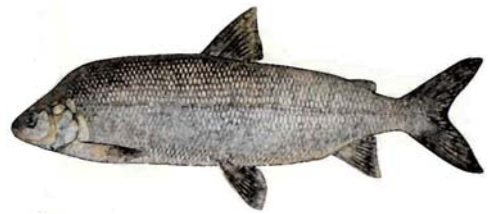
Technical Fisheries Committee Administrative Report 2006: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2005, with recommended yield and effort levels for 2006



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

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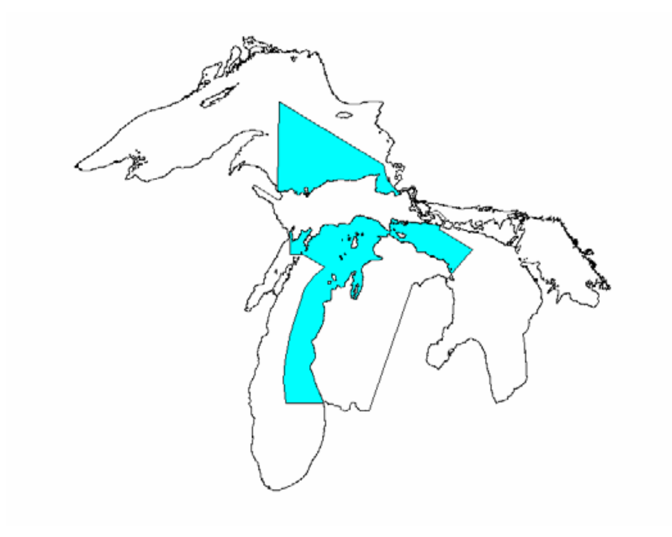
Editors



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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 2006. 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 2006 MSC recommended harvest and effort limits for whitefish and lake trout are provided in the attached report. However, final 2006 harvest limits for all lake trout units have not yet been finalized by the parties. This is the first time under the 2000 Consent Decree that final harvest limits have not been produced prior to the end of a fishing season. As a result, only MSC recommended lake trout harvest limits are given in this report, except in units where harvest limits were finalized as part of a Court Order. The MSC will issue an addendum to this report in the future to include all 2006 harvest limits once they are finalized by the parties.

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 recent mortality rates have been below target, and recreational harvest was well below the harvest limit 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 and MH-2, lake trout mortality rates remain 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. Lake trout growth rates remain stable, but low, and 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 lampreys.

In MM-5, mortality rates are less than the target rates for the third 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 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 some stocks recently, 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 some stocks. 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 2006, the WFH-03 HRG was set equal to the 2005 and 2004 HRGs, and the WFS-06 HRG was set equal to the 2005 HRG. 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 2006 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 continues to make progress 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 continue to meet Consent Decree mandated data submission deadlines. Doing so makes it possible for the MSC to provide yield and effort limits to the TFC and the parties by Consent Decree deadlines.

Finally, the MSC hopes to avoid going through another fishing season without finalized harvest limits for either lake trout or lake whitefish stocks.

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 2006 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 2006 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 2006 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2006, 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 2006, but did not in 2006, 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 2006

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. (Note that the harvest and survey data were adjusted so it reflected only lean, wild fish before they were compared with model predictions.)

The 2006 TACs for MM-123, MM-4, and MM-5 were set in accordance with Court Orders and agreements between the Parties reached at Executive Council Meetings.

The TAC for MM-6,7 was calculated per the Consent Decree. The 2006 TAC decreased by more than 15% compared to the 2005 TAC. The TFC agreed to accept a higher estimated TAC in 2006 limited by a 15% decline from the 2005 TAC's for MM-6,7.

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 2005 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 for models/management units where subsistence fishing is significant.

  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*. Tagging for these studies finished in Fall 2005.

- 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. Tagging for these studies finished in Fall 2005.

- 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.

  A graduate student at MSU is currently exploring this issue.

- 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 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, with an expected completion date of Spring 2008. We recommend the short report be produced annually and include text describing any changes in the modeling process for a given management unit and species. The long report will be produced periodically following substantial changes in methods used to produce harvest limits.

- The MSC is concerned about the short time frame between data availability and the deadline for lake trout harvest limits. The time period between the data submission deadline and the deadline for preliminary harvest limits is too narrow to allow sufficient model analysis, diagnostics of model convergence, and estimation of harvest limits. Given the life history of lake trout, it may be reasonable to either update the lake trout models every 2-3 years or update them with a one-year lag for some data sources.

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

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

STATUS OF LAKE TROUT POPULATIONS

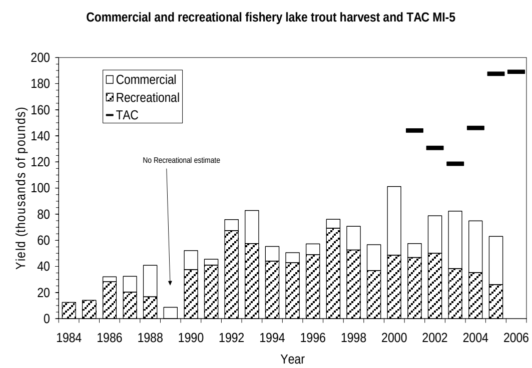
Lake Superior

MI-5 (Marquette - Big Bay)

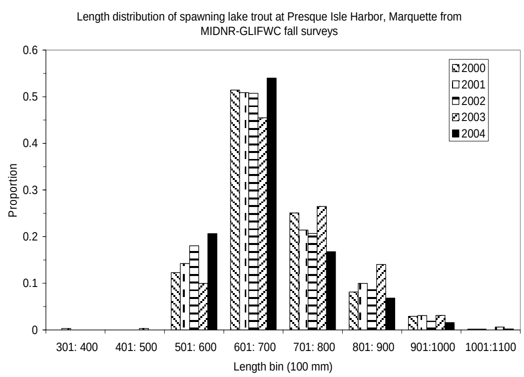
Prepared by Shawn P. Sitar and John K. Netto

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

The only tribal commercial fishery is a large-mesh gill-net fishery that is centered around Marquette and Big Bay in 1842 Treaty waters. This fishery mainly targets lake whitefish with lake trout as bycatch. However, lake trout have been targeted near spawning reefs in Marquette during recent fall fisheries. There have been some low levels of tribal subsistence gill-net fishing in 1836 Treaty waters. Tribal commercial yield of wild lake trout (in 1842 Treaty waters) has ranged from 3,800 round pounds in 1986 to a peak of 52,700 round pounds in 2000. During 2001 to 2005, tribal yield averaged 32,000 round pounds and tribal large-mesh gill-net effort averaged 574,000 ft per year.

