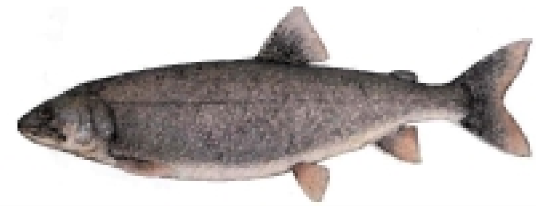
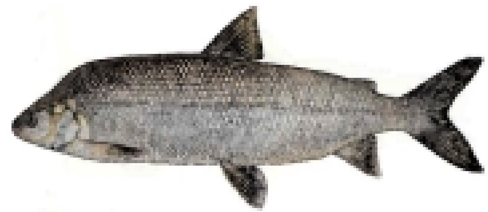
Technical Fisheries Committee Administrative Report 2004: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2003, with recommended yield and effort levels for 2004





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

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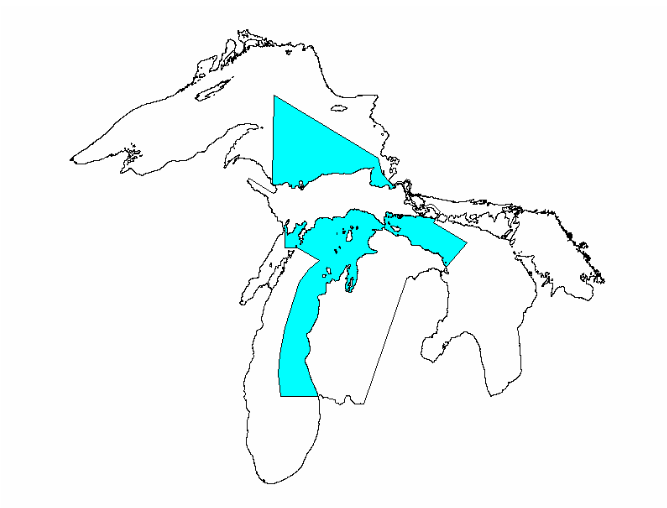

May 2005

Recommended Citation formats.

Entire report: Modeling Subcommittee, Technical Fisheries Committee. 2005. Technical Fisheries Committee Administrative Report 2004: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2003, with recommended yield and effort levels for 2004.

Section: Woldt, A.P., Bence, J.R., and Ebener, M.P. 2005. Executive Summary in Woldt, A.P., Sitar, S.P., Bence, J.R., and Ebener, M.P. (eds.). Technical Fisheries Committee Administrative Report 2004: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2003, with recommended yield and effort levels for 2004.

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EXECUTIVE SUMMARY

Prepared by Aaron P. Woldt, James R. Bence, and Mark P. Ebener

In August 2000 the State of Michigan's Department of Natural Resources (MDNR), five tribes of the Chippewa/Ottawa Resource Authority (CORA), and United States Department of Interior's U.S. Fish and Wildlife Service negotiated an agreement (Consent Decree) to resolve issues of allocation, management, and regulation of fishing in 1836 Treaty waters of lakes Superior, Michigan, and Huron (U.S. v. Michigan 2000). The Consent Decree states that mortality of lake trout shall be regulated with yield and effort limits in 1836 Treaty-ceded waters. In management units where the state and tribes both have commercial whitefish fisheries, the mortality of whitefish shall be regulated with yield limits. The Consent Decree provides specific guidelines on how these yield and effort limits should be calculated. A Modeling Subcommittee (MSC) of the Technical Fisheries Committee (TFC) was established and charged with developing the yield and effort limits required in the Consent Decree.

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. Where feasible we 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. In two units the available data did not allow us to develop reliable population estimates in this way, and instead we have used a more descriptive approach. SCAA models resulted in estimates of abundance and mortality which were combined with growth and maturity data for whitefish and lake trout in each stock or management unit to project recommended yield levels (upper bounds) for calendar year 2004. Recommended yield limits were obtained by either limiting mortality to a maximum rate, achieving a minimum spawning potential reduction, or projecting harvest for a specified level of fishing effort. The maximum allowable mortality rate (*A*) on whitefish was 65%, while the maximum mortality rate on lake trout was either 40 or 45%. In some areas the mortality rate was not considered for lake trout, and yields were instead tied to levels of fishing effort as part of a process for "phasing in" total mortality rate targets as specified in the Consent Decree. The target spawning potential reduction for whitefish ranged from 20 to 35%. Harvest limits were allocated to State and CORA fisheries for each stock following the percentages specified in the Consent Decree.

The 2004 MSC recommended harvest and effort 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 harvest regulation guidelines (HRGs). Details are given in the text of reports for units where recommended and actual harvest limits differ. The two estimates marked with asterisks in the table below are based on 2006 fully phased in mortality rates and are included for comparison only.

Species	Lake	Management unit	MSC recommended yield limit (lb)	Actual yield limit (lb)	Gill net limit (ft)
Lake trout	Superior	MI-5	146,000	146,000	NA
		MI-6	78,800	78,800	5.14 million
		MI-7	148,000	148,000	8.23 million
	Huron	MH-1	181,200	181,200	11.05 million
		MH-2	144,300	144,300	NA
	Michigan	MM-1,2,3	*250,200	478,000	9.36 million
		MM-4	*62,500	125,000	1.03 million
		MM-5	98,100	98,100	0.35 million
		MM-6,7	432,000	432,200	NA
Lake whitefish	Superior	WFS-04	91,000	91,000	NA
		WFS-05	344,000	344,000	NA
		WFS-06	210,000	210,000	NA
		WFS-07	585,000	585,000	NA
		WFS-08	184,000	184,000	NA
	Huron	WFH-01	232,000	232,000	NA
		WFH-02	261,000	261,000	NA
		WFH-03	no estimate	305,500	NA
		WFH-04	343,000	518,000	NA
		WFH-05	1,076,000	1,076,000	NA
	Michigan	WFM-01	1,197,000	1,197,000	NA
		WFM-02	520,000	520,000	NA
		WFM-03	1,938,000	1,938,000	NA
		WFM-04	752,000	752,000	NA
		WFM-05	268,000	268,000	NA
		WFM-06	355,000	355,000	NA
		WFM-07	no estimate	500,000	NA
		WFM-08	1,414,000	1,414,000	NA

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). In MI-6 and MI-7 siscowet and lean yield are combined in commercial catch reports, thus allowable total yield (leans and siscowets) can exceed the values in the above table by 21% and 41% respectively. In MI-6 recent mortality rates have been below target, and recreational harvest was below the harvest limit in 2003. This result was primarily due to a reduction from a 3 fish daily bag limit to a 2 fish daily bag limit in 2003 even though size limits were liberalized slightly. Stricter size limits with a 3 fish daily bag limit in 2001 and 2002 did not significantly lower recreational harvest and keep it below the harvest limit, indicating population size may be larger than the model predicts in MI-6. Stability of the MI-6 model was increased by borrowing catchability parameters for the large-mesh survey in MI-5 due to lack of survey data in MI-6. In MI-5 and MI-7 recent mortality rates have been well 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. There has been a general decline in size-at-age of lake trout across Lake Superior over the past 20 years, and tied to this is a shift toward later maturity. These changes in growth and maturation probably reflect increases in predator fish abundance and declines in the abundance of prey fish, most of which are less abundant than 20 years ago. Competitive effects of siscowet lake trout may also play a role.

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. In MH-1 lake trout mortality rates are below target rates for the first time under the 2000 Consent Decree, and in MH-2 mortality rates are again below target rates. Reductions in fishing mortality resulting from reduced commercial effort and an effective size limit (slot limit) in the recreational fishery, coupled with sea lamprey control, should allow spawning stocks to continue to build in MH-1. A drastic decline in sea lamprey-induced mortality in MH-2 is the main reason total mortality remains below target in this area. 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.

In Lake Michigan, lake trout mortality rates are well below target rates in the southern most area, MM-6,7. Northern Lake Michigan unit MM-123 lake trout mortality rates have been near target rates. However, recent large increases in sea lamprey-induced mortality and the Consent Decree's requirement for phased in yield limits that allow harvest levels above target rates may result in higher mortality rates in the near term. In MM-4, mortality rates continue to be higher than the target rates. Recent decreases in commercial fishing effort and increases in the minimum size limit for the recreational fishery should help to achieve mortality targets. In MM-5, mortality rates have been less than the target rates indicating acceptable mortality levels.

A big concern for Lake Michigan is that unlike northern Lake Huron, sea lamprey-induced mortality is not declining in northern Lake Michigan. Researchers suspect that another stream(s) like the Manistique River may be producing large numbers of sea lamprey in northern Lake Michigan. It is hoped that treatment of the Manistique River will lead to reduced levels of sea lamprey-induced mortality in northern Lake Michigan.

In general, fishery exploitation in recent years has not been excessive on lake whitefish stocks. However even though size at age stabilized for many stocks in 2002, it has declined for most stocks over the past two decades. In a number of stocks this 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. Many stocks also experienced a decline in recruitment near the end of the time series used in the assessments, although recruitment levels seemed to stabilize for many stocks in 2002. Again this pattern was most prevalent in Lake Michigan and Lake Huron. In 2004 WFH-03 and WFH-04 HRGs were set based on average recent yield levels. Mortality is currently below target for all whitefish units, but if harvest is maintained at recent levels in the face of declining or stable but low recruitment and growth, mortality rates may become excessive and decrease population abundance. In addition, widespread declines in growth rates of lake whitefish are a concern, and further research on this is important for supporting management strategies. A summary report is included for WFM-07, but modeling efforts to describe this stock currently have little utility for estimating allowable harvest due to lack of data. This area was not fished commercially between 1985 and 2000. Since 2001, there has been a small amount of tribal commercial harvest in WFM-07 by the Little River Band of Ottawa Indians. In 2004 the WFM-07 HRG was based on the approximate average of the 2004 model generated harvest limit for WFM-06 and WFM-08.

In addition to providing assessments for each stock, we also provide recommendations to the TFC to improve data collection and to improve the SCAA models. These recommendations include 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 curves, refining our methods of estimating lake trout recruitment, and developing methods of estimating time-varying catchability. The implementation of all these recommendations will take several years and will involve a significant and increased investment in staff, time, and other resources. The MSC has made significant progress this year in dealing with under-reporting in the commercial fisheries, estimating throwbacks in the commercial fishery where appropriate (e.g. MH-1), measuring and adding hooking mortalities from the recreational fishery into the models as harvest, conducting fishery-independent lake whitefish surveys, performing sensitivity analyses of stock assessment models, and launching studies in lakes Huron and Michigan to assess lake whitefish stock boundaries and movement.

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. Past TFC approved use of projected commercial fishery yield for the last few months of the year based on historic patterns of the yield has helped the MSC meet deadlines, but more is needed. The MSC will ask the TFC to consider a proposal for rotation of lake trout stock assessment models. Under this plan, the MSC would rotate updates of stock assessment models by lake on a 3 year cycle. We would still produce harvest limits for each unit in each year, but the stock assessment models would only be updated once every 3 years and annual harvest limits would be based on multiyear projections in 2 of 3 years. The time savings from not annually updating all stock assessment models could be used to make improvements to models, verify model performance, and conduct adequate model diagnostics. The proposed rotation techniques might also result in more stable harvest limit estimates from year to year.

We also want to urge parties to meet Consent Decree mandated data submission deadlines. Some parties have repeatedly missed data deadlines in the past. Doing so makes it nearly impossible for the MSC to provide yield and effort limits to the TFC and the parties by already short Consent Decree deadlines.

STOCK ASSESSMENT MODELS

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

Overview

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 2004 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-age model was fit to available data. Each model consisted of two components. The first was a submodel that described the population dynamics of the stock. The second was a submodel 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 submodels 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 submodel

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.

Sea lamprey mortality rates were not estimated during model fitting. Instead they were calculated based on observed wounding (sum of A1-A3 marks), as was done by Sitar et al. (1999). For a given size of lake trout, sea lamprey mortality was calculated by:

$$ML = w\frac{(1-p)}{p}$$

where w was the mean wounds per fish and p was an estimate of the probability of surviving an attack. Length-specific wounding rates were converted to age-specific rates using an age-length key.

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 in the 2003 harvest limit year stock assessments. 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:

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

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 1980-2002 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 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 a probability of survival of 0.25 from 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, with deviations from recruitment expected based on a Ricker stock-recruit function (with parameters estimated during model fitting) being 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 submodel

The observation submodel 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 not already needed for the population submodel 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 submodel.

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 2004 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 2004 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2004, 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. Although this was calculated as the average rate in recent years in most of the projection sheets, 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 2004, but did not in 2004, 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 2004

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-5, 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-5 the target mortality rate was 45% and the allocation was 60% state and 40% tribal. In MM-67 the target mortality rate was 40% and the allocation was 90% state, 10% tribal. In MH-1, the interim target mortality was 47%, and the allocation was 8% state and 92% 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 portion of the reported yields. 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. Thus total yield can be 121% and 141% of the recommended yield limits for lean lake trout that we table. (Note that the harvest and survey data were adjusted so it reflected only lean, wild fish before they were compared with model predictions.)

The TAC for MM-4 was calculated under a phase-in of effort guidelines for commercial effort, recreational regulations, and associated harvest limits. The base period for commercial effort was 1997-1999. Hence we adjusted the average commercial fishing mortality rates during that period by multiplying them by the proportion of 1997-1999 large-mesh gill net effort that was remaining after conversion of gill net fishers to trap nets. Recreational effort was the average of 2001-2003 values, adjusted for any change in size limits. In 2003 the recreational size limit increased from 20” to 22”. Commercial TACs were based on predicted kill**.** The estimated allowable commercial yield was greater than the 20% change allowed in the Consent Decree, and the TFC agreed to accept the higher estimated TAC.

TAC calculations for MM-123 were more complicated than for other areas because of special provisions in the Consent Decree. Potential TACs were calculated two ways. First, TACs were calculated assuming that target mortality rates and allocation were fully phased in (40% mortality, allocation 10% state: 90% tribal). Second, TACs were calculated using a phase-in approach that is based on the previous years’ harvest, less the reduction in lake trout harvest projected from gill net reductions. Then, the larger of the tribal TACs among these two options was chosen. The state TAC was estimated as though the model were fully phased-in. Thus for the second option we followed the same approach as we used in other areas (i.e., based on 2001-2003 effort and any regulation changes). The phase-in approach was guided by the Consent Decree's requirement that the tribal TAC be set to the 1997-1999 harvest adjusted for any change in effort. We did this by first calculating a 2004 yield based on no-conversion of gear (1997-1999 effort) and then calculating taking into account the proportion of large-mesh gill net that was converted (as for phase-in rules in other areas).

TAC estimates for fully phased-in units MI-5, MI-6, MI-7 and MH-2 were calculated as per the consent decree. The 2004 TACs for all 4 management units increased by more than 15% compared to the 2003 TACs. The TFC agreed to accept the higher estimated TACs for all 4 units in 2004.

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 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.

References cited:

Bence, J.R. 2002. Stock Assessment Models *in* Bence J.R. and Ebener, M.P. (eds.). Summary Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2000, with recommended yield and effort levels for 2001. Technical Fisheries Committee, 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan.

Pauly, D. 1980. On the interrelationships between natural mortality, growth-parameters, and mean environmental-temperature in 175 fish stocks. *Journal du Conseil 39*: 175-192.

Sitar, S.P., Bence, J.R., Johnson, J.E., Ebener, M.P., Taylor, W.W. 1999. Lake trout mortality and abundance in southern Lake Huron. *N. Am. J. Fish. Manage*. 19: 881-900.

Spangler, G.R., Robson, D.S., and Reiger, H.A. 1980. Estimates of lamprey-induced mortality in whitefish, *Coregonus clupeaformis*. *Can. J. Fish. Aquat. Sci.* 37:2146-2150.

RECOMMENDATIONS AND FUTURE DIRECTIONS TO IMPROVE ASSESSMENTS

Prepared by Aaron P. Woldt, James R. Bence, and Mark P. Ebener

The MSC annually revises its list of recommendations to improve stock assessments. The revised list reflects improvements made since the assessments used to determine 2003 harvest limits, ongoing work to address assessment needs, and a prioritized ranking (HIGH, MEDIUM, LOW) of recommendations.

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. The MSC assigned a HIGH priority to determining the following:

    i. the significance of subsistence fishery harvests

    Tribes have made strides in tracking this harvest, but more work is needed to better quantify this harvest for inclusion in models.

    ii. the extent of discarding by commercial fisheries

    In 2002, CORA submitted a study plan to the TFC for calculating the number of lake trout discards in the commercial fishery in MH1. This plan could be used for other management units where necessary.

    iii. the significance of recreational fishing for lake whitefish

    In 2002, Michigan compiled data showing yearly recreational harvest of lake whitefish in Treaty waters. After reviewing these data, the MSC determined that harvest was large enough in WFH03, WFM05, WFS05, and WFS06 to include in assessment models. At the MSC's request, the state of Michigan planned winter creel surveys in some of the above units to estimate lake whitefish harvest in the ice fishery. Continued assessment is needed.

    iv. the magnitude of recreational catch and release and associated hooking mortality

    The state of Michigan creel program now 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. Once implemented, this study design will allow the MSC to better estimate a hooking mortality rate. Currently the models use a rate of 15% based on Loftus (1986).

- 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 new tagging studies designed as needed. The MSC assigned a HIGH priority to this recommendation.

  Two basin-wide lake whitefish tagging studies in lakes Michigan and Huron began in 2003 and will help yield estimates of *M*.

- 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. The MSC assigned a HIGH priority to this recommendation.

  Two basin-wide lake whitefish tagging studies in lakes Michigan and Huron began in 2003 and will help delineate lake whitefish stock boundaries.

- The lake whitefish models continue to need “indices of abundance” based on fishery independent survey data. The MSC developed a sampling protocol for lake whitefish that was implemented on all lakes in 2002. Conducting this survey and incorporating its results into the lake whitefish models continues to be a HIGH priority for the MSC.

- Improved approaches for estimating the most recent year's lake trout yield need to be investigated. At the time assessment models are constructed, final yearly harvest estimates are not available because commercial catch reports have not all been turned in. In 2002, CORA began providing the MSC with projected year end lake trout harvest for the most recent year based on patterns in historic harvest data. The reliability of this approach needs to be evaluated. The MSC assigned a HIGH priority to this recommendation.

  Both CORA and Michigan are exploring ways to speed up the processing of commercial catch reports.

- Currently lake trout relative abundance indices (CPUE) used in SCAA models are pre-processed outside the models using mixed-model analysis. The assumptions underlying these mixed-models need to be reviewed and improvements made when appropriate. The MSC assigned a MEDIUM priority to this recommendation.

  A graduate student at Michigan State University (MSU) is currently exploring this issue.

- Estimates of uncertainty for all data used in models should be estimated when possible. The MSC assigned a MEDIUM priority to this recommendation.

- 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. The validity of this assumption needs to be assessed. The MSC assigned a LOW priority to this recommendation.

Models

- The overall approach in the SCAA models to estimate fishery selectivity needs to be evaluated, and alternative approaches should be considered. Currently the models use either a single or double logistic function of age. Alternative age-specific functions should be considered. Furthermore, some of the SCAA models have time-varying selectivity by assuming that one of the selectivity parameters varies over time following a polynomial function. Alternative approaches (such as using a random walk for this variation) should be evaluated. The MSC assigned a MEDIUM priority to this recommendation.

  A graduate student at MSU is currently exploring this issue.

- The assumption that fishery and survey catchability is constant in the SCAA models needs to be evaluated. Alternatives include allowing catchability to vary over time following a random walk or in response to population density. The MSC assigned a MEDIUM priority to this recommendation.

  A graduate student at MSU is currently exploring this issue

- Alternative approaches to weighting likelihood components needs to be reviewed. It is possible that some weighting factors could be improved using other statistical approaches. The MSC assigned a MEDIUM priority to this recommendation.

  A graduate student at MSU is currently exploring this issue

- Current approaches to modeling and estimating recruitment need to be reviewed. The MSC assigned a MEDIUM priority to this recommendation.

- Current harvest policies and possible alternatives should be evaluated using stochastic simulations that use information from the SCAA assessment models and from published and unpublished studies. The MSC assigned a MEDIUM priority to this recommendation.

- The procedures to convert fishery yield to numbers of fish harvested for comparison with SCAA model predictions needs to be reviewed. The current approach is to divide annual reported fishery yield by the annual average weight of a harvested fish. The average weight of a harvested fish is poorly estimated in some years. An alternative is to convert predicted numbers harvested to yield based on weight-at-age data, which may be a better estimate. The MSC assigned a MEDIUM priority to this recommendation.

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. The MSC moved this date to February 15 to allow additional time to run the SCAA models and calculate harvest limits. The MSC also set the second full week in March for its 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 - Currently CORA and the State cannot be ready by February 15. These numbers need to be made available in a more timely and accurate fashion.

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

2. Biological data-commercial:
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.

3. Biological data-recreational:
These data can be available by February 15. Occasionally Lake Superior data 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. We will use a general linear model to estimate CPUE.

    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 can 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. The MSC moved this deadline to September 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. The MSC also set the third full week in September for its 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

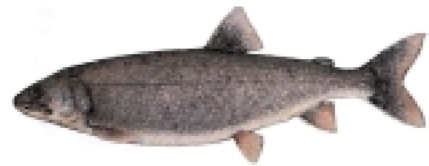
- The MSC recommends that in addition to this status of the stocks report (termed short report), a second report for the 2001 assessments be written that documents and describes in detail the modeling methods used (termed long report). The 2001 long report is currently being written. We recommend the short report be produced annually and include text describing any changes in the modeling process for a given management unit and species. The long report will be produced periodically following substantial changes in methods used to produce harvest limits.

- The MSC is concerned about the short time frame between data availability and the deadline for lake trout harvest limits. The time period between the data submission deadline and the deadline for preliminary harvest limits is too narrow to allow sufficient model analysis, diagnostics of model convergence, and estimation of harvest limits. 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.

- The lake whitefish models need to be updated annually. It would be more efficient if the date by which the results were due was moved forward to March 31, to correspond with the lake trout deadline (e.g. harvest limits based on 2002 data would be reported on March 31, 2004 instead of November 1, 2003).

- Age composition and commercial yield are the data that generally limit producing timely results. Above we have suggested an approach for providing commercial yield data sooner. In some areas age compositions may not be available when harvest limit calculations begin; we recommend proceeding without the most recent year's data in these cases.

STATUS OF LAKE TROUT POPULATIONS



Lake Superior

MI-5 (Marquette - Big Bay)

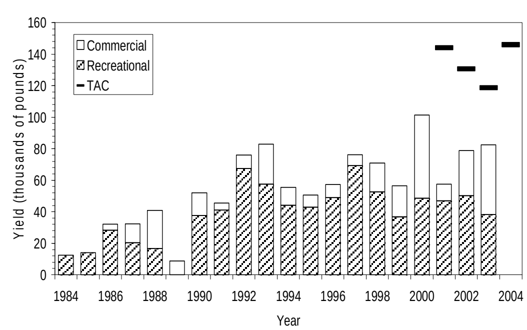
Prepared by Shawn P. Sitar and John K. Netto

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 depths down past 780 feet, and with 186,811 acres shallower than 240 feet.

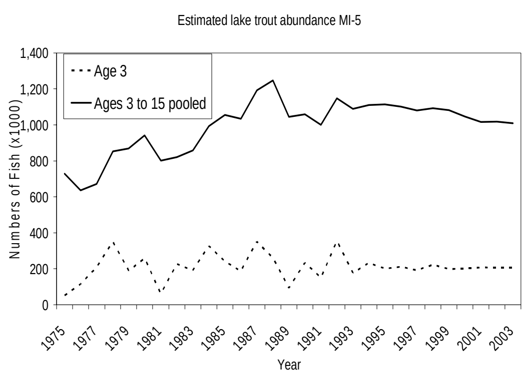
The only tribal commercial fishery is a large-mesh gill net fishery that is centered around Marquette and Big Bay in 1842 Treaty waters. This fishery mainly targets lake whitefish with lake trout as bycatch. However, lake trout have been targeted near spawning reefs in Marquette during recent fall fisheries. 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 1999 to 2003, tribal yield averaged 27,800 round lb and tribal large-mesh gill net effort averaged 444,000 ft per year. Generally, the fishery is conducted from late winter through early October, with a dome shaped age composition with peak age between age 7 and 10. However, in 2000 and 2003, the commercial fishers were allowed to harvest during the lake trout spawning season through the end of October. During these two years, nearly 50% of the annual yield was attained during October with the age composition of harvest skewed right with peak age being 15 years or older.

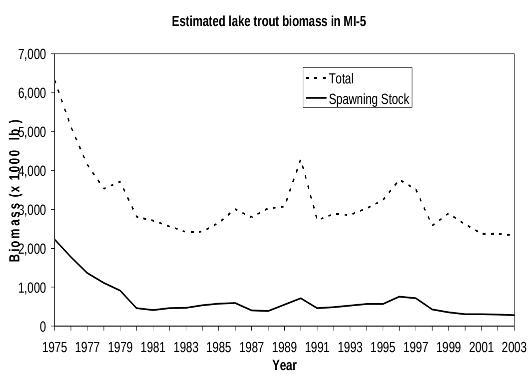
Recreational harvest of lake trout comprises both charter and sport angler fisheries. Most of this activity is centered around the port of Marquette, though some lake trout are harvested at Stannard Rock. There are no seasonal restrictions on the sport fishery, though most of the fishery occurs during 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 averaged 12,700 fish (45,000 lb) per year during the last three years. Recreational effort has declined from 146,000 angler hours in 1986 to 45,600 angler hours in 2003.

Commercial and recreational fishery lake trout harvest and TAC MI-5



Abundance of age-3 and older wild lake trout increased nearly two-fold since 1975 and has recently declined from a peaked of about 1.3 million fish in 1988. Total biomass of age-3 and older lake trout averaged 2.9 million lb during 1994-2003. Lake trout biomass declined from 4.3 million lb in 1990 to 2.3 million lb in 2003. Spawning stock biomass averaged 460,000 lb during 1994 to 2003. Although lake trout abundance has increased since the mid-1970s, spawning stock biomass has declined due to significant decreases in growth. This is likely to continue with declines in growth and increases in mortality rates.





Aside from background natural mortality, sea lamprey-induced mortality was the dominant mortality source during 1975 to 2003, although mortality from this source has declined since the mid-1980s. With the exception 2000, recreational fishing mortality has been higher than commercial fishing mortality since 1986. Average total annual mortality (A) for age 6 to11 lake trout has declined from 39% during 1975 to 1977 to 31% during 2001 to 2003. Spawning stock biomass produced per recruit during 2001 to 2003 has been above the target value indicating that mortality rates are not excessive and there is good population reproductive potential.

Notable stock dynamics

As in the fall of 2000, the 2003 tribal commercial fishery was allowed to harvest lake trout during the spawning season until the end of October and more than 50% of the annual lake trout yield was during this fall season. In all other years, there was a seasonal closure during the lake trout spawning season. The age composition during the years with the spawning season closed to fishing was typically dome shaped peaking between age 6 and 10. During 2000 and 2003, the age composition was bimodal with peaks at younger ages and then at the age 15+ group, indicating significant harvest of old fish (age 15 and older).

Model changes

There were about 15 versions of the MI-5 model run this year with varying degrees of changes from the 2003 Stock assessment model. A major change in the data was to set the under-reporting of tribal commercial yield to zero based on MSC/TFC decisions from the previous year. Although sport fishery hooking deaths was to be estimated through direct creel estimates of released fish, data and logistical problems were encountered which caused the sport releases to be assumed to be 35% of total harvest (decided by MSC on 17 March 04).

Major changes in model assumptions from the 2003 model included:

- Not estimating the starting abundance for ages 8-15 as individual parameters; and using a type 1 survivorship function to decay the abundance from age 7 to 15 based on the model's estimated Z for age-9 in the next year (fyear+1). This reduced the number of 'loose' parameters estimated in the model. Based on previous model versions, the model generally could not estimate these starting abundances because the lack of data on old fish in the early part of the model time series. The starting abundances for ages 4 to 7 were still estimated as formal model parameters.
- The pre-recruit survey selectivity was assumed to be constant (not time-varying). This was based on repeated large gradient components and standard errors on the time varying parameters. The observed age compositions do not have strong trends over time, this may be because declines in growth are not occurring or are less apparent in the younger lake trout.
- Selectivity for the recreational fishery and surveys were assumed constant in last 3 years of model. This was not done for the commercial fishery because of the major change in fishery selectivity/age composition in 2003.
- Two commercial fishery selectivity functions were estimated to match the major change in age composition in 2003 and 2000. A time-varying double logistic function was used to estimate the selectivity for the typical fishery with the dome at younger ages for the time period before 2000. A single logistic function was used to estimate selectivity for both 2000 and 2003 (both years assumed to have same selectivity). Based on early model runs with large standard errors on the inflection parameter (P1) for the single logistic; this parameter was assumed equal to the double logistic P1 parameter estimate. Thereby, making the model only estimate one additional parameter to estimate selectivity for 2000 and 2003. Selectivity in 2001 and 2002 was assumed equal to the selectivity for 1999.
- The pre-recruit survey selectivity parameter bounds were tightened which significantly stabilized the model's approach to convergence and reduced the gradient components and standard errors on these parameters. This is probably the major factor resulting in acceptable MCMC (Markhov Chain Monte Carlo) output.
- Recreational fishery discards (throwbacks, release mortality, hooking deaths) were integrated into the model's use of total recreational harvest. Sport releases were assumed to be 35% of 2003 harvest and discard mortality was assumed to be 15%.

A retrospective comparison was performed on a single version of the MI-5 model that was similar to the 2003

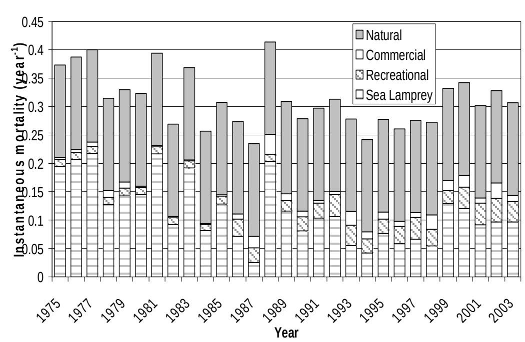
SCAA model. There were no systematic retrospective patterns observed in the model's estimates of total abundance, which converged towards the beginning of the time series modeled. The final 2004 model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. No major patterns in residuals were observed for fit to observed data sources. The MCMC simulations yielded good results with no problems with autocorrelation and no drift in the trace plots for all variables evaluated.

The 2004 SCAA model departs from previous stock assessment models in predictions of abundance in the late 1990s through 2003. The previous models indicate a steep decline in abundance, likely driven by observed declines in spring survey CPUEs from 2000 to 2003. Graded mesh survey CPUE'S have indicated an increasing trend in abundance in recent years, and the previous SCAA models predicted a significant decline in recruitment (see below). Thought still under-predicted, the current model's estimates better match the graded mesh survey CPUE data than the 2003 SCAA model.

Retrospective comparison of all stock assessment models for MI-5

The recommended yield limit for 1836 Treaty waters was 146,000 lb, allocated as 138,700 lb for the state recreational fishery and 7,300 lb for the tribal fishery. This recommended yield limit is 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 compose more than 90% of the total yield. The recommended limit is higher than recent yields in 1836 Treaty waters (e.g., an average of 73,000 lb during 2001-2003), producing recent mortality rates have been well below target rates.

