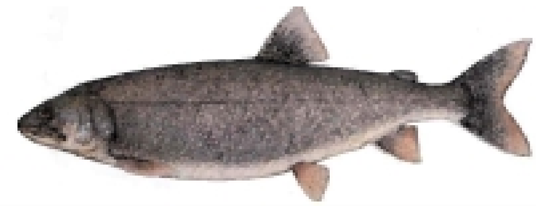
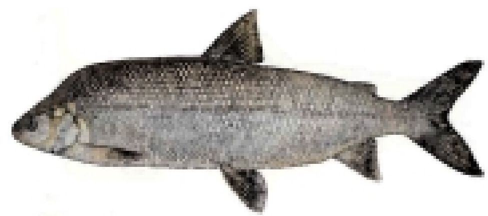
Technical Fisheries Committee Administrative Report 2005: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2004, with recommended yield and effort levels for 2005





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

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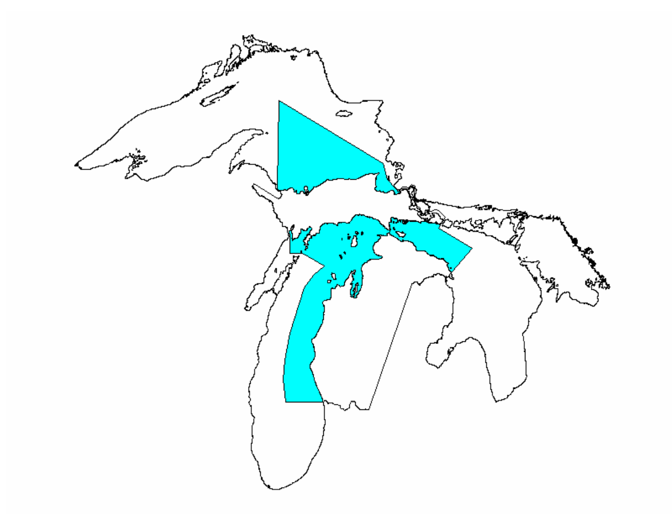

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EXECUTIVE SUMMARY

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-ceded 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 three 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 2005. 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 2005 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	187,600	187,600	NA
		MI-6	71,800	71,800	5.09 million
		MI-7	132,000	132,000	10.82 million
	Huron	MH-1	194,500	194,500	9.07 million
		MH-2	139,700	139,700	NA
	Michigan	MM-1,2,3	*8,400	462,100	9.36 million
		MM-4	*83,200	130,800	1.03 million
		MM-5	73,800	83,385	0.23 million
		MM-6,7	315,000	367,370	NA
Lake whitefish	Superior	WFS-04	177,000	177,000	NA
		WFS-05	372,000	372,000	NA
		WFS-06	no estimate	210,000	NA
		WFS-07	611,000	611,000	NA
		WFS-08	164,000	164,000	NA
	Huron	WFH-01	348,000	348,000	NA
		WFH-02	298,000	298,000	NA
		WFH-03	no estimate	306,000	NA
		WFH-04	415,000	415,000	NA
		WFH-05	927,000	927,000	NA
	Michigan	WFM-01	1,233,000	1,233,000	NA
		WFM-02	577,000	577,000	NA
		WFM-03	1,970,000	1,970,000	NA
		WFM-04	704,000	704,000	NA
		WFM-05	347,000	347,000	NA
		WFM-06	323,000	323,000	NA
		WFM-07	no estimate	500,000	NA
		WFM-08	1,404,000	1,404,000	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 well below the harvest limit in 2004. This result was due to a reduction from a 3 fish daily bag limit to a 2 fish daily bag limit starting in 2003 that effectively limited fishery effort (even though size limits were liberalized slightly in 2003) and a steadily increasing harvest limit since 2002. 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. Due to increasing harvest limits, the 3 fish daily bag limit in MI-6 will be reinstated in

2005. 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. Lower growth rates have led to decreases in lake trout biomass in all modeled Lake Superior units.

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 remain below target rates for the second consecutive year 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. A notable decline in lake trout growth rate is causing size and age of spawning fish to decline compared to 2003. This growth decline could begin to impact harvest limits in future years.

In Lake Michigan units MM-123 and MM-4 lake trout mortality rates are above target rates due to recent substantial increases in sea lamprey-induced mortality. Biomass and spawning stock biomass in both units continue to increase in the face of high total mortality rates, but the majority of harvestable size fish are consumed by sea lamprey. 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 and subsequent large increases in both lake trout total and spawning stock biomass in northern Lake Michigan in the near future.

In MM-5, mortality rates are less than the target rates for the second year in a row indicating acceptable mortality levels. In MM-6,7, lake trout mortality rates continue to be well below target rates. However, sea lamprey-induced mortality rates increased slightly in both MM-5 and MM-6,7.

In general, fishery exploitation in recent years has not been excessive on lake whitefish stocks, and total mortality is below target rates in all 15 units with functioning stock assessment models. However even though size-at-age stabilized or increased for many stocks in both 2002 and 2003, 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 and 2003. Again this pattern was most prevalent in Lake Michigan and Lake Huron.

Although current total mortality is below target for all whitefish units, mortality rates may become excessive and decrease population abundance if harvest is maintained at recent levels in the face of declining or stable but low recruitment and growth. In addition, widespread declines in growth rates of lake whitefish are a concern, and further research on this is important for supporting management strategies.

In 2005 the WFH-03 HRG was set based on average recent yield levels, and the WFS-06 HRG was set equal to the 2004 model generated harvest limit. 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 2005 the WFM-07 HRG was based on the 2004 HRG which was calculated as 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 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, performing retrospective 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 again 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 2005 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 sub-model that described the population dynamics of the stock. The second was a sub-model that predicted observed data, given the estimated population each year. The agreement between the model predictions and observed data was measured by statistical likelihood. Both the population and observation sub-models included adjustable parameters. Any given set of these parameters corresponded to a specific sequence of stock abundances, mortality rates, and predicted data. The set of such parameters and associated stock dynamics and mortality rates that maximized the likelihood (the maximum likelihood estimates) was taken as the best estimate.

Population sub-model

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

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

The proportion surviving was modeled as

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

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

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

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

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

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

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

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

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

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

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

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 1980-2003 in Lake Huron units. Essentially, the average marking rate on an age class was a function of the annual deviation in sea lamprey marking in a management 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 sub-model

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

Fishery kill was predicted using Baranov's catch equation:

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

Note that no additional parameters not already needed for the population sub-model needed to be estimated.

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

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

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

The Likelihood (defining the best fit)

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

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

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

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

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

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

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

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

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

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

Target Mortality Rates

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

Following the procedure of the IMG, we uniquely define mortality rates by making use of the idea of spawning stock biomass per recruit (SSBR). For lake trout, we first calculate spawning stock biomass for a default target mortality schedule. Any age-specific mortality schedule that produces as much spawning stock biomass as the default schedule was considered to be at or below the target mortality rate. The default schedule was to have only natural mortality (excluding sea lamprey-induced mortality) for ages below a specified age, and mortality equal to the target rate for ages equal to or above the specified age. The specified age at which the target rate first applied varied among areas depending upon maturity schedules and precedent.

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

Population at the Start of the 2005 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 2005 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2005, 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 2005, but did not in 2005, 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 2005

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 2002-2004 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 2002-2004 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 2005 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 MM-5 and MM-6,7 were calculated as per the consent decree. The 2005 TACs for both management units decreased by more than 15% compared to the 2004 TACs. The TFC agreed to accept a higher estimated TAC for both units in 2005 limited by a 15% decline from the 2004 TAC’s for each unit.

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.

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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

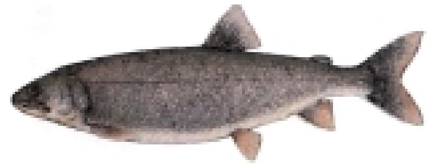
- The MSC recommends that in addition to this status of the stocks report (termed short report), a second report for the 2001 assessments be written that documents and describes in detail the modeling methods used (termed long report). The 2001 long report is currently being written. We recommend the 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

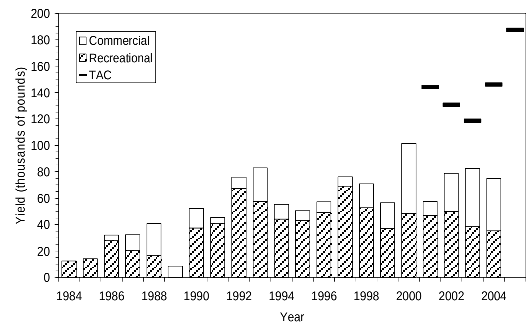
MI-5 (Marquette - Big Bay)

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-ceded waters (305,794 acres). The 1836 Treaty-ceded 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 over 780 feet, and with 186,811 acres shallower than 240 feet.

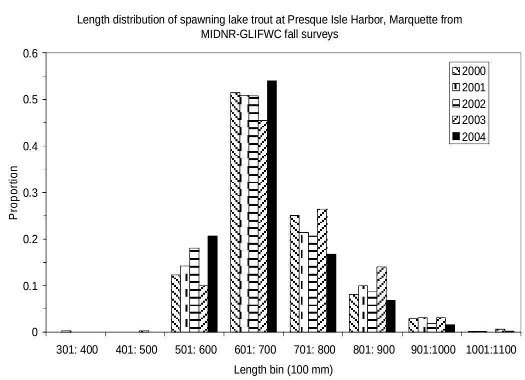
The only tribal commercial fishery is a large-mesh gill-net fishery that is centered around Marquette and Big Bay in 1842 Treaty-ceded waters. This fishery mainly targets lake whitefish with lake trout as bycatch. However, lake trout have been targeted near spawning reefs in Marquette during recent fall fisheries. There have been some low levels of tribal subsistence gill-net fishing in 1836 Treaty-ceded waters. Tribal commercial yield of wild lake trout (in 1842 Treaty-ceded waters) has ranged from 3,800 round lb in 1986 to a peak of 52,700 round lb in 2000. From 1999 to 2003, tribal yield averaged 27,800 round lb and tribal large-mesh gill-net effort averaged 444,000 ft per year.

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



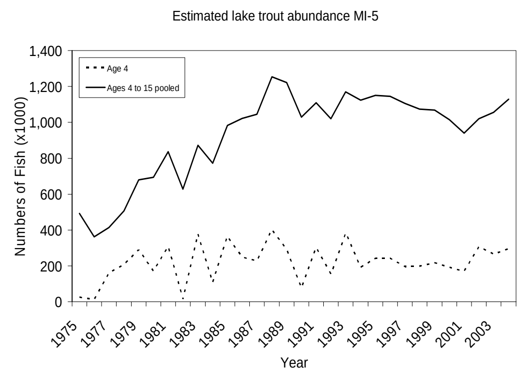
Generally, the fishery is conducted from late winter through early October. Harvested fish have a dome-shaped age composition with peak age between age 7 and 10. The commercial fishery operates in various grids near Marquette, and the overall impacts on the MI-5 population are nominal. However, in 2000, 2003, and 2004, the commercial fishers were allowed to harvest lake trout during the spawning season through the end of October. During these three years, total annual yield increased and nearly 50% of the annual yield was taken in October. The age composition of the harvest was skewed right with a peak age ≥ 15. The concentration of commercial fishing during the spawning has had a localized impact on lake trout. Essentially, all of the lake trout harvested in October were from the Presque Isle Harbor area of Marquette. During the years with commercial harvest during the spawning season at this site, instantaneous commercial fishing mortality rates (F_C) on age-15 and older fish were higher than all younger ages and were more than 10-

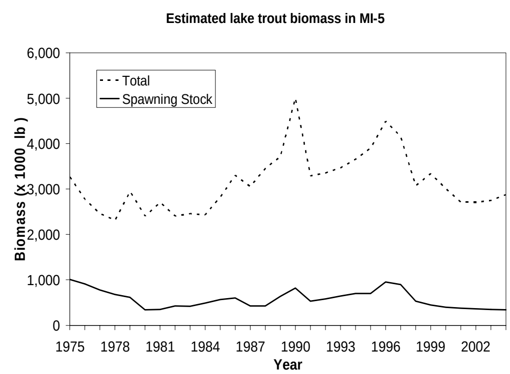
fold higher than all other years ($F_{C,2000}$=0.11 year^{-1}; $F_{C,2003}$=0.07 year^{-1}; $F_{C,2004}$=0.06 year^{-1}). The increased fishing mortality on spawners has affected the size structure of the lake trout that utilize the Presque Isle Harbor reef. The proportion of large lake trout (> 700 mm) collected in MIDNR-GLIFWC (Great Lakes Indian Fish and Wildlife Commission) fall surveys at the Presque Isle Harbor reefs has declined from 36% in 2000 to 25% in 2004.



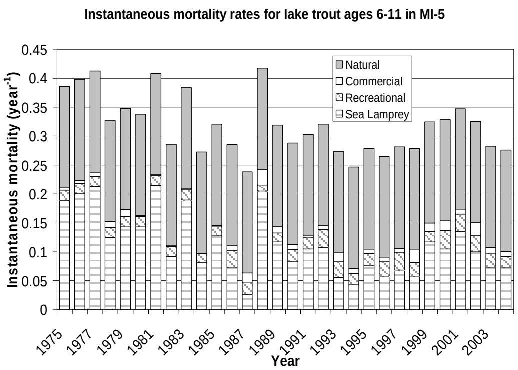
Recreational harvest of lake trout comprises both charter and sport angler fisheries. Most of this activity is centered around the port of Marquette, though some lake trout are harvested at Stannard Rock. There are no seasonal restrictions on the sport fishery, though most of the fishery occurs during 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 11,500 fish (41,000 lb) per year during the last three years. Recreational effort has declined from 146,000 angler hours in 1986 to 39,000 angler hours in 2004.

Abundance of wild lake trout increased more than two-fold since 1975 and has averaged about 1 million fish (age 4 and older) from 1993 to 2004. Total biomass of age-4 and older lake trout averaged 3.3 million lb from 1995 to 2004. Lake trout biomass declined from 4.4 million lb in 1996 to 2.9 million lb in 2004. Spawning stock biomass averaged 540,000 lb during the last 10 years. Although lake trout abundance has increased since the mid-1970s, spawning stock biomass has declined due to significant decreases in growth. This is likely to continue with declines in growth.





Apart from background natural mortality, sea lamprey-induced mortality was the dominant mortality source from 1975 to 2004, although mortality from this source has declined since the late 1980s. With the exception of 1988, recreational fishing mortality has been higher than commercial fishing mortality. Average total annual mortality (A) for age-6 to -11 lake trout has declined from 33% during 1975 to 1977 to 26% during 2002 to 2004. Spawning stock biomass produced per recruit from 2002 to 2004 has been above the target value indicating that mortality rates are not excessive and the population has good reproductive potential.



Notable stock dynamics

Like 2000 and 2003, in 2004 the tribal commercial fishery was allowed to harvest lake trout during the spawning season through 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 years with a spawning season fishery, 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).

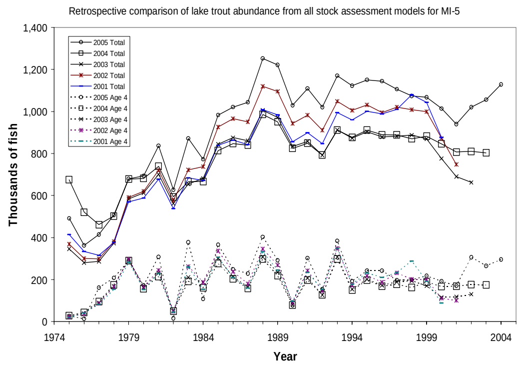
Model changes

There were 10 versions of the MI-5 model run this year with varying degrees of changes from the 2004 Stock assessment model. A major change in the data was to start the model at age 4 rather than at age 3 as in previous assessments.

Major changes in model assumptions from the 2004 model included:

- Recruitment at age 4 in the model was changed from a random walk function to estimating as individual recruitments using the population scaler-deviations approach.
- Time-varying selectivity was modeled as a random walk function as opposed to a quadratic function as in previous models.
- Recreational fishery discards (throwbacks, release mortality, hooking deaths) were based on creel survey estimates.
- Catchability coefficient (*q*) for the commercial fishery was highly correlated to recreational *q*, so the fishery parameters were consolidated to estimate recreational *q* and deviation parameter so that commercial *q* was equal to recreational *q* plus the deviation.
- Like the commercial fishery *q*, the graded-mesh survey *q* was highly correlated to large-mesh survey *q* and was modeled in the same way with the graded-mesh *q* equal to the sum of the large-mesh survey *q* and a deviation parameter.
- The graded-mesh survey was modeled as a negative single logistic.
- Commercial fishery selectivity for 2004 was assumed to be equal to the 2000 selectivity that accounts for the fall fishery with peak age in the older age classes.

We were not able to calculate probability intervals because of poor results from Markhov Chain Monte Carlo (MCMC) simulations. Further work is underway to improve the MCMC results. Summary table quantities are reported with asymptotic standard errors. The 2005 model has higher abundance estimates than previous assessment models. However, there were no systematic temporal patterns in model estimates of abundance.



The recommended yield limit for 2005 in 1836 Treaty-ceded waters was 187,600 lb, allocated as 178,200 lb for the State recreational fishery and 9,400 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 Treaty-ceded waters. Within 1836 Treaty-ceded 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.

Summary Status MI-5 Lake Trout	
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	4.499 lb (SE 0.465)
Current SSBR	1.61 lb (SE 0.15)
SSBR at target mortality	0.434 lb (SE 0.011)
Spawning potential reduction	
At target mortality	0.358 (SE 0.018)
Average yield per recruit	0.547 lb (SE 0.061)
Natural Mortality (M)	0.175 y^{-1}
Fishing Mortality	
Age of full selection Commercial Fishery (2002-2004)	15
Age of full selection Sport fishery (2002-2004)	8
Commercial Fishing mortality (F) (average 2002-2004, ages 6-11)	0.014 y^{-1} (SE 0.002)
Sport fishery F (average 2002-2004, ages 6-11)	0.024 y^{-1} (SE 0.003)
Sea lamprey mortality (ML) (average ages 6-11,2002-2004)	0.066 y^{-1}
Total mortality (Z) (average ages 6-11,2002-2004)	0.278 y^{-1} (SE 0.01)
Recruitment (age-4) (1995-2004 average)	233,110 fish (SE 33,550)
Biomass (age 3+) (1995-2004 average)	3,301,200 lb (SE 383,260)
Spawning biomass (1995-2004 average)	537,340 lb (SE 65,975)
MSC recommended yield limit in 2005	187,600 lb
Actual yield limit in 2005	187,600 lb

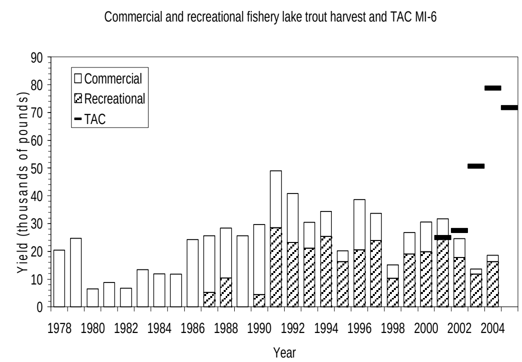
MI-6 (Au Train - Munising)

Prepared by Shawn P. Sitar and John K. Netto

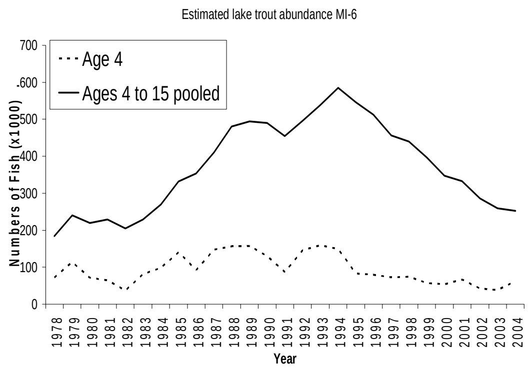
Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 1.8 million acres. This management unit includes Big Reef, an offshore reef complex about 20 miles northeast of Munising. This management unit contains the deepest waters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

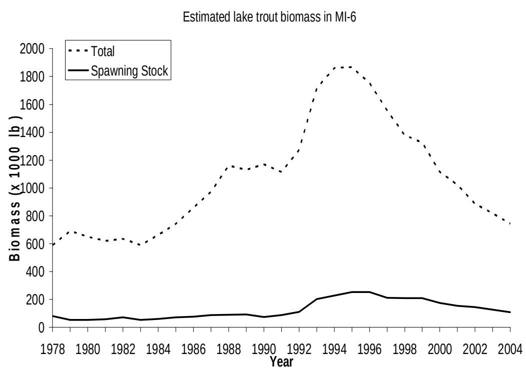
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is centered east of Grand Island. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout peaked in 1989 at 25,600 lb and declined to an average of 5,100 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 just over 1 million ft in 1994. Effort has remained relatively low since 1994; total gill-net effort has been less than 1 million ft in 8 of the last ten years. The average commercial effort from 2002 to 2004 was 880,000 ft.

Recreational harvest of lake trout comprises fish caught by both charter and sport angling. 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 4,960 fish in 2004 and averaged 4,660 fish per year from 2002 to 2004. 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 effort targeting lake trout has declined from a peak of 39,000 angler hours in 1993 to 16,700 angler hours in 2004.



Estimated abundance of age-4 and older wild lake trout declined from 585,000 fish in 1994 to 252,000 fish in 2004. Recruitment at age 4 has declined from 1995 to 2004 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 from 1994 to 2004. Total Biomass has declined from 1.9 million lb in 1995 to 743,000 lb in 2004. Spawning stock biomass averaged 185,000 lb from 1995 to 2004 and represented 15% of total stock biomass older than age 3.

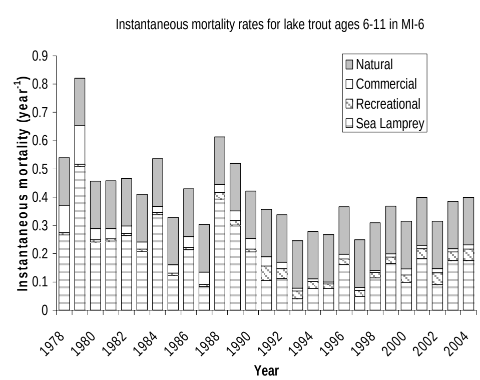




Excluding background natural mortality, sea lamprey predation was the highest mortality source for age-6 to -11 lake trout in MI-6, and has been increasing in recent years. Recreational fishing mortality has been higher than commercial fishing mortality since 1991. From 1978 to 2000, total annual mortality (*A*) was the highest in 1979 at 56% and declined to 22% in 1993. Subsequently, *A* increased to an average of 31% during 2002 to 2004.

Our estimates of population biomass continue to trend downward in this unit. The population biomass peaked in 1995 after several years of high recruitment. Estimated recruitment has been relatively low the last 10 years, and mortality rates have increased above the low levels seen in the early to mid-1990's. Additionally, size-at-age has decreased since the mid 1990's, which potentially delays recruitment to the fishery and the spawning population.

The recommended yield limit for 2005 is 71,800 lb of which 35,900 lb is allocated for State recreational yield and 35,900 lb for tribal commercial yield. While mortality rates apply only to wild lean lake trout, the yield limit includes both wild and hatchery lean lake 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. Since 2004, the MSC has assumed that there is no under-reporting in the commercial yield, so the TAC represents the total allowable catch without any under-reporting adjustment for commercial fishing. Recreational 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 196 lake trout released by anglers during 2003 and 676 in 2004.



Summary Status MI-6 Lake Trout	
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	4.69 lb
	(SE 0.547)
Current SSBR	1.07 lb
	(SE 0.1)
SSBR at target mortality	0.405 lb
	(SE 0.011)
Spawning potential reduction	
At target mortality	0.229
	(SE 0.010)
Average yield per recruit	0.310 lb
	(SE 0.035)
Natural Mortality (M)	0.168 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2002-2004)	8
Age of full selection	
Sport fishery (2002-2004)	8
Commercial Fishing mortality (F)	
(average 2002-2004, ages 6-11)	0.013 y^{-1}
	(SE 0.002)
Sport fishery F	
(average 2002-2004, ages 6-11)	0.035 y^{-1}
	(SE 0.005)
Sea lamprey mortality (ML)	
(average ages 6-11,2002-2004)	0.119 y^{-1}
Total mortality (Z)	
(average ages 6-11,2002-2004)	0.335 y^{-1}
	(SE 0.012)
Recruitment (age-4)	
(1995-2004 average)	63,120 fish
	(SE 6,409)
Biomass (age 3+)	
(1995-2004 average)	1,246,900 lb
	(SE 117,340)
Spawning biomass	
(1995-2004 average)	184,830 lb
	(SE 22,636)
MSC recommended yield limit in 2005	71,800 lb
Actual yield limit in 2005	71,800 lb

MI-7 (Grand Marais)

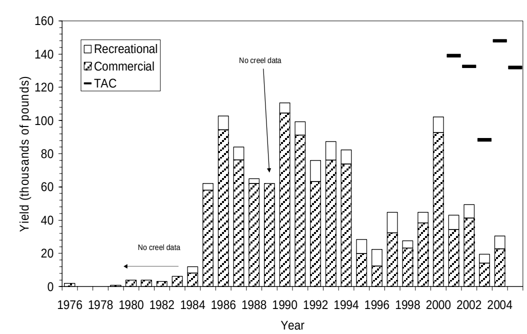
Prepared by Shawn P. Sitar and John K. Netto

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 1976 and 2004, 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 26,100 lb in the last three years. In recent years, these yields of wild lean lake trout comprise 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 2002 to 2004 has averaged 2.6 million ft.

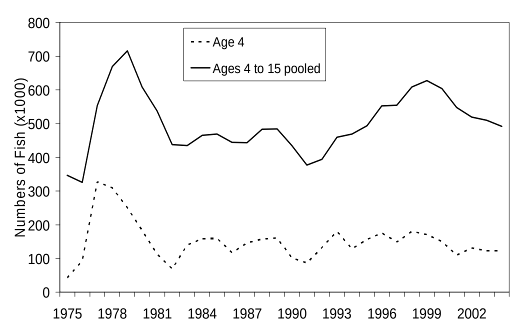
The standardized creel survey began at Grand Marais in 2001. Sport harvest and effort in MI-7 for years prior to 2001 were estimated using the average sport CPUE and effort index ratio between MI-7 to MI-5 from MIDNR creel mail survey data from 1971 to 1982 applied to MI-5 sport harvest and effort during 1984 to 2000. The estimates from this procedure indicate that recreational harvests in MI-7 are about half those of MI-6. This procedure required strong assumptions, hence there is much uncertainty regarding the true magnitude of the recreational harvest in MI-7 prior to 2001. Average harvest of wild lake trout during 2002 to 2004 was 2,000 fish. The average sport effort for the same time period was 18,500 angler hours.

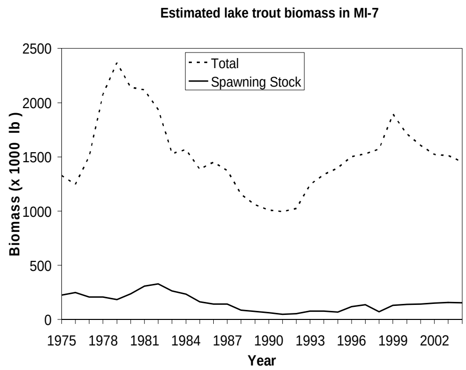
Commercial and recreational fishery lake trout harvest and TAC MI-7



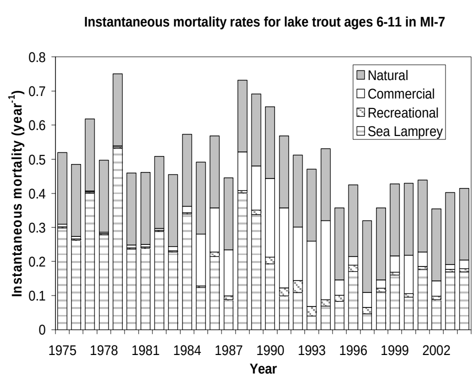
Abundance of age-4 and older wild lake trout averaged 550,000 fish from 1995 to 2004. In the same time period, recruitment at age-4 averaged 147,000 fish. Abundance has declined from 630,000 fish in 1999 to an average of 507,000 fish in 2002 to 2004. Spawning stock biomass averaged 127,000 lb during the last ten years and represented 8% of total stock biomass.

Estimated lake trout abundance MI-7





Sea lamprey predation has generally been the dominant mortality source for lake trout in MI-7 with the exception of the period from 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. From 1975 to 1979, total annual mortality (*A*) for age-6 to -11 lake trout averaged 41%. During the last five years, average *A* was 32%. 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.



Notable model changes:

No commercial monitoring data were available for 2004. There were substantial errors in survey age assessments for 2004 summer survey data, therefore there were no survey age compositions for 2004. Furthermore, there is likely an over-aging bias with the spring survey ages used for 2004.