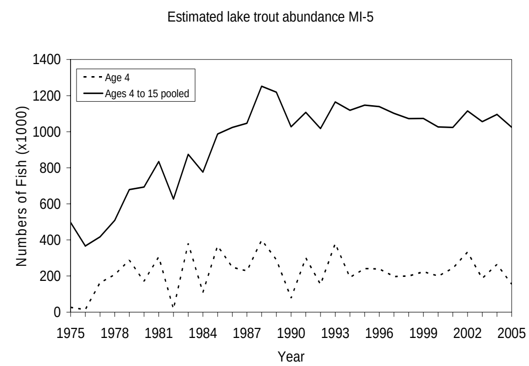


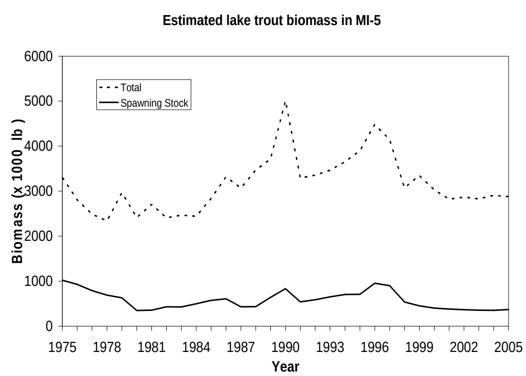
Generally, the fishery is conducted from late winter through early October, with a dome shaped age composition with peak age between 7 and 10. The commercial fishery operates in various grids near Marquette, and the overall impacts on the MI-5 population are nominal. However, in 2000, 2003, 2004, and 2005, the commercial fishers were allowed to harvest lake trout during the spawning season through the end of October. During these years, total annual yield increased and nearly 50% of the yield was from October. The commercial fishery age composition during the years that spawning lake trout were allowed to be harvested was skewed right with peak age being 15 years or older. The concentration of commercial fishing during the spawning has had a localized impact on lake trout in MI-5. Essentially all of the lake trout harvested in October were from the Presque Isle Harbor area of Marquette. 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 ($F_{C,2000}$=0.21 year^{-1}; $F_{C,2003}$=0.12 year^{-1}; $F_{C,2004}$=0.12 year^{-1}). The increased fishing mortality on spawners has affected the size-structure of the Presque Isle Harbor reefs lake trout. The proportion of large (> 700 mm) lake trout collected in MIDNR 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 11,000 fish (39,300 lb) per year during 2001 to 2005. Recreational effort has declined from 146,000 angler hours in 1986 to 37,400 angler hours in 2005.

Abundance of wild lake trout increased more than two-fold since 1975 and has averaged about 1 million fish (age 4 and older) from 1996 to 2005. Total biomass of age 4 and older lake trout averaged 3.2 million pounds from 1996 to 2005. Lake trout biomass declined from 4.5 million pounds in 1996 to 2.9 million pounds in 2005. Spawning stock biomass averaged 505,000 pounds during the last 10 years. Although lake trout abundance has increased since the mid-1970s, spawning stock biomass has declined due to significant decreases in growth.

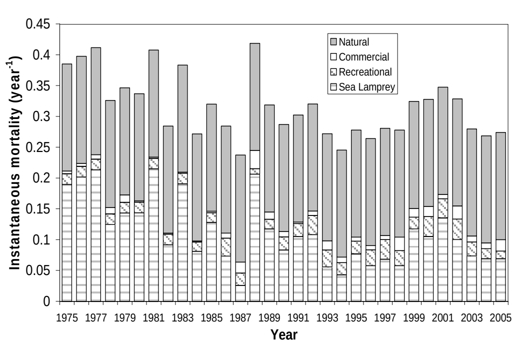




Apart from background natural mortality, sea lamprey-induced mortality was the dominant mortality source since 1975, although mortality from this source has declined since the late-1980s. With the exception 1988 and 2005, recreational fishing mortality has been higher than commercial fishing mortality. Average total annual mortality (A) for age-6 to -11 lake trout has declined from 33% during the period

1975-1977 to 24% during the period 2003-2005. Spawning stock biomass produced per recruit from 2003 to 2005 has been above the target minimum value indicating that mortality rates are not excessive and there is good population reproductive potential.

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



Notable stock dynamics

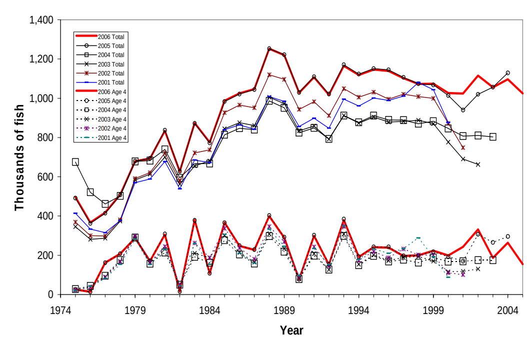
In contrast to the fall of 2000, 2003, and 2004 when the tribal commercial fishery was allowed to harvest lake trout during the spawning season through the end of October, the fall fishery was closed by mid-October in 2005. In all other years, there was a seasonal closure during the lake trout spawning 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

No major changes were made from last year's SCAA model.

As with last year's model, probability intervals were not able to be calculated 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 2006 model had consistent abundance estimates when compared to the 2005 model estimates; however, both the 2005 and 2006 models had higher abundance estimates than earlier assessment models. Nonetheless, there were no systematic temporal patterns in estimates of abundance across stock assessment models.

Retrospective comparison of lake trout abundance from all stock assessment models for MI-5



The recommended yield limit for 2006 in 1836 Treaty waters is 189,000 lb, allocated as 181,000 pounds for the State recreational fishery and 8,000 pounds for the tribal fishery, which was the actual harvest limit as well. This recommended yield limit was based on the target mortality rate of 45% defined in the Consent Decree, allocating 40% of the total yield to 1836 waters. Within 1836 waters, the recommended yield is allocated 95% to the State and 5% to the tribes. Note that this yield limit applies to wild and hatchery lake trout caught, whereas target mortality rates apply only to wild lean lake trout. In recent years wild lean lake trout 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	4.57 lb (SE 0.467)
	Current SSBR	1.84 lb (SE 0.17)
	SSBR at target mortality	0.435 lb (SE 0.011)
Spawning potential reduction		
	At target mortality	0.403 (SE 0.018)
Average yield per recruit		0.569 lb (SE 0.065)
Natural Mortality (M)		0.174 y^{-1}
Fishing Mortality		
	Age of full selection Commercial Fishery	10
	Age of full selection Sport fishery (2003-	8
	Commercial Fishing (average 2003-2005,	0.012 y^{-1} (SE 0.002)
	Sport fishery F (average 2003-2005,	0.017 y^{-1} (SE 0.002)
Sea lamprey mortality (ML)		
	(average ages 6-11,2003-	0.056 y^{-1}
Total mortality (Z)		
	(average ages 6-	0.26 y^{-1} (SE 0.009)
Recruitment (age-4)		
	(1996-2005 average)	224,040 fish (SE 31,303)
Biomass (age 3+)		
	(1996-2005 average)	3,237,300 lb (SE 376,310)
Spawning biomass		
	(1996-2005 average)	505,330 lb (SE 62,457)
MSC recommended yield limit for 2006		189,000 lb
Actual yield limit for 2006		189,000 lb

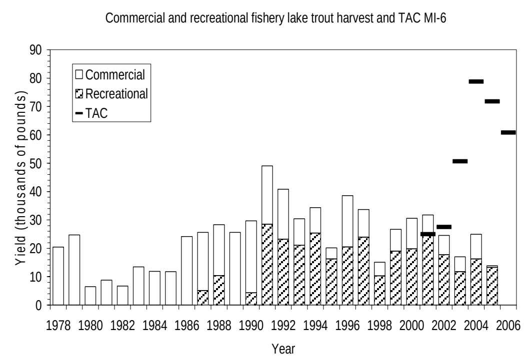
MI-6 (Au Train - Munising)

Prepared by Shawn P. Sitar and John K. Netto

Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 1.8 million acres. This management unit includes Big Reef, an offshore reef complex about 20 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.

