biomass averaged 394,000 lb during the last 10 years. Although lake trout abundance has increased since the mid-1970s, spawning stock biomass has declined due to significant decreases in growth.



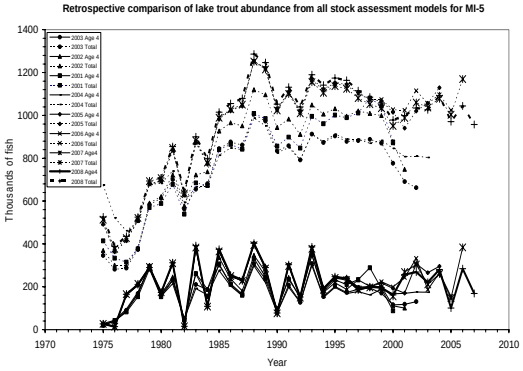


Apart from background natural mortality, sea lamprey-induced mortality was the dominant mortality source since 1975, and it nearly doubled from 0.084 y^{-1} in 2005 to 0.145 y^{-1} in 2006. With the exception 1988 and 2005, recreational fishing mortality has been higher than commercial fishing mortality for ages 6-11 lake trout. However, commercial fishing mortality on older lake trout, due to harvest during the spawning season, is higher than recreational fishing. Average total annual mortality (*A*) for age 6 to 11 lake trout averaged 28% during 2005 to 2007, which has increased since 1998 due to increases in sea lamprey mortality. Spawning stock biomass produced per

recruit during 2005 to 2007 has been above the target minimum value indicating that mortality rates are not excessive and there is good population reproductive potential.



As with last year's model, probability intervals were not able to be calculated because of poor results from Markov Chain Monte Carlo (MCMC) simulations. Further work is underway to improve the MCMC results. Summary table quantities are reported with asymptotic standard errors. The 2008 model had consistent abundance estimates when compared to the 2007 model estimates, though the recruitment estimates in the 2008 model was lower in the last two years. The recent assessment models (2005 through 2008) had higher abundance estimates than earlier assessment models. However, there were no systematic temporal patterns in estimates of abundance across stock assessment models.



The recommended yield limit for 2008 in 1836 Treaty waters is 126,600 lb, allocated as 121,200 lb for the state recreational fishery and 5,400 lb for the Tribal fishery. This recommended yield limit was based on the target mortality rate of 45% defined in the Consent Decree, allocating 40% of the total yield to 1836 waters. Within 1836 waters, the recommended yield is allocated 95% to the state and 5% to the Tribes. Note that this yield limit applies to wild and hatchery lake trout caught; whereas, target mortality rates apply only to wild lean lake trout. In recent years wild lean lake trout composed more than 90% of the total yield. The actual yield limit in MI-5 adopted by the TFC was 149,345 lb, which was a 15% decrease from the 2007 yield limit. The yield limit generated from the Consent Decree's 15% rule was still allocated 95% to the State and 5% to the Tribes.

Summary Status MI-5 Lake Trout	Value (Standard Error)
Female maturity	
Size at first spawning	2.34 lb
Age at first spawning	6 y
Size at 50% maturity	4.33 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	4.791 lb (SE 0.477)
Current SSBR	1.28 lb (SE 0.1)
SSBR at target mortality	0.440 lb (SE 0.011)
Spawning potential reduction	
At target mortality	0.266 (SE 0.011)
Average yield per recruit	0.339 lb (SE 0.040)
Natural mortality (M)	0.170 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	15
Sport fishery (2005-2007)	8
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.013 y^{-1} (SE 0.002)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.014 y^{-1}(SE 0.002)
Sea lamprey mortality (ML)	
(average ages 6-11, 2005-2007)	0.11 y^{-1}
Total mortality (Z)	
(average ages 6-11, 2005-2007)	0.306 y^{-1}(SE 0.009)
Recruitment (age 4)	
(average 1998-2007)	212,860 fish (SE 29,763)
Biomass (age 3+)	
(average 1998-2007)	2,884,500 lb (SE 333,780)
Spawning biomass	
(average 1998-2007)	393,790 lb (SE 49,217)
Recommended yield limit in 2008	126,600 lb
Actual yield limit in 2008	149,345 lb

MI-6 (Au Train - Munising)

John K. Netto

The model generated harvest limit for MI-6 was 104,000 lb, with 52,000 lb each being allocated to CORA and the State. A complete description of the status of the lake trout stock and the modeling process used to generate the TAC is not available as the author did not submit the required report.

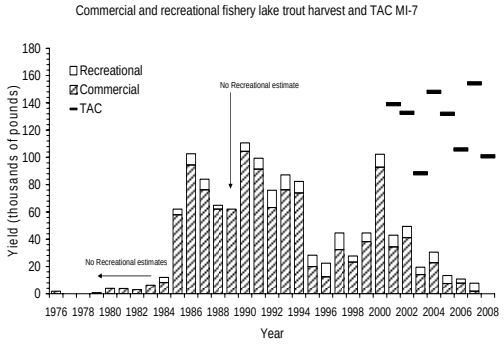
MI-7 (Grand Marais)

Prepared by Shawn P. Sitar and John K. Netto

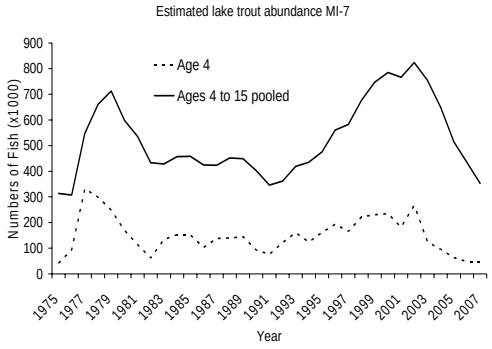
Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 987,000 acres. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There is approximately 92,000 acres of lean lake trout habitat (depth less than 240 ft).

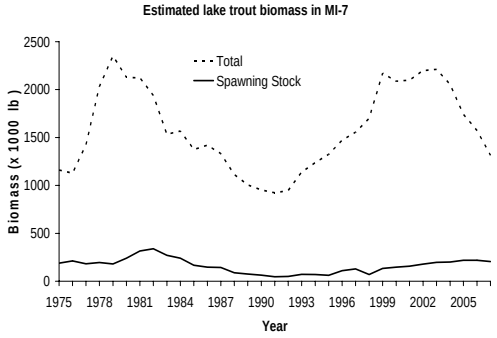
The commercial fishery that harvests lake trout is a Tribal large-mesh gill-net fishery that is mostly based out of Grand Marais. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout peaked in 1990 at 104,400 lb and declined to 12,400 lb in 1996. In the last three years, average yield was 5,700 lb. In recent years, yield of wild lean lake trout composed about 56% of the total lake trout yield, with the rest consisting of siscowet (41%) and hatchery lake trout (3%). Tribal large-mesh gill-net effort has shown the same temporal pattern as commercial yield, with a peak effort of 8.2 million ft in 1990. Total annual effort during 2005 to 2007 has averaged 1.8 million ft. Presently, there is only one commercial operator in MI-7.

The standardized creel survey began at Grand Marais in 2001. Sport harvest and effort in MI-7 prior to 2001 were estimated using the average sport CPUE and effort index ratio between MI-7 to MI-5 from MDNR creel mail survey data from 1971 to 1982 applied to MI-5 sport harvest and effort during 1984 to 2000. The estimates from this procedure indicate that recreational harvests in MI-7 are about half those of MI-6. This procedure required strong assumptions, hence there is much uncertainty regarding the true magnitude of the recreational harvest in MI-7 prior to 2001. Average harvest of lake trout during 2005 to 2007 was 1,300 fish (5,900 lb). The average sport effort for the same time period was 7,500 angler hours.

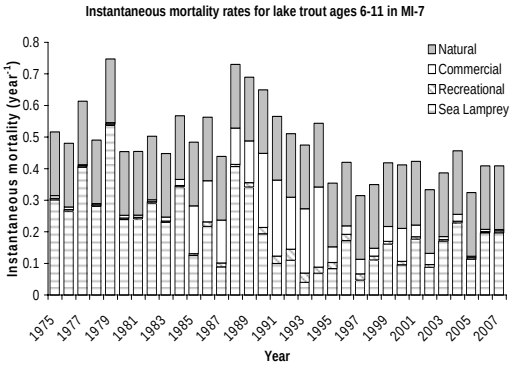


Abundance of age-4 and older wild lake trout averaged 650,000 fish during 1998 to 2007. In the same time period, recruitment at age 4 averaged 152,000 fish. Stock size increased steadily between 1992 and 2002. Abundance has declined since 2002 due to the combination of increases in sea lamprey-induced mortality, which doubled between 2002 and 2004, and declines in recruitment since 1999. Both sea lamprey-induced and commercial fishing mortality declined significantly in the first half of the 1990s. However, in recent years sea lamprey mortality has increased. Spawning stock biomass averaged 173,000 lb during the last ten years.





Sea lamprey predation has generally been the dominant mortality source for lake trout in MI-7 with the exception of 1990 to 1994. Commercial fishing mortality increased significantly in 1985 and exceeded sea lamprey-induced mortality during 1990 to 1994. Commercial fishing mortality declined during 1995 to 1998, and increased between 1999 and 2002. In recent years, commercial fishing has declined to very low levels. Sea lamprey mortality nearly tripled from 2003 to 2004, and although it has declined slightly, it remains double 1997 levels. During 1975 to 1979, total annual mortality (*A*) for age 6 to 11 lake trout averaged 43%. During the last five years, average *A* was 33%. The current spawning stock biomass per recruit (SSBR) estimate for MI-7 is above the target value, indicating that total mortality rates are not exceeding the target.



Notable stock dynamics

No commercial monitoring data were available for 2004-2007. Total commercial yield declined to near zero in 2005 and 2006. Recent increases in sea lamprey-induced mortality have caused the reduction in stock size and TAC. Furthermore, there has been significant declines in recruitment since 2002.

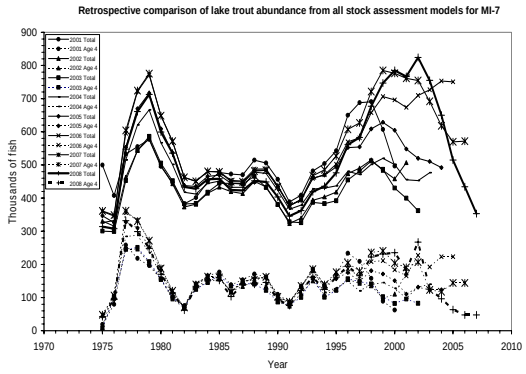
Model changes

No structural changes were made to the MI-7 SCAA model for the 2008 assessment.

Diagnostics and uncertainty

The final 2008 model reached convergence with acceptable maximum gradient components, and reasonable asymptotic standard errors on parameter estimates. No major patterns in residuals were observed for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all variables evaluated. In the retrospective analysis of the 2008 model, there were no systematic temporal patterns in biomass estimates, though there were some differences in biomass estimates for recent years.

There were no systematic patterns when comparing year 2000 abundance estimates from the past six stock assessments. However, there were major departures in abundance estimates across the 2005 through 2008 assessments.



The recommended yield limit for the year 2008 is 100,700 lb with 30,200 lb allocated for state recreational yield and 70,500 lb for Tribal commercial yield. These limits were calculated on the basis of the target mortality rate (*A*) of 45% and an allocation of 30% to the state and 70% to the Tribes, in accord with the Consent Decree. These yield limits apply to all lean lake trout, but mortality targets only apply to wild lean lake trout. In determination of the yield limit it was assumed that 3% of the lean lake trout yield would be hatchery fish. The yield limit does not include siscowet lake trout so actual commercial yields can exceed this limit by 41%, to allow for the portion of the commercial yield that siscowets are expected to compose. The recommended total yield limit is higher than observed yields from recent years reflecting mortality rates below target limits. The actual yield limit established by the TFC for MI-7 was 131,155 lb. This represented a 15% decline from the 2007 TAC. The yield limit generated with the Consent Decree's 15% rule was still allocated 30% to the State and 70% to the Tribes.

Summary Status MI-7 Lake Trout	Value (Standard Error)
Female maturity	
Size at first spawning	2.75 lb
Age at first spawning	6 y
Size at 50% maturity	4.96 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	3.948 lb (SE 0.459)
Current SSBR	1.12 lb (SE 0.09)
SSBR at target mortality	0.530 lb (SE 0.017)
Spawning potential reduction	
At target mortality	0.283 (SE 0.010)
Average yield per recruit	0.073 lb (SE 0.015)
Natural mortality (M)	0.201 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	8
Sport fishery (2005-2007)	7
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.005 y^{-1} (SE 0.001)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.005 y^{-1} (SE 0.001)
Sea lamprey mortality (ML)	
(average ages 6-11, 2005-2007)	0.141 y^{-1}
Total mortality (Z)	
(average ages 6-11, 2005-2007)	0.353 y^{-1} (SE 0.01)
Recruitment (age 4)	
(average 1998-2007)	151,690 fish (SE 28,316)
Biomass (age 3+)	
(average 1998-2007)	1,915,100 lb (SE 349,200)
Spawning biomass	
(average 1998-2007)	172,790 lb (SE 35,482)
Recommended yield limit in 2008	100,700 lb
Actual yield limit in 2008	131,155 lb

Lake Huron

MH-1 (Northern Lake Huron)

Prepared by Aaron P. Woldt and Ji X. He

Lake trout management unit MH-1 is located in northern Lake Huron and extends from the Mackinac Bridge south to the border between grids 607 and 608, encompassing statistical district MH-1 and adjacent Canadian waters (Canadian management area 4-1). The management unit has a wide bathymetric range with areas in grids 407 and 408 as deep as 426 ft. The Michigan portion of this unit lies completely within 1836 Treaty-ceded waters, covering 1,017,640 acres of which approximately 681,720 acres are less than 240 ft in depth. On the Michigan shore this unit encompasses the ports of DeTour, Cedarville, Saint Ignace, Mackinaw City, Cheboygan, Hammond Bay, and Rogers City. The St. Marys River, connecting Lakes Superior and Huron, flows into Lake Huron in grid 306. The St. Marys River had supported large spawning runs of sea lamprey, and until the late 1990s the resulting larval populations were untreated and contributed substantial numbers of parasitic-phase sea lamprey to the lake. Comprehensive treatment of the river by the Great Lakes Fishery Commission's control agents has reduced the number of sea lamprey produced in the St. Marys River, and decreases in lake trout wounding and sea lamprey-induced mortality rates have been documented in northern Lake Huron. The majority of Lake Huron's historically important lake trout spawning reefs and shoals are located in MH-1. The Drummond Island Refuge is located in grids 307, the northern ½ of grid 407, and Michigan waters of grids 308, 408, 409, and 410, and covers 177,840 acres of 1836 Treaty-ceded waters. Retention of lake trout in the refuge is strictly prohibited.

There is little or no natural recruitment of lake trout in northern Lake Huron, although recent indicators (increased trawl catches of age 0, increased CPUEs of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service and the Michigan Department of Natural Resources annually plant lake trout in MH-1. From 2003 to 2007, approximately 497,000 yearling lake trout were planted annually in MH-1. Under the 2000 Consent Decree, stocking was increased in MH-1 to levels prescribed in the Lake Huron Committee's Lake Trout Rehabilitation Guide. In 2007, approximately 420,000 yearling lake trout were stocked into MH-1. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-1 model estimated 614,000 yearling lake trout recruits in MH-1 for 2007.

Both commercial and recreational lake trout fisheries exist in MH-1. Tribal commercial fishers deploy trap nets and large-mesh gill nets (4.5 inch stretch) that target lake whitefish and small-mesh gill nets (2.5-3.0 inch stretch) that target bloater chubs. Lake trout are caught in these fisheries as bycatch and can be marketed by Tribal fishers under CORA regulations. No State-licensed

commercial fishers operate in MH-1. The Consent Decree prohibits State-licensed commercial fishing north of the 45th parallel in Lake Huron. Prior to August 2000 one State-licensed fisher operated a trap-net operation in MH-1. This operation targeted lake whitefish and was not allowed to market lake trout bycatch. All lake trout were returned to the water, regardless of condition.

Although few lake trout have been stocked in Canadian waters adjacent to MH-1, this region was included in the assessment model because there is a substantial commercial fishery for lake trout. This means that lake trout extractions from Canadian management area 4-1 were included in the data, and estimates of yields and recruitment into this area (primarily the result of movement from other areas) were also included. From 2003 to 2007, Tribal commercial yield of lake trout averaged 186,000 lb, while Canadian commercial yield averaged 23,000 lb. Due to a 400 lb daily bag limit enacted by CORA in 2002 for Tribal large-mesh gill-net fishers in US waters of MH-1, the Tribal harvest from 2002 to 2007 includes an estimate of throwback mortality (i.e. fish that were thrown back but later died due to handling). The majority of Tribal lake trout yield (94%) came from the large-mesh gill-net fishery. Tribal large-mesh gill-net effort averaged 5.8 million ft from 2003 to 2007, while Canadian large-mesh gill-net effort averaged 1.6 million ft. With the implementation of the 2000 Consent Decree, Tribal large-mesh gill-net effort has declined in MH-1. In 2007, large-mesh gill-net effort dropped by 7.2 million ft (55%) from the 2000 effort level. Lake trout harvest in large-mesh gill nets initially dropped under the Decree, but from 2004 to 2007 large-mesh gill-net harvests exceeded the 2000 harvest total.

The State-licensed recreational fishery in MH-1 is composed of both charter and non-charter anglers. Lake trout were primarily caught as bycatch by salmon anglers, but with declining salmon populations, some anglers have begun to target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to Tribal members in 1836 Treaty-ceded waters. Recreational harvest represents a small portion of the total fishery harvest in MH-1 (Figure 1). From 2003 to 2007, recreational yield of lake trout averaged 6,600 lb. In 2007, recreational harvest was 17,000 lb in MH-1. Starting in 2001, the State of Michigan raised the minimum size limit for lake trout in the recreational fishery from 10 inches to 20 inches in areas north of 44° 50’ N latitude. Starting in 2003, the State of Michigan imposed a 15 - 19 inch slot limit in MH-1. All fish outside the slot were non-legal, except for one fish daily that may be 34 inches or larger. In 2006, the State of Michigan imposed a 22 inch minimum size limit for lake trout in the recreational fishery. These regulations are intended to keep harvest below the State share of the MH-1 harvest limit. Due to these more restrictive State regulations, 2003-2007 State harvest includes an estimate of throwback mortality.

Figure 1. Harvest of lake trout by fishery.

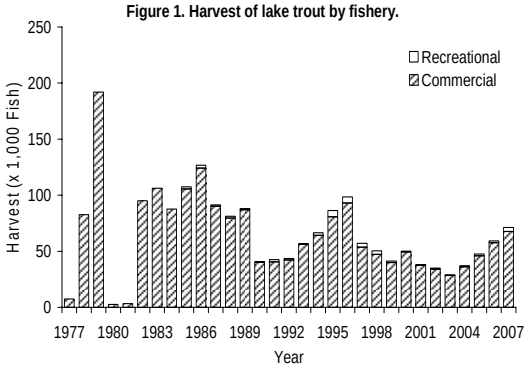
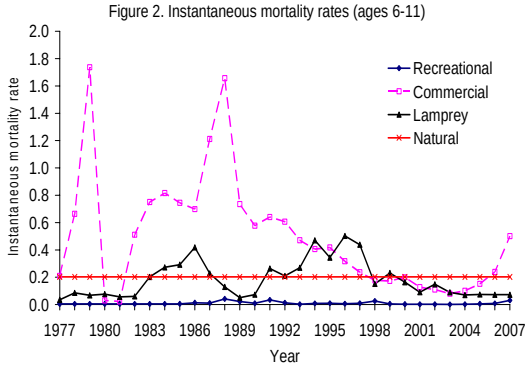


Figure 2. Instantaneous mortality rates (ages 6-11)



Instantaneous mortality rates have been variable and relatively high in northern Lake Huron (Figure 2). From 1977 to 1993, commercial fishing mortality was the leading source of lake trout mortality. After 1993, commercial fishing mortality decreased as sea lamprey-induced mortality increased. Sea lampreys were the largest source of lake trout mortality in the 1990s, until 1998 when sea lamprey-induced mortality decreased. From 2003 to 2007 sea lamprey-induced instantaneous mortality averaged 0.08 y^{-1}, and commercial fishing instantaneous mortality averaged 0.21 y^{-1}. Sea lamprey-induced mortality rates for age-6 to 11 lake trout in 2007 decreased 81% from the average of 1994-1998 levels. This decline is due to the treatment of the St. Marys River and subsequent reduction in parasitic phase sea lamprey. Recreational fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron (Figure 2). Commercial fishing mortality has been steadily increasing since 2004 (Figure 2).

In the 1980s and early 1990s, high rates of both sea lamprey-induced and commercial fishing mortality caused the age structure in northern Lake Huron to be truncated just before the age of first maturity. As a result, spawning stock biomass (SSB) has been extremely low in northern Lake Huron (Figure 3). However, since 1998 both total lake trout biomass and SSB have been steadily increasing. Total biomass is currently higher than at any time in the modeled time series (1977-2007). Much of this increase is due to lower rates of commercial and sea lamprey-induced mortality and increased stocking in MH-1. Total 2007 lake trout biomass was 2.42 million lb, well above the most recent 20-year average of 1.16 million lb. However, total 2007 SSB was only 239,000 lb indicating the majority of lake trout biomass in MH-1 is composed of young fish. Increases in abundance of older age classes will be needed to create a naturally-producing, self-sustaining stock.

Figure 3. Lake trout biomass and SSB in MH-1

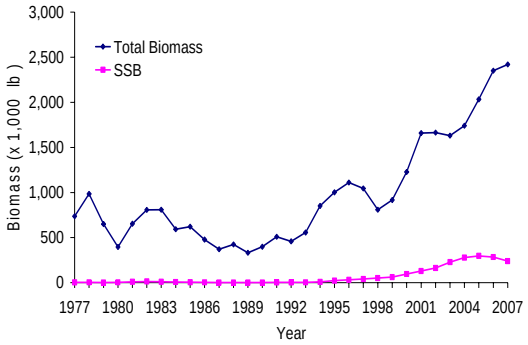
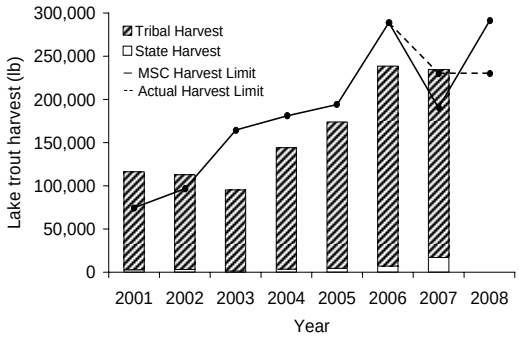


Figure 4. Yearly harvest and harvest limits



The 2008 stock assessment model did not meet minimum convergence criteria, and given that the harvest limit was already established via stipulation by the Parties, time was not invested into fine-tuning the model to improve performance. Despite the potential problems with the model, the recommended TAC generated from its parameters was 293,100 lb for 2008. This harvest was calculated using the interim target total annual mortality rate of 47%, and allocation was 91% for Tribal harvest and 9% for the State, resulting in an allocation of 266,700 lb to the Tribes and 26,400 lb to the State.

In 2001 the MH-1 harvest limit was calculated based on the phase-in requirements of the Consent Decree. In particular, it was based on the average effort from 1997 to 1999, either adjusted for gill-net operations converted to trap nets under provisions of the Consent Decree (Tribal commercial fishery) or changes in regulations (State recreational fishery). The Consent Decree states that this technique should be used to calculate the MH-1 harvest limit through 2005. However, due to changes in lake trout stock dynamics in MH-1 caused by larger than expected decreases in sea lamprey-induced mortality, calculating the 2002 to 2005 harvest limits using the phase-in method described in the Decree results in projected total annual mortality rates that fall below the target specified in the Decree.

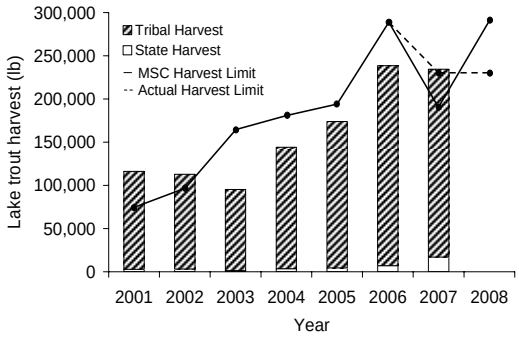
In February 2003 the Executive Council of the 2000 Consent Decree instructed the MSC to calculate lake trout harvest limits using interim total annual mortality rates in units where conformity to Consent Decree provisions resulted in harvest limits based on total annual mortality rates below target. As a result from February 2003 through 2007, MH-1 harvest limits have been calculated using the Consent Decree specified interim target mortality rate for 2006-2011 of 47%, and the 2006 allocation percentage of 92% Tribal and 8% State. Starting with the 2008 harvest limit, the allocation percentage changed to 91% Tribal and 9% State as specified in the Decree.

Current spawning stock biomass per recruit (SSBR) is near SSBR at target mortality, indicating total annual mortality rates are close to the interim target of 47% total annual mortality. If mortality rates continue to remain at this level or lower, stock biomass and spawning stock biomass should continue to increase. If, however, total mortality continues to increase in this unit, stock biomass and spawning stock biomass will be negatively impacted.

Tribal harvest (217,000 lb without throwbacks) was higher than the Tribal harvest limit (210,000 lb) in 2007, but State harvest was lower than the state harvest limits in 2007 (Figure 4). In

general, total harvest in this unit has increased under the 2000 Consent Decree, as has the total harvest limit. This is due to increased lake trout biomass resulting from reductions in total annual mortality and increased stocking. In 2007 for the first time under the Decree, the MSC recommended harvest limit dropped relative to the previous year. In 2008, the MSC recommended harvest limit increased to a level almost equal to the 2006 harvest limit.

Figure 4. Yearly harvest and harvest limits



In 2006, the MSC informed the TFC and the parties that it was not comfortable with the magnitude of the harvest limit increase from 2005 to 2006 in MH-1, especially after a period of relative stability from 2003 to 2005 and given that a harvest limit increase of similar magnitude did not occur in MH-2 in 2006. For the 2007 and 2008 harvest limit models, the MSC implemented methods (described below) in the model to better estimate survival and abundance of juvenile lake trout and more realistically match relative abundances seen in survey catches. The MSC felt that it might have been overestimating survival of age 1 to 2 lake trout in previous model runs.

Due to concerns over the drop in the 2007 MSC recommended harvest limit and concerns about juvenile lake trout survival, in August 2007 the Executive Council of the 2000 Consent Decree amended the Decree and set the 2007-2009 MH-1 harvest limit as follows:

> *The Tribes' lake trout harvest limit for unit MH-1 (including the Bay Mills Small Boat Zone) shall be 210,000 pounds plus estimated throwback mortality, and the State's lake trout harvest limit shall be 20,000 pounds.*

As part of this amendment, the parties also agreed to improve data collection and methodologies to better estimate throwback mortalities and juvenile lake trout survival during 2007-2009.

Model changes

No major changes were made to the model structure for this year's assessment; however, changes made for past TAC-year models were maintained in the current model. To address the estimated juvenile survival issues described above, starting with the 2007 TAC-year model we coded the assessment model to estimate time varying survival from age 1 to 2 as a bounded vector. We also stopped using the post stocking survival vector as in previous model runs. Also, starting in 2007 we modeled time varying selectivity in the commercial and recreational fisheries as a random walk function and set maximum age specific selectivity as 1 for each year.

Other past changes included modeling time varying selectivity in the spring survey as a random walk function starting with the 2006 TAC-year model, introducing time-varying maturity and weight-at-age in the model input data starting with the 2005 TAC-year model, and allowing the model to select the peak age of fishery selectivity, setting the under-reporting vector for the Tribal commercial fishery to zero, and including release mortalities from the

recreational fishery in harvest totals starting with the 2004-TAC year model.

Summary Status MH-1 Lake Trout	Value (Standard Error)
Female maturity	
Size at first spawning	1.27 lb
Age at first spawning	3 y
Size at 50% maturity	3.77 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	0.331 lb (SE 0.028)
Current SSBR	0.050 lb (SE 0.010)
SSBR at target mortality	0.051 lb (SE 0.001)
Spawning potential reduction	
At target mortality	0.153 (SE 0.029)
Average yield per recruit	0.055 lb (0.004)
Natural mortality (M)	0.203 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	8 y
Sport fishery (2005-2007)	7 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.297 y^{-1} (SE 0.059)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.015 y^{-1} (SE 0.004)
Sea lamprey mortality (ML)	
(average 2005-2007, ages 6-11)	0.073 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.588 y^{-1} (SE 0.063)
Recruitment (age 1)	
(average 1998-2007)	557,630 fish (SE 24,280)
Biomass (age 3+)	
(average 1998-2007)	1,645,400 lb (SE 141,510)
Spawning biomass	
(average 1998-2007)	182,520 lb (SE 20,561)
MSC recommended yield limit for 2008	293,100 lb
Actual yield limit for 2008 (Based on August 2007 Decree amendment)	230,000 lb (plus est. Tribal throwbacks)

MH-2 (North-central Lake Huron)

Prepared by Aaron P. Woldt and Ji X. He

Lake trout management unit MH-2 is located in north-central Lake Huron. It includes statistical district MH-2 (grids 409-410, 509-512, 608-614, 709-715, 809-815, and 909-915 for a total of 1,521,520 acres) as well as adjacent Canadian waters (areas 4-2, 4-3, and 4-7 for a total of 1,526,460 acres). Michigan waters of the MH-2 unit include both 1836 Treaty-ceded waters (723,710 acres) and non-treaty waters (797,810 acres), divided by a line running north-east from the tip of North Point to the international border. The Michigan ports of Presque Isle and Alpena are contained in this unit. The St. Marys River, connecting Lakes Superior and Huron, flows into northern Lake Huron in grid 306, to the north of this unit. The St. Marys River had supported large spawning runs of sea lamprey, and until the late 1990s the resulting larval populations were untreated and contributed substantial numbers of parasitic-phase sea lamprey to the lake. Comprehensive treatment of the river by the Great Lakes Fishery Commission's control agents has reduced the number of sea lamprey produced in the St. Marys River, and decreases in lake trout wounding and sea lamprey-induced mortality rates have been documented in northern Lake Huron. The management unit has a wide bathymetric range with areas in grids 714 and 814 deeper than 690 feet, and a total of 202,540 acres of 1836 Treaty-ceded waters with bottom depths of 240 ft or less. This management unit contains a limited number of historically important lake trout spawning reefs and shoals. These reefs are located near Middle Island, North Point, and Six Fathom Bank. The Six Fathom Bank Refuge is located in the eastern half of grids 913 and 1013, grids 914 and 1014, and Michigan waters of grids 915 and 1015 covering 251,940 acres. Canadian waters adjacent to the refuge are a commercially protected area where commercial fishers are prohibited from fishing in waters shallower than 40 fathoms. Recreational anglers may harvest lake trout in Canadian waters adjacent to the refuge, but few, if any, travel the long distance offshore. Approximately ½ of the refuge lies in MH-2 (118,560 acres), and retention of lake trout in the refuge is strictly prohibited.

There is little or no natural recruitment of lake trout in north-central Lake Huron, although recent indicators (increased trawl catches of age 0, increased CPUEs of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-2. From 2003 to 2007, approximately 493,000 yearling lake trout per year were planted annually in near-shore areas of MH-2. For the first time since 2001, lake trout were planted offshore on the Six Fathom Bank/Yankee Reef complex in 2007. Approximately 207,000 fall fingerling lake trout were planted offshore in grid 1012. These fish were destined for Yankee Reef (grid 1214) as requested by the Lake Huron

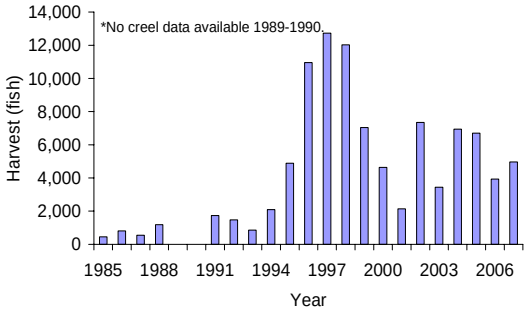
Technical Committee, but inclement weather forced the Service to stock the fish early. The Six Fathom/Yankee Reef complex had been stocked annually from 1985 to 2001, but in 2002 these fish were re-allocated to nearshore stocking sites. Approximately 28,000 yearling lake trout were planted annually in Canadian management area 4-3 from 2003 to 2007. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 633,000 yearling lake trout recruits in MH-2 for 2007.