Major changes in model assumptions from the 2004 model included:

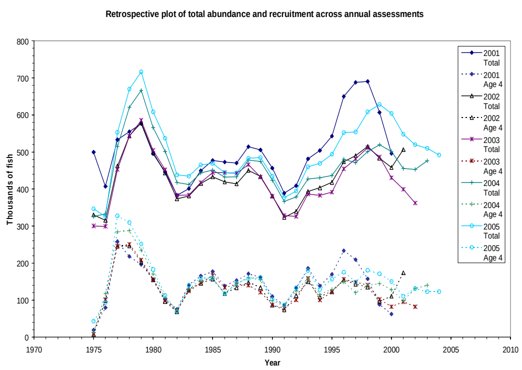
- Change starting age from 3 to 4
- Removed Max function in selectivity section of TPL
- Selectivity parameters that continually bounded were fixed: lnselcf_p1=-1.0; lnselcf_p3=1.5; lnselrf_p3=1.5; lnselgm_p4=2.0
- One of the time-varying parameters for summer (recruit) survey was not estimated (adjgmb1)
- Recreational fishery discards were based on actual estimate from the creel surveys. Recreational deaths from discards were assumed to be 15% of total sport releases.

Diagnostics and uncertainty:

The final 2005 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 model continues to exhibit poor fit to observed data for summer survey CPUE (recruit survey).

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 current model's estimate of abundance during the last ten years (see below) when compared to previous assessment model results. There were no systematic patterns when comparing year 2000 abundance estimates from the past four stock assessments. However, there were major departures in abundance estimates for 2003 and 2005 assessments.

Assessment year	N_{2000} x1000 fish	Percent difference from 2001 assessment
2001	496	
2002	458	-7.7
2003	430	-13.3
2004	501	1.0
2005	604	21.8



The recommended yield limit for the year 2005 is 132,000 lb with 39,600 lb allocated for State recreational yield and 92,400 lb for tribal commercial yield. These limits were calculated on the basis of the target mortality rate (A) of 45% and an allocation of 30% to the State and 70% to the tribes, in accord with the Consent Decree. These yield limits apply to all lean lake trout, but mortality targets only apply to wild lean lake trout. In determination of the yield limit it was assumed that 3% of the lean lake trout yield would be hatchery fish. The yield limit does not include siscowet lake trout so actual commercial yields can exceed this limit by 41%, to allow for the portion of the commercial yield that siscowets are expected to compose. The recommended total yield limit is higher than observed yields from recent years reflecting mortality rates below target limits.

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	3.563 lb (2.794-4.492)
Current SSBR	1.03 lb (0.854-1.24)
SSBR at target mortality	0.516 lb (0.481-0.549)
Spawning potential reduction	
At target mortality	0.289 (0.257-0.325)
Average yield per recruit	0.243 lb (0.145-0.343)
Natural Mortality (M)	0.211 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2002-2004)	9
Age of full selection	
Sport fishery (2002-2004)	8
Commercial Fishing mortality (F)	
(average 2002-2004, ages 6-11)	0.028 y^{-1} (0.016-0.042)
Sport fishery F	
(average 2002-2004, ages 6-11)	0.009 y^{-1} (0.005-0.013)
Sea lamprey mortality (ML)	
(average ages 6-11,2002-2004)	0.12 y^{-1}
Total mortality (Z)	
(average ages 6-11,2002-2004)	0.367 y^{-1} (0.343-0.394)
Recruitment (age-4)	
(1995-2004 average)	147,050 fish (105,586-242,872)
Biomass (age 4+)	
(1995-2004 average)	1,570,400 lb (1,180,180-2,560,020)
Spawning biomass	
(1995-2004 average)	127,010 lb (90,205-223,643)
MSC recommended yield limit in 2005	132,000 lb
Actual yield limit in 2005	132,000 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-ceded waters, covering 1,017,640 acres of which approximately 681,720 acres are less than 240 ft in depth. On the Michigan shore this unit encompasses the ports of 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-ceded waters. Retention of lake trout in the refuge is strictly prohibited.

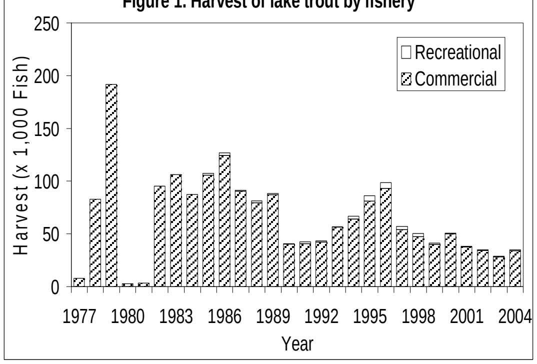
There is little or no natural recruitment of lake trout in northern Lake Huron, although recent indicators (increased trawl catches of age-0, increased CPUE's of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-1. From 2000 to 2004, approximately 454,000 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 2004, approximately 626,000 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 540,000 yearling lake trout recruits in MH-1 for 2004.

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 in Lake Huron. Previous to August 2000 one State-licensed fisher operated a trap-net operation in MH-1. This operation targeted lake whitefish and was not allowed to market lake trout bycatch. All lake trout were returned to the water, regardless of condition.

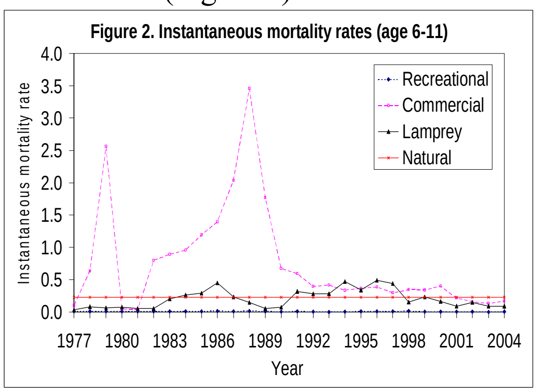
Although few lake trout have been stocked in Canadian waters adjacent to MH-1, this region was included in the assessment model because there is a substantial commercial fishery for lake trout. This means that lake trout extractions from Canadian management area 4-1 were included in the data, and estimates of yields and recruitment into this area (primarily the result of movement from other areas) were also included. From 2000 to 2004, tribal commercial yield of lake trout averaged 117,000 lb, while Canadian commercial yield averaged 21,000 lb. Due to a 400 lb daily bag limit enacted by CORA in 2002 for tribal large-mesh gill-net fishers in US waters of MH-1, the tribal harvest from 2002 to 2004 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 (93%) came from the large-mesh gill-net fishery. Tribal large-mesh gill-net effort averaged 7.8 million ft from 2000 to 2004, while Canadian large-mesh gill-net effort averaged 1.7 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 34,000 lb from 2000, although 2004 harvest essentially equaled 2000 harvest. 2004 large-mesh gill-net effort dropped by 8.8 million ft (67%) from the 2000 effort level.

The State-licensed recreational fishery in MH-1 is composed of both charter and non-charter anglers. Lake trout are caught as bycatch by salmon anglers, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty-ceded waters. Recreational harvest represents a small portion of the total fishery harvest in MH-1 (Figure 1). From 2000 to 2004, recreational yield of lake trout averaged 2,500 lb. In 2004, recreational harvest was 3,600 lb in MH-1. Starting in 2001, the State of Michigan raised the minimum size limit for lake trout in the recreational fishery from 10 inches to 20 inches in areas north of 44° 50' N latitude. Starting in 2003, the State of Michigan imposed a 15 - 19 inch slot limit in MH-1. All fish outside the slot were non-legal, except for one fish daily that may be 34 inches or larger. 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 and 2004 State harvest includes an estimate of throwback mortality.

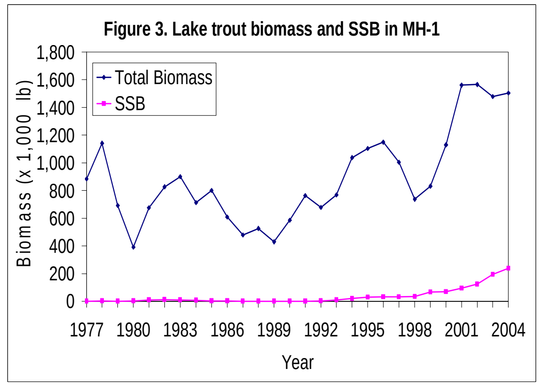
Figure 1. Harvest of lake trout by fishery



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 2000 to 2004 sea lamprey-induced instantaneous mortality averaged 0.12 y^{-1}, and commercial fishing instantaneous mortality averaged 0.21 y^{-1}. Sea lamprey-induced mortality rates for age-6 to -11 lake trout in 2004 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 fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron (Figure 2).



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 1998 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 2004 lake trout biomass was 1.50 million lb, well above the 20-year average of 937,000 lb. However, total 2004 SSB was only 237,000 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.



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 194,500 lb for MH-1 in 2005. 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 15,600 lb to the State and 178,900 lb to the tribes.

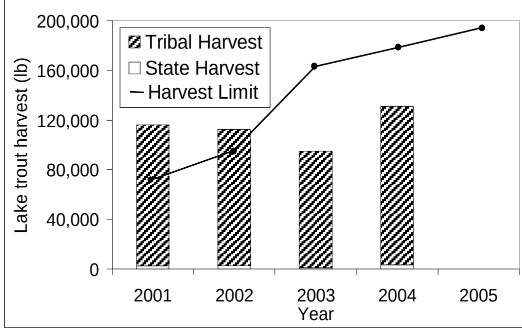
In 2001 the MH-1 harvest limit was calculated based on the phase-in requirements of the Consent Decree. In particular, it was based on the average effort from 1997 to 1999, either adjusted for gill-net operations converted to trap nets under provisions of the Consent Decree (tribal commercial fishery)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

In February 2003 the Executive Council of the 2000 Consent Decree instructed the MSC to calculate lake trout harvest limits using interim total annual mortality rates in units where conformity to Consent Decree provisions resulted in harvest limits based on total annual mortality rates below target.

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 continue to increase.

Both tribal and State harvests were significantly lower than their respective harvest limits in 2004 (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 13,300 lb from 2004 to 2005.

Figure 4. Yearly harvest and harvest limits



Model changes

No major changes were made to the model structure for this year's assessment. However, two large changes were made in the model data. First, time-varying maturity was introduced starting with the 2005 TAC-year model. Maturity-at-age was allowed to vary for blocks of years based on field observations. Secondly, weight-at-age was allowed to vary on an annual time step based on lake trout dynamic growth models developed by Ji He of MDNR and Jim Bence of MSU. Minor changes made for the 2004 TAC year model (allowing the model to select peak age of fishery selectivity, setting the under-reporting vector for the tribal commercial fishery to zero, and including release mortalities from the recreational fishery in harvest totals) were maintained in the 2005 TAC year model.

Summary Status MH-1 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	2.21 lb
Age at first spawning	4 y
Size at 50% maturity	4.68 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	3.323 lb (2.747 – 3.929)
Current SSBR	0.770 lb (0.543 – 1.009)
SSBR at target mortality	0.595 lb (0.541 – 0.653)
Spawning potential reduction	
At target mortality	0.231 (0.181 – 0.279)
Average yield per recruit	0.426 lb (0.359 – 0.483)
Natural mortality (M)	0.226 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	9 y
Sport fishery (2002-2004)	6 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.151 y^{-1} (0.110 – 0.214)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.002 y^{-1} (0.002 – 0.006)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.109 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.488 y^{-1} (0.442 – 0.562)
Recruitment (age-1)	
Average 1995-2004	382,920 fish (333,240 – 472,388)
Biomass (age 3+)	
Average 1995-2004	1,206,500 lb (1,012,600 – 1,430,530)
Spawning biomass	
Average 1995-2004	90,664 lb (66,955 – 113,244)
MSC recommended yield limit for 2005	194,500 lb
Actual yield limit for 2005	194,500 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-ceded waters (723,710 acres) and non-treaty waters (797,810 acres), divided by a line running north-east from the tip of North Point to the international border. The Michigan ports of Presque Isle and Alpena are contained in this unit. The St. Marys River, connecting Lakes Superior and Huron, flows into northern Lake Huron in grid 306, to the north of this unit. The St. Marys River 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-ceded waters with bottom depths of 240 ft or less. This management unit contains a limited number of historically important lake trout spawning reefs and shoals. These reefs are located near Middle Island, North Point, and Six Fathom Bank. The Six Fathom Bank Refuge is located in the eastern half of grids 913 and 1013, grids 914 and 1014, and Michigan waters of grids 915 and 1015 covering 251,940 acres. Canadian waters adjacent to the refuge are a commercially protected area where commercial fishers are prohibited from fishing in waters shallower than 40 fathoms. Recreational anglers may harvest lake trout in Canadian waters adjacent to the refuge, but few, if any, travel the long distance offshore. Approximately ½ of the refuge lies in MH-2 (118,560 acres), and retention of lake trout in the refuge is strictly prohibited.

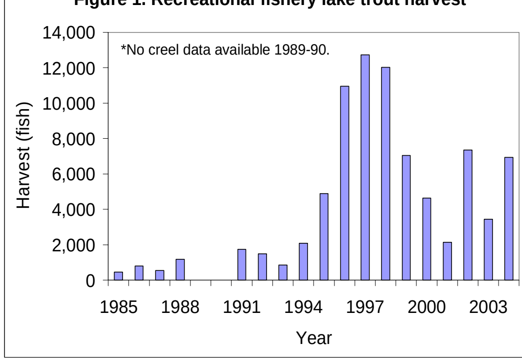
There is little or no natural recruitment of lake trout in north-central Lake Huron, although recent indicators (increased trawl catches of age-0, increased CPUE's of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-2. From 2000 to 2004, approximately 340,000 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 2004. 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. Approximately 134,000 yearling lake trout were planted annually in Canadian management area 4-3 from 2000 to 2004. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 409,000 yearling lake trout recruits in MH-2 for 2004.

In contrast to MH-1, there is no commercial harvest of lake trout in Michigan waters of MH-2. As of August 2000, tribal commercial fishers may deploy trap nets that target lake whitefish in 1836 Treaty-ceded waters of MH-2. This fishery is not allowed to market lake trout bycatch. Two State-licensed commercial fishing operations operate trap nets targeting lake whitefish in MH-2 south of the 45th parallel. These operations are also not allowed to market lake trout bycatch. All lake trout are returned to the water, regardless of condition. Prior to the signing of the Consent Decree, both 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 2000 to 2004, total Canadian commercial lake trout yield in these areas averaged 71,000 lb per year. The majority of this yield came from the large-mesh gill-net fishery. Canadian large-mesh gill-net effort averaged 8.9 million ft per year from 2000 to 2004. Canadian large-mesh gill-net effort in waters adjacent to MH-2 has been increasing since 1999.

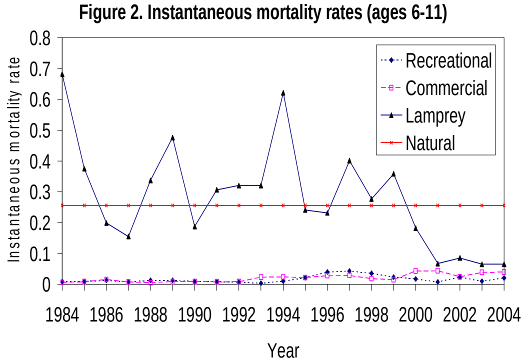
The State-licensed recreational fishery in MH-2 is composed of both charter and non-charter anglers. Lake trout are caught as bycatch by salmon anglers, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty-ceded waters. The magnitude of recreational harvest varies from year to year and has averaged 4,900 fish from 2000 to 2004 (Figure 1). From 2000 to 2004, recreational yield of lake trout averaged 24,700 lb, and in 2004 recreational harvest was 37,100 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 and 2004 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



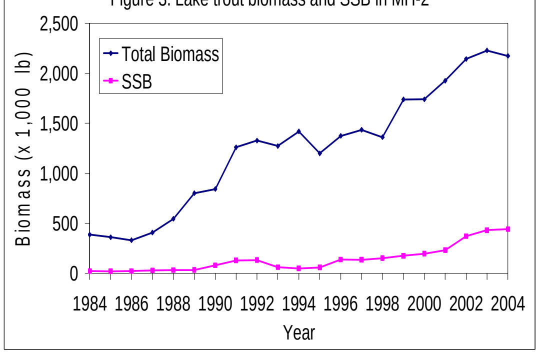
In most years, the dominant source of mortality for lake trout in MH-2 was sea lamprey (Figure 2). Sea lamprey-induced mortality was greater than all other mortality sources from 1984 to 1999 with the exception of 1986, 1987, 1990, 1995, and 1996 when natural mortality was the largest single mortality 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 2000 to 2004, sea lamprey-induced mortality averaged 0.09 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 2004 decreased 82% 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 2.04 million lb from 2000 to 2004, 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 2004 SSB was 441,000 lb (roughly 20% 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



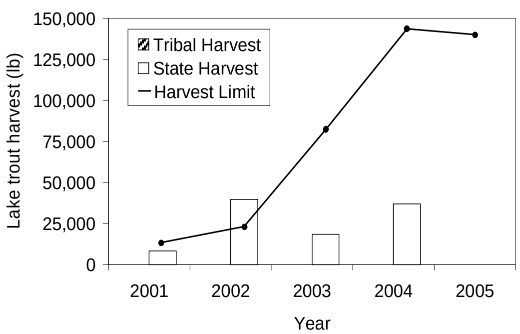
The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 139,700 lb for MH-2 in 2005. This harvest was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the State and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the Consent Decree. Based on these calculations, the total yield was allocated 132,700 lb to the State and 7,000 lb to the tribes.

Current spawning stock biomass per recruit (SSBR) is above SSBR at target mortality, indicating total annual mortality rates are below the target of 40% total annual mortality. This is due to the large declines in sea lamprey-induced mortality rates from 2000 to 2004. If sea lamprey-induced mortality remains low, spawning stock biomass and SSBR should continue to increase.

State harvest was significantly lower than the State harvest limit in 2004 (Figure 4). No tribal harvest was reported in MH-2 in 2004. 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 and decreased slightly in 2005 (Figure 4). Large increases in harvest limits since 2001 are due to large scale declines in sea lamprey-induced mortality rates during 2000-2004.

Figure 4. Yearly harvest and harvest limits



Model changes

No major changes were made to the model structure for this year's assessment. However, two large changes were made in the model data. First, time-varying maturity was introduced starting with the 2005 TAC year model. Maturity-at-age was allowed to vary for blocks of years based on field observations. Secondly, weight-at-age was allowed to vary on an annual time step based on lake trout dynamic growth models developed by Ji He of MDNR and Jim Bence of MSU. Minor changes made for the 2004 TAC year model (allowing the model to select peak age of fishery selectivity, setting the under-reporting vector for the tribal commercial fishery to zero, and including release mortalities from the recreational fishery in harvest totals) were maintained in the 2005 TAC year model.

Summary Status MH-2 Lake Trout	**Value (95% probability interval)**
Female maturity	
Size at first spawning	0.26 lb
Age at first spawning	2 y
Size at 50% maturity	4.98 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.474 lb (1.845 – 3.104)
Current SSBR	1.200 lb (0.851 – 1.549)
SSBR at target mortality	0.868 lb (0.728 – 0.992)
Spawning potential reduction	
At target mortality	0.486 (0.439 – 0.525)
Average yield per recruit	0.230 lb (0.188 – 0.275)
Natural mortality (M)	0.256 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	5 y
Sport fishery (2002-2004)	6 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.034 y^{-1} (0.024 – 0.054)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.018 y^{-1} (0.013 – 0.027)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.072 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.380 y^{-1} (0.348 – 0.431)
Recruitment (age-1)	
Average 1995-2004	431,540 fish (388,639 – 517,353)
Biomass (age 3+)	
Average 1995-2004	1,732,200 lb (1,418,040 – 2,106,740)
Spawning biomass	
Average 1995-2004	232,690 lb (173,418 – 298,073)
MSC recommended yield limit for 2005	139,700 lb
Actual yield limit for 2005	139,700 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, Big and Little Summer and Poverty Islands.

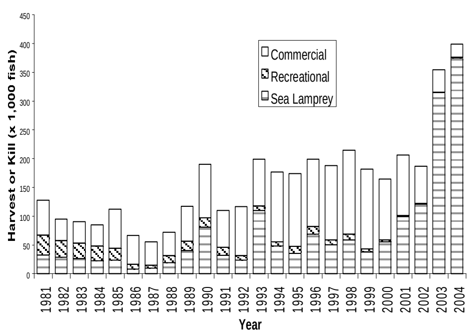
This management unit is entirely in 1836 Treaty-ceded waters, and contains a lake trout refuge. The northern refuge is nearly 900 square miles and occupies the southern ½ of grids 313 and 314, grids 413, 414, 513-516, the northwest quarter of grid 517, grid 613, and the northern ½ of grid 614. Retention of lake trout by sport or commercial fisheries is prohibited in the refuge. Gill-net fishing (both commercial and subsistence) is prohibited in the refuge, while commercial trap-net operations are permitted to harvest lake whitefish. 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, on average 610,590 yearling lake trout have been stocked into northern Lake Michigan and approximately 85% of these fish are stocked into the northern refuge. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for mortality and movement among the different management units in the lake. From 1995 to 2004 the recruitment of stocked lake trout to age one has averaged 786,930 fish in northern Lake Michigan.

Both State and tribal commercial fisheries operate in MM123. State-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish because possessing lake trout is prohibited. While the current tribal commercial fishery primarily targets lake whitefish, lake trout are sometimes kept as bycatch. From 1981 until 2000, commercial fishing killed more harvestable lake trout (> 17 in.) than other sources of mortality in northern Lake Michigan (Figure 1). In 2001, sea lamprey wounding increased and they killed comparable numbers of lake trout to commercial fisheries (~100,000 fish). Sea lamprey killed over

375,000 fish in 2004, the highest from 1981 to 2004.

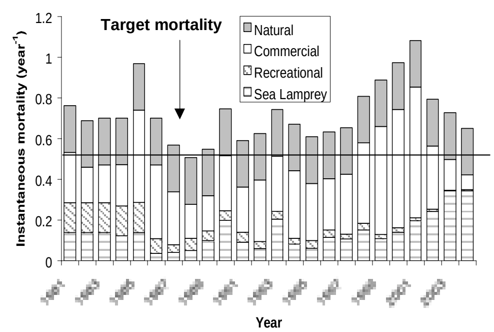
Figure 1. Number of lake trout killed by source in MM-123



The Chippewa Ottawa Resource Authority oversees three types of commercial fisheries in this area; large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery accounts for the majority of the lake trout yield. Predicted commercial yield increased from 378,000 lb in 1991 to 870,000 lb in 1998. After the implementation of the 2000 Consent Decree, commercial yield of lake trout has continuously decreased to a low of 89,000 lb in 2004. Large-mesh gill-net effort in tribal fisheries declined from 23 million ft in 1992 and 1993 to 4.3 million ft in 2004. The number of lake trout harvested from MM123 by the commercial fishery increased from 1991 (63,000 fish) to 1998 (144,000 fish). More recently, following implementation of the 2000 Consent Decree, the number of lake trout harvested by the commercial fishery has declined to a historic low of 22,000 fish in 2004 (Figure 1). In 2004, the harvest of lake trout in the region was less than both the phased and non-phased TAC allocations (Figure 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 mortality rate of lake trout resulting from recreational fishing in MM123 is significantly lower than that associated with commercial fishing or sea lamprey predation (Figure 2). In 1991, the minimum size limit for sport fishing in MM123 was increased from 10 to 24 inches, and a modest decline in recreational yield resulted. In 2003, the bag limit was raised from 2 to 3 fish. The recreational yield of lake trout had declined by over 97% from 1998 (68,000 lb) to 2003 (2,000 lb). Yield was up slightly in 2004 to 5,000 lb. The numbers harvested declined similarly. More recent declines are due in part to declines in recreational fishing effort, as angler hours decreased nearly 36%, from 116,000 in 1998 to 74,000 in 2003. A slight upward trend was observed in 2004 at 89,000 angler hours.

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 and 2004, sea lamprey mortality was estimated to be 0.34 year^{-1} compared to 0.11 year^{-1} for the commercial fishery. During the recent four years (2001 to 2004), lamprey mortality rates have been higher than during the previous sixteen years (Figure 2).

In northern Lake Michigan, lake trout generally are sexually mature 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 1995 increasing from 1.3 to 4.1 million lb. Since 1995, the biomass of lake trout has steadily decreased. In 2001, biomass levels were almost half those observed in 1995 (Figure 3). From 2001 to 2004, the biomass of lake trout has increased to 3.6 million lb. 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 2004 is below the target value indicating that mortality rates for the combined refuge/non-refuge population are above the 40% mortality target for this area.

The recommended yield limit for 1836 Treaty-ceded waters in 2005 is 9,100 lb for the State recreational fishery and 453,000 lb 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 90% to tribal fisheries, while meeting the 40% mortality target. In 2004, recommended commercial yields represented the average of the yield from 1997-1999 less the reduction due to gill-net conversions in the area (453,000 lb tribal) as per Consent Decree specifications. 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

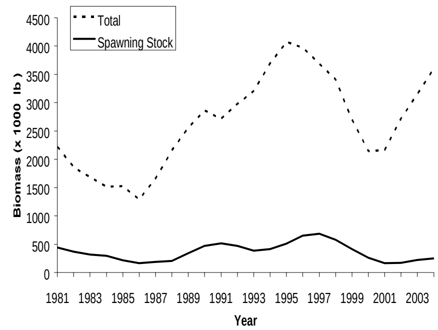
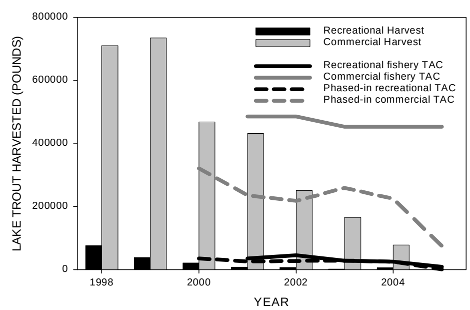


Figure 4. Comparison of Actual Harvest vs. TAC Decision vs. Model Recomendation



Model adjustments and changes:

We modeled the selectivity of the commercial fishery as a single logistic function. Previously, there was difficulty in estimating the parameters of the descending limb of a double logistic curve, likely because there are few larger fish in the population.

The size-at-age was re-estimated using the cohort based time-varying dynamic growth models developed by He and Bence (In review) and allowed to vary annually for each region. We were able to estimate size at ages 3-11 using He's method and then calculated von Bertalanffy growth parameters for ages 12-15. Only lake trout collected during spring and summer (April – August) were included in the growth model. Length weight conversions were completed using the following cubic function:

$$y = -1.618 + (0.258x) + (-0.002x^2) + (0.000013x^3)$$

Next year, we will evaluate the power function for a potential better fit, and if appropriate, it will be applied.

For this year's assessment, we estimated sea lamprey wounding rates on lake trout using methods described in Rutter and Bence (2003). Rutter and Bence (2003) used a logistic regression model to estimate the number of wounds per lake trout as a function of lake trout length. For Lake Michigan, we found that the shape of the relationship of wounds by length has changed over time. To allow for this change in the relationship over time, we used a parameterization of the wounding model that allowed the inflection point to vary over time through a random walk. Only spring wounding data were used to fit the relationship and estimate wounding rates. The wounds at length estimates were converted to mortality at age using length at age estimates described above and the probability of a lake trout surviving a lamprey attack.

References cited:

He, J.X., and J.R. Bence. In Review. Modeling annual growth variation using the von Bertalanffy growth function and a hierarchical Bayesian approach, with application to lake trout in southern Lake Huron. Transactions of the American Fisheries Society.

Summary Status MM-123	Value (95% probability interval)
Female maturity	
Size at first spawning	2.17 lb
Age at first spawning	3 y
Size at 50% maturity	6.16 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	6.49 lb (5.52 – 7.54)
Current SSBR combined w/ refuge	1.08 lb (0.88 – 1.29)
SSBR at target mortality	1.96 lb (1.71 – 2.23)
Spawning potential reduction	
At target mortality	0.301 (0.272 – 0.336)
Average yield per recruit	0.470 lb (0.395 – 0.551)
Natural mortality (M)	0.229 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	7 y
Sport fishery (2002-2004)	7 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.179 y^{-1} (0.131 – 0.254)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.006 y^{-1} (0.004 – 0.009)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.261 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.674 y^{-1} (0.624 – 0.752)
Recruitment (age-1)	
Average 1995-2004	786,930 fish (548,329 – 1,184,920)
Biomass (age 3+)	
Average 1995-2004	3,162,500 lb (2,725,470 - 3,738,730)
Spawning biomass	
Average 1995-2004	391,520 lb (335,529 – 452,078)
MSC recommended yield limit in 2005 (based on fully-phased rates)	8,400 lb
Actual yield limit in 2005 (based on phase-in requirements)	462,100 lb

MM-4 (Grand Traverse Bay)

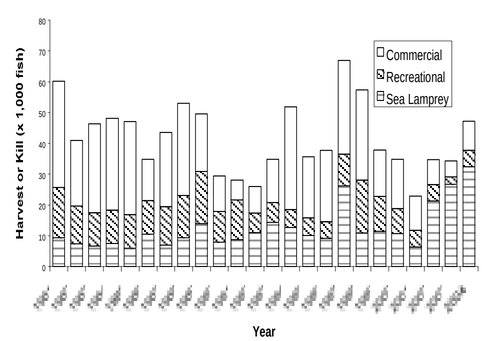
Prepared by Jory L. Jonas, John K. Netto, and Erik J. Olsen

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 ft in the west arm and 640 ft in the east arm. This management unit is entirely in 1836 Treaty-ceded 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 ft 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, 233,000 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 (1995-2004) the recruitment to age one has averaged 209,500 fish in the Grand Traverse management unit (Summary table).