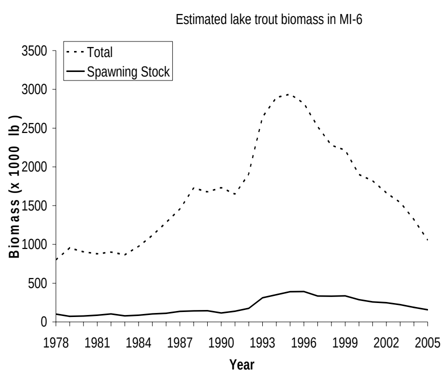
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is centered east of Grand Island. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout increased through the 1980's following the population increase at the time. Commercial yield and effort decreased in the early 1990's and maintained this low level until the present. Yield peaked in 1989 at 25,600 pounds and declined to an average of 4,800 pounds during the period from 2003 to 2005. In 2005, commercial yield and effort were the lowest in the time series with only 600 pounds harvested from 33,000 feet of gill-net effort.

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 through the late 1980's and early 1990's. In 1987, 971 lake trout were harvested while the harvest over the last ten years has ranged from 3,545 to 5,339 lake trout. Recreational fishery harvest averaged 4,140 fish per year from 2003 to 2005. In the last five years, wild fish composed nearly all (> 95%) of the total recreational harvest of lean lake trout. The remainder was of hatchery origin. Recreational lake trout targeted effort has declined from a peak of 39,000 angler hours in 1993 to 22,200 angler hours in 2005.

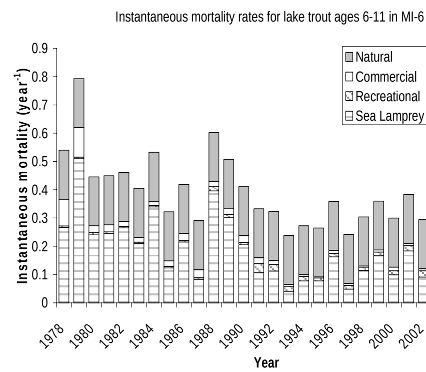


Excluding background natural mortality, sea lamprey predation was the highest mortality source for age 6 to 11 lake trout in MI-6 and has been increasing in recent years. Recreational fishing mortality has been higher than commercial fishing mortality since 1991. Fishing mortality has been relatively stable since the early 1990's and has shown further decline in recent years. During 1978 to 2000, total annual mortality (*A*) was the highest in 1979 at 56% and declined to 21% in 1993. Subsequently, *A* increased to an average of 34% during 2003 to 2005. Mortality has been increasing in recent years primarily due to the increase in sea lamprey mortality. Our sea lamprey mortality estimate for 2004 was the highest level since 1989.

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.

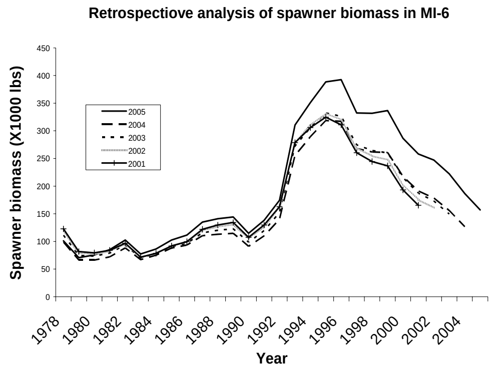


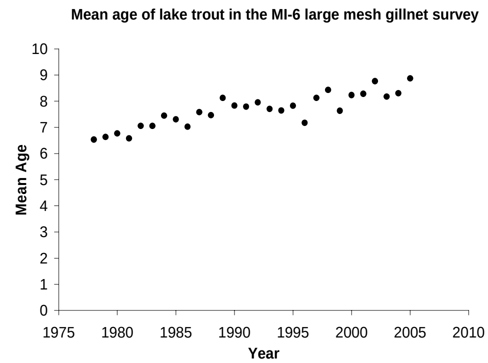
The recommended yield limit for 2006 is 61,000 pounds, of which 30,500 pounds is allocated for State recreational yield and 30,500 pounds for tribal commercial yield. These were the actual yield limits as well. While mortality rates apply only to wild lean lake trout, the yield limit includes both wild and hatchery lean lake trout. In calculating the limit, the Modeling Subcommittee assumed that 2% 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.



Model Diagnostics

The SCAA model for MI-6 is the most problematic lake trout model used by the MSC. Confidence in this model is consistently rated as low. Since 2003, we've set large-mesh survey catchability at the value estimated for MI-5 to reduce the parameter load and stabilize the model's solution. The model in its current form does converge to a single solution and is not sensitive to starting conditions. The model requires tight bounds on some of the selectivity parameters to converge. Retrospective analyses on this model indicate a trend in recent years. Each year we run the model, we estimate higher abundances than previous model runs.





Even with the low level of confidence we have in the model, we believe it is unlikely that the stock is being over-fished. Extractions from the fisheries, which are well below the imposed harvest limits, are low relative to the time series. The gill-net surveys conducted by MDNR do not indicate any major decrease in the adult population.

Model predictions and the age-composition data do not indicate a population that is decreasing in age. Mean age has been steadily increasing in the surveys, which could be a function of an aging population and/or delayed recruitment to the gear because of decreased growth rates. Also, size at age has decreased over the last ten years, which may indicate that factors other than adult mortality could be influencing the productivity of the population.

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	4.418 lb (SE 0.536)
Current SSBR	0.77 lb (SE 0.07)
SSBR at target mortality	0.400 lb (SE 0.012)
Spawning potential reduction	
At target mortality	0.175 (SE 0.009)
Average yield per recruit	0.150 lb (SE 0.034)
Natural Mortality (M)	0.173 y^{-1}
Fishing Mortality	
Age of full selection Commercial Fishery (2003-2005)	8
Age of full selection Sport fishery (2003-2005)	8
Commercial Fishing mortality (F) (average 2003-2005, ages 6-11)	0.006 y^{-1} (SE 0.002)
Sport fishery F (average 2003-2005, ages 6-11)	0.019 y^{-1} (SE 0.005)
Sea lamprey mortality (ML) (average ages 6-11,2003-2005)	0.174 y^{-1}
Total mortality (Z) (average ages 6-11,2003-2005)	0.372 y^{-1} (SE 0.012)
Recruitment (age-4) (1996-2005 average)	98,435 fish (SE 21,483)
Biomass (age 3+) (1996-2005 average)	1,912,500 lb (SE 407,480)
Spawning biomass (1996-2005 average)	275,060 lb (SE 64,389)
MSC recommended yield limit in 2006	61,000 lbs.
Actual yield limit in 2006	61,000 lbs.

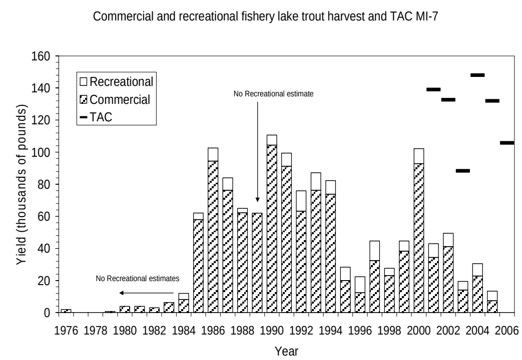
MI-7 (Grand Marais)

Prepared by Shawn P. Sitar and John K. Netto

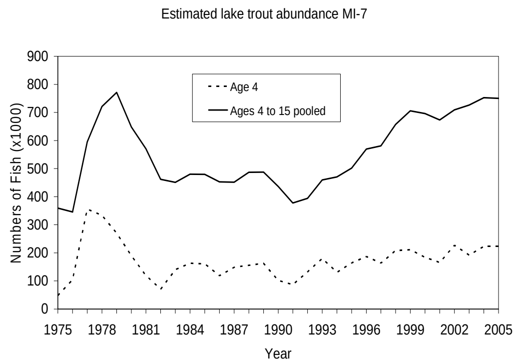
Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 987,000 acres. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There is approximately 92,000 acres of lean lake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