In contrast to MH-1, there is no commercial harvest of lake trout in Michigan waters of MH-2. As of August 2000, Tribal commercial fishers may deploy trap nets that target lake whitefish in 1836 Treaty-ceded waters of MH-2. This fishery is not allowed to market lake trout bycatch. Two State-licensed commercial fishing operations operate trap nets targeting lake whitefish in MH-2 south of the 45th parallel. These operations are also not allowed to market lake trout bycatch. All lake trout are returned to the water, regardless of condition. Prior to the signing of the Consent Decree, both of the State-licensed fisheries operated trap nets north of North Point. These fisheries were moved south of the 45th parallel to accommodate the new Tribal trap-net operations as stipulated in the Consent Decree.

There is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-2 (areas 4-2, 4-3, and 4-7) that we included in our assessment. From 2003 to 2007, total Canadian commercial lake trout yield in these areas averaged 70,000 lb per year. The majority of this yield came from the large-mesh gill-net fishery. Canadian large-mesh gill-net effort averaged 8.4 million ft per year from 2003 to 2007. Canadian large-mesh gill-net effort in waters adjacent to MH-2 increased substantially starting in 1999, stabilized from 2002-2004, and decreased in recent years. However, Canadian effort is currently near its highest levels during the 1984-2007 modeled time series.

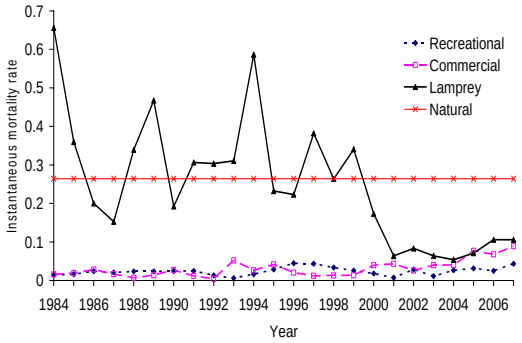
The State-licensed recreational fishery in MH-2 is composed of both charter and non-charter anglers. Lake trout are caught as bycatch by salmon anglers, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to Tribal members in 1836 Treaty-ceded waters. The magnitude of recreational harvest varies from year to year and has averaged 5,200 fish from 2003 to 2007 (Figure 1). From 2003 to 2007, recreational yield of lake trout averaged 26,900 lb, and in 2007 recreational harvest was 29,900 lb in MH-2. Starting in 2001, the State of Michigan raised the minimum size limit of lake trout in the recreational fishery from 10” to 20” in areas north of 44° 50’ N latitude. Starting in 2003, the State of Michigan raised the minimum size limit of lake trout in the recreational fishery from 20” to 22” in MH-2. These new regulations are intended to keep recreational harvest below the State share of the MH-2 harvest limit. Due to these more restrictive State regulations, 2003-2007 State harvest includes an estimate of throwback mortality (i.e. fish that were thrown back but later died due to handling).

Figure 1. Recreational fishery lake trout harvest



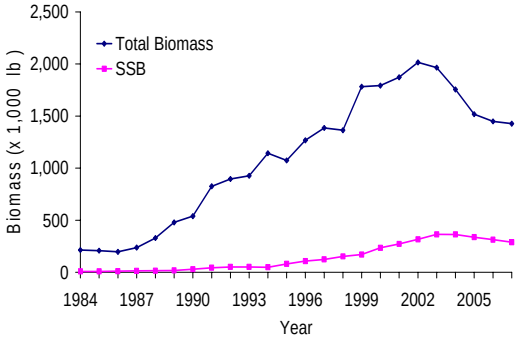
In most years, the dominant source of mortality for lake trout in MH-2 was sea lamprey (Figure 2). Sea lamprey-induced mortality was greater than all other mortality sources from 1984 to 1999 with the exception of 1986, 1987, 1990, 1995, and 1996 when natural mortality was the largest single mortality source (Figure 2). Sea lamprey mortality rates have been cyclic in north-central Lake Huron, reaching peaks in 1984, 1989, 1994, 1997, and 1999 (Figure 2). From 2003 to 2007, sea lamprey-induced mortality averaged 0.08 y^{-1}. From 1999 to 2001 sea lamprey-induced mortality rates declined drastically, and then leveled off in recent years. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2007 decreased 69% from the average of 1994-1998 and are now near their lowest levels over the modeled time series. This decline is due to the treatment of the St. Marys River and subsequent reduction in parasitic phase sea lamprey. Recreational and commercial fishing mortality were low in most years relative to sea lamprey-induced mortality; however, increases in commercial harvest of lake trout in Canadian waters have caused the commercial fishing mortality rate to increase since 1999 (Figure 2).

Figure 2. Instantaneous mortality rates (ages 6-11)



Past high rates of sea lamprey-induced mortality in most years caused the age structure in north-central Lake Huron to be truncated just before the age of first maturity. As a result, spawning stock biomass (SSB) is low in north-central Lake Huron (Figure 3). Total lake trout biomass steadily increased from 1984 to 2002, but declined from 2003 to 2007. Total biomass averaged 1.62 million lb from 2003 to 2007. SSB increased every year from 1984 to 2003, and has leveled off since 2004. Both total lake trout biomass and SSB remain at high levels relative to the modeled time series (1984-2007). Much of this increase is due to lower rates of sea lamprey-induced mortality and increased stocking in MH-2. Total 2007 SSB was 333,000 lb (roughly 21% of total biomass) indicating the majority of lake trout biomass in MH-2 is composed of young, immature fish. Increases in abundance of older age classes will be needed to create a naturally-producing, self-sustaining stock.

Figure 3. Lake trout biomass and SSB in MH-2



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 46,000 lb for MH-2 in 2008. This harvest limit was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the State and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the Consent Decree. Based on these calculations, the total yield was allocated 44,000 lb to the State and 2,000 lb to the tribes.

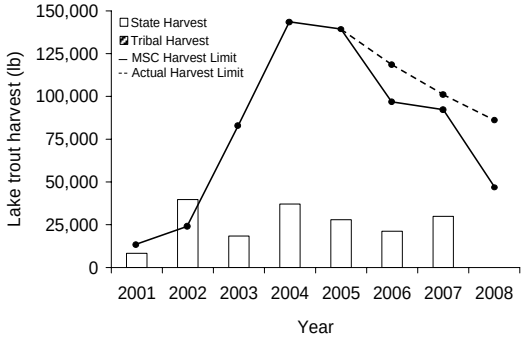
Current spawning stock biomass per recruit (SSBR) is above SSBR at target mortality, indicating total annual mortality rates are below the target of 40% total annual mortality. This is due to the large declines in sea lamprey-induced mortality rates from 2000 to 2007. If sea lamprey-induced mortality remains low, spawning stock biomass and SSBR should continue to increase.

State harvest was significantly lower than the State harvest limit in 2007 (Figure 4), as was Tribal harvest. All Tribal fishers in MH-2 fish trap nets and are required to release all lake trout regardless of condition.

The total 2008 MSC recommended harvest limit decreased significantly from the actual 2007 harvest limit (Figure 4). Section VII.A.6 of the Consent Decree states that for fully phased in units "changes in harvest limits from year to year shall not result in adjustments greater than a fifteen percent (15%) increase or decrease from the previous year in that unit, unless all parties agree that a greater change is appropriate." For MH-2 in 2008, the parties agreed to invoke the 15% rule to limit the harvest limit decline to a level 15% below the actual 2007 harvest limit. Invoking the 15% rule resulted in a 2008 harvest limit of 81,495 lb for the State and 4,299 lb for the tribes.

The large increases in harvest limits from 2001 to 2004 were due to large scale declines in sea lamprey-induced mortality rates during 2000-2004. The plateau and decline in harvest limit from 2005 to 2008 is likely due to a decline in growth rate and reduced biomass, but could indicate that this unit is approaching an asymptote in its harvest limit. We will continue to monitor the lake trout population dynamics in this unit in the future, especially dynamics of juvenile lake trout which have become less abundant in recent survey catches.

Figure 4. Yearly harvest and harvest limits



In 2006, the MSC informed the TFC and the parties that it was not fully comfortable with the magnitude of the harvest limit increases from 2001 to 2004 in MH-2. For the 2007 and 2008 harvest limit models, the MSC implemented methods (described below) in the model to better estimate survival and abundance of juvenile lake trout and more realistically match relative abundances seen in survey catches. The MSC felt that it might have been overestimating survival of age 1 to 2 lake trout in previous model runs.

Model changes

No major changes were made to the model structure for this year's assessment; however, changes made for past TAC-year models were maintained in the current model. To address the estimated juvenile survival issues

described above, starting with the 2007 TAC-year model we coded the assessment model to estimate time varying survival from age 1 to 2 as a bounded vector. We also stopped using the post stocking survival vector as in previous model runs. Also, starting in 2007 we modeled time varying selectivity in the commercial and recreational fisheries as a random walk function and set maximum age specific selectivity as 1 for each year.

Other past changes included modeling time varying selectivity in the spring survey as a random walk function starting with the 2006 TAC-year model, introducing time-varying maturity and weight-at-age in the model input data starting with the 2005 TAC-year model, and allowing the model to select the peak age of fishery selectivity, setting the under-reporting vector for the Tribal commercial fishery to zero, and including release mortalities from the recreational fishery in harvest totals starting with the 2004 TAC-year model.

Summary Status MH-2 Lake Trout	Value (Standard Error)
Female maturity	
Size at first spawning	0.62 lb
Age at first spawning	3 y
Size at 50% maturity	3.66 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	1.381 lb (SE 0.165)
Current SSBR	0.520 lb (SE 0.070)
SSBR at target mortality	0.471 lb (SE 0.020)
Spawning potential reduction	
At target mortality	0.380 (SE 0.024)
Average yield per recruit	0.180 lb (SE 0.020)
Natural mortality (M)	0.264 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	7 y
Sport fishery (2005-2007)	8 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.078 y^{-1} (SE 0.016)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.033 y^{-1} (SE 0.006)
Sea lamprey mortality (ML)	
(average 2005-2007, ages 6-11)	0.094 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.470 y^{-1} (SE 0.030)
Recruitment (age 1)	
(average 1998-2007)	484,360 fish (SE 39,162)
Biomass (age 3+)	
(average 1998-2007)	1,694,300 lb (SE 139,080)
Spawning biomass	
(average 1998-2007)	280,820 lb (SE 34,994)
MSC recommended yield limit for 2008	46,000 lb
Actual yield limit for 2008	85,794 lb

Lake Michigan

MM-123 (Northern Treaty Waters)

Prepared by Jory L. Jonas, Erik J. Olsen, Steve Lenart, and Mark Ebener

Management unit MM-123 is made up of statistical districts MM-1, MM-2 and MM-3 and encompasses Michigan's waters of northern Lake Michigan and northern Green Bay. This management unit covers 5,000 square miles. Water depths in more northern waters are for the most part less than 150 feet, and approximately 3,800 square miles (two-thirds of the area) are less than 240 feet. In southern portions of the unit, depths can be greater than 550 feet. Most of the historically important lake trout spawning reefs in Lake Michigan are located in MM-123. The unit contains many islands including the Beaver Island complex (Beaver, Hat, Garden, Whiskey, Trout, High and Squaw Islands), North and South Fox Islands, and Gull Island in Lake Michigan. Another series of islands form a line separating Green Bay from Lake Michigan; these include Little Gull, Gravely, St. Martins, Big and Little Summer and Poverty Islands.

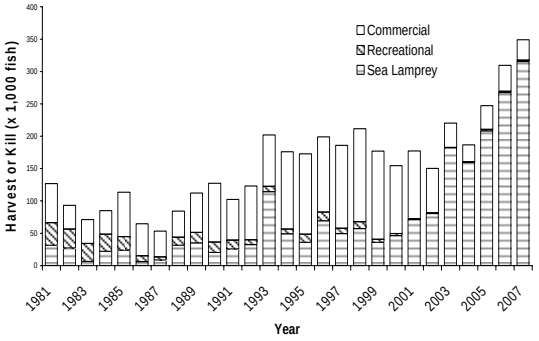
Except for the southern one-half of MM-1 in Green Bay, this management unit is entirely in 1836 Treaty-ceded waters, and contains a lake trout refuge. The "northern refuge" is nearly 900 square miles and occupies the southern ½ of grids 313 and 314, grids 413, 414, 513-516, the northwest quarter of grid 517, grid 613, and the northern ½ of grid 614. Retention of lake trout by sport or commercial fisheries is prohibited in the refuge. Both commercial and subsistence gill net fishing are prohibited in the refuge, while commercial trap net operations are permitted to harvest lake whitefish.

Outside of the refuge commercial fishing is also prohibited in the innermost area of Little Traverse Bay (grid 519) and portions of grid 306 in northern Green Bay.

Recruitment of lake trout in MM-123 is currently based entirely on stocking. In each of the last ten years, on average, 788,373 yearling lake trout have been stocked into northern Lake Michigan and approximately 68 percent of these fish were stocked into the northern refuge. To more accurately estimate recruitment to the fishable stock with the catch-at-age model, the number of fish stocked is adjusted to account for first year mortality. Coded-wire tag returns were used to assign movement of stocked fish into different management units in the lake. As a result, from 1998-2007 the estimated recruitment of age-1 stocked lake trout has averaged 866,990 fish.

Both state and Tribal commercial fisheries operate in MM-123. State-licensed commercial fisheries target lake whitefish primarily with trap nets in Green Bay. The Tribal commercial gill-net and trap-net fishery primarily targets lake whitefish, lake trout are harvested as by-catch. From 1981 until 2001, commercial fishing accounted for most of the lake trout mortality in northern Lake Michigan (Figure 1). In 2001, sea lamprey abundance began to increase and over the most recent 5 years the number of lake trout killed by sea lamprey peaked at an estimated 315,500 fish in 2007. Prior to the year 2000, sea lamprey killed an average of 37,000 fish per year.

Fig. 1 Number of lake trout killed by source in MM-123

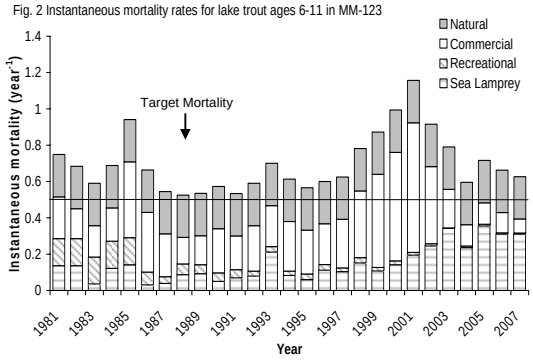


The Tribal commercial fishers in MM-123 use large- and small-mesh gill nets as well as trap nets. The large-mesh gill-net fishery accounts for the majority of the lake trout yield. Total commercial yield increased from 353,280 lb in 1991 to 880,257 lb in 1999. After the implementation of the 2000 Consent Decree, the Tribal commercial yield of lake trout decreased to a low of 105,491 lb in 2004 and has averaged 154,650 lb during the most recent 3 years. Large-mesh gill-net effort in Tribal fisheries declined from 23 million feet in 1992 and 1993 to 4.2 million feet in 2004. During the most recent 3 years effort has averaged 4.7 million feet. The number of lake trout harvested from MM-123 by the commercial fishery increased from 1991 (62,000 fish) to 1998 (144,000 fish). More recently, following implementation of the 2000 Consent Decree, the number of lake trout harvested by the commercial fishery declined to an all time low of 24,400 fish in 2004, and has averaged 34,500 fish during the most recent 3 years.

The management of recreational fisheries for lake trout is the primary responsibility of the State of Michigan and fisheries are comprised of both charter and sport anglers. Recreational fishing mortality of lake trout in MM-123 is significantly lower than commercial fishing or sea lamprey predation (Figure 2). In 1991, the minimum size limit for sport fishing in MM-123 was increased from 10 to 24 inches and a decline in recreational yield resulted. In 2003, the bag limit was raised from 2 to 3 fish, and appears to have had little effect on harvest. The 24-inch minimum size limit and 3 fish bag limit remained in effect through 2007. The recreational yield of lake trout declined by over 97 percent from 1998 (75,820 lb) to 2003 (2,300 lb). Recreational fishery yield has averaged 13,100 lb during the most recent 3 years. The numbers of lake trout harvested followed similar patterns to those described for yield. Recreational fishing effort is relatively low in this unit, averaging 95,000 angler hours during 1988-2007.

From 1989 until 2002, sea lamprey-induced mortality had been the second highest source of mortality for lake trout in northern Lake Michigan. Since 2003, sea lamprey mortality has exceeded all other sources, with average rates of 0.31 per year from 2003-2006.

Fig. 2 Instantaneous mortality rates for lake trout ages 6-11 in MM-123

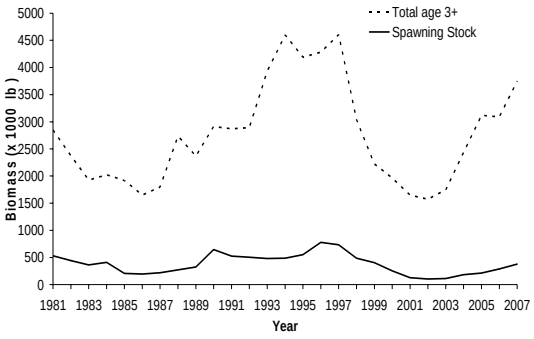


In northern Lake Michigan, lake trout generally are both spawning and fully-recruited into commercial and recreational fisheries by age 7. The biomass of lake trout in northern Lake Michigan had nearly quadrupled from 1986 to 1997, increasing from 1.7 to 4.6 million pounds. The biomass of lake

trout then steadily declined to 1.5 million pounds by 2002. Since this time the estimated biomass has increased to 3.7 million pounds in 2007. Spawning biomass showed similar though less pronounced patterns, with only a slight increase in recent years.

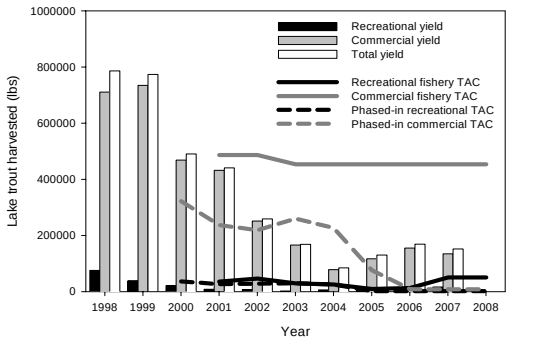
The spawning stock biomass produced per recruit (including the refuge population) during 2007 was below the target value indicating that mortality rates for the combined refuge/non-refuge population are above the 40% mortality target for this area.

Fig. 3 Estimated lake trout biomass in MM-123



The yield limit for 1836 Treaty waters in 2008 is 50,000 lb for the state recreational fishery and 453,000 lb for the Tribal commercial fishery. These values reflect an agreed upon extension of the phase-in requirements from the 2000 Consent Decree. In 2007, harvest limits for 2005 and 2006 were re-assessed, and the phase-in period extended until lamprey mortality is significantly below the 1998 baseline for three consecutive years, at which time management of this unit will be re-evaluated. Phase-in options allow for a temporary increase in mortality above the 40% target (Figure 4). When fully phased to the 40% mortality target, yield allocations in this management unit will be 10% to the State of Michigan and 90% to Tribal fisheries. The model generated harvest recommendations are extremely low because the combination of sea lamprey and natural mortality is so close to the mortality limit that few fish are left available to allocate to fisheries.

Fig. 4. Comparison of actual harvest vs. TAC decision vs. model recommendation



Model fit

The 2008 SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass estimates for recent years exist.

Summary Status MM-123 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	2.11 lb
Age at first spawning	3 y
Size at 50% maturity	5.80 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	6.24 lb (5.46 – 7.09)
Current SSBR combined w/ refuge	0.95 lb (0.81 – 1.11)
SSBR at target mortality	1.95 lb (1.72 – 2.19)
Spawning potential reduction	
At target mortality	0.312 (0.280 – 0.346)
Average yield per recruit	0.287 lb (0.240 – 0.342)
Natural mortality (M)	0.233 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	7 y
Sport fishery (2005-2007)	7 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.107 y^{-1} (0.078 – 0.144)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.009 y^{-1} (0.006 – 0.012)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 6-11)	0.301 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.651 y^{-1} (0.617 – 0.691)
Recruitment (age 1)	
(average 1998-2007)	866,990 fish (616,419 – 1,209,230)
Biomass (age 3+)	
(average 1998-2007)	2,454,455 lb (2,022,910 - 2,995,060)
Spawning biomass	
(average 1998-2007)	250,007 lb (207,624 – 302,554)
Recommended yield limit in 2008	7,900 lb
Actual yield limit in 2008 – Amendment	503,000 lb

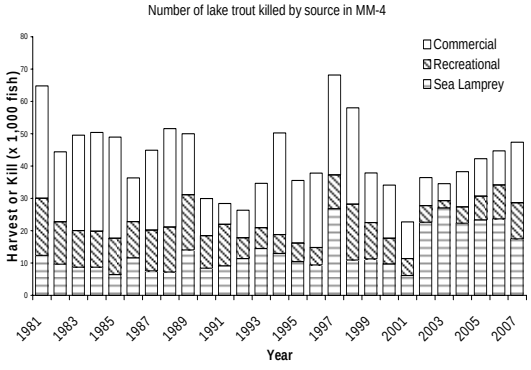
MM-4 (Grand Traverse Bay)

Prepared by Jory L. Jonas, and Erik J. Olsen

Lake trout management unit MM-4 encompasses the Grand Traverse Bay region of Lake Michigan. There are two islands in this management unit, Bellow and Marion Island. A large peninsula bisects the southern half of the bay. For the most part water depths in the bay range up to 280 feet. However, waters on either side of the peninsula are much deeper, ranging to 440 feet in the west arm and 640 feet in the east arm. This management unit is entirely in 1836 Treaty waters. There are no refuge areas allocated, however commercial fishing is prohibited in the southern most portion of the bay (grids 915 and 916). The total area of the unit is 255 square miles of which 168 square miles are less than 240 feet in depth. Based on estimates from historical commercial catch rates only a small amount of lake trout spawning habitat is located in the management unit. However, Grand Traverse Bay is one of the only areas of Lake Michigan where the recruitment of naturally reproduced lake trout has been documented. In the mid-1980s the frequency of unclipped fish in the bay increased significantly leading biologists to believe that rehabilitation efforts were succeeding. Unfortunately, in more recent evaluations few unclipped lake trout have been seen. This area constitutes an area of high use by both Tribal and State interests.

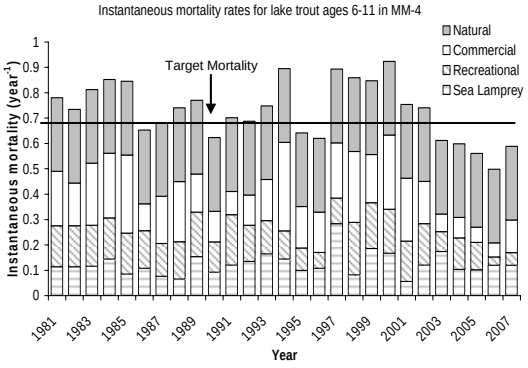
The recruitment of lake trout in Grand Traverse Bay is based entirely on stocking. The U.S Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. In each of the last ten years, on average, 260,519 yearling lake trout have been stocked into Grand Traverse Bay. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for variations in mortality and movement among the various regions in the lake. Over the last 10 years (1998-2007) the recruitment to age one has averaged 262,263 fish in the Grand Traverse management unit.

From 1994 until 2001 more lake trout were killed by commercial fishing than by either sea lamprey or sport fishing, averaging 22,000 fish (Figure 1). By 2003, the number of lake trout killed by commercial fishing had declined to less than 5,300 fish y^{-1}. The harvest of lake trout has increased in recent years and was 18,650 fish in 2007. Commercial fishing mortality rates in Grand Traverse Bay peaked in 1994 (0.35 y^{-1}), and remained relatively stable through 2002 averaging 0.21 y^{-1}. Mortality rates were < 0.09 y^{-1} from 2003 to 2006, and increased in 2007 to 0.13 y^{-1} (Figure 2).



Only Chippewa Ottawa Resource Authority licensed Tribal fishermen commercially harvest fish in this management unit. There are three types of Tribal commercial fisheries, large-

mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery, while primarily targeting lake whitefish, is responsible for the greatest number of harvested lake trout. The commercial harvest of lake trout in Tribal large-mesh gill net fisheries rose from a low of 6,300 fish in 1991 to 33,300 fish harvested in 1998. Harvest again declined to 5,000 fish in 2003, averaged 10,800 fish from 2004–2006, and increased to 18,700 fish in 2007. Accordingly, the yield of lake trout captured in Tribal commercial fisheries peaked in 1998 at 161,000 lb and declined by nearly 86% to 23,000 lb in 2003. Yield has increased in recent years and was 95,400 lb in 2007. Large-mesh gill-net effort in Tribal fisheries had declined from 2 million feet in 1996 to only 0.27 million feet in 2006. Effort in 2007 was higher at 0.6 million feet of net.

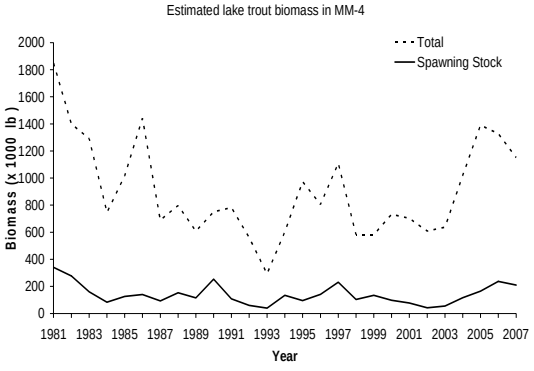


The management of recreational fisheries for lake trout is the primary responsibility of the State of Michigan and fisheries are comprised of both charter and sport anglers. The sport fishing harvest regulations in the Grand Traverse Bay management unit have changed significantly over the last 10 years, affecting recreational fishing mortality rates and harvest levels. From 1992-1996, the minimum size limit to harvest lake trout increased from 10 to 24 inches. In 1996, the season for harvesting lake trout was lengthened, from May 1 through Labor Day to Jan 1 through September 30. Mid-way through 1997 the minimum size limit was decreased to 20 inches and remained so through 2002. In 2003, the bag limit was raised from 2 to 3 fish and the minimum size limit increased to 22 inches. In 2006, regulations were again changed to protect larger spawning lake trout. An inverted slot limited was adopted where anglers are only allowed to keep fish between 20 and 25 inches, and are allowed one trophy fish greater than 34 inches. The mortality rates of lake trout resulting from recreational fishing had been declining from 1991 (0.20 y^{-1}) to 1996 (0.06 y^{-1}). Recreational fishing mortality was relatively consistent from 1998 to 2002 averaging 0.18 y^{-1} and has been consistently lower in recent years (2005-2007) averaging 0.06 y^{-1} (Figure 2). The estimated recreational yield of lake trout in Grand Traverse Bay had been steady during the years 1992-1996 averaging 39,000 lb. In response, at least in part to reductions in size limits, the recreational yield of lake trout from 1996 to 1998 increased reaching 93,000 lb by 1998. Yield then declined to an all time low of 12,000 lb in 2003. Yield has since increased to 48,300 lb in 2007. The numbers of lake trout harvested followed patterns similar to yield. Numbers were consistent from 1992 through 1996 averaging 6,000 fish and had increased to 19,000 fish in 1998. Harvest numbers then declined steadily to 2,000 fish in 2003 and have since been rising and an estimated 10,700 fish were harvested in 2007 (Figure 1). From 1991 to 2007 fishing effort has been relatively consistent averaging 197,000 angler

hours per year (range from 155,000 to 238,000 angler hours).

From 1981 to 1988, sea lamprey-induced mortality was the lowest source of mortality in the Grand Traverse Bay management unit with instantaneous rates averaging 0.10 y^{-1}. Wounding mortality increased to 0.28 y^{-1} in 1997 and declined to 0.06 y^{-1} by 2001. In the past three years (2004-2006) lamprey mortality has averaged 0.11y^{-1}. In 2001, lampreys were estimated to have killed just over 6,000 lake trout. The numbers of lake trout killed by lamprey have since increased. From 2002 to 2007 the average number of lake trout killed has been 23,000 per year.

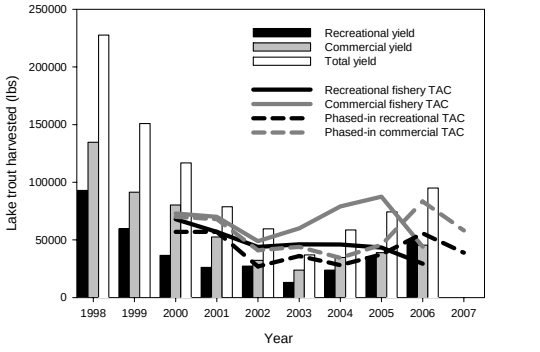
In the Grand Traverse Bay management unit, lake trout are recruited into sport fisheries by age 6 and commercial fisheries by age 7. Female lake trout first spawn at age 3 and 50% or more are spawning by age 6. The total biomass of lake trout over age 3 peaked in 1986 at 1.4 million pounds. Biomass increased from a low of 294,000 lb in 1993 to 1.1 million pounds in 1997. From 1998 to 2003 lake trout biomass averaged 640,000 lb and has increased in recent years to 1.2 million lb in 2007.



The spawning stock biomass produced per recruit is below the target value indicating that total mortality rates exceeded targets in Grand Traverse Bay. The model recommended harvest limit for 2008 in the Grand Traverse Bay management unit is 80,340 lb of which 32,140 lb was allocated to the state recreational fishery and 48,200 lb to the Tribal commercial/subsistence fishery.

Grand Traverse Bay represents an area where unique phase-in requirements are defined in the 2000 Consent Decree From 2006 to 2009, yield and effort limits meet the target mortality rate for the management unit of 45%, with a 40 percent allocation to the State of Michigan and a 60 percent allocation to Tribal fisheries. By decision of the parties, phase-in practices will continue to be used in 2008, however an agreement had not been reached at the time this report was written.

Fig. 4. Comparison of actual harvest vs. TAC decision vs. model recommendation



Model fit

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass

estimates for recent years exist. Retrospective patterns in recruitment indicate that year-class strength of a cohort does not stabilize until around age 5 in this SCAA model.