Instantaneous mortality rates for lake trout ages 6-11 in MI-5



Summary Status MI-5 Lake Trout	**Value (95% probability interval)**
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	4.435 lb (3.563-5.587)
Current SSBR	1.27 lb (1.056-1.573)
SSBR at target mortality	0.382 lb (0.358-0.408)
Spawning potential reduction	
At target mortality	0.287 (0.254-0.324)
Average yield per recruit	0.464 lb (0.350-0.568)
Natural Mortality (M)	0.163 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2001-2003)	15
Age of full selection	
Sport fishery (2001-2003)	9
Commercial Fishing mortality (F)	
(average 2001-2003, ages 6-11)	0.015 y^{-1} (0.011-0.0211)
Sport fishery F	
(average 2001-2003, ages 6-11)	0.039 y^{-1} (0.028-0.052)
Sea lamprey mortality (ML)	
(average ages 6-11,2001-2003)	0.079 y^{-1}
Total mortality (Z)	
(average ages 6-11,2001-2003)	0.296 y^{-1} (0.274-0.319)
Recruitment (age-3)	
(1994-2003 average)	208,070 fish (156,401-291,770)
Biomass (age 3+)	
(1994-2003 average)	2,870,700 lb (2,377,260-3,813,850)
Spawning biomass	
(1994-2003 average)	457,430 lb (380,784-621,884)
MSC recommended yield limit for 2004	146,000 lb
Actual yield limit for 2004	146,000 lb

MI-6 (Au Train - Munising)

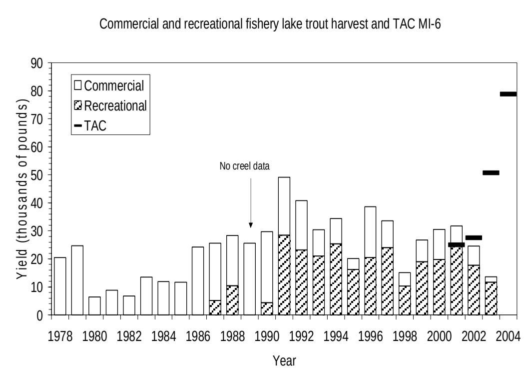
Prepared by Shawn P. Sitar and John K. Netto

Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 1.8 million acres. This management unit includes Big Reef, an offshore reef complex about 20 mi northeast of Munising. This management unit contains the deepest waters of Lake Superior with soundings deeper than 1,400 ft, and only 185,000 acres of the total area is shallower than 240 ft.

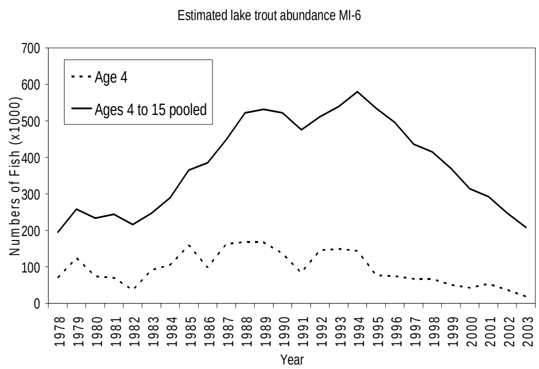
The commercial fishery that harvests lake trout is a tribal large-mesh gill net fishery that is centered east of Grand Island. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout peaked in 1989 at 25,600 lb and declined to an average of 5,100 lb during 2001 to 2003. In addition to wild lean lake trout the tribal fishery also harvests siscowet and hatchery lake trout. In recent years wild lean lake trout composed over 75% of total lake trout commercial yield, with 21% siscowet and 4% hatchery fish. Tribal large-mesh gill net effort decreased from a peak of 4.2 million ft in 1983 to 422,000 ft in 2002. The average commercial effort during 2001 to 2003 was 720,000 ft.

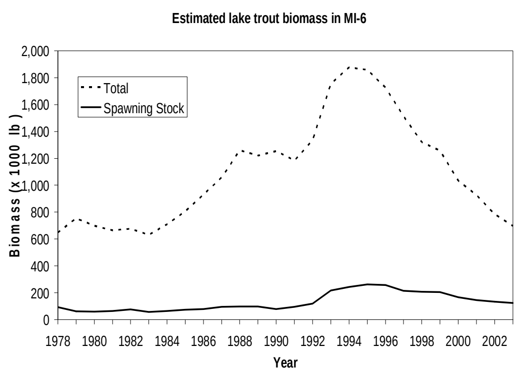
Recreational harvest of lake trout comprises fish caught by both charter and sport angler trolling. Most of the recreational harvest was from the Au Train Bay and Grand Island areas, although some harvest was also from Big Reef. Recreational harvest of wild lake trout has increased from 970 fish in 1987 to 5,400 fish in 2002 and averaged 4,700 fish per year during 2001 to 2003. In the last five years, wild fish composed 95% of the total recreational harvest of lean lake trout. The remainder was of hatchery origin. Recreational lake trout targeted effort has declined from 39,000 angler hours in 1993 to 20,600 angler hours in 2003.

The regulation in the recreational fishery was a minimum size of 10 inches and a daily creel limit of three fish prior to 2001. Anticipating that the recreational harvest may exceed the TAC in 2001, the minimum size limit shifted to 20 inches with the daily creel limit unchanged. Subsequently, regulations were changed because the state's TAC was exceeded in 2001 and 2002. In 2002, the size limit was changed to a slot of 10 to 25 in with one fish allowed over 34 inches, while the creel limit remained at 3 fish per day. Further changes were implemented in 2003 with the slot limit changing to 15 to 29 inches with one over 34 inches and the daily creel limit changing to 2 fish.



Abundance of age-4 and older wild lake trout declined from 579,000 fish in 1994 to 208,000 fish in 2003. Recruitment at age-4 has declined during 1994 to 2003 and averaged 63,000 fish during this period. The decline in abundance is related to increases in mortality rates starting in 1996 and declines observed in recruitment starting in 1995. Total biomass of age 4 and older lake trout has averaged 1.3 million lb during 1994 to 2003. Biomass has declined from 1.9 million lb in 1995 to 700,000 lb in 2003. Spawning stock biomass averaged 196,000 lb during 1994 to 2003 and represented 15% of total stock biomass older than age-3.





Excluding background natural mortality, sea lamprey predation was the highest mortality source for age 6 to 11 lake trout in MI-6. Recreational fishing mortality has been higher than commercial fishing mortality since 1991. During 1978 to 2002, total annual mortality (*A*) was the highest in 1979 at 56% and declined to 22% in 1993. Subsequently, *A* increased to an average of 29% during 2001 to 2003.

<u>Notable stock dynamics</u>

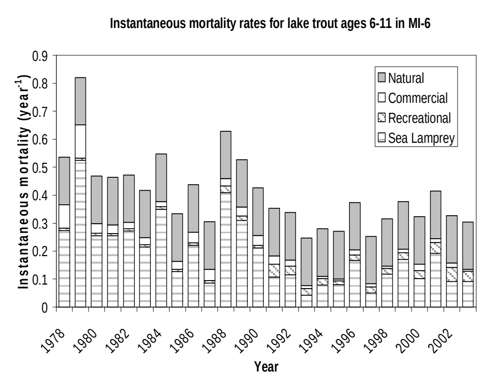
Due to penalties in the past few years, strict recreational fishery regulations have been imposed to reduce harvest. The regulation in 2003 was somewhat liberalized from 2002. The 2002 regulation for lake trout was a size limit 15 to 25 inches with a daily bag limit of three fish including one fish greater than 34 inches. The 2003 regulation was a size limit of 15 to 29 inches with a bag limit of two fish including one allowable over 34 inches. It appears that the bag limit had a significant effect in reducing harvest. The size limit regulations in previous years did not reduce harvest as anticipated, whereas harvest under the bag limit of two fish reduced harvest by 33.6% from 2002. Effort in 2003 only decreased 9.5% from 2002, likely indicating that harvest declined because of the bag limit reduction by one third. Based on reviewing creel data from the late 1990s, the proportion of angler parties attaining their daily maximum bag limit of lake trout has been high in MI-6 when compared to other areas of the Great Lakes. Since the bag limit had a more significant effect on harvest in MI-6, whereas size limits did not reduce harvest, this supports the view that there are more lake trout than is estimated in the previous stock assessment models. Even with a significant constraint on the sport fishery with a narrow size limit of 15 to 25 inch fish that limits harvest to a narrow portion of the stock, the sport CPUE did not change. This likely indicates that there were more fish in the population than the model predicted for the age ranges that were allowed to be harvested with the 15 to 25 size limit regulation.

<u>Model changes</u>

A major change in the data was to set the under-reporting of tribal commercial yield to zero based on MSC/TFC decisions from the previous year. Although sport fishery hooking deaths was to be estimated through direct creel estimates of released fish, data and logistical problems were encountered which caused the sport releases to be assumed to be 35% of total harvest (decided by MSC on 17 March 04). This model has always had problems converging to a single solution and producing reasonable stock size estimates. In order to generate reasonable/stable estimates from this model in 2003 the catchability of the large-mesh survey in mi-6 was assumed to be equal to the catchability of the large-mesh survey in MI-5. With this additional constraint the model was able to converge to a stable solution. In 2004, we needed to keep this constraint in order to get the model to converge to a solution, although we tried several alternative models attempting to model the unit relying on data from within MI-6.

In the 2004 MI-6 model, a few slight modifications were made to the model and data. The time varying component of the graded mesh survey selectivity was moved to the descending limb and the slope parameter for the ascending limb was set to a constant and not estimated from within the model. The reason for both of these changes is that the selectivity for the survey peaks at an early age throughout the time series. So very few ages are influencing the ascending limb where we have several parameters. The model was not sensitive to the value used for the slope of the ascending limb because it has very little influence on the quantities fit to the data sources. Leaving it free floating caused "nuisance" problems because of the small influence and the small amount data available to estimate this parameter value. With these changes the model converged to the data well, including the graded mesh survey in later years where earlier versions had under estimated graded mesh survey CPUE near the end of the time series. We were also able to run an MCMC with results that looked good. No apparent stickiness was seen through the trace pots, and the distributions looked reasonable for biomass based quantities.

The recommended yield limit for 2004 is 78,800 lb of which 39,400 lb is allocated for state recreational yield and 39,400 lb for tribal commercial yield. While mortality rates apply only to wild lean trout, the yield limit applies to all lean trout. In calculating the limit the Modeling Subcommittee assumed that 5% of the yield would be hatchery fish. Since 2002, recreational releases of lake trout in MI-6 have been measured in the creel survey. Catch and release mortality was estimated by multiplying the creel survey estimates of released lake trout by 15%, which was based on the hooking mortality estimated by Loftus et al. (1988). Reported total recreational harvest included estimated harvest and hooking deaths. There were 650 lake trout released by anglers during 2002 and 196 in 2003.



Summary Status MI-6 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	2.35 lb
Age at First Spawning	6 y
Size at 50% maturity	4.35 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	4.593 lb (3.493-5.614)
Current SSBR	1.2 lb (0.954-1.458)
SSBR at target mortality	0.403 lb (0.377-0.423)
Spawning potential reduction	
At target mortality	0.261 (0.075-0.108)
Average yield per recruit	0.353 lb (0.244-0.431)
Natural Mortality (M)	0.170 y^{-1} (0.154-0.193)
Fishing Mortality	
Age of full selection Commercial Fishery (2001-2003)	7
Age of full selection Sport fishery (2001-2003)	8
Commercial Fishing mortality (F) (average 2001-2003, ages 6-11)	0.012 y^{-1} (0.008-0.016)
Sport fishery F (average 2001-2003, ages 6-11)	0.039 y^{-1} (0.025-0.051)
Sea lamprey mortality (ML) (average ages 6-11,2001-2003)	0.099 y^{-1}
Total mortality (Z) (average ages 6-11,2001-2003)	0.32 y^{-1} (0.295-0.348)
Recruitment (age-4) (1994-2003 average)	63,280 fish (54,052-90,401)
Biomass (age 4+) (1994-2003 average)	1,299,200 lb (1,093,150-1,902,080)
Spawning biomass (1994-2003 average)	196,040 lb (153,480-298,284)
MSC recommended yield limit for 2004	78,800 lb
Actual yield limit for 2004	78,800 lb

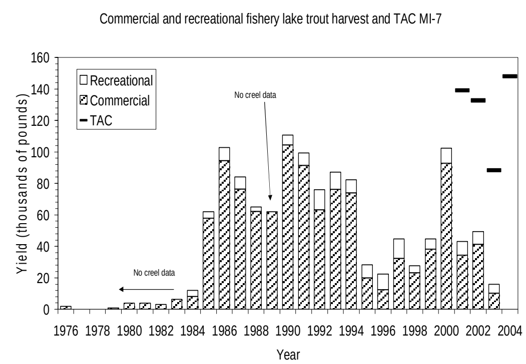
MI-7 (Grand Marais)

Prepared by Shawn P. Sitar and John K. Netto

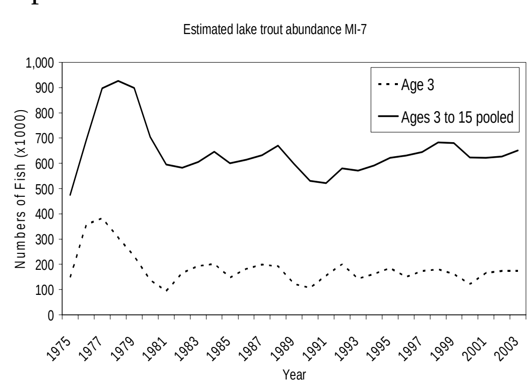
Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 987,000 acres. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There is approximately 92,000 acres of lean lake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

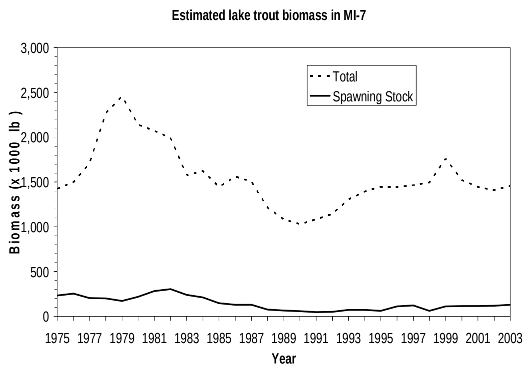
The commercial fishery that harvests lake trout is a tribal large-mesh gill net fishery that is mostly based out of Grand Marais. This fishery mainly targets lake whitefish with lake trout as bycatch. Between 1975 and 2003, tribal commercial yield of wild lake trout peaked in 1990 at 104,400 lb and declined to 12,400 lb in 1996. Subsequently, tribal yield increased to an average of 28,600 lb in the last three years. In recent years these yields of wild lean lake trout compose 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 2001 to 2003 has averaged 2.5 million ft.

The standardized creel survey began at Grand Marais in 2001. Sport harvest and effort in MI-7 for years prior to 2001 were estimated using the average sport CPUE and effort index ratio between MI-7 to MI-5 from MIDNR creel mail survey data 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 and somewhat questionable assumptions, hence there is much uncertainty regarding the true magnitude of the recreational harvest in MI-7 prior to 2001. However, the residuals between the ratio procedure estimates of harvest and actual creel survey estimates since 2001 were -16% (365 fish) in 2001, +3.1% (76 fish) in 2002, and +5.2% (76 fish) in 2003.



Abundance of age-3 and older wild lake trout averaged 640,000 fish during 1994 to 2003. Recruitment at age-3 averaged 139,000 fish during 1993 to 2002. Abundance has been increasing from a low of 522, 000 fish in 1991 to an average of 630,000 fish during 2001 to 2003. Spawning stock biomass averaged 102,700 lb during the last ten years and represented 7% of total stock biomass.





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 from 1990 to 1994. Commercial fishing mortality declined during 1995 to 1998, but has been increasing since 1998. During 1975 to 1979, total annual mortality (*A*) for age 6 to 11 lake trout averaged 44%. During the last five years, average *A* was 38%. The current spawning stock biomass per recruit (SSBR) estimate for MI-7 is above the target value, indicating that mortality rates are not exceeding the target.

<u>Notable stock dynamics</u>

Projected Commercial fishery yield was significantly lower than in 2002. This is likely due to reduced effort in MI-7 because the commercial fisher in MI-7 was also fishing in MI-6.

<u>Model changes</u>

There were five versions of this model run this year. A major change in the data was to set the under-reporting of tribal commercial yield to zero based on MSC/TFC decisions from the previous year. Although sport fishery hooking deaths was to be estimated through direct creel estimates of released fish, data and logistical problems were encountered which caused the sport releases to be assumed to be 35% of total harvest (decided by MSC on 17 March 04).

Major changes in model assumptions from the 2003 model included:

- The pre-recruit survey selectivity was assumed to be constant (not time-varying). This was based on large gradient components and standard errors on the time varying parameters. The observed age compositions do not have significant changes over time; this may be because declines in growth were not occurring or less apparent in the younger lake trout.
- The pre-recruit survey selectivity parameter bounds were tightened which significantly stabilized the model's approach to convergence and reduced the gradient components and standard errors on these parameters. This resulted in acceptable MCMC results.
- Other selectivity parameter bounds were also tightened
- Recreational fishery discards (throwbacks, release mortality, hooking deaths) were integrated into the model's use of total recreational harvest. Sport releases were assumed to be 35% of 2003 harvest and discard mortality was assumed to be 15%.
- There were problems with mixed model CPUE estimates because of zero catches; so there was pretty strong under-estimation of survey CPUE.
- Recreational age comps based on MI-6 creel data for 2000 and

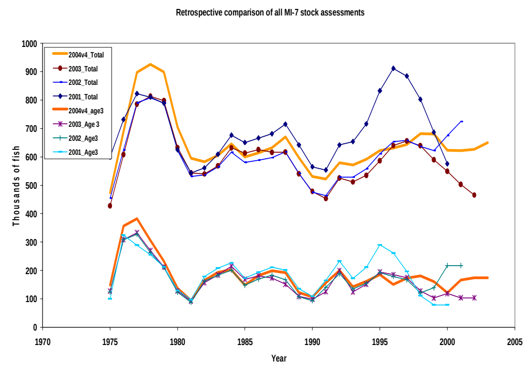
earlier as in pre-2002 SCAA models; recreational selectivity parameters were estimated in the model. The 2003 SCAA model assumed selectivity parameters from MI-6 model

- One of the time varying parameters for pre-recruit survey selectivity had to be turned off because of huge standard errors. This really stabilized model.
- Selectivity was assumed constant in last 3 years of model in 2004 model vs. estimating all years as in 2003 SCAA model.
- Fishing intensity dev. bounds were tightened

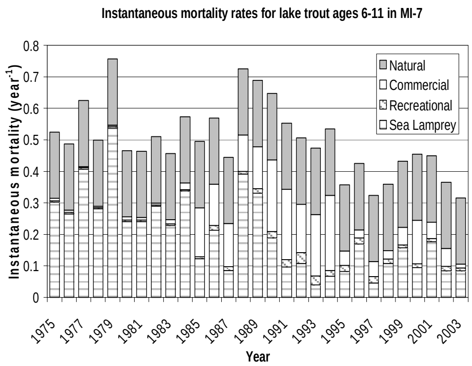
<u>Diagnostics and uncertainty</u>

The final 2004 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 with no problems with autocorrelation and no drift in the trace plots for all variables evaluated. There was a modest difference in the model's estimate of abundance during the last years of the model in comparison 2003 model (see below). The 2003 model indicated a steep decline in abundance: 23% decrease in total abundance from 1999 to 2002. The 2004 model does not show this much decline in abundance. The 2004 model's fit to survey CPUE, though not perfect, was improved from the 2003 SCAA model. There were no systematic patterns when comparing year 2000 abundance estimates from the past four stock assessments. However, there are major departures in abundance estimates for 2001 and 2002.

Assessment model Year	N_{2000} x1000 fish	% difference from 2001 assessment
2001	575.51	
2002	675.44	+17.4
2003	548.90	-4.6
2004	622.89	+8.2



The recommended yield limit for the year 2004 is 148,000 lb with 44,400 lb allocated for state recreational yield and 103,600 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 5% of the lean lake trout yield would be hatchery fish. The yield limit does not include siscowet lake trout so actual yields can exceed this limit by 41%, to allow for the portion of the yield that siscowet are expected to compose. The recommended total yield limit is higher than observed yields from recent years reflecting the fact that mortality rates have been below target limits.


Instantaneous mortality rates for lake trout ages 6-11 in MI-7
Instantaneous mortality (year^{-1})
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Natural
Commercial
Recreational
Sea Lamprey
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
Year

Summary Status MI-7 Lake Trout	Value (95% probability interval)
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	2.907 lb (2.20-3.72)
Current SSBR	0.86 lb (0.687-1.07)
SSBR at target mortality	0.419 lb (0.380-0.454)
Spawning potential reduction	
At target mortality	0.297 (0.246-0.352)
Average yield per recruit	0.289 lb (0.162-0.430)
Natural Mortality (M)	0.210 y^{-1}
Fishing Mortality	
Age of full selection Commercial Fishery (2001-2003)	13
Age of full selection Sport fishery (2001-2003)	9
Commercial Fishing mortality (F) (average 2001-2003, ages 6-11)	0.04 y^{-1} (0.021-0.065)
Sport fishery F (average 2001-2003, ages 6-11)	0.011 y^{-1} (0.006-0.017)
Sea lamprey mortality (ML) (average ages 6-11,2001-2003)	0.1 y^{-1}
Total mortality (Z) (average ages 6-11,2001-2003)	0.362 y^{-1} (0.334-0.394)
Recruitment (age-3) (1994-2003 average)	164,790 fish (109,560-302,530)
Biomass (age 3+) (1994-2003 average)	1,483,200 lb (1,078,080-2,572,090)
Spawning biomass (1994-2003 average)	102,700 lb (69,708-96,648)
MSC recommended yield limit for 2004	148,000 lb
Actual yield limit for 2004	148,000 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 Mackinaw 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 waters, covering 1,017,640 acres of which approximately 681,720 acres are less than 240 feet in depth. On the Michigan shore this unit encompasses the ports of 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 has supported large spawning runs of sea lamprey, and until the late 1990's 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 are being 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 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 YOY, increased CPUE's 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-1. From 1999 to 2003, approximately 380,000 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 2003, approximately 456,000 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 493,000 yearling lake trout recruits in MH-1 for 2003.

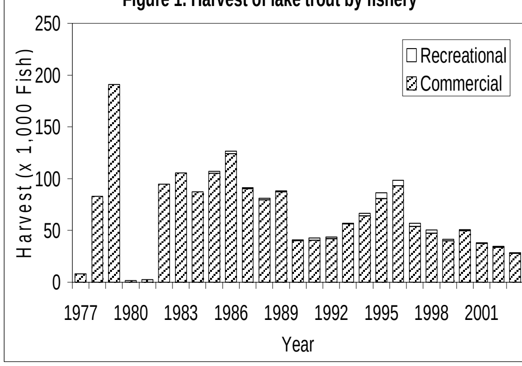
Both commercial and recreational lake trout fisheries exist in MH-1. Tribal commercial fishers deploy trap nets and large-mesh gill nets (4.5 inch stretch) that target lake whitefish and salmon, and small-mesh gill nets (2.5-3.0 inch stretch) that target bloater chubs. Lake trout are caught in these 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. Previous to August 2000 one state-licensed fisher, Gauthier and Spaulding Fisheries, 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.

Because there is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-1, although few lake trout have been stocked there, this region was included in the assessment model. 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 1999 to 2003, tribal commercial yield of lake trout averaged 103,000 lb, while Canadian commercial yield averaged 20,000 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, 2002 and 2003 tribal harvest 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 (91%) came from the large-mesh gill net fishery. Tribal large-mesh gill net effort averaged 9.1 million ft from 1999 to 2003, while Canadian large-mesh gill net effort averaged 1.9 million ft. With the implementation of the 2000 Consent Decree, tribal large-mesh gill net catch and effort is declining in MH-1. In 2003, large-mesh gill net harvest dropped by 37,000 lb from 2000, and large-mesh gill net effort dropped by 6.2 million feet (47%) from 2000.

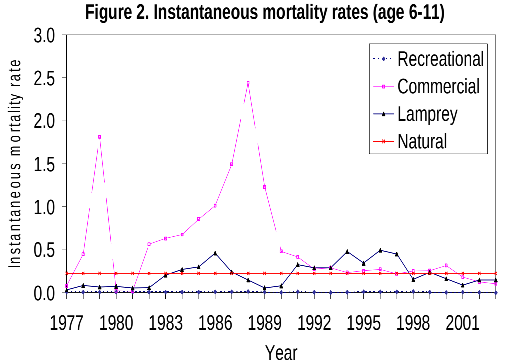
The state-licensed recreational fishery in MH-1 is composed of both charter and non-charter anglers. Lake trout are frequently caught as bycatch by salmon anglers trolling at or near the surface, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty waters. Recreational harvest represents a small portion of the total fishery harvest in MH-1 (Figure 1). From 1999 to 2003, recreational yield of lake trout averaged 2,900 lb. In 2003, recreational harvest was only 1,700 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” to 20” in areas north of 44° 50’ N latitude. Starting in 2003, the state of Michigan imposed a 15” to 19” slot limit in MH-1. All fish outside the slot must be released, except for one fish daily that may be 34” or larger. These new regulations are intended to keep harvest below the state share of the MH-1 harvest limit. Due to these more restrictive state regulations, 2003 state harvest includes an estimate of throwback mortality.

Figure 1. Harvest of lake trout by fishery



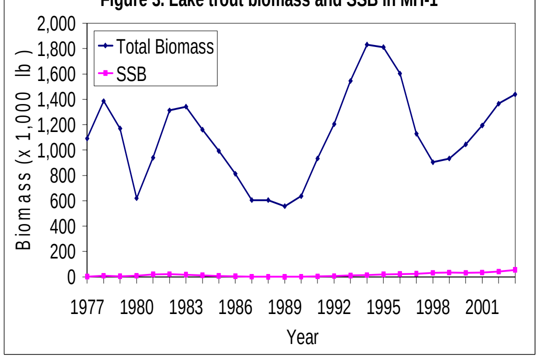
Instantaneous mortality rates have been variable and relatively high in northern Lake Huron (Figure 2). From 1977 to 1990, commercial fishing mortality was the leading source of lake trout mortality. After 1990, commercial fishing mortality decreased as sea lamprey-induced mortality increased. Sea lampreys were the largest source of lake trout mortality in the 1990s, until 1998 when sea lamprey-induced mortality decreased. From 1999 to 2003 sea lamprey-induced instantaneous mortality averaged 0.16 y^{-1}, and commercial fishing instantaneous mortality averaged 0.20 y^{-1}. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2003 decreased 61% from the average of 1994-1998 levels. This decline is likely 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).

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



Past 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 2000 total lake trout biomass and SSB have been steadily increasing. Much of this increase is due to lower rates of commercial and sea lamprey-induced mortality and increased stocking in MH-1. Total 2003 lake trout biomass was 1.44 million lb, well above the 20-year average of 1.11 million lb. However, total 2003 SSB was only 18,000 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



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 181,200 lb for MH-1 in 2004. This harvest was calculated using the interim-target total annual mortality rate of 47% and 2006 allocation percentage (92% for tribal harvest and 8% for the state) as outlined in Section VII.A.7.d of the Consent Decree. Based on these calculations, the total yield was allocated 14,500 lb to the state and 166,700 lb to the tribes.

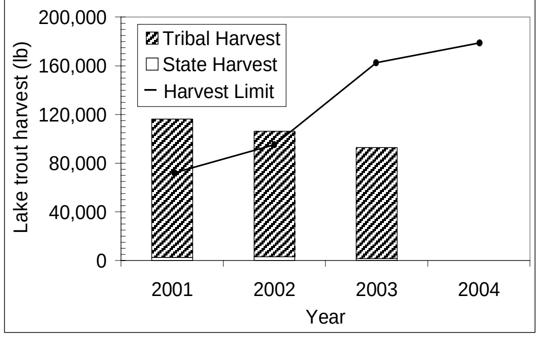
In 2001 the MH-1 harvest limit was calculated based on the phase-in described in the Consent Decree. In particular, it was based on the average effort during 1997 to 1999, either adjusted for gill net operations converted to trap nets under provisions of the Consent Decree (tribal commercial fishery) 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, 2003, and 2004 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.

Current spawning stock biomass per recruit (SSBR) is above SSBR at target mortality, indicating total annual mortality rates are below the interim target of 47% total annual mortality. This is due to harvest reductions due to gill net conversion and more stringent recreational fishing regulations, along with reductions in sea lamprey mortality due to the treatment of the St. Marys River. If mortality rates remain low, stock biomass and spawning stock biomass should increase.

Both tribal and state harvests were significantly lower than their respective harvest limits in 2003 (Figure 4). In general total harvest in this unit has declined under the 2000 Consent Decree. The total harvest limit has increased each year under the 2000 Consent Decree as well. This is due to increased lake trout biomass due to reductions in total annual mortality and increased stocking. The total harvest limit increased 18,200 lb from 2003 to 2004.

Figure 4. Yearly harvest and harvest limits



Model changes

No major changes were made to the model structure for this year's assessment. Model code was changed to allow the model to select the age of peak fishery selectivity, rather than using a fixed reference age for maximum selectivity as was done in the past. This change had little influence on the model output. However, two large changes were made in the model data. First, the under-reporting vector for tribal commercial fishery yield was set to zero at the request of the TFC starting in 2003. CORA now matches wholesale and catch reports for all landings and updates erroneous catch reports. Thus, the under-reporting adjustment in the model is no longer necessary. Secondly, release mortalities in the recreational fishery were added to estimates of recreational harvest. Based on 2003 data collected by state of Michigan creel clerks in MI-6 and MH-2, sport releases were estimated to be 35% of 2003 harvest, and the discard mortality was assumed to be 15% based on Loftus (1986).

Summary Status MH-1 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	3.33 lb
Age at first spawning	5 y
Size at 50% maturity	5.94 lb
Age at 50% maturity	8 y
Spawning stock biomass per recruit	
Base SSBR	2.312 lb (1.821 – 2.717)
Current SSBR	0.350 lb (0.186 – 0.412)
SSBR at target mortality	0.277 lb (0.250 – 0.300)
Spawning potential reduction	
At target mortality	0.153 (0.090 – 0.170)
Average yield per recruit	0.404 lb (0.373 – 0.503)
Natural mortality (M)	0.226 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	6 y
Sport fishery (2001-2003)	4 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.136 y^{-1} (0.129 – 0.263)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.004 y^{-1} (0.003 – 0.011)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.129 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.495 y^{-1} (0.486 – 0.634)
Recruitment (age-1)	
Average 1994-2003	342,800 fish (304,245 – 421,096)
Biomass (age 3+)	
Average 1994-2003	1,326,300 lb (1,105,140 – 1,474,190)
Spawning biomass	
Average 1994-2003	31,060 lb (18,858 – 32,763)
MSC recommended yield limit for 2004	181,200 lb
Actual yield limit for 2004	181,200 lb

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 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 has supported large spawning runs of sea lamprey, and until the late 1990's 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 are being 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 waters with bottom depths of 240 feet 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 YOY, increased CPUE's 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 1999 to 2003, approximately 296,000 yearling lake trout per year were planted annually in near-shore areas of MH-2. No lake trout were planted offshore on Six Fathom Bank/Yankee Reef in 2003. The Six Fathom/Yankee Reef complex was stocked annually from 1985 to 2001, but in 2002 these fish were re-allocated to nearshore stocking sites. In the future, stocked fish may again be planted on the mid-lake reefs as part of a pulse stocking regime being considered by the Lake Huron Technical Committee.

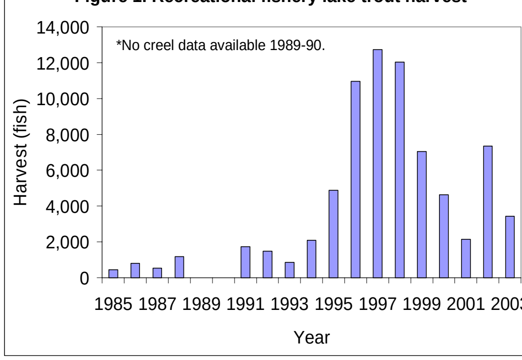
Approximately 200,000 yearling lake trout were planted annually in Canadian management area 4-3 from 1999 to 2003. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 449,000 yearling lake trout recruits in MH-2 for 2003.

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 waters of MH-2. This fishery is not allowed to market lake trout bycatch. Two state-licensed commercial fishing operations (Gauthier and Spaulding Fisheries, and Rochefort Fisheries) 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 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 1999 to 2003, total Canadian commercial lake trout yield in these areas averaged 51,000 lb per year. The majority of this yield came from the large-mesh gill net fishery. Canadian large-mesh gill net effort averaged 7.9 million ft per year from 1999 to 2003. Canadian large-mesh gill net effort in waters adjacent to MH-2 has been steadily increasing since 1999.