From 1994 until 2001 more lake trout were killed by commercial fishing than by either sea lamprey or sport fishing (Figure 1). From 2002 to 2004, the number of lake trout killed by commercial fishing had declined to less than 10,000 fish y^{-1}. Commercial fishing mortality in Grand Traverse Bay peaked in 1994 (0.38 y^{-1}), remained relatively stable through 2001 averaging 0.21 y^{-1}, and by 2004 had declined to 0.07 y^{-1} (Figure 2).

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



Only Chippewa Ottawa Resource Authority licensed tribal fishers 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 increased from a low of 6,000 fish in 1991 to 33,000 fish harvested in 1998. Harvest declined dramatically to 5,000 fish in 2003. In 2004, harvest increased to 9,000 fish. Accordingly, yield of lake trout captured in tribal commercial fisheries peaked in 1998 at 161,000 lb and declined by nearly 86% to 23,000 lb in 2003. Yield increased slightly in 2004 to 36,000 lb. Large-mesh gill-net effort in tribal fisheries also declined from 2 million ft in 1996 to only 0.62 million ft in 2003, rising slightly in 2004 to 0.80 million feet. Reduced levels of commercial harvest of lake trout in the Grand Traverse Bay management unit can be expected due to conversion of the regions largest gill-net fishers to trap-net operations.

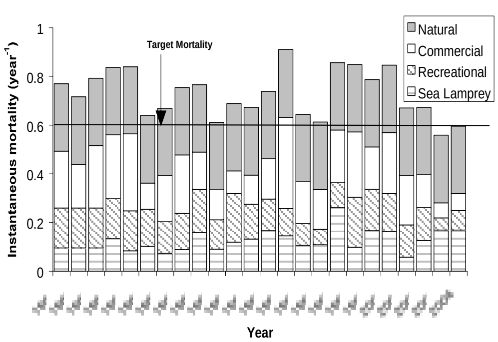


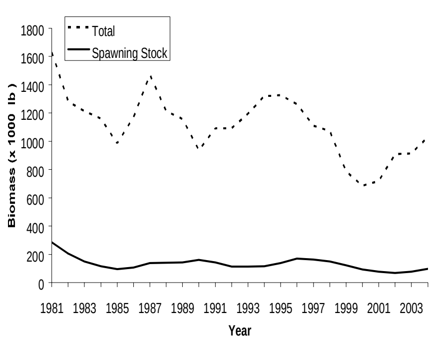
Figure 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-4

The management of the recreational fishery for lake trout is the primary responsibility of the State of Michigan and the fishery is 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 to 1996, the minimum size limit for lake trout harvest increased from 10 to 24 inches. In 1996, the season for harvesting lake trout was extended to 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 (0.20 y^{-1}) to 1996 (0.06 y^{-1}). Recreational fishing mortality averaged 0.16 y^{-1} from 1998 to 2002, declined to a low of 0.05 y^{-1} in 2003 and increased slightly to 0.07 y^{-1} in 2004 (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 92,000 lb. Yield declined to an all time low of 12,000 lb in 2003 and increased in 2004 to 24,000 lb. 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, steadily declined to 2,000 fish in 2003, and rose to 5,000 fish in 2004 (Figure 1). Effort levels have remained relatively stable over the last 10 years (1995-2004) averaging 203,000 angler hours per year (range = 183,000-238,000 angler hours).

From 1981 to 1988, sea lamprey-induced mortality was the lowest source of mortality in the Grand Traverse Bay management unit with instantaneous rates averaging 0.10 y^{-1}. Wounding rates increased to 0.26 y^{-1} in 1997, decreased to 0.06 y^{-1} by 2001, and in recent years have increased to a rate of 0.17 y^{-1} in 2004. In 2004, lampreys were estimated to have killed over 32,000 lake trout from the management unit.

In the Grand Traverse Bay management unit, lake trout are recruited into sport fisheries by age 6 and commercial fisheries by age 7. Female lake trout first spawn at age 3 and 50% or more are spawning by age 6. The total biomass of lake trout peaked in 1987 at 1.5 million lb. Biomass was relatively consistent from 1990 to 1998 averaging 1.1 million lb, and declined to 685,000 lb in 2000. In recent years the population appears to be recovering. The estimated biomass increased to 1.0 million lb in 2004. On average, the biomass of spawning lake trout has been around 117,600 lb during the last ten years (1995-2004).

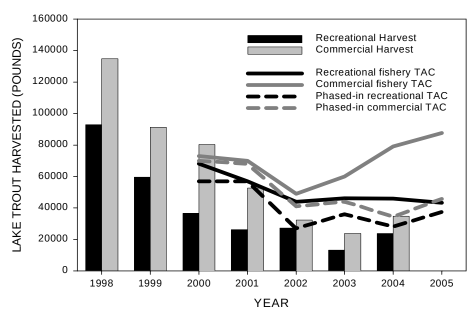
Figure 3. Estimated lake trout biomass in MM-4



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 2005 in the Grand Traverse Bay management unit is 130,800 lb of which 43,300 lb was allocated to the State recreational fishery and 87,500 lb 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 to 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. 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



Model adjustments and changes:

We used a single logistic function to estimate selectivity of the commercial fishery and recreational fishery. The parameters describing the descending limb of the curve of a double logistic model were not being estimated, likely because there were few larger fish in the population. Survey selectivity was modeled as a double logistic function.

The size-at-age was re-estimated using the cohort based time-varying dynamic growth models developed by He and Bence (In review) and allowed to vary annually for each region. We were able to estimate ages 3-11 using He's method and then calculated von Bertalanffy growth estimates for ages 12-15. Only lake trout collected during spring and summer (April – August) were included in the model estimation. Length weight conversions were completed using the following cubic function:

$$y = 0.642 + (0.314x) + (-0.002x^2) + (0.000014x^3)$$

Next year, we will evaluate the power function for a potential better fit, and if appropriate, it will be applied.

For this year's assessment, we estimated sea lamprey wounding rates on lake trout with the methods described in Rutter and Bence (2003). Rutter and Bence (2003) used a logistic regression to estimate the number of wounds per lake trout as a function of lake trout length. For Lake Michigan, we found that the shape of the relationship of wounds by length had changed over time. To allow for this change in the relationship over time, we used a parameterization of the wounding model that allowed the inflection point parameter to vary by year through a random walk. Only spring wounding data were used to fit the relationship and estimate wounding rates. The wounds at length estimates were then converted to mortality at age using the length at age estimates described above and the probability of lake trout surviving a lamprey attack.

References cited:

He, J.X., and J.R. Bence. In Review. Modeling annual growth variation using the von Bertalanffy growth function and a hierarchical Bayesian approach, with application to lake trout in southern Lake Huron. Transactions of the American Fisheries Society.

Summary Status MM-4	Value (95% probability interval)
Female maturity	
Size at first spawning	1.25 lb
Age at first spawning	3 y
Size at 50% maturity	5.82 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.619 lb (2.309 – 2.982)
Current SSBR	0.524 lb (0.450 – 0.605)
SSBR at target mortality	0.772 lb (0.706 – 0.839)
Spawning potential reduction	
At target mortality	0.296 (0.264 – 0.327)
Average yield per recruit	0.424 lb (0.382 – 0.469)
Natural mortality (M)	0.277 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	7 y
Sport fishery (2002-2004)	6 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.089 y^{-1} (0.067 – 0.117)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.089 y^{-1} (0.070 – 0.114)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.117 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.610 y^{-1} (0.569 – 0.657)
Recruitment (age-1)	
Average 1995-2004	209,500 fish (187,500 – 235,100)
Biomass (age 3+)	
Average 1995-2004	786,100 lb (703,100 – 876,000)
Spawning biomass	
Average 1995-2004	117,600 lb (102,300 – 134,900)
MSC recommended yield limit in 2005	
(based on fully-phased rates)	83,200 lb
Actual yield limit in 2005	
(based on phase-in requirements)	130,800 lb

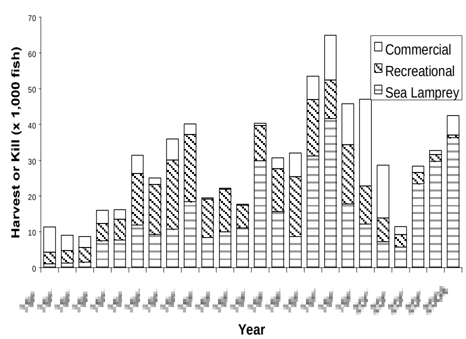
MM-5 (Leelanau Peninsula to Arcadia)

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 ft 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-ceded waters and there are no refuges allocated within the management unit. Only a small amount of lake trout spawning habitat is present, 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, 192,000 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 (1995-2004) the recruitment to age one has averaged 263,440 fish in MM-5.

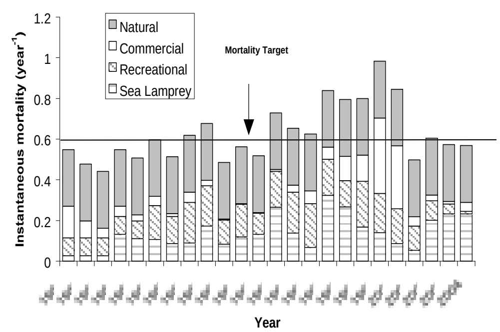
Figure 1. Number of lake trout killed by source in MM-5



Although both State and tribal commercial fishers harvest fish in the management unit, State-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish. State-licensed fishers are not permitted to harvest lake trout, and as a result, are not included in lake trout harvest allocations. The Chippewa Ottawa Resource Authority oversees three types of tribal commercial fisheries in this area including large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery, while primarily targeting lake whitefish, is generally responsible for the greatest number of harvested lake trout. However, the 2000 Consent Decree resulted in the conversion of the regions largest gill-net fishers to trap-net operations. These conversions, coupled with the low market value of lake trout have resulted in a considerable decrease in the commercial harvest and mortality of lake trout in recent years. From 1990 to 1993, mortality from commercial fishing was extremely low averaging $0.005y^{-1}$. Mortality rates increased over the next seven years, the highest commercial fishing mortalities were observed in 1999 and 2000 at 0.37 and $0.31y^{-1}$, respectively. In 1999 over 24,000 fish were harvested in commercial fisheries. After the year 2000, the commercial harvest decreased significantly, with only 1,100 lake trout harvested in 2003, and an associated mortality rate of $0.01y^{-1}$. In 2004 harvest increased to 5,500 fish (Figures 1 and 2). The predicted yield of lake trout in commercial fisheries rose precipitously from 3,800 lb in 1993 to 184,900 lb in 1999. From 2001 to 2003 the yield was extremely low, averaging 8,900 lb. In 2004 yield had increased to 26,800 lb. Large-mesh gill-net effort in tribal fisheries reflected patterns similar to those observed in mortality, harvest and yield. Gill-net effort rose from 22,000 ft in 1993 to 2 million in 1999. From 2001 to 2003 gill-net effort averaged 115,000 ft of net from 2001 to 2003 and increased to 505,000 ft in 2004.

Recreational fisheries for lake trout are primarily managed by the State of Michigan and include both charter and sport anglers. From 1986 until 1995, recreational fishing was the highest source of mortality in the MM-5 management unit, exceeding both sea lamprey and commercial fishing. Mortality (averaged over ages 6-11) from recreational fishing has declined from $0.17y^{-1}$ in 2000 to $0.01y^{-1}$ in 2004. The recreational fishery yield declined from 88,500 lb in 1998 to 3,800 lb in 2004. The numbers of lake trout harvested have also declined in recent years, dropping 96% between 1998 (18,000 fish) and 2004 (765 fish). Recreational fishing effort had been relatively consistent from 1995 to 2001 averaging 300,000 angler hours. After 2001, angler effort declined to 180,000 angler hours by 2003 and has risen to 270,000 angler hours in 2004. 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

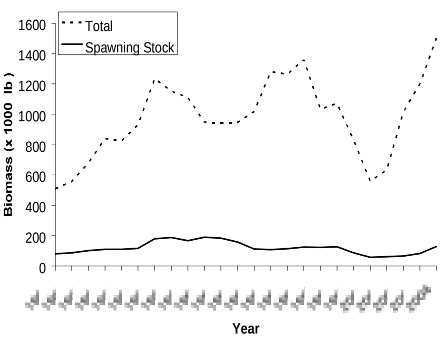


From 1984-1992 sea lamprey mortality rates were relatively consistent averaging $0.11y^{-1}$. Rates increased to $0.27y^{-1}$ in 1993 declining over the next two years to $0.07y^{-1}$. Rates increased again in 1994 to 0.32 y^{-1} and declined to $0.05y^{-1}$ by 2001. During 2002 and 2003 mortality rates averaged $0.22y^{-1}$ (Figure 2). Sea lamprey killed over 5,700 lake trout in 2001 and the number killed has increased to 36,300 in 2004. 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 8 they are fully recruited into commercial fisheries and age 12 into recreational fisheries. The biomass of lake trout was

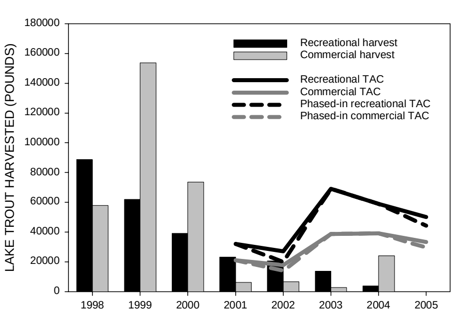
1.4 million lb in 1996, declined to 560,000 lb by 2000 and has since been increasing to 1.5 million lb in 2004 (Figure 3). The biomass of spawners has risen from 56,900 lb in 2000 to 128,000 lb in 2004.

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 2005 in unit MM-5 is 83,385 lb, and is based on a target mortality rate of 45% and no greater than a 15% reduction from the previous years harvest limit as per the consent decree. Of this yield, 50,065 lb were allocated to the State recreational fishery and 33,320 lb to the tribal commercial and subsistence fisheries. Allocations were based on a 60% allotment for the State of Michigan and 40% to tribal fisheries.

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



Model adjustments and changes:

A single logistic function was used to estimate selectivity of recreational and survey fisheries. We were not able to estimate the descending limb of curve for the double logistic functions, likely because there were few larger fish in the population. Selectivity for the commercial fishery was represented by a double logistic function.

Lake trout size-at-age was re-estimated using the cohort based time-varying dynamic growth models developed by He and Bence (In review) and allowed to vary annually for each region. We were able to estimate ages 3-11 using He's method and then calculated von Bertalanffy growth parameters for ages 12-15. Only lake trout collected during spring and summer (April – August) were included in the model estimation. For MM5, there was no size-at-age data for the years 1990-1993, and 1995. We borrowed data from MM123 to fill these gaps as this unit was most similar in years when data were collected in both. Length weight conversions were completed using the following cubic function:

$$y = 1.404 + (-0.340x) + (0.0004x^2) + (0.000011x^3)$$

Next year, we will evaluate the power function for a potential better fit, and if appropriate, it will be applied.

For this year's assessment, we estimated sea lamprey wounding rates on lake trout with the methods described in Rutter and Bence (2003). This method uses a logistic regression model to estimate the number of wounds per fish as a function of lake trout length. For Lake Michigan, we found that the shape of the relationship of wounds by length had changed over time. To allow for this change in the relationship over time, we used a parameterization of the wounding model that allowed the inflection point parameter to vary by year through a random walk. Only spring wounding data were used to fit the relationship and estimate wounding rates. Wounds at length estimates were then converted to mortality at age using the length at age estimates described above and the probability of lake trout surviving a lamprey attack.

References cited:

He, J.X., and J.R. Bence. In Review. Modeling annual growth variation using the von Bertalanffy growth function and a hierarchical Bayesian approach, with application to lake trout in southern Lake Huron. Transactions of the American Fisheries Society.

Summary Status MM-5	Value (95% probability interval)
Female maturity	
Size at first spawning	1.91 lb
Age at first spawning	3 y
Size at 50% maturity	6.23 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.119 lb (1.863 – 2.408)
Current SSBR	0.785 lb (0.665 – 0.916)
SSBR at target mortality	0.679 lb (0.612 – 0.750)
Spawning potential reduction	
At target mortality	0.370 (0.344 – 0.394)
Average yield per recruit	0.170 lb (0.139 – 0.204)
Natural mortality (M)	0.279 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	8 y
Sport fishery (2002-2004)	12 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.028 y^{-1} (0.027 – 0.038)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.054 y^{-1} (0.038 – 0.074)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.162 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.515 y^{-1} (0.489 – 0.547)
Recruitment (age-1)	
Average 1995-2004	263,440 fish (226,088 – 308,814)
Biomass (age 3+)	
Average 1995-2004	804,792 lb (697,789 – 924,715)
Spawning biomass	
Average 1995-2004	98,959 lb (83,765 – 116,314)
MSC recommended yield limit in 2005	
(based on model)	73,800 lb
Actual yield limit in 2005	
(limited by 15% rule)	83,385 lb

MM-67 (Manistee - Ludington)

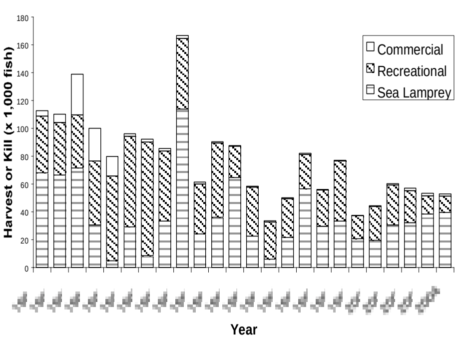
Prepared by Jory L. Jonas, John K. Netto, and Archie W. Martell Jr.

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 Michigan-Wisconsin boundary 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 ft in depth. The northern section of the region (MM-6) is deeper, reaching depths up to 900 ft 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. While the northern section (MM-6) is entirely 1836 Treaty-ceded territory, only the northern two-thirds of the southern section (MM-7) is within Treaty-ceded territory. A total of 690 square miles in the unit are outside of 1836 Treaty-ceded 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 Michigan-Wisconsin boundary in the middle of the lake delineates the southern boundary of treaty territories in the unit. Management unit MM-67 contains a portion of the deepwater mid-lake lake trout refuge, which comprises 850 square miles of the unit (grids 1606, 1607, 1706, 1707, 1806, 1807, 1906 and 1907). It is illegal for recreational, commercial and subsistence fishers to retain lake trout when fishing in the refuge area. Gill-net fishing (both commercial and subsistence) is prohibited in the refuge. Some State-licensed and tribal commercial trap-net operations are permitted, however, the retention of lake trout is prohibited. As of 2004, there was no tribal commercial fishing effort in management unit MM-7 and limited tribal fishing existed in MM-6. There is one State-licensed chub fisher in MM-6, though they have not been active since 1997. There are two active State-licensed trap-net operations in MM-7, and two chub permits as well.

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 201,000 yearling lake trout have been stocked into non-refuge southern treaty waters, while an additional 289,000 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 (1995-2004), the recruitment of lake trout to age one has averaged 490,000 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 2). In 2004, the commercial fishery in southern treaty waters of Lake Michigan was comprised of two State-licensed commercial fishers, two tribal trap-net operations (one beginning 1-month before closure), and one tribal small-mesh gill-net operation. State and tribal commercial fisheries primarily target lake whitefish and chubs, and they are not permitted to harvest lake trout with large-mesh gill nets. As a result, the yield of lake trout in commercial fisheries is low, and has averaged 6,500 lb over the last 19 years (1986-2004). During the recent three years (2001 to 2004) commercial fisheries have harvested an average of 1,700 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.

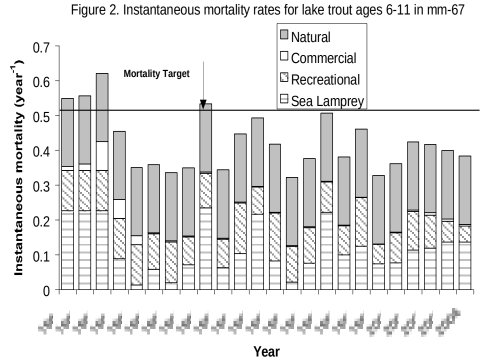
Figure 1. Number of lake trout killed by source in mm-67



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, observed recreational fishing mortality rates have been declining from 0.11y^{-1} in 2001 to 0.05y^{-1} in 2004. The yield of lake trout in recreational fisheries has also declined from 177,800 lb in 2001 to 53,800 lb in 2004. The highest recreational yield was observed in 1987 at 474,400 lb. The numbers of lake trout harvested have declined by nearly 59% in recent years, from 28,200 fish in 2001 to 11,500 fish in 2004, a trend which is continuing since 1987 (81,200 fish; Figure 1). Effort levels have been relatively consistent since 1990 averaging 1,171,000 angler hours. Size and bag limits did not change from 1981 until 2003. During that time, the fishing season changed twice, once in 1984 when 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 increased to 22 inches and the season expanded from May 1 to Sept 30.

Sea lamprey-induced mortality is lower in southern treaty waters of Lake Michigan when compared with rates observed in the northern units. Mortality rates have ranged from 0.01 to 0.24 during the last 20 years (Figure 2). In the recent four years (2001-2004), the number of lake trout killed by lamprey has averaged 35,200 fish (Figure 1).

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



The majority of lake trout in MM-67 are spawning by age 6, have recruited into recreational fisheries by age 7 and into commercial fisheries by age 8. The biomass of lake trout age 3 and older is high averaging over 2.4 million lb during the recent ten years (1995-2004; Figure 3). Spawning lake trout comprise a relatively high proportion of the total biomass in this unit (Figure 3), averaging over 600,000 lb from 1995-2004.

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 2005 in MM-67 is 315,000 lb and was adjusted to accommodate the 15% rule. Of the resulting 367,370 lb allocation, the State recreational fishery receives 330,650 lb and the tribal fishery 36,720 lb. 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

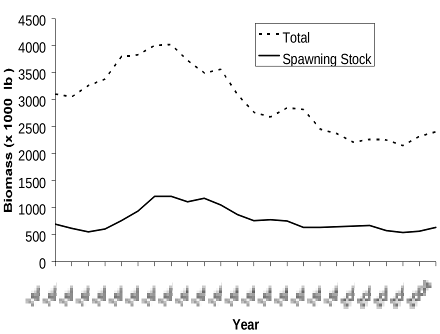
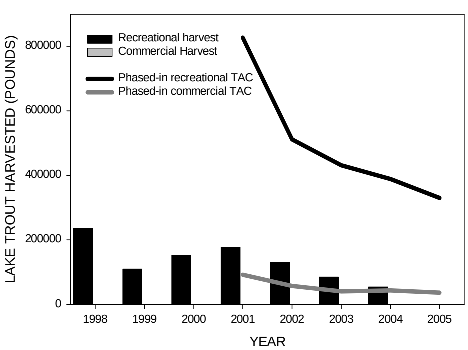


Figure 4. Comparison of Actual Harvest vs. TAC Decision



Model adjustments and changes:

The size-at-age was re-estimated using the cohort based time-varying dynamic growth models developed by He and Bence (In review) and allowed to vary annually for each region. We were able to estimate ages 3-11 using He's method and then calculated von Bertalanffy growth parameters for ages 12-15. Only lake trout collected during spring and summer (April – August) were included in the model estimation. For MM67, there was no size at age data from 1995, so we borrowed data from MM4 to fill these gaps as this unit was most similar in years when data were collected in both. Length weight conversions were completed using the following cubic function:

$$y = -7.545 + (0.433x) + (-0.002x^2) + 0.000013x^3)$$

Next year, we will evaluate the power function for a potential better fit, and if appropriate, it will be applied.

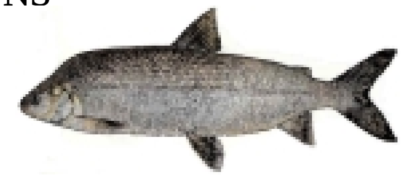
For this year's assessment, we estimated sea lamprey wounding rates on lake trout with the methods described in Rutter and Bence (2003). Rutter and Bence (2003) used a logistic regression model to estimate the number of wounds per fish as a function of lake trout length. For Lake Michigan, we found that the shape of the relationship of wounds by length had changed over time. To allow for this change in the relationship over time, we used a parameterization of the wounding model that allowed the inflection point to vary by year through a random walk. Only spring wounding data were used to fit the relationship and estimate wounding rates. The wounds at length estimates were then converted to mortality at age using the length at age estimates described above and the probability of lake trout surviving a lamprey attack.

References cited:

He, J.X., and J.R. Bence. In Review. Modeling annual growth variation using the von Bertalanffy growth function and a hierarchical Bayesian approach, with application to lake trout in southern Lake Huron. Transactions of the American Fisheries Society.

Summary Status MM-67	Value (95% probability interval)
Female maturity	
Size at first spawning	1.55 lb
Age at first spawning	3 y
Size at 50% maturity	5.73 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	6.302 lb (5.096 – 7.673)
Current SSBR combined w/ refuge	2.019 lb (1.550 – 2.519)
SSBR at target mortality	1.302 lb (1.121 – 1.483)
Spawning potential reduction	
At target mortality	0.320 (0.291 – 0.346)
Average yield per recruit	0.374 lb (0.332 – 0.418)
Natural mortality (M)	0.196 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2002-2004)	8 y
Sport fishery (2002-2004)	7 y
Commercial fishing mortality (F)	
Average 2002-2004, ages 6-11	0.006 y^{-1} (0.005 – 0.008)
Sport fishing mortality (F)	
Average 2002-2004, ages 6-11	0.068 y^{-1} (0.051 – 0.092)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 6-11	0.123 y^{-1}
Total mortality (Z)	
Average 2002-2004, ages 6-11	0.394 y^{-1} (0.365 – 0.430)
Recruitment (age-1)	
Average 1995-2004	324,400 fish (305,700 – 345,100)
Biomass (age 3+)	
Average 1995-2004	2,404,300 lb (1,903,600 – 2,943,600)
Spawning biomass	
Average 1995-2004	628,400 lb (464,200 – 813,100)
MSC recommended yield limit in 2005	
(based on model)	315,000 lb
Actual yield limit in 2005	
(limited by 15% rule)	367,370 lb

STATUS OF LAKE WHITEFISH POPULATIONS



Lake Superior

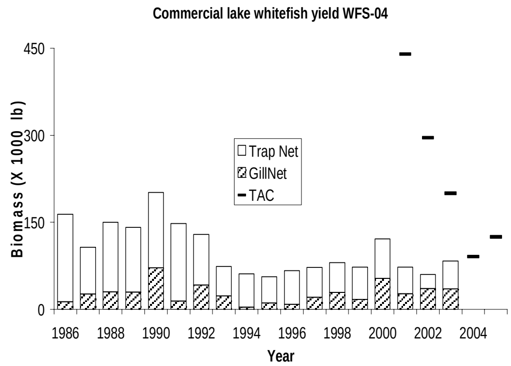
WFS-04 (Marquette - Big Bay)

Prepared by Philip J. Schneeberger

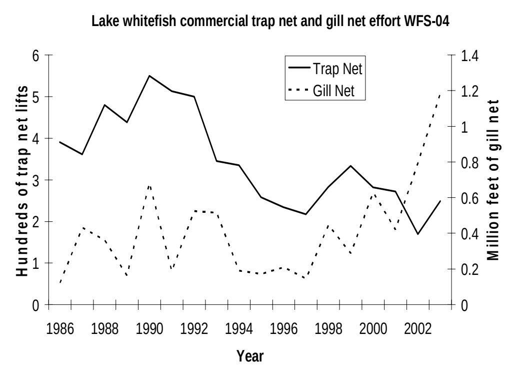
Lake whitefish unit WFS-04 (1,201,498 surface acres) is located in Lake Superior roughly between Big Bay and Laughing Fish Point east of Marquette. Fishable grids in this unit include 1326-1327, 1428-1429, and 1529-1531. Near shoreline features of this zone include many points, bays, islands, and in-flowing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

This unit 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-ceded area, but more than 90% of trap-net effort and yield are taken from waters west of the treaty line.

Yield during 2003 was 83,155 lb with 48,084 lb (58%) caught in trap nets and 35,071 lb (42%) in gill nets. Trap-net yield was about average for the 17-year data set and was nearly double the 2002 value, which was the lowest trap-net yield during 1986-2003. Gill-net yield was slightly less than in 2002, but was 30% higher than the 1986-2002 average. From 1986 to 2003, trap nets have caught 73% of the annual yield, on average, and gill nets have caught 27%.

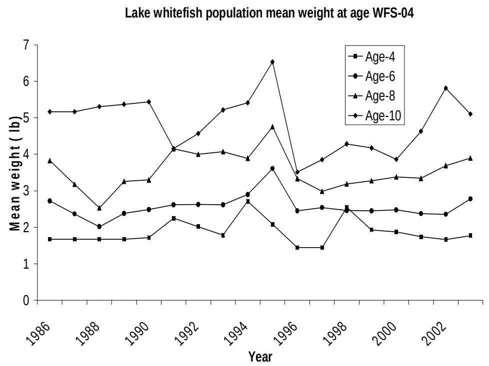


Although 2003 trap-net effort (249 lifts) represented a 46% increase from the previous year, it was 29% below the 1986-2002 average. Fishing effort with gill nets was 220% higher in 2003 than the 1986-2002 average and was the most gill-net effort (1.2 million feet) recorded for the data set.