Summary Status MM-4 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	2.60 lb
Age at first spawning	3 y
Size at 50% maturity	5.44 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.237 lb (1.954 – 2.562)
Current SSBR	0.527 lb (0.448 – 0.613)
SSBR at target mortality	0.667 lb (0.607 – 0.729)
Spawning potential reduction	
At target mortality	0.299 (0.264 – 0.335)
Average yield per recruit	0.465 lb (0.421 – 0.513)
Natural mortality (M)	0.290 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	7 y
Sport fishery (2005-2007)	6 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.082 y^{-1} (0.062 – 0.109)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.063 y^{-1} (0.049 – 0.081)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 6-11)	0.109 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.544 y^{-1} (0.506 – 0.589)
Recruitment (age 1)	
(average 1998-2007)	262,263 fish (238,232 – 289,381)
Biomass (age 3+)	
(average 1998-2007)	882,856 lb (760,268 – 1,019,480)
Spawning biomass	
(average 1998-2007)	125,458 lb (104,937 – 147,775)
Recommended yield limit in 2008	80,340 lb
Actual yield limit in 2008	Not set

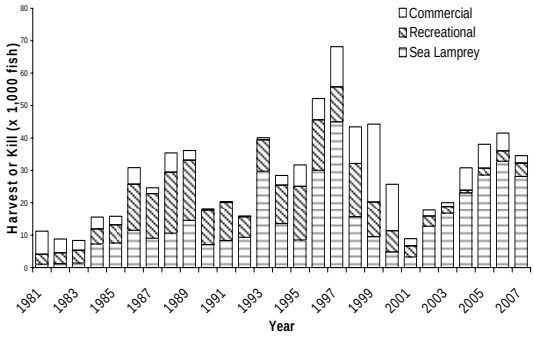
MM-5 (Leelanau Peninsula to Arcadia)

Prepared by Jory L. Jonas and Erik J. Olsen

Lake trout management unit MM-5 is located in eastern central Lake Michigan and corresponds to the MM-5 statistical district. This area constitutes an area of high use by both Tribal and state interests. The unit covers 2,100 square miles and encompasses Michigan's waters of Lake Michigan from Arcadia north to the tip of the Leelanau Peninsula, extending to the state line bisecting the middle of the lake. There are two islands in this management unit, the North and South Manitou Islands. Some of the deepest waters and largest drop-offs in Lake Michigan occur in MM-5. Water depths range to 825 feet and for the most part are greater than 400 feet. Only 440 square miles (21%) of the unit are at depths less than 240 feet. The entire area is in 1836 Treaty waters and there are no refuges allocated within the management unit. Only a small amount of lake trout spawning habitat is located here, most of which is located in the near shore zone and around the North and South Manitou Islands.

The recruitment of harvestable lake trout in the MM-5 management unit of Lake Michigan is based entirely on stocking. The U.S. Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. Over the last ten years, on average, 221,934 yearling lake trout were stocked into the MM-5 management unit annually. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for variations in mortality and for movement among the various regions in the lake. Over the last 10 years (1998-2007) the recruitment to age 1 has averaged 282,585 fish in MM-5.

Fig. 1 Number of lake trout killed by source in MM-5

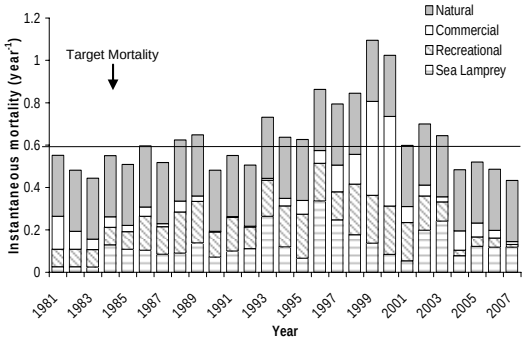


Although both state and Tribal commercial fishermen harvest fish in the management unit, state-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish. State licensed fishermen are not permitted to harvest lake trout, and as a result, are not included in lake trout harvest allocations. The Chippewa Ottawa Resource Authority oversees three types of Tribal commercial fisheries in this area including large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery, while primarily targeting lake whitefish, is generally responsible for the greatest number of harvested lake trout. The 2000 Consent Decree resulted in the conversion of the region's largest gill-net fishers to trap-net operations and recently the market value of lake trout has been low. As a result, commercial harvest and mortality of lake trout have decreased considerably. From 1990 to 1993, mortality from commercial fishing was extremely low averaging $0.005y^{-1}$. Mortality rates increased over the next seven years; the highest commercial

fishing mortalities were observed in 1999 and 2000 at 0.44 and 0.42 y^{-1}, respectively. In 1999 nearly 25,000 fish were harvested in commercial fisheries. After the year 2000, the commercial harvest decreased and only 1,100 lake trout were harvested in 2003. In 2007 2,300 lake trout were commercially harvested and the mortality rate was 0.01 y^{-1} (Figures 1 and 2). The yield of lake trout in commercial fisheries rose precipitously from 3,800 lb in 1993 to 184,900 lb in 1999. From 2001 to 2003, the yield was extremely low, averaging 8,800 lb. From 2004-2006, yield had increased averaging 27,200 lb. However, in 2007 yield was back down to 12,800 lb. Large-mesh gill-net effort in Tribal fisheries reflected patterns similar to those observed in mortality, harvest, and yield. Gill-net effort rose from 22,000 feet in 1993 to 2 million in 1999. After implementation of the 2000 Consent Decree, gill-net effort went down considerably. From 2001 to 2006 gill-net effort averaged 34,000 feet of net and in 2008 was 11,000 feet.

Recreational fisheries for lake trout are primarily managed by the State of Michigan and include both charter and sport anglers. From 1986 until 1999, recreational fishing mortality exceeded or equaled commercial fishing mortality in the MM-5 management unit. Mortality (averaged over ages 6-11) from recreational fishing has been declining since 1998 from 0.24 y^{-1} to 0.01 y^{-1} in 2007. The recreational fishery yield declined from 88,500 lb in 1998 to 3,800 lb in 2004. Yield has gradually increased in recent years, totaling 18,700 lb in 2007. The numbers of lake trout harvested had also dropped between 1998 (16,400 fish) and 2004 (785 fish) declining by nearly 95%. In 2007, the number of fish harvested increased to 4,100. Recreational fishing effort had been relatively consistent from 1995 to 1999 averaging 279,000 angler hours. By 2001, angler effort increased to 370,000 angler hours, declined to 180,000 hours in 2003 and was 200,000 hours in 2007. The sport fishing harvest regulations in the MM-5 management unit of Lake Michigan have historically allowed for the take of 10-inch lake trout. In 2001 the minimum harvest limit was changed to 22 inches and in 2003 the size limit was further increased to 24 inches. The fishing season was extended in 2003, shifting from May 1 - Labor Day to May 1 - Sept 30 and the bag limit was raised from 2 to 3 fish. In 2006, regulations were changed to protect larger spawning lake trout. A maximum size limit was adopted where anglers are only allowed to keep fish below 24 inches and one trophy fish greater than 34 inches.

Fig. 2 Instantaneous mortality rates for lake trout ages 6-11 in MM-5

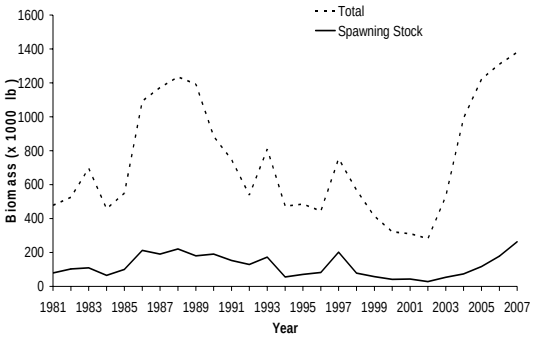


From 1984-1992 sea lamprey mortality rates were relatively consistent, averaging 0.11 y^{-1}. Rates increased to 0.26 y^{-1} in 1993, declining over the next two years to 0.07 y^{-1}. Rates increased again in 1996 to 0.34 y^{-1} and steadily declined to 0.05 y^{-1} in 2001. In 2003 lamprey mortality rates had risen to 0.24 y^{-1}. During the last four years (2004-2007) lamprey mortality rates have averaged 0.11 y^{-1} (Figure 2). Sea lamprey killed only 3,300 lake trout

in 2001 and numbers killed have increased to 32,800 in 2006 and 28,100 in 2007.

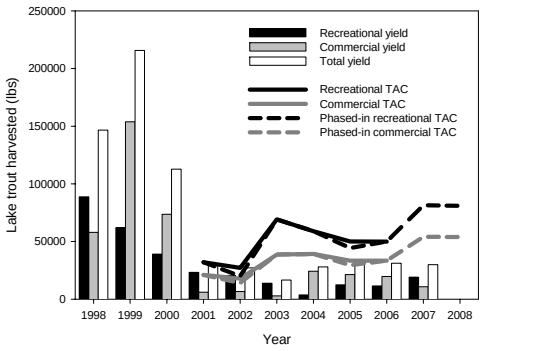
Fifty percent of lake trout are spawning by age 6 in MM-5. By age 8 they are fully recruited into commercial fisheries and age 5 into recreational fisheries. The biomass of lake trout older than age 3 was 752,000 lb in 1997, declined to 282,000 lb in 2002, and has since increased to 1.4 million lb in 2007. The biomass of spawning age lake trout increased from 28,600 lb in 2002 to 263,700 lb in 2007.

Fig. 3 Estimated lake trout biomass in MM-5



The spawning stock biomass produced per recruit has been improving in this unit and is now above the target value, indicating that mortality is at acceptable levels in MM-5. The recommended yield limit for 2008 in unit MM-5 is 134,383 lb, and is based on a target mortality rate of 45%. Of this yield, 80,988 lb were allocated to the state recreational fishery and 53,850 lb to the Tribal commercial and subsistence fisheries. Allocations were based on a 60 percent allotment for the State of Michigan and 40 percent to Tribal fisheries. Parties are contesting the model based TAC for this unit, and an agreement had not been reached at the time this report was written.

Fig. 4. Comparison of actual harvest vs. TAC decision vs. model recommendation



Model fit

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass estimates for recent years exist.

Summary Status MM-5 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	2.15 lb
Age at first spawning	3 y
Size at 50% maturity	6.91 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.170 lb (1.883 – 2.484)
Current SSBR	0.903 lb (0.735 – 1.078)
SSBR at target mortality	0.682 lb (0.604 – 0.765)
Spawning potential reduction	
At target mortality	0.315 (0.289 – 0.343)
Average yield per recruit	0.168 lb (0.138 – 0.202)
Natural mortality (M)	0.288 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	8 y
Sport fishery (2005-2007)	5 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.039 y^{-1} (0.027 – 0.055)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.034 y^{-1} (0.023 – 0.048)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 6-11)	0.107 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.457 y^{-1} (0.431 – 0.488)
Recruitment (age 1)	
(average 1998-2007)	292,585 fish (250,344 – 343,216)
Biomass (age 3+)	
(average 1998-2007)	749,671 lb (594,612 – 929,815)
Spawning biomass	
(average 1998-2007)	96,325 lb (74,799 – 122,470)
Recommended yield limit in 2008	134,838 lb
Actual yield limit in 2008	Not set

MM-67 (Southern Treaty Waters)

Prepared by Jory L. Jonas and Archie W. Martell Jr.

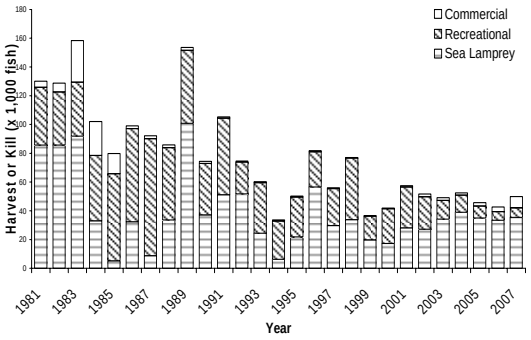
Lake trout management unit MM-67 is located in eastern central Lake Michigan, and is made up of statistical districts MM-6 and MM-7. The area covers Michigan's waters of Lake Michigan from Arcadia to Holland, extending to the state line bisecting the middle of the lake. The management unit covers a total area of 4,460 square miles, of which 930 square miles are less than 240 feet in depth. The northern section of the region (MM-6) is deeper ranging in depth from 0 up to 900 feet and is characterized by greater slope than the southern section (MM-7). For the most part, water depths in MM-7 are less than 400 feet. There are no islands or structures in southern treaty waters, and there is little lake trout spawning habitat with the exception of offshore deepwater spawning reefs located within the mid-lake refuge. Stocked lake trout almost certainly attempt to spawn in the nearshore zones. However, the likelihood of successful recruitment is negligible. The southern treaty management unit is not entirely comprised of 1836 waters', the northern section (MM-6) is entirely treaty ceded territory while only the northern two-thirds of the southern section (MM-7) is within treaty territory. A total of 690 square miles in the unit are outside treaty waters. A line running parallel to the northern side of the Grand River (located approximately ¾ of the way through grids in the 1900 series) out to the state line in the middle of the lake delineates the southern boundary of treaty territories in the unit. Management unit MM-67 contains a portion of the deepwater mid-lake lake trout refuge, which comprises 850 square miles of the unit (grids 1606, 1607, 1706, 1707, 1806, 1807, 1906 and 1907). It is illegal for recreational, commercial and subsistence fishers to retain lake trout when fishing in the refuge area. Gill-net fishing (both commercial and subsistence) is prohibited in the refuge, some State- and Tribal-licensed commercial trap-net operations are permitted, however, the retention of lake trout is prohibited. As of the year 2007, there was no Tribal commercial fishing effort in management unit MM-7 and Tribal fishing effort increased in MM-6.

The recruitment of lake trout in the southern treaty waters of Lake Michigan is based entirely on stocking. During the past ten years, an average of 190,537 yearling lake trout have been stocked into non-refuge southern treaty waters, while an additional 287,618 fish were stocked into the mid-lake refuge area, much of which is in Wisconsin waters. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for varying mortality and for movement among the various regions in the lake. Over the last 10 years (1998-2007), the recruitment of lake trout to age one has averaged 407,601 fish in the southern treaty management unit of Lake Michigan.

Since 1986, commercial fishing has killed fewer lake trout of harvestable size in the southern unit (MM-67) than either recreational fishing or sea lamprey (Figure 2). In 2007, the state's commercial fishery in southern treaty waters of Lake Michigan was comprised of two trap-net operations and one small-mesh gill-net chub operation. The 2007 Tribal commercial fishery within this area consisted of five trap-net permits,

and five small-mesh gill-net permits. State and Tribal commercial fisheries primarily target lake whitefish and chubs, Tribal trap net operations are allowed 100 lb per day lake trout bycatch and state licensed operations are not permitted to harvest lake trout. As a result, state commercial fishermen are not included in lake trout harvest allocations. The yield of lake trout in commercial fisheries has averaged 3,400 lb over the last 20 years (1987-2007). During the recent three years the harvest in commercial fisheries has been increasing, from 1,500 fish y^{-1} in 2004 to 7,800 y^{-1} in 2007. As a result of stipulations of the 2000 consent decree, this area may experience greater commercial fishing effort from Tribal interests in the future.

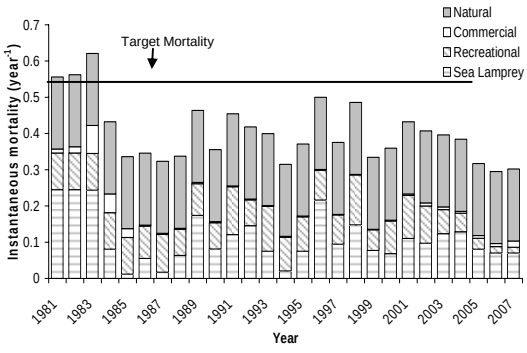
Fig. 1. Number of lake trout killed by source in MM-67



State recreational fisheries for lake trout are comprised of both charter and sport anglers. Recreational fishing mortality is generally higher than commercial fishing mortality (Figure 2). During the last five years, observed recreational fishing mortality rates have been declining from 0.12 y^{-1} in 2001 to 0.02 y^{-1} in 2007. The yield of lake trout in recreational fisheries has also declined from 177,800 lb in 2001 to 35,200 lb in 2007. The highest recreational yield was observed in 1987 at 474,400 lb. The numbers of lake trout harvested have declined by nearly 80 percent in recent years, from 28,300 fish in 2001 to 6,600 fish in 2007 (Figure 1). Effort levels have been relatively consistent since 1990 averaging 1.17 million angler hours. Size and bag limits did not change from 1981 until 2003. The fishing season had changed twice, once in 1984 which restricted it from the entire year to May 1 through August 15th, and again in 1989 when the season was extended through Labor Day. In 2003, the bag limit was increased from 2 to 3 fish, the size limit increased to 22 inches and the season expanded from May 1 to Sept 30.

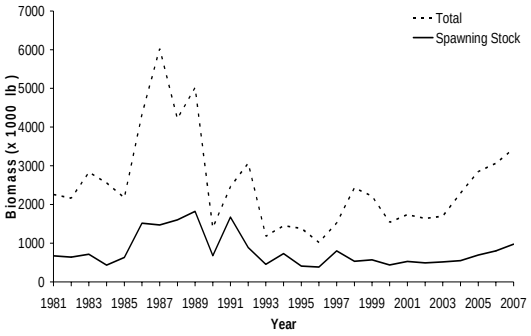
Sea lamprey-induced mortality is lower in southern treaty waters of Lake Michigan relative to the northern management units. Mortality rates have ranged from 0.01 to 0.24 y^{-1} during the last 20 years (Figure 2). In recent years (2004-2006), the number of lake trout killed by lamprey has averaged 35,800 fish (Figure 1).

Fig. 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-67



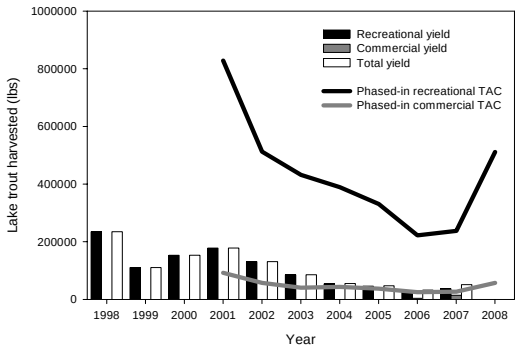
The majority of lake trout in MM-67 are spawning by age 6, have recruited into recreational fisheries by age 7, and commercial fisheries by age 8. The biomass of lake trout > age 3 is high averaging over 2.3 million lb during the recent ten years (Figure 3). Spawning lake trout comprise a relatively high proportion of the total biomass in this unit (Figure 3), averaging over 608,500 lb from 1998-2007.

Fig. 3. Estimated lake trout biomass in MM-67



The spawning stock biomass produced per recruit is greater than the target value indicating that mortality is below the targeted 40% level in MM-67. The model recommended yield limit for MM-67 in 2007 was 567,628 lb; however, the TFC limited the harvest limit to a +15% deviation from the 2007 TAC. The 2008 harvest limits were 274,729 lb for the State and 30,510 lb for the Tribes. The yield limit and allocations in this management unit are set to achieve a total mortality rate target of 40% and establish a 90 percent allocation to the state of Michigan and a 10 percent allocation to Tribal fisheries. Both recreational and commercial fisheries are well below established TAC levels (Figure 4).

Fig. 4. Comparison of actual harvest vs. TAC decision



Model fit

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and slight drift in the trace plots for all quantities evaluated. Retrospective patterns for MM-67 indicate that we need to address time varying parameters in the models to improve performance.

Summary Status MM-67 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	1.58 lb
Age at first spawning	3 y
Size at 50% maturity	6.29 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	5.998 lb (5.293 – 7.002)
Current SSBR combined w/ refuge	2.750 lb (2.411 – 3.162)
SSBR at target mortality	1.369 lb (1.218 – 1.481)
Spawning potential reduction	
At target mortality	0.229 (0.206 – 0.257)
Average yield per recruit	0.201 lb (0.188 – 0.217)
Natural mortality (M)	0.199 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2005-2007)	8 y
Sport fishery (2005-2007)	7 y
Commercial fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.011 y^{-1} (0.009 – 0.014)
Sport fishing mortality (F)	
(average 2005-2007, ages 6-11)	0.020 y^{-1} (0.017 – 0.023)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 6-11)	0.093 y^{-1}
Total mortality (Z)	
(average 2005-2007, ages 6-11)	0.328 y^{-1} (0.313 – 0.346)
Recruitment (age-1)	
(average 1998-2007)	407,601 fish (391,296 – 422,660)
Biomass (age 3+)	
(average 1998-2007)	2,354,193 lb (2,113,170 – 2,610,430)
Spawning biomass	
(average 1998-2007)	634,332 lb (558,283 – 719,713)
Recommended yield limit in 2008	567,628 lb
Actual yield limit in 2008	305,239 lb

STATUS OF LAKE WHITEFISH POPULATIONS

Lake Superior

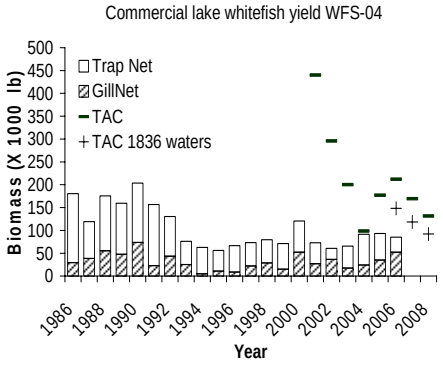
WFS-04 (Marquette - Big Bay)

Prepared by Philip J. Schneeberger

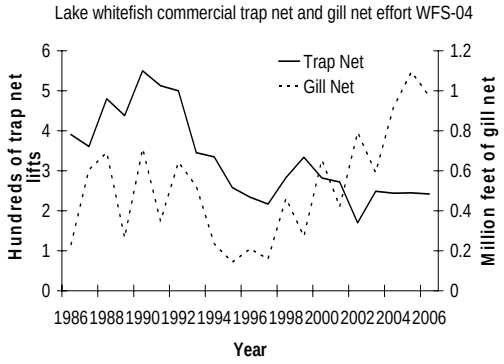
Lake whitefish unit WFS-04 (1,201,498 surface acres) is located in Lake Superior near Marquette roughly between Big Bay and Laughing Fish Point. Near shoreline features of this zone include many points, bays, islands, and in-flowing rivers. Habitat suitable for lake whitefish growth and reproduction is associated with many of these features.

This unit holds waters both within and outside the 1836 Treaty area. Based partly on the number of statistical grids on either side of the treaty line and partly on established protocol for a similar situation with lake trout, 70% of WFS-04 is considered to be in 1836 waters. Therefore, a quota for WFS-04 is calculated for the modeled stock which includes lake whitefish from the entire unit, but this quota is multiplied by 0.70 (70%) to determine the yield limit in 1836 Treaty waters for the Consent Decree. (Note: this procedure was adopted and used starting with the issuance of the 2006 yield limit.)

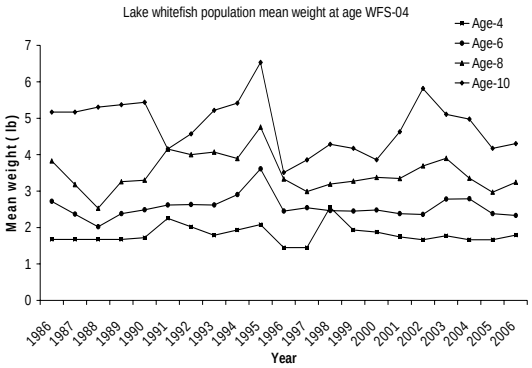
Overall yield in WFS-04 during 2006 was 85,292 lb. Trap-net yield (32,831 lb) was exceeded by gill-net yield (52,461 lb) in 2006, a circumstance that only occurred one other time in the 21-year time series. Lake whitefish yield was 6,075 lb in 1836 waters of WFS-04, all taken in trap nets, and representing 7% of the overall yield from the management unit.



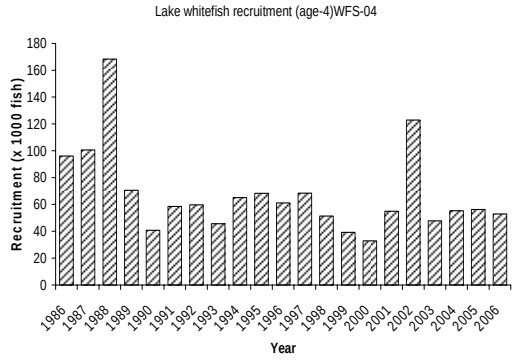
The 2006 trap-net effort in WFS-04 was 242 lifts, a level of effort that has changed less than 3% over the last four years. Gill-net effort (971,000 feet of net) was 11% lower in 2006 than in 2005 but 30% higher than the 2000-05 average. Only 11% of the trap-net effort and none of the gill-net effort took place in 1836 Treaty waters during 2006.



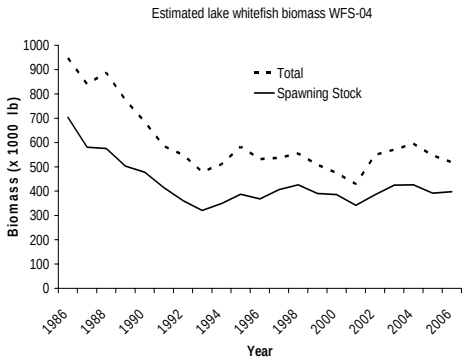
Between 2005 and 2006, calculations of mean weight-at-age increased by an average of 5% for ages 4-12+. In general, weight-at-age data had exhibited declines in WFS-04 during the previous 2-4 years.



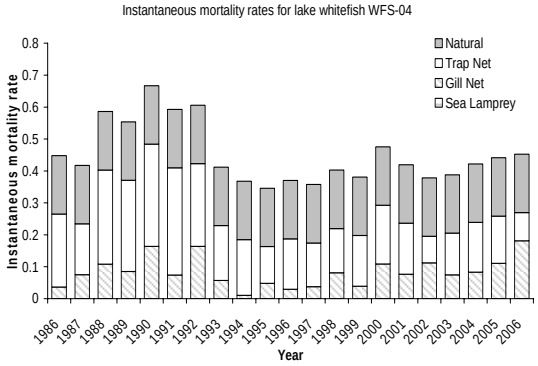
Recruitment (number of age-4 lake whitefish) was estimated at 53,000 in 2006 and estimates were relatively stable for five of six previous years, but down 6% from the estimate for 2005. The 2006 recruitment estimate was 10% below the 10-year average for 1996-2005.



Both fishable biomass and spawning stock biomass have been remarkably stable since 1993. Estimated fishable biomass was 519,000 lb and spawning stock biomass was 398,000 lb in 2006. The 2006 ratio of spawning stock biomass to fishable biomass was 0.77, the highest ratio since 2001.



Total instantaneous mortality rate (Z) for the WFS-04 lake whitefish stock has been below 0.50 y^{-1} in all years since 1993. The 2006 estimate for Z was 0.45 y^{-1}, up slightly from the 0.44 y^{-1} value for 2005. Estimated instantaneous fishing mortality rates (F) were 0.18 y^{-1} for gill nets and 0.09 y^{-1} for trap nets in 2006. The instantaneous natural mortality rate was estimated at 0.18 y^{-1}.



The calculated overall 2008 yield limit for lake whitefish in WFS-04 is 131,000 lb in WFS-04. Applying the reduction to reflect the proportion of this management unit that is outside the Consent Decree, the 2008 yield limit becomes 92,000 lb for 1836 Treaty waters, a 22% decrease from the limit calculated for the 2007 fishing season and the second successive drop of 20% or more. Part of the reduction from 2006 to 2007 was attributed to a recalibration of model inputs for the gill-net fishery that resulted from a more precise determination by Tribal biologists of yield and effort within the

management unit boundaries. The further decline of the yield limit for 2008 may reflect a slight decline in recruitment along with a small upturn in total mortality.

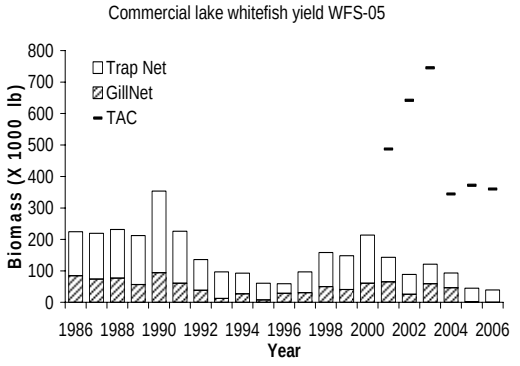
Summary Status WFS-04 Whitefish	Value (95% Probability Interval)
Female maturity	
Size at first spawning	1.71 lb
Age at first spawning	4 y
Size at 50% maturity	1.97 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	7.791 lb (7.764 - 7.817)
Current SSBR	2.07 lb (1.90 - 2.23)
SSBR at target mortality	0.213 lb
Spawning potential reduction	
At target mortality	0.265 (0.244 - 0.287)
Average yield per recruit	1.476 lb (1.468 - 1.181)
Natural mortality (M)	0.183 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	11
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.143 y^{-1} (0.124 - 0.164)
Average trap net F, ages 4+	0.136 y^{-1} (0.120 - 0.154)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.462 y^{-1} (0.430 - 0.497)
Recruitment (age 4) (average 1997-2006)	58,295 fish (52,110 - 65,794)
Biomass (age 3+) (average 1997-2006)	530,862 lb (490,047 - 575,359)
Spawning biomass (average 1997-2006)	399,619 lb (368,644 - 433,007)
Recommended yield limit in 2008	92,000 lb
Actual yield limit in 2008	92,000 lb

WFS-05 (Munising)

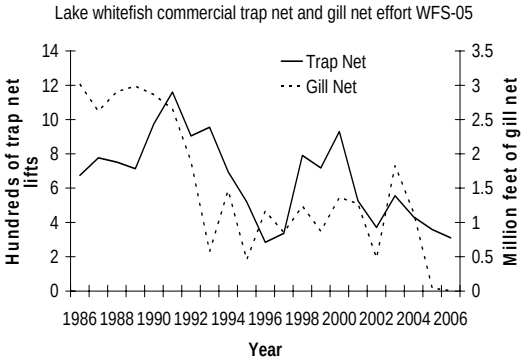
Prepared by Philip J. Schneeberger

The WFS-05 lake whitefish management unit extends approximately from Laughing Point to Au Sable Point in Michigan waters of Lake Superior. Surface area of the unit is 1,845,495 acres. Several bays (Shelter Bay, Au Train Bay, South Bay, and Trout Bay) and islands (Au Train Island, Wood Island, Williams Island, and Grand Island) are prominent in this area, providing substrate and depth contours suitable for lake whitefish habitat and spawning. Different whitefish stocks exist within this unit, including a smaller, slower-growing stock identified in Munising (South) Bay.

Total yield of lake whitefish in WFS-05 for 2006 was 39,000 lb, a reduction of 12% from 2005 and the third straight year of declining yield. Trap nets accounted for 99% of the lake whitefish yield during 2006, and gill nets took the remaining 1%. Trap-net and gill-net yields in 2006 were 48% below and 99% below the 2000-2005 averages for each gear type, respectively.

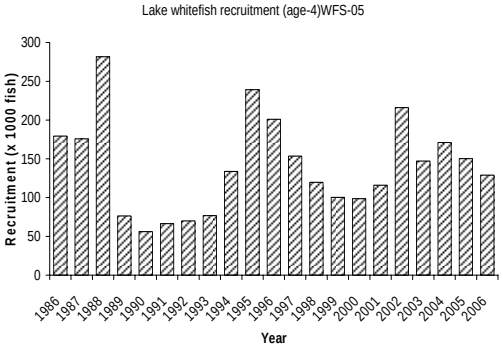


Fishing effort decreased 13% for trap nets and 91% for gill nets between 2005 and 2006. Fishing effort in 2006 was at its lowest point since 1996 for trap nets and is almost non-existent (4,000 feet) for gill nets.

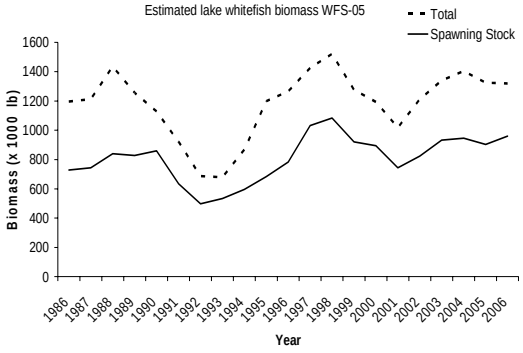


Mean weights at age declined in 2006 compared to 2000-05 averages for all ages except age 8. The magnitude of these declines averaged 8% for ages 3-11.

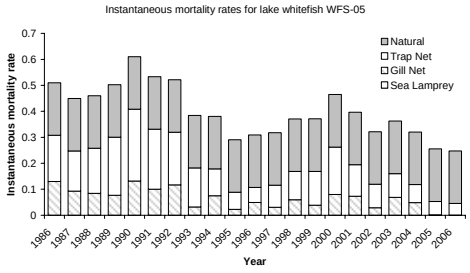
The 2006 estimate of recruitment, reported as annual numbers of age-4 lake whitefish in the population, was 129,000 fish, down 14% from 2005. A general trend of declining recruitment has occurred since 2002.