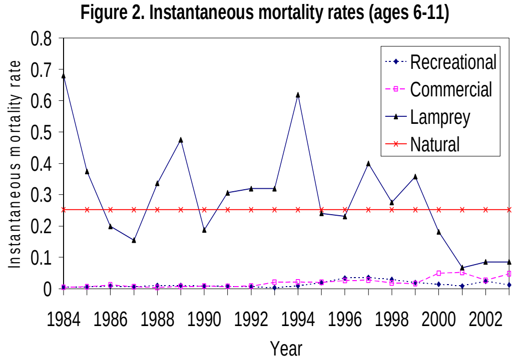
The state-licensed recreational fishery in MH-2 is composed of both charter and non-charter anglers. Lake trout are frequently caught as bycatch by salmon anglers trolling at or near the surface, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty waters. The magnitude of recreational harvest varies from year to year and has averaged 4,900 fish from 1999 to 2003 (Figure 1). From 1999 to 2003, recreational yield of lake trout averaged 37,000 lb, and in 2003 recreational harvest was 31,800 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 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



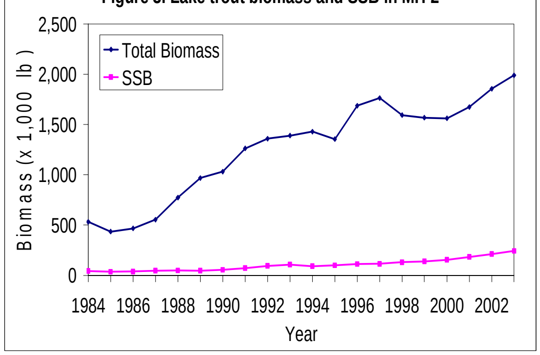
In most years, the dominant source of mortality for lake trout in MH-2 was sea lamprey (Figure 2). Sea lamprey-induced mortality was greater than all other mortality sources from 1984 to 1999 with the exception of 1986, 1987, 1990, 1995, and 1996 when natural mortality was the largest single mortality 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 1999 to 2003, sea lamprey-induced mortality averaged 0.16 y^{-1}, and sea lamprey-induced mortality rates have been declining drastically since 1999. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2003 decreased 76% from the average of 1994-1998 levels. This decline is likely 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 has steadily increased since 1984 averaging 1.73 million lb from 1999 to 2003, and both total lake trout biomass and SSB have been increasing since 2000. Much of this increase is due to lower rates of sea lamprey-induced mortality and increased stocking in MH-2. Total 2003 SSB was 243,000 lb (roughly 12 % 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



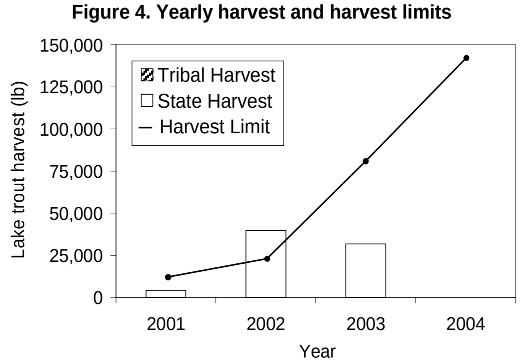
The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 144,300 lb for MH-2 in 2004. This harvest was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the state and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the Consent Decree. Based on these calculations, the total yield was allocated 137,100 lb to the state and 7,200 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 in 2000 to 2003. If sea lamprey-induced mortality remains low, spawning stock biomass and SSBR should increase.

State harvest was significantly lower than the state harvest limit in 2003 (Figure 4). No tribal harvest was reported in MH-2 in 2003. All tribal fishers in MH-2 fish trap nets and are required to release all lake trout regardless of condition.

The total harvest limit increased significantly from 2003 to 2004. This is due to the large declines in sea lamprey-induced mortality rates during 2000-2003. 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 2004 all parties agreed that increasing the harvest limit by greater than the 15% threshold was appropriate.

Figure 4. Yearly harvest and harvest limits



Model changes

No major changes were made to the model structure for this year's assessment. Model code was changed to allow the model to select the age of peak fishery selectivity, rather than using a fixed reference age for maximum selectivity as was done in the past. This change had little influence on the model output. However, one large change was made in the model data. Release mortalities in the recreational fishery were added to estimates of recreational harvest. Based on 2003 data collected by state of Michigan creel clerks in MI-6 and MH-2, sport releases were estimated to be 35% of 2003 harvest, and the discard mortality was assumed to be 15% based on Loftus (1986).

Summary Status MH-2 Lake Trout	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.99 lb
Age at first spawning	4 y
Size at 50% maturity	6.04 lb
Age at 50% maturity	7 y
Spawning stock biomass per recruit	
Base SSBR	2.834 lb (2.016 – 3.650)
Current SSBR	1.070 lb (0.696 – 1.443)
SSBR at target mortality	0.666 lb (0.557 – 0.760)
Spawning potential reduction	
At target mortality	0.379 (0.327 – 0.415)
Average yield per recruit	0.254 lb (0.210 – 0.310)
Natural mortality (M)	0.252 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	6 y
Sport fishery (2001-2003)	7 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.042 y^{-1} (0.029 – 0.069)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.015 y^{-1} (0.011 – 0.022)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.079 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.389 y^{-1} (0.356 – 0.443)
Recruitment (age-1)	
Average 1994-2003	412,410 fish (377,455 – 477,084)
Biomass (age 3+)	
Average 1994-2003	1,647,700 lb (1,359,750 – 1,969,080)
Spawning biomass	
Average 1994-2003	148,230 lb (106,331 – 190,196)
MSC recommended yield limit for 2004	144,300 lb
Actual yield limit for 2004	144,300 lb

Lake Michigan

MM-123 (Northern Lake Michigan)

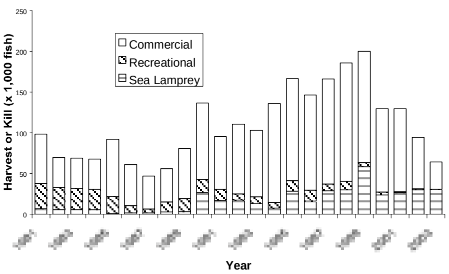
Prepared by Jory L. Jonas, John K. Netto, Erik J. Olsen, Steve J. Lenart, and Mark P. Ebener

Lake trout 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 also 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, Summer and Poverty Islands. This management unit is entirely in 1836 Treaty 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. It is illegal for recreational fishers to retain lake trout when fishing in the refuge. Gill net fishing (both commercial and subsistence) is also prohibited. Commercial trap net operations are permitted; however, the retention of lake trout is not allowed. Commercial fishing is also restricted in the innermost area of Little Traverse Bay (grid 519) and portions of grid 306 in northern Green Bay.

Recruitment of lake trout in the northern management unit of Lake Michigan is currently based entirely on stocking. In each of the last ten years, approximately 633,190 yearling lake trout have been stocked into northern Lake Michigan and approximately 86 percent of these fish are stocked into the northern refuge area. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for mortality and movement among the various regions in the lake. Over the last 10 years (1993-2002) the recruitment to age one has averaged 519,000 fish in northern Lake Michigan.

Both state and tribal commercial fisheries operate in northern Lake Michigan. State licensed commercial fisheries are primarily trap net operations targeting lake whitefish; the harvest of lake trout is prohibited. While the current tribal commercial fishery primarily targets lake whitefish, lake trout are sometimes targeted or kept as by-catch. From 1981 until 2002 commercial fishing had killed more harvestable lake trout (fish > 17 in.) than other sources of mortality in northern Lake Michigan (Figure 1). In 2003, commercial harvest was lower than any prior estimates and comparable to lamprey losses (~30,000 fish).

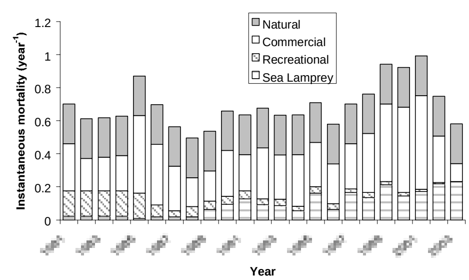
Figure 1. Number of lake trout killed by source in MM-123



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 accounts for the majority of the yield. Predicted tribal commercial yield increased from 367,000 lb in 1991 to 840,000 lb in 1998. After the implementation of the 2000 Consent Decree, yield fell to 277,000 lb in 2002 and in 2003 yield predicted yields were lower than estimates from all previous years (151,500 lb). Large-mesh gill net effort in tribal fisheries has been steadily declining from 23 million feet in 1992 and 1993 to 4.5 million feet in 2003. The number of lake trout harvested in northern Lake Michigan tribal fisheries had increased from 1991 (63,000 fish) until 1998 (144,000 fish). More recently harvest numbers have declined to an all time low of 32,500 fish in 2003 (Figure 1). In recent years, the harvest of lake trout in the region is significantly below both the phased and non-phased TAC allocations (Figure 4). Harvest requirements in the unit will be fully phased in 2006 as specified in the 2000 Consent Decree.

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 mortality rate of lake trout resulting from recreational fishing in the northern management unit of Lake Michigan is significantly lower than rates associated with commercial fishing or sea lamprey predation (Figure 2). In 1991, the minimum size limit for sport fishing in the northern management unit of Lake Michigan was increased from 10 to 24 inches, a modest decline in recreational yield resulted. In 2003, the bag limit was raised from 2 to 3 fish. In recent years, the estimated recreational yield of lake trout has declined, by over 97 percent from 1998 (67,000 lb) to 2003 (2,000 lb). The numbers harvested declined similarly, 96 percent fewer fish were harvested in 2003 (Figure 1). More recent declines are due in part to declines in recreational fishing effort, as angler hours decreased nearly 31 percent, from 108,000 in 1998 to 74,000 in 2003.

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



From 1989 until 2002 sea lamprey-induced mortality had been the second highest source of mortality for lake trout in northern Lake Michigan. In 2003, the lamprey (0.23 year^{-1}) mortality rate exceeded commercial fishing (0.11 year^{-1}). During the recent six years (1998 to 2003), lamprey mortality rates have been higher than during the previous sixteen years (Figure 2). The number of lake trout killed by sea lamprey has increased from an average of 3,600 fish per year during 1981-1989 to over 33,000 fish per year during 1998-2003 (Figure 1).

In northern Lake Michigan, lake trout generally are both spawning and recruited into commercial and recreational fisheries by age 7 (Summary table). The biomass of lake trout in northern Lake Michigan had nearly tripled from 1986 to 1997 increasing from 1.3 to 3.8 million pounds. Since 1997, the biomass of lake trout has steadily decreased. In 2001 levels were almost half those observed in 1997 (1.9 million pounds; Figure 3). Biomass estimates for 2002 and 2003 appear to be rising; in 2003, biomass was estimated at 2.3 million pounds. Spawning biomass showed similar patterns in abundance with a less pronounced peak in 1997.

The spawning stock biomass produced per recruit (including the refuge population) during 2003 is similar to the target value indicating that mortality rates for the combined refuge/non-refuge population are near the 40% mortality target for this area.

The recommended yield limit for 1836 Treaty waters in 2004 is 25,000 pounds for the state recreational fishery and 453,000 pounds for the tribal commercial/subsistence fishery. These values reflect phase in requirements specified in the 2000 Consent Decree. When fully phased in, yield allocations in this management unit will allot 10% to the state of Michigan and a 90% to tribal fisheries, while meeting the 40% mortality target. In 2004, two options were considered: 1) allowable yield based on the fully-phased mortality rate (225,200 lb tribal); or 2) average yield from 1997-1999 less the reduction due to gill net conversions in the area (453,000 lb tribal). Consistent with the Consent Decree specifications, option two was selected and approved by the TFC because it provided the highest tribal yield of lake trout. This specific phase-in option allows for temporary increases in mortality above the 40% target (Figure 4).

Figure 3. Estimated lake trout biomass in MM-123

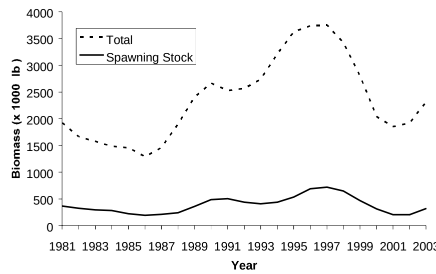
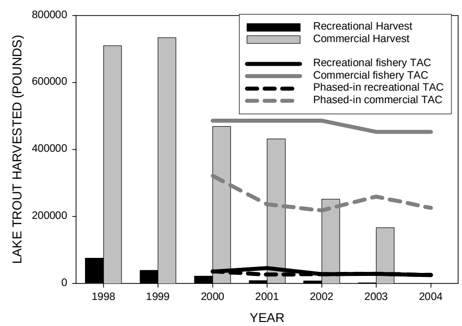


Figure 4. Comparison of Actual Harvest vs. TAC Decision vs. Model Recomendation



Model adjustments and changes

No changes to the model structure were required for this year's assessment. Two significant changes were made to the data used to fit the model. The TFC decided to no longer include an under-reporting correction for the commercial fisheries for 2003 and forward. This year was also the first year that the MSC included estimates of mortalities from caught and released fish in the sport fishery. The State of Michigan creel program estimated the number of released fish in MH-2 and MI-6. The MSC decided to use the average of these units to estimate the number of released fish relative to the total harvest (35%). This proportion of harvest was multiplied by Loftus' hooking mortality estimate of 15% to estimate the number of released fish killed in the sport fishery.

Summary Status MM-123	Value (95% probability interval)
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	6.84 lb (5.86 – 7.91)
Current SSBR combined w/ refuge	1.78 lb (1.44 – 2.15)
SSBR at target mortality	2.09 lb (1.84 – 2.37)
Spawning potential reduction	
At target mortality	0.307 (0.274 – 0.343)
Average yield per recruit	1.101 lb (0.990 – 1.215)
Natural mortality (M)	0.240 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	7 y
Sport fishery (2001-2003)	7 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.330 y^{-1} (0.248 – 0.427)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.008 y^{-1} (0.006 – 0.011)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.207 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.787 y^{-1} (0.703 – 0.884)
Recruitment (age-1)	
Average 1994-2003	532,500 fish (400,000 – 714,600)
Biomass (age 3+)	
Average 1994-2003	2,855,600 lb (2,511,800 - 3,256,000)
Spawning biomass	
Average 1994-2003	445,500 lb (381,300 – 520,400)
MSC recommended yield limit for 2004 (based on fully-phased rates)	250,200 lb
Actual yield limit for 2004 (based on phase-in requirements)	478,000 lb

MM-4 (Grand Traverse Bay)

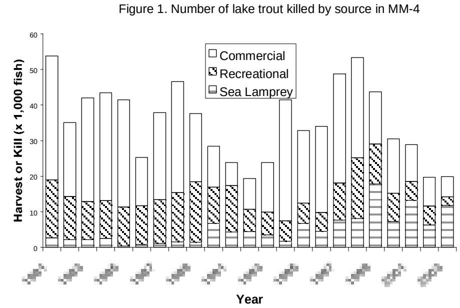
Prepared by Jory L. Jonas, John K. Netto, and Erik J. Olsen

Lake trout management unit MM-4 encompasses the Grand Traverse Bay region of Lake Michigan, and is also called the MM-4 statistical district. 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-1980's 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, 249,000 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 (1993-2002) the recruitment to age one has averaged 224,000 fish in the Grand Traverse management unit (Summary table).

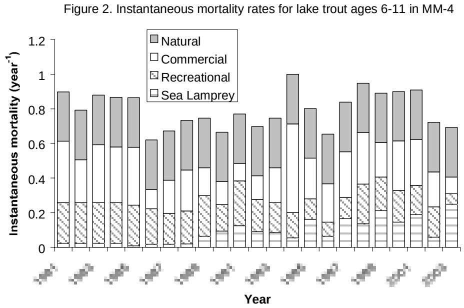
From 1993 until 1998 more lake trout were killed by commercial fishing than by either sea lamprey or sport fishing (Figure 1). However, from 2000 to 2003, the number of lake trout killed by commercial fishing is steadily declining. Commercial fishing mortality in Grand Traverse Bay peaked in 1994 (0.51 y^{-1}), remained stable over the next eight years averaging of 0.25 y^{-1}, and in 2003 declined to 0.10 y^{-1} (Figure 2).

Figure 1. Number of lake trout killed by source in MM-4



Only 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 thousand fish in 1991 to 31 thousand fish harvested in 1997. In recent years, harvest has been declining; an estimated 6 thousand fish were harvested in 2003. The yield of lake trout captured in tribal commercial fisheries peaked in 1998 at 161,000 lb and has declined by nearly 85% to 25,000 lb in 2003. Large-mesh gill net effort in tribal fisheries also declined from 2 million feet in 1996 to only 0.68 million feet in 2003. It is expected that decreases in the commercial harvest of lake trout in the Grand Traverse Bay management unit will be sustained at some level as a result of converting the regions largest gill net fishers to trap net operations.

Figure 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-4

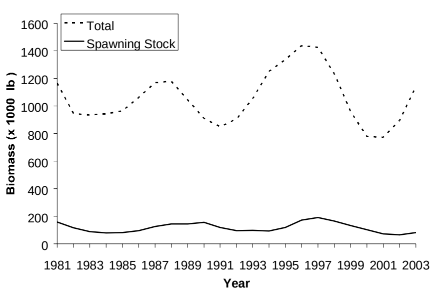


The management of recreational fisheries for lake trout is the primary responsibility of the state of Michigan and fisheries are comprised of both charter and sport anglers. The sportfishing harvest regulations in the Grand Traverse Bay management unit have changed significantly over the last 10 years, affecting recreational fishing mortality rates and harvest levels. From 1992-1996, the minimum size limit for lake trout harvest increased from 10 to 24 inches. In 1996, the season for harvesting lake trout was lengthened, so that it extended from Jan 1 through September 30 in contrast to the previous season of May 1 through Labor Day. Mid-way through the year in 1997 the minimum size limit was decreased to 20 inches and has 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. The mortality rates of lake trout resulting from recreational fishing steadily declined from 1991 (0.26 y^{-1}) to 1996 (0.08 y^{-1}). Recreational fishing mortality averaged 0.19 y^{-1} from 1997 to 2002 and declined to 0.06 y^{-1} in 2003 (Figure 2). The estimated recreational yield of lake trout in Grand Traverse Bay had been consistent during the years 1992-1996 averaging 39,000 lb. In response to changes in size regulations from 1996 to 1998 the recreational yield of lake trout increased dramatically reaching 93,000 lb. Yield has been declining since and was at an all time low of 12,000 lb in 2003. The numbers of lake trout harvested followed similar patterns, remaining stable from 1992 through 1996 averaging 6 thousand fish. Harvest increased through 1998 peaking at 19 thousand fish and has been steadily declining to 2,000 fish in 2003 (Figure 1). Effort levels have remained relatively stable over the last 10 years (1994-2003) averaging 203 thousand angler hours (range=185-240 thousand angler hours).

From 1981-1988, sea lamprey-induced mortality was the lowest source of mortality in the Grand Traverse Bay management unit with instantaneous rates averaging 0.02 y^{-1}. Wounding rates gradually increased to 0.13 y^{-1} in 1991, then declined to 0.05 y^{-1} in 1994. After 1994 rates were variable and generally increased. The highest lamprey mortality rate was observed in 2003 (0.25 y^{-1}). In 2003, lampreys were estimated to have killed over 12,000 lake trout from the management unit.

In the Grand Traverse Bay management unit, lake trout are recruited into sport and commercial fisheries by age 7. Female lake trout first spawn at age 3 and 50 percent or more are spawning by age 6. The total biomass of lake trout peaked in 1997 at 1.4 million pounds. Biomass had been declining through 2000 (779,000 lb). In the recent three years the population appears to be recovering as the estimated biomass increased to 1.1 million pounds in 2003. The spawning stock biomass of lake trout was estimated at 200,000 lb in 1997; by 2002 the estimate had decreased to 66,000 lb. In 2003, spawning biomass increased slightly to 82,000 lb. On average, the biomass of spawning lake trout has been around 122,500 lb during the last ten years (1994-2003).

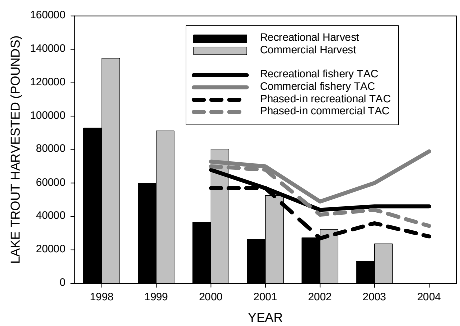
Figure 3. Estimated lake trout biomass in MM-4



The spawning stock biomass produced per recruit is below the target value indicating that the mortality rate is too high in Grand Traverse Bay. The recommended harvest limit for 2004 in the Grand Traverse Bay management unit is 125,000 pounds of which 46,000 pounds was allocated to the state recreational fishery and 79,000 pounds to the tribal commercial/subsistence fishery.

Grand Traverse Bay represents an area where unique phase in requirements defined in the 2000 Consent Decree were considered in establishing yield limits (Figure 4). From 2001 to 2005 commercial limits are to be set in Grand Traverse Bay based on mean yield and effort values from 1997-1999 minus the conversion of gill net effort to trap nets. Recreational yield limits are set at the mean for the previous three years and are to be adjusted for regulation changes. From 2006 to 2009, yield and effort limits will be set to meet the target mortality rate for the management unit of 45%, with a 40% allocation to the state of Michigan and a 60% allocation to tribal fisheries. If the fully-phased mortality rate of 45% was used in the current model, the recommended harvest limit would be 62,500 lb for MM-4. After 2009, allocations will be set at 45% to the state and 55% to tribal fisheries.

Figure 4. Comparison of Actual Harvest vs. TAC Decision vs. Model Recomendation



<u>Model adjustments and changes</u>

No changes were made to the assessment model this year. Two changes were made to the data used to fit the model. The TFC decided to no longer include an under-reporting correction for the commercial fisheries from 2003 and forward. This year was also the first year that the MSC included estimates of mortalities from caught and released fish in the sport fishery. The State of Michigan creel program estimated the number of released fish in MH-2 and MI-6. The MSC decided to use the average of these units to estimate the number of released fish relative to the total harvest (35%). This proportion of harvest was multiplied by Loftus' hooking mortality estimate of 15% to estimate the number of released fish killed in the sport fishery.

Summary Status MM-4	Value (95% probability interval)
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.707 lb (2.371 – 3.083)
Current SSBR	0.565 lb (0.491 – 0.648)
SSBR at target mortality	0.816 lb (0.749 – 0.889)
Spawning potential reduction	
At target mortality	0.303 (0.269 – 0.339)
Average yield per recruit	0.539 lb (0.486 – 0.594)
Natural mortality (M)	0.286 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	7 y
Sport fishery (2001-2003)	7 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.190 y^{-1} (0.146 – 0.243)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.129 y^{-1} (0.103 – 0.160)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.166 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.778 y^{-1} (0.711 – 0.855)
Recruitment (age-1)	
Average 1994-2003	223,500 fish (199,500 – 251,800)
Biomass (age 3+)	
Average 1994-2003	866,100 lb (781,600 – 955,700)
Spawning biomass	
Average 1994-2003	122,500 lb (108,500 – 137,900)
MSC recommended yield limit for 2004 (based on fully-phased rates)	62,500 lb
Actual yield limit for 2004 (based on phase-in requirements)	125,000 lb

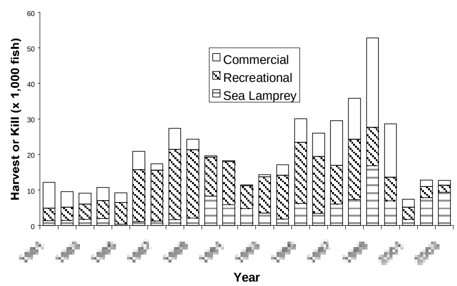
MM-5 (Leelanau Peninsula to Arcadia)

Prepared by Jory L. Jonas, John K. Netto, 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 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, 231,500 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 (1993-2002) the recruitment to age one has averaged 286,000 fish in MM-5.

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

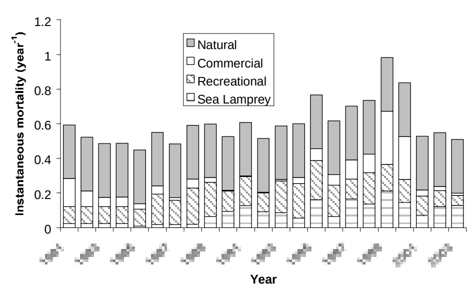


Although both state and tribal commercial fishermen harvest fish in the management unit, state licensed commercial fisheries are primarily trap net operations targeting lake whitefish. State licensed fishermen are not permitted to harvest lake trout, and as a result, are not included in lake trout harvest allocations. There are three types of tribal commercial fisheries, large-mesh gill net, small-mesh gill net, and trap net. While primarily targeting lake whitefish, the large-mesh gill net fishery is generally responsible for the greatest number of harvested lake trout in commercial fisheries. The 2000 Consent Decree resulted in the conversion of the regions 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 in recent years. From 1990 to 1993, mortality from commercial fishing was extremely low averaging 0.005 y^{-1}. Mortality rates increased over the next seven years, the highest commercial fishing mortalities were observed in 1999 and 2000 at 0.31 and 0.25 y^{-1} respectively. In 1999 over

25,000 fish were harvested in commercial fisheries. After the year 2000 harvest decreased significantly and only 1,300 lake trout were harvested in 2003 and the mortality rate was 0.01 y^{-1} (Figures 1 and 2). The yield of lake trout in tribal commercial fisheries rose precipitously from 4,000 lb in 1993 to 184,900 lb in 1999. During the most recent three years (2001 to 2003) the yield has been extremely low averaging 9,000 lb. Large-mesh gill net effort in tribal fisheries reflected patterns similar to those observed in mortality, harvest and yield. After 1993, gill net effort rose from 22,000 to 2 million feet in 1999. In more recent years, effort has declined averaging 118,000 feet of net from 2001 to 2003.

Recreational fisheries for lake trout include both charter and sport anglers. From 1983 until 1997, recreational fishing was the highest source of mortality in the MM-5 management unit, exceeding both sea lamprey and commercial fishing mortality. In more recent years, lake trout mortality (averaged over ages 6-11) due to recreational fishing has decreased. Dropping from a high level of 0.23 y^{-1} observed in 1995 to 0.06 y^{-1} in 2003. The recreational fishery yield averaged 68,000 lb over the 8-year period between 1990 and 1998. Yields have been steadily declining since 1998, reaching 11,000 lb in 2003. The numbers of lake trout harvested have also declined in recent years, dropping by nearly 90 percent between 1998 (18,000 fish) and 2003 (1,900 fish). Recreational fishing effort had been relatively consistent from 1991 to 2001 averaging 331 thousand angler hours. During this time period low harvest levels were likely reflecting declines in the abundance of lake trout. After 2001, angler effort hours declined to 180 thousand by 2003. Perhaps in response to poor catch rates and increased size regulations in the management unit. The sportfishing 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 also 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.

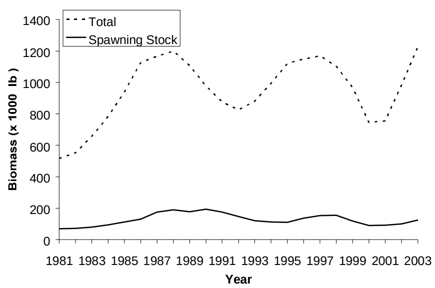
Figure 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-5



From 1981-1988 sea lamprey mortality was less than either recreational or commercial mortality. From 1996 to 1999 sea lamprey mortality rates increased substantially from 0.06 y^{-1} to 0.21 y^{-1}. In recent years (2001 to 2003) lamprey mortality rates have averaged 0.11 y^{-1} (Figure 2). Sea lamprey killed over 16,900 lake trout in 1999 and 9,000 in 2003. The U.S. Fish and Wildlife Service has initiated efforts to improve controls on lamprey populations in northern Lake Michigan which should have a positive effect on wounding rates in the MM-5 management unit.

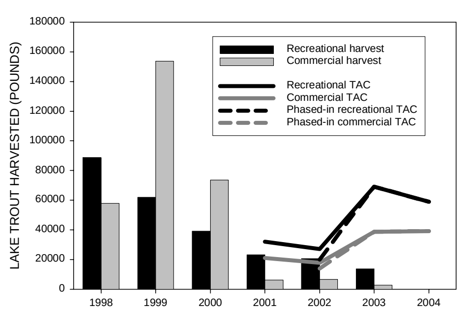
Fifty percent of lake trout are spawning by age 6 in MM-5. By age 7 they are recruited into commercial fisheries and age 9 into recreational fisheries. The total biomass rose to a peak in 1988, declined, in the late 1980s and early 1990s and then rose to a high value in 1997 and declined 755,000 lb in 2001 (Figure 3). In recent years (2002 and 2003) the biomass of lake trout appears to be increasing reaching 1,224,000 lb in 2003. The biomass of spawners has risen from 91,000 lb in 2000 to 125,000 lb in 2003.

Figure 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 2003 in Unit MM-5 is 98,100 pounds, and is based on a target mortality rate of 45%. Of this yield, 58,900 pounds were allocated to the state recreational fishery and 39,200 pounds 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.

Figure 4. Comparison of Actual Harvest vs. TAC Decision vs. Model Recomendation



Model adjustments and changes

A couple of changes were made to the assessment model in this unit as a result of the review and diagnostic process. First, we down-weighted the commercial age composition in the likelihood function. Commercial age composition data are only available for seven years of the time series, and the model does not estimate selectivity for this fishery. Commercial selectivity is borrowed from MM-123. The second change was to change the survey selectivity from a double logistic function to a logistic function. This change was made because of high error values for the parameters of the descending limb of the selectivity function. Also, the estimated descending limb of the function was at ages older than the ages present in the data. These changes had very little effect on the model predictions.

Two changes were made to the data used to fit the model. A decision was made by the TFC to no longer include an under-reporting correction for the commercial fisheries for 2003 and forward. This year was also the first year that the MSC included estimates of mortalities from caught and released fish in the sport fishery. The State of Michigan creel program estimated the number of released fish in MH-2 and MI-6. The MSC decided to use the average of these units to estimate the number of released fish relative to the total harvest (35%). This proportion of harvest was multiplied by Loftus' hooking mortality estimate of 15% to estimate the number of released fish killed in the sport fishery.

Summary Status MM-5	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	1.916 lb (1.662 – 2.203)
Current SSBR	0.902 lb (0.724 – 1.096)
SSBR at target mortality	0.651 lb (0.578 – 0.730)
Spawning potential reduction	
At target mortality	0.340 (0.313 – 0.369)
Average yield per recruit	0.237 lb (0.196 – 0.281)
Natural mortality (M)	0.310 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	7 y
Sport fishery (2001-2003)	9 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.024 y^{-1} (0.017 – 0.033)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.088 y^{-1} (0.060 – 0.123)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.107 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.522 y^{-1} (0.484 – 0.568)
Recruitment (age-1)	
Average 1994-2003	289,300 fish (245,800 – 342,500)
Biomass (age 3+)	
Average 1994-2003	795,900 lb (678,500 – 933,600)
Spawning biomass	
Average 1994-2003	122,200 lb (100,600 – 147,800)
MSC recommended yield limit for 2004	98,100 lb
Actual yield limit for 2004	98,100 lb

MM-67 (Manistee - Ludington)

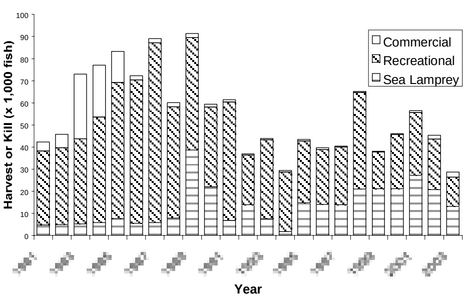
Prepared by Jory L. Jonas, John K. Netto, and Archie W. Martell Jr.

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 fishers to retain lake trout when fishing in the refuge area. Gill net fishing (both commercial and subsistence) are 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 2002, there was no tribal commercial fishing effort in management unit MM-7 and limited tribal fishing existed 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 211,000 yearling lake trout have been stocked into non-refuge southern treaty waters, while an additional 290,000 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 (1994-2003), the recruitment of lake trout to age one has averaged 330,000 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 1). In the year 2003, the commercial fishery in southern treaty waters of Lake Michigan was comprised of only a few state licensed commercial fishers, one tribal trap net operation, and one tribal small-mesh gill net operation. State and tribal licensed commercial fisheries primarily target lake whitefish and chubs, and they are not permitted to harvest lake trout. As a result, state and tribal commercial fishermen are not included in lake trout harvest allocations. The yield of lake trout in commercial fisheries has averaged 2,500 pounds over the last 18 years (1986-2003). Since 1998, on average, commercial fisheries have harvested 1,130 fish year^{-1}. As a result of stipulations of the 2000 consent decree, this area may experience greater commercial fishing effort from tribal interests in the future.