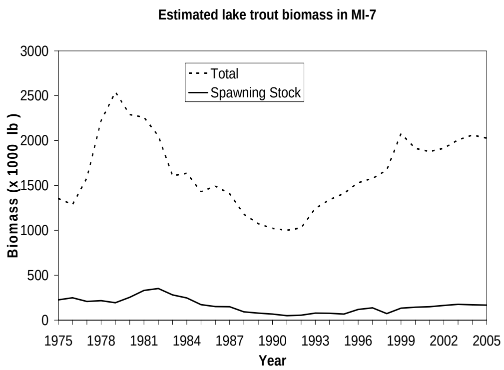
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is mostly based out of Grand Marais. This fishery mainly targets lake whitefish with lake trout as bycatch. Between 1976 and 2005, tribal commercial yield of wild lake trout peaked in 1990 at 104,400 pounds and declined to 12,400 pounds in 1996. In the last three years, average yield was 14,800 lb. In recent years, yield of wild lean lake trout composed about 56% of the total lake trout yield, with the rest consisting of siscowet (41%) and hatchery lake trout (3%). Tribal large-mesh gill-net effort has shown the same temporal pattern as commercial yield, with a peak effort of 8.2 million ft in 1990. Total annual effort from 2003 to 2005 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 2003 to 2005 was 1,800 fish (6,300 lb). The average sport effort for the same time period was 18,000 angler hours.

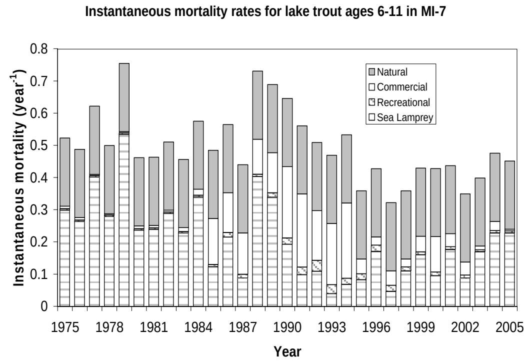


Abundance of age-4 and older wild lake trout averaged 682,000 fish from 1996 to 2005. In the same time period, recruitment at age 4 averaged 198,000 fish. Stock size has increased steadily since 1991 corresponding with a modest decline in total mortality. Both sea lamprey-induced and commercial fishing mortality declined significantly in the first half of the 1990s. Spawning stock biomass averaged 143,000 pounds during the last ten years and represented 8 % of total stock biomass.





Sea lamprey predation has generally been the dominant mortality source for lake trout in MI-7 except 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 from 1995 to 1998, but has increased since 1998. Sea lamprey mortality has increased by more than two fold since 1997 and has nearly tripled since 2002. From 1975 to 1979, total annual mortality (*A*) for age-6 to -11 lake trout averaged 44%. During the last five years, average *A* was 34%. The current spawning stock biomass per recruit (SSBR) estimate for MI-7 is above the target value, indicating that mortality rates are not exceeding the target.



<u>Notable stock dynamics</u>

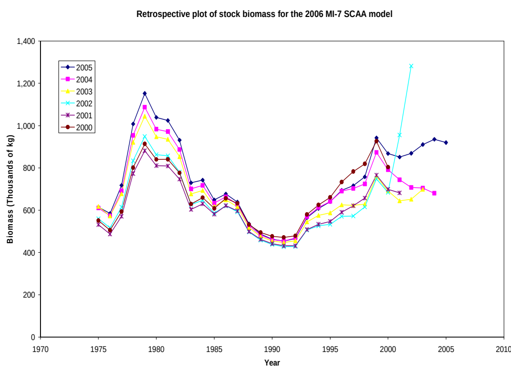
No commercial monitoring data were available for 2004 and 2005. Total commercial yield declined to near zero in 2005. Recent increases in sea lamprey-induced mortality have caused the reduction in TAC despite model predictions of increasing trends in stock size.

<u>Model changes:</u>

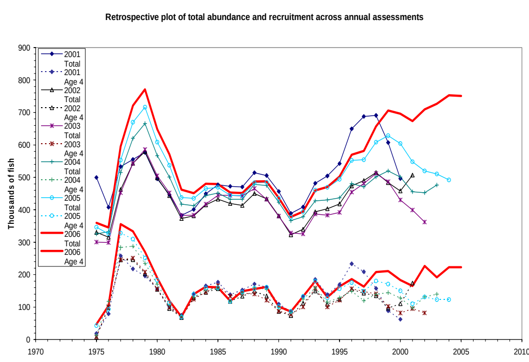
No structural changes were made to the MI-7 SCAA model for the 2006 assessment.

<u>Diagnostics and uncertainty:</u>

The final 2006 model reached convergence with acceptable maximum gradient components, and reasonable asymptotic standard errors on parameter estimates. No major patterns in residuals were observed for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all variables evaluated. In the retrospective analysis of the 2006 model, there were no systematic temporal patterns in biomass estimates, though there were modest differences in biomass estimates for recent years. With the addition of 2005 data to the model, biomass estimates were much higher for 2000-2005.



When comparing the 2006 model results with previous assessment results, there was a modest difference in the current model's estimate of abundance during the last ten years. There were no systematic patterns when comparing year 2000 abundance estimates from the past six stock assessments. However, there were major departures between abundance estimates and assessments for 2003 and 2005,



The recommended yield limit for the year 2006 is 105,700 pounds with 31,700 pounds allocated for State recreational yield and 74,000 pounds for tribal commercial yield. The actual yield limit, based on limiting change to -15% of the 2005 harvest limit, was 112,200 pounds with 33,700 allocated for State recreational yield and 78,500 pounds 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	3.535 lb (2.726-4.449)
Current SSBR	0.77 lb (0.645-0.914)
SSBR at target mortality	0.514 lb (0.477-0.548)
Spawning potential reduction	
At target mortality	0.219 (0.200-0.242)
Average yield per recruit	0.114 lb (0.062-0.167)
Natural Mortality (M)	0.212 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2003-2005)	9
Age of full selection	
Sport fishery (2003-2005)	8
Commercial Fishing mortality (F)	
(average 2003-2005, ages 6-11)	0.015 y^{-1} (0.008-0.023)
Sport fishery F	
(average 2003-2005, ages 6-11)	0.006 y^{-1} (0.003-0.009)
Sea lamprey mortality (ML)	
(average ages 6-11,2003-2005)	0.175 y^{-1}
Total mortality (Z)	
(average ages 6-11,2003-2005)	0.408 y^{-1} (0.385-0.434)
Recruitment (age-4)	
(1996-2005 average)	198,300 fish (139,036-356,339)
Biomass (age 3+)	
(1996-2005 average)	1,866,000 lb (1,371,440-3,325,660)
Spawning biomass	
(1996-2005 average)	142,900 lb (97,786-278,961)
MSC recommended yield limit in 2006	105,700 lb
Actual yield limit in 2006 (15% rule)	112,200 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 had 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.