Biomass estimates in 2006 were 1.32 million lb for the fishable stock (lake whitefish age-4 and older) and 960,000 lb for the spawning stock. Both of these values were slightly higher than 2005 estimates. Spawning stock biomass was 73% of fishable biomass in 2006, above the 1986-2005 average of 68%.



Estimates for total instantaneous mortality rate (Z) have remained consistently below 0.45 y^{-1} since 2001. The estimate for Z was 0.25 y^{-1} in 2006. Natural mortality rate (M) was the largest component (80%) of Z in WFS-05. Instantaneous fishing mortality (F) rate was 0.002 y^{-1} for gill nets and 0.045 y^{-1} for trap nets.



The calculated 2008 yield limit for WFS-05 was 459,000 lb, a 14% increase from the yield limit for 2007. The combination of a slight increase in biomass and a small drop in mortality apparently counteracted the downturns in recruitment and weight-at-age for the 2008 yield limit calculation.

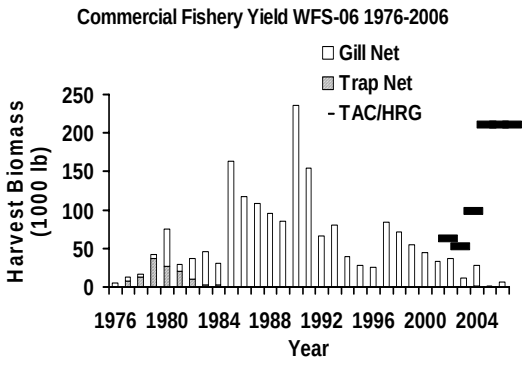
Summary Status WFS-05 Whitefish	Value (95% Probability Interval)
Female maturity	
Size at first spawning	1.91 lb
Age at first spawning	4 y
Size at 50% maturity	2.00 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	4.756 lb (4.741 - 4.770)
Current SSBR	3.01 lb (2.87 - 3.16)
SSBR at target mortality	0.218 lb
Spawning potential reduction	
At target mortality	0.634 (0.603 - 0.664)
Average yield per recruit	0.640 lb (0.590 - 0.690)
Natural mortality (M)	0.202 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	10
Fully selected age to trap nets	10
Average gill net F, ages 4+	0.017 y^{-1} (0.015 - 0.020)
Average trap net F, ages 4+	0.058 y^{-1} (0.050 - 0.067)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.278 y^{-1} (0.268 - 0.288)
Recruitment (age 4) (1997-2006 average)	143,443 fish (124,637 - 166,751)
Biomass (age 3+) (1997-2006 average)	1,322,832 lb (1,195,500 - 1,465,770)
Spawning biomass (1997-2006 average)	935,974 lb (844,190 - 1,038,130)
Recommended yield limit in 2008	459,000 lb
Actual yield limit in 2008	459,000 lb

Prepared by Mark P. Ebener

WFS-06 is located in the center of the 1836 treaty-ceded waters of Lake Superior. The unit contains no islands or bays, has 88,600 surface acres of waters less than 240 ft deep and is part of the open water of Lake Superior. There is little habitat for whitefish reproduction in the unit; therefore, it is likely that many of the lake whitefish that inhabit WFS-06 spawn elsewhere.

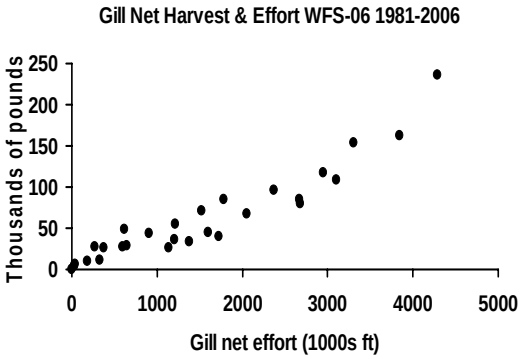
WFS-06 has been an exclusive commercial fishing zone for CORA fishers since 1985. Access to the unit is limited mainly to the Grand Marais area in the west and Little Lake Harbor in the east. A sizeable sport fishery targets whitefish off the pier at Grand Marais, but this yield and effort has not been included in the stock assessment model.

The commercial yield of lake whitefish from WFS-06 has averaged 59,200 lb during 1976-2006, but it has been on a long-term decline. The gill-net fishery has accounted for nearly 100% of the yield during 1976-2006. The peak yield was 236,000 lb in 1990 and the yield was 6,600 lb in 2006.



Peak gill-net effort was 4.3 million ft in 1990 and declined thereafter to 43,000 ft. in 2006. Trap-net effort has always been low in WFS-06 and never exceeded 225 lifts during 1976-2006. In 2004 and 2005 trap-net effort totaled 5 lifts, and there has been no effort since.

There was a direct linear relationship between gill-net effort and yield of whitefish in WFS-06 during 1976-2006. Gill-net effort explained 88% of the variation in gill-net yield during 1976-2006. Catch per unit effort of whitefish averaged only 42 lb per 1,000 ft of gill net during 1976-2006.



About the only appealing aspect of fishing for whitefish in WFS-06 is their large size. Annual mean weight of whitefish in the commercial fishery from WFS-06 ranged from 3.0 to 5.6 lb and averaged 3.8 lb during 1985-2005. Mean weight averaged 3.2 lb in 2005; the last year commercial harvests were sampled in WFS-06. The proportion of medium (3.0-3.9 lb) and jumbo whitefish (>3.9 lb) in the harvest from WFS-06 was typically greater than nearly all other units in the 1836 ceded waters.

No stock assessment model has been developed for whitefish in WFS-06 since 2003 because low yield from this unit prevents collections of biological data. The harvest regulation guideline for 2008 was 210,000 lb and has been constant at this level since 2004.

WFS-07 (Tahquamenon Bay)

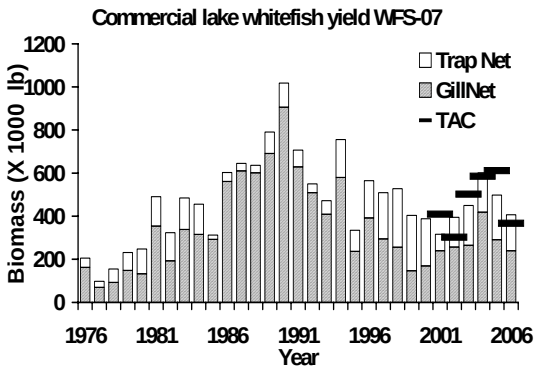
Prepared by Mark P. Ebener

WFS-07 includes the western portion of Whitefish Bay and the main basin of eastern Lake Superior. The unit contains 371,000 surface acres of water less than 240 ft deep. There is also a substantial commercial fishery in adjacent Canadian management units 33 and 34.

WFS-07 contains a single, large stock of whitefish that spawns in the southwest portion of Whitefish Bay. After spawning, many whitefish disperse north to Whitefish Point and then west to areas of the main basin of Lake Superior, but many also remain in Whitefish Bay and some move into Canadian waters.

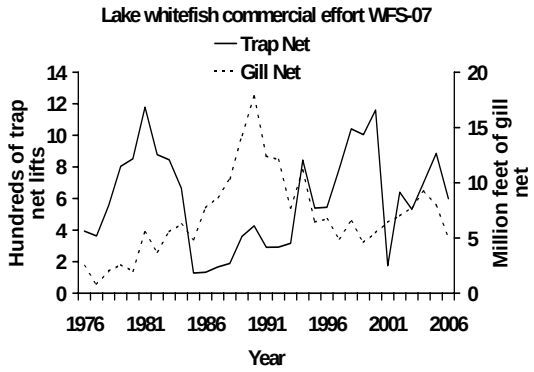
WFS-07 is an important fishing ground for the CORA fishery, and has been an exclusive CORA zone since 1985. Large- and small-boat gill-net fisheries as well as several trap-net fisheries operate in WFS-07. An ice fishery also takes place nearly every winter. There are a large number of relatively good access sites that offer fishermen reasonable protection from wind and waves.

The commercial yield of whitefish from WFS-07 averaged 470,000 lb during 1976-2006. A peak yield of one million pounds occurred in 1990 and the lowest reported yield was 98,000 lb in 1977. The 2006 yield was 406,800 lb while the TAC and HRG were both 367,000 lb in 2006.

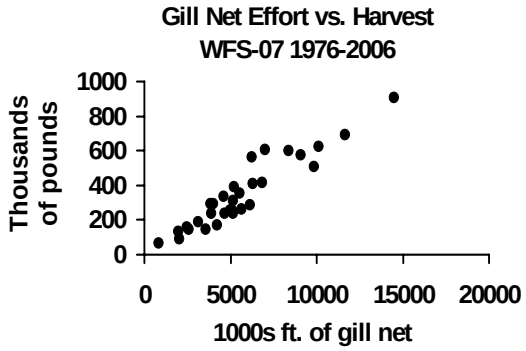


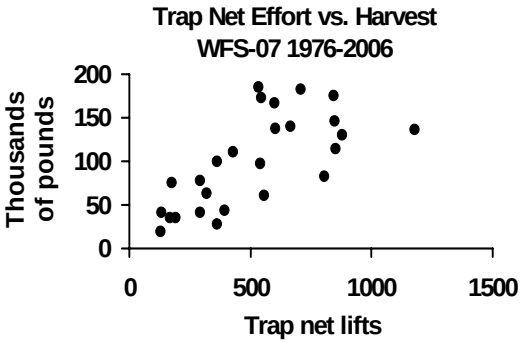
The large-mesh gill-net fishery accounted for 74% of the whitefish yield from WFS-07 during 1976-2006. The trap-net fishery harvested more whitefish from the unit than the gill-net fishery only during 1998-2000. The yield in 2006 was 239,200 lb from the gill-net fishery and 167,600 lb from the trap-net fishery.

Yield of whitefish from WFS-07 has mirrored changes in fishing effort during 1976-2006. After peaking at 17.8 million ft in 1990, large-mesh gill-net effort declined to between 3.8 and 6.8 million ft during 1997-2006. Gill-net effort was 3.9 million ft in 2006. Trap-net effort increased from 128 lifts in 1985 to 1,161 lifts in 2000 before declining to 175 lifts in 2001. Trap-net effort was 599 lifts in 2006.



Harvest of whitefish was directly proportional to fishing effort during 1976-2006. Gill net and trap net effort explained 88% and 61%, respectively, of the variation in harvest by each gear during 1976-2006. The average catch-per-unit-effort was 62 pounds per 1,000 ft. in the gill-net fishery and 180 pounds per lift in the trap-net fishery.

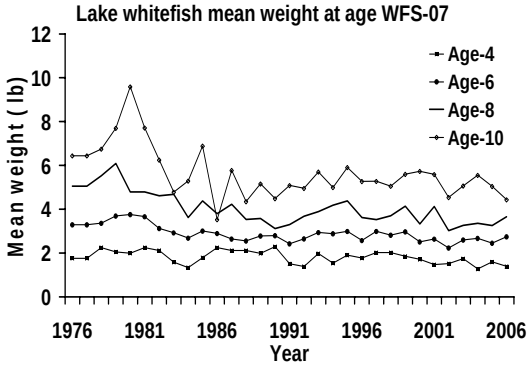




Whitefish caught in WFS-07 are of moderate to large size. Mean weight of a harvested whitefish averaged 3.3 lb in the gill-net fishery and 2.8 lb in the trap-net fishery during 1976-2006. Mean weight of a harvested whitefish in 2006 was 3.1 lb in the gill-net fishery and 2.8 lb in the trap-net fishery.

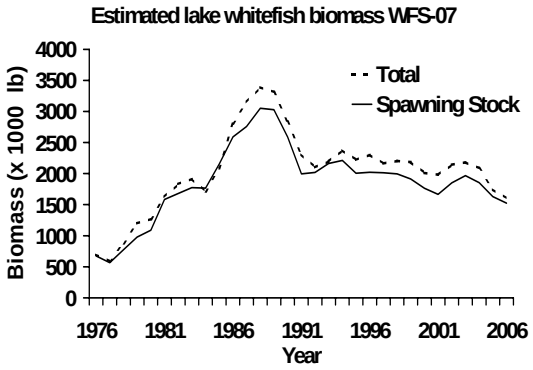
After declining from 1976 to 1990, mean weight at age of whitefish from WFS-07 has remained constant through time. Mean weight of age 4-9 whitefish has varied little since 1990, while mean weight of age 10 and older fish generally increased from 1990 to 2004 and has declined since.

Sexual maturity of whitefish in WFS-07 occurs at a small size and young age, but complete maturity of females occurs at a large size and old age. Female whitefish begin reaching sexual maturity at age 3 and about 15 inches long, and by age 5 over 50% of females are sexually mature. After age 5, however, the rate of sexual maturity slows and complete maturity is not achieved until whitefish reach 26 inches long and age 12.



Estimated recruitment of age-4 whitefish to the fishable population peaked in 1988 and has declined continually since then. The stock assessment model estimated that an average of 291,000 age-4 whitefish recruited to the fishable population each year during 1976-2006. Recruitment varied from 50,000 fish in 1976 to 584,000 fish in 1988. Recruitment was estimated to be 219,000 and 163,000 whitefish in 2005 and 2006, respectively.

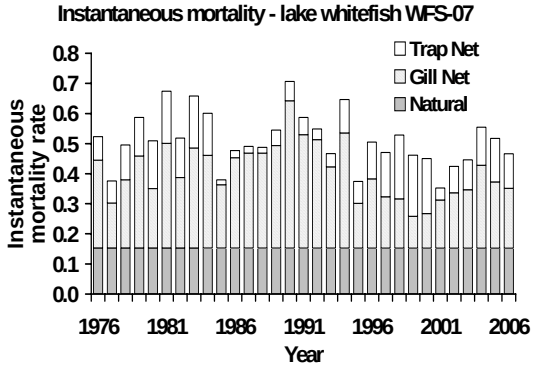
Average total biomass of age-4 and older whitefish peaked at 3.39 million lb in 1988 and has declined ever since. The total biomass was 1.6 million lb in 2006, compared to a spawning biomass of 1.5 million lb. The estimated biomass of whitefish in 2006 was equal to levels observed in the early 1980s.



Using Pauly's relationship between average water temperature occupied by a fish (4°C) and von Bertalanffy growth parameters L∞ (78.8 cm) and k (0.1340) natural mortality was estimated to be 0.15 y^{-1} in the stock assessment model. The von Bertalanffy growth model was updated with mean length at age data for whitefish caught in commercial gill nets and trap nets, and graded-mesh survey gill nets in all months of the year during 2002-2006. A mean length of 41 mm was used for age-0 whitefish in the growth model and represents the estimated mean value for fish caught in seines in lower Whitefish Bay management units WFS-07 and WFS-08 from May through mid October of 1993-2001.

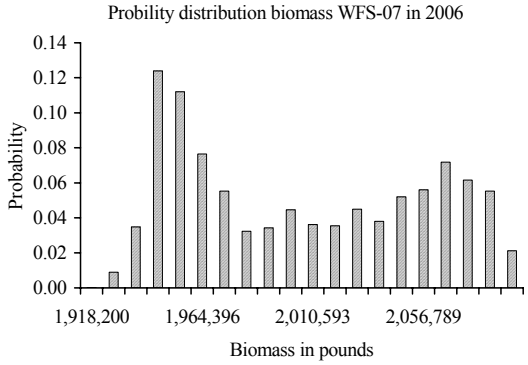
Instantaneous total annual mortality of age-4 and older whitefish showed little change during 1976-2006. The variations in total mortality were largely driven by changes in gill-net effort. Instantaneous total annual mortality averaged 0.51 y^{-1} during 1976-2006 and ranged from 0.35 y^{-1} in 2001 to 0.71 y^{-1} in 1990. Fishing mortality averaged 0.36 y^{-1} during 1976-2006. Gill-net mortality averaged 0.26 y^{-1} and trap-net mortality 0.10 y^{-1} during 1976-2006. Gill-net fishing mortality in 2006 was 0.20 y^{-1}, and trap-net mortality was 0.12 y^{-1}.

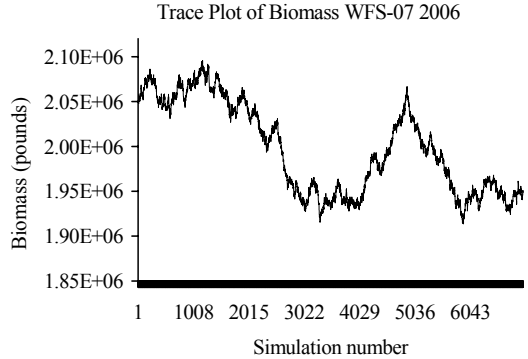
The projection model estimated that fishing mortality could be increased by



1.49 times in 2008 above levels estimated for 2004-2006. As a consequence, the recommended yield limit was estimated to be 535,000 lb in 2008.

Convergence criteria were not met for the WFS-07 stock assessment model. Probability distributions and trace and autocorrelation plots from the Markov Chain Monte Carlo simulations were not acceptable. The model did, however, always arrive at the same final values in the last year regardless of the starting values. Consequently, reliability of the stock assessment model and projected estimates of total allowable catches were rated as medium.





Summary Status WFS-07 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	1.43 lb
Age at first spawning	4 y
Size at 50% maturity	1.97 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	8.907 lb (SE 0.001)
Current SSBR	1.49 lb (SE 0.09)
SSBR at target mortality	0.272 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.168 (SE 0.010)
Average yield per recruit	1.784 lb (SE 0.006)
Natural mortality (M)	0.152 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	6
Fully selected age to trap nets	6
Average gill net F, ages 4+	0.232 y^{-1} (SE 0.016)
Average trap net F, ages 4+	0.129 y^{-1} (SE 0.008)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.513 y^{-1} (SE 0.023)
Recruitment (age 4) (average 1997-2006)	250,970 fish (SE 8,208)
Biomass (age 3+) (average 1997-2006)	2,030,200 lb (SE 76,006)
Spawning biomass (average 1997-2006)	1,817,600 lb (SE 72,060)
Recommended yield limit in 2008	535,000 lb
Actual yield limit in 2008	535,000 lb

WFS-08 (Brimley)

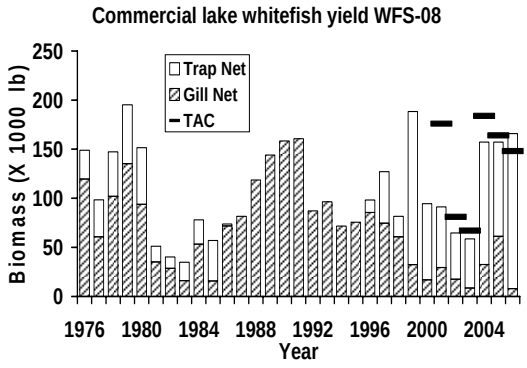
Prepared by Mark P. Ebener

WFS-08 is located in the very southeast portion of Whitefish Bay, Lake Superior. WFS-08 is spatially the smallest of the management units in the 1836 ceded waters of Lake Superior. The unit contains 160,000 surface acres of water less than 240 ft deep. A substantial commercial fishery targeting whitefish also exists in adjacent Canadian management units 33 and 34.

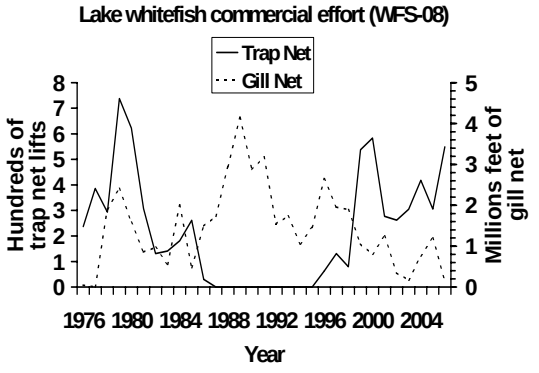
There are probably four reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Whitefish that spawn in WFS-07, two areas of WFS-08, and a fourth population that spawns in Canadian waters of management unit 34 all contribute to the fishery.

WFS-08 continues to be a traditional commercial fishing area for the CORA small-boat and gill-net ice fishery. WFS-08 has been an exclusive fishing zone for the CORA fishery since 1985. There are multiple undeveloped landing sites that are commonly used by the small-boat fishery during the open-water fishing season. A commercial trap-net fishery and a sport fishery for whitefish also occur in the unit.

The commercial yield of whitefish from WFS-08 has averaged 106,700 lb during 1981-2006. Annual yields ranged from 35,000 lb in 1983 to 188,000 lb in 1999. The peak yield of 195,000 lb occurred in 1979, just prior to the creation of CORA. The large-mesh gill-net fishery accounted for 64% of the yield from WFS-08 during 1981-2006. There was no trap-net yield from WFS-08 during 1987-1995. The trap-net yield in 2006 was 157,900 lb, while the gill-net yield was 7,900 lb.

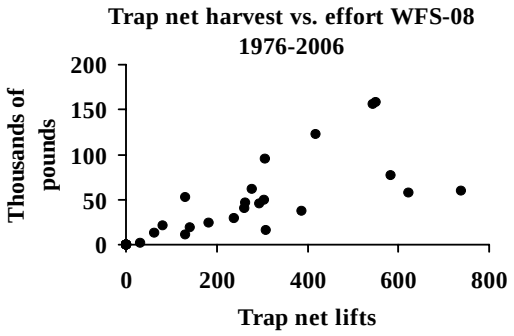


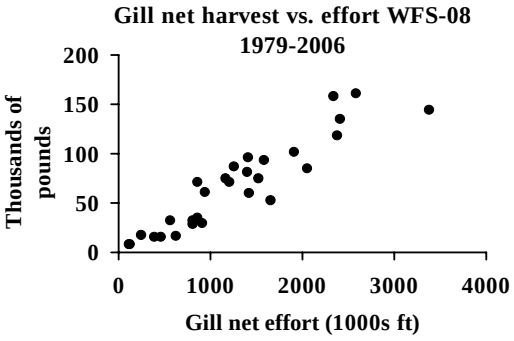
Gill-net effort has been declining in WFS-08 while trap-net effort has increased tremendously. Peak gill-net effort was 3.4 million ft in 1989, but it had declined to 0.12 million ft by 2006. Trap-net effort peaked at 738 lifts in 1979, declined to zero during 1987-1995, increased to 583 lifts in 2000, then declined somewhat before increasing again to 549 lifts in 2006.



Both gill-net and trap-net harvest was linearly related to their respective fishing efforts. Fishing effort explained 86% of the variation in gill-net harvest and 61% of the variation in trap-net harvest. Average gill-net CPUE was 52 lb per 1000 ft. and average trap-net

CPUE was 159 lb per lift during 1976-2006.

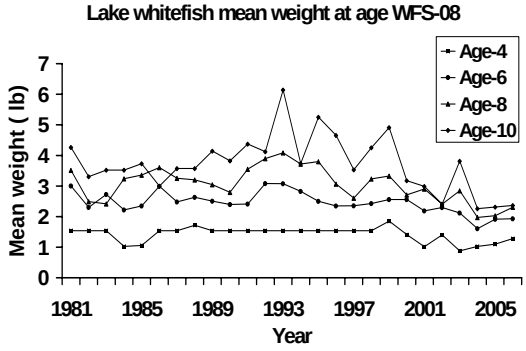




Whitefish in WFS-08 are of moderate to large size. Mean weight of a harvested whitefish in the gill-net fishery averaged 3.0 lb and mean weight in the trap-net fishery averaged 2.2 lb during 1981-2006. Mean weight of a harvested whitefish in 2006 was 2.1 lb in the trap-net fishery and 2.6 lb in the gill-net fishery.

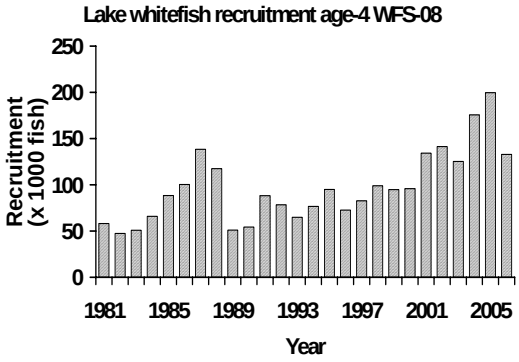
Growth of whitefish in WFS-08 remained fairly stable during 1981-1993, declined through 2004, and has increased slightly since then. Although length at age has increased during the last few years, nearly all age classes of lake whitefish weighed less in 2006 than during most previous years.

Female whitefish in WFS-08 begin maturing at 15 inches total length and at age 3. Two-thirds of whitefish in WFS-08 are sexually mature by age 4.



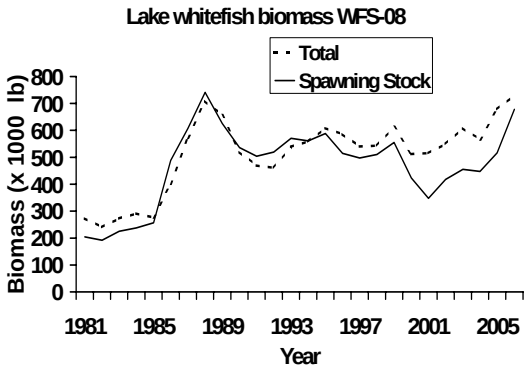
Complete maturity is reached at 23 inches total length and age 11.

Recruitment of age-4 whitefish in WFS-08 has been less variable than in adjacent unit WFS-07, and has increased continually since 1989. The stock assessment model estimated that an average of 97,300 age-4 whitefish recruited to the population each year during 1981-2006. Recruitment peaked at 199,500 age-4 whitefish in 2005.

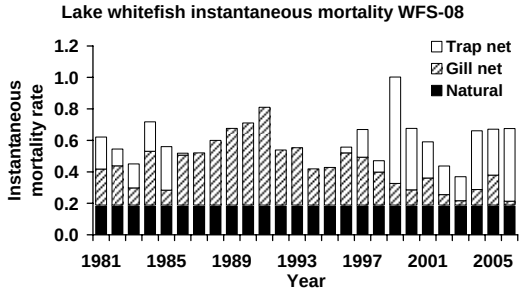


Estimated recruitment was 132,900 age-4 fish in 2006.

Because of declines in growth and mean weight at age, the disparity between total fishable biomass and spawning stock biomass has been increasing since 1995. From 1981-1995 fishable biomass and spawning stock biomass were roughly equal, during 1996-2006 spawning stock biomass was always less than total biomass. In 2006 total biomass was estimated to be 730,900 lb and spawning biomass was estimated to be 677,800 lb.

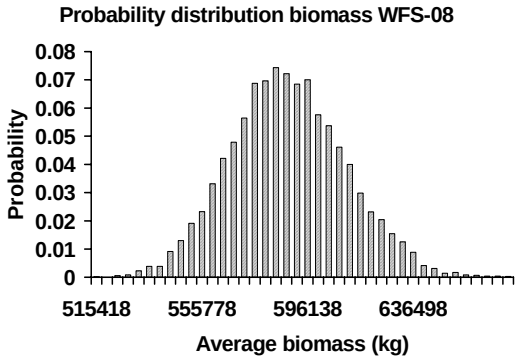


Using Pauly's relationship between average water temperature occupied by a fish (4°C) and von Bertalanffy growth parameters L∞ (67.6 cm) and k (0.1491), natural mortality was estimated to be 0.189 y^{-1} in the WFS-08 stock assessment model. The von Bertalanffy growth model was updated with mean length at age data for whitefish caught in commercial gill nets and trap nets, graded-mesh survey gill nets, and beach seines in all months of the year during 1980-2006. In the 2006 stock assessment model only mean length data from fish collected during 2002-2006 was used in the von Bertalanffy growth model. A mean length of 41 mm was used for age-0 whitefish in the growth model and represents the estimated mean value of fish caught in seines in lower Whitefish Bay management units WFS-07 and WFS-08 from May through mid October of 1991-2001. Total annual mortality of age-4 and older whitefish has been fairly high but stable in WFS-08. Instantaneous total annual mortality of age-4 and older whitefish averaged 0.59 y^{-1} during 1981-2006 and was 0.68 y^{-1} in 2006. Fishing mortality averaged 0.41 y^{-1} during 1981-2006 and was 0.49 y^{-1} in 2006. Trap-net mortality was 0.46 y^{-1} and gill-net mortality 0.02 y^{-1} in 2006.



Total annual mortality on age-4 and older whitefish was less than the target rate of 1.05 y^{-1} during 2004- 2006. The SPR value at the target mortality rate was 0.38 and greater than the target SPR value of 0.20. Thus the projection model estimated that fishing mortality rate in 2006 could be increased 1.20 times from levels experienced during 2004-2006. The recommended yield limit at this rate of fishing was estimated to be 195,000 lb in 2008.

Convergence criteria were not met for the WFS-08 stock assessment model, but probability distributions and trace and autocorrelation plots from the MCMC simulations were acceptable. The model arrived at the same estimates of biomass in the last year (2006) regardless of the initial starting values for multiple parameters. Consequently, reliability of the model and estimates of TAC were rated as high.



Summary Status WFS-08 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	1.14 lb
Age at first spawning	4 y
Size at 50% maturity	1.47 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	3.675 lb (SE 0.005)
Current SSBR	1.0 lb (SE 0.03)
SSBR at target mortality	0.195 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.272 (SE 0.009)
Average yield per recruit	1.085 lb (SE 0.008)
Natural mortality (M)	0.189 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	10
Fully selected age to trap nets	10
Average gill net F, ages 4+	0.104 y^{-1} (SE 0.009)
Average trap net F, ages 4+	0.376 y^{-1} (SE 0.024)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.669 y^{-1} (SE 0.029)
Recruitment (age 4) (average 1997-2006)	128,190 fish (SE 7,919)
Biomass (age 3+) (average 1997-2006)	585,800 lb (SE 22,271)
Spawning biomass (average 1997-2006)	484,900 lb (SE 17,818)
Recommended yield limit in 2008	195,000 lb
Actual yield limit in 2008	195,000 lb

Lake Huron

WFH-01 (St. Ignace)

Prepared by Mark P. Ebener

Management unit WFH-01 is located in the northwest portion of the main basin of Lake Huron. The unit is relatively shallow and contains 232,275 surface acres of water less than 240 ft deep.

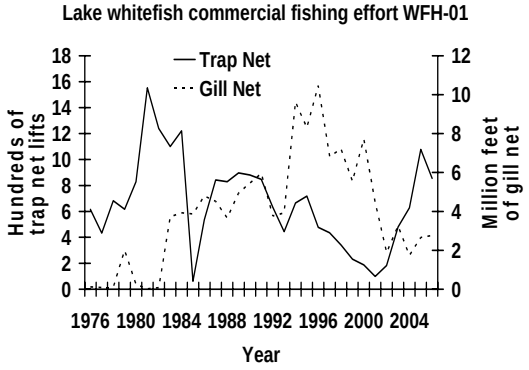
There are multiple reproductively isolated stocks of lake whitefish that inhabit WFH-01. One stock is located near Cheboygan, MI, another stock spawns north of St. Ignace, MI, a third stock spawns in St. Martin Bay, and a fourth stock spawns near Cedarville, MI.

WFH-01 has been an exclusive fishing zone for the CORA fishery since 1985 and is a favored fishing area for small-boat gill-net fishers, especially during the early spring and fall. In most years some gill-net fishing occurs under the ice in St. Martin Bay.

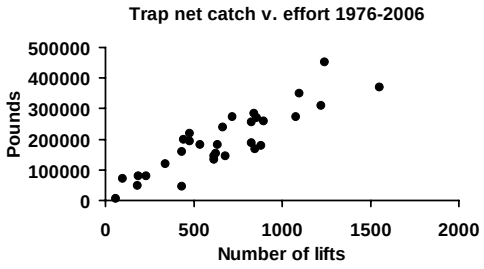
Commercial fishery yield has ranged from a low of 46,000 lb in 1977 to a high of 806,000 lb in 1994 and averaged 418,400 lb during 1976-2006. The commercial yield was 466,500 lb in 2006 compared to 433,800 lb in 2005. The yield in 2006 was greater than the recommended harvest limit of 395,000 lb in 2006.