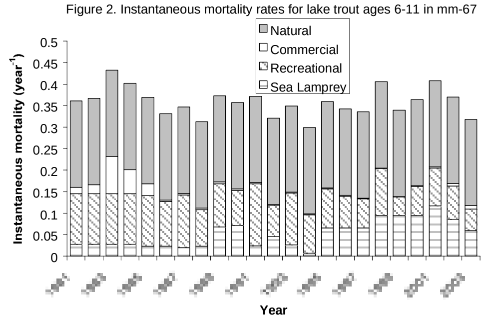
Figure 1. Number of lake trout killed by source in mm-67



State recreational fisheries for lake trout are comprised of both charter and sport anglers. Recreational fishing mortality is usually higher than either commercial fishing or sea lamprey mortality (Figure 2). During the last four years (2000 to 2003), observed recreational fishing mortality rates have been relatively consistent, averaging 0.07 y^{-1}. The yield of lake trout in recreational fisheries has been declining since 1987, dropping from 474,000 lb to 85,000 lb in 2003. The numbers of lake trout harvested had declined by nearly 84 percent from 81,000 fish in 1987 to 13,000 fish in 2003 (Figure 1). Effort levels have been relatively consistent since 1990 averaging 1,157,000 angler hours. Size and bag limits did not change from 1981 until 2003. However, the fishing season had changed twice, once in 1984 where the season was restricted 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 was increased to 22 inches and the season was expanded from May 1 to Sept 30.

Sea lamprey-induced mortality is lower in southern treaty waters of Lake Michigan when compared with rates observed in the northern units. Rates ranged from 0.007 to 0.12 (Figure 2). In the last five years (1999-2003), the number of lake trout killed by lamprey has averaged 20,700 fish (Figure 1).

Figure 2. Instantaneous mortality rates for lake trout ages 6-11 in mm-67



Lake trout in MM-67 are spawning and recruited into commercial and recreational fisheries by age 6. The total biomass of lake trout is high, averaging over 3 million lb during the recent ten years (1994-2003; Figure 3). Spawning lake trout comprise a relatively high proportion of the total biomass in this unit (Figure 3), averaging over 900,000 lb from 1994-2003. The spawning biomass of lake trout in MM-67 followed similar temporal shifts in abundance when compared with total biomass.

The spawning stock biomass produced per recruit is significantly above the target value indicating that target mortality rates have been achieved in MM-67 (Summary table).

The recommended yield limit for the year 2004 in MM-67 is 432,200 lb. Of this, 389,000 pounds are allocated to the state recreational fishery and 43,200 pounds to the tribal fishery. The yield limit and allocations in this management unit are set to achieve a total mortality rate target of 40% and establish a 90% allocation to the state of Michigan and a 10% allocation to tribal fisheries. Both recreational and commercial fisheries are well below established TAC levels (Figure 4).

Figure 3. Estimated lake trout biomass in mm-67

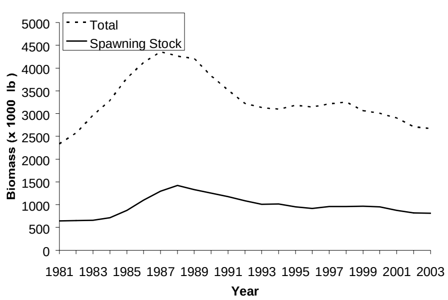
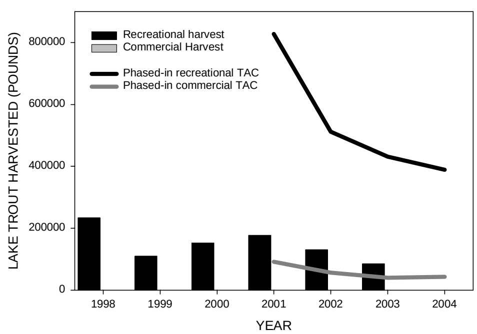


Figure 4. Comparison of Actual Harvest vs. TAC Decision

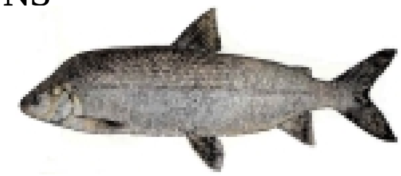


<u>Model adjustments and changes</u>

No changes to the model structure were required for this year's assessment. Two changes were made to the data used to fit the model. The TFC decided to no longer include an under-reporting correction for the commercial fisheries from 2003 and forward. This year was also the first year that the MSC included estimates of mortalities from caught and released fish in the sport fishery. The State of Michigan creel program estimated the number of released fish in MH-2 and MI-6. The MSC decided to use the average of these units to estimate the number of released fish relative to the total harvest (35%). This proportion of harvest was multiplied by Loftus' hooking mortality estimate of 15% to estimate the number of released fish killed in the sport fishery.

Summary Status MM-67	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.34 lb
Age at first spawning	3 y
Size at 50% maturity	6.14 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	5.873 lb (4.710 – 7.278)
Current SSBR combined w/ refuge	2.435 lb (1.840 – 3.114)
SSBR at target mortality	1.289 lb (1.094 – 1.490)
Spawning potential reduction	
At target mortality	0.221 (0.193 – 0.253)
Average yield per recruit	0.470 lb (0.426 – 0.516)
Natural mortality (M)	0.201 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2001-2003)	6 y
Sport fishery (2001-2003)	6 y
Commercial fishing mortality (F)	
Average 2001-2003, ages 6-11	0.006 y^{-1} (0.004 – 0.008)
Sport fishing mortality (F)	
Average 2001-2003, ages 6-11	0.073 y^{-1} (0.055 – 0.096)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.087 y^{-1}
Total mortality (Z)	
Average 2001-2003, ages 6-11	0.368 y^{-1} (0.337 – 0.402)
Recruitment (age-1)	
Average 1994-2003	331,200 fish (312,300 – 351,500)
Biomass (age 3+)	
Average 1994-2003	3,042,400 lb (2,339,000 – 3,838,500)
Spawning biomass	
Average 1994-2003	920,100 lb (670,500 – 1,221,800)
MSC recommended yield limit in 2004	432,200 lb
Actual yield limit for 2004	432,000 lb

STATUS OF LAKE WHITEFISH POPULATIONS



Lake Superior

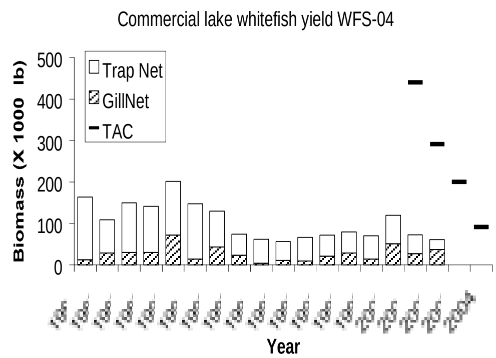
WFS-04 (Marquette - Big Bay)

Prepared by Philip J. Schneeberger

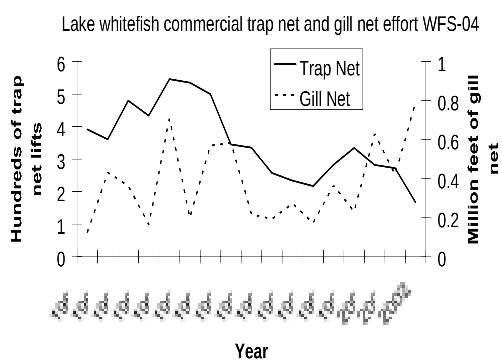
Lake whitefish unit WFS-04 (1,201,498 surface acres) is located in Lake Superior roughly between Big Bay and Laughing Fish Point east of Marquette. Fishable grids in this unit include 1326-1327, 1428-1429, and 1529-1531. Near shoreline features of this zone includes many points, bays, islands, and in-flowing rivers. Habitat suitable for lake whitefish growth and reproduction is associated with many of these features.

This unit historically has been treated as a single management area though it certainly contains several reproductively isolated stocks. It contains waters both within and outside the 1836 Treaty area, but more than 90% of trap net effort and yield are taken from waters west of the treaty line.

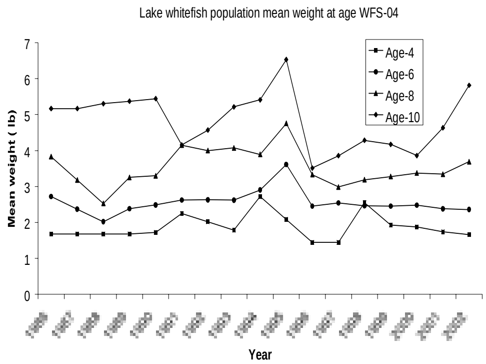
Yield during 2002 was 61,000 lb with 24,000 lb (39%) caught in trap nets and 37,000 lb (61%) in gill nets. Trap net yield was the lowest of the 17-yr data set, but gill net yield was 40% higher than the 1986-2001 average. On average, trap nets have caught 74% of the annual yield from 1986 through 2002.

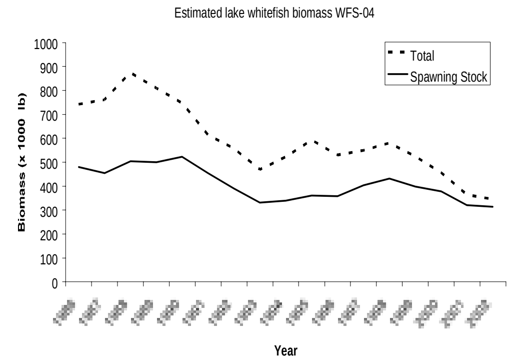


Fishing effort declined for trap nets but increased for gill nets between 2001 and 2002. Trap net effort in 2002 (167 lifts) was the lowest value recorded between 1986 and 2002, whereas gill net effort (793 thousand ft) was the highest during the time frame.



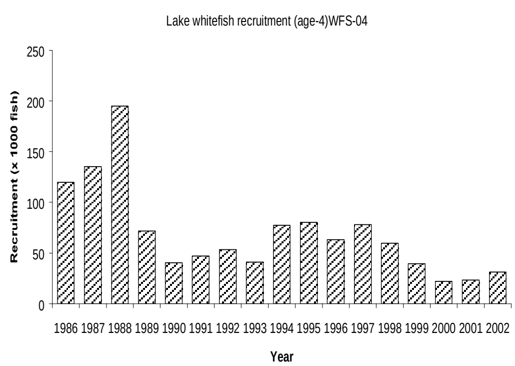
In general, calculations of mean weight-at-age improved between 2001 and 2002, especially for ages 8 and above. Values were lower in 2002 for ages 3-7, and higher for ages 8-12+ compared to 1986-2001 averages.

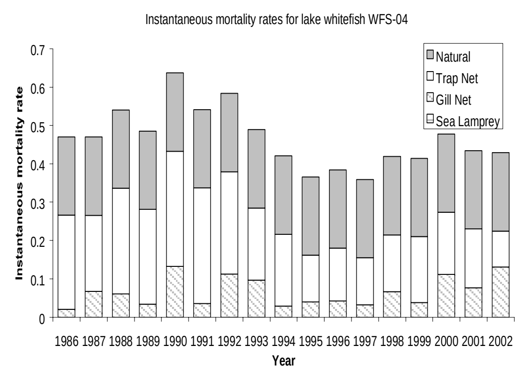




Recruitment (number of age-4 lake whitefish) was estimated at 31,000 in 2002, up slightly from 2000-2001 values estimated with the 2002 model. Compared to the 1986-2001 average, recruitment estimated in 2002 was less than half.

Total instantaneous mortality rates (Z) have been relatively low since the mid-1990s. Estimated instantaneous fishing mortality rates (F) were 0.13 y^{-1} for gill nets and 0.09 y^{-1} for trap nets in 2002. Instantaneous natural mortality rate was 0.20 y^{-1}.





Both fishable biomass and spawning stock biomass declined slightly but were almost level between 2001 and 2002. Estimated fishable biomass was 345,000 lb and spawning stock biomass was 314,000 lb in 2002. The ratio of spawning stock biomass to fishable biomass was 0.91.

The calculated yield limit for 2004 is 91,000 lb in WFS-04, less than half of the 2003 limit of 200,000 lb. Yield limits have decreased each year since 2001. Various 2002 stock parameter estimates such as recruitment and biomass are relatively low, but they are partly offset by other parameters like mortality and weight-at-age, so the steep drop in yield limit may be indicative of problems in the model for this management unit.

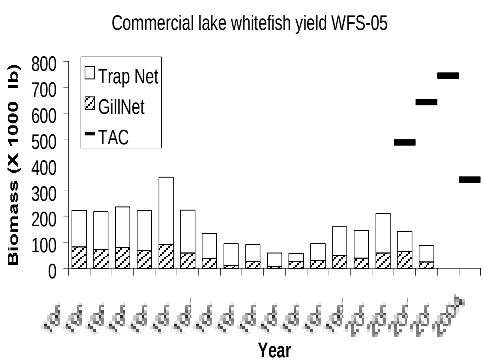
Summary Status WFS-04 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.76 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.01 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	8.219 lb (8.189 - 8.249)
	Current SSBR	2.16 lb (2.02 - 2.30)
	SSBR at target mortality	0.237 lb (0.237 - 0.237)
Spawning potential reduction		
	At target mortality	0.263 (0.245 - 0.281)
Average yield per recruit		1.465 lb (1.455 - 1.475)
Natural Mortality (M)		0.204 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.114 y^{-1} (0.102 - 0.126)
	Average trap net F, ages 4+	0.142 y^{-1} (0.130 - 0.154)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.46 y^{-1} (0.438 - 0.482)
Recruitment (age-4)	(1993-2002 average)	51,531 fish (47,961 - 55,101)
Biomass (age 3+)	(1993-2002 average)	493,590 lb (461,100 - 526,080)
Spawning biomass	(1993-2002 average)	363,270 lb (335,788 - 390,752)
MSC recommended yield limit for 2004		91,000 lb
Actual yield limit for 2004		91,000 lb

WFS-05 (Munising)

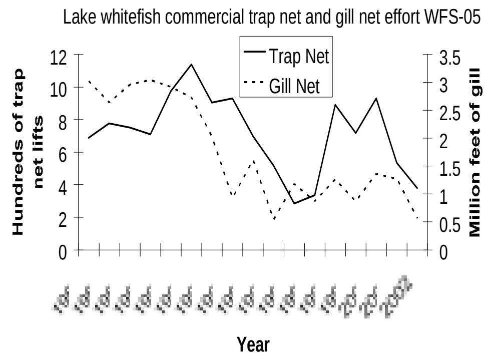
Prepared by Philip J. Schneeberger

The WFS-05 lake whitefish management extends approximately from Laughing Point to Au Sable Point in Lake Superior. Surface area 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.

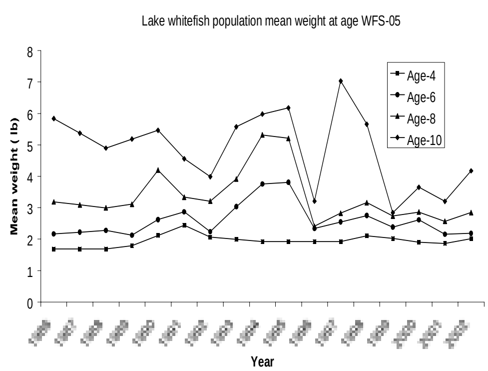
Total yield of lake whitefish in WFS-05 for 2002 was 89,000 lb. This represented a 38% decrease from the yield in 2001 and a 47% decrease over the average yield from 1986 through 2001. Trap nets accounted for 71% of the lake whitefish yield during 2002, and gill nets took the remaining 29%. Trap net yield declined for the second consecutive year whereas gill net yield declined in 2002 following a generally increasing trend that began in 1995.



Effort for both gear types has declined about 59% since 2000. Trap net effort fell from 930 lifts in 2000 to 535 lifts in 2001 to only 380 lifts in 2002. Gill net effort dropped from 1.36 to 1.27 to 0.56 million ft over the same time period. Compared to 1986-2001 averages, fishing effort during 2002 was lower by 48% for the trap net fishery and by 69% for the gill net fishery.



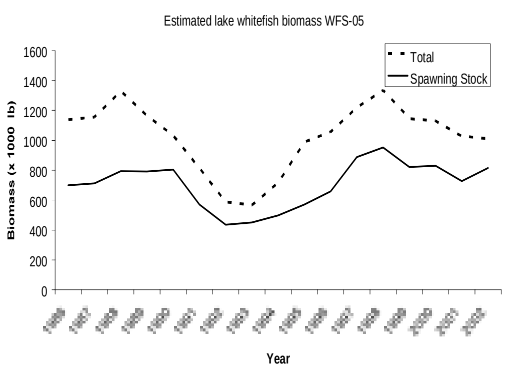
Between 2001 and 2002, mean weight-at-age values stayed nearly equivalent or increased, with largest increases recorded for ages 8-12+. These increases reversed a consistent decline in whitefish weight-at-age that had been evident since 1998.



The 2002 estimate of recruitment, measured as annual estimated numbers of age-4 lake whitefish in the population, dropped 36% from the current estimate for 2001.

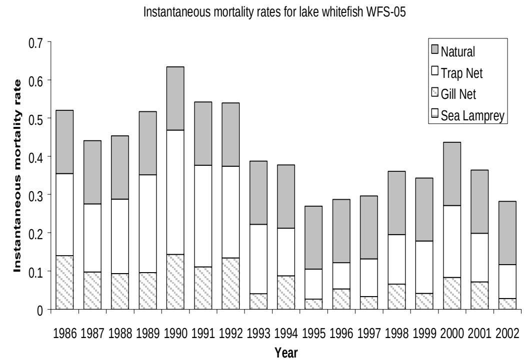
Estimated recruitment in 2002 was 83,000 fish, but prior experience indicates that this estimate is subject to revision in subsequent years. For example, the recruitment estimate in 2000 using the 1986-2000 data set was 155,000, but adding one more year of data (1986-2001 data set) changed the 2000 estimate to 565,000.

Biomass estimates in 2002 were 1.01 million lb for the fishable stock (lake whitefish age-4 and older) and 815,000 lb for the spawning stock. These values were a slight decline for the fishable stock and an increase in the spawning stock, compared to current estimates for 2001. Spawning stock biomass was 80% of fishable biomass in 2002, larger than the 1986-2001 average of 69%.



Estimates for total instantaneous mortality rate (Z) have remained consistently below 0.45 y^{-1} since 1993. The estimate for Z was 0.28 y^{-1} in 2002.

Natural mortality rate (M) was the largest component (59%) of Z in WFS-05. Instantaneous fishing mortality (F) rate was 0.10 y^{-1} for gill nets and 0.31 y^{-1} for trap nets.



The calculated 2004 yield limit for WFS-05 was 344,000 lb, a 54% decrease from the yield limit for 2003. Increased effort and yield from the gill net fishery would be necessary to reach the 2004 TAC while maintaining the mandated split between tribal and state-licensed fishers.

Summary Status WFS-05 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.93 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.28 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	7.966 lb (7.938 - 7.994)
	Current SSBR	2.09 lb (1.89 - 2.29)
	SSBR at target mortality	0.184 lb (0.184 - 0.184)
Spawning potential reduction		
	At target mortality	0.263 (0.239 - 0.287)
Average yield per recruit		1.475 lb (1.461 - 1.489)
Natural Mortality (M)		0.165 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.063 y^{-1} (0.055 - 0.071)
	Average trap net F, ages 4+	0.141 y^{-1} (0.123 - 0.159)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.369 y^{-1} (0.345 - 0.393)
Recruitment (age-4)	(1993-2002 average)	116,850 fish (104,146 - 129,554)
Biomass (age 3+)	(1993-2002 average)	1,019,600 lb (936,478 - 1,102,722)
Spawning biomass	(1993-2002 average)	721,140 lb (656,964 - 785,316)
MSC recommended yield limit for 2004		344,000 lb
Actual yield limit for 2004		344,000 lb

WFS-06 (Grand Marais)

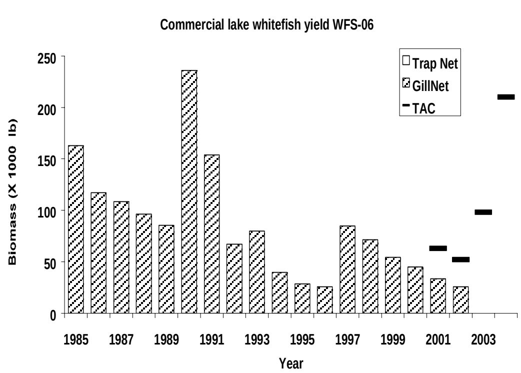
Prepared by Mark P. Ebener

WFS-06 is located in the center of the 1836 treaty-ceded waters of Lake Superior. The unit is part of the open water of Lake Superior and contains no islands or bays, and only a small amount of water is <120 ft deep. There are only 88,600 surface acres of waters <240 ft deep in the unit.

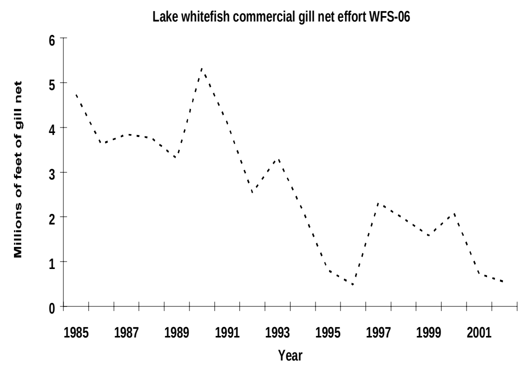
There is little habitat for whitefish reproduction in WFS-06. The entire shoreline is relatively straight and is composed of sand with lesser amounts of small-sized gravel and scattered cobble that are found only on the immediate shoreline. It is likely that many of the lake whitefish that inhabit WFS-06 spawn elsewhere.

WFS-06 has been an exclusive commercial fishing zone for CORA fishers since 1985. Because the unit is so exposed to the open water of Lake Superior, and because access to the unit is limited to the Grand Marais area, only large-boat gill net fisheries typically operate here. A sizeable sport fishery targets whitefish off the pier at Grand Marais, but this yield and effort is not included in the stock assessment model.

The commercial yield of lake whitefish from WFS-06 has averaged only 84,000 lb during 1985-2002. The peak yield was 236,000 lb in 1990 and the lowest yield was 25,760 lb in 2002.

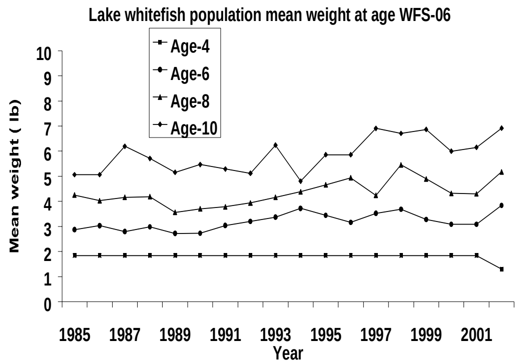


The large-mesh gill net fishery has accounted for the entire yield from WFS-06 since 1985. Effort averaged 2.6 million ft during 1985-2002 and ranged from 5.3 million ft in 1990 to 0.49 million ft in 1996. Large-mesh gill net effort was 0.54 million ft in 2002. Much of the gill net effort in made up of 5 ¼ and 5 ½ inch stretched mesh.

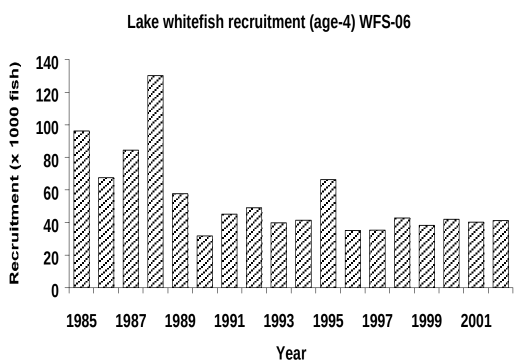


Whitefish caught in WFS-06 are large so the fishery targets them with 5 ¼ and 5 ½ inch mesh gill nets because fishers are paid more per pound for mediums and jumbos than for No.1 whitefish. Annual mean weight of whitefish in the gill net yield from WFS-06 ranged from 3.0 to 5.6 lb and averaged 3.8 lb during 1985-2002. Mean weight of a harvest whitefish was 5.3 lb in 2002. The proportion of medium and jumbo whitefish in the harvest from WFS-06 is greater than nearly all other units in the 1836 ceded waters.

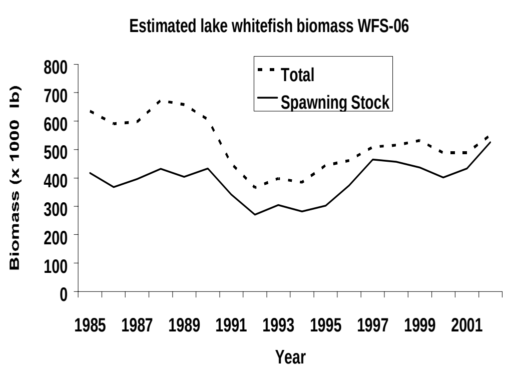
Growth of whitefish in WFS-06 has remained constant through time or slightly increased. Mean weight of nearly all age-classes in 2002 was equal to or greater than prior to the mid 1980s.

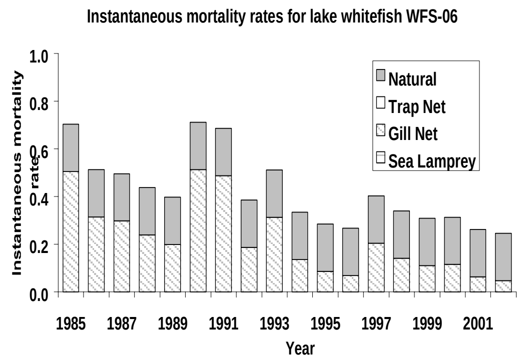


Recruitment to the fishable population of whitefish in WFS-06 has remained stable since 1990. Recruitment of age-4 whitefish was estimated to range from 32,000 fish in 1990 to 130,000 in 1988. Recruitment was estimated to be 41,200 age-4 whitefish in 2002, which is nearly equal to average recruitment during 1990-2002.



Biomass of whitefish peaked at 673,000 lb in 1988, declined to 366,000 lb in 1992, and then slowly increased to 551,000 lb in 2002. Biomass averaged 774,000 lb during the last decade in WFS-06. Spawning biomass has made up a larger proportion of total biomass in the last few years primarily because of the increases in growth of whitefish in WFS-06.





Total annual mortality of whitefish has declined through time based on the stock assessment model. Total mortality averaged only 0.27 y^{-1} on age-4 and older whitefish in WFS-06 during 2000-2002 and was lower in 2002 than most other years. Fishing mortality rate averaged 0.075 y^{-1} during 2000-2002 and was 0.047 y^{-1} in 2002. Because total mortality was substantially less than the target rate of 1.05 y^{-1} the projection model estimated that fishing mortality could be increased from the current level. The recommended yield limit in 2004 at the increased level of fishing was estimated to be **210,000 lb** compared to the harvest limit of 98,000 lb in 2003.

Summary Status WFS-06 Whitefish		
Female maturity		
	Size at first spawning	1.67 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.50 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	10.372 lb (SE 0.002)
	Current SSBR	6.27 lb (SE 0.29)
	SSBR at target mortality	0.266 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.605 (SE 0.028)
Average yield per recruit		1.343 lb (SE 0.084)
Natural Mortality (M)		0.198 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	
	Average gill net F, ages 4+	0.075 y^{-1} (SE 0.008)
	Average trap net F, ages 4+	0. y^{-1} (SE 0.)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.273 y^{-1} (SE 0.008)
Recruitment (age-4)	(1993-2002 average)	42,209 fish (SE 3,078)
Biomass (age 3+)	(1993-2002 average)	477,210 lb (SE 41,812)
Spawning biomass	(1993-2002 average)	398,110 lb (SE 37,129)
MSC recommended yield limit for 2004		210,000 lb
Actual yield limit for 2004 (HRG)		210,000 lb

WFS-07 (Tahquamenon Bay)

Prepared by Mark P. Ebener

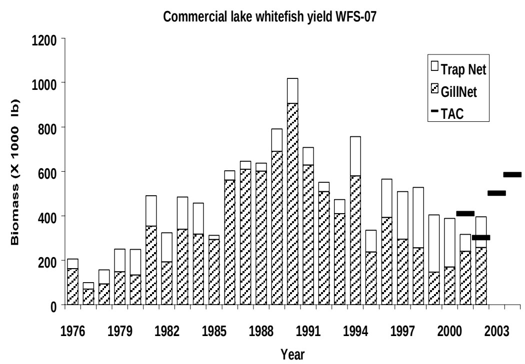
WFS-07 is located in the Whitefish Bay area of Lake Superior. The primary geographic feature of WFS-07 is Whitefish Point. West and north of Whitefish Point is the open water of Lake Superior, while south of the Point includes western Whitefish Bay and a large amount of shallow water. WFS-07 contains 371,000 surface acres of water < 240 ft deep. There is also a substantial commercial fishery in adjacent Canadian management unit 33.

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. Many whitefish also remain in Whitefish Bay and some move into Canadian waters.

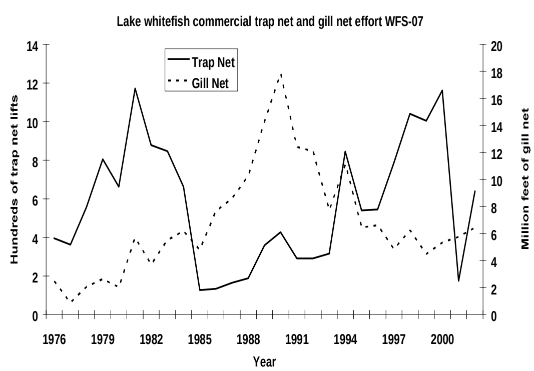
This unit is a very important fishing ground for the CORA fishery, and has been an exclusive CORA fishing area since 1985. Large- and small-boat gill net fisheries as well as several trap net fisheries operate in WFS-07. An ice fishery also takes place nearly every winter. There are a large number of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

The commercial yield of whitefish from WFS-07 has averaged 468,000 lb during 1976-2002. A peak yield of one million pounds occurred in 1990 and the lowest reported yield was 98,000 lb in 1977. The 2002 yield was 394,000 and the TAC was 302,000 lb.

The large-mesh gill net fishery accounted for 76% of the whitefish yield from WFS-07 during 1976-2002. The trap net fishery harvested more whitefish from the unit than the gill net fishery only during 1998-2000. The yield in 2002 was 257,000 lb from the gill net fishery and 137,000 lb from the trap net fishery.



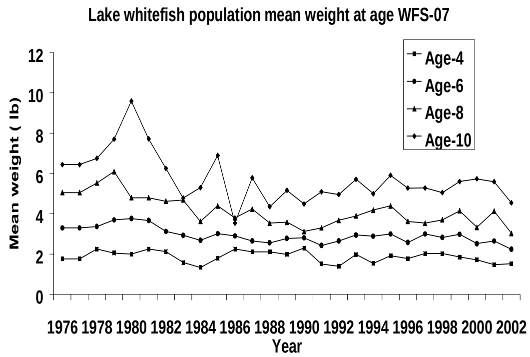
Yield of whitefish from WFS-07 has mirrored changes in fishing effort during 1976-2002. After peaking at 17.8 million ft in 1990, large-mesh gill net effort declined to between four and six million ft during 1996-2002. Gill net effort was 6.4 million ft in 2002. Trap net effort increased almost annually from 128 lifts in 1985 to 1,161 lifts in 2000, and then declined to 175 lifts in 2001 and 640 lifts in 2002.



Whitefish caught in WFS-07 are of moderate to large size. Mean weight of a harvested whitefish averaged 3.2 lb in the gill net fishery and 2.8 lb in the trap net fishery during 1976-2002. Mean weight of a harvested whitefish in

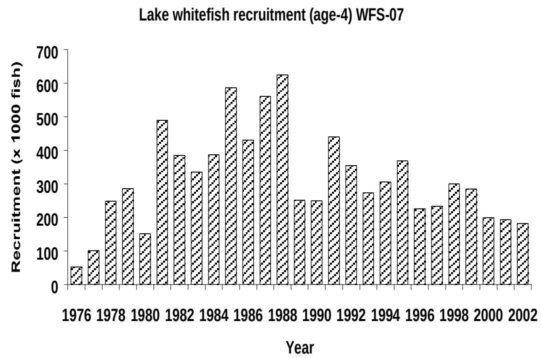
2002 averaged 3.1 lb in the gill net fishery and 2.7 lb in the trap net fishery.