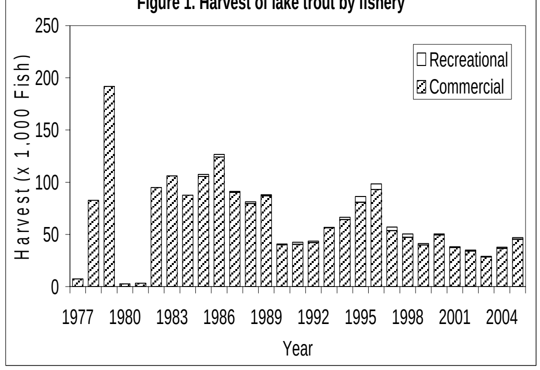
There is little or no natural recruitment of lake trout in northern Lake Huron, although recent indicators (increased trawl catches of age-0, increased CPUE's of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually stocks lake trout in MH-1. From 2001 to 2005, approximately 495,000 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 2005, approximately 467,000 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 482,000 yearling lake trout recruits in MH-1 for 2005.

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 2001 to 2005, tribal commercial yield of lake trout averaged 125,000 lb, while Canadian commercial yield averaged 24,000 lb. Due to a 400-pound 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 2005 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 6.3 million ft from 2001 to 2005, while Canadian large-mesh gill-net effort averaged 1.8 million ft. With the implementation of the 2000 Consent Decree, tribal large-mesh gill-net effort has declined in MH-1. Large-mesh gill-net effort in 2005 was 8.3 million ft less (62%) than the 2000 effort level. Lake trout harvest in large-mesh gill nets initially decreased under the Decree, but the 2004 and 2005 large-mesh gill-net harvests exceeded the 2000 harvest.

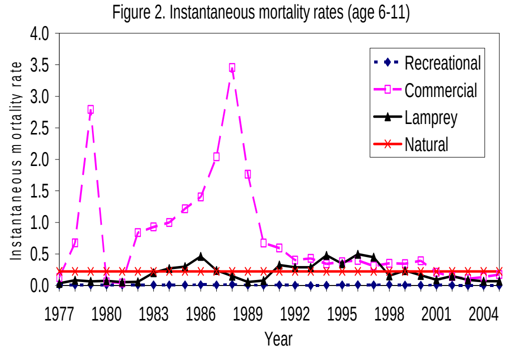
The State-licensed recreational fishery in MH-1 is composed of both charter and non-charter anglers. Lake trout are caught as bycatch by salmon anglers, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty-ceded waters. Recreational harvest represents a small portion of the total fishery harvest in MH-1 (Figure 1). From 2001 to 2005, recreational yield of lake trout averaged 3,000 lb. In 2005, recreational harvest was 4,400 pounds 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, 2004, and 2005 State harvest includes an estimate of throwback mortality.

Figure 1. Harvest of lake trout by fishery



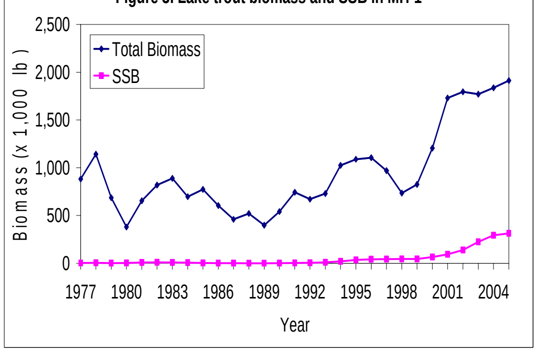
Instantaneous mortality rates have been variable and relatively high in northern Lake Huron (Figure 2). From 1977 to 1990, commercial fishing mortality was the leading source of lake trout mortality. After 1990, commercial fishing mortality decreased as sea lamprey-induced mortality increased. Sea lampreys were the largest source of lake trout mortality in the 1990s, until 1998 when sea lamprey-induced mortality decreased. From 2001 to 2005 sea lamprey-induced instantaneous mortality averaged 0.09 y^{-1}, and commercial fishing instantaneous mortality averaged 0.15 y^{-1}. Sea lamprey-induced mortality rates for age-6 to 11 lake trout in 2005 decreased 76% from the average of 1994-1998 levels. This decline is due to the treatment of the St. Marys River and subsequent reduction in parasitic phase sea lamprey. Recreational fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron (Figure 2).

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



In the 1980's and early 1990's, 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 2005 lake trout biomass was 1.91 million lb, well above the most recent 20-year average of 1,033,000 lb, and the highest level in the modeled time series. However, total 2005 SSB was only 313,000 pounds indicating the majority of lake trout biomass in MH-1 is composed of young fish. Increases in abundance of older age classes will be needed to create a naturally-producing, self-sustaining stock.

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



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 290,200 pounds for MH-1 in 2006. 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 23,200 pounds to the State and 267,000 pounds to the tribes.

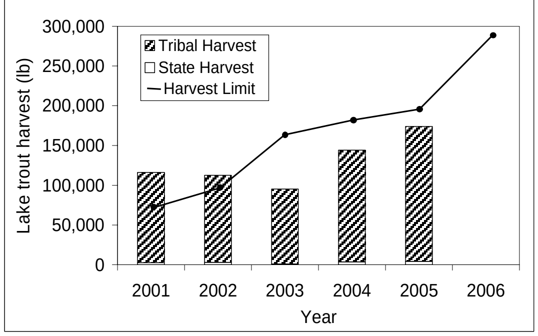
In 2001 the MH-1 harvest limit was calculated based on the phase-in requirements of the Consent Decree. In particular, it was based on the average effort from 1997 to 1999, either adjusted for gill-net operations converted to trap nets under provisions of the Consent Decree (tribal commercial fishery) 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. As a result, since February 2003 MH-1 harvest limits have been calculated using the Consent Decree specified interim target mortality rate for 2006-2011 of 47%, and the 2006 allocation percentage of 92% Tribal : 8% State.

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 lower than their respective harvest limits in 2005 (Figure 4). In general, total harvest in this unit has increased under the 2000 Consent Decree, as has the total harvest limit. This is due to increased lake trout biomass due to reductions in total annual mortality and increased stocking. The total harvest limit increased 95,700 pounds from 2005 to 2006. The magnitude of this increase from 2005 to 2006, after a period of relative stability from 2003 to 2005, concerns the Modeling Subcommittee, especially since an increase of similar magnitude did not occur in MH-2. The Modeling Subcommittee will explore methods used in the model to estimate survival and abundance of juvenile lake trout to determine if these estimated rates are appropriate.

Figure 4. Yearly harvest and harvest limits



Model changes

One major change was made to the model structure for this year's assessment. We modeled time varying selectivity in the spring survey as a random walk function, as opposed to a double logistic function in previous models, to improve model fit to the survey data.

Changes made for past TAC-year models were maintained in the current model. These changes include introducing time-varying maturity and weight-at-age in the model input data starting with the 2005 TAC-year model, and allowing the model to select the peak age of fishery selectivity, setting the under-reporting vector for the tribal commercial fishery to zero, and including release mortalities from the recreational fishery in harvest totals starting with the 2004-TAC year model.