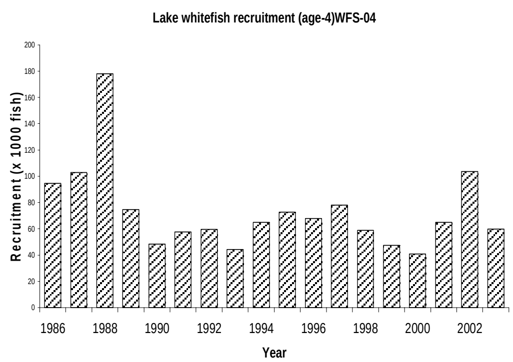


Between 2002 and 2003, calculations of mean weight-at-age increased by an average of 12% for ages 3-8, and decreased by the same average for ages 9-12+. Overall, weight-at-age values in 2003 were slightly higher than 1986-2002 averages for ages 5-11 and 4-11%

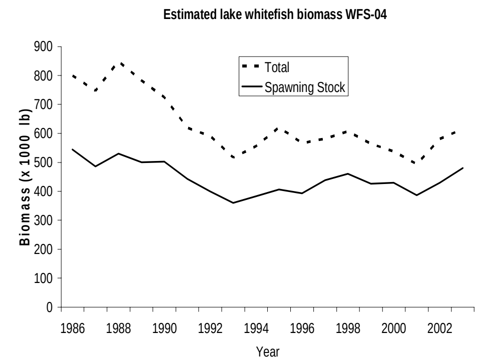
lower than averages for ages 3, 4, and 12+.



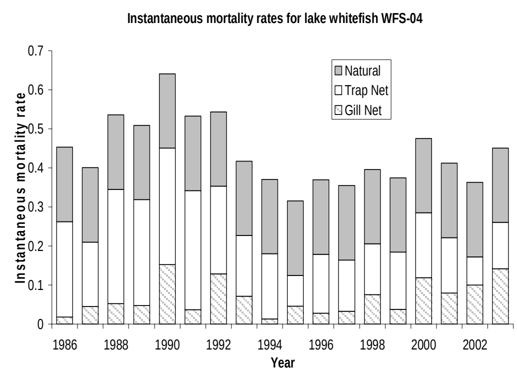
Recruitment (number of age-4 lake whitefish) was estimated at 60,000 in 2003. The 2003 recruitment was 19% below the 1986-2002 average using the 2003 model estimates.



Both fishable biomass and spawning stock biomass increased between 2002 and 2003. Estimated fishable biomass was 615,000 lb and spawning stock biomass was 481,000 lb in 2003. The ratio of spawning stock biomass to fishable biomass was 0.78.



Total instantaneous mortality rates (Z) remained below 0.50 y^{-1} as they have since 1993. Estimated instantaneous fishing mortality rates (F) were 0.14 y^{-1} for gill nets and 0.12 y^{-1} for trap nets in 2003. Instantaneous natural mortality rate was estimated at 0.19 y^{-1}.



The calculated yield limit for 2005 is 177,000 lb in WFS-04, an 81% increase over the 2004 limit of 98,000 lb. The increase is justified by favorable estimates for biomass, mortality, and weight-at-age as well as acceptable estimates for recruitment.

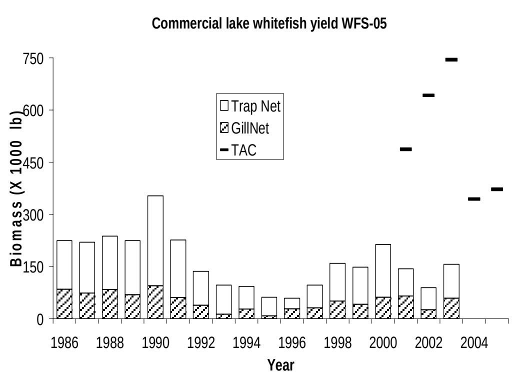
Summary Status WFS-04 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.73 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.04 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	8.237 lb (8.210 - 8.263)
	Current SSBR	2.74 lb (2.53 - 2.96)
	SSBR at target mortality	0.265 lb (2.65 - 2.65)
Spawning potential reduction		
	At target mortality	0.333 (0.307 - 0.360)
Average yield per recruit		1.573 lb (1.542 - 1.600)
Natural Mortality (M)		0.190 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.119 y^{-1} (0.102 - 0.138)
	Average trap net F, ages 4+	0.116 y^{-1} (0.102 - 0.132)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.426 y^{-1} (0.397 - 0.458)
Recruitment (age-4)	(1994-2003 average)	67,133 fish (59,585 - 76,385)
Biomass (age 3+)	(1994-2003 average)	579,129 lb (531,724 - 633,356)
Spawning biomass	(1994-2003 average)	428,574 lb (392,239 - 469,432)
MSC recommended yield limit in 2005		177,000 lb
Actual yield limit for 2005		177,000 lb

WFS-05 (Munising)

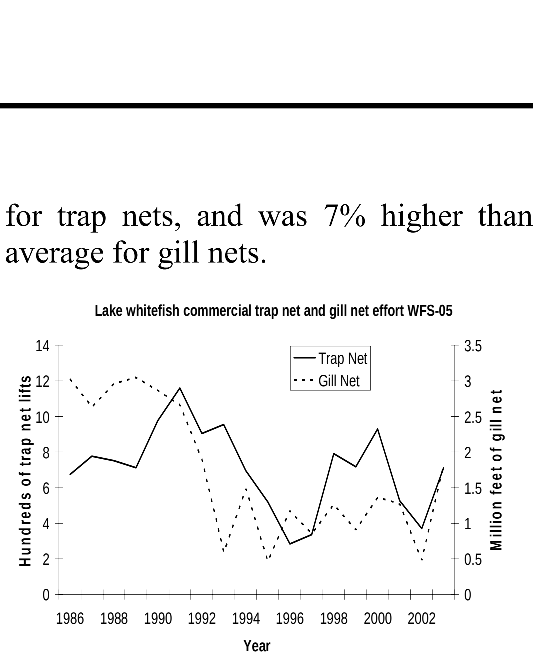
Prepared by Philip J. Schneeberger

The WFS-05 lake whitefish management unit extends approximately from Laughing Fish 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.

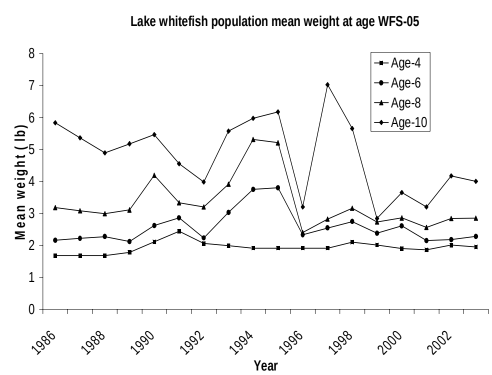
Total yield of lake whitefish in WFS-05 for 2003 was 156,000 lb, up 76% from 89,000 lb in 2002. The 2003 yield was 4% less than the average for 1986-2002. Trap nets accounted for 62% of the lake whitefish yield during 2003, and gill nets took the remaining 38%. Trap-net and gill-net yields in 2003 were 14% below and 18% above the 1986-2002 averages for each gear type, respectively.



Fishing effort increased 91% for trap nets and 281% for gill nets between 2002 and 2003. Fishing effort in 2003 was the same as the 1986-2002 average for trap nets, and was 7% higher than average for gill nets.

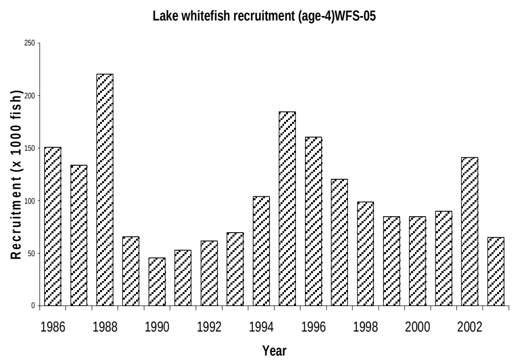


Mean weight-at-age has remained relatively static since 1999, especially for ages less than 10. Prior to 1999, mean weight-at-age values fluctuated more severely and exhibited a general downward trend.



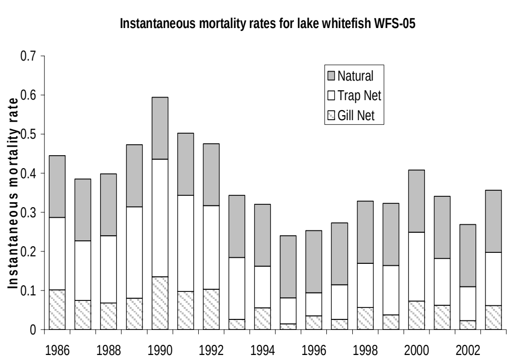
The 2003 estimate of recruitment, reported as annual numbers of age-4 lake whitefish in the population, was 65,000 fish, a decrease of 54% from the 2002 estimate, and the lowest estimated recruitment since 1992. As Stated in previous reports, prior experience indicates that this estimate is subject to revision in subsequent years. For example, the recruitment estimate in 2000 using the 1986-2000 dataset was

155,000, but adding one more year of data (1986-2001 dataset) changed the 2000 estimate to 565,000.

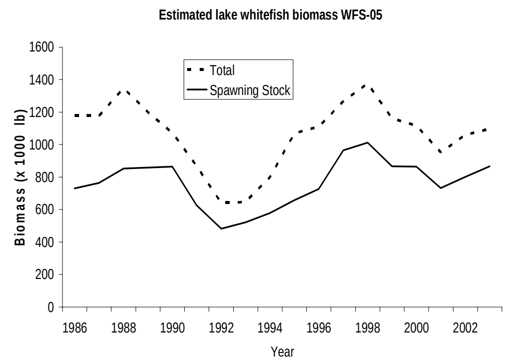


Biomass estimates in 2003 were 1.1 million lb for the fishable stock (lake whitefish age-4 and older) and 866,000 lb for the spawning stock. Both of these values were higher than 2002 estimates. Spawning stock biomass was 79% of fishable biomass in 2003, larger than the 1986-2002 average of 72%.

Estimates for total instantaneous mortality rate (Z) have remained consistently below 0.45 y^{-1} during 1993-2003. The estimate for Z was 0.36 y^{-1} in 2003. Natural mortality rate (M) was the largest component (44%) of Z in WFS-05. Instantaneous fishing mortality (F) rate was 0.06 y^{-1} for gill nets and 0.14 y^{-1} for trap nets.



The calculated 2005 yield limit for WFS-05 was 372,000 lb, an 8% increase from the yield limit for 2004. Estimated parameter values were within desirable ranges (biomass, mortality) or were at least not at levels of concern (weight at age, recruitment).



Summary Status WFS-05 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.94 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.16 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	11.269 lb (11.233 - 11.307)
	Current SSBR	3.28 lb (2.97 - 3.60)
	SSBR at target mortality	0.255 lb (2.55 - 2.55)
Spawning potential reduction		
	At target mortality	0.29 (0.26 - 0.32)
Average yield per recruit		1.530 lb (1.500 - 1.554)
Natural Mortality (M)		0.159 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.05 y^{-1} (0.044 - 0.056)
	Average trap net F, ages 4+	0.119 y^{-1} (0.104 - 0.136)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.328 y^{-1} (0.308 - 0.349)
Recruitment (age-4)	(1994-2003 average)	114,341 fish (105,135 - 124,668)
Biomass (age 3+)	(1994-2003 average)	1,107,671 lb (1,016,870 - 1,203,190)
Spawning biomass	(1994-2003 average)	812,652 lb (738,441 - 892,427)
MSC recommended yield limit in 2005		372,000 lb
Actual yield limit in 2005		372,000 lb

WFS-06 (Grand Marais)

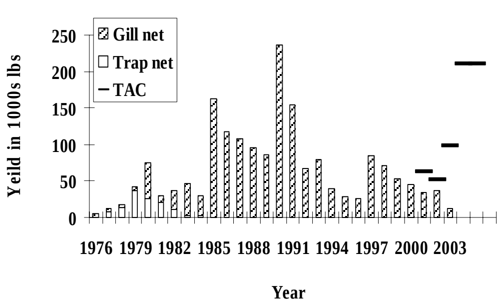
Prepared by Mark P. Ebener

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

WFS-06 has been an exclusive commercial fishing zone for CORA fishers since 1985. Typically, only large-boat gill-net fishers operate here because the unit is exposed to the open water of Lake Superior, and access to the unit is limited to the Grand Marais area. 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.

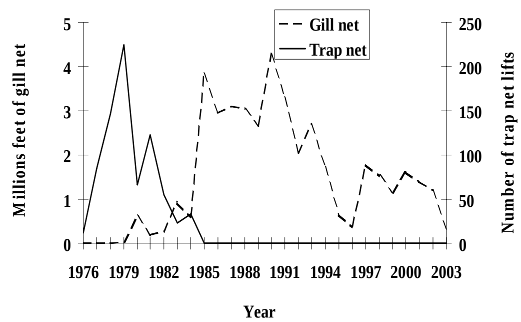
The commercial yield of lake whitefish from WFS-06 has averaged only 65,400 lb during 1976-2003. The peak yield was 236,000 lb in 1990 and the lowest yield was 4,900 lb in 1976. The commercial fishery yield of whitefish was 11,800 lb in 2003.

Commercial lake whitefish yield WFS-06



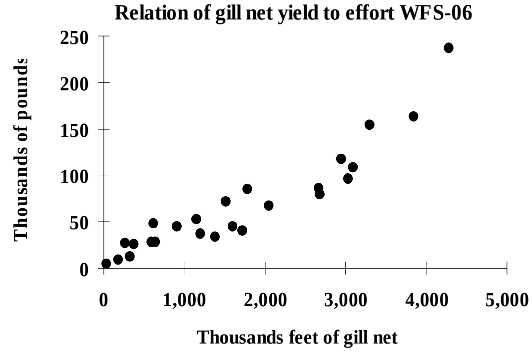
The large-mesh gill-net fishery has accounted for 93% of the entire yield from WFS-06 during 1976-2003. Peak gill-net effort was 4.2 million ft in 1990 and the lowest effort was 0.33 million ft in 2003.

Lake whitefish commercial trap net and gill net effort WFS-06



There was a direct linear relationship between gill-net effort and yield of whitefish in WFS-06 during 1976-2003. Gill-net effort explained 86% of the variation in gill-net yield from WFS-06 during 1976-2003

Relation of gill net yield to effort WFS-06



No stock assessment was conducted on whitefish in WFS-06 for 2003 because little sampling of the commercial catch occurred during 2000-2003. The harvest regulating guideline for 2005 was **210,000 lb** and represents the same value as in 2004.

WFS-07 (Tahquamenon Bay)

Prepared by Mark P. Ebener

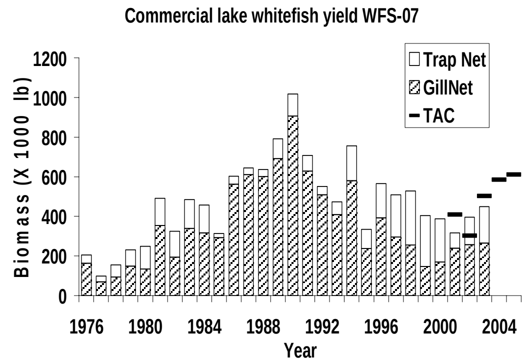
WFS-07 is located in the Whitefish Bay area of Lake Superior and contains 371,000 surface acres of water < 240 ft deep. There is a substantial commercial fishery in adjacent Canadian management unit 33.

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.

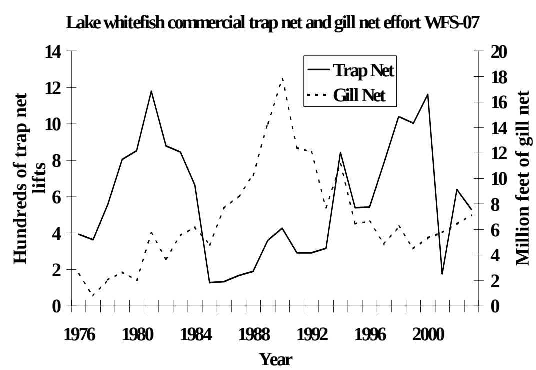
WFS-07 is an important fishing ground for the CORA fishery, and has been an exclusive CORA fishing area since 1985. Large- and small-boat gill-net fisheries as well as several trap-net fisheries operate in WFS-07. An ice fishery also takes place nearly every winter. There are a large number of relatively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

The commercial yield of whitefish from WFS-07 has averaged 467,000 lb during 1976-2003 and 464,000 lb during 1994-2003. A peak yield of one million lb occurred in 1990 and the lowest reported yield was 98,000 lb in 1977. The 2003 yield was 449,000 and the TAC was 502,000 lb.

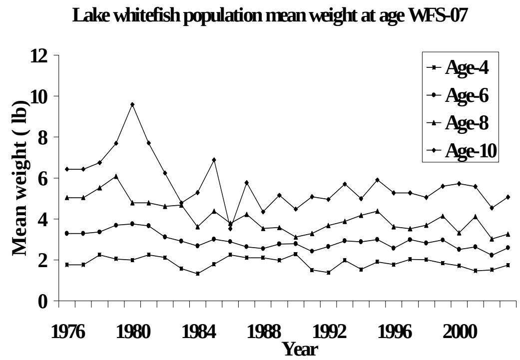
The large-mesh gill-net fishery accounted for 75% of the whitefish yield from WFS-07 during 1976-2003. The trap-net fishery harvested more whitefish from the unit than the gill-net fishery only during 1998-2000. The yield in 2003 was 264,700 lb from the gill-net fishery and 184,800 lb from the trap-net fishery.



Yield of whitefish from WFS-07 has mirrored changes in fishing effort during 1976-2003. After peaking at 17.8 million ft in 1990, large-mesh gill-net effort declined to between four and seven million ft during 1996-2003. Gill-net effort was 7.1 million ft in 2003. Trap-net effort increased from 128 lifts in 1985 to 1,161 lifts in 2000, and then declined to 530 lifts in 2003.



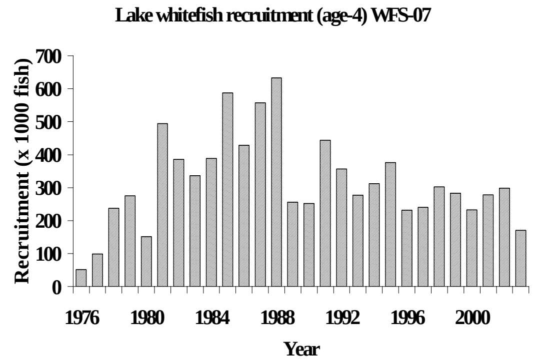
Whitefish caught in WFS-07 are of moderate to large size. Mean weight of a harvested whitefish averaged 3.2 lb in the gill-net fishery and 2.8 lb in the trap-net fishery during 1976-2003. Mean weight of a harvested whitefish in 2003 averaged 2.9 lb in the gill-net fishery and 2.7 lb in the trap-net fishery.



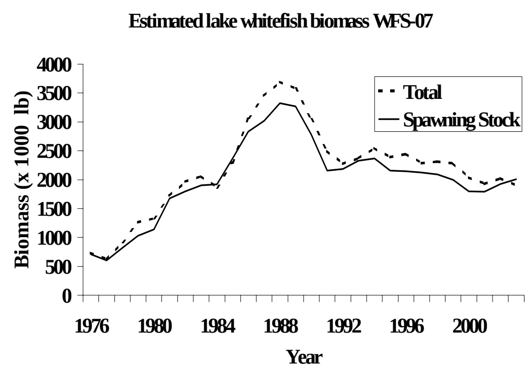
There have been two directional changes in growth of whitefish in WFS-07. From 1976 to 1990 mean weight-at-age declined, particularly for whitefish ≥ age 6. Mean weight-at-age generally increased for whitefish ≥ age 6 in the unit after 1990, unlike in lakes Michigan and Huron were mean weight-at-age declined after 1990.

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

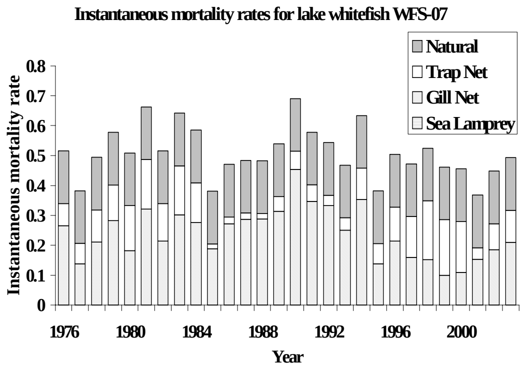
Estimated recruitment of age-4 whitefish to the fishable population peaked in 1988 then declined slowly thereafter. Recruitment increased through time from 1976 to 1988, then declined by one-half and has slowly declined since 1991. The stock assessment model estimated that an average of 319,000 age-4 whitefish recruited to the fishable population each year from 1976 to 2003. Recruitment varied from 52,000 fish in 1976 to 632,000 fish in 1988. About 273,000 age-4 whitefish have recruited to the fishable population each year from 1994 to 2003. Recruitment was estimated to be 171,000 age-4 whitefish in 2003.



Average total biomass of age-4 and older whitefish peaked at 3.69 million lb in 1989 and has declined and stabilized since then. The total biomass was 1.9 million lb in 2003, compared to a spawning biomass of 2.0 million lb. The estimated biomass of whitefish in 2003 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 1976-2003. 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 0.51 y^{-1} from 1976 to 2003 and ranged from 0.38 y^{-1} in 1985 to 0.69 y^{-1} in 1990. Fishing mortality averaged 0.33 y^{-1} from 1976 to 2003, while natural mortality was estimated to be 0.17 y^{-1}. Gill-net mortality averaged 0.24 y^{-1} and trap-net mortality 0.09 y^{-1} from 1976 to 2003. Fishing mortality in 2003 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, the projection model estimated that fishing mortality could be increased 1.78 times from the levels experienced from 2001 to 2003. As a consequence, the recommended yield limit was estimated to be **611,000 lb** in 2005. The recommended yield limits were 585,000 in 2004, 502,000 lb in 2003, 302,000 in 2002, and 409,000 lb in 2001.

Summary Status WFS-07 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.58 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.58 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	7.688 lb (SE 0.001)
	Current SSBR	2.08 lb (SE 0.13)
	SSBR at target mortality	0.352 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.271 (SE 0.016)
Average yield per recruit		1.586 lb (SE 0.018)
Natural Mortality (M)		0.176 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	6
	Fully selected age to trap nets	6
	Average gill net F, ages 4+	0.183 y^{-1} (0.159-0.219)
	Average trap net F, ages 4+	0.078 y^{-1} (0.069-0.092)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.437 y^{-1} (SE 0.02)
Recruitment (age-4)	(1994-2003 average)	272,740 fish (249,245-292,382)
Biomass (age 3+)	(1994-2003 average)	2,214,700 lb (2,028,770-2,400,090)
Spawning biomass	(1994-2003 average)	2,040,700 lb (1,861,590-2,220,080)
Recommended yield limit in 2005		611,000 lb
Actual yield limit for 2005 (HRG)		611,000 lb

WFS-08 (Brimley)

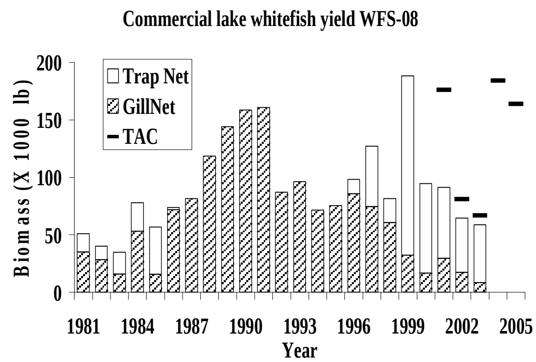
Prepared by Mark P. Ebener

WFS-08 is located in the very southeast portion of Whitefish Bay in Lake Superior. Although WFS-08 is spatially the smallest of the management units in the 1836 Treaty-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.

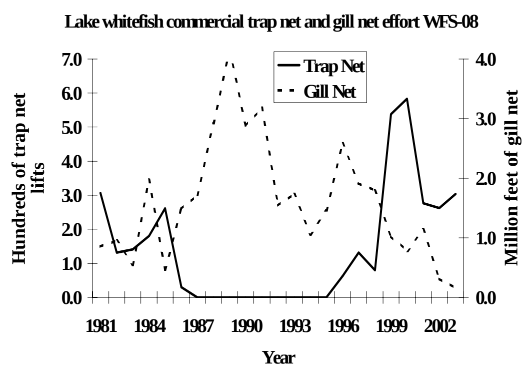
There are probably four reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Whitefish that spawn in WFS-07 are caught in the commercial fishery of WFS-08. The areas off Birch Point and Iroquois Island are both whitefish spawning grounds that contribute to 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 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 92,700 lb during 1981-2003. 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 72% of the whitefish yield from WFS-08 during 1981-2003. There was no trap-net yield from WFS-08 during 1987-1995. The trap-net yield in 2003 was 50,000 lb, while the gill-net yield was 8,500 lb.

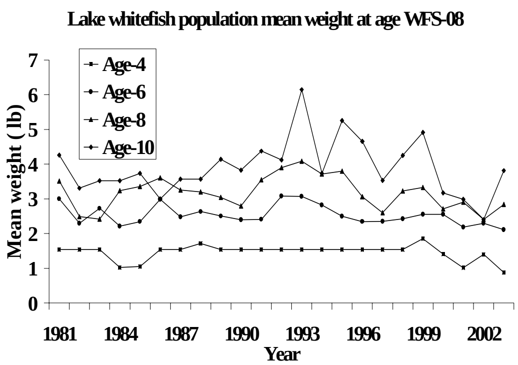


Gill-net effort has been declining in WFS-08 while trap-net effort has increased tremendously. Peak gill-net effort was 4.1 million ft in 1989, but declined to 0.156 million ft in 2003. Trap-net effort peaked at 738 lifts in 1979, declined to zero during 1987-1995, and increased to 583 lifts in 2000. Trap-net effort was 304 lifts in 2003.



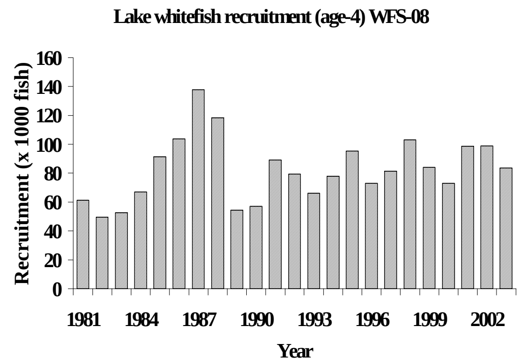
Whitefish in WFS-08 are of moderate to large size. Mean weight of a harvested whitefish in the gill-net fishery averaged 3.0 lb and mean weight in the trap-net fishery averaged 2.2 lb during 1981-2003. Mean weight of a harvested whitefish in 2003 was 1.9 lb in the trap-net fishery and 2.6 lb in the gill-net fishery.

Growth in weight of whitefish in WFS-08 has remained fairly stable from 1981 to 2003, but appears to have declined over the period from 1994 to 2003 unlike in adjacent WFS-07. Mean weight of age-5 and older whitefish was lower in 2003 than in 1994, but for the most part has remained near the average experienced by whitefish in the unit. The exception was that mean weight of age-4 to age-6 whitefish was lower in 2003 than all other years during 1981-2003.

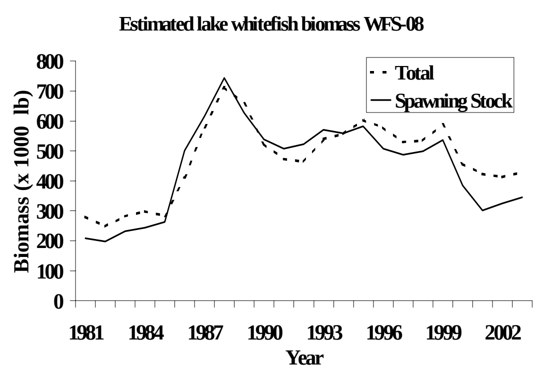


Whitefish in WFS-08 mature at smaller sizes and ages than in WFS-07. Female whitefish in WFS-08 begin maturing at 15 inches total length and at age 3. Two-thirds of whitefish in WFS-08 are sexually mature by age 4. Complete maturity is reached at 23 inches total length and age 11.

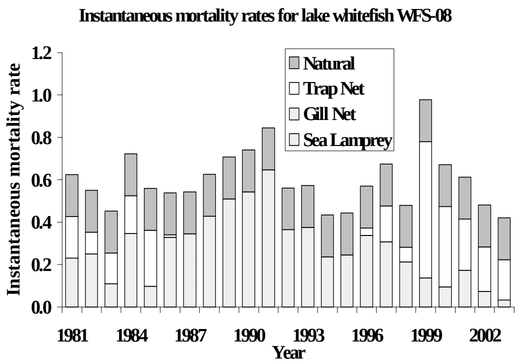
Recruitment of age-4 whitefish to the fishable population in WFS-08 has been less variable than in adjacent unit WFS-07, and recruitment in WFS-08 has increased during the last decade unlike in WFS-07. The stock assessment model estimated that an average of 82,500 age-4 whitefish recruited to the fishable population in WFS-08 each year from 1981 to 2003. Recruitment peaked in 1987 and 1988 at 138,000 and 118,000 age-4 whitefish, respectively. Thereafter, recruitment appeared to increase slowly varying from 54,000 to 103,000 fish from 1989 to 2003. Recruitment was estimated to be 83,500 age-4 whitefish in 2003.