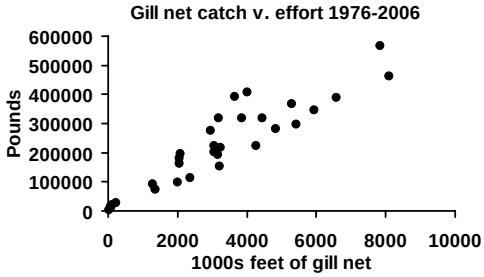
The large-mesh gill-net fishery has accounted for the majority of the commercial yield from WFH-01 during 1976-2006. From 1976-1984 large-mesh gill nets accounted for 0-41% of the annual yield, while after 1985 gill nets accounted for 37-81% of the annual yield. Since 2003 the trap-net fishery has accounted for the majority of the whitefish harvest from WFH-01. The gill-net fishery harvested 196,300 lb in 2006 compared to 270,200 lb for the trap-net fishery.

Gill-net effort continued to be much lower than the long-term average in WFH-01 during 2006, while trap-net effort approached the long-term average for the unit. Gill-net effort was stable at about 3.6 million ft from 1983 to 1993, increased to 8.1 million ft in 1996, and then declined to between 1.2 and 2.3 million ft during 2002-2006. Gill-net effort was 2.1 million feet in 2006. Trap-net effort peaked at 1,357 lifts in 1981 and declined to only 98 lifts by 2001 before increasing to 1,078 lifts in 2005. Trap net effort was 855 lifts in 2006.



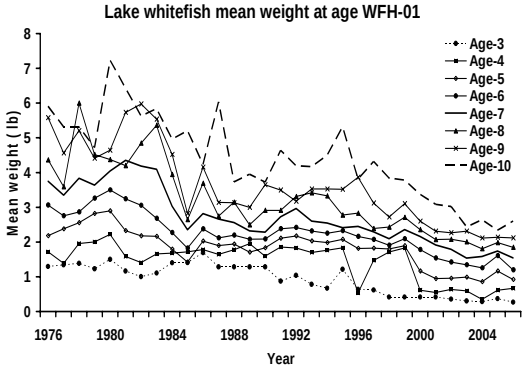
Harvest of whitefish was directly proportional to fishing effort in WFH-01. Gill-net and trap-net effort explained 84% and 77%, respectively, of the variation in harvest by each gear during 1976-2006. The average catch-per-unit-effort was 62 pounds per 1,000 ft. in the gill-net fishery and 253 pounds per lift in the trap-net fishery.





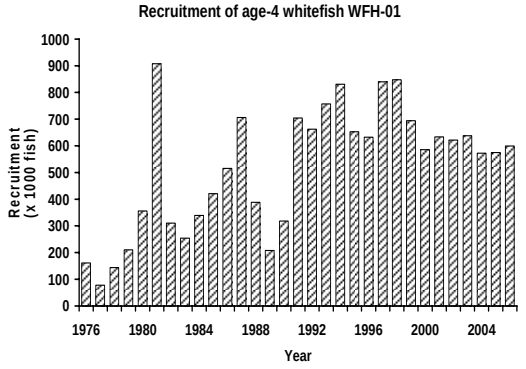
Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No.1 fish that weigh less than 3 lb. Mean weight of whitefish in the trap-net and gill-net fisheries ranged from 2.1 to 2.3 lb and 2.2 to 3.0 lb, respectively, during 1980-2006. Mean weight of a harvested whitefish was 2.5 lb in the gill-net fishery and 2.2 lb in the trap-net fishery in 2006.

The declines in growth of lake whitefish, expressed as mean weight at age, that was ongoing for several decades appear to have stabilized since 2004. Mean weight of nearly all age classes of whitefish either increased or remained the same in 2006 as the previous few years.

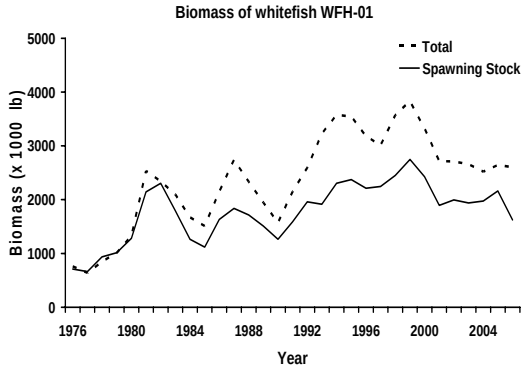


Large year-classes of whitefish were produced during 1987-2002 in WFH-01. These large year-classes produced the highest yield of 806,000 lb in 1994 and probably suppressed growth.

The 1987-2002 year classes averaged 623,000 fish. An estimated average of 521,400 age-4 whitefish recruited the population each year during 1976-2006. Recruitment varied from a low of 78,000 fish in 1977 to a high of 847,000 fish in 1998. Recruitment was estimated to be 599,000 age-4 whitefish in 2006.

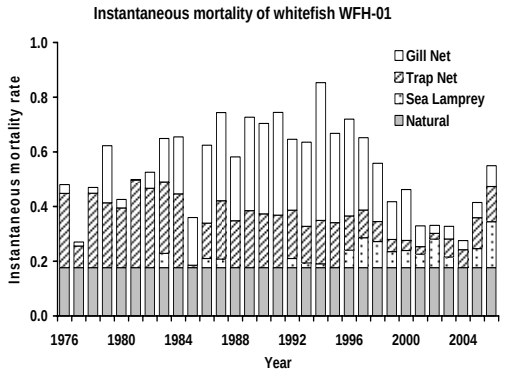


Since peaking at 3.8 million lb in 1998, biomass of whitefish has declined to a lower level. Total fishable biomass was estimated to be 2.6 million lb in 2006, which was similar to the previous three years. Spawning biomass has not kept pace with total biomass because of the declines in mean weight at age. In 2006 spawning biomass was estimated to be 1.6 million lb.



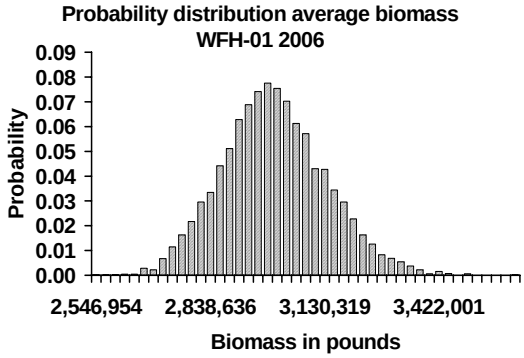
Using Pauly's relationship between average water temperature occupied by a fish (5.3°C) and von Bertalanffy growth parameters L∞ (62.8 cm) and k (0.1533), natural mortality was estimated to be 0.20 y^{-1} in the WFH-01 stock assessment model. The von Bertalanffy growth model for WFH-01 was updated with mean length at age data collected during 2002-2006 from commercial trap nets and gill nets, and survey gill nets.

Total instantaneous mortality of whitefish in WFH-01 has been substantially lower since the 2000 Consent Decree than prior to the Decree due primarily to a 65% reduction in fishing mortality. Average instantaneous total mortality was 0.55 y^{-1} during 1976-2006 and fishing mortality was 0.34 y^{-1}. Since 2000 total instantaneous mortality has averaged 0.37 y^{-1} and fishing mortality 0.12 y^{-1}. Gill-net mortality was 0.18 y^{-1} and trap net-mortality 0.15 y^{-1} in 2006.



The current spawning potential reduction value of 0.40 in WFH-01 during 2004-2006 was greater than the minimum value of 0.20 as defined by the MSC. Thus, the projection model estimated that fishing mortality rate could be increased 1.05 times above the 2004-2006 values. The increase in fishing effort produced a recommended yield limit of 231,000 lb for 2008. Consequently a harvest regulation guideline of 384,000 lb was established for the CORA fishery in WFH-01 in 2008. Previous harvest limits were 394,000 lb for 2007, 395,000 lb in 2006, 348,000 lb in 2005, 232,000 lb in 2004, 375,000 in 2003, 248,000 lb in 2002, and 327,000 lb in 2001.

Convergence criteria were not met for the WFH-01 stock assessment model, but probability distributions and trace and autocorrelation plots from the Markov Chain Monte Carlo simulations were acceptable. In addition, estimated biomass in 2006 did not vary regardless of initial starting values in the stock assessment model. Consequently, reliability of the stock assessment model and projected estimates of total allowable catches were rated as high.



Summary Status WFH-01 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.55 lb
Age at first spawning	4 y
Size at 50% maturity	1.62 lb
Age at 50% maturity	7 y
Spawning biomass per recruit	
Base SSBR	2.255 lb (SE 0.004)
Current SSBR	0.61 lb (SE 0.02)
SSBR at target mortality	0.058 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.272 (SE 0.008)
Average yield per recruit	0.493 lb (SE 0.012)
Natural mortality (M)	0.202 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	9
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.063 y^{-1} (SE 0.005)
Average trap net F, ages 4+	0.117 y^{-1} (SE 0.008)
Sea lamprey mortality (ML)	
(Average ages 4+, 2004-2006)	0.091 y^{-1}
Total mortality (Z)	
(Average ages 4+, 2004-2006)	0.473 y^{-1} (SE 0.012)
Recruitment (age 4)	
(average 1997-2006)	660,600 fish (SE 47,739)
Biomass (age 3+)	
(average 1997-2006)	2,958,000 lb (SE 129,260)
Spawning biomass	
(average 1997-2006)	2,145,600 lb (SE 89,980)
Recommended yield limit in 2008	231,000 lb
Actual yield limit in 2008	384,000 lb

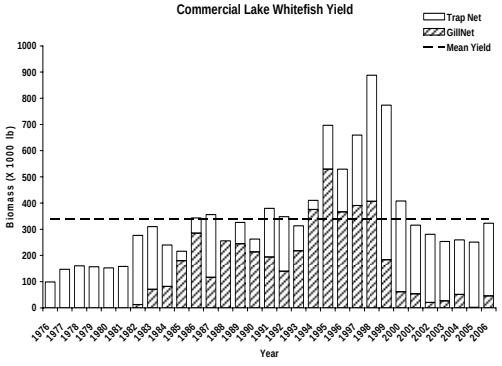
WFH-02 (Detour)

Prepared by Mark P. Ebener and David C. Caroffino

Management unit WFH-02 is located along the northern shore of the main basin of Lake Huron. Much of WFH-02 is deeper than 150 ft and maximum depth is slightly more than 300 ft. WFH-02 is a small unit made up of only three statistical grids and contains 122,562 surface acres of water less than 240 ft deep. The unit has an irregular shoreline with many small, rocky points, small bays, and scattered boulders.

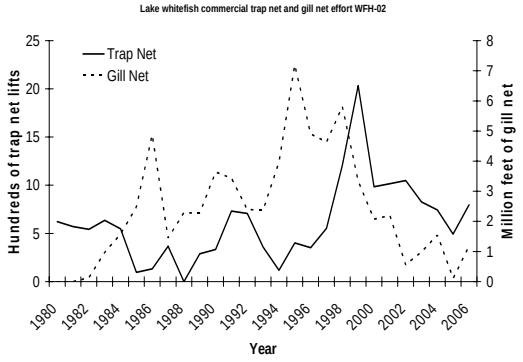
Because the shoreline of WFH-02 is highly irregular and rocky, nearly the entire unit contains habitat suitable for reproduction and survival of young whitefish. Spawning concentrations of whitefish can be found from Beavertail Point in the west portion of the unit to St. Vitals Point in the middle of the unit. This area covers roughly 16 miles or more of shoreline. A large aggregation of spawning whitefish can be found in the area from Albany Island to Saddle Bag Islands.

WFH-02 has been an exclusive CORA fishing zone since 1985. The commercial yield of whitefish averaged 370,000 lb during 1980-2006 and ranged from a low of 152,000 lb in 1980 to a high of 888,000 lb in 1998. The fishery yield was 323,000 lb in 2006.



The allocation of the harvest among fishing gears has changed dramatically in WFH-02 over the past few years. The large-mesh gill-net fishery accounted for the majority of harvest until 1997, after which the trap-net fishery harvested the largest proportion. In 2006, the trap-net fishery harvested more than six times the gill-net fishery (277,000 lb vs. 46,000 lb).

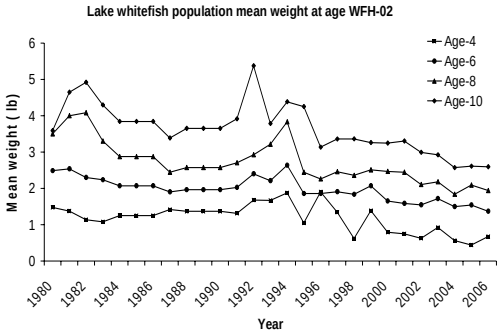
Both large-mesh gill-net and trap-net effort have changed markedly in WFH-02 since 1980. Trap-net effort ranged from 0 to 732 lifts between 1980 and 1997. Effort increased to 2,033 lifts in 1999, then declined to only 492 lifts, before increasing in 2006 to nearly 800 lifts. Large-mesh gill-net effort increased from zero in 1981 to 7.2 million ft in 1995, since then gill-net effort declined almost annually to 0.10 million ft in 2005; however, gill-net effort increased to 1.17 million feet in 2006.



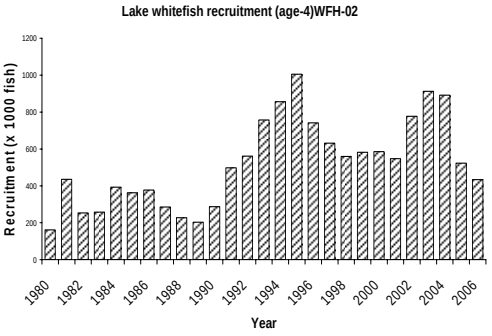
Whitefish in WFH-02 have always been of small size. No.1 fish made up 90% of the harvest from the unit during 1980-2006. Mean weight in the trap-net harvest has ranged from 2.0 to 2.3 lb and mean weight in the gill-net harvest ranged from 1.9 to 2.8 lb during 1980-2006. Mean weight of a harvested whitefish was 2.2 lb in the trap-net fishery and 2.7 lb in the gill-net fishery in 2006.

Unlike other units in Lake Huron, growth of whitefish in WFH-02 remained stable through 2000. There was a slight decline in mean weight-at-age from 1980

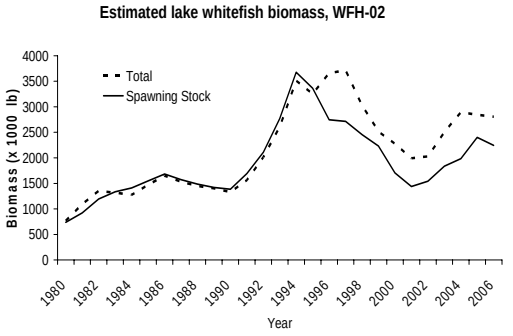
to 1984, but it was not as steep as in WFH-01, WFH-04, and WFH-05. Other than age-4 fish, mean weight at age slightly decreased from 2005 to 2006.



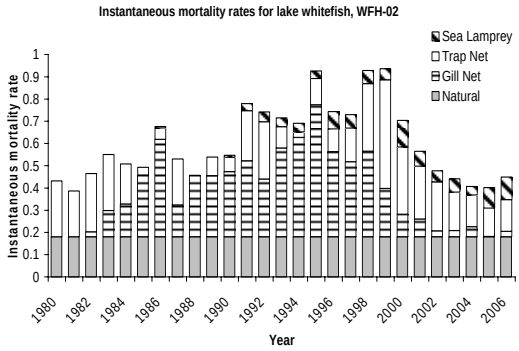
The increase in commercial fishery yield during the mid 1990s was driven largely by increased recruitment. The 1989-1993 year classes of whitefish were substantially larger than preceding and subsequent year classes. The stock assessment model estimated that the 1991 year class contained one million fish when it recruited to the fishery at age 4 in 1995. Recruitment averaged 522,000 fish during 1980-2006 and was estimated to be 433,000 fish in 2006.



The large increase in recruitment during the mid 1990s nearly tripled the biomass of whitefish in WFH-02. Total biomass of age-4 and older whitefish increased from 1.35 million lb in 1990 to 3.8 million lb in 1997. Total and spawning biomass were nearly equivalent in WFH-02 through 1994 because the fish matured at such a small size and because growth had not declined much. With the decline in growth that began in the mid-1990s the difference between total and spawning biomass became much larger. Total biomass was estimated to be 2.8 million lb and spawning biomass 2.2 million lb in 2006.



Total annual mortality rate on age-4 and older whitefish in WFH-02 increased nearly annually from 1980 to 1999, and declined thereafter. Total instantaneous mortality of age-4 and older whitefish increased from 0.37 y^{-1} in 1981 to 0.93 y^{-1} in 1999, and then declined to 0.45 y^{-1} in 2006.



The increase in total mortality was due to substantial increases in fishing mortality through 1999 and increased sea lamprey mortality since 1990. Fishing mortality increased from 0.21 y^{-1} in 1981 to 0.71 y^{-1} in 1999 and then declined to 0.17 y^{-1} in 2006. Gill-net mortality was 0.03 y^{-1} and trap-net mortality was 0.14 y^{-1} in 2006. Sea lamprey mortality of age-4 and older whitefish increased from 0.01 y^{-1} in 1990 to 0.12 y^{-1} in 2000, then declined to 0.04 y^{-1} in 2004 before increasing to 0.10 y^{-1} in 2006.

Total annual mortality of age-4 and older whitefish averaged 0.479 y^{-1} during 2004-2006. Spawning potential reduction at the current mortality rate was 0.34 and considerably greater than the target of 0.20. The projection model estimated that fishing mortality rate could increase to achieve the target mortality rate. As a consequence, the projection model estimated a yield limit of 432,000 lb for 2008, which was adopted by CORA as the harvest regulation guideline. By comparison, harvest limits were 410,000 lb in 2007, 454,000 lb in 2006, 298,000 lb in 2005, 261,000 lb in 2004 and 221,000 lb in 2003.

Summary Status WFH-02 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.56 lb
Age at first spawning	4 y
Size at 50% maturity	1.22 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	2.662 lb (SE 0.004)
Current SSBR	0.9 lb (SE 0.02)
SSBR at target mortality	0.098 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.34 (SE 0.008)
Average yield per recruit	0.510 lb (SE 0.014)
Natural mortality (M)	0.181 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	9
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.024 y^{-1} (SE 0.003)
Average trap net F, ages 4+	0.137 y^{-1} (SE 0.011)
Sea lamprey mortality (ML)	
(average ages 4+, 2004-2006)	0.077 y^{-1}
Total mortality (Z)	
(average ages 4+, 2004-2006)	0.479 y^{-1} (SE 0.013)
Recruitment (age 4)	
(average 1997-2006)	644,230 fish (SE 53,898)
Biomass (age 3+)	
(average 1997-2006)	2,659,800 lb (SE 137,220)
Spawning biomass	
(average 1997-2006)	2,055,600 lb (SE 97,139)
Recommended yield limit in 2008	432,000 lb
Actual yield limit in 2008	432,000 lb

WFH-03 (Drummond Island)

Mark P. Ebener

Management unit WFH-03 is small and encompasses only the area around Drummond Island. A lake trout refuge is located along the south shore of Drummond Island where large-mesh gill-net fishing is prohibited and retention of lake trout by trap-net fisheries is prohibited. The south side of WFH-03 is deep with much of the water exceeding 150 ft deep, whereas the north and west sides of Drummond Island are relatively shallow. WFH-03 contains six statistical grids and less than 100,000 surface acres of water less than 240 ft deep.

The spawning shoals for lake whitefish in WFH-03 are located primarily along the south shore of Drummond Island in the main basin of Lake Huron. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal during gill-net surveys in October and early November.

WFH-03 has been an exclusive fishing zone for the CORA fishery since 1985. The unit is primarily a trap-net fishery, but a winter gill-net fishery takes place under the ice in the North Channel from January through March of some years. The trap-net fishery takes place year-round along the south shore of Drummond Island since ice seldom forms here.

A complete description of the status of the stock and fishery in this unit is not available as the author did not submit the required report. However, no attempt was made to develop a stock assessment model for lake whitefish this unit, because past attempts to do so were unsuccessful. Reasonable and consistent estimates of abundance and mortality could not be produced with the stock assessment model because they would change by an order of magnitude in some cases after only small changes were made to starting values of the input parameters. The harvest regulation guideline (HRG) for this unit had been 306,000 lb since 2003, but in 2008 the HRG was set conservatively at 150,000 lb.

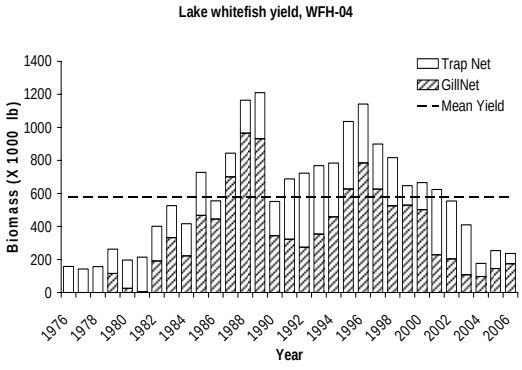
WFH-04 (Hammond Bay)

Prepared by Mark P. Ebener and David C. Caroffino

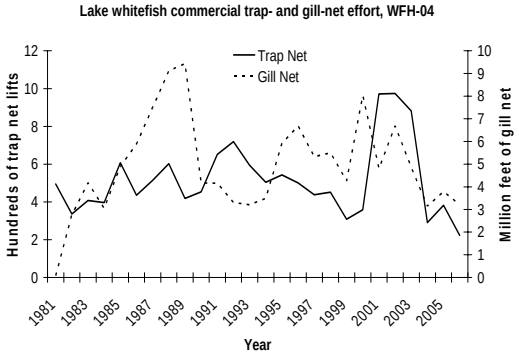
WFH-04 is the largest whitefish management unit in the 1836 treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water less than 240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found from Cheboygan, MI to Hammond Bay.

In August 2000 WFH-04 became an exclusive CORA commercial fishing zone. Prior to 2000 the area south of 40 Mile Point was an exclusive commercial fishing zone for state-licensed trap-net fisheries, while the area north of 40 Mile Point was an exclusive CORA commercial fishing zone since 1985.

The CORA large-mesh gill-net fishery accounted for 61% of the whitefish harvest from WFH-04 during 1980-2006. The annual yield from WFH-04 ranged from a high of 1.2 million lb in 1989 to a low of 177,000 lb in 2004. The annual yield of whitefish from the unit averaged 655,000 lb during 1981-2006. The trap-net fishery harvested 62,000 lb of whitefish in 2006 compared to 174,000 lb for the gill-net fishery. The 2006 yield of 236,000 lb was less than the predicted harvest limit of 460,000 lb.



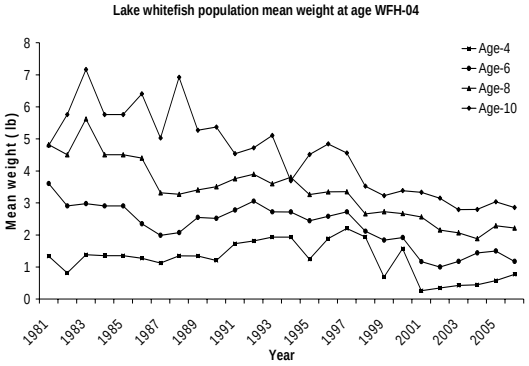
Both trap-net and gill-net effort decreased slightly in this unit from 2005 to 2006. Trap-net effort peaked at 719 lifts in 1992, declined to 308 lifts in 1999, increased to 974 lifts in 2002, but then declined to 223 lifts in 2006. Large-mesh gill-net effort peaked at 9.4 million ft in 1989 and 8.0 million ft in 2000, but was only 3.2 million ft in 2006.



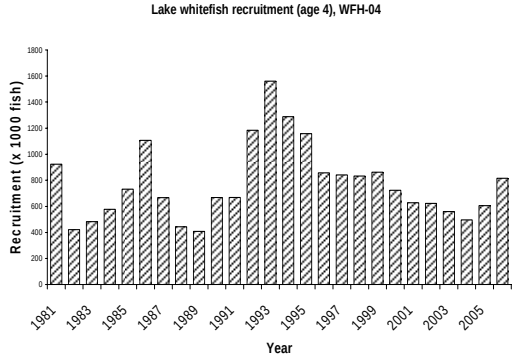
Whitefish from WFH-04 are of moderate size. The commercial harvest from WFH-04 was composed of 64% No.1 whitefish, 27% mediums, and 9% jumbos during 1982-2006. Annual mean weight of whitefish caught in the gill-net fishery ranged from 2.5 to 3.0 lb during 1982-2006, while mean weight in the trap-net fishery ranged from 2.4 to 3.6 lb during 1982-2006. Mean weight in the harvest in 2006 was 2.9 lb for the trap-net fishery and 2.6 lb for the gill-net fishery.

After significant declines in weight-at-age during the late 1990s, growth of whitefish in WFH-04 has remained largely stable. From 2005 to 2006 a slight reduction was observed in size of fish at age 6 and 8, but a slight increase in size of age 4 was also observed. The declines in harvests from WFH-04 that occurred after 1996 were largely being

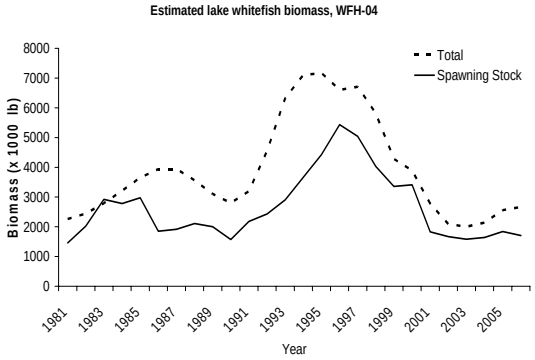
driven by declines in both mean weights at age and recruitment.



The 1988-1991 year classes of whitefish were the most abundant on record for this unit, ranging from 1.16 to 1.56 million fish at age 4. During the 1981-2006 period, the 1984 and 1985 year classes were the least abundant; however the 2000 year class was also small at only 496,000 fish recruiting to age 4. The 2002 year class was estimated to contain approximately 815,000 fish at age 4 in 2006.



The combined effects of reduced recruitment and growth drove biomass of whitefish in WFH-04 to low levels during 2001-2006. After peaking at 7.1 million lb in 1995, total biomass declined nearly annually to only 2.0 million lb in 2003 and was 2.7 million lb in 2006. Spawning stock biomass declined from 5.4 million lb in 1996 to 1.7 million lb in 2006.



Total instantaneous mortality of age-4 and older whitefish averaged 0.33 y^{-1} during 2004-2006. Gill-net mortality averaged 0.055 y^{-1}, trap-net mortality 0.034 y^{-1}, and sea lamprey mortality 0.043 y^{-1} during 2004-2006. In 2006 gill-net mortality was 0.06 y^{-1}, trap-net mortality 0.02 y^{-1}, and sea lamprey mortality 0.06 y^{-1} on age-4 and older whitefish. Natural mortality was estimated to be 0.20 y^{-1}.

Since total annual mortality on all age classes of whitefish was less than the target of 1.05 y^{-1}, the projection model estimated that fishing mortality could increase in 2008 over that experienced during 2004-2006. The spawning potential reduction value at the target-fishing rate was 0.42. The recommended harvest level for WFH-04 in 2008 was 546,000 lb compared to 597,000 lb in 2007, 460,000 lb in 2006, and 415,000 lb in 2005.

Summary Status WFH-04 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.60 lb
Age at first spawning	4 y
Size at 50% maturity	1.94 lb
Age at 50% maturity	7 y
Spawning biomass per recruit	
Base SSBR	1.936 lb
Current SSBR	0.81 lb (SE 0.02)
SSBR at target mortality	0.085 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.418 (SE 0.013)
Average yield per recruit	0.460 lb (SE 0.020)
Natural mortality (M)	0.20 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	9
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.055 y^{-1} (SE 0.006)
Average trap net F, ages 4+	0.034 y^{-1} (SE 0.003)
Sea lamprey mortality (ML)	
(average ages 4+, 2004-2006)	0.043 y^{-1}
Total mortality (Z)	
(average ages 4+, 2004-2006)	0.330 y^{-1} (SE 0.009)
Recruitment (age 4)	
(average 1997-2006)	698,690 fish (SE 50,123)
Biomass (age 3+)	
(average 1997-2006)	3,493,600 lb (SE 142,440)
Spawning biomass	
(average 1997-2006)	2,611,600 lb (SE 105,560)
Recommended yield limit in 2008	546,000 lb
Actual yield limit in 2008	546,000 lb

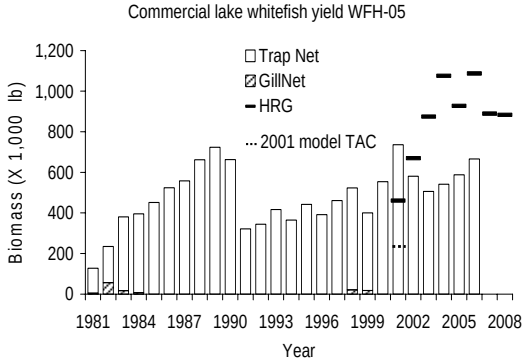
WFH-05 (Alpena)

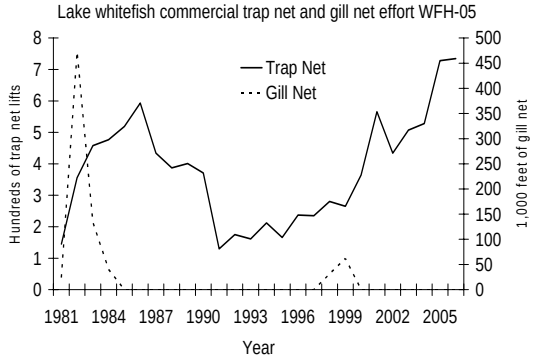
Prepared by Aaron P. Woldt and Mark P. Ebener

WFH-05 runs from Presque Isle south to the southern end of grids 809-815 in US waters and includes some waters of Lake Huron that lie outside the 1836 Treaty-ceded waters. There are an estimated 209,000 surface acres of water < 240 ft deep in WFH-05. WFH-05 contains a large spawning stock of whitefish that spawns throughout the unit.

The 2000 Consent Decree converted WFH-05 from an exclusive State zone to an exclusive CORA trap-net fishing zone beginning in August 2000. There are two areas open to Tribal trap-net fishing in WFH-05: 1) the Southern Lake Huron Trap Net (SLHTN) Zone, and 2) Michigan waters south of the SLHTN Zone and north of a line from the tip of North Point on Thunder Bay in a straight line northeast to the international border. Only four CORA trap-net operations from two tribes can fish the SLHTN Zone, and each operation can fish no more than 12 trap nets. The CORA fishery in this zone has a 17-inch minimum length limit, and there is no limit on the depth of water in which trap nets can be fished. In the area south of the SLHTN Zone and north of North Point, the 4 Tribal fishers fishing the SLHTN Zone can apply for State permits to fish up to 16 total trap nets (4 each). In this zone, there has been a 19-inch minimum length limit set by the State, and trap nets can only be fished in waters < 90 ft deep.

Annual commercial trap-net yield has ranged from 124,000 lb in 1981 to 736,000 lb in 2001 and averaged 478,000 lb during 1981-2006. In general, trap-net harvest and effort have been directly related over the modeled time series and have been especially linked since 1991. As trap-net effort increased from 130 lifts in 1991 to 566 lifts in 2001, the yield increased from 322,000 lb in 1991 to 736,000 lb in 2001. Trap-net effort and yield both declined in 2002. Since 2002, trap-net effort and yield have increased annually, until 2006 when effort seemed to level off relative to 2005. Trap-net yield has increased from 581,000 lb in 2002 to 666,000 lb in 2006. The relatively tight relationship between trap-net effort and yield diverged a little in 2006, as trap net effort increased by only 1% from 2005 levels, and trap net yield increased 13%.