Summary Status MH-1 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	1.08 lb
Age at first spawning	3 y
Size at 50% maturity	4.39 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	3.108 lb (2.585 – 3.667)
Current SSBR	0.910 lb (0.657 – 1.184)
SSBR at target mortality	0.547 lb (0.498 – 0.598)
Spawning potential reduction	
At target mortality	0.292 (0.233 – 0.350)
Average yield per recruit	0.454 lb (0.374 – 0.516)
Natural mortality (M)	0.223 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	9 y
Sport fishery (2003-2005)	6 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.138 y^{-1} (0.100 – 0.195)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.002 y^{-1} (0.001 – 0.005)
Sea lamprey mortality (ML)	
Average 2003-2005, ages 6-11	0.076 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.439 y^{-1} (0.395 – 0.507)
Recruitment (age-1)	
Average 1996-2005	421,640 fish (372,704 – 506,505)
Biomass (age 3+)	
Average 1996-2005	1,388,500 lb (1,164,560 – 1,660,620)
Spawning biomass	
Average 1996-2005	130,170 lb (99,607 – 162,475)
MSC recommended yield limit for 2006	290,200 lb
Actual yield limit for 2006	Not yet finalized

MH-2 (North-central Lake Huron)

Prepared by Aaron P. Woldt and Ji X. He

Lake trout management unit MH-2 is located in north-central Lake Huron. It includes statistical district MH-2 (grids 409-410, 509-512, 608-614, 709-715, 809-815, and 909-915 for a total of 1,521,520 acres) as well as adjacent Canadian waters (areas 4-2, 4-3, and 4-7 for a total of 1,526,460 acres). Michigan waters of the MH-2 unit include both 1836 Treaty-ceded waters (723,710 acres) and non-Treaty waters (797,810 acres), divided by a line running north-east from the tip of North Point to the international border. The Michigan ports of Presque Isle and Alpena are contained in this unit. The St. Marys River, connecting Lakes Superior and Huron, flows into northern Lake Huron in grid 306, to the north of this unit. The St. Marys River had supported large spawning runs of sea lamprey, and until the late 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.

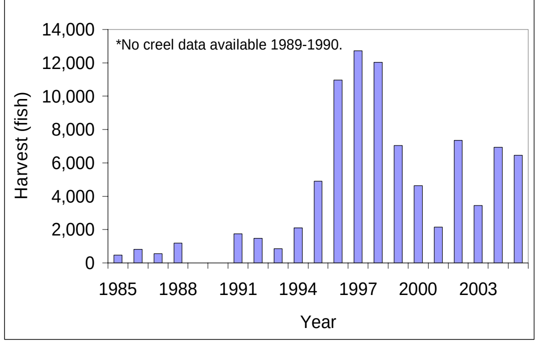
There is little or no natural recruitment of lake trout in north-central Lake Huron, although recent indicators (increased trawl catches of age-0, increased CPUE's of unclipped, spawning adults) suggest natural recruitment may be on the rise. As a result, nearly all of the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually stocks lake trout in MH-2. From 2001 to 2005, approximately 374,000 yearling lake trout per year were planted annually in near-shore areas of MH-2. No lake trout were stocked offshore on Six Fathom Bank/Yankee Reef in 2005. 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, fish may again be stocked on the mid-lake reefs. Approximately 92,000 yearling lake trout were stocked annually in Canadian management area 4-3 from 2001 to 2005. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 370,000 yearling lake trout recruits in MH-2 for 2005.

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.

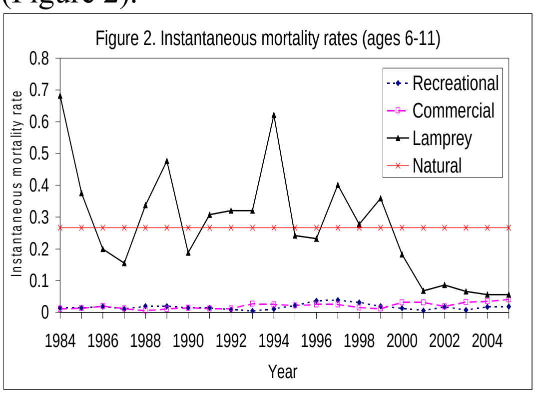
There is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-2 (areas 4-2, 4-3, and 4-7) that we included in our assessment. From 2001 to 2005, total Canadian commercial lake trout yield in these areas averaged 73,000 pounds per year. The majority of this yield came from the large-mesh gill-net fishery. Canadian large-mesh gill-net effort averaged 9.2 million ft per year from 2001 to 2005. Canadian large-mesh gill-net effort in waters adjacent to MH-2 increased starting in 1999, and stabilized in recent years at its highest levels during the 1984-2005 modeled time series.

The State-licensed recreational fishery in MH-2 is composed of both charter and non-charter anglers. Lake trout are caught as bycatch by salmon anglers, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty-ceded waters. The magnitude of recreational harvest varies from year to year and has averaged 5,300 fish from 2001 to 2005 (Figure 1). From 2001 to 2005, recreational yield of lake trout averaged 26,300 lb, and in 2005 recreational harvest was 27,900 pounds 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, 2004, and 2005 State harvest includes an estimate of throwback mortality (i.e. fish that were thrown back but later died due to handling).

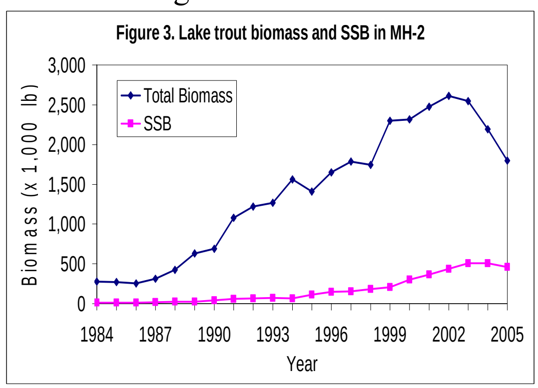
Figure 1. Recreational fishery lake trout harvest



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 2001 to 2005, sea lamprey-induced mortality averaged 0.07 y^{-1}, and sea lamprey-induced mortality rates have been declining drastically since 1999. Sea lamprey-induced mortality rates for age- 6 to -11 lake trout in 2005 decreased 84% from the average of 1994-1998 levels, and are now at their lowest levels since 1984. This decline is due to the treatment of the St. Marys River and subsequent reduction in parasitic phase sea lamprey. Recreational and commercial fishing mortality were low in most years relative to sea lamprey-induced mortality; however, increases in commercial harvest of lake trout in Canadian waters have caused the commercial fishing mortality rate to increase since 1999 (Figure 2).



Past high rates of sea lamprey-induced mortality in most years caused the age structure in north-central Lake Huron to be truncated just before the age of first maturity. As a result, spawning stock biomass (SSB) is low in north-central Lake Huron (Figure 3). Total lake trout biomass steadily increased from 1984 to 2003, but declined in 2004 and 2005. Total biomass averaged 2.32 million pounds from 2001 to 2005. SSB increased every year from 1984 to 2004, with a slight decline in 2005. Both total lake trout biomass and SSB remain at high levels relative to the modeled time series (1984-2005). Much of this increase is due to lower rates of sea lamprey-induced mortality and increased stocking in MH-2. Total SSB in 2005 was 462,000 pounds (roughly 26% 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.



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 96,800 pounds for MH-2 in 2006. The yield limit, based on limiting change to -15% of the 2005 harvest limit, would be 118,800 pounds with 112,800 allocated for State recreational yield and 6,000 pounds for tribal commercial yield; however, harvest limits were not finalized when this report was completed. This harvest limit was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the State and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the

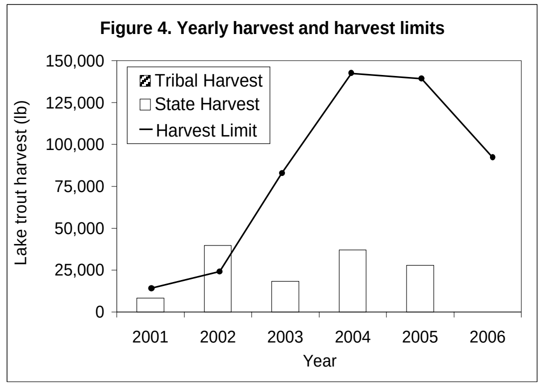
Consent Decree. Based on these calculations, the total yield was allocated 92,000 pounds to the State and 4,800 pounds to the tribes.