There have been two directional changes in growth of whitefish in WFS-07. From 1976-1990 mean weight-at-age declined, particularly for whitefish $\geq$age 6. Mean weight-at-age generally increased for whitefish $\geq$age 6 in WFS-07 after 1990.

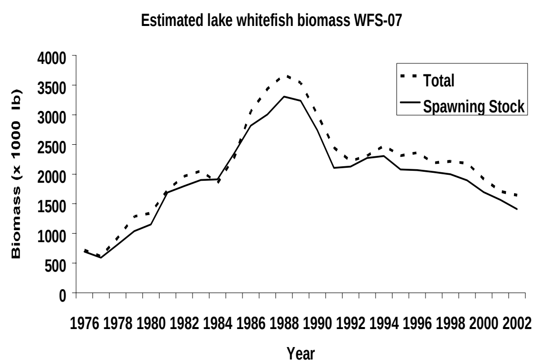


Sexual maturity of whitefish in WFS-07 occurs at a small size and young age, but complete maturity of females occurs at a large size and old age. Female whitefish begin reaching sexual maturity at age 3 and about 15 inches long, and by age 5 over 50% of females are sexually mature. After age 5, however, 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 has gone through at least two significant changes during 1976-2002. Recruitment increased through time from 1976-1988, thereafter, recruitment declined by one-half and has been slowly declining since 1991. The stock assessment model estimated that an average of 315,000 age-4 whitefish recruited to the fishable population each year during 1976-2002. Recruitment varied from 52,000 fish in 1976 to 625,000 fish in 1988. About 257,000 age-4 whitefish have recruited to the fishable population each year during 1993-2002. Recruitment was estimated to be 182,000 age-4 whitefish in 2002.

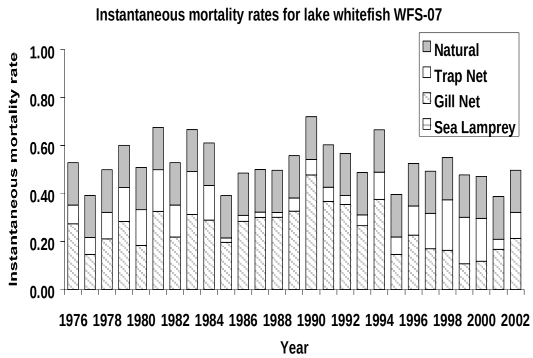


Average fishable biomass of age-4 and older whitefish peaked at 3.67 million lb in 1989 and has declined and stabilized since then. The fishable stock biomass was 1.6 million lb in 2002, compared to a spawning biomass of 1.4 million lb in 2002. The estimated biomass of whitefish in 2002 was equal to levels observed in the mid 1980s.



Instantaneous total annual mortality of age-4 and older whitefish showed little change through time during 1976-2002. The variations in total mortality were driven largely by changes in fishing effort, particularly large-mesh gill net effort. Instantaneous total annual mortality on age-4 and older fish averaged 0.53 y^{-1} during 1976-2002 and ranged from 0.72 y^{-1} in 1990 to 0.38 y^{-1} in 2001. Fishing mortality averaged 0.35 y^{-1} during 1976-2002, while natural mortality was estimated to be 0.17 y^{-1}. Gill net mortality averaged 0.25 y^{-1} and trap net mortality 0.10 y^{-1} during 1976-2002. Fishing mortality in 2002 was

0.32 y^{-1}, with gill net mortality being 0.21 y^{-1} and trap net mortality 0.11 y^{-1}.



Since total annual mortality was less than the target rate of 1.05 y^{-1} in WFS-07 in 2001, the projection model estimated that fishing mortality could be increased from the levels experienced during 2000-2002. As a consequence, the recommended yield limit was estimated to be **585,000 lb** in 2004. The recommended yield limits were 502,000 lb in 2003, 302,000 in 2002, and 409,000 lb in 2001.

Summary Status WFS-07 Whitefish		
Female maturity		
	Size at first spawning	1.57 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.01 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	7.283 lb (SE 0.001)
	Current SSBR	1.57 lb (SE 0.1)
	SSBR at target mortality	0.250 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.216 (SE 0.014)
Average yield per recruit		1.475 lb (SE 0.006)
Natural Mortality (M)		0.176 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.166 y^{-1} (SE 0.013)
	Average trap net F, ages 4+	0.11 y^{-1} (SE 0.007)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.452 y^{-1} (SE 0.019)
Recruitment (age-4)	(1993-2002 average)	256,660 fish (SE 9,738)
Biomass (age 3+)	(1993-2002 average)	2,132,600 lb (SE 81,100)
Spawning biomass	(1993-2002 average)	1,933,100 lb (SE 75,639)
MSC recommended yield limit for 2004		585,000 lb
Actual yield limit for 2004 (HRG)		585,000 lb

WFS-08 (Brimley)

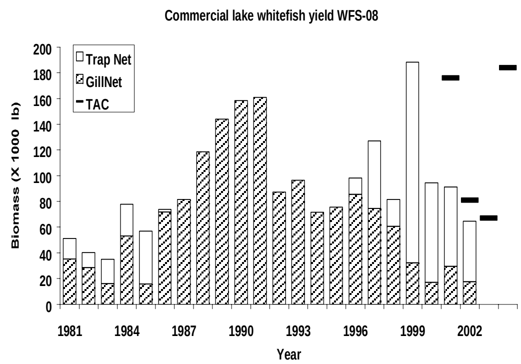
Prepared by Mark P. Ebener

WFS-08 is located in the very southeast portion of Whitefish Bay, Lake Superior. Although 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 <240 ft deep. A substantial commercial fishery targeting whitefish also exists in the adjacent Canadian management units 33 and 34.

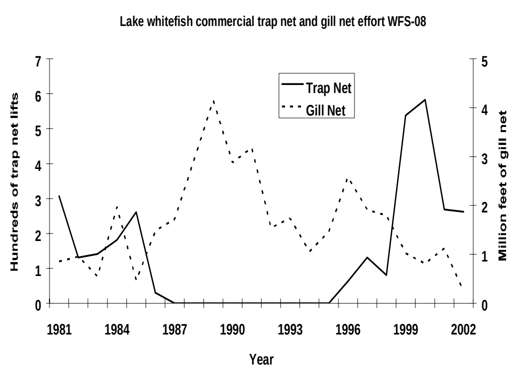
There are probably four reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Whitefish that spawn in WFS-07 are caught in the commercial fishery of WFS-08. The areas off Birch Point and Iroquois Island are both whitefish spawning grounds that contribute to the fishery in WFS-08. A fourth spawning population located in Canadian waters off Gros Cap to the east of Iroquois Point also contributes whitefish to the fishery in WFS-08.

WFS-08 has been and 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 seven or eight undeveloped landing sites that are commonly used by the CORA 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.

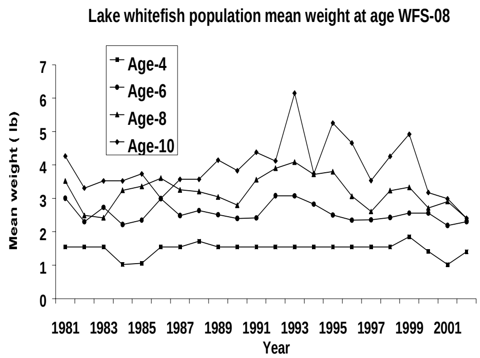
The commercial yield of whitefish from WFS-08 has averaged 94,300 lb during 1981-2002. Annual yields ranged from 35,000 lb in 1983 to 188,000 lb in 1999. The peak yield of 195,000 lb occurred in 1979, just prior to the creation of CORA. The large-mesh gill net fishery accounted for 74% of the whitefish yield from WFS-08 during 1981-2002. There was no trap net yield from WFS-08 during 1987-1995. The trap net yield in 2002 was 47,200 lb, while the gill net yield was 17,500 lb.



Gill net effort has been declining in WFS-08 while trap net effort has increased tremendously. Peak gill net effort was 4.1 million ft in 1989 but has declined to an average of 0.7 million ft during 2000-2002. Gill net effort was 0.25 million ft in 2002. Trap net effort peaked at 738 lifts in 1979, declined to zero during 1987-1995, and increased to 583 lifts in 2000. Trap net effort was 262 lifts in 2002.



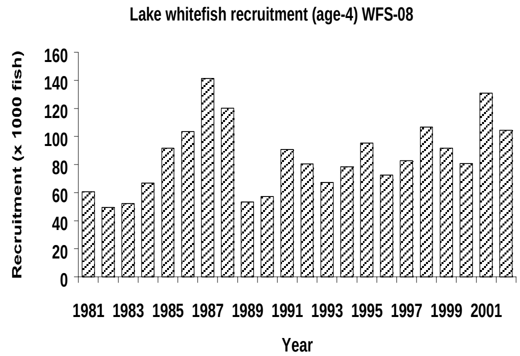
Whitefish in WFS-08 are of moderate to large size. Mean weight of a harvested whitefish in the gill net fishery averaged 3.0 lb and mean weight in the trap net fishery averaged 2.3 lb during 1981-2002. Mean weight of a harvested whitefish in 2002 was 2.1 lb in the trap net fishery and 3.0 lb in the gill net fishery.



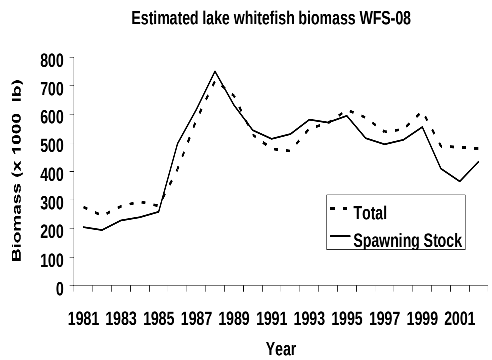
Growth in weight of whitefish in WFS-08 has remained constant through time unlike in other units of the 1836 ceded territory. There have been some minor patterns in mean weight-at-age, but for the most part growth has been stable.

Whitefish in WFS-08 mature at smaller sizes and ages than in WFS-07. 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.

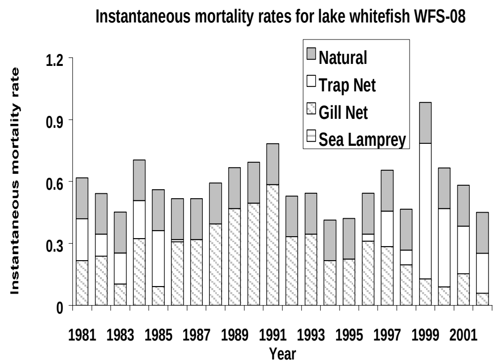
Recruitment of age-4 whitefish to the fishable population in WFS-08 has been less variable than in adjacent unit WFS-07. The stock assessment model estimated that an average of 85,000 age-4 whitefish recruited to the fishable population in WFS-08 each year during 1981-2002. Recruitment peaked in 1987 and 1988 at 141,000 and 120,000 age-4 whitefish, respectively. Thereafter, recruitment was fairly stable ranging from 53,000 to 131,000 lb during 1989-2002. Recruitment was estimated to be 104,000 age-4 whitefish in 2002.



Because whitefish in WFS-08 mature at a young age and small size, fishable and spawning stock biomass vary concurrently and are nearly equal. Fishable stock biomass in WFS-08 averaged 486,000 lb during 1981-2002 and ranged from 241,000 lb in 1982 to 718,000 lb in 1988. Fishable and spawning stock biomass was 480,000 and 434,000 lb, respectively.



The large-mesh gill net fishery was the largest single source of mortality in whitefish from WFS-08. Annual instantaneous total annual mortality of age-4 and older whitefish averaged 0.59 y^{-1} during 1981-2002 and ranged from 0.41 y^{-1} to 0.93 y^{-1}. Total mortality rate was 0.65 y^{-1} in 2002. Average gill net mortality was 0.27 y^{-1} compared to 0.12 y^{-1} for the trap net fishery during 1981-2002. Trap nets were the largest single source of mortality during 1999-2002. Trap net mortality was 0.19 y^{-1} and gill net mortality 0.06 y^{-1} in 2002.



Total annual mortality on age-4 and older whitefish was less than the target rate of 1.05 y^{-1} during 2000- 2002. The SPR value at the target mortality rate was 0.26 and greater than the target SPR value of 0.20. Thus the projection model estimated that fishing mortality rate could be increased from levels experienced during 2000-2002. The recommended yield limit was estimated to be **184,000 lb** in 2004, compared to 67,000 lb in 2003. The recommended yield limit was 81,000 lb in 2002, and 176,000 in 2001.

Summary Status WFS-08 Whitefish		
Female maturity		
	Size at first spawning	1.28 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	4.32 lb (SE 0.007)
	Current SSBR	1.13 lb (SE 0.04)
	SSBR at target mortality	0.212 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.263 (SE 0.009)
Average yield per recruit		1.216 lb (SE 0.010)
Natural Mortality (M)		0.197 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.101 y^{-1} (SE 0.007)
	Average trap net F, ages 4+	0.268 y^{-1} (SE 0.017)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.566 y^{-1} (SE 0.022)
Recruitment (age-4)	(1993-2002 average)	91,054 fish (SE 4,840)
Biomass (age 3+)	(1993-2002 average)	547,250 lb (SE 18,240)
Spawning biomass	(1993-2002 average)	503,570 lb (SE 16,310)
MSC recommended yield limit for 2004		184,000 lb
Actual yield limit for 2004 (HRG)		184,000 lb

Lake Huron

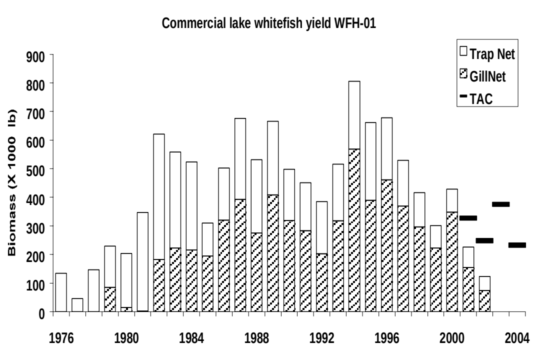
WFH-01 (St. Ignace)

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 as most water is <150 ft deep. WFH-01 contains 232,275 surface acres of water <240 ft deep.

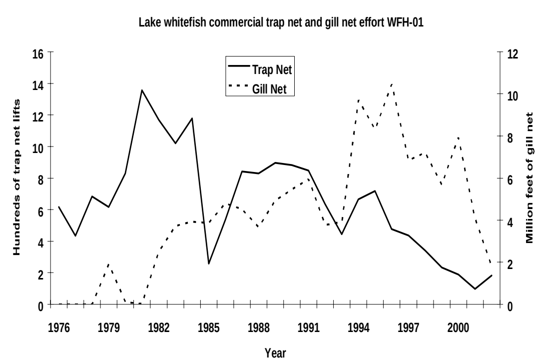
There are probably several reproductively isolated stocks of lake whitefish that inhabit WFH-01. One stock is located near Cheboygan, MI, another stock spawns north of St. Ignace near Rabbitsback and Horseshoe Bay, and third stock spawns in St. Martin Bay. A fourth stock probably spawns near Hessel, 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 806,000 lb in 1994 and averaged 468,000 lb during 1993-2002. The commercial yield was 122,000 lb in 2002 compared to 226,000 lb in 2001 and the commercial yield in 2002 was less than the recommended harvest limit of 248,000 lb.



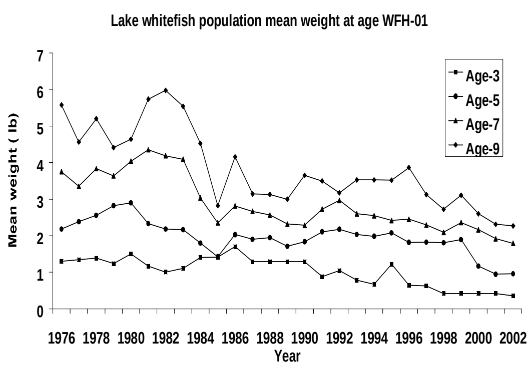
The large-mesh gill net fishery has accounted for the majority of the commercial yield from WFH-01 during 1976-2002. From 1976-1984 large-mesh gill nets accounted for 0-41% of the annual fishery yield, while after 1985 gill nets accounted for 52-81% of the annual yield. The gill net fishery accounted for 68% of the commercial yield of lake whitefish from WFH-01 during 1993-2002. The gill net fishery harvested 73,900 lb in 2002 compared to 48,500 for the trap net fishery.

Both gill net and trap net fishing effort has been declining in WFH-01. Trap net effort peaked at 1,357 lifts in 1981 and since then it has declined almost annually reaching a low of 98 lifts in 2001. Trap net effort was 128 lifts in 2002. Gill net effort was stable at about 4 million ft from 1983 to 1993, increased to 10.5 million ft in 1996, and has declined since to 1.8 million ft in 2002.



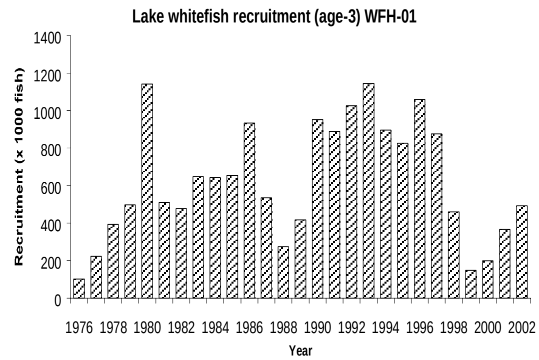
Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No1 fish (<3 lb). Mean weight of whitefish in the trap net fishery ranged from 2.1 to 2.3 lb during 1993-2002. Mean weight of whitefish in the gill net fishery ranged from 2.2 to 2.5 lb during 1993-2002. Mean weight of a harvested whitefish was 2.5 lb in the gill net fishery and 2.2 lb in the trap net fishery in 2002.

Growth of lake whitefish, expressed as mean weight at age, appeared to stabilize somewhat in WFH-01 during 2002. Mean weight of age-4 and age-5 whitefish increase 15% and 1%, respectively, from 2001 to 2002. In comparison, mean weight declined 2-8% for age 6 and older fish from 2001 to 2002. Mean weight at ages-4 and older in 2002 was 49-63% less than during 1976-1983.

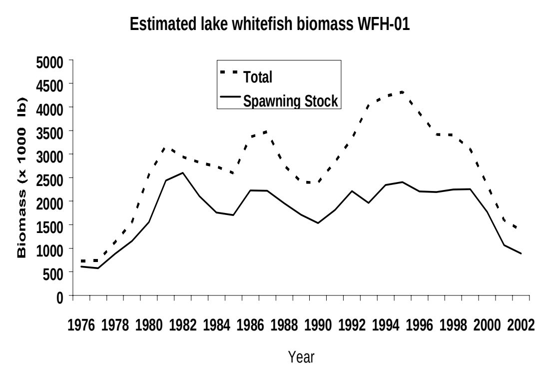


The decline in growth has had a profound effect on sexual maturity of whitefish in WFH-01. All female whitefish of age-6 and older were sexually mature during 1976-1980. Since then the proportion of mature females at any age has declined dramatically. For example, the proportion of sexually mature age-4 female whitefish declined from 66% during 1976-1982 to 45% during 1983-1992, to 24% during 1993-2000 and to 5% during 2001-2002. During 2001-2002 the proportion of mature females was 20% at age-5, 54% at age-6, 72% at age-7, 80% at age-8, and 90% for ages 9 and older.

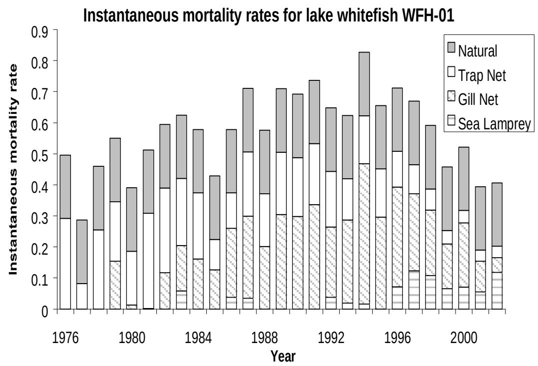
Large year-classes of whitefish were produced during 1987-1994 in WH-01, and then recruitment declined. These large year-classes produced the large yield of 806,000 lb in 1994 and also probably helped suppress growth of whitefish in the unit. The long-term trend in recruitment in WFH-01 appears be cyclic with stable and good recruitment for 8-9 yr then declines of 2-3 yr before increasing again.



Because of the declines in growth and recruitment in WFH-01, biomass declined to a low level in 2002. Spawning stock biomass of whitefish in WFH-01 has always been considerably less than total biomass, in comparison to some other units in Lake Huron, but the biomass of 1.38 million lb in 2002 was lower than all years except prior to 1979. Total stock biomass declined from 1.59 million lb in 2001 to 1.38 million lb in 2002. Spawning biomass declined from 1.07 million lb in 2001 to 0.89 million lb in 2002.



The large-mesh gill net fishery has been the single largest source of fishing mortality on whitefish in WFH-01. Gill net fishing mortality rate of age-4 and older whitefish ranged from 0.0 y^{-1} to 0.45 y^{-1} during 1976-2002, whereas trap net fishing mortality rate ranged from 0.04 y^{-1} to 0.31 y^{-1} during 1976-2002 on age-4 and older fish. Gill net fishing mortality rate was 0.05 y^{-1} and trap net fishing mortality rate average 0.04 y^{-1} in 2002.



Natural mortality rate, including sea lamprey-induced mortality, was greater than fishing mortality during the last five years in WFH-01. Natural mortality including sea lamprey mortality ranged from 0.25 y^{-1} to 0.32 y^{-1} during 1998-2002, whereas total fishing mortality rate declined from 0.27 y^{-1} in 1998 to 0.08 y^{-1} in 2002. From 1998 to 2002 natural mortality averaged 0.20 y^{-1}, gill net mortality 0.14 y^{-1}, sea lamprey morality 0.08 y^{-1} and trap net mortality 0.04 y^{-1} on age-4 and older whitefish.

The current spawning potential reduction value of 0.28 in WFH-01 during 2000-2002 was greater than the minimum value of 0.20 as defined by the modeling subcommittee. Thus, the projection model estimated that fishing mortality rate could be increased above the 1999-2001 values. The increase in fishing effort produced a recommended yield limit of **232,000 lb** for 2004, a decrease from the 375,000 lb limit in 2003.

Summary Status WFH-01 Whitefish		
Female maturity		
	Size at first spawning	0.40 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.59 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.642 lb (SE 0.003)
	Current SSBR	0.46 lb (SE 0.02)
	SSBR at target mortality	0.046 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.283 (SE 0.010)
Average yield per recruit		0.378 lb (SE 0.014)
Natural Mortality (M)		0.233 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.118 y^{-1} (SE 0.011)
	Average trap net F, ages 4+	0.037 y^{-1} (SE 0.003)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	0.093 y^{-1}
Total mortality (Z)		
	Average ages 4+,2000-2002	0.47 y^{-1} (SE 0.013)
Recruitment (age-3)	(1993-2002 average)	646,540 fish (SE 41,683)
Biomass (age 3+)	(1993-2002 average)	3,170,200 lb (SE 112,710)
Spawning biomass	(1993-2002 average)	1,934,800 lb (SE 72,117)
MSC recommended yield limit for 2004		232,000 lb
Actual yield limit for 2004 (HRG)		232,000 lb

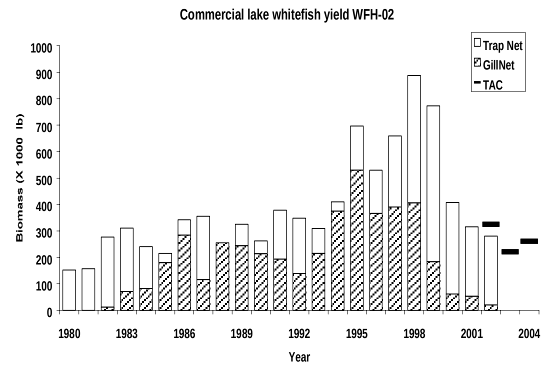
WFH-02 (Detour)

Prepared by Mark P. Ebener

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 greater than 300 ft. WFH-02 is a small unit that is made up of only three statistical grids and contains 122,562 surface acres of water <240 ft deep. The unit has an irregular shoreline with many small, rocky points, isolate bays, and scattered boulders.

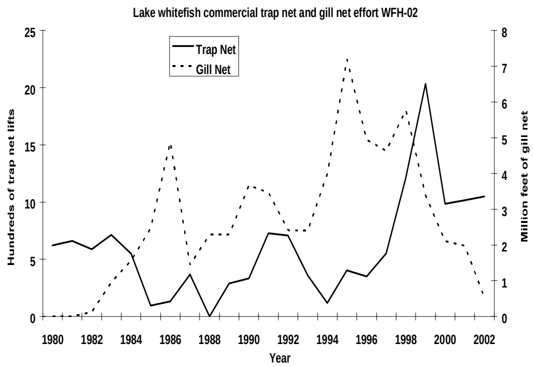
Because the shoreline of WFH-02 is highly irregular and rocky, nearly the entire unit contains habitat suitable for reproduction and survival of young. Spawning concentrations of whitefish can be found throughout the unit from Beavertail Point in the west portion of the unit to St. Vitals Point in the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

WFH-02 has been a CORA exclusive fishing zone since the 1985 Consent Decree. The commercial yield of lake whitefish ranged from a low of 152,000 lb in 1980 to 888,000 lb in 1998. The fishery yield averaged 527,000 lb during 1993-2002. The yield of whitefish from WFH-02 declined from 408,000 lb in 2000 to 316,000 lb in 2001 and to 281,000 lb in 2002.

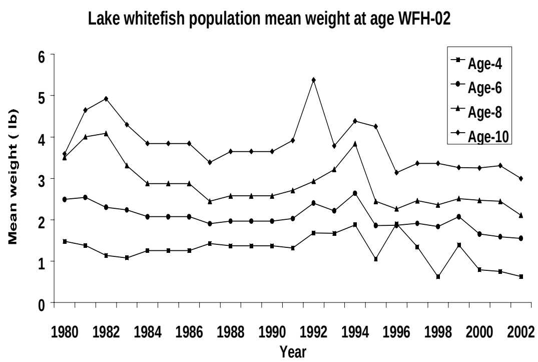


The allocation of the harvest among fishing gears has changed dramatically in WFH-02 over the past few years. During 1985-1997 the large-mesh gill net fishery accounted for the majority of harvest in every year. After 1997 the trap net fishery accounted for the largest proportion of the harvest. The trap net fishery harvested 260,000 lb of whitefish in 2002, while the gill net fishery harvested only 20,700 lb. The gill net yield in 2002 was lower than every other year except 1982 when the CORA fishery began in WFH-02.

Both large-mesh gill net and trap net effort have changed markedly in WFH-02 since 1980. Trap net effort ranged from 0 to 713 lifts between 1980 and 1997, thereafter effort increased to 2,033 lifts in 1999, then declined by half and stabilized between 950 and 1,050 lift during 2000-2002. Large-mesh gill net effort increased from zero in 1981 to 7.2 million ft in 1995, since then gill net effort has declined to 0.5 million ft in 2002.



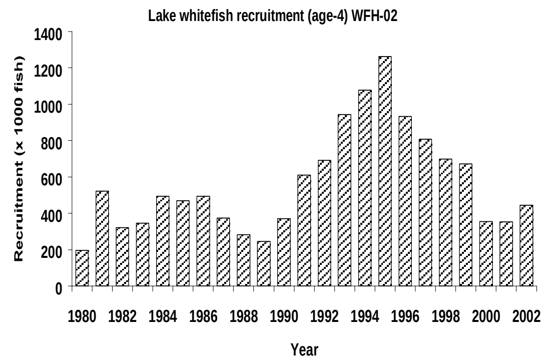
Whitefish in WFH-02 have always been of small size. No. 1 fish make up 90% of the harvest from the unit. Mean weight in the trap net harvest has ranged from 2.0 to 2.3 lb and mean weight in the gill net harvest ranged from 1.9 to 2.8 lb during 1993-2002. Mean weight of a harvested whitefish was 2.2 lb in the trap net fishery and 2.6 lb in the gill net fishery in 2002.



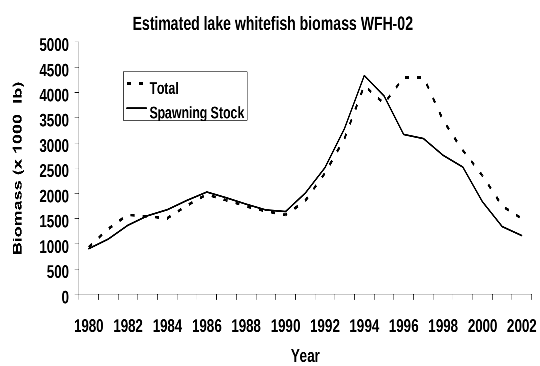
A distinct characteristic of whitefish in WFH-02 is their small size at sexual maturity. Some females are sexually mature by 14 inches long and 50% are sexually mature at 15.7 inches long. Age at first maturity begins at age-3 and 90% are sexually mature by age-7.

Unlike other units in Lake Huron, growth of whitefish in WFH-02 has remained stable through time. There has been a slight decline in mean weight at age since the early 1980s, but the declines have not been nearly as steep as in WFH-01, WFH-04, and WFH-05.

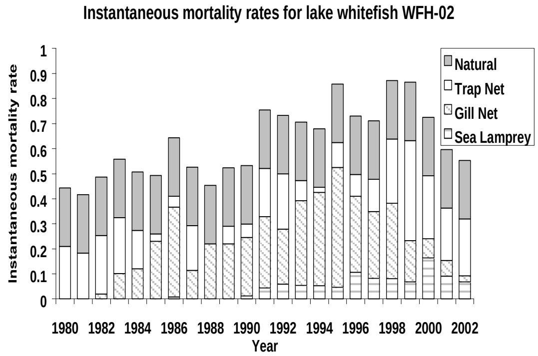
The substantial increase in commercial fishery yield during the mid 1990s in WFH-02 was driven largely by increased recruitment. The 1988-1993 year classes of whitefish were substantially larger than preceding and subsequent year classes in WFH-02. The stock assessment model estimated that the 1991-year class contained 1.26 million fish when it recruited to the fishery at age 4 in 1995. The 1989, 1990, 1992, and 1993 year classes contained between 933,000 and 1.1 million age-4 whitefish when they recruited to the fishery. Prior to 1992 and after 1997 most year classes that recruited to the fishery at age-4 did not exceed 600,000 fish. The 1998 year class was estimated to contain 445,000 fish at age-4 when it recruited in 2002.



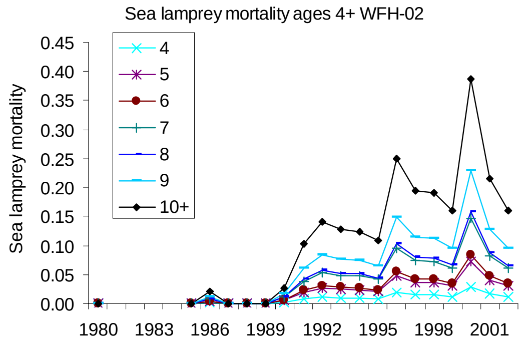
The large increase in recruitment during the mid 1990s more than doubled biomass of whitefish in WFH-02. Fishable biomass of whitefish in WFH-02 increased from 1.57 million lb in 1990 to 4.3 million lb in 1996 and 1997. Fishable and spawning stock biomass are nearly equivalent in WFH-02 because the fish mature at such a small size and because growth has not declined much. Fishable biomass was estimated to be 1.5 million lb and spawning biomass 1.16 million lb in 2002.



Total annual mortality rate on age-4 and older whitefish in WFH-02 has increased nearly annually since 1980. Total annual mortality of age-4 and older whitefish nearly doubled from 0.44 y^{-1} in 1980 to 0.87 y^{-1} in 1999. Total annual mortality was 0.55 y^{-1} in 2002.