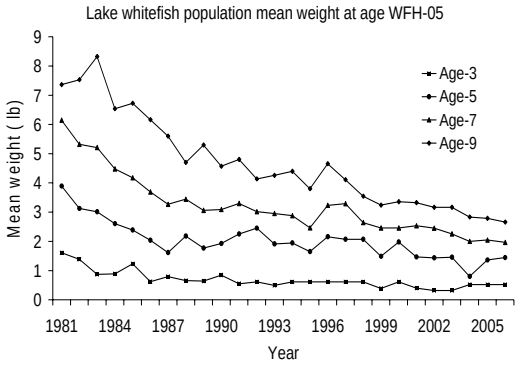




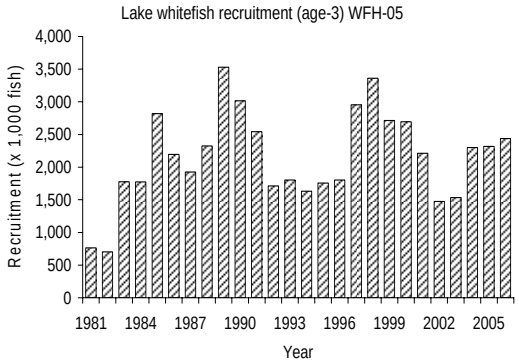
Whitefish in WFH-05 are of similar size to those in WFH-04. Mean weight of a harvested whitefish has been steadily decreasing since 1998 (3.5 lb), but seems to have leveled off from 2004 to 2006. Mean weight of a harvested whitefish was 2.4 lb in WFH-05 in 2006. The weight of harvested lake whitefish

averaged 3.3 lb over the modeled time series (1981-2006).

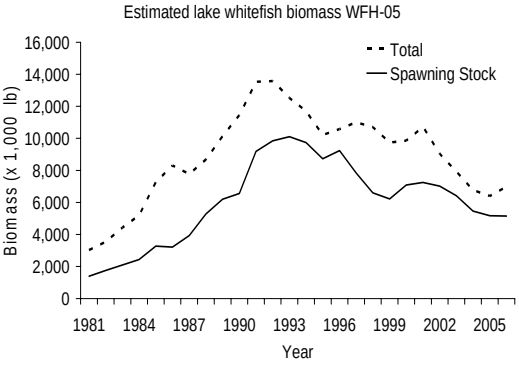
Weight-at-age of whitefish in WFH-05 has stabilized over the last few years after continually declining from 1981 to 1999. Prior to 1984, age 9 and older whitefish weighed between 7 and 8 lb, but by 2006 they weighed about 2.7 lb. This large decrease in average weight for older fish is likely due to decreased growth rates and concurrent changes in the whitefish forage base. Mean weight of all age classes in 2006 was similar to mean weight-at-age from 1999 to 2005. Mean weight-at-age of age-5 fish increased slightly in 2006, for the second year in a row, to a level nearly equal to mean weight-at-age in 2003.



Recruitment of age-3 whitefish to the fishable population in WFH-05 has been cyclical since 1981. Recruitment peaked at 3.5 million age-3 whitefish in 1989, and then declined annually to about 1.8 million age-3 whitefish in 1996 (1993 year class). Recruitment then peaked again in 1998 at 3.4 million age-3 whitefish, before declining annually to about 1.5 million age-3 whitefish in 2002. From 2003 through 2006, estimated recruitment increased and averaged about 2.15 million age-3 whitefish. The stock assessment model estimated that 2.44 million age-3 whitefish were present in the population during 2006.

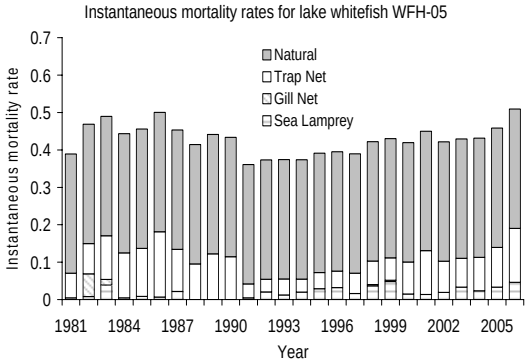


Both fishable and spawning stock biomass have been declining in WFH-05 since the early 1990s, primarily because of low recruitment in the early and mid-1990s and declining weight-at-age. Fishable stock size peaked at 13.6 million lb in 1992 and has since declined to 7.0 million lb in 2006. Spawning stock biomass peaked at 10.1 million lb in 1993 and then declined to 5.1 million lb in 2006. Total biomass did increase slightly in 2006 relative to 2005, but spawning stock biomass remained stable.



Natural mortality has consistently been the most significant source of mortality affecting age-4 and older whitefish in WFH-05. Natural mortality was greater than fishing and sea lamprey mortality combined in all years in WFH-05 and was estimated to be 0.319 y^{-1}. In general, trap-net fishing mortality has been increasing in WFH-05 over the last decade and was estimated to be 0.144 y^{-1} in 2006. Sea lamprey-induced mortality had been cyclical but low in WFH-05 over the last decade, peaking in 1999 at 0.048 y^{-1}. Since 2002, sea lamprey-

induced mortality estimates have been increasing, reaching 0.046 y^{-1} in 2006.



Total annual mortality was estimated to be 0.455 y^{-1} on age-4 and older whitefish in WFH-05 during 2004-2006. Total mortality was estimated to be 0.509 y^{-1} in 2006. Because total mortality was less than the target rate of 1.05 y^{-1}, the projection model estimated that trap-net fishing effort could be increased 2.60 times over the 2004-2006 levels. The recommended yield limit at this increased rate of fishing was estimated to be 883,000 lb in WFH-05 for 2008. The recommended yield limit in 2007 was 889,000 lb. In general, the harvest limit in this unit has been steadily increasing under the 2000 Consent Decree. However, the yield limit seems to have stabilized since 2004, oscillating around an average of 972,000 lb from 2004 to 2008. Total Tribal trap-net harvest was below the HRG in 2006.

Summary Status WFH-05 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	0.52 lb
Age at first spawning	3 y
Size at 50% maturity	1.76 lb
Age at 50% maturity	6 y
Spawning biomass per recruit	
Base SSBR	1.051 lb (1.050 – 1.051)
Current SSBR	0.610 lb (0.578 – 0.661)
SSBR at target mortality	0.215 lb (0.215 – 0.215)
Spawning potential reduction	
At target mortality	0.585 (0.585 – 0.585)
Average yield per recruit	0.260 lb (0.210 – 0.296)
Natural mortality (M)	0.319 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	8
Fully selected age to trap nets	8
Average gill-net F, ages 4+	Not applicable
Average trap-net F, ages 4+	0.097 y^{-1} (0.069 – 0.124)
Sea lamprey mortality (ML)	
(average ages 4+, 2004-2006)	0.046 y^{-1}
Total mortality (Z)	
(average ages 4+, 2004-2006)	0.455 y^{-1} (0.427 – 0.482)
Recruitment (age 3)	
(average 1997-2006)	2,400,200 fish (2,007,080 – 3,198,240)
Biomass (age 3+)	
(average1997-2006)	8,912,100 lb (7,516,440 – 11,708,000)
Spawning biomass	
(average 1997-2006)	6,420,800 lb (5,367,810 – 8,493,420)
MSC recommended yield limit for 2008	883,000 lb
Actual yield limit in 2008	883,000 lb

Lake Michigan

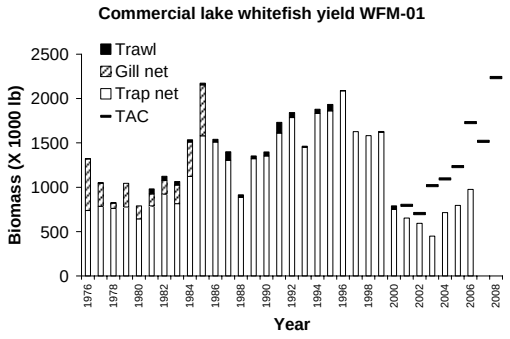
WFM-01 (Bays de Noc)

Prepared by Philip J. Schneeberger

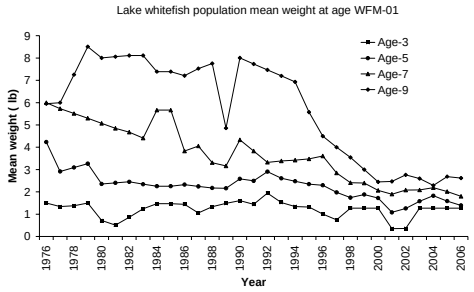
Lake whitefish management unit WFM-01 is located in 1836 Treaty waters of northern Green Bay. Prominent features of this area include two large bays (Big and Little bays de Noc), numerous small embayments, several islands (including St. Martins Island, Poverty Island, Summer Island, Little Summer Island, Round Island, Snake Island, and St. Vital Island), as well as various shoal areas (Gravelly Island Shoals, Drisco Shoal, North Drisco Shoal, Minneapolis Shoal, Corona Shoal, Eleven Foot Shoal, Peninsula Point Shoal, Big Bay de Noc Shoal, Ripley Shoal, and shoals associated with many of the islands listed above). Little Bay de Noc is the embayment delineated by statistical grid 306. Its surface area is 39,880 acres. Shallow waters characterize the northern end and nearshore areas, but there is a 40- to 100-ft deep channel that runs the length of the bay. Rivers that flow into Little Bay de Noc include the Whitefish, Rapid, Tacoosh, Days, Escanaba, and Ford. Big Bay de Noc is a larger embayment of 93,560 acres delineated by statistical grids 308 and 309. Big Bay de Noc is relatively shallow with over half the area less than 30-ft deep and a maximum depth of 70 ft. Rivers that empty into Big Bay de Noc include the Big, Little, Ogontz, Sturgeon, Fishdam, and Little Fishdam.

Waters in WFM-01 (380,652 total surface acres) offer extensive areas where suitable habitat is available and is likely used by spawning whitefish. The Big Bay de Noc Shoal is documented as being a very important area for lake whitefish reproduction. Fairly consistent favorable conditions on this shoal result in relatively stable whitefish recruitment from year to year. The bay areas are important nursery grounds for whitefish larvae and fry.

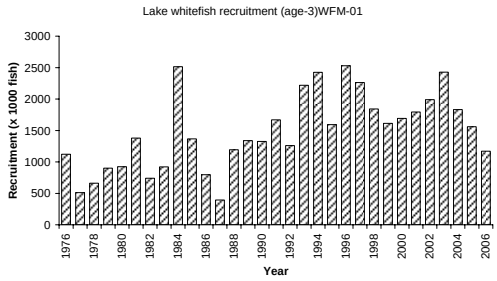
Trap-net yield for lake whitefish in WFM-01 was 976,000 lb during 2006, up 23% from 2005. The increase in yield occurred despite an 8% decline in effort between 2005 and 2006, from 1,540 to 1,420 lifts. The resultant 2006 catch-per-unit effort, 687 lb/lift, was substantially higher than for any other year in the data series and was a 33% increase over the 2005 value. The 1976-2005 average was less than half of the 2006 CPUE. Commercial gill netting in this management zone ceased after 1985.



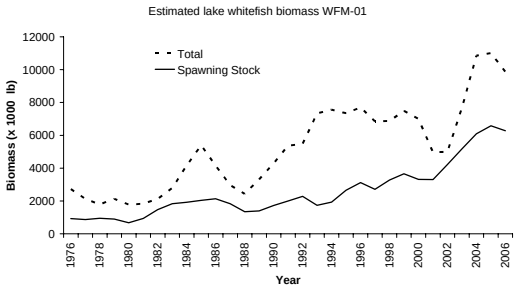
Between 2005 and 2006, weight-at-age for WFM-01 lake whitefish decreased for fish of all ages 4 and above. Weight-at-age values in 2006 were also less than averages for 1996-2000, the five years prior to full implementation of the 2000 Consent Decree.



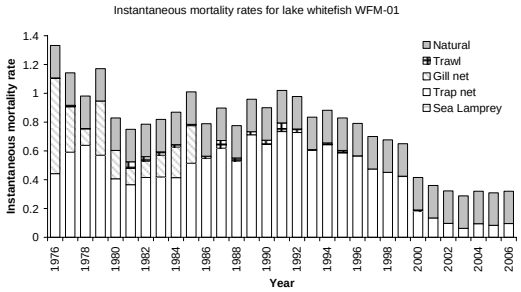
Estimated recruitment (numbers of age-3 fish) decreased 24% from 2005 to 2006. The 2006 recruitment estimate of 1.17 million lake whitefish was 23% less than average recruitment estimated for the previous 5-year period, 2001-05.



Based on the latest model estimates, fishable biomass was 9.9 million lb in 2006 and of this total, spawning stock biomass (6.3 million lb) represented 64%. Fishable biomass has shown an annual increase for all but 11 of the 31 years of the time series. Spawning stock biomass followed a similar trend of general and substantial increase between 1976 and 2006.



Estimates of total instantaneous mortality rate (Z) have remained below 0.42 y^{-1} during 2000-06. The 2006 estimate was 0.32 y^{-1} with 0.22 y^{-1} attributable to instantaneous natural mortality rate (M) and 0.10 y^{-1} attributable to instantaneous fishing mortality rate (F).



The projected 2008 yield limit for WFM-01 is 2.24 million lb. This value is a 47% increase from the 2007 yield limit of 1.52 million lb.

Summary Status WFM-01 Whitefish	Value (95% Probability Interval)
Female maturity	
Size at first spawning	1.34 lb
Age at first spawning	4 y
Size at 50% maturity	1.64 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	2.382 lb (2.373 - 2.390)
Current SSBR	1.19 lb (1.10 - 1.27)
SSBR at target mortality	0.2505 lb (0.2503 - 0.2507)
Spawning potential reduction	
At target mortality	0.498 (0.464 - 0.532)
Average yield per recruit	0.573 lb (0.542 - 0.603)
Natural mortality (M)	0.225 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	7
Fully selected age to trap nets	8
Fully selected age to trawls	6
Average gill net F, ages 4+	NA
Average trap net F, ages 4+	0.116 y^{-1} (0.100 - 0.135)
Average trawl F, ages 4+	NA
Sea lamprey mortality (ML)	
(average ages 4+, 2004-2006)	N/A
Total mortality (Z)	
(average ages 4+, 2004-2006)	0.342 y^{-1} (0.325 - 0.361)
Recruitment (age 3)	
(average 1997-2006)	1,932,124 fish (1,465,610 - 2,643,440)
Biomass (age 3+)	
(average 1997-2006)	8,002,565 lb (6,753,350 - 9,730,290)
Spawning biomass	
(average 1997-2006)	4,532,103 lb (4,001,320 - 5,183,970)
Recommended yield limit in 2008	2,261,310 lb
Actual yield limit in 2008	2,261,310 lb

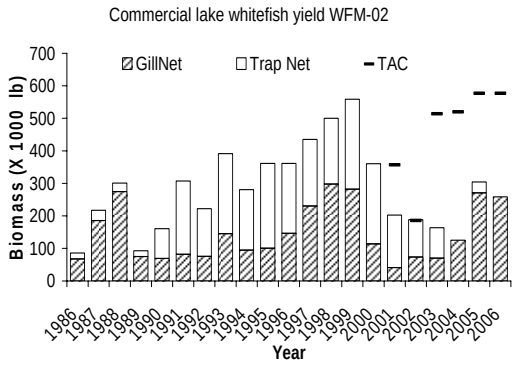
WFM-02 (Manistique)

Prepared by David C. Caroffino

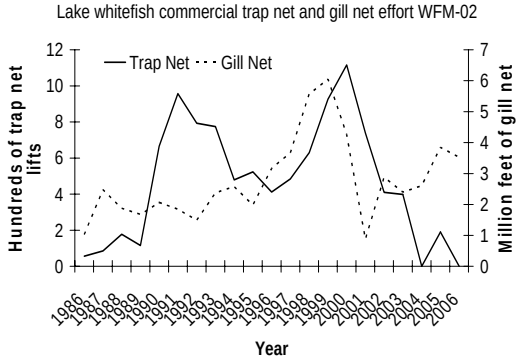
WFM-02 is located in the northwest portion of Lake Michigan on the east side of Michigan's Garden Peninsula. There are 387,000 surface acres of water less than 240 ft deep in the unit. The entire shoreline of WFM-02 lies within the Niagara Escarpment and is composed of dolomite limestone. The only known spawning population of whitefish in WFM-02 is located in Portage Bay, and it is not as abundant as other stocks in Lake Michigan. Many of the whitefish inhabiting WFM-02 move into the unit from adjacent units and Wisconsin waters.

WFM-02 has been an exclusive CORA fishing zone since 1985. One trap-net operation and up to four gill-net boats have regularly fished WFM-02 through the years, but only two gill-net boats currently fish in the unit. Very little small-boat gill-net effort occurs in this unit. Besides whitefish, the large-boat gill-net fishery routinely targets bloater chubs in offshore waters.

Commercial harvest in this unit has averaged 280,000 lb per year from 1986-2006. The lowest harvest was 86,000 lb in 1986 and the highest was 559,000 lb in 1999. Overall, the large-mesh gill-net fishery has accounted for 52% of the harvest, but since the year 2004 it has accounted for 93% of the whitefish harvest. The commercial harvest in 2006 was 258,000 lb, well below the harvest limit of 577,000 lb.

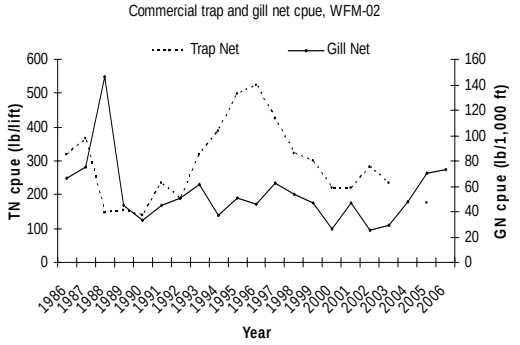


The distribution of trap-net effort in this unit has been bimodal. After an initial peak of 957 lifts in 1991, effort declined to 412 lifts in 1996. It then increased again to another peak of 1,114 lifts in 2000 before substantially declining in recent years. Gill-net effort steadily increased to a peak in 1999, corresponding with peak harvest. Gill-net effort has since declined and averaged 3.7 million feet in 2005 and 2006.

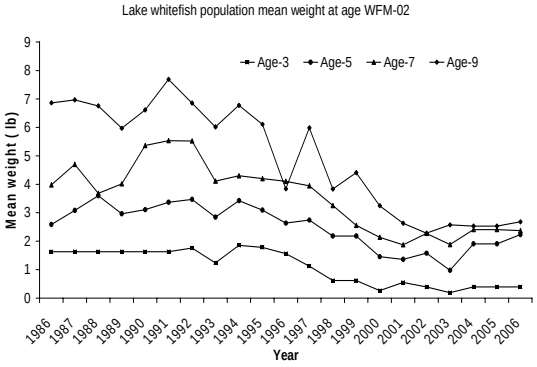


Gill-net catch per unit effort peaked in 1988 at 146 lb per 1,000 ft of net. It then declined in the early 1990s and has largely been stable, averaging 44 lb per 1,000 ft from 1989 through 2004. A slight increase occurred in 2005 and 2006 as the gill-net catch per unit effort averaged 72 lb per 1,000 ft of net. Trap

net catch per unit effort peaked in 1996 at 522 lb per trap-net lift. It has steadily declined since, and the most recent value was 175 lb per lift in 2005. There was no trap-net effort in 2006.

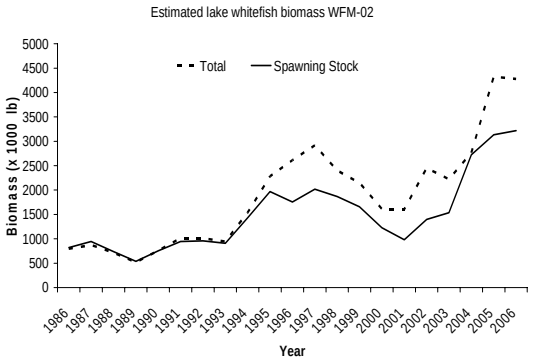


Growth of whitefish in WFM-02 has mirrored that of other units in northern Lake Michigan. Mean weight of nearly all age classes of whitefish declined continually after 1986. The average size of an age-9 whitefish was nearly 7 pounds in 1986, and in 2006 the average age-9 whitefish was less than 3 pounds. Since the year 2000 weight-at-age has remained relatively stable; however, age-5 whitefish increased in size between 2003 and 2006 (1 lb to 2.2 lb).



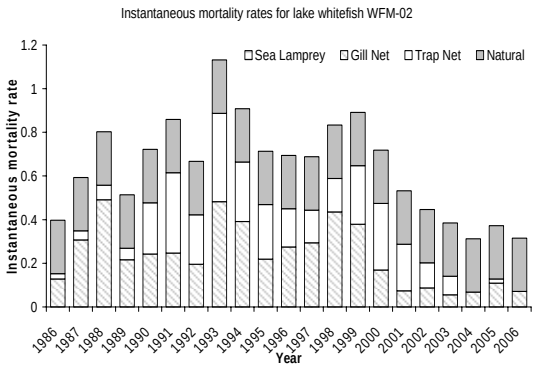
Predicted recruitment of age-3 whitefish to the fishable population in WFM-02 has varied by more than 35 times during 1986-2002. However, low predicted recruitment prior to 1994 is the cause of this extensive variation. In the later part of the time series recruitment has been more stable, but has declined from a peak of 1.1 million fish in 2002 to 675,000 fish in 2006. The average recruitment since 1994 has been 720,000 whitefish.

Estimated biomass of whitefish in WFM-02 increased from 1986 through 1997 then declined until 2001. Fishable stock biomass has rapidly increased since 2002 and peaked in 2005 at more than 4.3 million lb. Spawning stock biomass has followed the same trends as population biomass. Spawning stock biomass first peaked in 1997 at 2 million lb, then declined until 2001. Since 2002, spawning stock biomass has increased and reached an all-time high in 2006 at more than 3.2 million lb.



Total mortality of whitefish age 4 and older has been lower than the target mortality rate of 1.05 since 1994. Fishing mortality peaked at 0.88 y^{-1} in 1993 in WFM-02 and gill-net effort accounted for 54% of that mortality. The maximum trap-net mortality rate of

0.40 y^{-1} also occurred in 1993. The fishing mortality rate on whitefish in WFM-02 has consistently declined since 1999. The 2006 fishing mortality rate (0.07 y^{-1}) was only 8% of the 1993 peak. Fishing mortality of age 4 and older whitefish was 0.09 y^{-1} during 2004-2006 compared to a fishing mortality rate of 0.67 y^{-1} from 1993 to 1995. Sea lamprey induced mortality on whitefish is not estimated for this unit. The total annual mortality rate experienced by whitefish in this unit in 2006 was 27%.



The stock assessment model projected a total allowable harvest of 921,000 lb from WFM-02 for 2008. This value is greater than any single year of harvest in the time series, so the harvest regulation guideline (HRG) was set near peak historical harvest or 558,000 lb. Previous HRGs for this unit were 357,000 lb in 2001, 186,000 lb in 2002, 514,000 lb in 2003, 520,000 lb in 2004, 577,000 lb in 2005 and 2006, and 849,000 lb in 2007.

Summary Status WFM-02 Whitefish	Value (Standard error)
Female maturity	
Size at first spawning	0.39 lb
Age at first spawning	3 y
Size at 50% maturity	2.02 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	2.402 lb (SE 0.041)
Current SSBR	1.6 lb (SE 0.05)
SSBR at target mortality	0.198 lb (SE 0.00)
Spawning potential reduction	
At target mortality	0.664 (SE 0.021)
Average yield per recruit	0.494 lb (SE 0.032)
Natural mortality (M)	0.244 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	8
Fully selected age to trap nets	8
Average gill net F, ages 4+	0.083 y^{-1} (SE 0.01)
Average trap net F, ages 4+	0.006 y^{-1} (SE 0.001)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.334 y^{-1} (SE 0.011)
Recruitment (age 3) (average 1997-2006)	731,880 fish (SE 91,076)
Biomass (age 3+) (average 1997-2006)	2,673,800 lb (SE 232,090)
Spawning biomass (average 1997-2006)	1,977,100 lb (SE 163,950)
Recommended yield limit in 2008	921,000 lb
Actual yield limit in 2008	558,000 lb

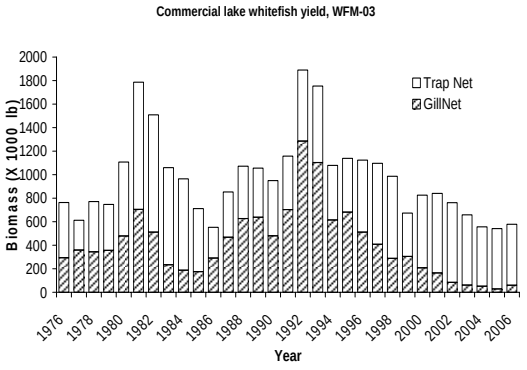
WFM-03 (Naubinway)

Prepared by Mark P. Ebener and David C. Caroffino

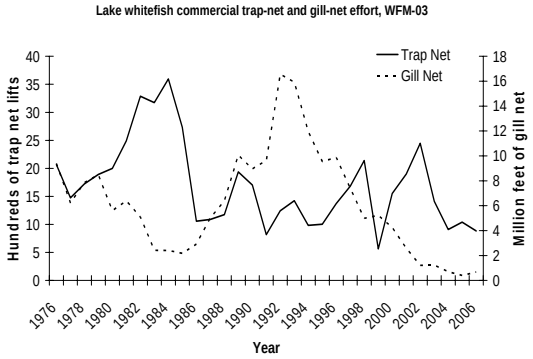
WFM-03 is located in northern Lake Michigan. The unit extends from the Straits of Mackinac west to Seul Choix Point and is bounded on the south by Beaver Island and the complex of shoals and islands that surround it. Nearly the entire unit is shallow water less than 90 ft deep. There are 483,000 surface acres of water less than 240 ft deep.

WFM-03 has been an exclusive commercial fishing zone for the CORA fishery since 1985. However, these commercial fishing grounds have been important for most of the twentieth century. A trap-net and both large- and small-boat gill-net fishery operate throughout WFM-03.

The commercial fishery yield from WFM-03 averaged 1 million lb during 1980-2006. The trap-net fishery yield averaged 590,000 lb and the gill-net fishery yield averaged 410,000 lb during that same time period. Total fishery yield peaked at 1.89 million lb in 1992 and declined slowly thereafter. The trap-net yield was 518,000 lb, and the gill-net yield was only 61,000 lb in 2006. The commercial yield in 2006 represented only 29% of the harvest limit.

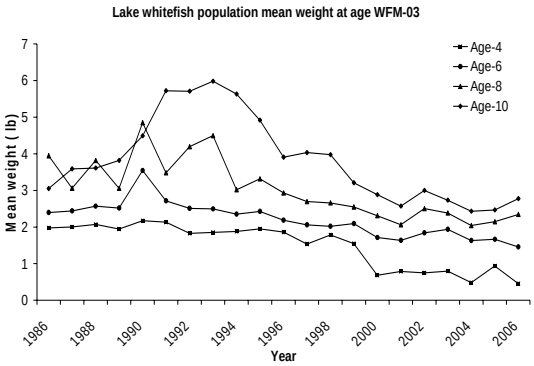


Trap-net fishing effort in WFM-03 has been highly variable and gill-net effort has declined substantially since the early 1990s. Trap-net effort has varied from 565 lifts to 3,597 lifts and averaged 1,690 during 1980-2006. Gill-net effort increased from 2.2 million ft in 1985 to 16.6 million ft in 1992 before declining to only 0.67 million feet in 2006. Trap-net effort was 883 lifts in 2006.



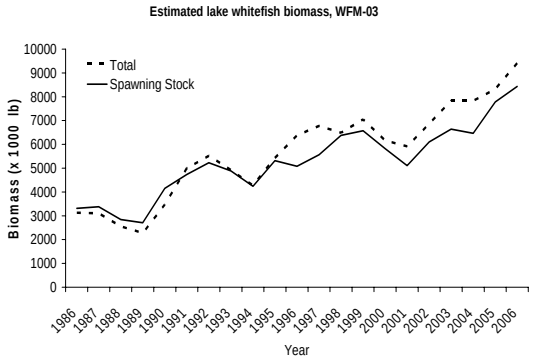
Whitefish in WFM-03 are of small size. During 1986-2006 No.1 whitefish made up 85%, mediums 12%, and jumbos 3% of the harvest from this unit. Mean weight of a harvested whitefish in 2006 was 2.4 lb in both the gill-net fishery and the trap-net fishery.

Changes in mean weight-at-age were mixed from 2005 to 2006. Older ages (age 8 and 10) slightly increased in size, while younger fish (ages 4 and 6) slightly decreased. Mean weight-at-age in 2006 continued to be less than the average during the 1990s.

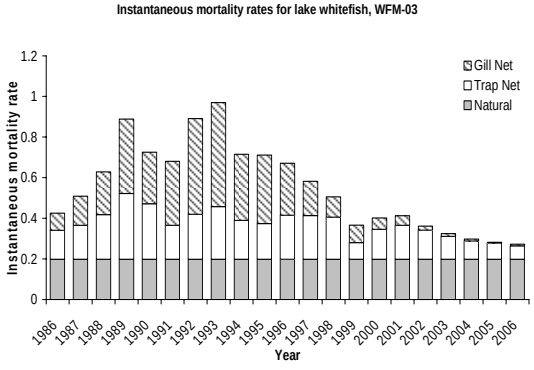


Estimated recruitment of age-4 whitefish remains relatively consistent and high in WFM-03. Recruitment increased from an average of 1.1 million fish during 1986-1999, to 1.9 million during 2001-2006. Recruitment of age-4 whitefish was estimated to be 1.77 million fish in 2006.

Biomass of age-4 and older whitefish has been fairly stable or increasing in WFM-03 based on the stock assessment model. Total biomass ranged from 2.3 to 7.1 million lb during 1986-2001 but increased thereafter due to the estimated large recruitment during 2001-2006. Total biomass and spawning stock biomass were estimated to be 9.4 and 8.4 million lb in WFM-03 in 2006.



Changes in gill-net effort have been primarily responsible for the changes in total annual mortality of whitefish in WFM-03. Total instantaneous mortality of age-4 and older whitefish increased from 0.42 y^{-1} in 1986 to 0.96 y^{-1} in 1993, and then declined to 0.27 y^{-1} in 2006. Gill-net induced mortality peaked in 1993 at 0.51 y^{-1} then declined to 0.007 y^{-1} in 2006. Trap-net mortality has been fairly stable throughout the time series, averaging 0.17 y^{-1}. Natural mortality was estimated to be 0.20 y^{-1} in WFM-03 and has been greater than total fishing mortality in most years since 1999. In 2006, trap-net and gill-net mortality was estimated to be 0.007 y^{-1} and 0.07 y^{-1}, respectively.



Total annual mortality on fully vulnerable age-classes was less than the target rate during 2004-2006 and the spawning potential reduction at current mortality rates and at the target mortality rate was greater than 0.20. Consequently, the projection model

estimated that fishing mortality could be increased. The projected harvest limit for 2008 under the increased fishing rate was estimated to be 2.55 million lb. By comparison, the harvest limit was 1.97 million lb from 2005 to 2007, 1.94 million lb in 2004, 1.46 million lb in 2003, 1.31 million lb in 2002, and 0.95 million lb in 2001.

Summary Status WFM-03 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.63 lb
Age at first spawning	4 y
Size at 50% maturity	1.21 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	3.294 lb
Current SSBR	2.0 lb (SE 0.04)
SSBR at target mortality	0.133 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.606 (SE 0.013)
Average yield per recruit	0.596 lb (SE 0.017)
Natural mortality (M)	0.20 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	9
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.007 y^{-1} (SE 0.001)
Average trap net F, ages 4+	0.078 y^{-1} (SE 0.006)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.284 y^{-1} (SE 0.006)
Recruitment (age 4) (average 1997-2006)	1,748,700 fish (SE 110,080)
Biomass (age 3+) (average 1997-2006)	7,266,100 lb (SE 366,150)
Spawning biomass (average 1997-2006)	6,486,300 lb (SE 314,340)
Recommended yield limit in 2008	2,551,000 lb
Actual yield limit in 2008	2,551,000 lb

WFM-04 (Beaver Island)

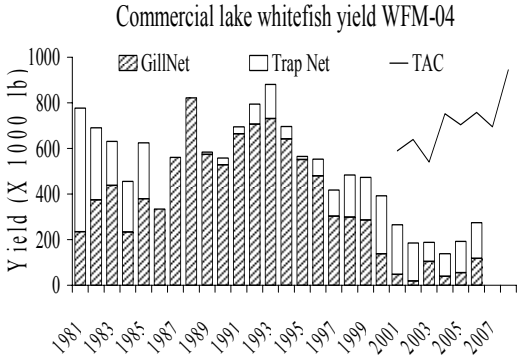
Prepared by Stephen J. Lenart

WFM-04 is located in central northern Lake Michigan and contains a very diverse range of habitat. The Beaver Island archipelago, which consists of eight named islands, is the dominant feature of the unit. These islands, located mainly along the northern edge of the unit, are associated with a large, rocky reef complex that extends about 15 miles west from Waugoshance Point near the northwestern tip of Michigan's Lower Peninsula. This northern reef complex is shallow, ranging from 5 to 30 ft deep. Many smaller submerged reefs extend from the northern reef complex to the south, running along the east and west sides of Beaver Island, a 55 mi^2 landmass that bisects the unit. These latter reefs are surrounded by deep water. WFM-04 contains 577,000 surface acres of water < 240 ft deep.