Because of the decline in mean weight-at-age after 1993, spawning stock biomass of whitefish in WFS-08 has declined faster than total biomass. Total biomass of age-4 and older whitefish averaged 472,000 lb from 1981 to 2003 and ranged from 248,000 lb in 1982 to 712,000 lb in 1988. Total and spawning biomass were nearly equal through 1995, thereafter the disparity between total and spawning biomass increased. Total biomass was estimated to be 429,000 lb in 2003 and spawning biomass was estimated to be 345,500 lb.



Total annual mortality of age-4 and older whitefish has been declining in WFS-08 since 1999. Annual instantaneous total annual mortality of age-4 and older whitefish was 0.98 y^{-1} in 1999 and declined to 0.42 y^{-1} in 2003. The trap-net fishery has accounted for the majority of fishing mortality on whitefish in WFS-08 since 1999. Trap-net mortality was 0.19 y^{-1}, gill-net mortality 0.03 y^{-1}, and natural mortality 0.20 y^{-1} in 2003.



Total annual mortality on age-4 and older whitefish was less than the target rate of 1.05 y^{-1} from 2001 to 2003. The SPR value at the target mortality rate was 0.25 and greater than the target SPR value of 0.20. Thus the projection model estimated that fishing mortality rate in 2005 could be increased 1.95 times from levels experienced during 2001-2003. The recommended yield limit at this increased rate of fishing was estimated to be **164,000 lb** in 2005, compared to 184,000 lb in 2004.

Summary Status WFS-08 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.10 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.81 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	4.326 lb (SE 0.007)
	Current SSBR	1.08 lb (SE 0.05)
	SSBR at target mortality	0.139 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.249 (SE 0.011)
Average yield per recruit		1.171 lb (SE 0.007)
Natural Mortality (M)		0.197 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.093 y^{-1} (0.083-0.109)
	Average trap net F, ages 4+	0.214 y^{-1} (0.191-0.244)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.505 y^{-1} (SE 0.019)
Recruitment (age-4)	(1994-2003 average)	86,887 fish (80,387-95,522)
Biomass (age 3+)	(1994-2003 average)	511,060 lb (482,048-544,755)
Spawning biomass	(1994-2003 average)	452,770 lb (427,243-481,776)
Recommended yield limit in 2005		164,000 lb
Actual yield limit for 2005 (HRG)		164,000 lb

Lake Huron

WFH-01 (St. Ignace)

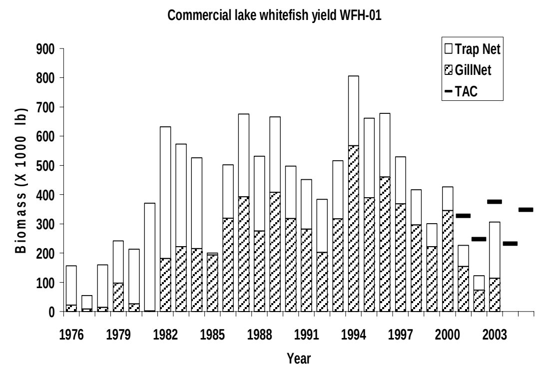
Prepared by Mark P. Ebener

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.

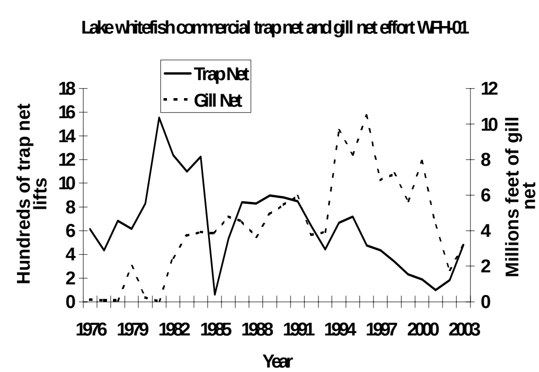
There are probably several reproductively isolated stocks of lake whitefish that inhabit WFH-01. One stock is located near Cheboygan, MI, another stock spawns north of St. Ignace near Rabbitsback and Horseshoe Bay, and third stock spawns in St. Martin Bay. A fourth stock probably spawns near Hessel, 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 a high of 806,000 lb in 1994 and averaged 447,000 lb during 1994-2003. The commercial yield was 306,000 lb in 2003 compared to 122,000 lb in 2002. The commercial yield in 2003 was less than the recommended harvest limit of 375,000 lb.

The large-mesh gill-net fishery has accounted for the majority of the commercial yield from WFH-01 during 1976-2003. From 1976-1984 large-mesh gill nets accounted for 0-41% of the annual fishery yield, while after 1985 gill nets accounted for 37-81% of the annual yield. The gill-net fishery accounted for 67% of the commercial yield of whitefish from WFH-01 during 1994-2003. The gill-net fishery harvested 113,800 lb in 2003 compared to 192,500 lb for the trap-net fishery.

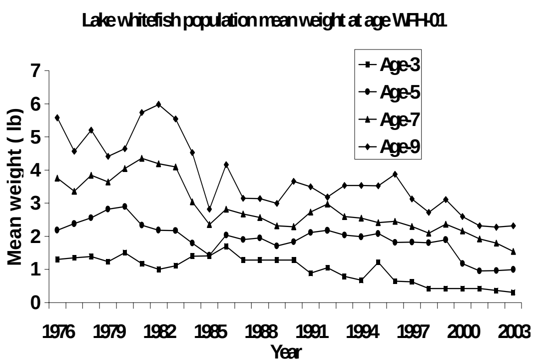


Both gill-net and trap-net fishing effort increased from 2002 to 2003. Trap-net effort peaked at 1,357 lifts in 1981 and declined to only 98 lifts in 2001 before increasing to 480 lifts in 2003. Gill-net effort was stable at about 4 million ft from 1983 to 1993, increased to 10.5 million ft in 1996, then declined to 1.8 million ft in 2002 before increasing to 3.1 million ft in 2003.



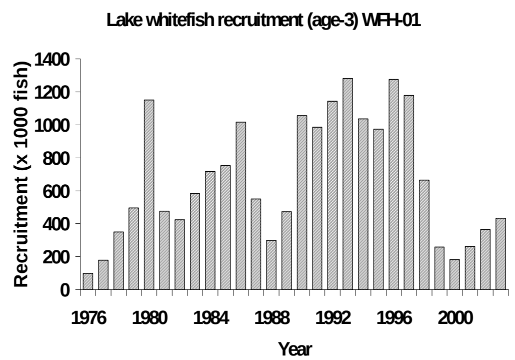
Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No.1 fish (< 3 lb). Mean weight of whitefish in the trap-net fishery ranged from 2.1 to 2.3 lb from 1993 to 2003. Mean weight of whitefish in the gill-net fishery ranged from 2.2 to 2.5 lb from 1993 to 2003. Mean weight of a harvested whitefish was 2.4 lb in the gill-net fishery and 2.5 lb in the trap-net fishery in 2003.

Growth of lake whitefish in 2003, expressed as mean weight-at-age, continued to be low in comparison to past years. Mean weight of age-5 and age-9 whitefish increased 2-3% from 2002 to 2003, but mean weight of other age classes declined 4-19% from 2002 to 2003. Mean weight of age-3, age-6, age-7, age-8, and age-10+ whitefish was lower in 2003 than all other years.

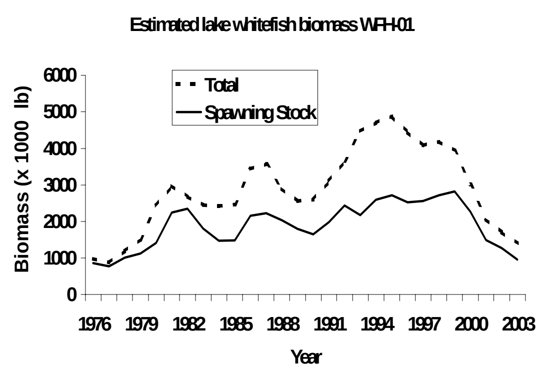


The decline in growth has had a profound effect on sexual maturity of whitefish in WFH-01. All female whitefish of age-6 and older were sexually mature during 1976-1980. Since then the proportion of mature females at any age has declined dramatically. For example, the proportion of sexually mature age-4 female whitefish declined from 66% during 1976-1982 to 45% during 1983-1992, to 24% during 1993-2000 and to 6% during 2001-2003. From 2001 to 2003 the proportion of mature females was 28% at age-5, 58% at age-6, 74% at age-7, 82% at age-8, and 90% for ages 9 and older.

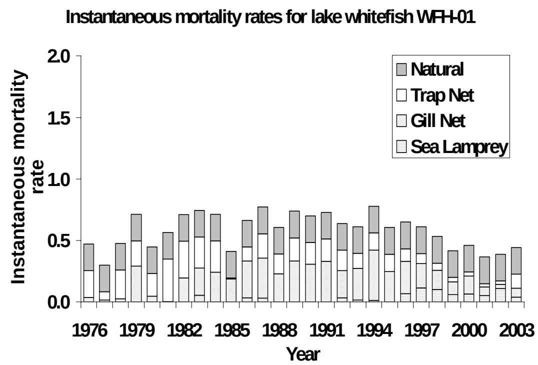
Large year-classes of whitefish were produced during 1987-1994 in WFH-01. These large year-classes produced the highest yield of 806,000 lb in 1994 and also probably helped suppress growth of whitefish in the unit. The long-term trend in recruitment in WFH-01 appears be cyclic with stable and good recruitment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



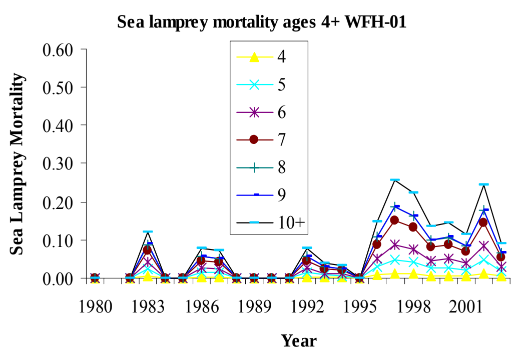
Because of the declines in growth and recruitment in WFH-01, biomass declined to a low level in 2003. Spawning stock biomass of whitefish in WFH-01 has always been considerably less than total biomass, in comparison to some other units in Lake Huron, but the spawning biomass in 2003 was lower than all years except prior to 1979. Total biomass of age-3 and older fish declined from 1.7 million lb in 2002 to 1.4 million lb in 2003. Spawning biomass declined from 1.3 million lb in 2002 to 0.96 million lb in 2003.



The large-mesh gill-net fishery has been the single largest source of fishing mortality on whitefish in WFH-01. Gill-net mortality rate of age-4 and older whitefish ranged from 0.0 y^{-1} to 0.41 y^{-1} during 1976-2003, whereas trap-net mortality ranged from 0.01 y^{-1} to 0.34 y^{-1} during 1976-2003 on age-4 and older fish. In 2003 gill-net mortality rate was 0.07 y^{-1} and trap-net mortality rate was 0.11 y^{-1}.



Natural mortality rate, including sea lamprey-induced mortality, was greater than fishing mortality during the last five years in WFH-01. Natural mortality was estimated to be 0.22 y^{-1} from 1999 to 2003, whereas total fishing mortality rate ranged from 0.06 y^{-1} to 0.19 y^{-1} during the same time. In 2003 sea lamprey mortality was estimated to be 0.04 y^{-1}.



The current spawning potential reduction value of 0.38 in WFH-01 during 2001-2003 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 3.4 times above the 2001-2003 values. The increase in fishing effort produced a recommended yield limit of **348,000 lb** for 2005, an increase from the 232,000 lb limit in 2004.

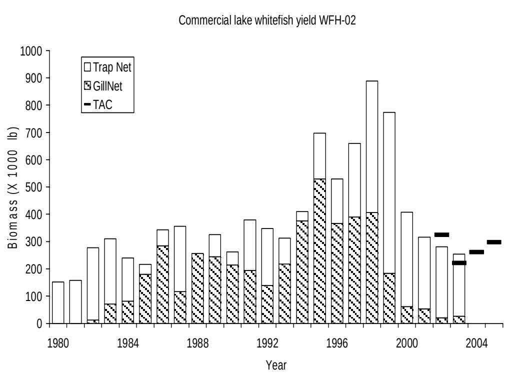
Summary Status WFH-01 Whitefish		
Female maturity		
	Size at first spawning	0.36 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.44 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.213 lb (SE 0.002)
	Current SSBR	0.46 lb (SE 0.01)
	SSBR at target mortality	0.045 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.379 (SE 0.012)
Average yield per recruit		0.289 lb (SE 0.012)
Natural Mortality (M)		0.247 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.058 y^{-1} (SE 0.005)
	Average trap net F, ages 4+	0.057 y^{-1} (SE 0.005)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	0.078 y^{-1}
Total mortality (Z)		
	Average ages 4+,2001-2003	0.43 y^{-1} (SE 0.009)
Recruitment (age-3)	(1994-2003 average)	663,550 fish (SE 45,037)
Biomass (age 3+)	(1994-2003 average)	3,439,500 lb (SE 135,180)
Spawning biomass	(1994-2003 average)	2,193,300 lb (SE 89,722)
MSC recommended yield limit in 2005		348,000 lb
Actual yield limit in 2005 (HRG)		348,000 lb

WFH-02 (Detour)

Prepared by Mark P. Ebener

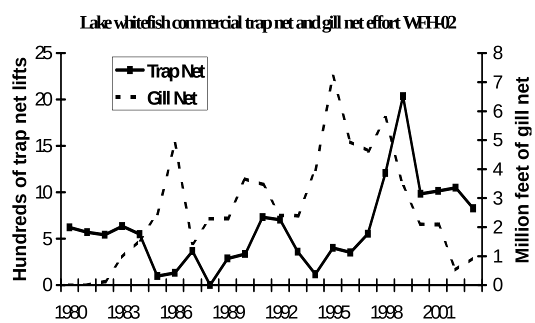
Management unit WFH-02 is located along the northern shore of the main basin of Lake Huron. Much of WFH-02 is deeper than 150 ft, and the maximum depth is slightly greater than 300 ft. WFH-02 is a small unit that is made up of only three statistical grids and contains 122,562 surface acres of water <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 early survival. Spawning concentrations of whitefish can be found from Beavertail Point in the west portion of the unit to St. Vitals Point in the middle of the unit. This area covers roughly 16 miles or more of shoreline. A large aggregation of spawning whitefish can be found in the area from Albany Island to Saddle Bag Islands.



WFH-02 has been an exclusive CORA fishing zone since the 1985. The commercial yield of whitefish ranged from a low of 152,000 lb in 1980 to a high of 888,000 lb in 1998. The fishery yield averaged 521,000 lb during 1994-2003.

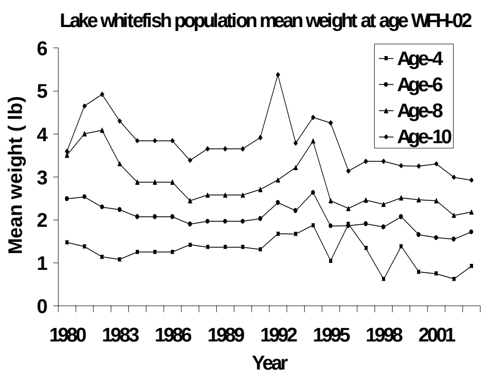
The allocation of the harvest among fishing gears has changed dramatically in WFH-02 over the past few years. During 1985-1997 the large-mesh gill-net fishery accounted for the majority of harvest in every year. After 1997, the trap-net fishery accounted for the largest proportion of the harvest. The trap-net fishery harvested 227,100 lb of whitefish in 2003, while the gill-net fishery harvested only 26,500 lb. Both large-mesh gill-net and trap-net effort have changed markedly in WFH-02 since 1980. Trap-net effort ranged from 0 to 713 lifts between 1980 and 1997, thereafter effort increased to 2,033 lifts in 1999, then declined by half and stabilized between 827 and 1,050 lifts during 2000-2003. Large-mesh gill-net effort increased from zero in 1981 to 7.2 million ft in 1995 and since then gill-net effort has declined to 0.9 million ft in 2003. Trap-net effort was 827 lifts in 2003 and gill-net effort was 0.9 million ft.



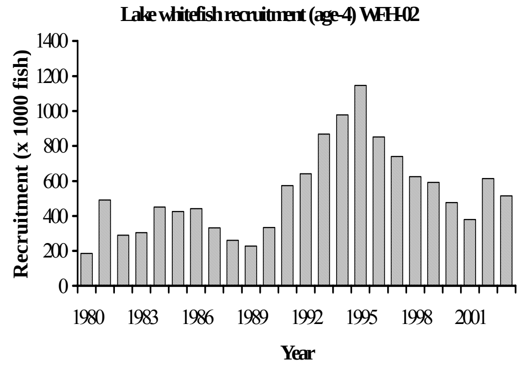
Whitefish in WFH-02 have always been of small size; no. 1 fish (< 3 lb) make up 90% of the harvest from the unit. Mean weight in the trap-net harvest has ranged from 2.0 to 2.3 lb and mean weight in the gill-net harvest ranged from 1.9 to 2.8 lb during 1993-2003. Mean weight of a harvested whitefish was 2.1 lb in the trap-net fishery and 2.7 lb in the gill-net fishery in 2003.

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.

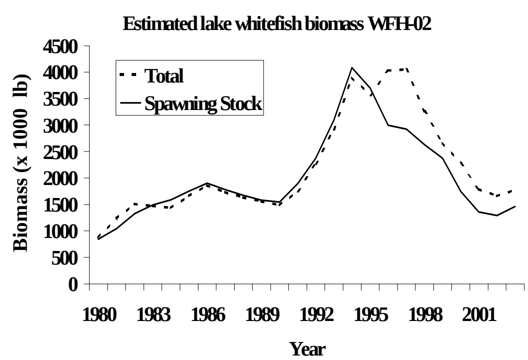
Unlike other units in Lake Huron, growth of whitefish in WFH-02 has remained stable through time. There was a slight decline in mean weight-at-age since the early 1980s, but the declines have not been nearly as steep as in WFH-01, WFH-04, and WFH-05. Mean weight of age 3-5 and age-7 whitefish increased from 2002 to 2003 in the unit.



The substantial increase in commercial fishery yield during the mid 1990s was driven largely by increased recruitment. The 1989-1993 year classes of whitefish were substantially larger than preceding and subsequent year classes in WFH-02. The stock assessment model estimated that the 1991 year class contained 1.15 million fish when it recruited to the fishery at age 4 in 1995. The 1989, 1990, 1992, and 1993 year classes contained between 739,000 and 939,000 age-4 whitefish when they recruited to the fishery. Prior to 1992 and after 1999 most year classes that recruited to the fishery at age 4 did not exceed 600,000 fish.



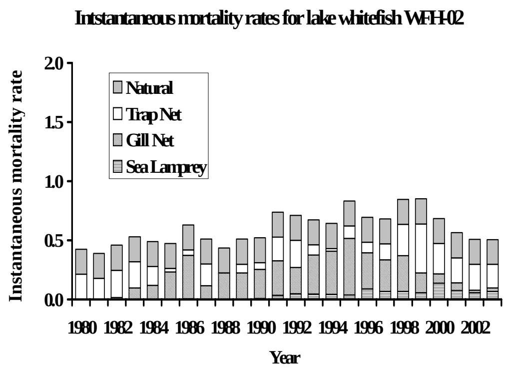
The large increase in recruitment during the mid 1990s more than doubled the biomass of whitefish in WFH-02. Total biomass of age-4 and older whitefish in WFH-02 increased from 1.48 million lb in 1990 to 4.0 million lb in 1996 and 1997. Total and spawning biomass are nearly equivalent in WFH-02 because the fish mature at such a small size and because growth has not declined much. Total biomass was estimated to 1.78 million lb and spawning biomass 1.46 million lb in 2003.

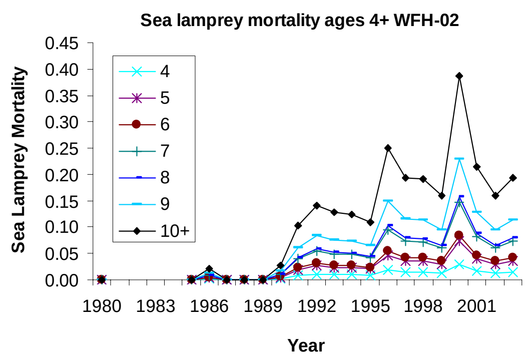


Total annual mortality rate on age-4 and older whitefish in WFH-02 increased nearly annually from 1980 to 1999, and declined thereafter. Total annual mortality of age-4 and older whitefish nearly doubled from 0.43 y^{-1} in 1980 to 0.85 y^{-1} in 1999, then declined to 0.51 y^{-1} in 2003.

The increase in total mortality was due to substantial increases in fishing effort through 1999, and because of increased sea lamprey predation since 1990. Prior to 1997 trap-net mortality ranged from 0.00 y^{-1} to 0.23 y^{-1}, while after 1997 trap-net mortality ranged from

0.20 y^{-1} to 0.42 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 0.03 y^{-1} and trap-net mortality was 0.20 y^{-1} in 2003. Sea lamprey mortality increased annually in WFH-02 from 1990 to 2000, then leveled off. Sea lamprey mortality of whitefish averaged 0.07 y^{-1} during 1994-2003 and was 0.07 y^{-1} in 2003.





Total annual mortality of age-4 and older whitefish averaged 0.602 y^{-1} from 2001 to 2003. Spawning potential reduction at the current mortality rate was 0.34; which is considerably greater than the target of 0.20. The projection model estimated that fishing mortality rate could be increased only 1.03 times to achieve the target mortality rate. As a consequence, the projection model estimated a yield limit of **298,000 lb** for 2005, compared to 261,000 lb in 2004 and 221,000 lb in 2003.

Summary Status WFH-02 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	0.77 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.30 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.372 lb (SE 0.004)
	Current SSBR	0.81 lb (SE 0.02)
	SSBR at target mortality	0.130 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.34 (SE 0.010)
Average yield per recruit		0.601 lb (SE 0.013)
Natural Mortality (M)		0.241 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.044 y^{-1} (0.037-0.054)
	Average trap net F, ages 4+	0.239 y^{-1} (0.208-0.273)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	0.077 y^{-1}
Total mortality (Z)		
	Average ages 4+,2001-2003	0.602 y^{-1} (SE 0.02)
Recruitment (age-4)	(1994-2003 average)	691,990 fish (631,776-784,715)
Biomass (age 3+)	(1994-2003 average)	2,897,200 lb (2,733,450-3,110,390)
Spawning biomass	(1994-2003 average)	2,457,200 lb (2,323,640-2,624,550)
MSC recommended yield limit for 2005		298,000 lb
Actual yield limit for 2005 (HRG)		298,000 lb

WFH-03 (Drummond Island)

Prepared by Mark P. Ebener

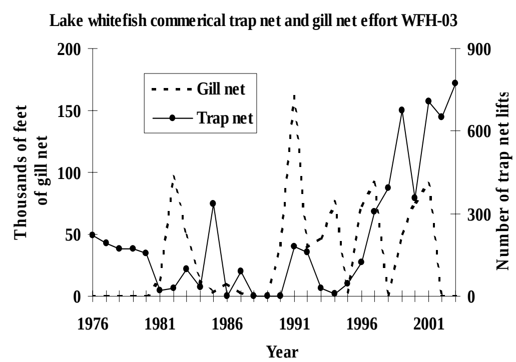
Management unit WFH-03 is small and encompasses only the area around Drummond Island. A lake trout refuge is located along the south shore of Drummond Island where large-mesh gill net fishing is prohibited, and retention of lake trout by trap-net fisheries is prohibited. The south side of WFH-03 is deep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

The spawning shoals for lake whitefish in WFH-03 are located primarily along the south shore of Drummond Island in the main basin of Lake Huron. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal during gill-net surveys in October and early November of 1991-2003.

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

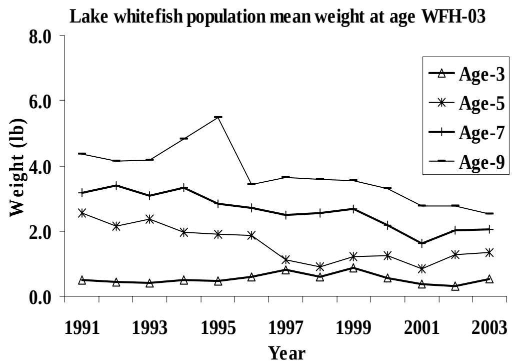
The commercial yield of lake whitefish from WFH-03 has increased tremendously since 1998. Prior to 1998 the commercial yield of lake whitefish exceeded 100,000 lb only once in 1985. After 1998 the commercial yield from WFH-03 was 221,000 lb in 1999, 295,000 lb in 2000, 370,000 lb in 2001, 296,000 lb in 2002, and 269,000 lb in 2003. Ninety-nine percent of the yield was taken with trap nets during 1999-2003. The harvest regulating guideline ranged from 250,000 to 318,000 lb during 1999-2003.

The large increase in harvest from WFH-03 during 1999-2003 was directly related to increased trap-net effort. Trap-net effort ranged from 0 to 392 lifts during 1976-1997; thereafter, trap-net effort increased to 673 lifts in 1999, 356 lifts in 2000, 706 lifts in 2001, 650 lifts in 2002, and 774 lifts in 2003. Gill-net effort in WFH-03 was highly variable and low, ranging from 0 to 162,000 ft from 1976-2003.

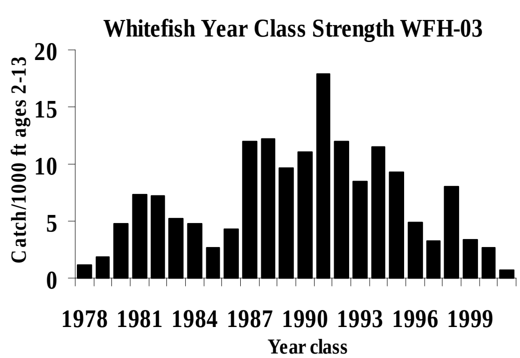


Whitefish caught in the fishery of WFH-03 are of moderate size. During 1987-2003 69% of the whitefish harvested were No. 1 fish (< 3 lb), 24% were mediums (3-4 lb), and 7% were jumbos (≥ 4 lb). Mean weight of whitefish in the trap-net harvest ranged from 2.0 to 2.8 lb and average 2.5 lb during 1991-2003. Mean weight in the gill-net fishery ranged from 2.3 to 3.0 lb and averaged 2.6 lb. Mean weight of whitefish was 2.4 lb in both the trap-net and gill-net fisheries in 2003.

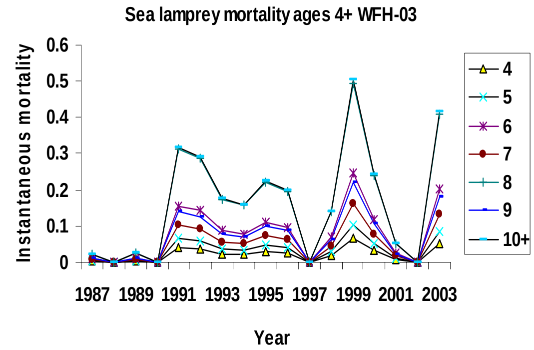
Growth of whitefish in WFH-03 has declined through time, but not at the rate that has occurred in more western areas of Lake Huron. Mean weight at age 3, 5, 7, and 9 declined from 1991 to 2001, but increased from 2001 to 2003. The decline in mean weight-at-age was most pronounced for whitefish of age 4 and older.



Recruitment of whitefish in WFH-03 appears similar to that in WFH-02. The 1987-1995 year classes were abundant, whereas the 1996 and 1997 year classes, as well as the 1985 and 1986 year classes were not abundant. The 1998 year class appears to be of reasonable size based on survey catches, whereas the 1999-2001 year classes do not appear to be abundant.



Sea lamprey-induced mortality rate of whitefish in WFH-03 increased in 2003 from levels observed during 2000-2002. Sea lamprey-induced mortality averaged 0.21 y^{-1} in 2003 compared to 0-12 y^{-1} during 2000-2002. Sea lamprey mortality of whitefish in 2003 was equal to or greater than rates observed on lake trout in the same year from MH-1.



No attempt was made to develop a stock assessment of whitefish in WFH-03 in 2003 because past attempts to do so were unsuccessful. Reasonable and consistent estimates of abundance and mortality could not be produced with the stock assessment model because these estimated values would change by an order of magnitude in some cases, after only small changes were made to starting values of the input parameters.

A harvest regulating guideline of **306,000 lb** was established for WFH-03 in 2005 and is identical to the 2004 harvest regulating guideline.