The increase in total mortality was due to the substantial increases in fishing effort through 1999 and because of increased sea lamprey predation since 1990. Prior to 1997 trap net mortality ranged from 0.02 y^{-1} to 0.23 y^{-1}, while after 1997 trap net mortality ranged from 0.21 y^{-1} to 0.40 y^{-1}. Gill net mortality ranged from 0.00 y^{-1} to 0.48 y^{-1} prior to 1997 and from 0.02 y^{-1} to 0.30 y^{-1} thereafter. Gill net mortality was 0.02 y^{-1} and trap net mortality was 0.23 y^{-1} in 2002. Sea lamprey mortality averaged 0.08 y^{-1} during 1993-2002 and was 0.07 y^{-1} in 2002.



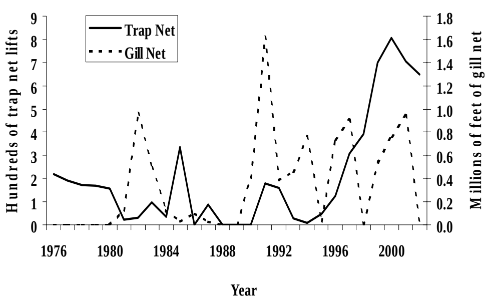
Total annual mortality of age-4 and older whitefish averaged 0.714 y^{-1} during 2000-2002, but mortality on fully vulnerable ages-9 and older exceeded the target rate of 1.05 y^{-1}. Spawning potential reduction at the current mortality rates was 0.30 and considerably greater than the target of 0.20. The projection model estimated that fishing mortality rate should be reduced to achieve the target mortality rate on older age classes even though the SPR was greater than target. As a consequence, the projection model estimated a yield limit of **261,000 lb** for 2004.

Summary Status WFH-02 Whitefish		
Female maturity		
	Size at first spawning	0.72 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.25 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	1.908 lb (SE 0.003)
	Current SSBR	0.58 lb (SE 0.02)
	SSBR at target mortality	0.099 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.305 (SE 0.010)
Average yield per recruit		0.520 lb (SE 0.014)
Natural Mortality (M)		0.267 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.062 y^{-1} (SE 0.007)
	Average trap net F, ages 4+	0.262 y^{-1} (SE 0.02)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	0.123 y^{-1}
Total mortality (Z)		
	Average ages 4+,2000-2002	0.714 y^{-1} (SE 0.026)
Recruitment (age-4)	(1993-2002 average)	754,430 fish (SE 36,743)
Biomass (age 3+)	(1993-2002 average)	3,150,900 lb (SE 106,950)
Spawning biomass	(1993-2002 average)	2,743,700 lb (SE 88,238)
MSC recommended yield limit for 2004		261,000 lb
Actual yield limit for 2004 (HRG)		261,000 lb

WFH-03 (Drummond Island)

Prepared by 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 and part of the North Channel and St. Marys River. WFH-03 contains six statistical grids and <100,000 surface acres of water <240 ft deep.



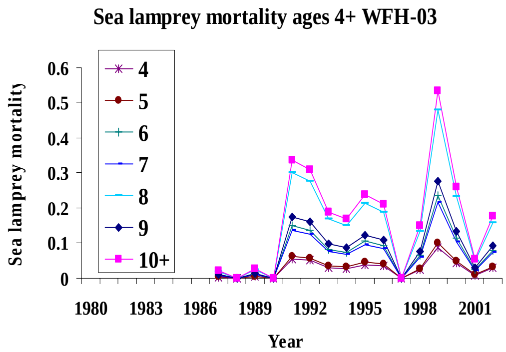
All of WFH-03 lies within the Niagara Escarpment and is composed of dolomite limestone. The spawning shoals for lake whitefish in WFH-03 are located primarily along the south shore of Drummond Island in the main basin of Lake Huron. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal by CORA staff during gill net surveys in October of 1991-2002.

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

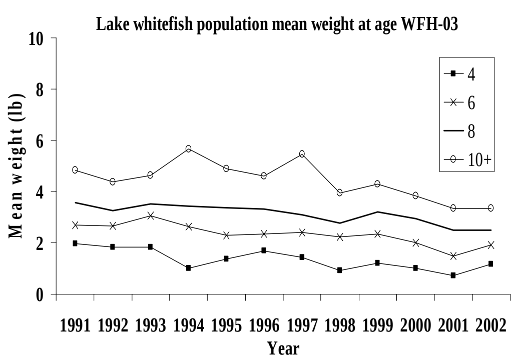
The commercial yield of lake whitefish from WFH-03 has increased tremendously since 1998. Prior to 1998 the commercial yield of lake whitefish exceeded 100,000 lb only once in 1985. After 1998 the commercial yield from WFH-03 was 221,000 lb in 1999, 295,000 lb in 2000, 370,000 lb in 2001, and 296,000 lb in 2002. Ninety-nine percent of the yield was taken with trap nets during 1999-2001. The harvest regulating guideline ranged from 250,000 to 318,000 lb during 1999-2001.

The large-increase in harvest in WFH-03 during 1999-2002 was directly related to increased trap net effort. Trap net effort ranged from 0 to 392 lifts in WFH-03 during 1976-1997, thereafter trap net effort increased to 673 lifts in 1999, 806 lifts in 2000, 706 lifts in 2001, and 650 lifts in 2002. Gill net effort was highly variable in WFH-03 ranging from 0 to 162,000 ft. during 1976-2002.

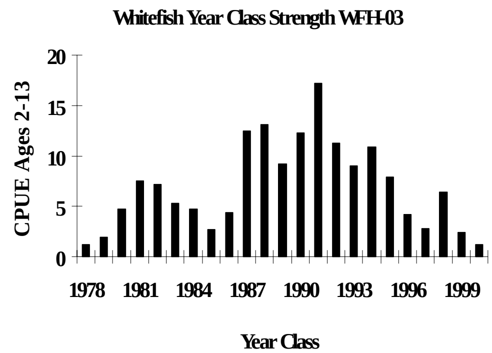
Whitefish caught in the fishery of WFH-03 are moderate size. During 1987-2001 67% of the whitefish harvested were No. 1 fish, 25% were mediums (3-4 lb) and 8% were jumbos (>4 lb). Mean weight of whitefish in the trap net harvest ranged from 2.0 to 2.8 lb and average 2.7 lb during 1991-2002. Mean weight in the gill net fishery ranged from 2.3 to 3.0 lb and averaged 2.7 lb.



Growth of whitefish in WFH-03 has declined through time, but not at the rate that has occurred in more western areas of Lake Huron. Mean weight at age 4, 6, 8, and 10+ did decline during 1991-2002 based on catches made during CORA graded-mesh gill net surveys and monitoring of commercial trap net catches.



Recruitment of whitefish in WFH-03 appears very similar to that in WFH-02. The 1987-1995 year classes were very abundant, whereas the 1996 and 1997 year classes, as well as the 1985 and 1986 year classes, were not very abundant based on CPUE in CORA gill net surveys in WFH-03. The 1998 year class appears to be of reasonable size based on survey catches. It is too early to assess abundance of the 1999 and 2000 year classes.



Sea lamprey-induced mortality rate has been declining in WFH-03 since 1991 and after a short peak in 1999. Sea lamprey mortality of age-4 and older whitefish was <0.02 y^{-1} during 1987-1990, increased to 0.17 y^{-1} in 1991, then declined to 0.0 y^{-1} in 1997. Sea lamprey mortality peaked at 0.27 y^{-1} in 1999 then declined to 0.13 y^{-1} in 2000, 0.03 y^{-1} in 2001, and was 0.09 y^{-1} in 2002.

Reasonable estimates of abundance and mortality could not be produced with the stock assessment model for WFH-03. The model results were very unstable and changed by an order of magnitude in some cases after only small changes were made to input parameters of starting values.

A harvest regulating guideline of **305,500 lb** was established for WFH-03 in 2004 and represents the average yield during 2000-2002 from the unit. The harvest regulating guideline was 318,000 lb in 2003.

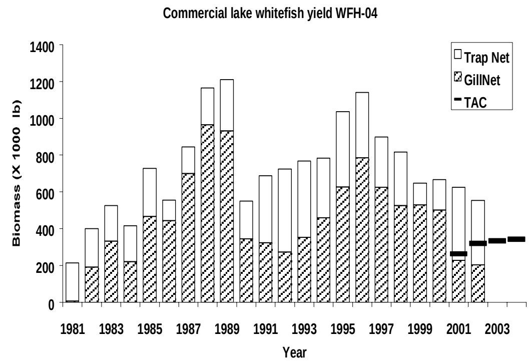
WFH-04 (Hammond Bay)

Prepared by Mark P. Ebener

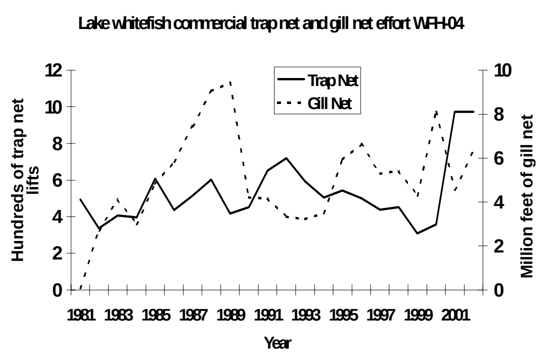
WFH-04 is the largest whitefish management unit in the 1836 treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water <240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found from Cheboygan, MI to Hammond Bay.

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 the majority of the whitefish harvest from the unit from 1985-2000. In 2001 the trap net harvest from WFH-04 exceeded the gill net harvest for the first time since 1981. The annual yield ranged from a high of 1.2 million lb in 1989 to a low of 231,000 lb in 1981. The annual yield of whitefish from the unit averaged 793,000 lb during 1993-2002. The trap net harvest of whitefish was 3506,000 lb in 2002 compared to 203,000 lb for the large-mesh gill net fishery. The 2002 yield of 554,000 lb was substantially less than the harvest regulating guideline of 634,000 lb for 2002, but substantially greater than the recommended harvest limit (TAC) of 320,000 lb.



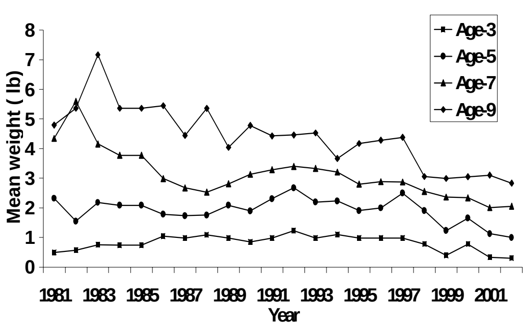
Trap net effort continued to be high in 2002 and gill net effort increased slightly from 2001 to 2002. Large-mesh gill net effort peaked at 7.7 million ft in 1989 and 5.2 million ft in 2000. Large-mesh gill net effort was 6.3 million ft in 2002. Trap net effort peaked at 719 lifts in 1992 then declined to 308 lifts in 1999 before increasing to 974 lifts in 2002. The changes in fishing effort occurred largely because two CORA trap net operations began fishing in WFH-04 during 2001 as part of the gear conversion program stipulated in the 2000 Consent Decree.



Whitefish from WFH-04 are of moderate size. The commercial harvest from WFH-04 was composed of 65% No. 1 whitefish (<3.0 lb), 26% mediums (3-4 lb), and 9% jumbos (>4.0 lb) during 1982-2002. Annual mean weight of whitefish caught in the gill net fishery ranged from 2.5 to 3.0 lb during 1982-2002, while mean weight in the trap net fishery ranged from 2.4 to 3.6 lb during 1982-2002. Mean weight in the harvest in 2002 was 2.4 lb for the trap net fishery and 2.8 lb for the gill net fishery.

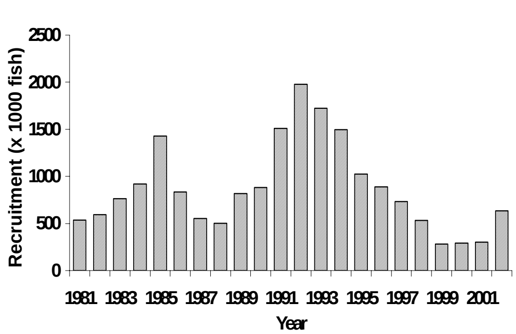
Growth rate of whitefish from WFH-04 continues to decline. Only mean weight of age-7 whitefish increased from 2001 to 2002. Mean weight of other ages was lower in 2002 than any other year during 1981-2002.

Lake whitefish population mean weight at age WFH-04



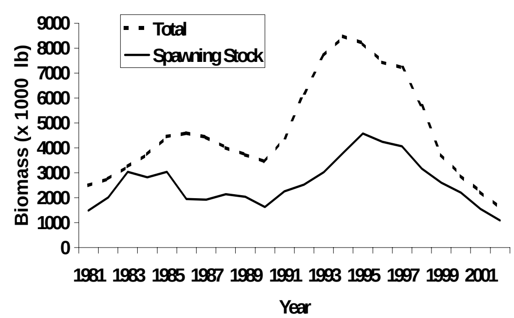
The declines in harvest from WFH-04 that have occurred from 1996 to 2002 are largely being driven by declines in both mean weights at age and recruitment. The 1988-1991 year classes of whitefish were very abundant in WFH-04 ranging from 1.50 to 1.98 million age-3 whitefish for these four year classes. Unfortunately, recruitment declined dramatically after the 1991 year class and the 1996-1998 year classes were the least abundant as they recruited at age 3 to the fishery in WFH-04. Abundance at age 3 for the 1996-1998 year classes ranged from 280,000 to 300,000 fish.

Lake whitefish recruitment (age-3) WFH-04



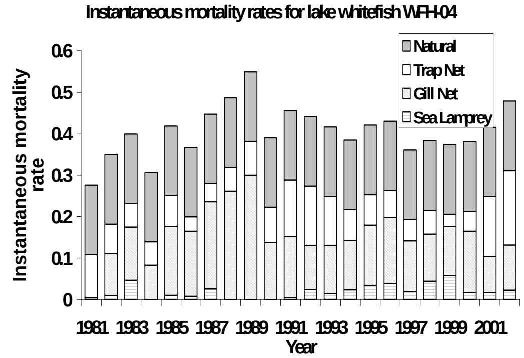
The combined effects of reduced recruitment and growth has meant that biomass of whitefish in WFH-04 was lower in 2002 than any other year during last 21 yr. After peaking at 8.5 million lb in 1994, fishable biomass declined annually to only 1.6 million lb in 2002. Spawning stock biomass declined from 4.6 million lb in 1995 to 1.1 million lb in 2002. Given that the 1999 year class does not appear to be very abundant, biomass of whitefish in WFH-04 can be excepted to continue to decline.

Estimated lake whitefish biomass WFH-04



Total annual mortality of age-4 and older whitefish averaged 0.518 y^{-1} during 2000-2002. Gill net fishing mortality averaged 0.131 y^{-1}, trap net fishing mortality 0.142 y^{-1}, and sea lamprey mortality 0.025 y^{-1} during 2000-2002. Gill net mortality was 0.11 y^{-1}, trap net mortality 0.18 y^{-1}, and sea lamprey mortality 0.02 y^{-1} on age-4 and older whitefish in 2002.

Instantaneous mortality rates for lake whitefish WFH-04



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 rate could be increased in 2004 over that experienced during 2000-2002. The SPR value at the target-fishing rate was 0.23. The recommended harvest was **343,000 lb** for 2004. The HRG set for 2004 was 518,000 lb, which represents the average yield from 2001-2003.

Summary Status WFH-04 Whitefish		
Female maturity		
	Size at first spawning	0.47 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.71 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.69 lb (SE 0.)
	Current SSBR	0.39 lb (SE 0.02)
	SSBR at target mortality	0.105 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.229 (SE 0.012)
Average yield per recruit		0.693 lb (SE 0.005)
Natural Mortality (M)		0.224 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.131 y^{-1} (SE 0.008)
	Average trap net F, ages 4+	0.142 y^{-1} (SE 0.011)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	0.025 y^{-1}
Total mortality (Z)		
	Average ages 4+,2000-2002	0.518 y^{-1} (SE 0.018)
Recruitment (age-3)	(1993-2002 average)	790,150 fish (SE 29,294)
Biomass (age 3+)	(1993-2002 average)	5,512,600 lb (SE 154,040)
Spawning biomass	(1993-2002 average)	3,032,400 lb (SE 104,100)
MSC recommended yield limit for 2004		343,000 lb
Actual yield limit for 2004 (HRG = 2001-2003 average yield)		518,000 lb

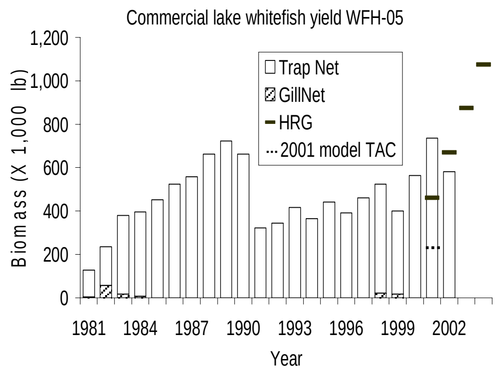
WFH-05 (Alpena)

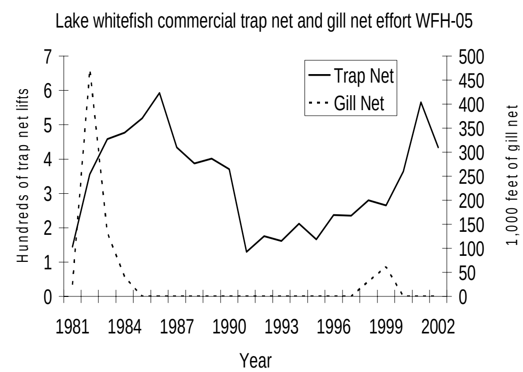
Prepared by Aaron P. Woldt and Mark P. Ebener

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-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 essentially 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 2 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.

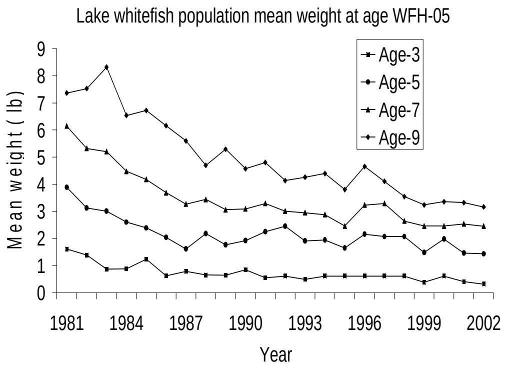
Annual commercial trap net yields have ranged from 124,000 lb in 1981 to 736,000 lb in 2001 and averaged 461,000 lb during 1981-2002. Trap net harvest and effort have been directly related over the modeled time series and have been especially linked since 1991. As trap net effort increased from 130 lifts in 1991 to 566 lifts in 2001, the yield increased from 322,000 lb in 1991 to 736,000 lb in 2001. In 2002, both trap net effort (434 lifts) and yield (581,000 lb) decreased slightly. These decreases may be linked to low wholesale prices for lake whitefish in 2002.



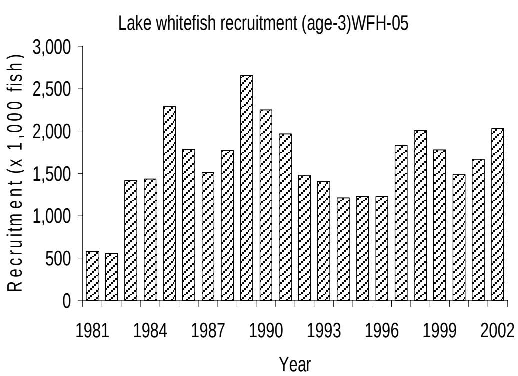


Whitefish in WFH-05 are of similar size to those in WFH-04. The commercial harvest from WFH-05 was made up of 70% No. 1 whitefish, 23% mediums, and 7% jumbos. Mean weight of a harvested whitefish was 2.7 lb in WFH-05 in 2002.

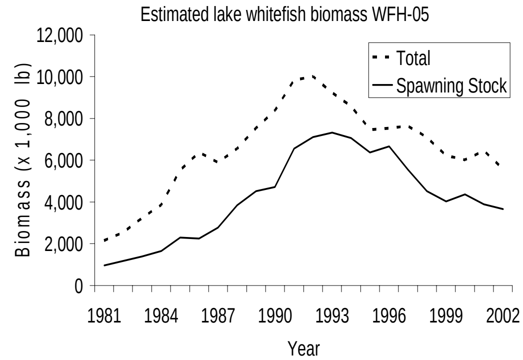
Weight at age of whitefish in WFH-05 has stabilized over the last few years after continually declining from 1981 to 1999. Prior to 1984 age-9 and older whitefish weighed between 7 and 8 lb, but by 2002 they weighed about 3.2 lb. This large decrease in average weight for older age fish is likely due to decreased growth rates. Mean weight of all age-classes in 2002 was similar to mean weight in 1999, 2000, and 2001.



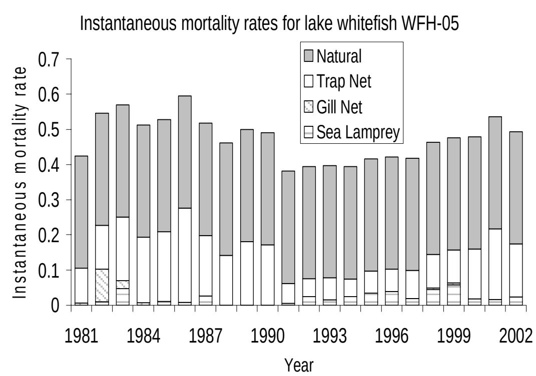
Recruitment of age-3 whitefish to the fishable population in WFH-05 has increased and remained relatively constant since 1997. Recruitment peaked at 2.7 million age-3 whitefish in 1989 and then declined annually to about 1.2 million age-3 whitefish in 1996 (1993 year class). From 1997 through 2002 estimated recruitment averaged about 1.80 million age-3 whitefish. The stock assessment model estimated that 2.03 million age-3 whitefish were present in the population during 2002.



Both fishable and spawning stock biomass has 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 10.0 million lb in 1992 and has since declined to 5.6 million lb in 2002. Spawning stock biomass peaked at 7.3 million lb in 1993 and then declined to 3.7 million lb in 2002.



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, although trap net mortality decreased slightly in 2002 to 0.15 y^{-1}. Sea lamprey-induced mortality had been increasing in WFH-05 over the last decade, but since 2000 recent estimates have declined steadily to 0.02 y^{-1} in 2002.



Total annual mortality was estimated to be only 0.482 y^{-1} on age-4 and older whitefish in WFH-05 during 2000-2002. Total mortality was estimated to be 0.493 y^{-1} in 2002. 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 2.06 times over the 2000-2002 levels. The recommended yield limit at this increased rate of fishing was estimated to be 1,076,000 lb in WFH-05 for 2004. The recommended yield limit in 2003 was 875,000 lb. The harvest limit in this unit has steadily increased since 2001. Total tribal trap net harvest was below the HRG in 2002.

Summary Status WFH-05 Whitefish		
Female maturity		
	Size at first spawning	0.45 lb
	Age at First Spawning	3 y
	Size at 50% maturity	2.13 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.077 lb
		(SE 0.)
	Current SSBR	0.53 lb
		(SE 0.03)
	SSBR at target mortality	0.144 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.488
		(SE 0.027)
Average yield per recruit		0.407 lb
		(SE 0.025)
Natural Mortality (M)		0.319 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0. y^{-1}
		(SE 0.)
	Average trap net F, ages 4+	0.141 y^{-1}
		(SE 0.02)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	0.025 y^{-1}
Total mortality (Z)		
	Average ages 4+,2000-2002	0.482 y^{-1}
		(SE 0.02)
Recruitment (age-3)	(1993-2002 average)	1,587,100 fish
		(SE 183,120)
Biomass (age 3+)	(1993-2002 average)	7,183,100 lb
		(SE 724,900)
Spawning biomass	(1993-2002 average)	5,340,700 lb
		(SE 545,190)
MSC recommended yield limit for 2004		1,076,000 lb
Actual yield limit for 2004 (HRG)		1,076,000 lb

Lake Michigan

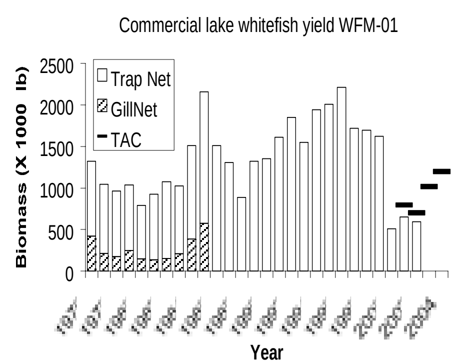
WFM-01 (Bays de Noc)

Prepared by Philip J. Schneeberger

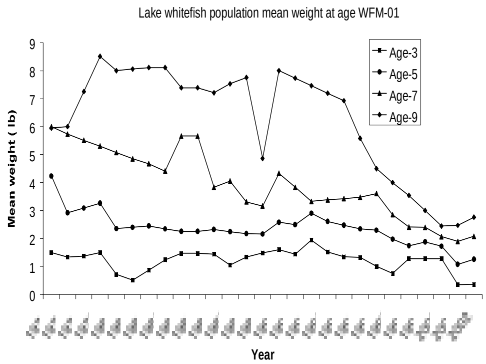
Lake whitefish management unit WFM-01 is located in 1836 Treaty waters of northern Green Bay. Prominent features of this area include two large bays (Big and Little bays de Noc), numerous small embayments, several islands (including St. Martins Island, Poverty Island, Summer Island, Little Summer Island, 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 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 that exhibits fairly consistent favorable conditions resulting in relatively stable recruitment from year to year. It is speculated that stocks spawning in other areas of WFM-01 are mixed. The bay areas are important nursery grounds for whitefish larvae and fry.

Trap net yield of lake whitefish in WFM-01 was 594,000 lb during 2002. There has been no commercial gill netting in this management zone since 1985. Total annual yield averaged 586,000 lb during 2000-02 compared to an average of 1,613,000 lb during 1986-99, prior to the 2000 Consent Decree, a 64% decline. Average trap net effort was 1,814 lifts/yr during 2000-02 compared with 5,084 lifts/yr during 1986-99, also a 64% decline.

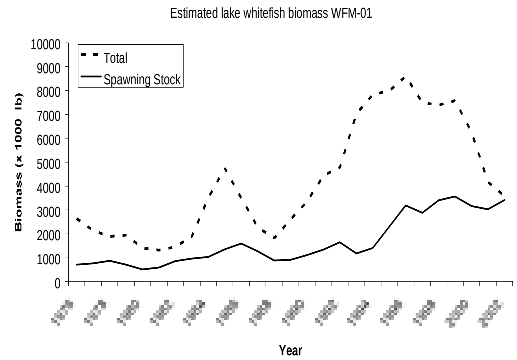


Weight-at-age for WFM-01 lake whitefish improved by an average of 26% across all age groups between 2001 and 2002. However, 2002 weight-at-age values averaged 30% below 1996-2000 average values.

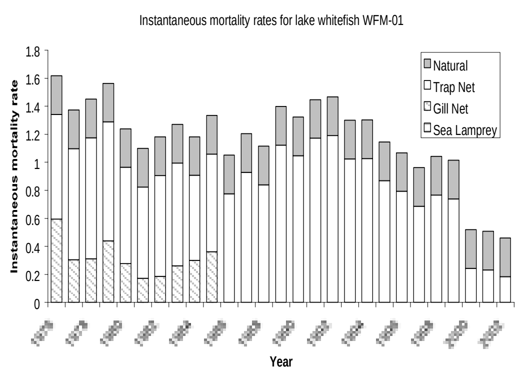


Estimated recruitment (numbers of age-3 fish) decreased in 2002 compared to 2001 and was the lowest of any estimate since 1986. The 2002 recruitment estimate of 832,000 lake whitefish was 25% less than average recruitment estimated between 1976 and 1992, and was 68% lower than the average for years of highest recruitment, 1993-1998.

Fishable biomass was estimated at 3.6 million lb in 2002 and of this total, spawning stock biomass (3.4 million lb) represented 95%. Compared to 2001, 2002 estimates of fishable biomass decreased but spawning stock biomass increased.



Estimates of instantaneous mortality rates decreased between 2001 and 2002. Total instantaneous mortality rate (Z) was estimated at 0.46 y^{-1} in 2002, with 0.28 y^{-1} attributable to instantaneous natural mortality rate (M) and 0.18 y^{-1} attributable to instantaneous fishing mortality rate (F). Instantaneous mortality rates were considered excessively high prior to 2000.



The projected 2004 yield limit for WFM-01 is 1.2 million lb. This represents an 18% increase from the 2003 yield limit of 1.02 million lb. The increase was influenced by low harvest in 2002 relative to the yield limit (594,000 lb vs. 703,000 lb), continued low estimated mortality rates, and fairly steady, though low, estimated recruitment. Factors that held the yield limit down included below average weight-at-age and decreased fishable biomass.

Summary Status WFM-01 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	0.84 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.35 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	1.938 lb (1.930 -1.946)
	Current SSBR	0.85 lb (0.79 -0.91)
	SSBR at target mortality	0.256 lb (0.256 - 0.256)
Spawning potential reduction		
	At target mortality	0.441 (0.409 -0.473)
Average yield per recruit		0.542 lb (0.520 - 0.564)
Natural Mortality (M)		0.276 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average trap net F, ages 4+	0.188 y^{-1} (0.164 - 0.212)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.464 y^{-1} (0.440 - 0.488)
Recruitment (age-3)	(1993-2002 average)	1,968,900 fish (1,650,580 - 2,287,220)
Biomass (age 3+)	(1993-2002 average)	6,792,700 lb (6,231,860 - 7,353,540)
Spawning biomass	(1993-2002 average)	2,755,500 lb (2,490,200 - 3,020,800)
MSC rcommended yield limit for 2004		1,197,000 lb
Actual yield limit for 2004		1,197,000 lb

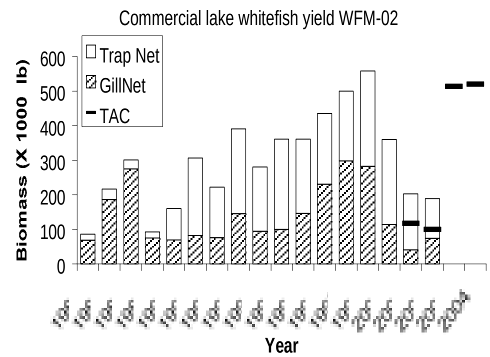
WFM-02 (Manistique)

Prepared by John K. Netto and Mark P. Ebener

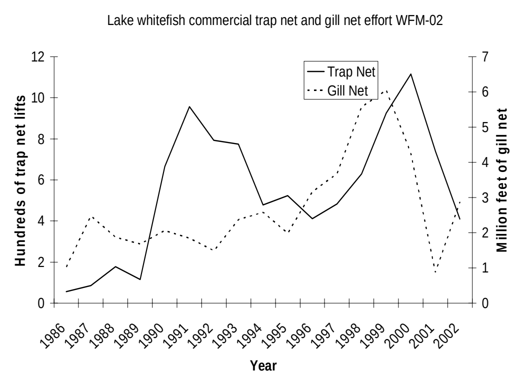
WFM-02 is located in the northwest portion of Lake Michigan. There are 387,000 surface acres of water less than 240 ft deep in the unit. The entire shoreline of WFM-02 lies within the Niagara Escarpment and is composed of dolomite limestone. The only known spawning population of whitefish in WFM-02 is located in Portage Bay; this population 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 large gill net boats have regularly fished WFM-02. 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. The unit is known for being a difficult place to fish with gill nets because logs, dead algae and periphyton, zebra mussels, and burbot routinely foul the gear.

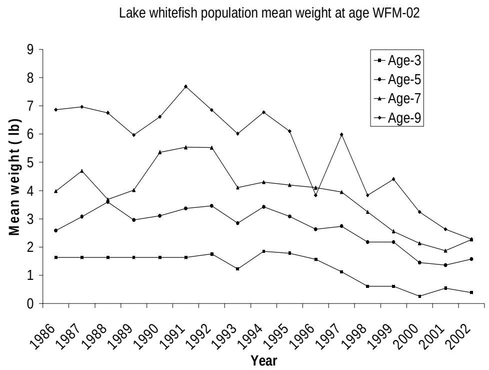
The average commercial yield from WFM-02 was 295,000 lb from 1986-2002. The peak yield was 559,000 lb in 1999 and the lowest yield was 11,000 lb in 1977. During 1993-2002 the average yield was 364,000 lb. The long-term harvest has been equally split between trap nets and gill nets.