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 2005. 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 2005 (Figure 4). No tribal harvest was reported in MH-2 in 2005. All tribal fishers in MH-2 fish trap nets and are required to release all lake trout regardless of condition.

The total MSC recommended harvest limit decreased significantly from 2005 to 2006 (Figure 4). Section VII.A.6 of the Consent Decree states that for fully phased in units "changes in harvest limits from year to year shall not result in adjustments greater than a fifteen percent (15%) increase or decrease from the previous year in that unit, unless all parties agree that a greater change is appropriate." For MH-2 in 2006, the parties have not yet agreed whether to accept the MSC recommended harvest limit or invoke the 15% rule to limit the harvest limit decline to a level 15% below the 2005 harvest limit. Invoking the 15% rule would result in a 2006 harvest limit of 112,795 pounds for the State and 5,950 pounds for the tribes.

The large increases in harvest limits from 2001 to 2004 were due to large scale declines in sea lamprey-induced mortality rates during 2000-2004. The plateau and decline in harvest limit in 2005 and 2006 is likely due to declined growth rate and reduced biomass, but could indicate that this unit is approaching an asymptote in its harvest limit. We will continue to monitor the lake trout population dynamics in this unit in the future.



<u>Model changes</u>

One major change was made to the model structure for this year's assessment. We modeled time-varying selectivity in the spring survey as a random walk function, as opposed to a double logistic function in previous models, to improve model fit to the survey data.

Changes made for past TAC-year models were maintained in the current model. These changes include introducing time-varying maturity and weight-at-age in the model input data starting with the 2005 TAC-year model, and allowing the model to select the peak age of fishery selectivity, setting the under-reporting vector for the tribal commercial fishery to zero, and including release mortalities from the recreational fishery in harvest totals starting with the 2004-TAC year model.

Summary Status MH-2 Lake Trout	Value (95% probability interval)
Female maturity	
Size at first spawning	0.82 lb
Age at first spawning	3 y
Size at 50% maturity	4.46 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	1.926 lb (1.339 – 2.450)
Current SSBR	0.950 lb (0.624 – 1.271)
SSBR at target mortality	0.655 lb (0.526 – 0.756)
Spawning potential reduction	
At target mortality	0.492 (0.437 – 0.546)
Average yield per recruit	0.187 lb (0.144 – 0.224)
Natural mortality (M)	0.267 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	5 y
Sport fishery (2003-2005)	6 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.036 y^{-1} (0.024 – 0.055)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.014 y^{-1} (0.010 – 0.023)
Sea lamprey mortality (ML)	
Average 2003-2005, ages 6-11	0.059 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.376 y^{-1} (0.343 – 0.431)
Recruitment (age-1)	
Average 1996-2005	429,410 fish (386,079 – 557,607)
Biomass (age 3+)	
Average 1996-2005	2,141,300 lb (1,667,450 – 2,683,820)
Spawning biomass	
Average 1996-2005	326,830 lb (226,062 – 425,748)
MSC recommended yield limit for 2006	96,800 lb
Actual yield limit for 2006	Not yet finalized

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

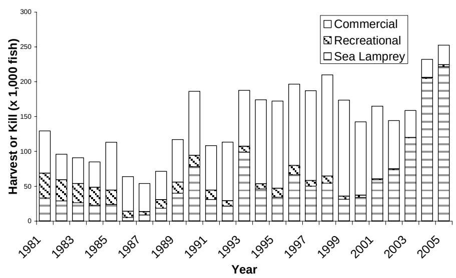
Lake trout management unit MM-123 is made up of statistical districts MM-1, MM-2 and MM-3 and encompasses Michigan's waters of northern Lake Michigan and northern Green Bay. This management unit covers 5,000 square miles. Water depths in more northern waters are for the most part less than 150 feet, 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 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 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. 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 635,261 yearling lake trout have been stocked into northern Lake Michigan and approximately 81 percent 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 1996 to 2005 the recruitment of stocked lake trout to age one has averaged 630,180 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 by-catch. 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, and in the recent 3 yrs greater, numbers of lake trout relative to commercial fisheries (~100,000 – 220,000 fish).

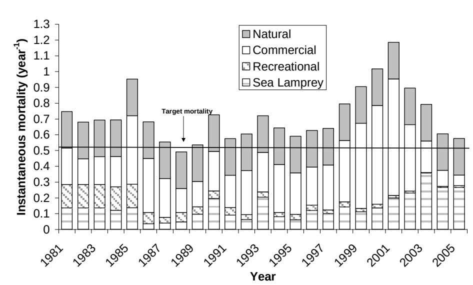
Fig. 1. Number of lake trout killed by source in MM-123



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. Commercial yield increased from 353,280 pounds in 1991 to 880,257 pounds in 1999. After the implementation of the 2000 Consent Decree, commercial yield of lake trout has continuously decreased to a low of 105,491 pounds in 2004. Large-mesh gill-net effort in tribal fisheries declined from 23 million feet in 1992 and 1993 to 4.3 million feet in 2005. The number of lake trout harvested from MM123 by the commercial fishery increased from 1991 (62,000 fish) to 1998 (144,000 fish). More recently, following implementation of the 2000 Consent Decree, the number of lake trout harvested by the commercial fishery has declined to an all time low of 24,000 fish in 2004, up only slightly in 2005 to 27,000 fish (Figure 1). In 2005, the commercial yield of lake trout in this unit was less than the phased-in TAC and greater than the non-phased TAC allocation (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 decline in recreational yield resulted. In 2003, the bag limit was raised from 2 to 3 fish, and appears to have had little effect on harvest. The recreational yield of lake trout declined by over 97 percent from 1998 (75,820 lb) to 2003 (2,000 lb). Yield was up slightly in 2005 to 12,500 lb. The number of lake trout harvested followed similar patterns to those described for yield. More recent declines in harvest and yield are due in part to declines in recreational fishing effort. The number of angler hours decreased by nearly 40 percent from 123,000 in 1998 to 74,000 in 2003. A slight positive trend has been observed through 2005 to 101,000 angler hours, likely the result of improved fishing for Chinook salmon in the recent few years.

Fig. 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. Since 2003, sea lamprey mortality has exceeded other sources and was estimated to be 0.27 year^{-1} in 2004. Estimates of sea lamprey induced mortality have been higher during the most recent two years (2003 and 2004) than observed during the previous sixteen years (Figure 2).

In northern Lake Michigan, lake trout generally are both spawning and recruited into commercial and recreational fisheries by age 7 (Summary table). The biomass of lake trout in northern Lake Michigan had nearly quadrupled from 1986 to 1995 increasing from 0.9 to 3.8 million pounds. After 1995, the biomass of lake trout steadily decreased until 2001. In 2001, biomass levels were almost half those observed in 1995 (Figure 3). From 2001 to 2005, the biomass of lake trout has increased to 3.1 million pounds. Spawning biomass showed similar though less pronounced patterns in abundance with a slight increase in recent years.

The spawning stock biomass produced per recruit (including the refuge population) during 2005 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 (see also Fig 2).