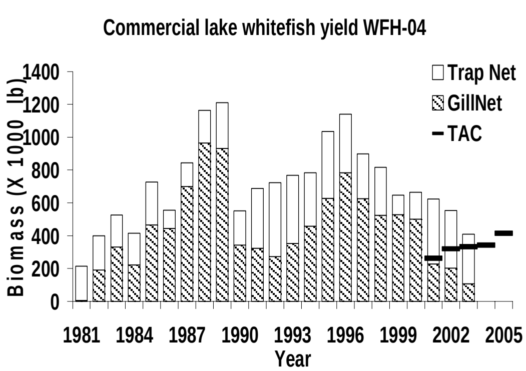
WFH-04 (Hammond Bay)

Prepared by Mark P. Ebener

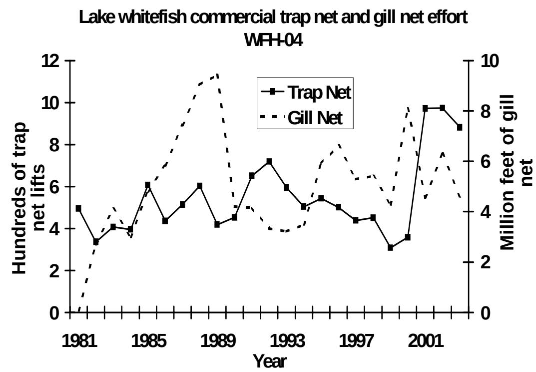
WFH-04 is the largest whitefish management unit in the 1836 Treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water <240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations from Cheboygan to Hammond Bay.

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 62% of the whitefish harvest from WFH-04 during 1981-2000. The annual yield from WFH-04 ranged from a high of 1.2 million lb in 1989 to a low of 230,000 lb in 1981. The annual yield of whitefish from the unit averaged 758,000 lb during 1994-2003. The trap-net fishery harvested 302,000 lb of whitefish in 2003 compared to 108,000 lb from the gill-net fishery. The 2003 yield of 410,000 lb was less than the harvest regulating guideline of 518,000 lb for 2003, but greater than the recommended harvest limit (TAC) of 343,000 lb.

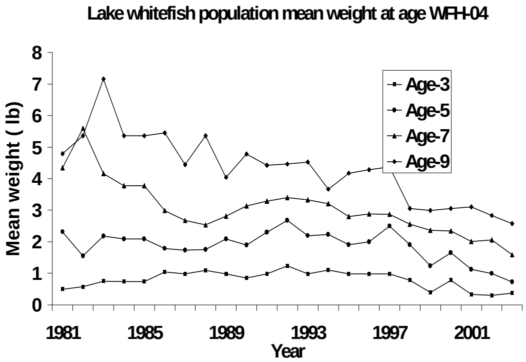


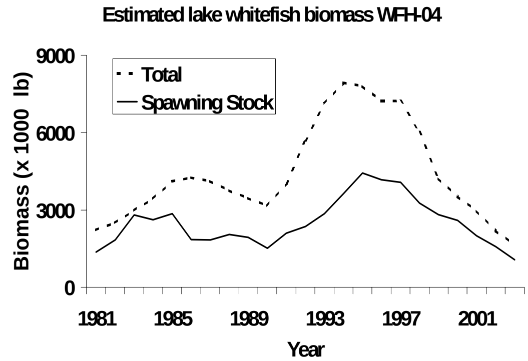
Trap-net effort continued to be high in 2003 while gill-net effort remained near the average of the last two decades. Trap-net effort peaked at 719 lifts in 1992 then declined to 308 lifts in 1999 before increasing to 974 lifts in 2002. Trap-net effort was 882 lifts in 2003. Large-mesh gill-net effort peaked at 7.7 million ft in 1989 and 5.2 million ft in 2000 and was 4.6 million ft in 2003.



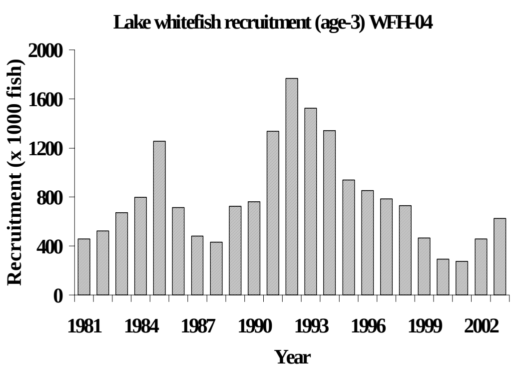
Whitefish from WFH-04 are of moderate size. The commercial harvest from WFH-04 was composed of 65% No. 1 whitefish (< 3 lb), 26% mediums (3-4 lb), and 9% jumbos (≥ 4 lb) during 1982-2003. Annual mean weight of whitefish caught in the gill-net fishery ranged from 2.5 to 3.0 lb during 1982-2003, while mean weight in the trap-net fishery ranged from 2.4 to 3.6 lb during 1982-2003. Mean weight in the harvest in 2003 was 2.2 lb for the trap-net fishery and 2.7 lb for the gill-net fishery.

Unlike other units where growth has stabilized or increased slightly in 2003, the growth rate of whitefish from WFH-04 continues to decline. Mean weight of age-5 and older whitefish declined from 2002 to 2003 and was less than any other year during 1981-2003.



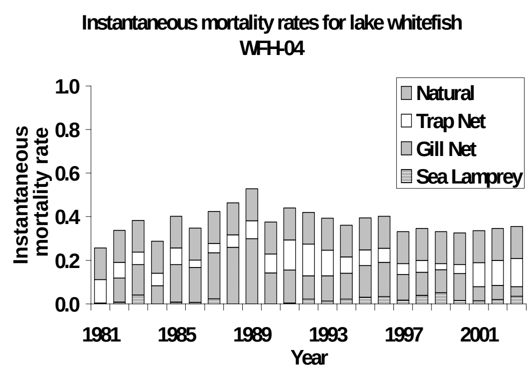


The decline in harvest from WFH-04 that occurred after 1996 was largely being driven by declines in both mean weight-at-age and recruitment. The 1988-1991 year classes of whitefish were very abundant in WFH-04 ranging from 1.4 to 1.8 million fish at age 3. Recruitment declined dramatically after the 1991 year class. The 1997 and 1998 year classes were the least abundant during 1981-2003, averaging only about 300,000 fish at age 3. The 2000 year class was estimated to contain 630,000 age-3 fish in 2003.



The combined effects of reduced recruitment and growth has resulted in a biomass of whitefish that was lower in 2003 than any other time during the last 23 years. After peaking at 7.9 million lb in 1994, total biomass declined annually to only 1.6 million lb in 2003. Spawning stock biomass declined from 4.4 million lb in 1995 to 1.1 million lb in 2003. Given that the 1997-2000 year classes do not appear to be very abundant, biomass of whitefish in WFH-04 is expected to continually decline.

Total annual mortality of age-4 and older whitefish averaged 0.42 y^{-1} during 2001-2003. Gill-net mortality averaged 0.06 y^{-1}, trap-net mortality 0.14 y^{-1}, and sea lamprey mortality 0.03 y^{-1} during 2001-2003. In 2003, gill-net mortality was 0.04 y^{-1}, trap-net mortality 0.13 y^{-1}, and sea lamprey mortality 0.04 y^{-1} on age-4 and older whitefish.



Since total annual mortality on all age classes of whitefish was less than the target of 1.05 y^{-1}, the projection model estimated that fishing mortality could be increased 1.6 times in 2005 over that experienced during 2001-2003. The SPR value at the target-fishing rate was 0.22. The recommended harvest level for WFH-04 in 2005 was **415,000 lb**.

Summary Status WFH-04 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	0.34 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.46 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.871 lb (SE 0.)
	Current SSBR	0.42 lb (SE 0.03)
	SSBR at target mortality	0.078 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.222 (SE 0.014)
Average yield per recruit		0.639 lb (SE 0.008)
Natural Mortality (M)		0.195 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.065 y^{-1} (0.055-0.079)
	Average trap net F, ages 4+	0.136 y^{-1} (0.116-0.160)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	0.031 y^{-1}
Total mortality (Z)		
	Average ages 4+,2001-2003	0.423 y^{-1} (SE 0.017)
Recruitment (age-3)	(1994-2003 average)	677,090 fish (631,776-784,715)
Biomass (age 3+)	(1994-2003 average)	5,073,000 lb (4,743,690-5,446,840)
Spawning biomass	(1994-2003 average)	2,966,500 lb (2,737,210-3,213,010)
MSC recommended yield limit for 2005		415,000 lb
Actual yield limit for 2005 (HRG)		415,000 lb

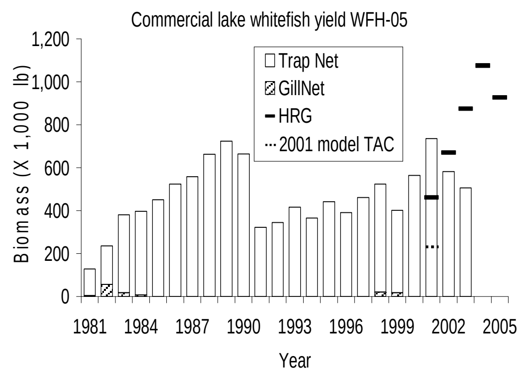
WFH-05 (Alpena)

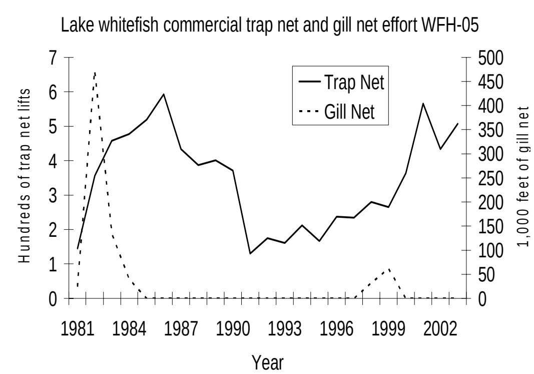
Prepared by Aaron P. Woldt and Mark P. Ebener

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

The 2000 Consent Decree converted WFH-05 from an exclusive State zone to an exclusive CORA trap-net fishing zone beginning in August 2000. There are 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.

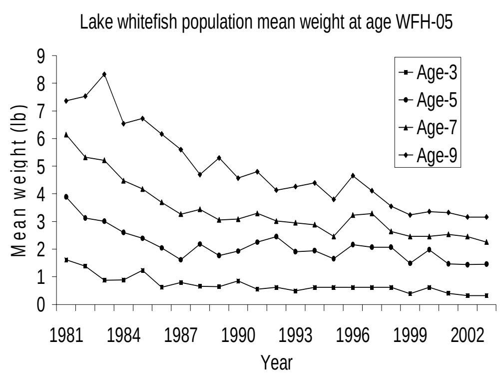
Annual commercial trap-net yield has ranged from 124,000 lb in 1981 to 736,000 lb in 2001 and averaged 463,000 lb during 1981-2003. In general, trap-net harvest and effort have been directly related over the modeled time series and have been especially linked since 1991. As trap-net effort increased from 130 lifts in 1991 to 434 lifts in 2002, the yield increased from 322,000 lb in 1991 to 581,000 lb in 2002. However, trap-net effort did increase in 2003 (507 lifts) while trap-net yield declined (506,000 lb). The decrease in yield may be linked to low wholesale prices and demand for lake whitefish in 2003, but is more likely the result of decreased lake whitefish size at age.



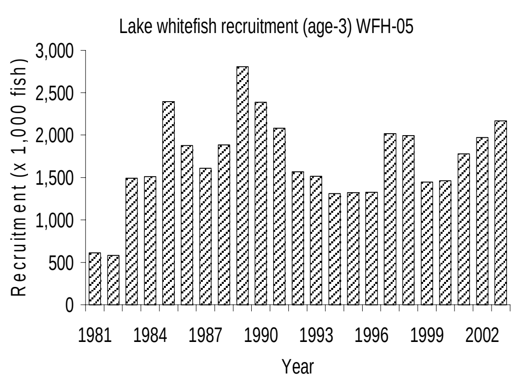


Whitefish in WFH-05 are of similar size to those in WFH-04. The commercial harvest from WFH-05 was made up of 70% No. 1 whitefish (< 3 lb), 23% mediums (3-4 lb), and 7% jumbos (≥ 4 lb). Mean weight of a harvested whitefish was 2.6 lb in WFH-05 in 2003. Mean weight of a harvested whitefish has been steadily decreasing since 1998.

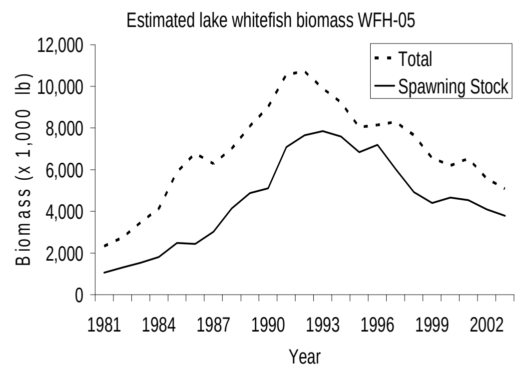
Weight-at-age of whitefish in WFH-05 has stabilized over the last few years after continually declining from 1981 to 1999. Prior to 1984, age-9 and older whitefish weighed between 7 and 8 lb, but by 2003 they weighed about 3.2 lb. This large decrease in average weight for older fish is likely due to decreased growth rates. Mean weight of all age classes in 2003 was similar to mean weight in 1999, 2000, 2001 and 2002.



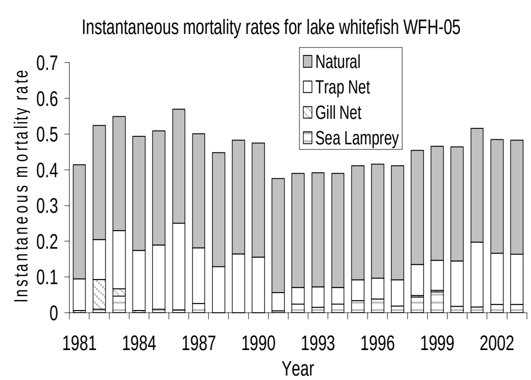
Recruitment of age-3 whitefish to the fishable population in WFH-05 has increased and remained relatively constant since 1997. Recruitment peaked at 2.8 million age-3 whitefish in 1989 and then declined annually to about 1.3 million age-3 whitefish in 1996 (1993 year class). From 1997 through 2003 estimated recruitment averaged about 1.83 million age-3 whitefish. The stock assessment model estimated that 2.17 million age-3 whitefish were present in the population during 2003.



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 10.7 million lb in 1992 and has since declined to 5.1 million lb in 2003. Spawning stock biomass peaked at 7.9 million lb in 1993 and then declined to 3.8 million lb in 2003.



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 2003 to 0.14 y^{-1}. Sea lamprey-induced mortality had been increasing in WFH-05 over the last decade, but recent estimates have declined and remained low, averaging 0.02 y^{-1} from 2000 to 2003.



Total annual mortality was estimated to be 0.476 y^{-1} on age-4 and older whitefish in WFH-05 during 2001-2003. Total mortality was estimated to be 0.483 y^{-1} in 2003. 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 2.05 times over the 2001-2003 levels. The recommended yield limit at this increased rate of fishing was estimated to be 927,000 lb in WFH-05 for 2005. The recommended yield limit in 2004 was 1,076,000 lb. In general, the harvest limit in this unit has been steadily increasing, but the 2005 recommended limit is lower than the 2004 limit. This change is likely due to the decreased size at age for lake whitefish in this unit. Total tribal trap-net harvest was below the HRG in 2003.

Summary Status WFH-05 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	0.35 lb
Age at first spawning	3 y
Size at 50% maturity	1.91 lb
Age at 50% maturity	6 y
Spawning biomass per recruit	
Base SSBR	1.103 lb (1.102 – 1.103)
Current SSBR	0.550 lb (0.505 – 0.620)
SSBR at target mortality	0.163 lb (0.163 – 0.163)
Spawning potential reduction	
At target mortality	0.148 (0.148 – 0.148)
Average yield per recruit	0.373 lb (0.318 – 0.411)
Natural Mortality (M)	0.319 y^{-1}
Fishing mortality rate 2001-2003	
Fully selected age to gill nets	8
Fully selected age to trap nets	8
Average gill-net F, ages 4+	Not applicable
Average trap-net F, ages 4+	0.133 y^{-1} (0.097 – 0.168)
Sea lamprey mortality (ML)	
Average ages 4+, 2001-2003	0.028 y^{-1}
Total mortality (Z)	
Average ages 4+, 2001-2003	0.476 y^{-1} (0.440 – 0.511)
Recruitment (age-3)	
Average 1994-2003	1,679,800 fish (1,397,410 – 2,186,410)
Biomass (age 3+)	
Average 1994-2003	7,131,200 lb (6,045,390 – 9,081,980)
Spawning biomass	
Average 1994-2003	5,408,300 lb (4,558,090 – 6,911,940)
MSC recommended yield limit for 2005	927,000 lb
Actual yield limit for 2005 (HRG)	927,000 lb

Lake Michigan

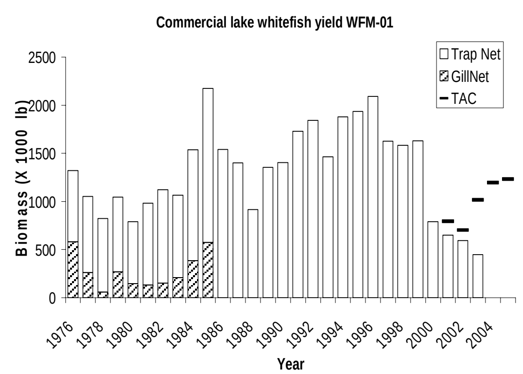
WFM-01 (Bays de Noc)

Prepared by Philip J. Schneeberger

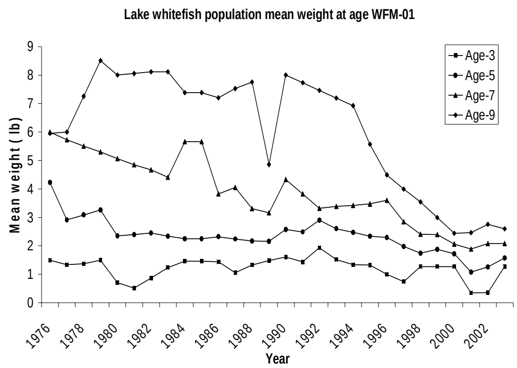
Lake whitefish management unit WFM-01 is located in 1836 Treaty-ceded waters of northern Green Bay. Prominent features of this area include two large bays (Big and Little bays de Noc), numerous small embayments, several islands (including St. Martins Island, Poverty Island, Summer Island, Little Summer 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 of suitable spawning habitat. The Big Bay de Noc Shoal is documented as being an important area for lake whitefish reproduction. Fairly consistent favorable conditions on this shoal result in relatively stable whitefish recruitment annually. 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.

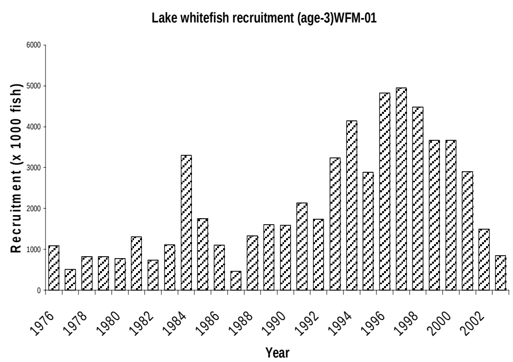
Trap-net yield for lake whitefish in WFM-01 was 450,000 lb during 2003, down from 594,000 lb in 2002. Similarly, trap-net effort was 835 lifts in 2003, down from 1,542 lifts in 2002. Between 1999 and 2003, yield declined 72% and effort declined 85%. Catch-per-unit effort has increased 89% since the late 1990s. There has been no commercial gill netting in this management zone since 1985.



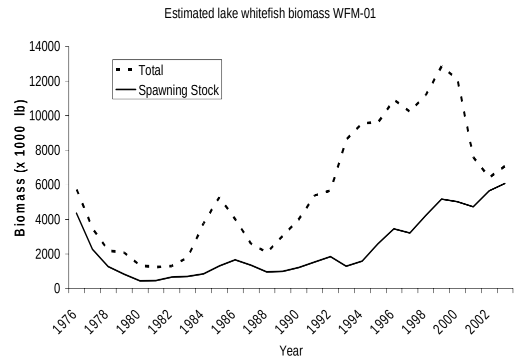
Weight-at-age for WFM-01 lake whitefish improved by an average of 57% across all age groups between 2002 and 2003 with the most substantial gains observed for younger fish (age 2-5). Weight-at-age values in 2003 were less than 1996-2000 average values for ages 5-9+, but were above or near averages for ages 2-4.



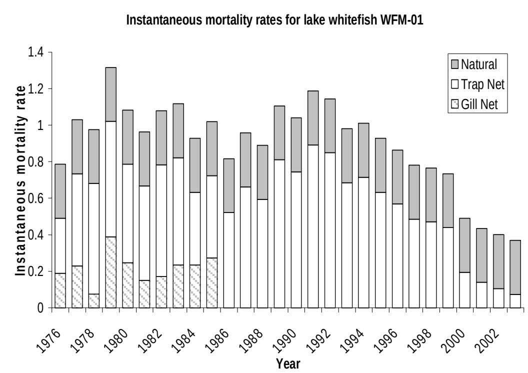
Estimated recruitment (numbers of age-3 fish) has decreased precipitously since 1997. The 2003 recruitment estimate of 849,000 lake whitefish was 35% less than average recruitment estimated between 1976 and 1992, and was 79% lower than the average for years of high sustained recruitment (1993-2000).



Fishable biomass was estimated at 7.1 million lb in 2003, with spawning stock biomass representing 86% (6.1 million lb) of the total. Fishable biomass continued an increasing trend that was gradual during 1981-1993 and was more pronounced thereafter. Spawning stock biomass increased in 2003, reversing a downward trend between 1999 and 2002.



Estimates of instantaneous mortality rates decreased between 2002 and 2003, continuing a 10+ year trend. Total instantaneous mortality rate (Z) was estimated at 0.37 y^{-1} in 2003, with 0.30 y^{-1} attributable to instantaneous natural mortality rate (M) and 0.07 y^{-1} attributable to instantaneous fishing mortality rate (F). Instantaneous mortality rates were considered excessively high prior to 2000.



The projected 2005 yield limit for WFM-01 is 1.233 million lb. This value is a 3% increase from the 2003 yield limit of 1.197 million lb. The increase was influenced by low harvest in 2003 relative to the yield limit (450,000 lb vs. 1,018,000 lb), continued low estimated mortality rates, and increasing biomass that offsets low estimated recruitment.

Summary Status WFM-01 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	0.92 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.31 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	0.947 lb (0.943 - 0.951)
	Current SSBR	0.65 lb (0.62 - 0.68)
	SSBR at target mortality	0.243 lb (0.242 - 0.243)
Spawning potential reduction		
	At target mortality	0.689 (0.661 - 0.716)
Average yield per recruit		0.235 lb (0.216 - 0.253)
Natural Mortality (M)		0.295 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0. y^{-1}
	Average trap net F, ages 4+	0.121 y^{-1} (0.105 - 0.139)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.515 y^{-1} (0.499 - 0.533)
Recruitment (age-3)	(1994-2003 average)	3,558,019 fish (2,922,110 - 4,533,200)
Biomass (age 3+)	(1994-2003 average)	9,972,882 lb (8,848,350 - 11,393,700)
Spawning biomass	(1994-2003 average)	4,258,318 lb (3,726,320 - 4,881,100)
MSC recommended yield limit in 2005		1,233,000 lb
Actual yield limit in 2005		1,233,000 lb

WFM-02 (Manistique)

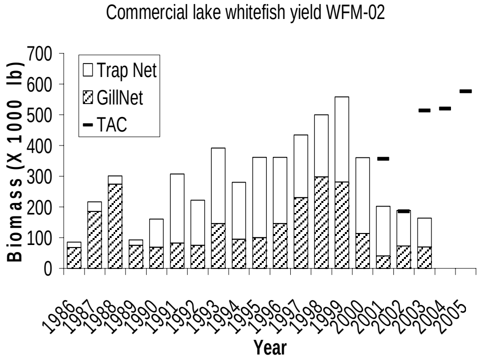
Prepared by John K. Netto and Mark P. Ebener

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, and abundance of this population is lower than 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 a difficult place to fish with gill nets because logs, dead algae and periphyton, zebra mussels, and burbot routinely foul the gear.

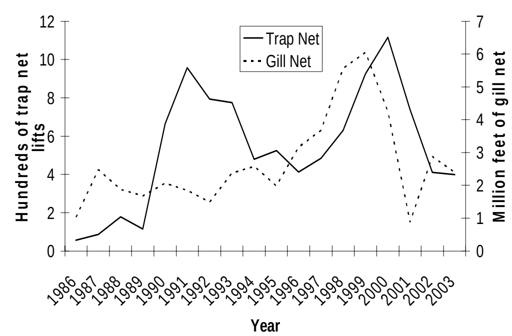
During the modeled time series, commercial yield ranged from a low of 86,000 lb in 1986 to a maximum yield of 559,000 lb in 1999. The average yield from 1986 to 2003 was 288,000 lb.

Commercial lake whitefish yield WFM-02



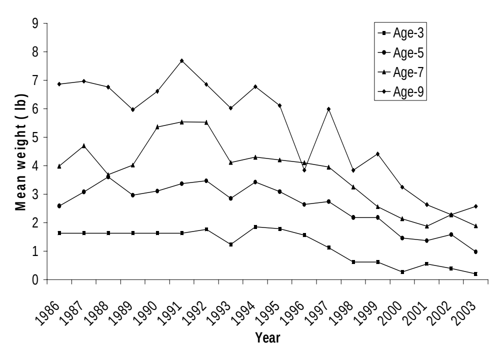
The increase in yield from WFM-02 during the 1990’s was due to substantial increases in fishing effort. Large-mesh gill-net effort peaked at 4.5 million ft in 1999, but then declined substantially in subsequent years. Trap-net effort peaked at 1,114 lifts in 2000 then declined to a low of 399 lifts in 2003.

Lake whitefish commercial trap net and gill net effort in WFM-02



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

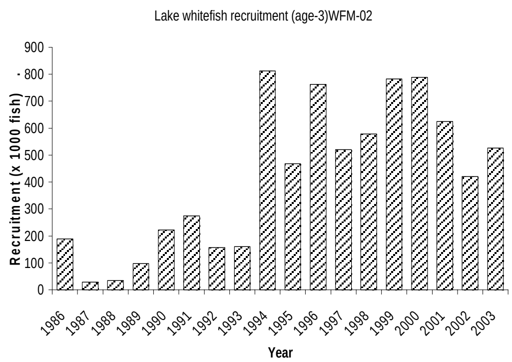
Lake whitefish population mean weight at age WFM-02



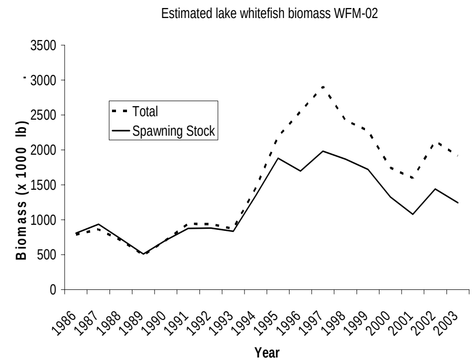
As would be expected from the decreased growth rates, female whitefish maturity rate has slowed dramatically. In the mid 1980’s, slightly more than 50% of age-3 and 90% of age-5 female whitefish were sexually mature in WFM-02. By 2001, less than 5% of age-3 and 50% of age-5 female whitefish were sexually mature.

Predicted recruitment of age-3 whitefish to the fishable population in

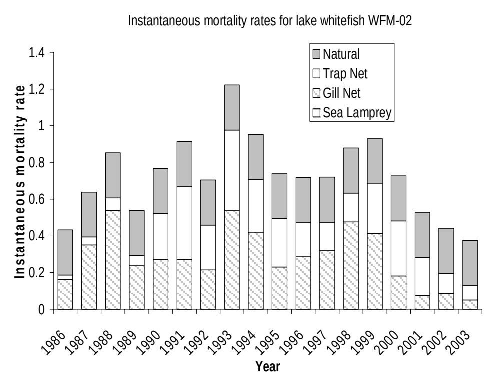
WFM-02 varied 29-fold from 1986 to 2002. The stock assessment model estimated that the 1991 year class contained 821,000 age-3 fish, compared to only 28,000 age-3 fish for the 1984 year class. Recruitment of age-3 whitefish to the fishable population averaged 409,000 fish during 1986-2002 and 595,000 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 2003 estimate for fishable biomass is 1.9 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 consistently declined since 1999; fishing mortality of age-4 and older whitefish was 0.27 y^{-1} during 2000-2003 compared to a fishing mortality rate of 0.61 y^{-1} from 1990 to 1999.



Total annual mortality of whitefish age 4 and older was lower than the target mortality rate of 1.05 during 2001-2003. The projection model estimate for the 2005 total allowable harvest was 577,000 lb. which is greater than any single year's harvest since 2000.

Summary Status WFM-02 Whitefish		
Female maturity		
	Size at first spawning	0.38 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.31 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	1.841 lb (SE 0.035)
	Current SSBR	0.74 lb (SE 0.03)
	SSBR at target mortality	0.079 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.402 (SE 0.017)
Average yield per recruit		0.583 lb (SE 0.014)
Natural Mortality (M)		0.245 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.07 y^{-1} (SE 0.007)
	Average trap net F, ages 4+	0.132 y^{-1} (SE 0.009)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.448 y^{-1} (SE 0.015)
Recruitment (age-3)	(1994-2003 average)	628,210 fish (SE 65,838)
Biomass (age 3+)	(1994-2003 average)	2,118,100 lb (SE 113,620)
Spawning biomass	(1994-2003 average)	1,558,100 lb (SE 70,770)
MSC Recommended yield limit in 2005		577,000 lb
Actual yield limit in 2005 (HRG)		577,000 lb

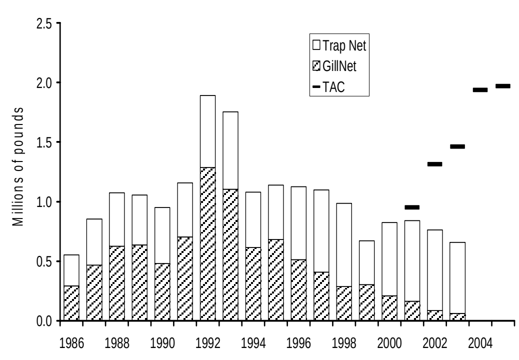
WFM-03 (Naubinway)

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 the 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. Large spawning aggregations are associated with the area between Epoufette and Naubinway, 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.