The increase in yield from WFM-02 during the 1990's was due to substantial increases in fishing effort. Large-mesh gill net effort peaked at 4.5 million ft in 1999, but then declined substantially in subsequent years. Trap net effort peaked at 1,114 lifts in 2000 then declined to 739 lifts in 2001 and 410 lifts in 2002.



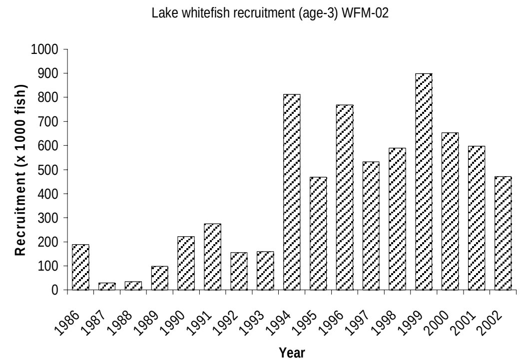
Mean weight of nearly all age classes of whitefish declined continually after 1986 but has remained relatively stable since 2000.



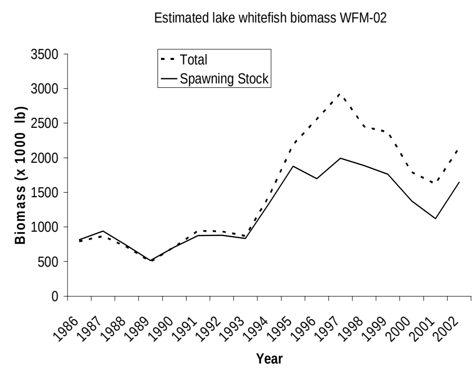
The decline in growth rates has strongly affected the sexual maturity of female whitefish in WFM-02. In the mid 1980’s, slightly more than 50% of age 3 and 90% of age 5 female whitefish were sexually mature in WFM-02. By 2001, less than 5% of age 3 and 50% of age-5 female whitefish were sexually mature.

Predicted recruitment of age-3 whitefish to the fishable population in WFM-02 varied 29-fold during 1986-2002. The stock assessment model estimated that the 1991-year class contained 821,000 fish at age 3, compared to only 28,000 fish for the 1984-year class at age 3. Recruitment of age-3 whitefish to the fishable population averaged 409,000 fish during 1986-2002 and 595,000 fish during 1993-2002. Although the model estimated declines in recruitment for the last few years, recruitment in WFM-02 from 1994 through the present is much higher than 1986-1993 levels..

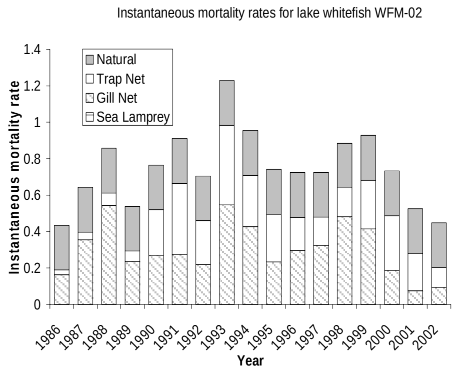
Estimated biomass of whitefish in WFM-02 increased from 1986 through 1997 then declined until 2002. The stock assessment model estimated that fishable stock biomass increased from an average of 769,000 lb during 1986-1993 to 2.9 million lb in 1997; the 2002 estimate for fishable biomass is 2.1 million lb.



Spawning stock biomass has followed the same trends as population biomass. Spawning stock biomass peaked in 1997 and the estimates for spawning stock biomass for 2000-2002 are lower than the peak, but substantially higher than the 1986-1993 levels.



Fishing mortality peaked at 0.98 y^{-1} in 1993 in WFM-02 and gill net effort accounted for 55% of that mortality. The maximum trap net mortality rate was 0.43 y^{-1} in 1993. The fishing mortality rate on whitefish in WFM-02 has declined since 1999; fishing mortality of age 4 and older whitefish was 0.32 y^{-1} during 2000-2002 compared to a fishing mortality rate of 0.61 y^{-1} from 1990 to 1999.



Total annual mortality of age-4 and older whitefish was lower than the target mortality rate of 1.05 during 2000-2002. The recommended total allowable harvest for 2004 is 520,000 lb. which is greater than the average yield from 2000-2002 of 251,000 lb.

Summary Status WFM-02 Whitefish		
Female maturity		
	Size at first spawning	0.40 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.47 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.135 lb (SE 0.036)
	Current SSBR	0.86 lb (SE 0.03)
	SSBR at target mortality	0.171 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.403 (SE 0.014)
Average yield per recruit		0.716 lb (SE 0.015)
Natural Mortality (M)		0.245 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.116 y^{-1} (SE 0.012)
	Average trap net F, ages 4+	0.203 y^{-1} (SE 0.013)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.564 y^{-1} (SE 0.022)
Recruitment (age-3)	(1993-2002 average)	590,880 fish (SE 62,052)
Biomass (age 3+)	(1993-2002 average)	2,037,700 lb (SE 101,600)
Spawning biomass	(1993-2002 average)	1,555,900 lb (SE 68,776)
MSC recommended yield limit for 2004		520,000 lb
Actual yield limit for 2004		520,000 lb

WFM-03 (Naubinway)

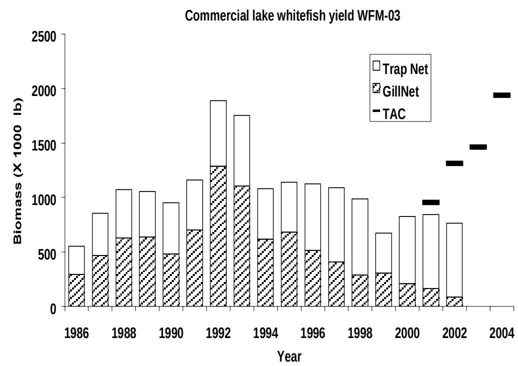
Prepared by Mark P. Ebener

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

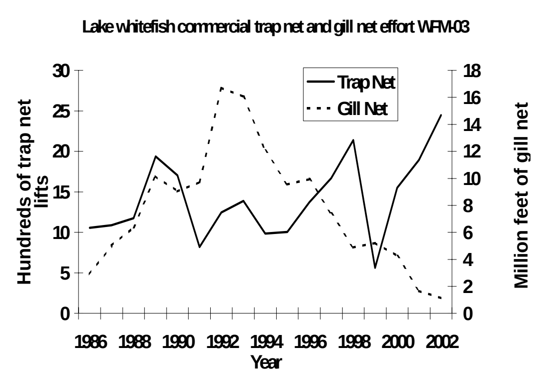
WFM-03 contains several very large spawning aggregations of whitefish. The entire northern shoreline is part of the Niagara Escarpment thus much of the whitefish spawning occurs here. Large spawning aggregations are associated with the area between Epoufette and Naubinway, Michigan, and in the Straits of Mackinaw along the upper and lower Peninsulas

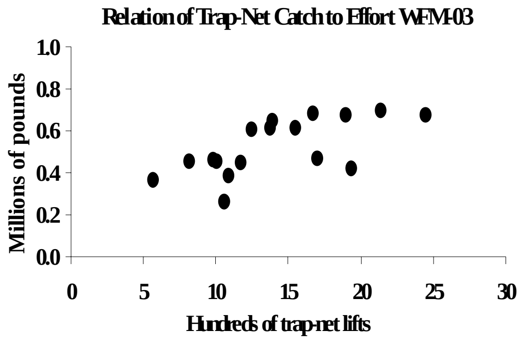
WFM-03 has been an exclusive commercial fishing zone for the CORA fishery since 1985. For that matter, WFM-03 has been an important commercial fishing area for most of the twentieth century. A trap net and both large- and small-boat gill net fishery operate throughout WFM-03.

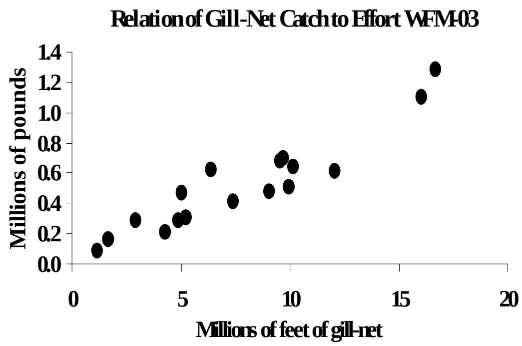
The commercial fishery yield from WFM-03 averaged 1.048 million lb during 1986-2002. The trap net fishery yield averaged 529,000 lb and the gill net fishery yield averaged 522,000 lb during 1986-2002. Total fishery yield peaked at 1.89 million lb in 1992 and 1.75 million lb in 1993 and declined slowly thereafter. The trap net yield was 678,000 lb and the gill net yield only 85,000 in 2002. The commercial yield in 2001 and 2002 were less than the TAC.



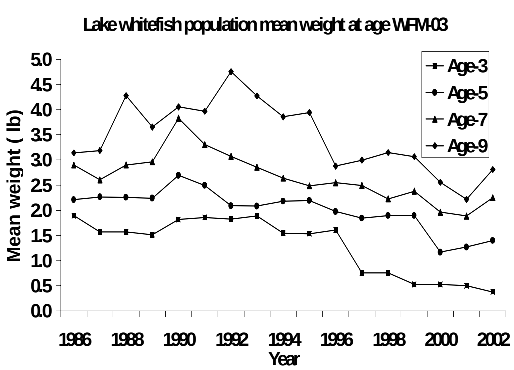
Fishing effort in WFM-03 has been highly variable. Gill net fishing effort increased from 2.9 million ft in 1986 to 16.7 million ft in 1992 then declined to only 1.13 million ft in 2002. Trap net effort varied between 565 and 2,447 lifts during 1986 to 2002 without any significant trends, although trap net effort was greater in 2002 than other years. There was a positive linear relationship between gill net effort and yield where effort explained 88% of the variation in gill net yield. In contrast, the relationship between trap net effort and yield was not linear and effort explained only 43% of the variation in trap net yield. Trap net yield appeared to be asymptotic between 1,400 and 1,500 lifts.





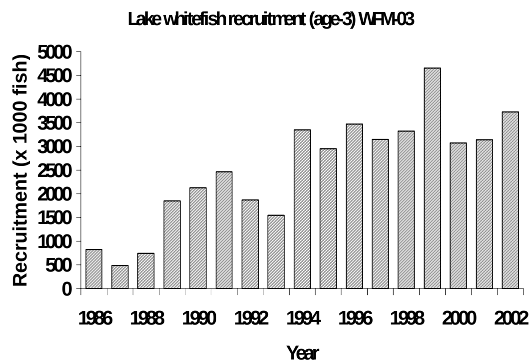


Whitefish in WFM-03 are of small size. During 1985-2002 No. 1 whitefish made up 85%, mediums 12%, and jumbos only 3% of the harvest from WFM-03. Mean weight of a harvested whitefish ranged from 2.0 to 3.6 lb in the gill net fishery and 2.0 to 2.7 lb in the trap net fishery during 1986-2002. Mean weight of a harvested whitefish in 2002 was 2.25 lb in the gill net fishery and 2.46 lb in the trap net fishery.

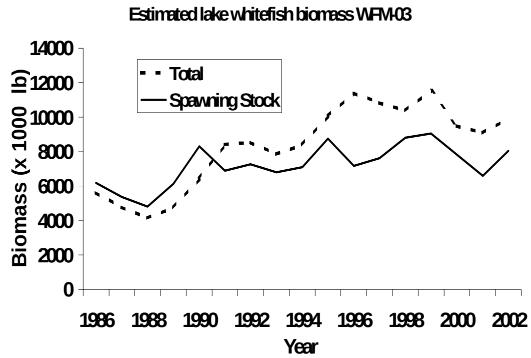


Growth of whitefish in WFM-03 continued to decline for young fish but increased for older ages in 2002. Mean weight of age-2, age-3, and age-4 whitefish were lower than any other time during 1986-2002, while mean weight of age-5 and older whitefish increased from 2001 to 2002. Mean weight of age-5 and older whitefish in 2002 was still lower than most other years.

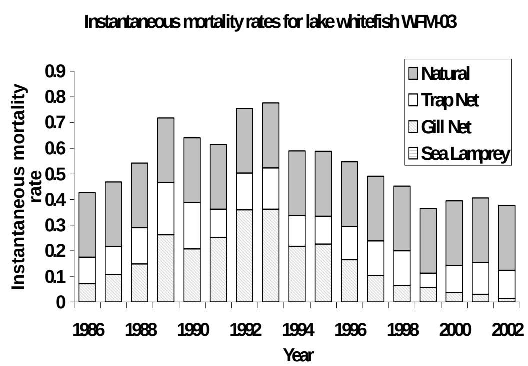
Recruitment of age-3 whitefish was fairly consistent and high in WFM-03. Recruitment increased from roughly 686,000 whitefish in 1986-1988 to an average of 1.97 million fish during 1989-1993, and increased further to 3.4 million fish during 1994-2002.



Biomass of age-3 and older whitefish has been fairly stable in WFM-03 compared to other units in the 1836-ceded waters. Total biomass of whitefish in WFM-03 varied less than three-fold from 4.1 to 11.5 million lb during 1986-2002. Total biomass averaged 9.9 million lb during 1993-2002. Spawning-stock biomass was more stable than total biomass varying less than two-fold from 4.8 to 9.0 million lb during 1986-2002. Spawning stock biomass exceeded total biomass during 1986-1990 before the dramatic declines in growth reduced the proportion of mature females at ages 3-5. In 2002 total biomass was 9.9 million lb and spawning biomass was 8.0 million lb.



Changing gill net fishing effort was primarily responsible for the changes in total annual mortality of whitefish in WFM-03. Total mortality of age-4 and older whitefish increased from 0.43 y^{-1} in 1986 to 0.76 y^{-1} in 1993, then declined to 0.38 y^{-1} in 2002. Gill net fishing mortality increased from 0.07 y^{-1} in 1986 to 0.36 y^{-1} in 1993 then declined to 0.02 y^{-1} in 2002. Trap net fishing mortality was fairly stable ranging from 0.6 to 0.16 y^{-1} during 1986-2002 and averaged 0.13 y^{-1}. Natural mortality was estimated to be 0.25 y^{-1} in WFM-03 and has been greater than total fishing mortality every year since 1997.



Total annual mortality on fully vulnerable age-classes was less than the target rate during 2000-2002. Further, 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 above the levels experienced during 2000-2002. The recommended yield limit at the increased rate of fishing was estimated to be **1,938,000 lb** for 2004. The 2003 recommended yield limit was 1,462,000 lb.

Summary Status WFM-03 Whitefish		
Female maturity		
	Size at first spawning	0.47 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.28 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	1.515 lb (SE 0.003)
	Current SSBR	0.87 lb (SE 0.02)
	SSBR at target mortality	0.144 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.577 (SE 0.013)
Average yield per recruit		0.389 lb (SE 0.010)
Natural Mortality (M)		0.336 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.031 y^{-1} (SE 0.002)
	Average trap net F, ages 4+	0.129 y^{-1} (SE 0.008)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.497 y^{-1} (SE 0.01)
Recruitment (age-3)	(1993-2002 average)	3,240,200 fish (SE 220,580)
Biomass (age 3+)	(1993-2002 average)	9,891,800 lb (SE 456,260)
Spawning biomass	(1993-2002 average)	7,774,800 lb (SE 342,180)
MSC rcommended yield limit for 2004		1,938,000 lb
Actual yield limit for 2004 (HRG)		1,938,000 lb

WFM-04 (Beaver Island)

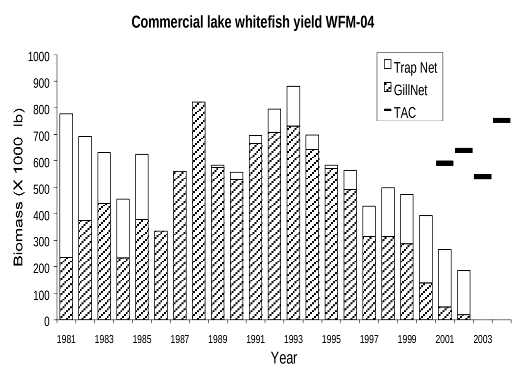
Prepared by Stephen J. Lenart

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.

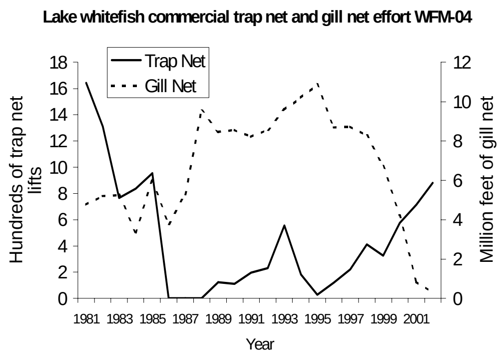
At least several reproductively isolated stocks of whitefish inhabit WFM-04, and most, if not all, of these are associated with the large northern reef complex. One stock spawns in Sturgeon Bay along the northeast side of the unit, while another stock is found at Hog Island.

WFM-04 has been an exclusive commercial fishing zone for the CORA fishery 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 fisheries 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.

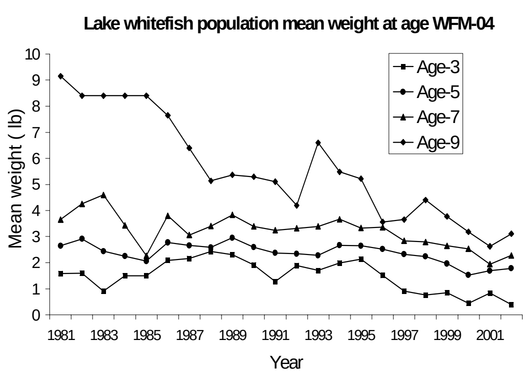
The commercial fishery yield of whitefish from WFM-04 has consistently declined since 1993, when the commercial harvest peaked at 880,000 lb. Commercial yield was at a historic low of 186,000 lb in 2002, a decrease of nearly 30% from 2001 (average commercial yield during 1981-2002 was 565,000 lb). The trap net fishery yield ranged from 0 lb during 1986-1988 to 542,000 lb in 1981, while the gill net yield ranged from 19,000 lb in 2002 to 822,000 lb in 1988. In 2002, the trap net yield from WFM-04 was 167,000 lb, approximately 90% of the total commercial harvest.



Fishing effort in WFM-04 has been quite variable through the years. Trap net effort peaked at 1,642 lifts in 1981 then declined to zero during 1986-1988. Since 1995, trap net effort has increased steadily each year, reaching 881 lifts in 2002, an increase of 23% from 2001. In contrast, gill net effort has progressively declined since 1995, when nearly 11 million ft of gill net effort was reported. In 2002, gill net effort was at its lowest level in the time series (0.29 million feet). The decline in gill net effort followed as a consequence of the 2000 Consent Decree with the conversion of gill net fisheries to trap net fisheries.

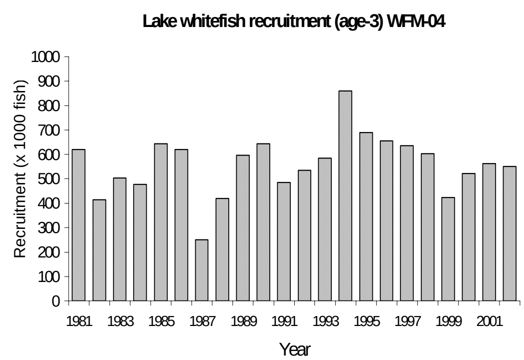


Whitefish in WFM-04 are of moderate size compared to other management units. Annual mean weight of a harvested whitefish in the trap net fishery ranged from 2.0 to 3.2 lb during 1981-2002. The mean weight of whitefish harvested in the 2002 trap net fishery was 2.4 lb, the long-term average for the unit. Annual mean weight of a whitefish harvested in the gill net fishery ranged from 2.6 to 3.5 lb during 1981-2002. The mean weight of a gill net harvested whitefish was 2.8 lb in 2002.

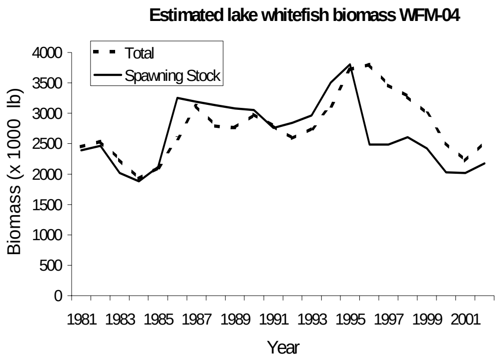


Growth of whitefish in WFM-04 has not declined to the same extent as in other Lake Michigan units. Age-9+ whitefish experienced the most significant decline in mean weight during the time series (from 9.1 lb in 1981 to 2.6 lb in 2001). However, mean weight in this age class did increase slightly in 2002 to 3.3 lb, the first positive annual change since 1998. A similar, yet less pronounced increase in mean weight was evident in age-5 and age-7 whitefish from 2001 to 2002. Mean weight of age-3 whitefish decreased slightly from 2001 to 2002, although sample size tends to be small for this age class.

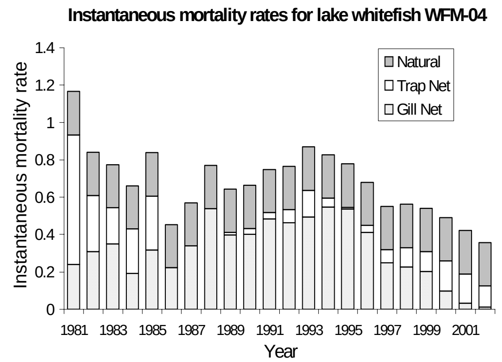
Recruitment of age-3 whitefish to the population in WFM-04 was remarkably stable, in contrast to other Lake Michigan management units. Average estimated recruitment of age-3 whitefish in WFM-04 was 559,000 fish during 1981-2002. Annual recruitment varied only from 234,000 to 861,000 fish during this time period. Estimated recruitment changed very little from 2001 to 2002 (562,000 to 551,000 fish, respectively)



Biomass of age-3 and older whitefish was also fairly stable in WFM-04, a consequence of the consistent recruitment. Total biomass ranged from 1.9 million lb in 1984 to 3.8 million lb in 1996. Spawning stock biomass ranged from 1.9 million lb in 1984 to 3.8 million lb in 1995. In 2002, both total biomass and spawning-stock biomass increased from prior-year levels, the first such annual increase since 1995. Total biomass was 2.7 million lb and spawning biomass was 2.2 million lb in 2002, still well below peak levels of the mid-1990s. Except for a few years in the later 1990s, total biomass and spawning stock biomass have followed the same general trends.



Mortality of age-4 and older whitefish in WFM-04 has steadily declined since 1993, when total instantaneous mortality was estimated to be 0.87 y^{-1}. Prior to this, total mortality ranged from 1.16 y^{-1} in 1981 to 0.45 y^{-1} in 1986. Recent total mortality rates, however, are among the lowest in the time series, driven mainly by decreasing gill net mortality. The gill net fishery accounted for nearly all the fishing mortality of whitefish in WFM-04 during 1986-1999, when instantaneous gill net mortality ranged from 0.20 y^{-1} to 0.55 y^{-1} (average 0.39 y^{-1}). During 2000-2002, instantaneous gill net mortality was significantly lower, averaging 0.05 y^{-1}. Since 1999, the trap net fishery has been the primary source of fishing mortality in WFM-04. Instantaneous trap net mortality was estimated to be 0.11 y-1 in 2002, a slight decrease from 2001 and below the long-term average of 0.13 y^{-1}. Natural mortality, estimated to be 0.231 y^{-1}, exceeded total fishing mortality in 2001 and 2002 and was the largest single mortality source in WFM-04 during 1998-2002. Sea lamprey mortality is not estimated separately in this unit.



The average total instantaneous mortality of age-4+ whitefish was 0.42 y^{-1} during 2000-2002, well below the target mortality rate of 1.05 y^{-1}. The spawning potential reduction in 2002 was 0.49. Thus, the projection model estimated that fishing effort could be increased nearly 2.7 fold from the effort levels recorded during 2000-2002. Yield limits have trended upward since during this period, likely a response to decreasing fishing mortality rates. The 2004 recommended yield limit of 752,000 lb was adopted as the final harvest limit for WFM-04.

Summary Status WFM-04 Whitefish		**Value** (95% probability interval)
Female maturity		
	Size at first spawning	0.55 lb
	Age at first Spawning	3 y
	Size at 50% maturity	1.47 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	3.181 lb (3.171 - 3.190)
	Current SSBR	1.56 lb (1.51 - 1.65)
	SSBR at target mortality	0.304 lb
Spawning potential reduction		
	At target mortality	0.492 (0.475 - 0.519)
Average yield per recruit		0.750 lb (0.716 - 0.769)
Natural Mortality (M)		0.231 y^{-1}
Fishing mortality (F), 2000-2002		
	Fully selected age to gill nets	8
	Fully selected age to trap nets	8
	Average gill-net F, ages 4+	0.047 y^{-1} (0.041 - 0.052)
	Average trap-net F, ages 4+	0.144 y^{-1} (0.125 - 0.157)
Sea lamprey mortality (ML)		
	Average ages 4+, 2000-2002	N/A
Total mortality (Z)		
	Average ages 4+, 2000-2002	0.423 y^{-1} (0.399 - 0.438)
Recruitment (age-3)	(1993-2002 average)	608,520 fish (561,237 - 699,988)
Biomass (age-3+)	(1993-2002 average)	3,037,900 lb (2,890,860 - 3,284,600)
Spawning biomass	(1993-2002 average)	2,649,200 lb (2,528,580 - 2,856,830)
MSC recommended yield limit for 2004		752,000 lb
Actual yield limit for 2004 (HRG)		752,000 lb

WFM-05 (Grand Traverse Bay)

Prepared by Mark P. Ebener and 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.

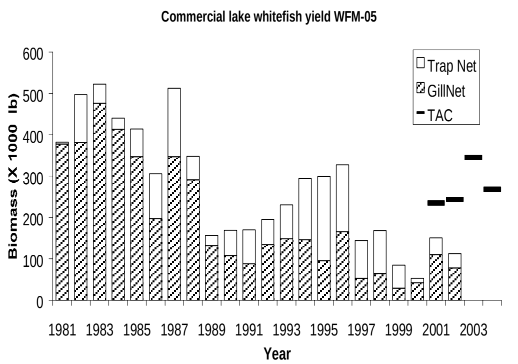
There are at least four reproductively isolated stocks of lake whitefish that inhabit WFM-05. Discrete spawning stocks of whitefish are found in both the east and west arms of Grand Traverse Bay, and in the outer Bay associated with Northport Bay based on mark-recapture studied conducted by Michigan 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. CORA small-boat fishermen 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 fishermen 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.

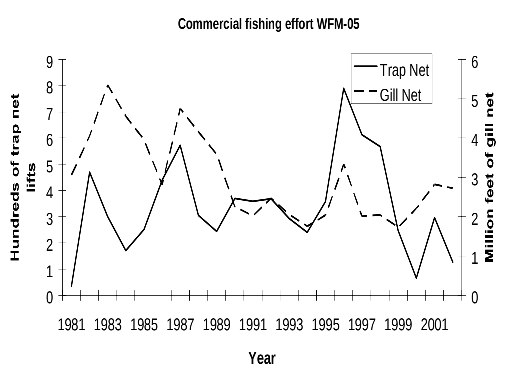
Initial tribal fishing activities in WFM-05 were focused on an exploited population of whitefish. Commercial fishing by state-licensed fisheries had been prohibited in WFM-05 for several decades before tribal small-boat fishermen began fishing the area in the late 1970s. Initial yields in 1978 and 1979 were in excess of 400,000 lb and jumbo (>4 lb) whitefish made up more than 90% of the yield. Harvests 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 were substantially less during the decade of the 1990s than during the 1980s. The commercial yield averaged 384,000 lb from 1980-1989 and 208,000 lb during 1990-1999. The fishery declined through the late 1990s with the lowest recorded total yield coming in 2000, with a yield of 53,000 lb. The commercial fishery rebounded to yield an average of 105,500 lb from 2000-

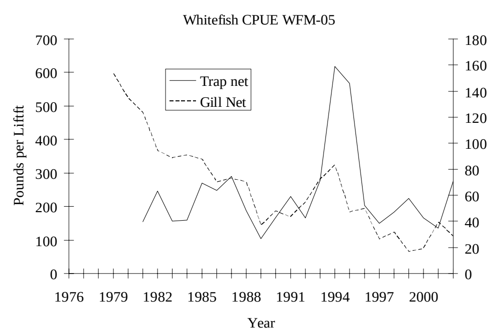
2002. Gill net yield was 78,000 lb and trap net yield 35,000 lb in 2002. The large-mesh gill net yield has exceeded the trap net yield in every year except the period from 1994 to 1999.



Large-mesh gill net effort in WFM-05 declined from 1984 through 1990 and has held relatively stable since. Trap net effort has been highly varied, but with a downward trend since 1996. Gill net effort declined from 5.3 million ft. in 1983 to a relatively stable 2.3 million ft since 1990. Trap net effort varied annually from 1982-1999 between 200 and 500 lifts, peaking out at 790 lifts in 1996. Since 2000, trap net effort has averaged 163 lifts per year, with a low of 66 lifts in 2000. In 2002, large-mesh gill net effort was steady at 2.7 million ft, while trap net lifts declined to 127 lifts.



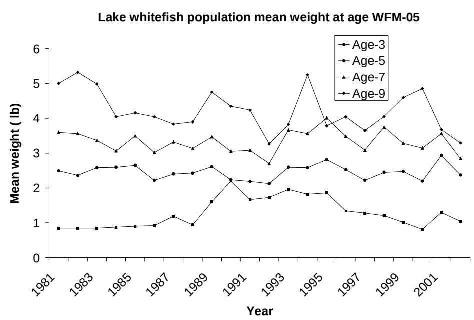
The decline in yield of whitefish in WFM-05 has mirrored the decline in lake whitefish recruitment within this management unit. In addition, there was an apparent decline in catchability of whitefish to the large-mesh gill net fishery in the late 1990s. CPUE of whitefish in the large-mesh gill net fishery declined from 153 lb per 1,000 ft. of gill net in 1979 to17 lb per 1,000 ft. of gill net in 1999. On the other hand, CPUE of whitefish in the trap net fishery has been remarkably stable between 150 and 300 lb per lift, except for 1994 and 1995, during 1981-2000. Gill net fishermen in WFM-05 claim the decline in catchability has been caused in part because the gill nets commonly become coated with an algal slime that makes the net highly visible to whitefish. Whatever the cause, it is obvious that something is reducing catch rates of whitefish to the large-mesh gill net fishery in the unit.



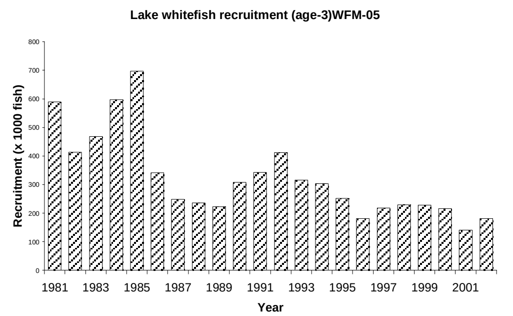
Whitefish from WFM-05 are currently of small to moderate size. The proportion of the yield made up of the three size classes of whitefish were 68% No. 1 (<3 lb), 26% mediums (3-4 lb), and 6% jumbos (>4 lb) during 2000-2002. This compares with 65% No. 1, 22% mediums, and 13% jumbos from 1980-1989 and 65% No. 1, 20% mediums, and 15% jumbos from 1990-1999.

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 (2000-2002). 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 (2000-2002).

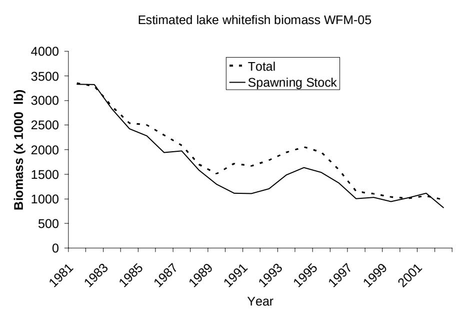
Growth of whitefish from WFM-05 has remained very stable through the years, unlike the pattern of declining growth seen in other areas of Lakes Michigan and Huron, including substantial declines in areas adjacent to this management unit. Mean weight of ages 3-9 whitefish showed no trends through time in WFM-05 from 1981 to 2002, although some age classes did weigh slightly less in 2002 than in 1981.