At least several reproductively isolated stocks of whitefish inhabit WFM-04, and most, if not all, of these are associated with the large northern reef complex. One stock spawns in Sturgeon Bay along the northeast side of the unit, while another stock is found at Hog Island.

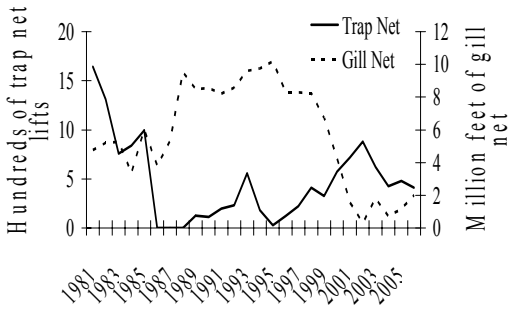
WFM-04 has been an exclusive commercial fishing zone for the Chippewa-Ottawa Resource Authority (CORA) Tribes since 1985. Much of the western half of the unit is designated as a lake trout refuge where retention of lake trout by recreational or commercial fishers is prohibited. The eastern portion of WFM-04 along the Lower Peninsula of Michigan has been a favorite fishing area for CORA small-boat fisheries, although access along this eastern shore is quite limited. The offshore waters of WFM-04 are fished exclusively by large-boat gill-net and trap-net operations. Only trap-net operations targeting whitefish conduct fisheries within the lake trout refuge. The recreational whitefish fishery is not likely a significant factor in this unit.

In the four years prior to implementation of the 1985 Agreement, the trap-net fishery accounted for a substantial proportion (30 – 70%) of the total commercial yield. Average commercial yield was 636,000 lb during this period. After 1985, the gill-net fishery dominated, accounting for more than 90% of the total commercial yield during 1986 to 1996 (no trap-net operations were active during 1986 to 1989). Commercial yield peaked at 880,000 lb in 1993, then declined steadily to a historical low of 139,000 lb in 2004. This decline can be attributed to a shrinking gill-net fishery, which has harvested, on average, 75,000 lb of whitefish per year during 2000 to 2006. By comparison, average gill-net harvest was 524,000 lb during 1985 to 1999. Commercial yield has increased marginally since the 2004 low, reaching 274,000 lb in 2006, the highest yield recorded since 2000.



Fishing effort in WFM-04 has been quite variable through the years. After averaging more than 1,100 lifts per year during 1981 to 1985, the trap-net fishery was inactive for a three-year period. Effort remained low through the mid-1990s (average of 200 lifts during 1989 to 1996). During the period 1997 to 2002, trap-net effort steadily increased, reaching 881 lifts in 2002. Trap-net effort then declined by 29% in 2003. Reported effort during 2004 to 2006 has been fairly stable, ranging from 412 to 479 lifts. By contrast, gill-net effort has progressively declined since 1995, when more than 10 million ft of gill-net effort was reported. The decline in gill-net effort in recent years followed as a consequence of the 2000 Consent Decree with the conversion of gill-net fisheries to trap-net fisheries. During 1985 to 1999, average gill-net effort was approximately 8 million feet per year, more than four times higher than the average reported since the Decree was implemented in 2000. In 2006, two million feet of effort was reported in WFM04.

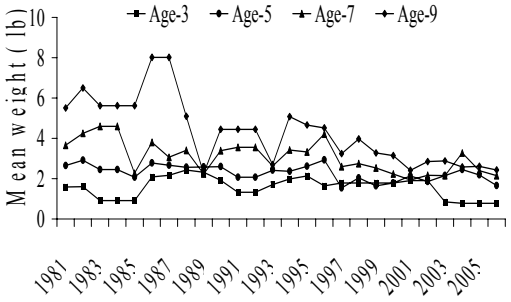
Lake whitefish commercial effort WFM-04



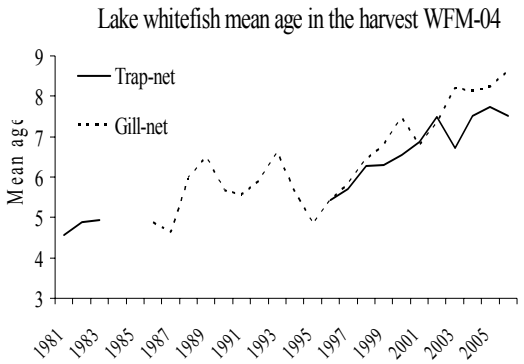
Whitefish in WFM-04 are of moderate size compared to other management units. Annual mean weight of a whitefish harvested in the trap-net fishery ranged from 2.0 to 3.3 lb during 1981 to 2006. The mean weight of whitefish harvested in the 2006 trap-net fishery was 2.25 lb. The mean weight of a whitefish harvested in the gill-net fishery ranged from 2.6 to 3.5 lb during 1981 to 2006. Since 1995, the mean weight of whitefish in the gill-net fishery has remained relatively constant (2.6 to 2.8 lb).

Although growth of whitefish in WFM-04 has not declined to the same extent as in other Lake Michigan units, significant declines are still evident. For example, age-9 whitefish weighed, on average, 5.8 lb during the 1980s. This declined to an average of 4.1 lb in the 1990s and then to 2.62 lb during 2001 - 2006. While a similar long-term decline was evident in younger age classes, growth appeared to have stabilized during the early 2000s. The most recent data suggest a slight decline in growth for most age classes, a trend that bears watching in the future.

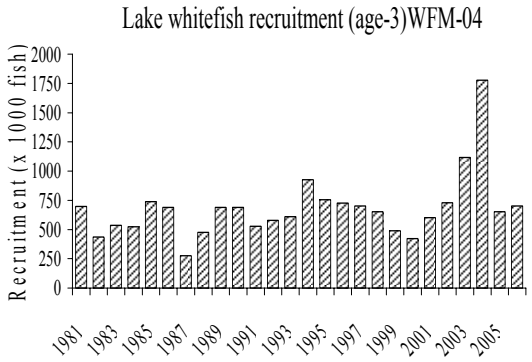
Lake whitefish population mean weight at age WFM-04



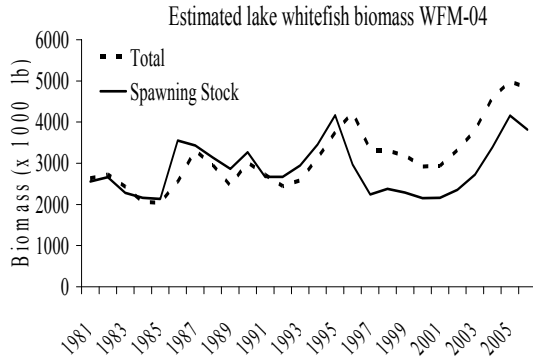
Further indicators of the long-term change in growth can be gleaned from the fishery. During the 1980s, the mean age of a whitefish harvested in the trap-net fishery was approximately 5 years. By 2006, the mean age in the trap-net fishery had increased to approximately 7.5 years. A similar trend is evident in the gill-net fishery as well, where the mean age of a harvested fish was 8.7 years in 2006.



Recruitment of age-3 whitefish to the population in WFM-04 is quite stable. During the years 1981 to 2001, average estimated recruitment of age-3 whitefish was 607,000 fish. Annual estimated recruitment varied from 277,000 to 925,000 fish during this time period. During the three-year period 2002 to 2004 (corresponding to the 1999, 2000, and 2001 year classes), estimated recruitment of age-3 fish was significantly higher, averaging 1.2 million fish. In fact, these estimates suggest that three of the five largest recruitment events in the time series have occurred during this three-year period. These recent estimates have driven the ten-year running average to 784,000 age-3 fish. Of particular interest is the estimate for the 2001 year class (age-3 fish in 2004). This estimate is more than 90% greater than the next highest in the time series. As these fish have not yet fully recruited to the fishery, the reliability of this estimate remains uncertain. However, estimates from adjacent management units in northern Lake Michigan suggest similar trends and the survey data, though limited, provides support for a strong 2001 cohort.

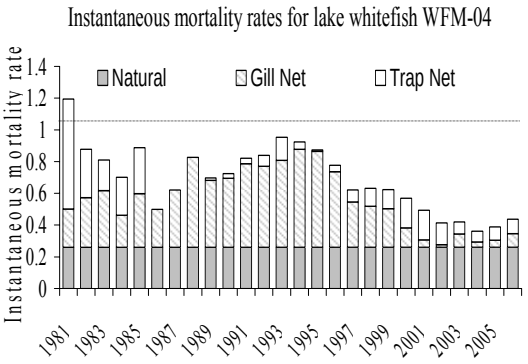


Spawning stock biomass has generally been quite stable in WFM-04, a consequence of the consistent recruitment. During the period 1981 to 1999, estimated spawning-stock biomass ranged from a low of 2.1 million lb in 1985 to a high of 4.2 million lb in 1995. After declining in the late 1990s from the mid-decade peak, estimated spawning stock biomass has increased substantially, reaching 4.2 million pounds in 2005. In 2006, estimated spawning-stock biomass was approximately 3.8 million lb.



A significant factor in this increase in spawning stock biomass was the general decline in fishing mortality rates since the mid-1990s, particularly in the gill-net fishery. During 1987 to 1996, instantaneous gill-net mortality ranged between 0.36 and 0.62 y^{-1} (average 0.51 y^{-1}). After 1996, gill-net mortality declined for six consecutive years,

reaching its lowest point in the time series in 2002 (0.015 y^{-1}). During 2004 to 2006, average instantaneous gill-net mortality was 0.053 y^{-1}. Trap-net mortality, which was highest in the early part of the time series, was a minor component of the overall mortality during the mid 1980s and most of the 1990s (average 0.039 y^{-1} during 1986 to 1997). Trap-net mortality increased gradually from 1997 to 2001, but has leveled off in recent years. During 2004 to 2006, average trap-net mortality was 0.081 y^{-1}. Total mortality (Z) of age-4 and older whitefish in WFM-04 has steadily declined since 1993 and recent total mortality rates are among the lowest in the time series. Since 2000, natural mortality (estimated at 0.261 y^{-1}) has been the primary mortality component in this unit. Sea lamprey mortality is not estimated separately in this unit, although the high abundance of sea lamprey in northern Lake Michigan may precipitate an evaluation of this mortality component for whitefish.



The average total mortality rate of age-4 and older whitefish was 0.396 y^{-1} during 2004 to 2006, well below the maximum target rate of 1.05 y^{-1}. The spawning potential reduction was estimated at 0.645. The 2008 fishery multipliers are 2.3 for the trap-net fishery and 4.6 for the gill-net fishery. The 2008 model-generated yield limit of 945,000 lb, which represented a 36% increase over the 2007 model-generated limit, was adopted by CORA as the Harvest Regulation Guideline for management unit WFM-04.

Structural changes and Model Diagnostics

After updating the source file to include 2006 data, three separate models were evaluated during the 2008 TAC assessment: (1) last year's model with no changes (gill-net selectivity modeled as a double logistic function); (2) a model in which gill-net selectivity was modeled as a simple logistic function; and (3) a model in which gill-net selectivity parameters of the descending limb were fixed. As in years past, the most problematic parameters continue to be those associated with gill-net selectivity. This was the primary reason why models 2 and 3 were evaluated. Although all three models evaluated during the 2008 assessment reached minimum convergence criteria, none yielded acceptable diagnostics. Model 2 (gill-net selectivity modeled as simple logistic) was discarded since the predicted age composition provided a poor fit to the observed data. Furthermore, this method of modeling selectivity in the gill-net fishery is inconsistent with the method used in adjacent units and is likely inappropriate, given our understanding of the fishery. Fixing the selectivity parameters of the descending limb (Model 3) did not improve diagnostics. Therefore, the original model (Model 1) was retained since it seemed arbitrary to fix parameters if doing so provided no discernable benefit. Models 1 and 3 provided the same solution for biomass, regardless of changes to the bounds of normally sensitive parameters. Model 2,

on the other hand, predicted much lower (36%) biomass, but again, a poor fit to the fishery age composition resulted in this model being discarded. The retrospective analysis did not indicate any major temporal trends, although the addition of 2006 data did increase estimates of biomass in years 2004 to 2006. This was primarily a result of the large estimated 2001 year class that had begun to recruit to the fishery in 2006.

In prior assessments, changing the bounds of the gill-net selectivity parameters helped yield reasonable MCMC outputs. This was not the case during the 2008 assessment and MCMC simulations were plagued by high autocorrelations. Given the poor diagnostics, the model was given a low quality rating. Due to the poor results from MCMC simulations, probability intervals are not reported in the summary table.

Summary Status WFM-04 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.77 lb
Age at first spawning	3 y
Size at 50% maturity	1.49 lb
Age at 50% maturity	4 y
Spawning biomass per recruit	
Base SSBR	2.533 lb (SE 0.004)
Current SSBR	1.63 lb (SE 0.03)
SSBR at target mortality	0.300 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.645 (SE 0.013)
Average yield per recruit	0.428 lb (SE 0.014)
Natural mortality (M)	0.261 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	10
Fully selected age to trap nets	10
Average gill net F, ages 4+	0.053 y^{-1} (SE 0.005)
Average trap net F, ages 4+	0.081 y^{-1} (SE 0.006)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.396 y^{-1} (SE 0.01)
Recruitment (age 3) (average 1997-2006)	784,050 fish (SE 80,316)
Biomass (age 3+) (average 1997-2006)	3,717,600 lb (SE 250,250)
Spawning biomass (average 1997-2006)	2,765,100 lb (SE 177,630)
Model-generated yield limit in 2008	945,000 lb
Actual yield limit in 2008	945,000 lb

WFM-05 (Grand Traverse Bay)

Prepared by Erik J. Olsen

Management unit WFM-05 encompasses the area from Little Traverse Bay through Grand Traverse Bay and offshore waters of Lake Michigan north and west of the Leelanau Peninsula. Much of WFM-05 contains water >240 ft. deep including the both the east and west arms of Grand Traverse Bay. The deepest parts of WFM-05 exceed 600 ft, both in the offshore waters west of the Leelanau Peninsula, as well as within the east arm of Grand Traverse Bay. Several small shallow reef areas are located in the offshore waters, and there is an extensive shallow water area associated with the Fox Islands. Seventeen statistical grids make up WFM-05, but only 488,000 surface acres, or 46% of the water in these grids, is less <240 ft. deep. Much of the offshore waters of WFM-05 are part of the northern Lake Michigan lake trout refuge.

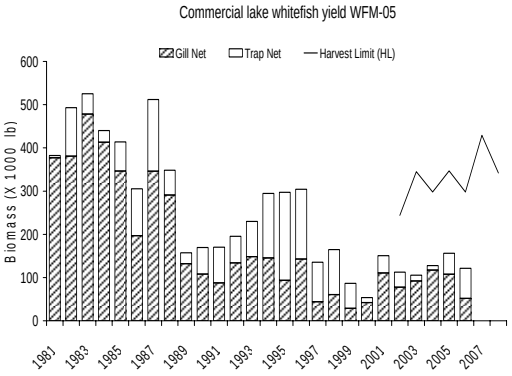
There are at least four reproductively isolated stocks of lake whitefish that inhabit WFM-05. Discrete spawning stocks of whitefish are found in both the east and west arms of Grand Traverse Bay, and in the outer Bay associated with Northport Bay based on mark-recapture studied conducted by Michigan State University researchers. There probably is another spawning stock of whitefish associated with the Fox Islands based on size and age structure of fish caught at the islands. Another, but smaller, spawning stock is likely found in Little Traverse Bay.

WFM-05 has been an important Tribal fishing area since the 1970s. Much of the Tribal fishing activity that occurred prior to and immediately after re-affirmation of treaty-reserved fishing rights took place in Grand Traverse Bay. Tribal small-boat fishers relied on Grand Traverse Bay as an important fishing ground because the Bay contains deep water located close to shore, and because it offers small-boat fishers protection from wind and waves. WFM-05 has been an exclusive Tribal commercial fishing zone since 1985 and WFM-05 waters of Grand Traverse Bay have been an exclusive commercial fishing area for the Grand Traverse Band since 1985.

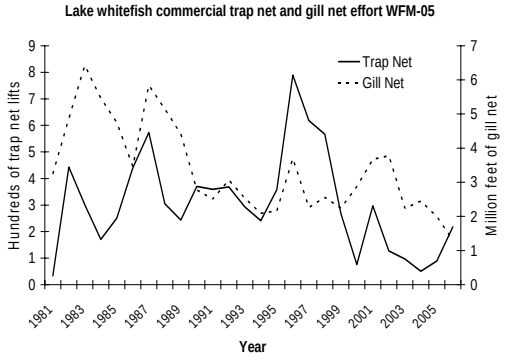
Initial Tribal fishing activities in WFM-05 were focused on an unexploited population of whitefish. Commercial fishing by State-licensed fisheries had been prohibited in WFM-05 for several decades before Tribal small-boat fishers began fishing the area in the late 1970s. Initial yields in 1978 and 1979 were in excess of 400,000 lb, and jumbo (≥ 4 lb) whitefish made up more than 90% of the yield. Harvest increased to >500,000 lb in 1983 and 1984, but by then jumbo whitefish made up only 30% of the yield.

Commercial yields of lake whitefish during the 1990s were substantially less than during the 1980s. The commercial yield averaged 383,000 lb from 1980 to 1989 and 205,000 lb during 1990 to 1999. The fishery declined through the late 1990s with the lowest recorded yield coming in 2000 at 53,000 lb. The fishery has rebounded slightly through 2006, averaging 129,000 lb during the timeframe. The large-mesh gill-net yield has exceeded the trap-net yield in every year except the period from 1994 to 1999. Increased trap net effort in 2006

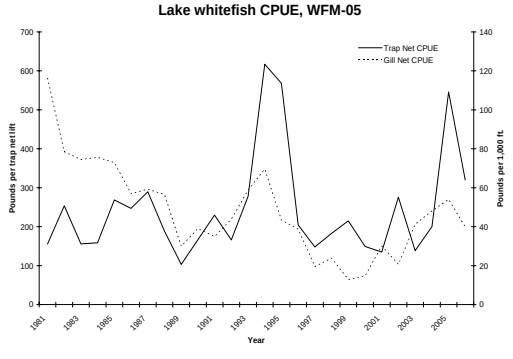
resulted in trap net yield again surpassing that of gill net.



Large-mesh gill-net effort in WFM-05 declined from 1984-1989 and has held relatively stable since; whereas trap-net effort has varied, but with a downward trend since 1996. Gill-net effort declined from an average of 6.4 million feet from 1983 through 1990. Since then, the large-mesh gill-net fishery has averaged 2.6 million feet annually, with an all-time low of 1.3 million feet in 2006. Trap-net effort has varied annually between 200 and 800 lifts during 1982-1999. Through the 1990s, trap-net effort averaged 423 lifts per year, peaking at 790 lifts in 1996. Trap-net effort has declined since, averaging 136 lifts since 2000, with an all-time low of 51 lifts in 2004.



The decline in yield of whitefish in WFM-05 has generally mirrored the decline in lake whitefish recruitment within this management unit. CPUE of whitefish in the large-mesh gill-net fishery declined from 153 lb per 1,000 ft. of gill net in 1979 to a low of 13 lb per 1000 ft. in 1999. Since 2000, gill-net CPUE has been increasing. In contrast, during 1981-2004 the CPUE of whitefish in the trap-net fishery has been remarkably stable holding between 150 and 300 lb per lift, except for 1994, 1995, and 2005. From 2000-2004, trap-net CPUE averaged 183 lb, but jumped significantly to 546 lb per lift in 2005, before dropping back to 319 lb in 2006. Gill-net fishers in WFM-05 claim the long-term decline in catch rates is a result of both increased water clarity due to zebra mussel activity, along with increased algal growth that makes the net highly visible to whitefish. Catch rates have increased recently with the relatively strong 1997-1999 year-classes entering the fishery. Whatever the case, it is evident that catch rates of whitefish in the large-mesh gill-net fishery have declined substantially in the unit relative to the early part of the time series.

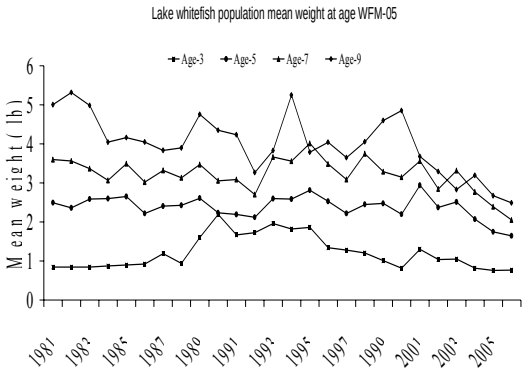


Whitefish from WFM-05 are currently of small to moderate size. Mean weight at age is trending down in recent years. From 2000 to 2006, the proportion of the yield made up of the three size classes of whitefish were 80% No.1 (< 3 lb), 16% mediums (3-4 lb), and 4% jumbos (≥ 4 lb). In comparison, from 1980 to 1989, 65% were classified No.1, 22% mediums, and 13% jumbos

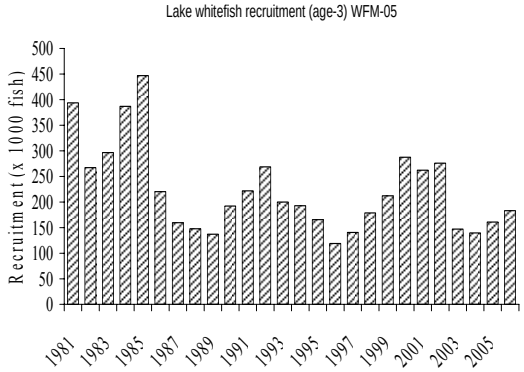
and from 1990-1999, 65% No.1, 20% mediums, and 15% jumbos.

As illustrated earlier, size structure of whitefish in the yield from WFM-05 has changed over time, as the proportion of jumbos declined and the proportion of No.1 whitefish increased. Annual mean weight of whitefish sampled from trap-net harvests ranged from 2.0 to 3.6 lb since 1979 and averaged 2.4 lb during the last three years (2004-2006). Annual mean weight of whitefish in the gill-net harvest ranged from 2.4 to 3.5 lb since 1979 and averaged 2.9 lb during the last three years (2004-2006).

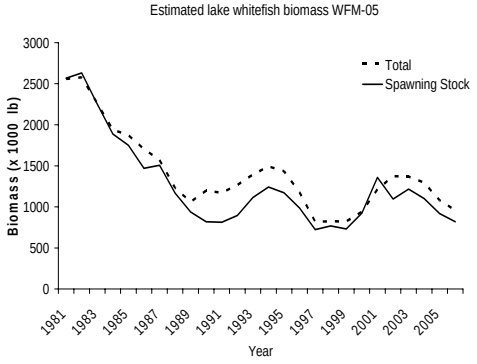
Mean weights of lake whitefish (ages 3-9) from WFM-05 have been slowly declining since 1981. This pattern of declining growth is also being observed in other areas of Lakes Michigan and Huron, including substantial declines in areas adjacent to this management unit.



Recruitment of age-3 whitefish to the population in WFM-05 is highly variable and has generally declined since the mid-1980s based on estimates from the stock assessment model. The number of age-3 whitefish entering the population has declined significantly over time. Early on (1981-1985) year classes averaged 358,000 fish, ranging from 267,000 to 487,000. Since 1985, estimates have been relatively stable, ranging between 119,000 and 287,000, with an average of 191,000 age-3 fish entering the fishery annually.



Biomass of whitefish estimated with the stock assessment model declined in response to declines in recruitment. Annual biomass of whitefish ≥ age 3 (calculated at the beginning of each year) peaked at the beginning of the 1981-2007 timeframe with 2.6 million lb. This steadily declined to 1.1 million lb in 1989 and has ranged from 820,000 to 1.5 million lb from 1990 to 2006. Spawning stock biomass followed the same trend with a peak of 2.6 million lb in 1981 and has ranged between 723,000 and 1.4 million lb since 1990.



From 1981-1998, the combined commercial fishing mortality (F) met or exceeded natural mortality in this unit. Since 1998, F dropped to an annual level less than that of natural mortality. Fishing mortality within this unit has been dominated by gill nets; however during the late 1990s (1995-1998) trap net approached or surpassed gill net mortality. Since then, both gill-net and

trap-net mortality have held relatively steady at a reduced level, with an increase in trap net mortality in 2006. Average fishing-induced mortality on whitefish ≥ age 4 averaged 0.10 for the large-mesh gill-net fishery and 0.05 for the trap-net fishery during 2004-2006. Gill-net-induced fishing mortality ranged from 0.39 in 1983 to 0.07 in 1999, while trap-net-induced fishing mortality ranged from 0.01 in 1981 to 0.29 in 1996. The gill- and trap-net mortality level has declined from a combined rate of 0.62 in 1996 to a low of 0.13 in 2000.

Total annual mortality on the fishable stock in WFM-05 during 2004-2006 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 40% during 2004-2006 and the spawning potential reduction value was 0.52.

To generate the 2008 yield limit, the model .dat file was updated with biological data through 2006. Due to low sample size, weight-at-age for age-2 fish in the population was based on a three-year average of survey data. Female maturity-at-age and von Bertalanffy growth parameters were calculated from running, five-year time blocks, the most recent being 2002-2006. All other data updates were straight forward. No substantive changes were made to the model code during the 2008 TAC assessment.

Historically, selectivity in the gill-net fishery has been modeled as a double logistic function, while a simple logistic function was used to describe trap-net selectivity. This structure was carried forward in this latest assessment since the model for this unit has generally been quite stable. Although the model reached convergence and was not sensitive to changes in initial condition, MCMC diagnostics were quite poor across all variables (hence the summary table does not include 95% confidence intervals). Increasing the length of the chain (from one million to two million) did not improve the outputs. In other units, experimentally changing the bounds of the gill-net selectivity parameters has produced better results, but no set of bound values produced good results here. The model generally fit the data fairly well, except perhaps for some disagreement between observed and predicted mean-age in the trap-net fishery during the period 1998 to 2002. These years represent a period of relatively low yield and small sample size in the trap-net fishery. In recent years, sample size has increased.

Retrospective analysis of biomass suggests that estimates of biomass in the last few years of the model are higher than those estimated from previous assessments. This is likely due to the contribution of the 1997–1999 year classes which were relatively large and only now are all individuals fully recruited to the fishery. The 2008 model-generated yield limit of 342,000 lb represents a 20% decline from the 2007 limit. This decline can likely be attributed to a period of lower recruitment in recent years. A continued decline in weight-at-age is another contributing factor.

Consequently, the projection model estimated that fishing mortality could be increased 3.2 times in WFM-05 in 2008 from the average value during 2004-2006. The projected yield associated with this level of fishing is 342,000 lb, which was accepted as the HRG for 2008.

Summary Status WFM-05 Whitefish	Value (Standard Error)
Female maturity	
Size at first spawning	0.78 lb
Age at first spawning	3 y
Size at 50% maturity	1.40 lb
Age at 50% maturity	4 y
Spawning biomass per recruit	
Base SSBR	3.074 lb (SE 0.001)
Current SSBR	1.6 lb (SE 0.04)
SSBR at target mortality	0.307 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.521 (SE 0.014)
Average yield per recruit	0.552 lb (SE 0.014)
Natural mortality (M)	0.244 y^{-1}
Fishing mortality rate 2004-2006	
Fully selected age to gill nets	11
Fully selected age to trap nets	11
Average gill net F, ages 4+	0.107 y^{-1} (SE 0.006)
Average trap net F, ages 4+	0.053 y^{-1} (SE 0.004)
Sea lamprey mortality (ML) (average ages 4+, 2004-2006)	N/A
Total mortality (Z) (average ages 4+, 2004-2006)	0.404 y^{-1} (SE 0.009)
Recruitment (age 3) (average 1997-2006)	198,690 fish (SE 12,516)
Biomass (age 3+) (average 1997-2006)	1,069,300 lb (SE 48,618)
Spawning biomass (average 1997-2006)	965,570 lb (SE 43,110)
Recommended yield limit in 2008	342,000 lb
Actual yield limit in 2008	342,000 lb

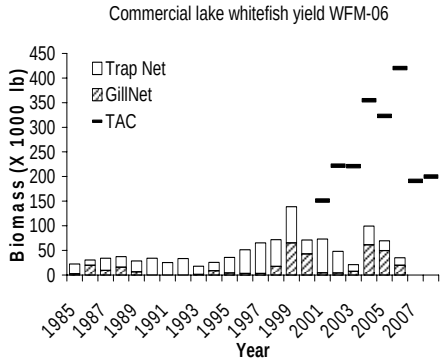
WFM-06 (Leland - Frankfort)

Prepared by Randall M. Claramunt, Philip J. Schneeberger, and Erik Olsen

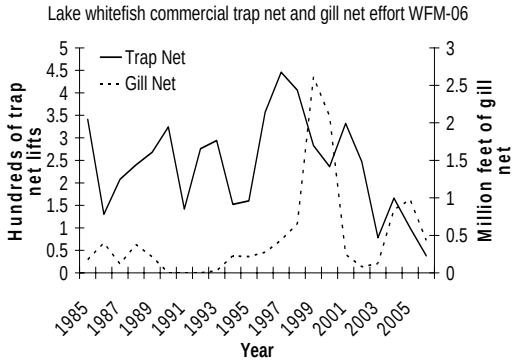
Lake whitefish management unit WFM-06 is located in 1836 Treaty waters west of the Leelanau Peninsula from about Cathead Point south to Arcadia. Surface area for this unit is 945,156 acres (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include Good Harbor Bay, Sleeping Bear Bay, and Platte Bay. Two large islands, North Manitou and South Manitou, are contained in this management zone, as are three large shoal areas including North Manitou Shoal, Pyramid Point Shoal, and Sleeping Bear Shoal. Major rivers flowing into WFM-06 include the Platte, and the Betsie. Betsie Lake is a drowned river mouth formed where the Betsie River flows into Lake Michigan. Except for areas near shore or around the islands, most of the waters in WFM-06 are deep (>200 ft). Bays, islands, and shoal areas offer the best habitat for lake whitefish spawning in this management area.

WFM-06 was reserved for state licensed commercial trap-net-fishing operations from 1985 through 1999, except that Tribal gill netting was allowed in grid 714. Most state-licensed trap-net effort and harvest is reported from grids 812-814 and 912. Beginning in 2000, WFM-06 became a true shared zone, and waters were opened to both state and Tribal fishers. Since 2000, State-licensed effort has declined and the majority of yield is from Tribal effort (trap and gill nets). One important regulation since 2000 was a change in 2005 allowing State-licensed trap-net fishers to fish in water depths up to 130 feet (instead of restricted to 90 feet).