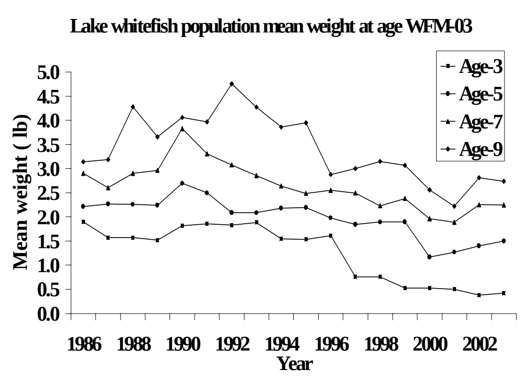
The commercial fishery yield from WFM-03 averaged 1.03 million lb during 1986-2003. The trap-net fishery yield averaged 530,000 lb and the gill-net fishery yield averaged 496,000 lb during 1986-2003. Total fishery yield peaked at 1.89 million lb in 1992 and 1.75 million lb in 1993 and declined slowly thereafter. The trap-net yield was 597,000 lb and the gill-net yield only 61,000 in 2003. The commercial yield in 2003 was much less than the TAC.



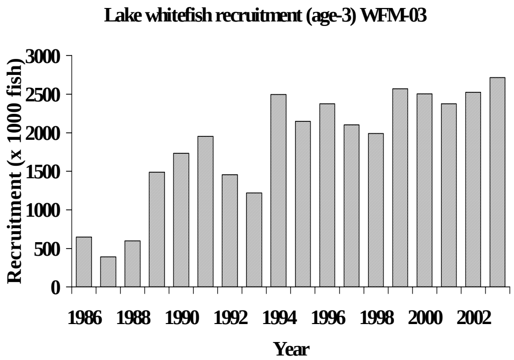
Fishing effort in WFM-03 has been highly variable. Gill-net fishing effort increased from 2.9 million ft in 1986 to 16.7 million ft in 1992 then declined to only 1.2 million ft in 2003. Trap-net effort increased from 817 lifts in 1991 to 2,447 lifts in 2002 before declining to 1,412 lifts in 2003.

Whitefish in WFM-03 are of small size. During 1986-2003 No. 1 whitefish (< 3 lb) made up 84%, mediums (3-4 lb) 13%, and jumbos (≥ 4 lb) 3% of the harvest from WFM-03. Mean weight of a harvested whitefish in 2003 was 2.4 lb in the gill-net fishery and 2.3 lb in the trap-net fishery.

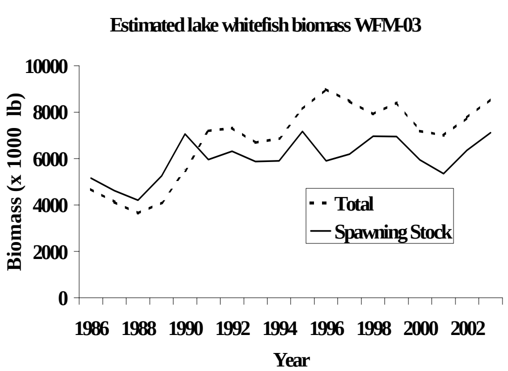
Growth of whitefish in WFM-03 appears to have stabilized or increased, although it remains much below growth experienced from 1986 to 1993. Mean weight of age-2 to -8 whitefish either increased or remained the same from 2002 to 2003, while mean weight of age-9 and older whitefish declined slightly.



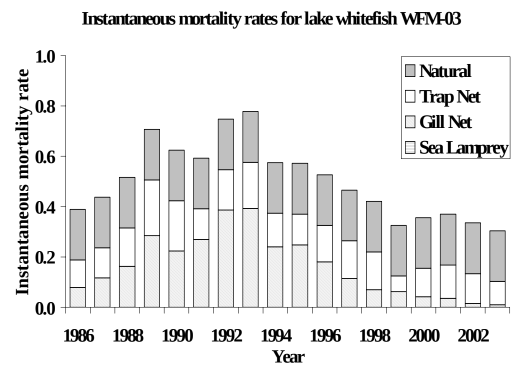
Recruitment of age-3 whitefish was fairly consistent and high in WFM-03. Recruitment increased from roughly 546,000 whitefish in 1986-1988 to an average of 1.57 million fish during 1989-1993, and increased further to 2.5 million fish during 1999-2003. Recruitment of age-3 whitefish was estimated to be 2.7 million fish in 2003.



Biomass of age-3 and older whitefish has been fairly stable in WFM-03 compared to other units in the 1836 Treaty-ceded waters. Total biomass of whitefish in WFM-03 varied less than three-fold from 3.6 to 9.0 million lb during 1986-2003. Total biomass averaged 7.9 million lb during 1994-2003. Spawning-stock biomass was more stable than total biomass, varying less than two-fold from 4.2 to 7.1 million lb during 1986-2003. The declines in growth rate since 1993 have resulted in the spawning biomass not increasing at the same rate as recruitment or total biomass. In 2003 total biomass was 8.6 million lb and spawning biomass was 7.1 million lb.



Changes in gill-net effort have been primarily responsible for the changes in total annual mortality of whitefish in WFM-03. Total mortality of age-4 and older whitefish increased from 0.39 y^{-1} in 1986 to 0.71 y^{-1} in 1993, and then declined to 0.30 y^{-1} in 2003. Gill-net mortality increased from 0.08 y^{-1} in 1986 to 0.39 y^{-1} in 1993 then declined to 0.01 y^{-1} in 2003. Trap-net mortality was fairly stable ranging from 0.6 to 0.22 y^{-1} during 1986-2003 and averaging 0.14 y^{-1}. Natural mortality was estimated to be 0.20 y^{-1} in WFM-03 and has been greater than total fishing mortality every year since 1999.



Total annual mortality on fully vulnerable age-classes was less than the target rate during 2001-2003. Furthermore, 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 1.95 times above the levels experienced during 2001-2003. The recommended yield limit at the increased rate of fishing was estimated to be **1,970,000 lb** for 2005. The 2004 recommended yield limit was 1,938,000 lb.

Summary Status WFM-03 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	0.43 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.39 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.151 lb (SE 0.004)
	Current SSBR	1.14 lb (SE 0.03)
	SSBR at target mortality	0.168 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.531 (SE 0.012)
Average yield per recruit		0.554 lb (SE 0.011)
Natural Mortality (M)		0.268 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.024 y^{-1} (0.021-0.027)
	Average trap net F, ages 4+	0.131 y^{-1} (0.117-0.147)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.423 y^{-1} (SE 0.009)
Recruitment (age-3)	(1994-2003 average)	2,380,200 fish (2,166,820-2,666,020)
Biomass (age 3+)	(1994-2003 average)	7,933,500 lb (7,411,740-8,645,780)
Spawning biomass	(1994-2003 average)	6,389,200 lb (5,983,430-6,938,900)
Recommended yield limit in 2005		1,970,000 lb
Actual yield limit for 2005 (HRG)		1,970,000 lb

WFM-04 (Beaver Island)

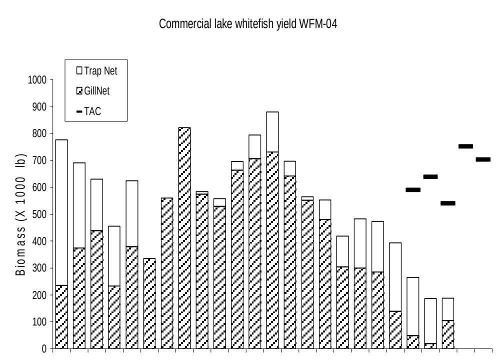
Prepared by Stephen J. Lenart

WFM-04 is located in 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 square mile 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 fishers is prohibited. The eastern portion of WFM-04 along the Lower Peninsula of Michigan has been a favorite fishing area for CORA small-boat fisheries, although access along this eastern shore is quite limited. The offshore waters of WFM-04 are fished exclusively by large-boat gill-net and trap-net operations. Only trap-net operations targeting whitefish conduct fisheries within the lake trout refuge. The recreational whitefish fishery is not likely a significant factor in this unit.

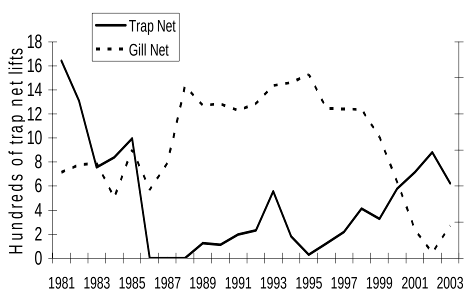
In the four years prior to implementation of the 1985 Agreement, the trap-net fishery accounted for a substantial proportion (30–70%) of the total commercial yield. Average commercial yield was 636,000 lb during this period. From 1986 to 1992, the commercial gill-net fishery accounted for more than 95% of the total yield. After peaking at 880,000 lb in 1993, commercial yield declined steadily through 2002, when it reached a historic low of 186,000 lb (average of 491,000 lb from 1993 to 2002). This decline mirrored the decline in gill-net yield, which was 19,000 lb in 2002. Commercial yield increased only slightly in 2003 to 188,000 lb; however, gill-net fishers were responsible for a larger proportion of the catch in 2003 than in recent years.



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.

During the period from 1995 to 2002, trap-net effort steadily increased, reaching 881 lifts in 2002. Trap-net effort declined slightly to 623 lifts in 2003. In contrast, gill-net effort has progressively declined since 1995, when nearly 11 million ft of gill-net effort was reported. After a historic low of 0.29 million ft was reported in 2002, gill-net effort increased to 1.8 million ft in 2003. The decline in gill-net effort in recent years followed as a consequence of the 2000 Consent Decree with the conversion of gill-net fisheries to trap-net fisheries.

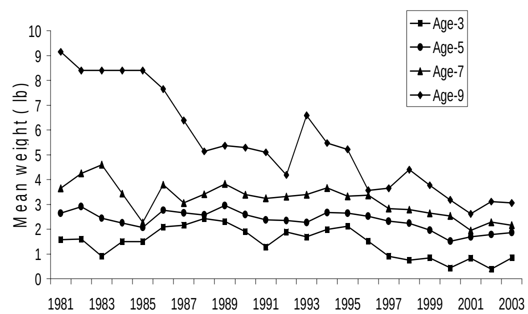
Lake whitefish commercial trap net and gill net effort WFM-04



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 2.1 to 3.3 lb during 1981-2003. The mean weight of whitefish harvested in the 2003 trap-net fishery was 2.3 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 to 2003. The mean weight of a gill-net harvested whitefish has remained relatively constant (2.6 to 2.8 lb) since 1995.

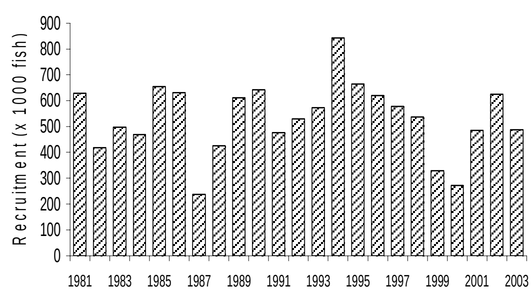
Growth of whitefish in WFM-04 has not declined to the same extent as in other Lake Michigan units. Age-9+ whitefish experienced the most significant decline in weight during the time series (from a mean of 9.1 lb in 1981 to 2.6 lb in 2001). A similar decline was evident in younger age classes as well. After stabilizing in the early 1990's, mean weight-at-age declined for all age classes through the end of the decade. Since 2001, however, a moderate increase in mean size has been evident in age-5 to 9+ whitefish.

Lake whitefish population mean weight at age WFM-04



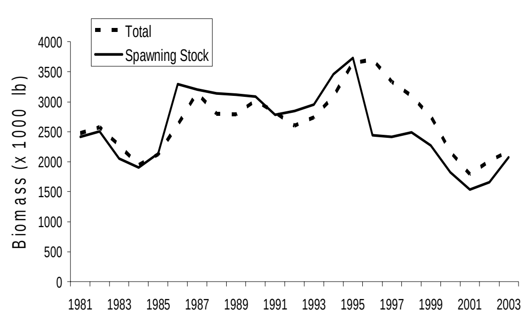
Recruitment of age-3 whitefish to the population in WFM-04 was quite stable, in contrast to other Lake Michigan management units. Average estimated recruitment of age-3 whitefish in WFM-04 was 532,000 fish during 1981 to 2003. Annual recruitment varied from 237,000 to 843,000 fish during this time period. Average estimated recruitment during 1999-2003 was 440,000 age-3 fish, slightly lower than the long term average for the unit.

Lake whitefish recruitment (age-3) WFM-04



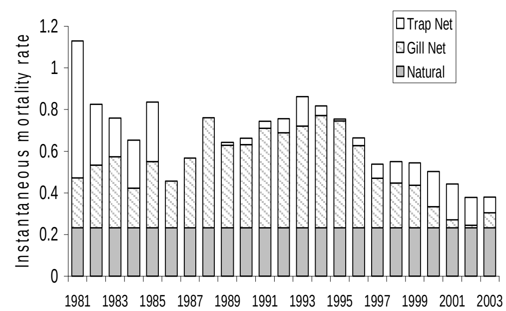
Biomass of age-3 and older whitefish was also fairly stable in WFM-04, a consequence of the consistent recruitment. Total biomass, which ranged from 1.8 to 3.7 million lb during 1981-2003, peaked in the mid-1990s. Total biomass then declined through the remainder of the decade before trending upward in the past few years. Except for a few years in the later 1990s, trends in spawning stock biomass have mirrored those of total biomass. During the period from 1981 to 2003, estimated spawning-stock biomass ranged from a high of 3.7 million lb in 1995 to a low of 1.5 million lb in 2001. In 2003, estimated spawning-stock biomass was approximately 2.1 million lb.

Estimated lake whitefish biomass WFM-04



Mortality of age-4 and older whitefish in WFM-04 has steadily declined since 1993, when the total instantaneous mortality (Z) was estimated to be 0.86 y^{-1}. Prior to this, total mortality ranged from 1.13 y^{-1} in 1981 to 0.46 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 0.21 y^{-1} to 0.54 y^{-1} (average 0.39 y^{-1}). From 2000 to 2003, gill-net mortality was significantly lower, averaging 0.06 y^{-1}. From 2000 to 2002, the trap-net fishery was the primary source of fishing mortality (F) in WFM-04 (average trap-net mortality was 0.16 y^{-1} during this period). Both trap-net and gill-net mortality were estimated to be 0.07 y^{-1} in 2003. Natural mortality (estimated to be 0.23 y^{-1}) exceeded total fishing mortality during 2001-2003 and was the largest single mortality source in WFM-04 from 1998 to 2003. Sea lamprey mortality is not estimated separately in this unit, although a significant increase in the abundance of adult sea lamprey in northern Lake Michigan in recent years may precipitate an evaluation of this mortality component for whitefish.

Instantaneous mortality rates for lake whitefish WFM-04



The average total mortality rate of age-4+ whitefish was 0.40 y^{-1} during 2001 to 2003, well below the maximum target rate of 1.05 y^{-1}. The spawning potential reduction in 2003 was 0.53. Thus, the projection model estimated that fishing effort could be increased three-fold from the effort levels recorded during 2001-2003. The 2005 model-generated yield limit of 704,000 lb was down slightly from the 2004 recommended limit of 752,000 lb. This decrease was attributed mainly to a decline in estimated recruitment in recent years.

The only substantive change in model structure compared to the prior-year was in the approach used to model gill-net selectivity. In the past, gill-net selectivity was modeled as a double-logistic function in which selectivity was expected to decline for the older age classes. Recent declines in size-at-age have made the WFM04 model somewhat sensitive to this parameter (a similar situation was reported for other whitefish models). Modeling gill-net selectivity as a simple logistic function (the approach used for the trap-net fishery) resulted in improved model diagnostics without resulting in any significant change in estimates of recruitment, biomass, or total allowable catch.

The 2005 recommended yield limit of 704,000 lb was adopted by CORA as the Harvest Regulation Guideline for management unit WFM04.

Summary Status WFM-04 Whitefish		**Value** (95% Probability Interval)
Female maturity		
	Size at first spawning	0.69 lb
	Age at first Spawning	3 y
	Size at 50% maturity	1.62 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	3.182 lb (3.173 - 3.193)
	Current SSBR	1.69 lb (1.604 - 1.769)
	SSBR at target mortality	0.385 lb
Spawning potential reduction		
	At target mortality	0.529 (0.504 - 0.556)
Average yield per recruit		0.700 lb (0.667 - 0.730)
Natural Mortality (M)		0.231 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to gill nets	8
	Fully selected age to trap nets	8
	Average gill-net F, ages 4+	0.042 y^{-1} (0.036 - 0.047)
	Average trap-net F, ages 4+	0.126 y^{-1} (0.111 - 0.143)
Sea lamprey mortality (ML)		
	Average ages 4+, 2001-2003	N/A
Total mortality (Z)		
	Average ages 4+, 2001-2003	0.399 y^{-1} (0.380 - 0.421)
Recruitment (age-3)	(1994-2003 average)	543,970 fish (485,672 - 620,377)
Biomass (ages 3+)	(1994-2003 average)	2,773,800 lb (2,590,820 - 2,981,520)
Spawning biomass	(1994-2003 average)	2,389,400 lb (2,230,980 - 2,567,930)
MSC recommended yield limit in 2005		704,000 lb
Actual yield limit in 2005 (HRG)		704,000 lb

WFM-05 (Grand Traverse Bay)

Prepared by Mark P. Ebener and Erik J. Olsen

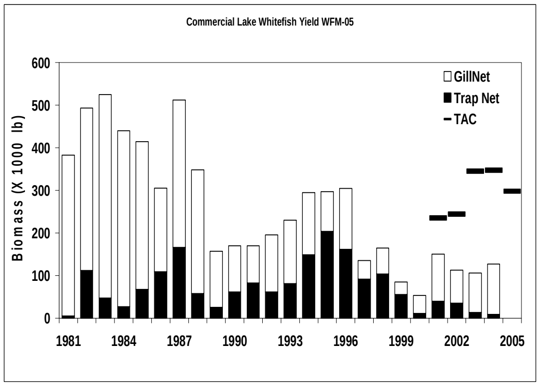
Management unit WFM-05 encompasses the area from Little Traverse Bay through Grand Traverse Bay and offshore waters of Lake Michigan north and west of the Leelanau Peninsula. Much of WFM-05 contains water >240 ft. deep including the both the east and west arms of Grand Traverse Bay. The deepest parts 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.

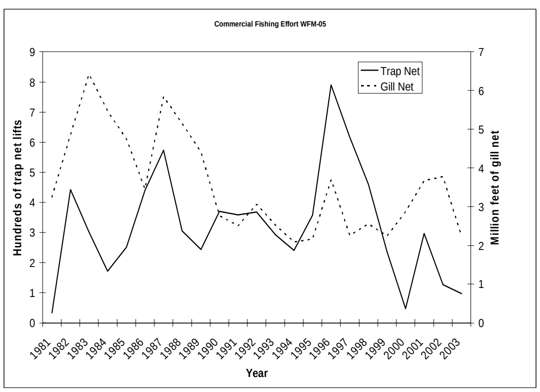
WFM-05 has been an important tribal fishing area since the 1970s. Much of the tribal fishing activity that occurred prior to and immediately after re-affirmation of treaty-reserved fishing rights took place in Grand Traverse Bay. CORA small-boat fishers relied on Grand Traverse Bay as an important fishing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

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

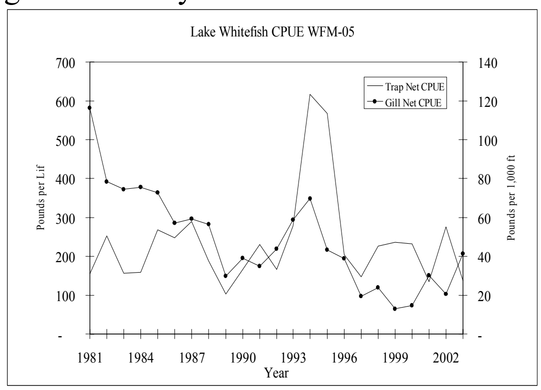
Commercial yields of lake whitefish during the 1990s were substantially less than during the 1980s. The commercial yield averaged 383,000 lb from 1980 to 1989 and 205,000 lb during 1990-1999. The fishery has declined through the late 1990s with the lowest recorded yield coming in 2000 at 53,000 lb. The fishery has rebounded slightly through 2004, averaging 124,000 lb during the timeframe. The large-mesh gill-net yield has exceeded the trap-net yield in every year except the period from 1994 to 1999.



Large-mesh gill-net effort in WFM-05 declined almost every year since 1984, whereas trap-net effort has varied, but with a downward trend since 1996. Gill-net effort declined from 6.4 million ft. in 1983 to a low of only 2.1 million ft. in 1994. Trap-net effort has varied annually between 200 and 800 lifts during 1982-2001. Since 1991, trap-net effort has averaged 323 lifts per year, peaking at 790 lifts in 1996, with a low of 47 in 2000.



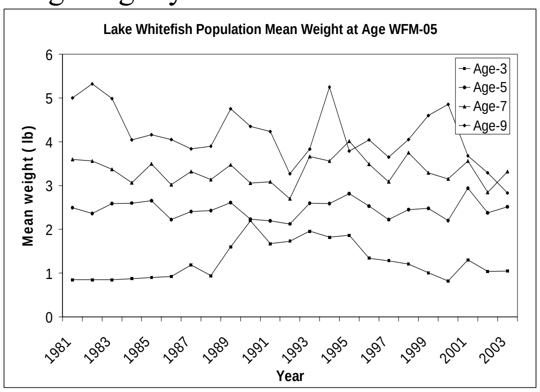
The decline in yield of whitefish in WFM-05 has mirrored the decline in lake whitefish recruitment within this management unit. In addition, there is an apparent decline in catchability of whitefish to the large-mesh gill-net fishery. CPUE of whitefish in the large-mesh gill-net fishery declined from 153 lb per 1,000 ft. of gill net in 1979 to 13 lb per 1000 ft. of gill net in 1999. Since 2000, gill-net CPUE has averaged only 27 lb. On the other hand, during 1981-1999 the CPUE of whitefish in the trap-net fishery has been remarkably stable holding between 150 and 300 lb per lift, except for 1994 and 1995. From 2000-2003, trap-net CPUE averaged 245 lb. Gill-net fishers in WFM-05 claim the decline in catchability is a result of both increased water clarity due to zebra mussel activity, along with increased algal slime that makes the net highly visible to whitefish. Whatever the cause, it is evident that something is reducing catch rates of whitefish to the large-mesh gill-net fishery in the unit.



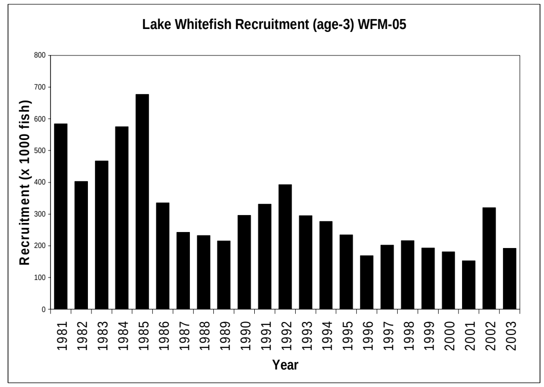
Whitefish from WFM-05 are currently of small to moderate size. From 2000 to 2003, the proportion of the yield made up of the three size classes of whitefish were 76% No.1 (< 3 lb), 19% mediums (3-4 lb), and 5% jumbos (≥ 4 lb). This compares with 65% No.1, 22% mediums, and 13% jumbos from 1980 to 1989 and 65% No.1, 20% mediums, and 15% jumbos from 1990 to 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 2.2 lb during the last three years (2001-2003). 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 (2001-2003).

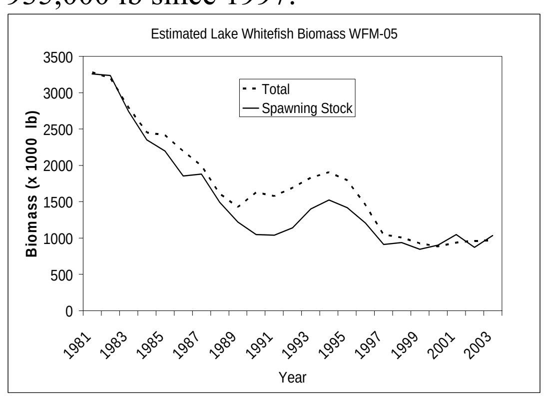
Growth of whitefish from WFM-05 has remained very stable through the years, unlike the pattern of declining growth seen in other areas of Lakes Michigan and Huron, including substantial declines in areas adjacent to this management unit. Mean weight of age-3 to -9 whitefish showed no trends through time in WFM-05 from 1981 to 2003, although some age classes did weigh slightly less in 2003 than in 1981.



Recruitment of age-3 whitefish to the population in WFM-05 was highly variable and has generally declined since the late 1980s 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 to 1989, the average was still relatively high at 421,000 fish per year. More recently, the average has dropped. From 1994 to 2003 only 213,250 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 ≥ age 3 (calculated at the beginning of each year) peaked at the beginning of the 1981-2003 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 leveled out at approximately 961,000 lb from 1997 to 2003. Spawning stock biomass also followed the same trend, peaking at 3.3 million lb in 1981 and holding at about 935,000 lb since 1997.



Fishing mortality (F) in WFM-05 has historically been split about equally between the gill- and trap-net fisheries. However, during 2001-2003, gill-net mortality has increased slightly, while trap-net mortality has declined due to reduced effort. Average fishing-induced mortality on whitefish ≥ age 4 averaged 0.15 for the large-mesh gill-net fishery and 0.05 for the trap-net fishery during 2001-2003. Gill net-induced fishing mortality ranged from 0.31 in 1984 to 0.07 in 1999, while trap-net-induced fishing mortality ranged from 0.22 in 1996 to 0.01 in 1981. The gill-and trap-net mortality level has declined from a combined rate of 0.48 in 1996 to a low of 0.10 in 2000, averaging 0.18 from 2000-2003.

Total annual mortality on the fishable stock in WFM-05 during 2001-2003 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 53% during 2001-2003 and the spawning potential reduction value was 0.60. Consequently, the projection model estimated that fishing mortality could be increased 2.98 times in WFM-05 in 2005 from the average value during 2001-2003. The projected yield associated with this level of fishing was 347,000 lb, and this was also accepted as the HRG in 2005.

Summary Status WFM-05 Whitefish		
Female maturity		
	Size at first spawning	1.13 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.91 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.376 lb (SE 0.)
	Current SSBR	1.42 lb (SE 0.04)
	SSBR at target mortality	0.527 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.597 (SE 0.017)
Average yield per recruit		0.618 lb (SE 0.024)
Natural Mortality (M)		0.335 y^{-1}
Fishing mortality rate 2001-2003		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.148 y^{-1} (SE 0.014)
	Average trap net F, ages 4+	0.045 y^{-1} (SE 0.003)
Sea lamprey mortality (ML)		
	(average ages 4+,2001-2003)	N/A
Total mortality (Z)		
	Average ages 4+,2001-2003	0.527 y^{-1} (SE 0.017)
Recruitment (age-3)	(1994-2003 average)	213,250 fish (SE 12,932)
Biomass (age 3+)	(1994-2003 average)	1,188,900 lb (SE 61,968)
Spawning biomass	(1994-2003 average)	1,069,300 lb (SE 58,909)
MSC recommended yield limit in 2005		347,000 lb
Actual yield limit in 2005 (HRG)		347,000 lb

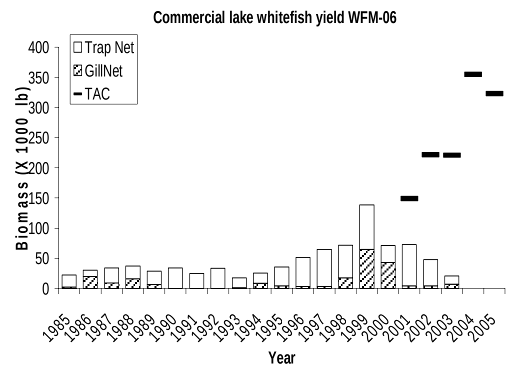
WFM-06 (Leland - Frankfort)

Prepared by Randall M. Claramunt and Philip J. Schneeberger

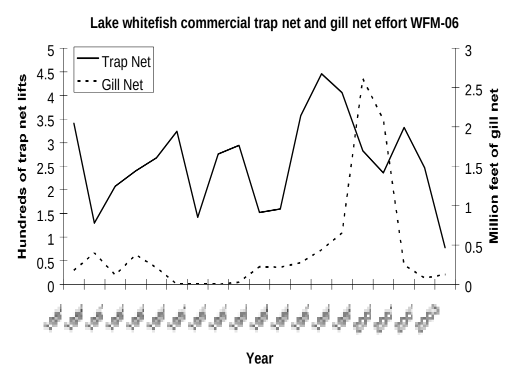
Lake whitefish management unit WFM-06 is located in 1836 Treaty-ceded waters west of the Leelanau Peninsula from about Cathead Point south to Arcadia. Surface area for this unit is 945,156 acres (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include 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.