Recruitment of age-3 whitefish to the population in WFM-05 was highly variable and has declined lately based on estimates from the stock assessment model. The number of age-3 whitefish entering the population has declined significantly over time. The 1978-1983 year classes were estimated to range from 340,000 to 591,000 fish. From 1981-1989, the average was still relatively high at 421,000 fish per year. More recently, the average has dropped. From 1993-2002 only 226,480 age-3 fish were estimated to be entering the fishery each year. It is difficult to assess whether the decline in recruitment is real, or an artifact of changing catchability to the gill net fishery.



Biomass of whitefish estimated with the stock assessment model declined in response to declines in recruitment. Annual biomass of whitefish $\geq$ age-3 calculated at the beginning of each year were peaked at the beginning of the 1981-2002 timeframe with 3.3 million lb. This steadily declined to 1.5 million lb in 1989, rebounded to 2.0 million lb in 1994 and has declined to only 980,000 lb in 2002. Spawning stock biomass followed a similar trend peaking at 3.3 million lb in 1981 and declining to 820,000 lb in 2002.



Fishing mortality (F) in WFM-05 had been split about equally between the gill and trap net fisheries through 1999. Since 2000, average gill net mortality is about three times that of the trap net fishery. Average fishing-induced mortality on whitefish $\geq$ age-4 averaged 0.11 y^{-1} for the large-mesh gill net fishery and 0.04 y^{-1} for the trap net fishery during 2000-2002. Gill net induced fishing mortality ranged from 0.26 y^{-1} in 1984 to 0.06 y^{-1} in 1999, while trap net induced fishing mortality varied from 0.20 y^{-1} in 1996 to 0.01 y^{-1} in 1981. The gill and trap net mortality level has declined from a combined rate of 0.43 y^{-1} in 1996 to 0.18 y^{-1} in 2002.

Total annual mortality on the fishable stock in WFM-05 during 2000-2002 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 49% during 2000-2002 and the spawning potential reduction value was 0.58. Consequently, the projection model estimated that fishing mortality could be increased 3.193 times in WFM-05 in 2003 from the average value during 2000-2002. The projected yield associated with this level of fishing was 268,000 lb and was accepted as the recommended maximum yield in 2004.

Summary Status WFM-05 Whitefish		
Female maturity		
	Size at first spawning	1.05 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.86 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.212 lb (SE 0.)
	Current SSBR	1.29 lb (SE 0.05)
	SSBR at target mortality	0.374 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.582 (SE 0.021)
Average yield per recruit		0.519 lb (SE 0.024)
Natural Mortality (M)		0.335 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.099 y^{-1} (SE 0.008)
	Average trap net F, ages 4+	0.039 y^{-1} (SE 0.003)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.472 y^{-1} (SE 0.011)
Recruitment (age-3)	(1993-2002 average)	226,480 fish (SE 13,625)
Biomass (age 3+)	(1993-2002 average)	1,389,200 lb (SE 78,693)
Spawning biomass	(1993-2002 average)	1,191,900 lb (SE 72,275)
MSC recommended yield limit for 2004		268,000 lb
Actual yield limit for 2004 (HRG)		268,000 lb

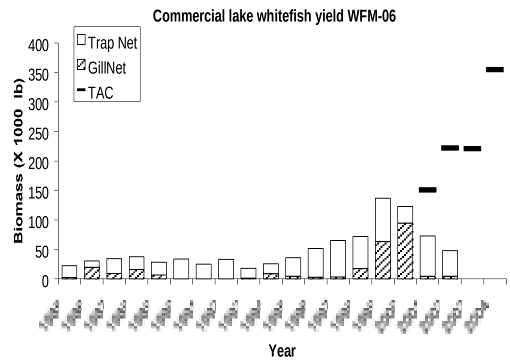
WFM-06 (Leland - Frankfort)

Prepared by Randall M. Claramunt and Philip J. Schneeberger

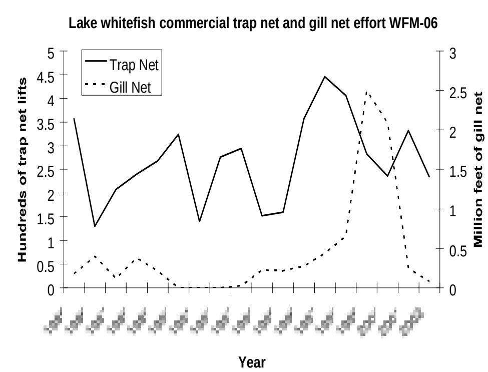
Lake whitefish management unit WFM-06 is located in 1836 Treaty waters west of the Leelanau Peninsula from about Cathead Point south to Arcadia. Surface area for this unit is 945,156 acres (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include 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. Most trap net effort and harvest is reported from grids 812-814 and 912 (areas associated with the above-mentioned bays).

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. Beginning in 2000, WFM-06 became a shared zone in a truer sense of the term, and waters were opened to both state and tribal fishers.

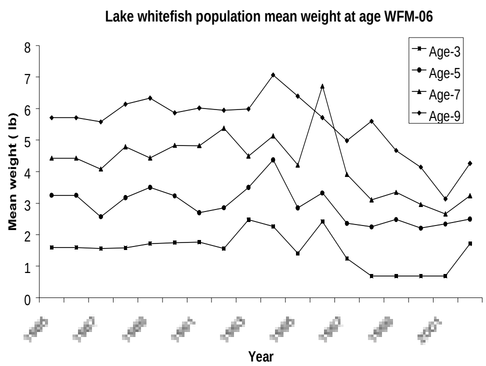
Yield for 2002 was 48 thousand lb in WFM-06, down from 73 thousand lb in 2001, but similar to the 1985-2001 average of 50 thousand lb. Of the total in 2002, trap net yield was 43.8 thousand lb (91.2%) and gill net yield was 4.2 thousand lb (8.8 %). Proportions of yield by gear type have varied considerably from year to year with an average split of 78% from trap nets and 22% from gill nets between 1985 and 2002.



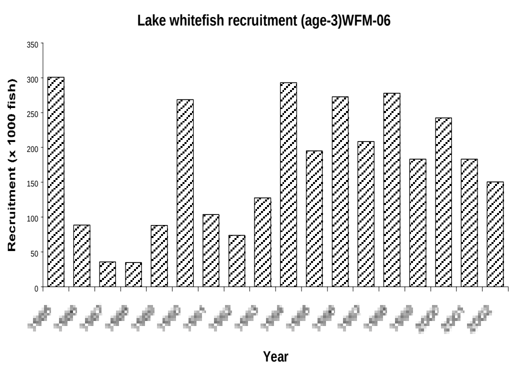
Trap net and gill net effort decreased from 2001 to 2002 by 29% and 63%, respectively. The 2002 trap net effort (235 lifts) was similar to the 1985-2001 average (271 lifts), but gill net effort (81,000 ft) was 83% lower in 2002 than for the 1985-2001 average.



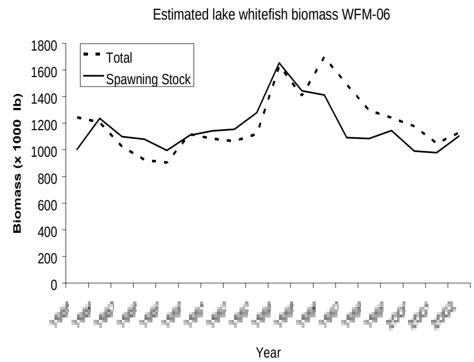
Lake whitefish weight-at-age in 2002 increased for all age groups from the relatively constant values from 1998 through 2001 for ages under 7 and from the declines in weight-at-age that was documented for fish ages 7 to 12+ over the last eight years. However, weight-at-age values in 2002 for fish aged 3-12+ were still 23% lower than the 1985-2001 averages.



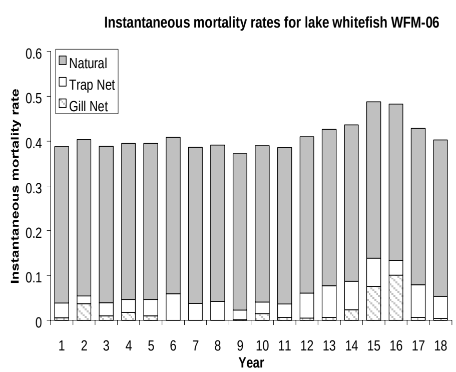
Recruitment, based on estimated numbers of age-3 fish, was lower in 2002 than any year since 1993. Estimates of recruitment were highest during 1994-98 and lowest for the time series during 1987-88.



Estimates of fishable biomass and spawning stock biomass have been stable relative to other management zones, and have roughly paralleled each other from 1985 through 2002. Values estimated for 2002 were 1,129 thousand lb for fishable biomass and 1,104 thousand lb for spawning stock biomass. The ratio of spawning stock biomass to fishable biomass was 0.97 in 2002 which is similar to the ratio averaged from 1985 to 2001.



Total instantaneous mortality rate (Z) in 2002 was 0.43 y^{-1}, showing a decrease in the rate for the third year in a row. Based on current estimates, the 2002 rate for Z is approximately 2.0% lower than the average for 1985-2001. Instantaneous fishing mortality rates (F) have varied considerably for trap nets and gill nets throughout the time series. During 2002, F was much higher for the trap net fishery. Estimates for F were 0.045 y^{-1} for trap nets and 0.033 y^{-1} for gill nets. The 2002 estimate for instantaneous natural mortality rate was 0.35 y^{-1}, still the largest source of lake whitefish mortality in WFM-06.



The 2004 yield limit is 355 thousand pounds, which is an increase from the limit calculated for 2003 of 221 thousand pounds. The projection model shows that the 2003 level of effort may increase -fold for gill nets and -fold for trap nets as one way to reach the 2004 yield limit.

Summary Status WFM-06 Whitefish		
Female maturity		
	Size at first spawning	1.03 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.81 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.638 lb (SE 0.005)
	Current SSBR	1.87 lb (SE 0.13)
	SSBR at target mortality	0.417 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.711 (SE 0.048)
Average yield per recruit		0.388 lb (SE 0.062)
Natural Mortality (M)		0.349 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	7
	Fully selected age to trap nets	7
	Average gill net F, ages 4+	0.034 y^{-1} (SE 0.008)
	Average trap net F, ages 4+	0.047 y^{-1} (SE 0.011)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.43 y^{-1} (SE 0.018)
Recruitment (age-3)	(1993-2002 average)	213,470 fish (SE 38,672)
Biomass (age 3+)	(1993-2002 average)	1,323,900 lb (SE 277,290)
Spawning biomass	(1993-2002 average)	1,218,900 lb (SE 262,620)
MSC recommended yield limit for 2004		355,000 lb
Actual yield limit for 2004		355,000 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. There are no islands or bays and apart from the shoreline, 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 this area has few other obvious distinguishing features relevant to lake whitefish biology.

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.

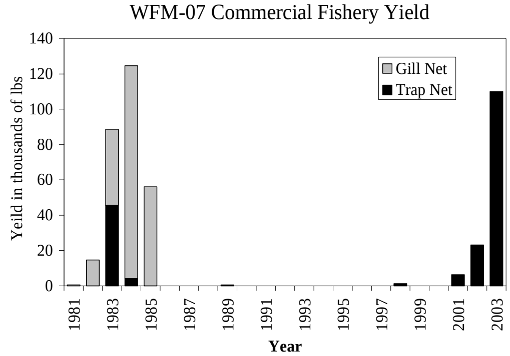
The current regulations prohibit the use of large-mesh gill nets and only allow for use of large-mesh trap nets for commercial lake whitefish exploitation. In 2001 LRBOI enacted a 19-inch minimum size limit, rather than 17-inches under the CORA regulations, on lake whitefish harvest within this unit. In 2003 LRBOI adopted the CORA 17-inch minimum size limit on lake whitefish for this unit. This decision was based upon review of the length distribution of lake whitefish within the unit and the percent of their relative abundance, from graded mesh surveys, at $\leq$19-inch and $\leq$17-inch minimum size limits. This review indicated that under the $\leq$19-inch minimum size limit 44.0% of the stock was available for harvest, and 83.4% was available under the $\leq$17-inch minimum size limit. The average size, in length, of a lake whitefish in this unit from graded mesh gill net surveys was below the minimum size limit of 19-inches as indicated in the table below for 2000 through 2002.

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

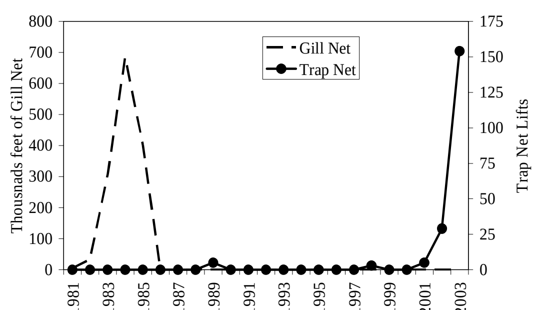
At the conclusion of the 2003 fishing season, Tribal fishers have conducted three years of commercial fishing activity for lake whitefish within this unit. Pursuant to the 2000 Consent Decree, and the Tribal Management Plan, a Harvest Regulation Guideline (HRG) for lake whitefish will have to be developed for this unit for the 2004 and future fishing seasons.

Commercial fishing harvest of lake whitefish within WFM-07 for 1981-2002 peaked at 124,735 pounds in 1984 represented mostly by large-mesh gill net effort of 684,700 feet. All large-mesh gill net effort for commercial fishing was eliminated in this unit by 1986. Current Tribal commercial fishing activities for lake whitefish began in 2001. These activities were limited and effort was distributed only in October and November with a total harvest of 6,361 pounds from 5 trap net lifts. In 2002 Tribal commercial harvest was 23,165 pounds with 29 trap net lifts. 2003, Tribal commercial harvest was 110,080 pounds with an effort of 154 trap net lifts.

WFM-07 Commercial Fishery Yield

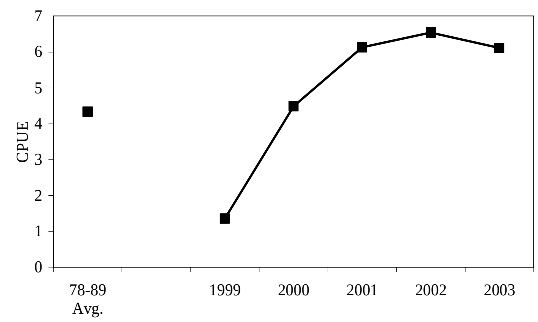


WFM-07 Commercial Fishing Effort



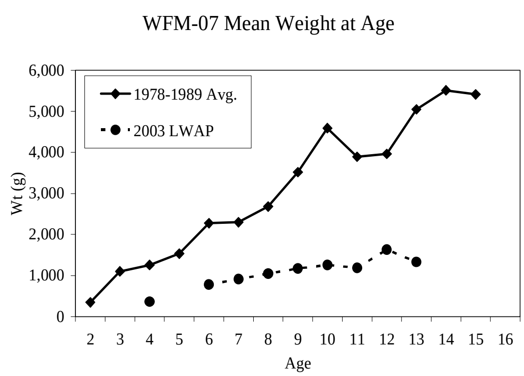
Relative abundance of lake whitefish in WFM-07 are higher currently as compared to historical levels represented by the 1978-1989 average. Historical graded mesh gill net CPUE of 4.3/1,000 feet for lake whitefish from spring surveys is represented by the average for 1978-1989. From 1999 through 2003, graded mesh gill net surveys CPUE for lake whitefish in spring assessments ranged from 1.4, 4.5, 6.1, 6.5, and 6.1 per 1,000 feet respectively.

WFM-07 CPUE from Spring LWAP Assessments



The current, 2000-2003, mean weight, and mean length of lake whitefish sampled in spring graded mesh gill net surveys has declined as compared to the average from 1978-1989. The mean weight and mean length of commercially harvested lake whitefish have declined when comparing 1983 to 2001-2002. The mean age of lake whitefish in spring graded mesh gill net surveys has increased for 2000-2003 as compared to the 1978-1989 average. Also, the mean age of lake whitefish from commercial harvests has increased for 2001-2003 as compared to 1983. The mean weight at age of lake whitefish from 2001-2003 graded mesh gill net surveys compared to 1978-1989 average weight at age indicates a reduction in weight at increased age.

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	CF	19.89	2.76	10.9
2001	GMGN	18.96	2.37	9.9
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



The instantaneous total annual mortality rates for WFM-07 lake white fish were determined from catch curve analysis. The instantaneous total annual mortality rate (Z) for 1978-1989 spring graded mesh gill net survey averaged 0.20 y^{-1} for ages 3 through 15. The instantaneous total annual mortality rate (Z) for 2001, 2002 and 2003 spring graded mesh gill net survey averaged Z = 0.13 y^{-1} for ages 6 through 16, Z = 0.03 y^{-1} for ages 5 through 13, and Z= 0.25 y^{-1} for ages 6 through 13 respectively. The total annual mortality rates calculated for this lake whitefish stock has been far below the target maximum total annual mortality rate of Z = 0.65 y^{-1} as outlined in the 2000 Consent Decree.

The lake whitefish stocks within WFM-07 are relatively unexploited as compared to other management zones in northern Lake Michigan. There are indications that the abundance of lake whitefish has increased within this management unit as compared to historical observations. The current spring graded mesh gill net surveys and the commercial harvest as compared to historical information are showing signs of decreased weight at age and an increase in mean stock age.

The WFM-07 2004 lake whitefish HRG of 500,000 pounds was developed by LRBOI and adopted by CORA for implementation. LRBOI imposed effort limitations of 4 trap net permits with a maximum of 12 nets per permit for 2004. The WFM-07 2004 lake whitefish HRG was developed by examining the current status of the WFM-07 lake whitefish stocks and the harvest limits established by the Technical Fisheries Committee's Modeling Subcommittee for the adjacent whitefish zones WFM-06 and WFM-08.

WFM-08 (Muskegon)

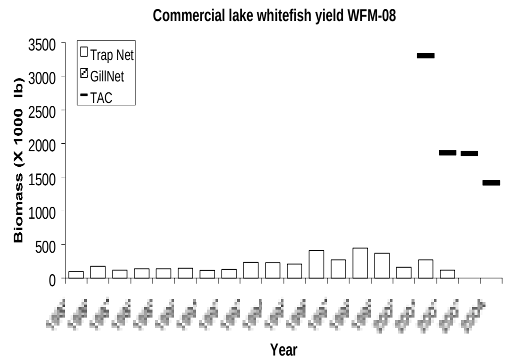
Prepared by Randall M. Claramunt and Philip J. Schneeberger

Management unit WFM-08 is the Lake Michigan whitefish zone from about 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.

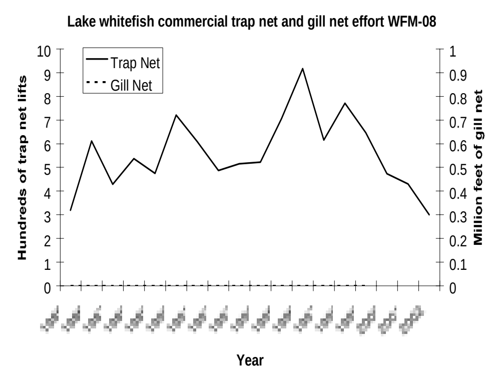
Although commercial exploitation and monitoring have occurred for many years, little is known about reproductive biology of the WFM-08 lake whitefish stock. Fish in this area are near the southern end of the distribution for lake whitefish.

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 2002 there has been no gill net harvest of lake whitefish in WFM-08.

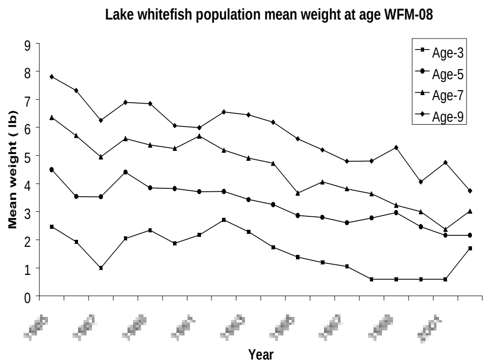
Lake whitefish yield from WFM-08 in 2002 was 121 thousand pounds. Yield decreased by 65% from 2001 and was 43% lower than the 1985-2001 average.



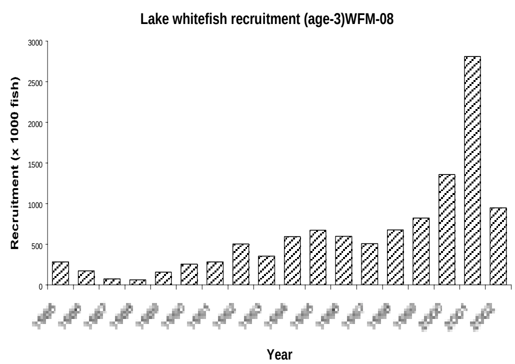
Trap net effort also decreased from 431 lifts in 2001 to 301 lifts in 2002. Effort in 2002 represented a 48% decrease from the average for 1985-2001.



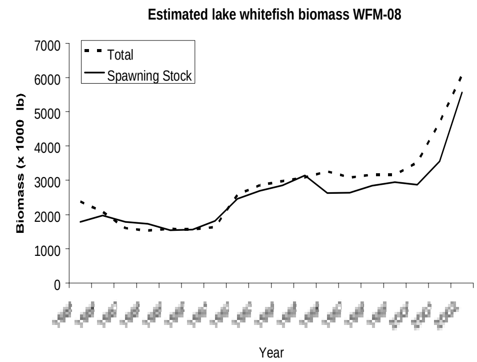
Weight-at-age data have trended downward from 1985 through 2002. Considering a shorter time frame comparison, 2002 weight-at-age values were 40% or less than averages for 1998-2001 for ages 4-9. However, fish 10-years old and older were generally heavier than for corresponding ages averaged from 1998 to 2000.



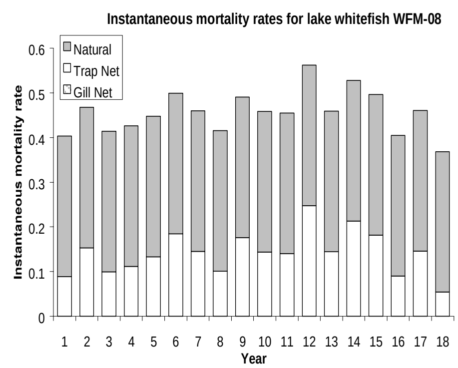
Recruitment, based on the estimated number of age-3 fish, was 948,000 in 2002. Estimates of recruitment were considerably higher (average 1,663,000) during 1999-2001, but the estimate for 2002 was almost double the 1985-2001 average of 599,000 age-3 fish.



Estimates of fishable biomass and spawning stock biomass continued increasing trends that have persisted since the early 1990s. Fishable biomass was estimated at 6.1 million lb and spawning stock biomass was 5.7 million lb in 2002. The ratio of spawning stock biomass to fishable biomass was 0.92 in 2002, slightly lower than the 1985-2001 average ratio of 0.94.

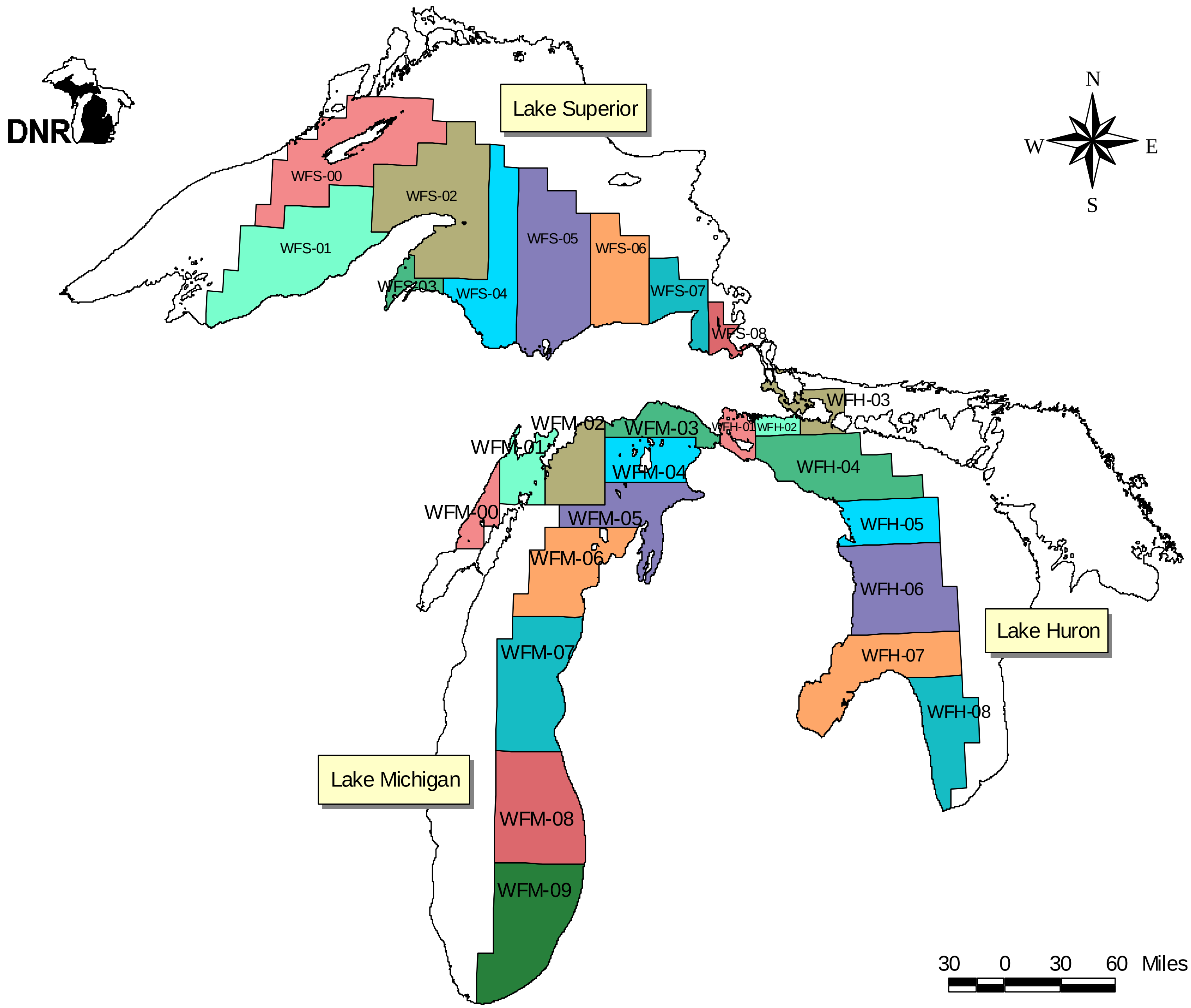


Mortality rates have been relatively stable throughout the time series. Instantaneous total mortality rate (Z) was estimated at 0.37 y^{-1} during 2002. Components of the total rate consisted of 0.05 y^{-1} for instantaneous trap net fishing mortality (F) and 0.32 y^{-1} for instantaneous natural mortality (M). Estimates of mortality have been very consistent from 1985-2002 and the ratio of F to Z averaged 0.30 from 1985 through 2002.

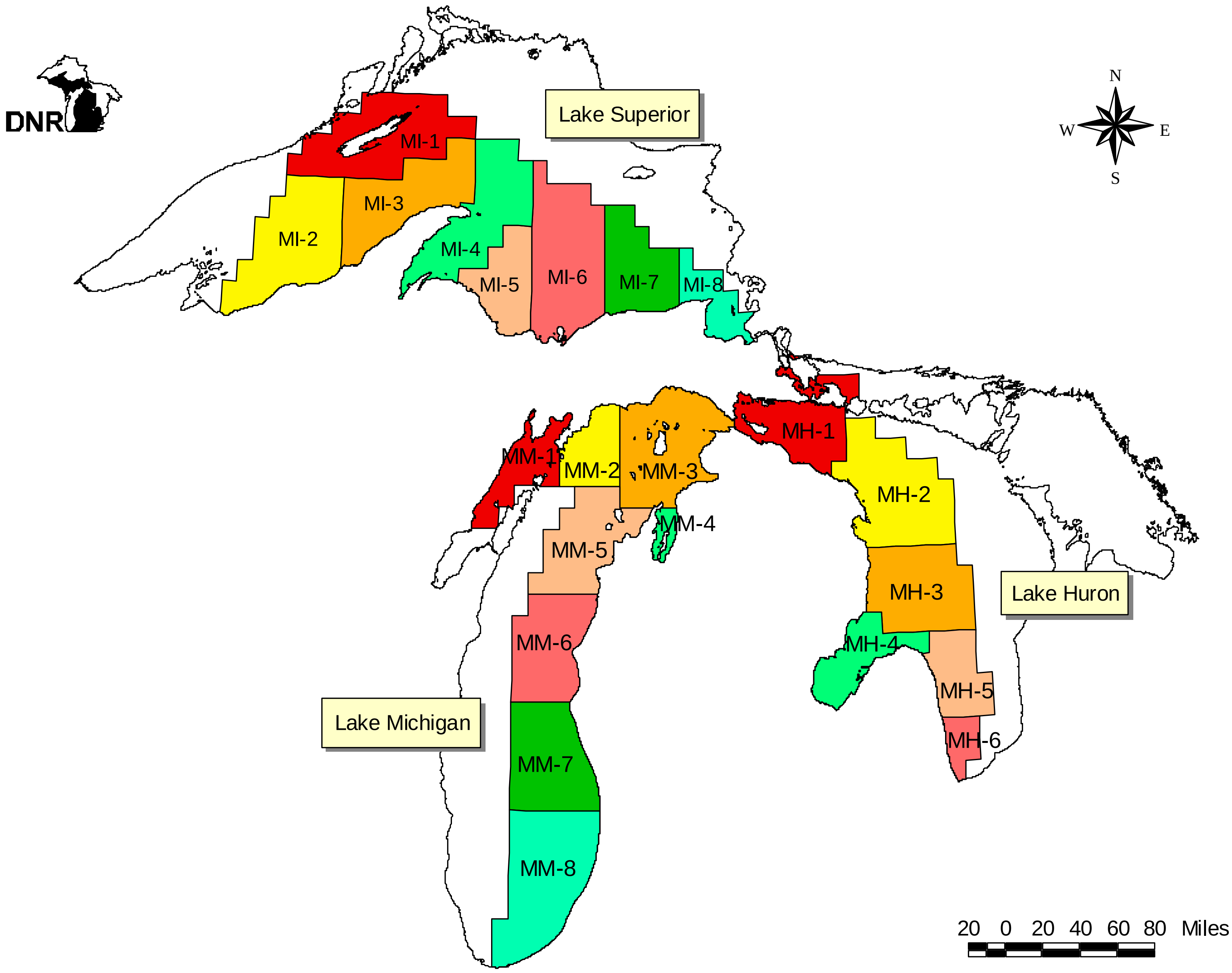


The 2004 yield limit for WFM-08 was 1.414 million lb, calculated using the projection model. This projected yield is close to the limit calculated for 2003 (1.852 million lb).

Summary Status WFM-08 Whitefish		
Female maturity		
	Size at first spawning	0.96 lb
	Age at First Spawning	3 y
	Size at 50% maturity	2.10 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.935 lb (SE 0.006)
	Current SSBR	2.01 lb (SE 0.09)
	SSBR at target mortality	0.386 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.684 (SE 0.032)
Average yield per recruit		0.417 lb (SE 0.039)
Natural Mortality (M)		0.314 y^{-1}
Fishing mortality rate 2000-2002		
	Fully selected age to Gill Nets	
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0. y^{-1} (SE 0.)
	Average trap net F, ages 4+	0.089 y^{-1} (SE 0.013)
Sea lamprey mortality (ML)		
	(average ages 4+,2000-2002)	N/A
Total mortality (Z)		
	Average ages 4+,2000-2002	0.404 y^{-1} (SE 0.013)
Recruitment (age-3)	(1993-2002 average)	933,570 fish (SE 177,700)
Biomass (age 3+)	(1993-2002 average)	3,587,000 lb (SE 463,840)
Spawning biomass	(1993-2002 average)	3,175,100 lb (SE 396,830)
MSC rcommended yield limit for 2004		1,414,000 lb
Actual yield limit for 2004		1,414,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.