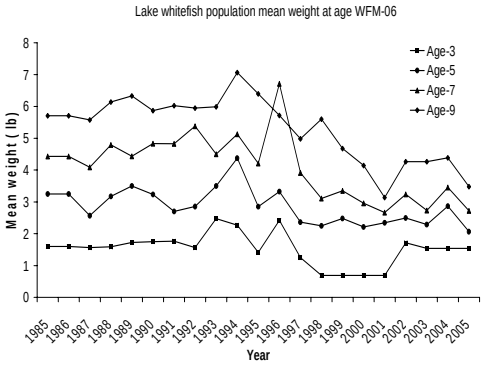
Yield for 2006 was 35,000 lb in WFM-06, down from 70,000 lb in 2005, and down from the 1985-2005 average of 49,000 lb. Of the total in 2006, trap-net yield was 14,400 lb (43.8 %) and gill-net yield was 19,700 lb (56.2 %). Proportions of yield by gear type have varied considerably from year to year with an average split of 67.5% from trap nets and 32.5% from gill nets between 1985 and 2006.



Trap-net effort decreased from 100 lifts in 2005 to 38 lifts in 2006. The 2006 trap-net effort was lowest recorded for the 1985-2005 series (average of 247 lifts). Similarly, gill-net effort in 2006 (432,300 feet) decreased from 2005 (977,300 feet), and was slightly lower than the 1985-2005 average of 480,700 feet.

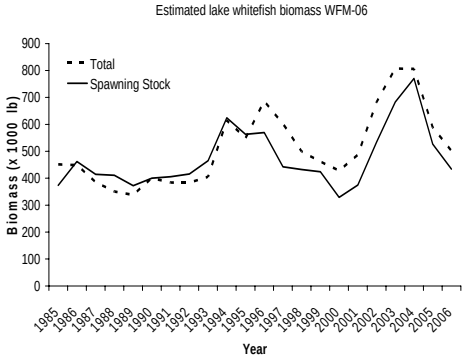


Lake whitefish weight-at-age in 2006 was relatively unchanged for most age groups from the 2005 values. Weight-at-age in 2004 and 2005 appeared to have stabilized from observed declines during 1996 to 2001 for most ages. However, weight-at-age values in 2006 were not available because trap net biodata samples were not collected. Based on 2005 samples for fish aged 5-12+, weight-at-age values were still 34% lower than the 1985-2004 averages.



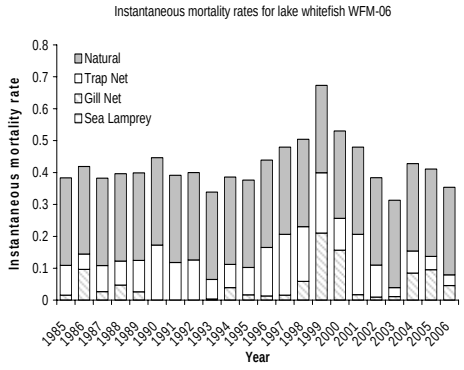
Recruitment, based on estimated numbers of age-3 fish, increased from 29,000 fish in 2005 to 64,000 fish in 2006. However, recruitment in 2006 was lower than the long-term average of 73,000 fish. Estimates of recruitment were highest during 1994-98 and 2000-2002 and lowest for the time series during 1987-88 and 2004 and 2005.

Estimates of total biomass and spawning stock biomass have roughly paralleled each other from 1985 through 2006, and reflect changes in recruitment estimates. Biomass values estimated for 2006 were 501,000 lb for total and 434,000 lb for spawning stock biomass. The ratio of spawning stock biomass to total biomass was 0.87 in 2006.



Total instantaneous mortality rate (Z) in 2006 was 0.35 y^{-1}, showing a moderate decrease in the rate from 0.41 y^{-1} in 2005. Based on current estimates, the 2006 rate for Z is lower than the average of 0.43 y^{-1} for 1985-2005. Instantaneous fishing mortality rates (F) have varied considerably for trap nets and gill nets throughout the time series. During 2006, F was slightly higher for the gill-net fishery. Estimates for F were 0.034 y^{-1} for trap nets and 0.046 y^{-1} for gill nets. The 2006 estimate for instantaneous natural mortality rate was

0.274 y^{-1}, still the largest source of lake whitefish mortality in WFM-06.



The 2008 yield limit is 201,000 lb, which is a slight increase from the limit calculated for 2007 of 191,000 lb. Moreover, based on current fishing mortality and 2008 yield limit and projection model, the level of commercial fishing effort inWFM-06 could increase from the 2007 levels.

Summary Status WFM-06 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	1.54 lb
Age at first spawning	3 y
Size at 50% maturity	2.13 lb
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	3.422 lb (3.305 – 3.428)
Current SSBR	1.96 lb (1.731 – 2.049)
SSBR at target mortality	0.377 lb (0.366 – 0.408)
Spawning potential reduction	
At target mortality	0.574 (0.522 – 0.618)
Average yield per recruit	0.580 lb (0.519 – 0.638)
Natural mortality (M)	0.274 y^{-1}
Fishing mortality rates	
Age of full selection	
Fully selected age to gill nets	8 y
Fully selected age to trap nets	8 y
Gill net fishing mortality (F)	
Average 2004-2006, ages 4+	0.068 y^{-1} (0.059 – 0.086)
Trap net fishing mortality (F)	
Average 2004-2006, ages 4+	0.044 y^{-1} (0.034 – 0.049)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 4+)	N/A
Total mortality (Z)	
(average 2004-2006, ages 4+)	0.386 y^{-1} (0.366 – 0.408)
Recruitment (age 3)	
(average 1997-2006)	92,971 fish (81,527 – 104,479)
Biomass (age 3+)	
(average 1997-2006)	586,520 lb (495,259 – 669,418)
Spawning biomass	
(average 1997-2006)	495,110 lb (413,218 – 570,203)
Recommended yield limit in 2008	201,000 lb
Actual yield limit in 2008	201,000 lb

WFM-07 (Ludington)

Prepared by Archie W. Martell Jr.

Lake whitefish management unit WFM-07 is located within the 1836 Treaty-Ceded Waters of eastern central Lake Michigan from Arcadia in the north to just south of Stony Lake, and west to the state line bisecting the middle of the lake. This lake whitefish management unit includes part or all of grids 1107-1111, 1207-1211, 1306-1310, 1406-1410, 1506-1510 and 1606-1609. The surface area for this unit is 1,286,940 acres (2,011 square miles) of which 274,943 acres (430 square miles) have bottom depths of 240 feet or less, with maximum depths up to 900 feet. Apart from the shoreline, there are no islands or bays that would be distinguishing features relevant to whitefish biology, but there are several inflows from the Manistee, Little Manistee, Big Sable, Pere Marquette, and Pentwater Rivers, and drowned river mouths at Manistee Lake, Pere Marquette Lake, and Pentwater Lake.

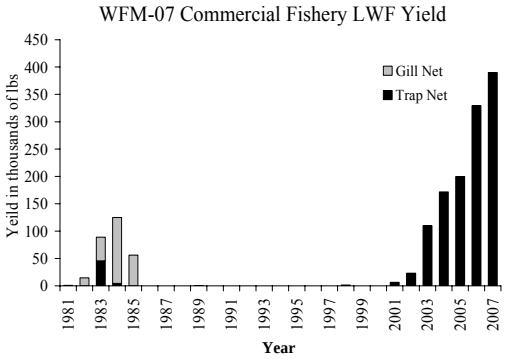
Since 2000, WFM-07 has been a Tribal commercial fishing zone for lake whitefish, part of the Little River Zone with Tribal fishing regulated under permitting control of the Little River Band of Ottawa Indians (LRBOI). From 1985 through 2000, there was no significant State commercial-fishing effort and no Tribal commercial-effort for lake whitefish within this unit. The current regulations prohibit the use of large-mesh gill nets and only allow for use of large-mesh trap nets for commercial lake whitefish exploitation.

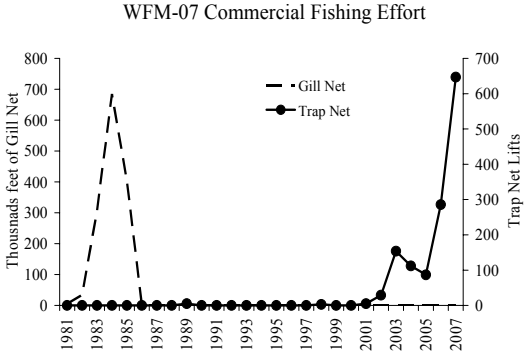
There has been no statistical catch at age modeling of the lake whitefish stock in WFM-07 due to a lack of long-term commercial catch-at-age information. Pursuant to the 2000 Consent Decree, the tribes had three years of allowable commercial fishing without harvest limits in this unit during 2001-2003. During the three-year period, commercial fishing was limited to an effort restriction of two trap-net operations with twelve nets each.

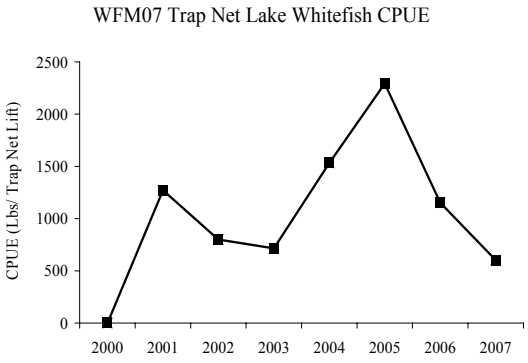
At the conclusion of the 2003 fishing season, three years of commercial trap-net fishing activity for lake whitefish was completed by Tribal fishers within this unit. Following the regulations in the 2000 Consent Decree and the Tribal Management Plan, an annual Harvest Regulation Guideline (HRG) for lake whitefish was developed for this management unit beginning in 2004.

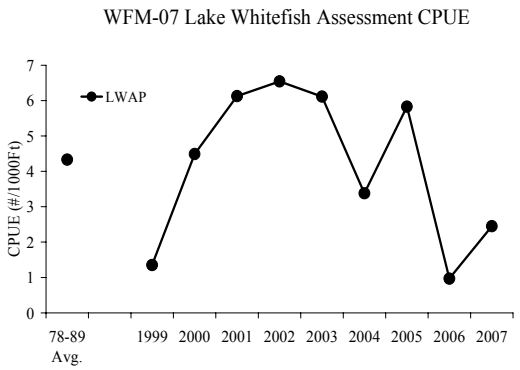
The 2001-2007 average lake whitefish commercial harvest within this unit has been 175,750 lb. In 2001 Tribal commercial fishing activities began, with effort only occurring in October and November with a total harvest of 6,361 lb from 5 trap-net lifts. In 2002 Tribal commercial harvest was 23,165 lb with 29 trap-net lifts. By 2003, Tribal commercial fisheries were distributed across the fishing season and harvest and effort increased to 110,080 lb and 154 trap-net lifts, respectively. Commercial lake whitefish activity continued to increase in 2004 with a harvest of 171,755 lb, but effort decreased to 112 trap-net lifts. A similar pattern was observed in 2005 as harvest increased (199,570 lb), but effort declined (87 trap-net lifts). In 2006, both harvest (329,270 lb) and effort (286 trap-net lifts) increased. Commercial fishing

harvest of lake whitefish within WFM-07 reached 389,997 lb in 2007 represented by 647 trap-net lifts.







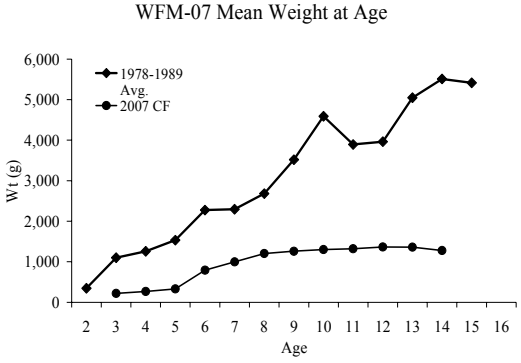


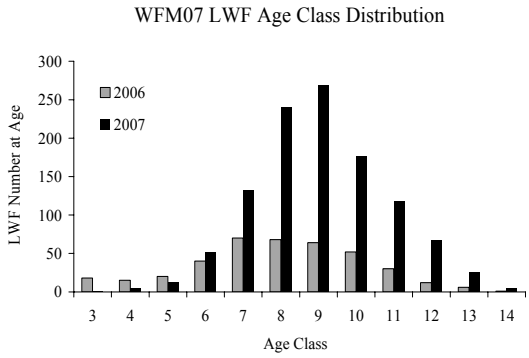
Fishery-independent surveys were conducted following the Lakewide Assessment Plan LWAP using graded-mesh gill nets (GMGN). From 1999 through 2007, GMGN catch-per-unit-effort (CPUE; number per 1,000 feet of GMGN) for lake whitefish in spring assessments have been 1.4, 4.5, 6.1, 6.5, 6.1, 4.3, 5.8, 0.97and 2.45, respectively. The average LWAP GMGN survey CPUE of lake whitefish in WFM-07 was higher from 2000-2005 compared to historical levels represented by the 1978-1989 average using similar survey gill nets. Historical graded-mesh gill-net CPUE of 4.3 per 1,000 feet for lake whitefish from spring surveys is represented by the average for 1978-1989. However, in 1999, 2004, 2006 and 2007 the LWAP CPUE was lower than the historical average.

The mean length of lake whitefish sampled in spring GMGN surveys in 2007 increased to above 20 inches, and is larger than seen in the previous year's survey. The 2004-2007 samples of commercial lake whitefish have shown that whitefish are maintaining a mean length of over 20 inches and are larger than the 2001-2003 samples. The mean length of the lake whitefish within this unit are still below those of the 1978-1989 survey average. For example, lake whitefish collected from 1983 commercial samples averaged over 23 inches.

Similar to average length, the mean weight of lake whitefish from both the GMGN surveys (3.12 lb) and commercial samples (2.65 lb) in 2007 are currently lower than the 1978-1989 survey average (6.84 lb) and the 1983 commercial samples (5.54 lb). The mean age of lake whitefish from the 2007 GMGN survey is 8.8 yrs and 9.0 yrs from the commercial samples. The current data suggests that the lake whitefish population has an older mean age as compared to the 1978-1989 GMGN survey mean of 4.8 yrs and the 1983 commercial sample of 7.3 yrs.

Lake whitefish mean weight at age from commercial samples in 2007 was substantially lower as compared to the 1978-1989 survey average. This follows a similar trend that has been observed from 2000 to present. The lower weight at age indicates that growth rates have been suppressed within this unit as compared to historical levels.





The instantaneous total annual mortality rates for WFM-07 lake white fish were estimated using catch curve analysis. The estimated instantaneous total annual mortality rate (Z) for 1978-1989 spring GMGN survey averaged 0.20 y^{-1} for ages 3 through 15. The 2006 lake whitefish instantaneous total annual mortality rate (Z) from all assessment GMGN surveys and commercial samples combined was estimated to be 0.339 y^{-1} for ages 7-13. The instantaneous total annual mortality rate (Z) for 2007 lake whitefish from all assessment GMGN surveys and commercial samples combined was estimated to be 0.386 y^{-1} for ages 7-14. The total annual mortality rate (*A*) calculated for this lake whitefish stock (33%) is below the target maximum rate of 65% as outlined in the 2000 Consent Decree.

The lake whitefish stocks within WFM-07 have relatively low exploitation rates as compared to other management zones in northern Lake Michigan. With the development of the Tribal commercial fishery, however, there are indications that the abundance of lake whitefish is relatively stable and may be decreasing slightly within this management unit as compared to recent and historical observations. Results from the current spring GMGN surveys and the commercial harvest, when compared to historical information,

shows signs of depressed weight at age and increased mean age of the population. Also the stock is showing indications of relatively stable mean size at age since 2000, but is currently below historical averages. These results suggest that this stock may be regulated by density-dependent mechanisms which could improve under higher exploitation rates.

In 2004, LRBOI adopted additional effort limitations of 4 trap-net permits with a maximum of 12 nets per permit for this unit. The 2008 lake whitefish HRG of 500,000 lb for WFM-07 is a continuation of the 2004 HRG that was developed and recommended by the LRBOI and adopted by CORA. The HRG was established by examining the current status of the lake whitefish population (e.g., catch rates, mean size at age) and the harvest limits established by the Technical Fisheries Committee's Modeling Sub-Committee for the adjacent whitefish zones (WFM-06 and WFM-08).

Year	Gear	Mean TL (Inch)	Mean Wt (Lb)	Mean Age
1978-1989 Avg.	GMGN	23.34	6.84	4.8
1983	CF	23.32	5.54	7.3
2000	GMGN	18.61	2.22	6.1
2001	GMGN	18.96	2.37	9.9
2001	CF	19.89	2.76	10.9
2002	GMGN	18.44	2.33	8.9
2002	CF	19.34	2.69	9.7
2003	GMGN	19.14	2.38	8.4
2003	CF	19.68	2.52	11.5
2004	GMGN	20.68	3.02	10.6
2004	CF	20.21	2.77	9.2
2005	GMGN	17.99	2.37	7.7
2005	CF	20.31	2.86	10.9
2006	GMGN	19.20	2.70	10.8
2006	CF	20.15	2.58	7.8
2007	GMGN	20.95	3.12	8.8
2007	CF	20.27	2.65	9.0

GMGN – Graded mesh gill net survey, CF – Commercial fish surveys

WFM-08 (Muskegon)

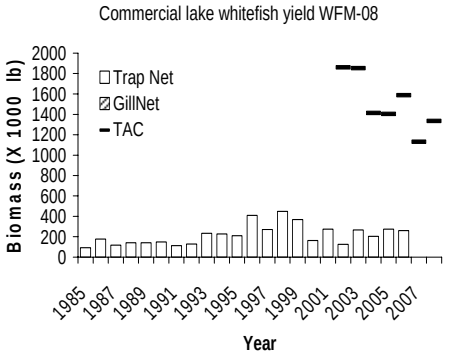
Prepared by Randall M. Claramunt, Philip J. Schneeberger, and Archie W. Martell Jr

Management unit WFM-08 is the Lake Michigan whitefish zone from Montague south past Port Sheldon. WFM-08 has a surface area of 1,506,880 acres in Michigan grids 1706-1710, 1806-1810, 1906-1911, and 2006-2011. Apart from the shoreline, inflows from the White, Muskegon, and Grand rivers, and drowned river mouths at White Lake, Muskegon Lake, Mona Lake, and Pigeon Lake, this area has few other distinguishing features relevant to lake whitefish biology. Depth gradients west from shore are relatively gradual, but most of the waters in WFM-08 are 200-ft deep or deeper. More than three quarters of the trap-net effort and over 80% of the trap-net harvest is reported from grid 1810.

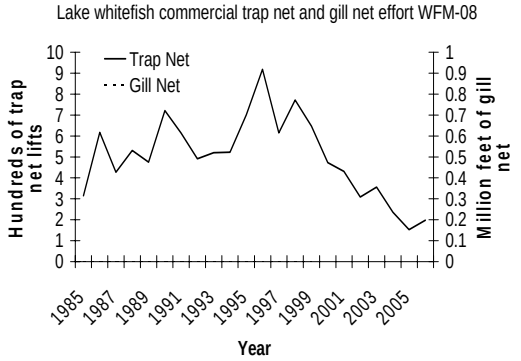
Although commercial exploitation and monitoring have occurred for many years, little is known about reproductive biology of the WFM-08 lake whitefish stock. Fish in this area are near the southern end of the distribution for lake whitefish.

Two State-licensed trap-net fishers operate in WFM-08 where minimum length for whitefish in commercial catches was 19 inches TL through 1999, then changed to 17 inches TL in 2000. Other management zones have had a 17-inch minimum size limit throughout the time series. Through 2005 there has been no gill-net harvest of lake whitefish in WFM-08. One important regulation since 2000 was a change in 2005 allowing State-licensed trap-net fishers to fish in water depths up to 130 feet (instead of restricted to 90 feet).

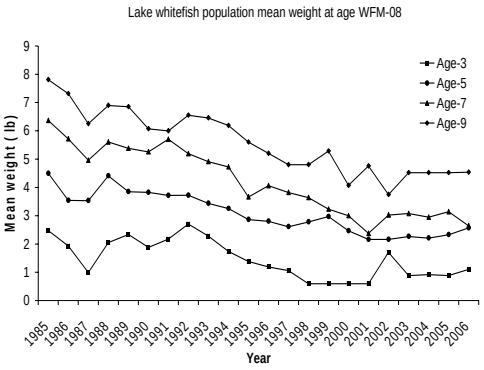
Lake whitefish yield from WFM-08 in 2006 was 260,000 lb. In 2006, yield decreased from 2005 (275,000 lb), but was slightly higher than the 1985-2005 average of 216,000 lb. Trap-net effort increased from 153 lifts in 2005 to 198 lifts in 2006.



Effort in 2006 remained lower than the average for 1985-2005 of 516 lifts.

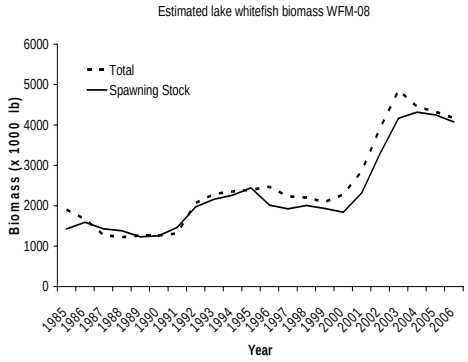


Weight-at-age data have trended downward from 1985 through 2003. From 2003 to 2006, however, weight-at-age increased or appeared to have stabilized for most of the age groups. Overall, weight-at-age values in 2006 represent a 25% decrease from the averages for 1985 to 2005 for ages 4-9.

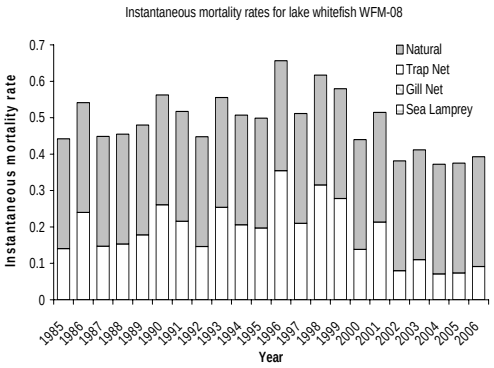


Recruitment, based on the estimated number of age-3 fish, was 526,000 in 2006. Estimates of recruitment were considerably higher during 1999-2002 (averaged 979,000 and peaked at 1,059,000), but the estimate for 2006 was very similar to the 1985-2005 average of 445,000 age-3 fish.

Up to 2003, estimates of total fishable biomass and spawning stock biomass continued increasing trends that have persisted since the early 1990s. In 2004 and 2005, however, fishable biomass and spawning stock biomass appear to have reached a plateau or carrying capacity for this stock. The trend through 2006 suggests that the stock may be experiencing density-dependent controls as total biomass decreased from 2005 (4.3 million lb) and was estimated at 4.2 million lb and spawning stock biomass was similar at 4.1 million lb. The ratio of spawning stock biomass to fishable biomass was close to 1.0 in 2006, slightly higher than the 1985-2005 average ratio of 0.94.

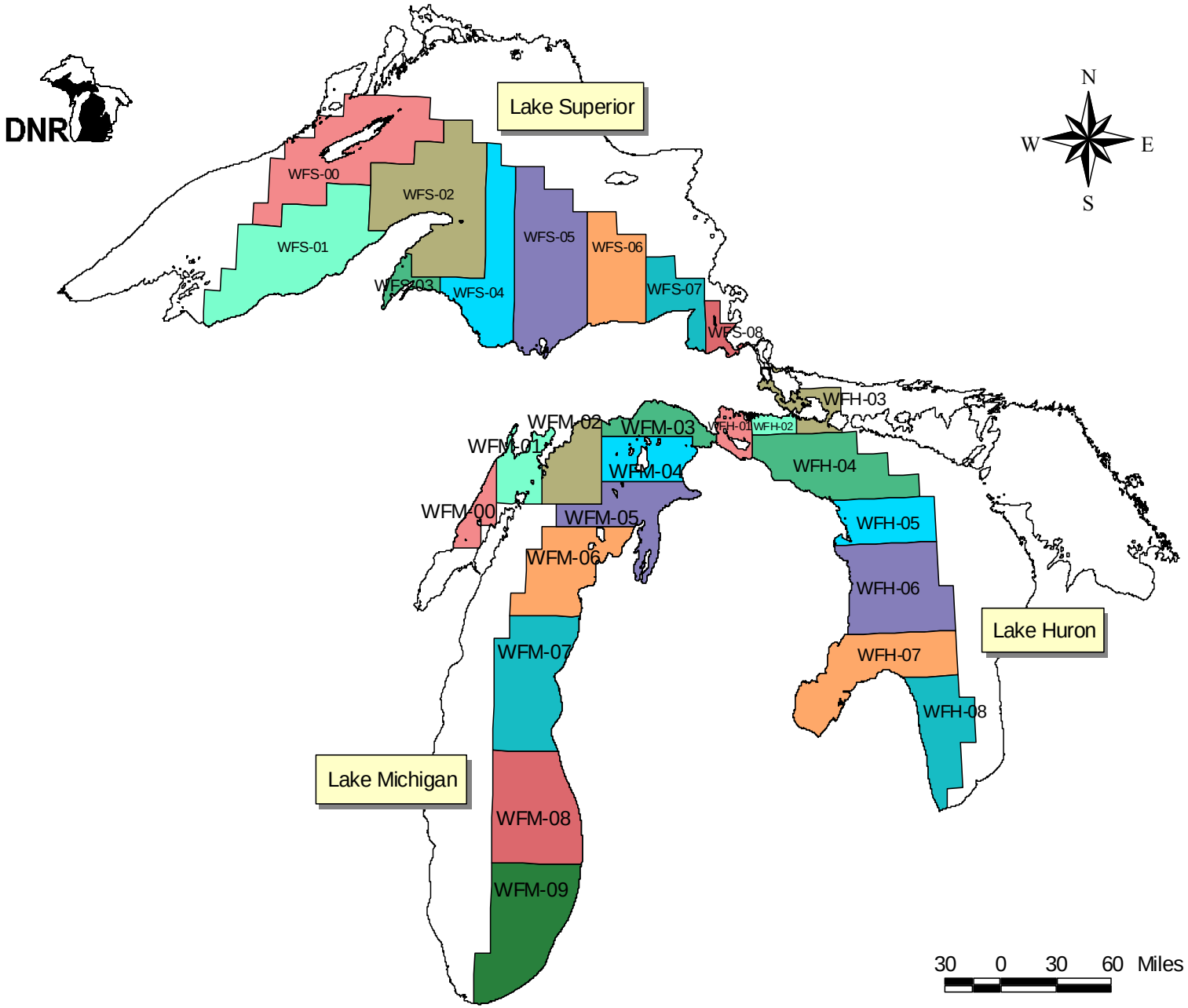


Mortality rates have been relatively stable throughout the time series. Instantaneous total mortality rate (Z) was estimated at 0.39 y^{-1} during 2006. Components of the total rate consisted of 0.09 y^{-1} for instantaneous trap-net fishing mortality (F) and 0.30 y^{-1} for instantaneous natural mortality (M). Estimates of mortality have been very consistent from 1985-2005 and the ratio of F to Z averaged 0.36 from 1985 through 2006.

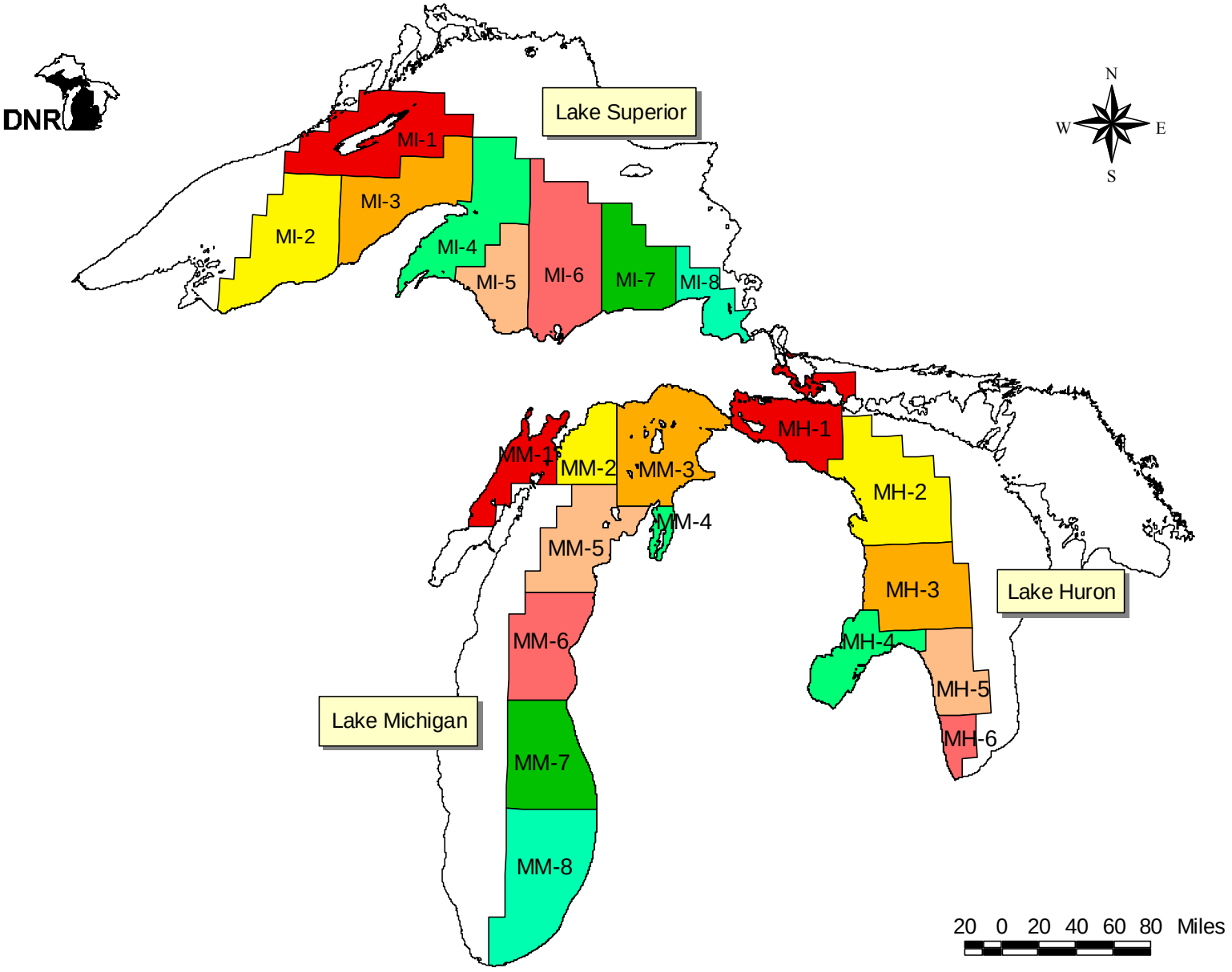


The 2008 yield limit for WFM-08 was 1.335 million lb, calculated using the projection model. This projected yield is close to the limit calculated for 2007 (1.131 million lb).

Summary Status WFM-08 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	0.97 lb
Age at first spawning	3 y
Size at 50% maturity	1.99 lb
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	3.39 lb (3.35 – 3.42)
Current SSBR	2.46 lb (2.27 – 2.51)
SSBR at target mortality	0.47 lb (0.43 – 0.49)
Spawning potential reduction	
At target mortality	0.72 (0.70 – 0.75)
Average yield per recruit	0.42 lb (0.40 – 0.49)
Natural mortality (M)	0.301 y^{-1}
Fishing mortality rates	
Age of full selection	
Fully selected age to gill nets	N/A
Fully selected age to trap nets	11 y
Gill net fishing mortality (F)	
Average 2004-2006, ages 4+	0 y^{-1}
Trap net fishing mortality (F)	
Average 2004-2006, ages 4+	0.073 y^{-1} (0.05 – 0.09)
Sea lamprey mortality (ML)	
(average 2004-2006, ages 4+)	N/A
Total mortality (Z)	
(average 2004-2006, ages 4+)	0.374 y^{-1} (0.36 – 0.39)
Recruitment (age 3)	
(average 1997-2006)	674,140 fish (550,156 – 722,136)
Biomass (age 3+)	
(average 1997-2006)	3,338,000 lb (2,890,940 – 3,534,850)
Spawning biomass	
(average 1997-2006)	3,011,600 lb (2,757,170 – 3,283,100)
Recommended yield limit in 2008	1,335,000 lb
Actual yield limit in 2008	1,335,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.