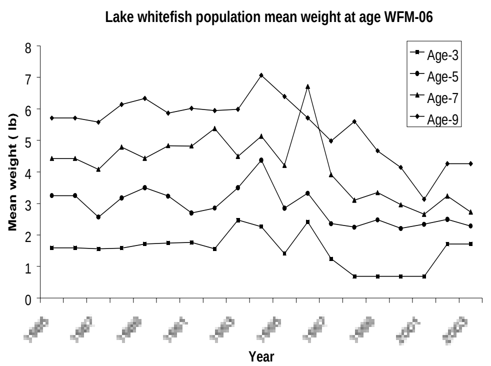
Yield for 2003 was 21,000 lb in WFM-06, down from 48,000 lb in 2002, and below the 1985-2002 average of 47,000 lb. Of the total in 2003, trap-net yield was 13.8 thousand lb (65.7%) and gill-net yield was 7.2 thousand lb (34.3%). Proportions of yield by gear type have varied considerably from year to year with an average split of 79% from trap nets and 21% from gill nets between 1985 and 2003.



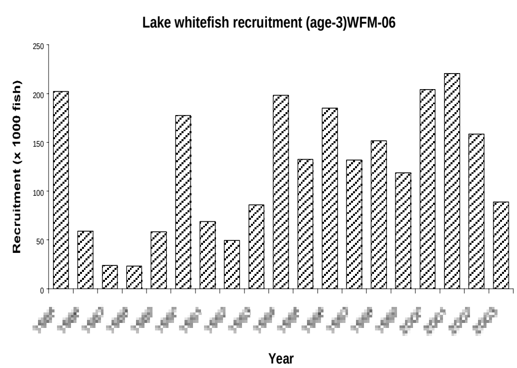
Trap-net effort decreased by 68% from 2002 to 2003 while gill-net effort increased by 54%. The 2003 trap-net effort (78 lifts) was substantially lower than the 1985-2001 average (269 lifts), and gill-net effort (125,000 ft) was substantially lower in 2003 than for the 1985-2001 average (453,000 ft).



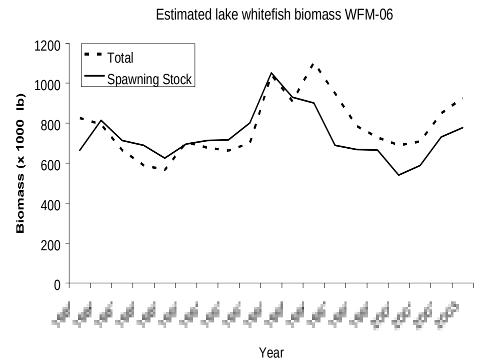
Lake whitefish weight-at-age in 2003 was relatively unchanged for all age groups from the 2002 values. Weight-at-age in 2002 and 2003 had increased from 1998 to 2001 for ages < 7 and from the declines in weight-at-age that were documented for fish ages 7 to 12+ since 1996. However, weight-at-age values in 2003 for fish aged 3-12+ were still 18% lower than the 1985-2002 averages.



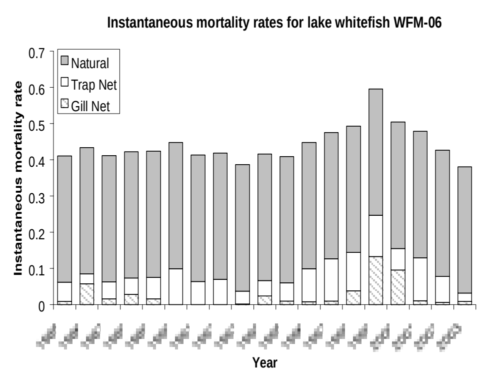
Recruitment, based on estimated numbers of age-3 fish, was lower in 2003 than any year since 1993. Estimates of recruitment were highest during 1994-1998 and 2000-2001, and lowest for the time series during 1987-1988.



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 2003. Values estimated for 2003 were 926,000 lb for fishable biomass and 778,000 lb for spawning stock biomass. The ratio of spawning stock biomass to fishable biomass was 0.84 in 2003.



Total instantaneous mortality rate (Z) in 2003 was 0.38 y^{-1}, showing a decrease in the rate for the fourth year in a row. Based on current estimates, the 2003 rate for Z is approximately 14.0% lower than the average for 1985-2002. Instantaneous fishing mortality rates (F) have varied considerably for trap nets and gill nets throughout the time series. During 2003, F was much higher for the trap-net fishery. Estimates for F were 0.022 y^{-1} for trap nets and 0.010 y^{-1} for gill nets. The 2003 estimate for instantaneous natural mortality rate was 0.35 y^{-1}, still the largest source of lake whitefish mortality in WFM-06.



The 2005 yield limit is 323,000 lb, which is a slight decrease from the limit calculated for 2004 of 355,000 lb. Based on the projection model, the lake whitefish stock in WFM-06 could support a five-fold increase in trap- and gill-net effort.

Summary Status WFM-06 Whitefish	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.37 lb
Age at first spawning	3 y
Size at 50% maturity	1.81 lb
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	2.559 lb (2.549 – 2.569)
Current SSBR	1.86 lb (1.719 – 2.034)
SSBR at target mortality	0.391 lb (0.390. – 0.391)
Spawning potential reduction	
At target mortality	0.727 (0.672 – 0.795)
Average yield per recruit	0.363 lb (0.276 – 0.433)
Natural mortality (M)	0.349 y^{-1}
Fishing mortality rates	
Age of full selection	
Fully selected age to gill nets	8 y
Fully selected age to trap nets	8 y
Gill-net fishing mortality (F)	
Average 2001-2003, ages 4+	0.008 y^{-1} (0.007 – 0.009)
Trap-net fishing mortality (F)	
Average 2001-2003, ages 4+	0.065 y^{-1} (0.055 – 0.082)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 4+	N/A
Total mortality (Z)	
Average 2001-2003, ages 4+	0.422 y^{-1} (0.399 – 0.443)
Recruitment (age-1)	
Average 1994-2003	158,970 fish (132,870 – 209,353)
Biomass (age 3+)	
Average 1994-2003	869,430 lb (702,923 – 1,195,980)
Spawning biomass	
Average 1994-2003	568,350 lb (456,295 – 647,133)
MSC recommended yield limit in 2005	323,000 lb
Actual yield limit in 2005	323,000 lb

WFM-07 (Ludington)

Prepared by Archie W. Martell Jr.

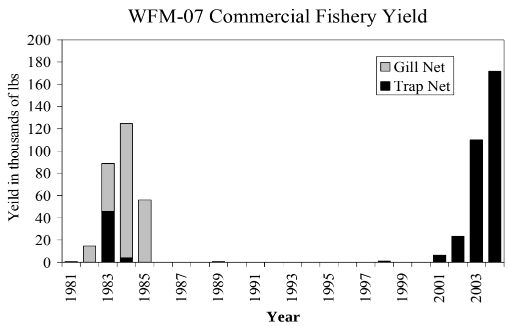
Lake whitefish management unit WFM-07 is located within the 1836 Treaty-ceded waters of eastern central Lake Michigan from Arcadia in the north to just south of Stony Lake, and west to the State border bisecting the middle of the lake. This lake whitefish management unit includes part or all of grids 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 ft or less with maximum depths up to 900 feet. There are no islands or bays, and apart from the shoreline, rivers (Manistee, Little Manistee, Big Sable, Pere Marquette, and Pentwater), and drowned river mouth lakes (Manistee Lake, Pere Marquette Lake, and Pentwater Lake) this area has few other distinguishing features relevant to lake whitefish biology.

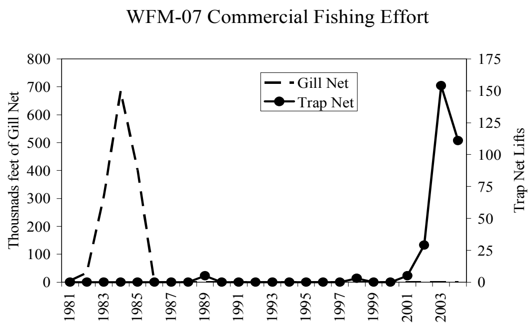
Since 2000, WFM-07 has been a Tribal commercial fishing zone for lake whitefish, part of the Little River Zone with tribal fishing regulated under permitting control of the Little River Band of Ottawa Indians (LRBOI). From 1985 through 2000 there was no significant State commercial fishing effort and 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.

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 initial three-year period of Tribal commercial trap-net fishing activity from 2001-2003, the tribes were limited to an effort restriction of two trap-net operations with twelve nets each.

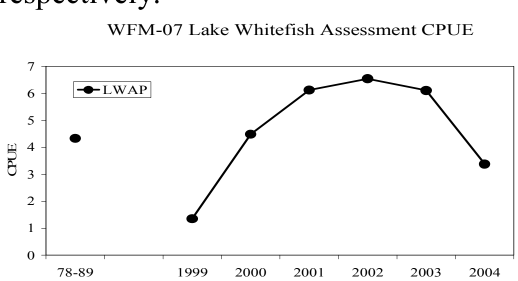
At the conclusion of the 2003 fishing season three years of commercial fishing activity for lake whitefish within this unit have been conducted by Tribal fishers. Pursuant to the 2000 Consent Decree, and the Tribal Management Plan, in 2004 a Harvest Regulation Guideline (HRG) for lake whitefish was developed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

Commercial harvest of lake whitefish within WFM-07 from 1981 to 2004 peaked at 171,755 lb in 2004 represented by 111 trap-net lifts. This increase in harvest was due to the addition of a second active trap-net permit for this unit. Also, the increase can be attributed to the second permit holder concentrating effort for lake whitefish in the fall before the closure. In 2001, Tribal commercial fishing activities began and were limited with effort distributed only in October and November with a total harvest of 6,361 lb from 5 trap-net lifts. In 2002, Tribal commercial harvest was 23,165 lb with 29 trap-net lifts. In 2003, Tribal commercial harvest was 110,080 lb with an effort of 154 trap-net lifts.



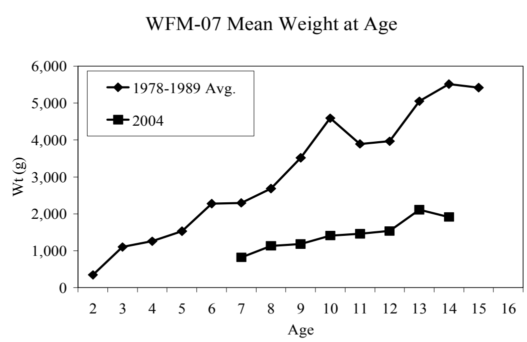


Spring LWAP graded-mesh gill-net (GMGN) survey CPUE of lake whitefish in WFM-07 was higher from 2000 to 2003 as compared to historical levels represented by the 1978-1989 average. The 2004 LWAP CPUE of 3.4/1,000 ft was lower than both the historical average and the 2000-2003 average. Historical graded-mesh gill-net CPUE of 4.3/1,000 ft for lake whitefish from spring surveys is represented by the average for 1978-1989. From 1999 through 2003, graded-mesh gill-net survey 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.



The 2004 mean length of lake whitefish sampled in spring GMGN surveys and commercial samples has increased to over 20 inches as compared to 2000-2003 values. However, the mean length of the lake whitefish within this unit are still below the 1978-1989 average and the 1983 commercial samples of over 23 inches. The 2004 mean weight of lake whitefish indicates a slight increase from both GMGN surveys and commercial samples as compared to 2001-2003. The 2004 mean weight of lake whitefish from both the GMGN surveys (3.02lb) and commercial samples (2.77lb) in this unit is currently lower than the 1978-1989 average (6.84lb) and the 1983 commercial samples (5.54lb). The mean age of lake whitefish was 10.6 from the GMGN survey and 9.2 from commercial samples. This represents a continuing trend in older mean age as compared to the 1978-1989 GMGN survey mean of 4.8 and the 1983 commercial sample mean of 7.3.

The 2004 mean weight-at-age of lake whitefish sampled in spring graded-mesh gill-net surveys is lower as compared to the 1978-1989 GMGN survey average. This follows a similar trend that has been observed from 2000 to present. The lower weight-at-age for lake whitefish indicates that growth rates are reduced within this unit as compared to historical levels.



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, 2003 and 2004 spring GMGN surveys averaged 0.13 y^{-1} for ages 6 through 16, 0.03 y^{-1} for ages 5 through 13, 0.25 y^{-1} for ages 6 through 13, and 0.04 y^{-1} for ages 7 through 14, respectively. The total annual mortality rates calculated for this lake whitefish stock have 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 may be decreasing within this management unit as compared to recent and historical observations. The current spring GMGN 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. Also, the stock is showing indications of increasing mean length and mean weight since 2000, but is currently below historical means for both.

The WFM-07 2005 lake whitefish HRG of 500,000 lb was developed and recommended by the Little River Band of Ottawa Indians (LRBOI) and adopted by CORA for implementation. The 2005 HRG is a continuation of the 2004 HRG which was developed by examining the current status of the WFM-07 lake whitefish stock and the harvest limits established by the Modeling Subcommittee for the adjacent whitefish zones WFM-06 and WFM-08. In 2004 LRBOI imposed effort limitations of 4 trap-net permits with a maximum of 12 nets per permit for this unit.

Year	Gear	Mean TL (Inch)	Mean Wt (Lb)	Mean Age
1978-1989 Avg.	GMGN	23.34	6.84	4.8
1983	CF	23.32	5.54	7.3
2000	GMGN	18.61	2.22	6.1
2001	GMGN	18.96	2.37	9.9
2001	CF	19.89	2.76	10.9
2002	GMGN	18.44	2.33	8.9
2002	CF	19.34	2.69	9.7
2003	GMGN	19.14	2.38	8.4
2003	CF	19.68	2.52	11.5
2004	GMGN	20.68	3.02	10.6
2004	CF	20.21	2.77	9.2

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

WFM-08 (Muskegon)

Prepared by Randall M. Claramunt and Philip J. Schneeberger

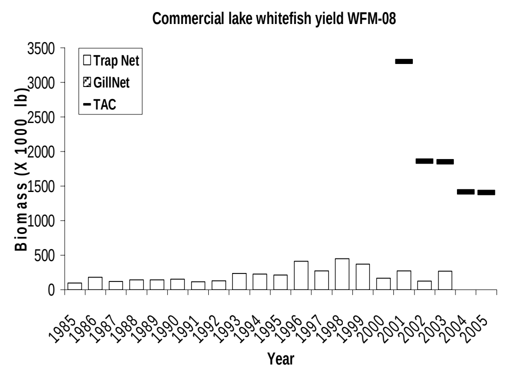
Management unit WFM-08 is the Lake Michigan whitefish zone from about Montague south past Port Sheldon. WFM-08 has a surface area of 1,506,880 acres in Michigan grids 1706-1710, 1806-1810, 1906-1911, and 2006-2011. Apart from the shoreline, inflows from the White, Muskegon, and Grand rivers, and drowned 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. 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.

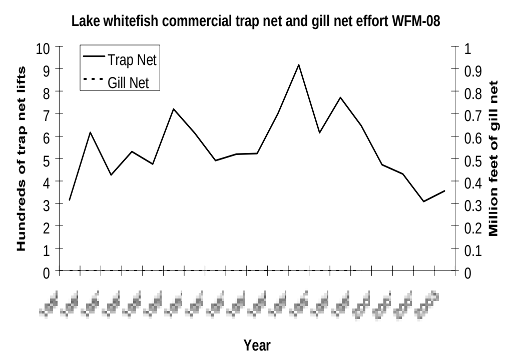
Two State-licensed trap-net fishers operate in WFM-08 where minimum length for whitefish in commercial catches was 19 inches through 1999, then changed to 17 inches in 2000. Other management zones have had a 17-inch minimum size limit throughout the time series. Through 2003 there has been no gill-net harvest of lake whitefish in WFM-08.

Lake whitefish yield from WFM-08 in 2003 was 268,000 lb. Yield more than doubled from 2002 and was 28% higher than the 1985-2002 average.

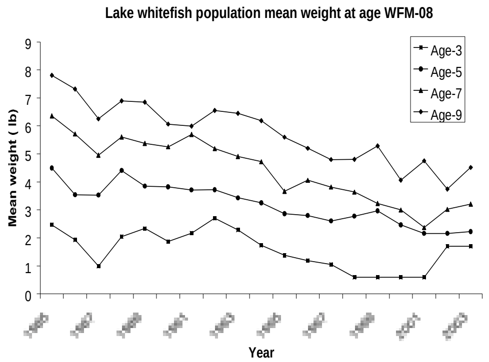
Trap-net effort also increased from 301 lifts in 2002 to 356 lifts in 2003.



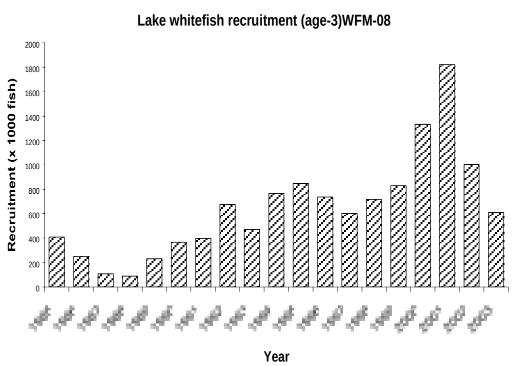
Effort in 2003; however, is still lower by 37% from the average for 1985-2002.



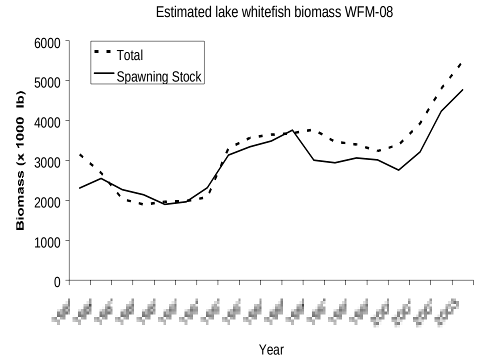
Weight-at-age data have trended downward from 1985 through 2002. In 2003, weight-at-age increased or was stable for most of the age groups. Weight-at-age values in 2003 were 10% or less than averages for 1998 to 2002 for ages 4-9, but fish age-10 and older were generally heavier than for corresponding ages averaged from 1998 to 2002.



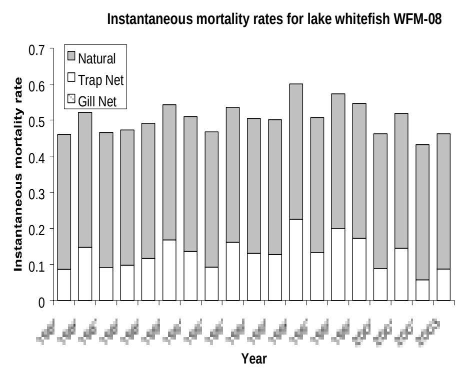
Recruitment, based on the estimated number of age-3 fish, was 609,000 in 2003. Estimates of recruitment were considerably higher (average 1,247,000) during 1999-2002, but the estimate for 2003 was very similar to the 1985-2002 average of 645,000 age-3 fish.



Estimates of fishable biomass and spawning stock biomass continued increasing trends that have persisted since the early 1990s. Fishable biomass was estimated at 5.5 million lb and spawning stock biomass was 4.8 million lb in 2003. The ratio of spawning stock biomass to fishable biomass was 0.87 in 2003, slightly lower than the 1985-2002 average of 0.94.

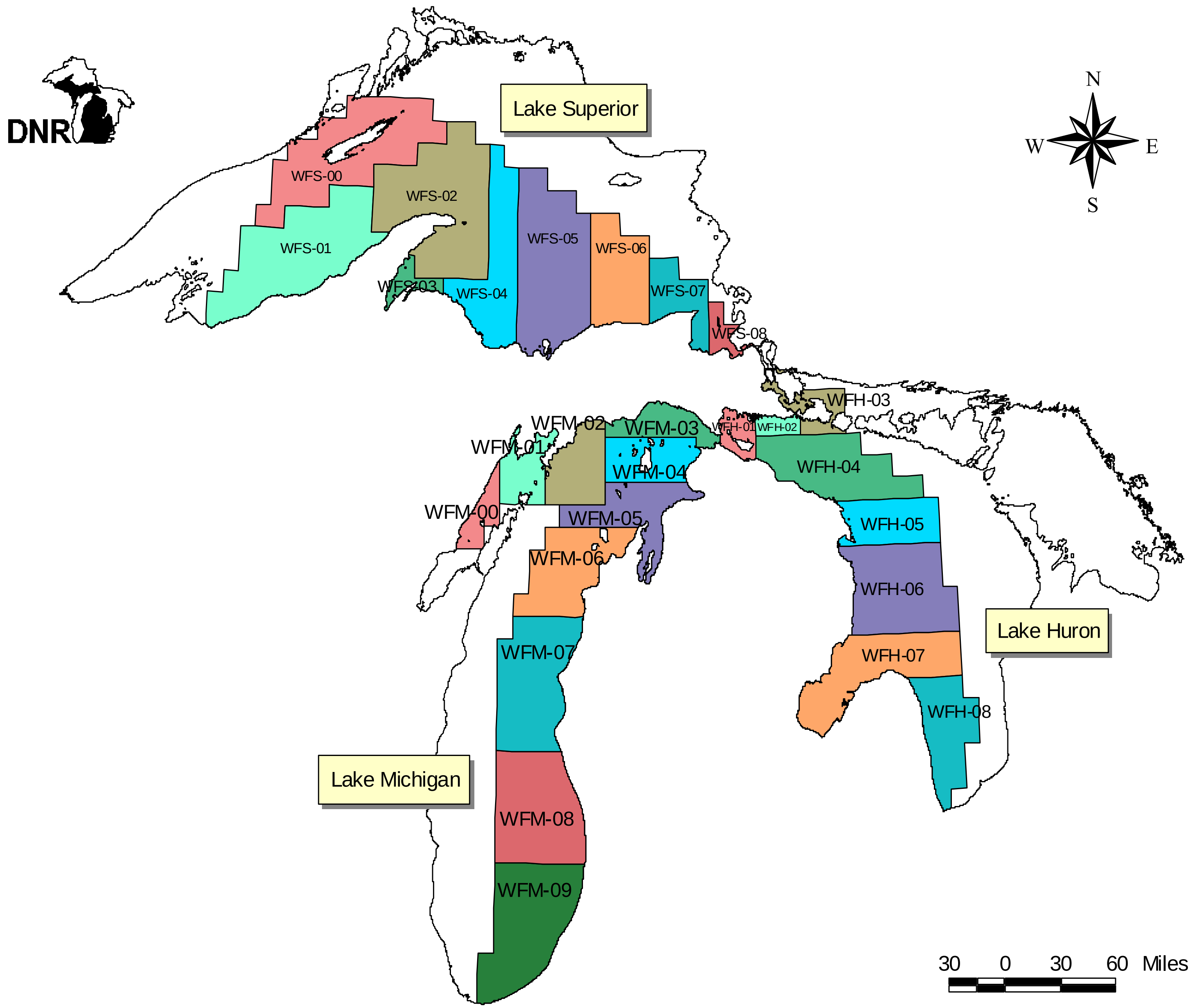


Mortality rates have been relatively stable throughout the time series. Instantaneous total mortality rate (Z) was estimated at 0.46 y^{-1} during 2003. Components of the total rate consisted of 0.09 y^{-1} for instantaneous trap-net-fishing mortality (F) and 0.37 y^{-1} for instantaneous natural mortality (M). Estimates of mortality have been very consistent from 1985-2003 and the ratio of F to Z averaged 0.25 from 1985 through 2003.

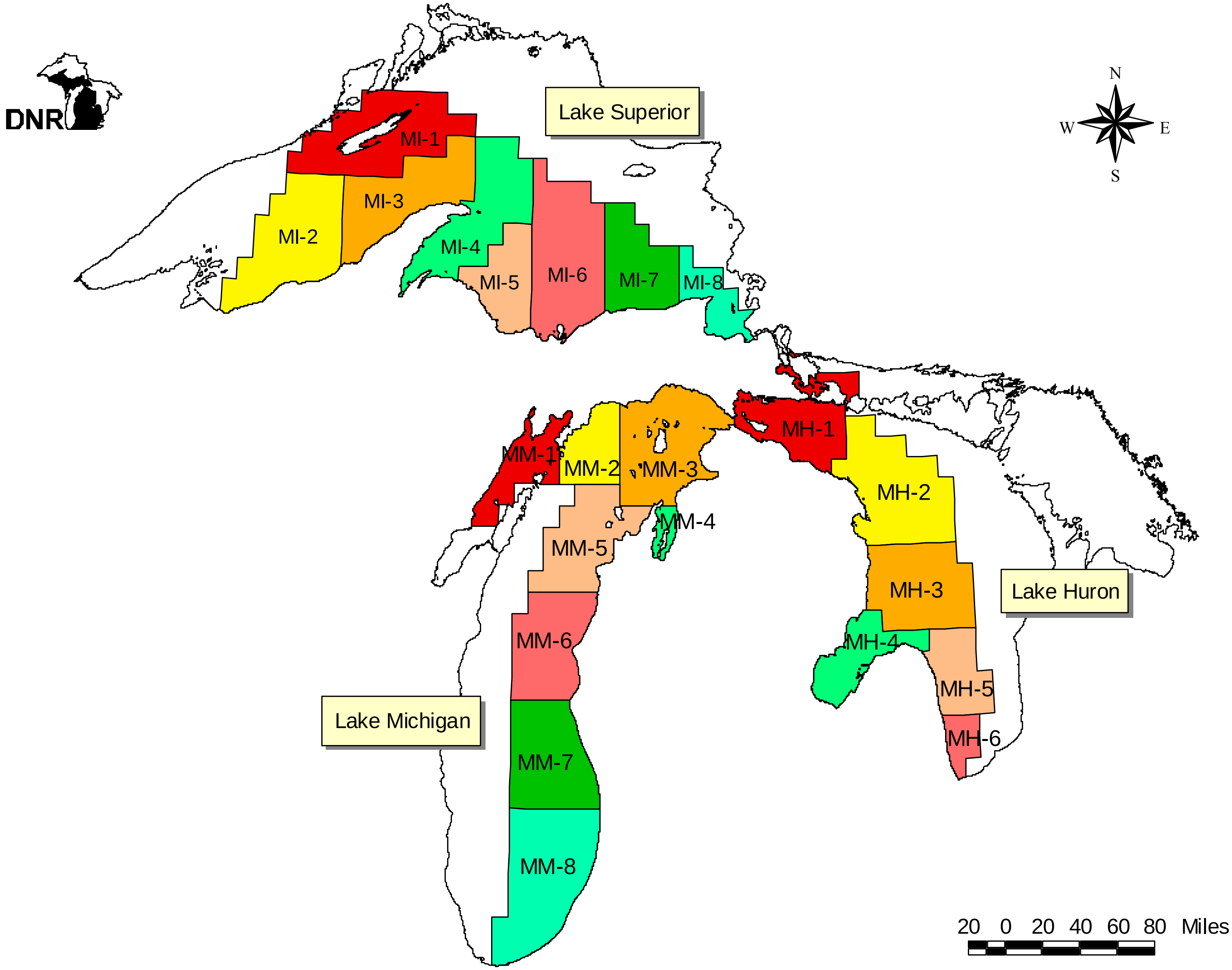


The 2005 yield limit for WFM-08 was 1.404 million lb, calculated using the projection model. This projected yield is close to the limit calculated for 2004 (1.414 million lb).

Summary Status WFM-08 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	1.33 lb
Age at first spawning	3 y
Size at 50% maturity	1.97 lb
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	2.131 lb (2.124 – 2.135)
Current SSBR	1.54 lb (1.45 – 1.61)
SSBR at target mortality	0.369 lb (0.369 – 0.370)
Spawning potential reduction	
At target mortality	0.721 (0.683 – 0.756)
Average yield per recruit	0.323 lb (0.284 – 0.364)
Natural mortality (M)	0.374 y^{-1}
Fishing mortality rates	
Age of full selection	
Fully selected age to gill nets	N/A
Fully selected age to trap nets	11 y
Gill-net fishing mortality (F)	
Average 2001-2003, ages 4+	0. y^{-1}
Trap-net fishing mortality (F)	
Average 2001-2003, ages 4+	0.089 y^{-1} (0.106 – 0.147)
Sea lamprey mortality (ML)	
Average 2001-2003, ages 4+	N/A
Total mortality (Z)	
Average 2001-2003, ages 4+	0.463 y^{-1} (0.445 – 0.483)
Recruitment (age-1)	
Average 1994-2003	926,590 fish (757,598 – 1,058,860)
Biomass (age 3+)	
Average 1994-2003	3,881,700 lb (3,249,500 – 4,431,500)
Spawning biomass	
Average 1994-2003	3,427,600 lb (2,875,400 – 3,929,000)
MSC recommended yield limit in 2005	1,404,000 lb
Actual yield limit in 2005	1,404,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.