The yield limit for 1836 Treaty waters in 2006 is 14,000 for the State recreational fishery and 453,000 pounds for the tribal commercial/subsistence fishery, for a combined yield of 467,000 pounds. For the tribal fishery these values reflect phase-in requirements specified in the 2000 Consent Decree, while for the State fishery they reflect the results of the April 4, 2007 Court Order. 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 2006, recommended commercial yields represented the average of the yield from 1997 to 1999 less the reduction due to gill-net conversions in the area (453,000 pounds tribal) as per Consent Decree specifications. This specific phase-in option allows for temporary increases in mortality above the 40% target (Figure 4). The model-generated harvest recommendations are extremely low because the combination of sea lamprey-induced and natural mortality are so close to the mortality limits that there is little left to allocate to the fishery. In 2007, harvest limits for 2005 and 2006 were re-assessed, and the phase-in period extended until lamprey mortality is below the 1998 baseline for three consecutive years. Limits for the State fishery in 2005 and 2006 are equal to 10 percent of the average tribal harvest during the previous three years (17,400 pounds in 2005 and 14,000 pounds in 2006).

Fig. 3. Estimated lake trout biomass in MM-123

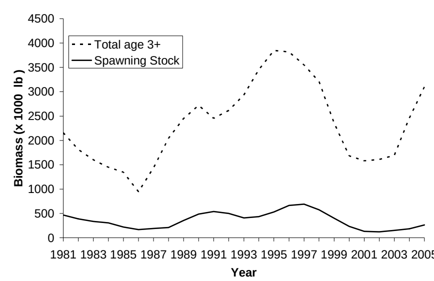
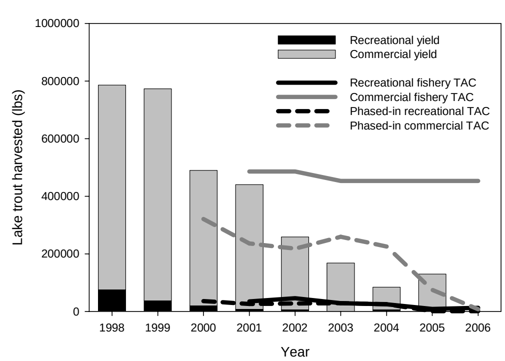


Fig. 4. Comparison of actual harvest vs. TAC decision vs. model recommendation



Model evaluation and changes:

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass estimates for recent years exist. With the addition of 2005 data to the model, biomass estimates were slightly lower for 2001-2005 compared to model runs in previous years.

Summary Status MM-123	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.95 lb
Age at first spawning	3 y
Size at 50% maturity	5.47 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	5.73 lb (4.91 – 6.66)
Current SSBR combined w/ refuge	0.98 lb (0.81 – 1.17)
SSBR at target mortality	1.78 lb (1.56 – 2.04)
Spawning potential reduction	
At target mortality	0.312 (0.280 – 0.347)
Average yield per recruit	0.323 lb (0.262 – 0.392)
Natural mortality (M)	0.232 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	7 y
Sport fishery (2003-2005)	7 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.127 y^{-1} (0.089 – 0.175)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.007 y^{-1} (0.005 – 0.011)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.285 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.652 y^{-1} (0.610 – 0.704)
Recruitment (age-1)	
Average 1996-2005	630,180 fish (443,133 – 896,527)
Biomass (age 3+)	
Average 1996-2005	2,790,609 lb (2,374,160 - 3,300,120)
Spawning biomass	
Average 1996-2005	339,717 lb (292,714 – 395,451)
MSC recommended yield limit in 2006	8,388 lb
(based on fully-phased rates)	
Actual yield limit in 2006	467,000 lb
(April 4, 2007 Court Order)	

MM-4 (Grand Traverse Bay)

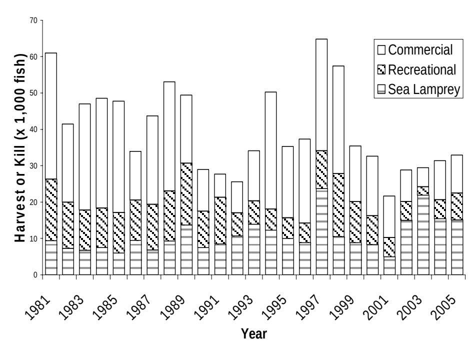
Prepared by Jory L. Jonas, John K. Netto, and Erik J. Olsen

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

The recruitment of lake trout in Grand Traverse Bay is based entirely on stocking. The U.S Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. In each of the last ten years, on average, 235,000 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 (1996-2005) the recruitment to age one has averaged 195,030 fish in the Grand Traverse management unit (Summary table).

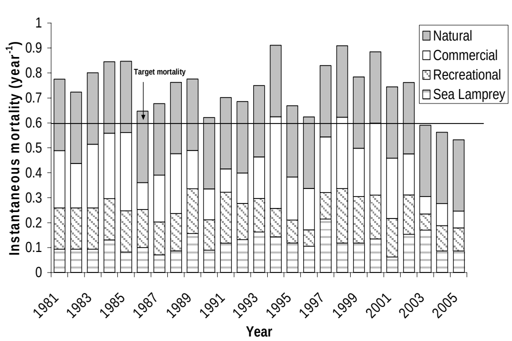
From 1994 until 2001 more lake trout were killed by commercial fishing than by either sea lampreys or sport fishing, averaging 22,000 fish (Figure 1). By 2003, the number of lake trout killed by commercial fishing had declined to less than 5,200 fish y^{-1}. The harvest of lake trout has increased in recent years to slightly above 10,400 fish y^{-1}. Commercial fishing mortality in Grand Traverse Bay peaked in 1994 (0.37 y^{-1}), and remained relatively stable through 2002 averaging 0.22 y^{-1}. Mortality has been significantly lower during the last three years (2003 to 2005) averaging 0.08 y^{-1} (Figure 2).

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



Only Chippewa Ottawa Resource Authority licensed tribal fishermen commercially harvest fish in this management unit. There are three types of tribal commercial fisheries, large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery while primarily targeting lake whitefish is responsible for the greatest number of harvested lake trout. The commercial harvest of lake trout in tribal large-mesh gill-net fisheries rose from a low of 6 thousand fish in 1991 to 33 thousand fish harvested in 1998. Harvest declined dramatically to 5 thousand fish in 2003, and has increased to 10,300 fish in 2004 and 2005. Accordingly, yield of lake trout captured in tribal commercial fisheries peaked in 1998 at 161,000 pounds and declined by nearly 86% to 23,000 pounds in 2003. Yield increased slightly in recent years to 42,000 pounds in 2005. Large-mesh gill-net effort in tribal fisheries has declined from 2 million feet in 1996 to only 0.55 million feet in 2005. Reduced levels of commercial lake trout harvest in the Grand Traverse Bay management unit had been expected due to conversion of the regions largest gill-net fishers to trap-net operations.

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

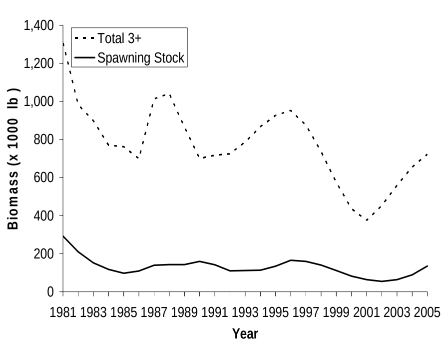


The management of recreational fisheries for lake trout is the primary responsibility of the State of Michigan and fisheries are comprised of both charter and sport anglers. The sportfishing harvest regulations in the Grand Traverse Bay management unit have changed significantly over the last 10 years, affecting recreational fishing mortality rates and harvest levels. From 1992 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 lengthened, so that it extended from Jan 1 through September 30 in contrast to the previous season of May 1 through Labor Day. Mid-way through the year in 1997 the minimum size limit was decreased to 20 inches and 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 have steadily declined from 1991 (0.20 y^{-1}) to 1996 (0.06 y^{-1}). Recreational fishing mortality averaged 0.18 y^{-1} from 1998 to 2002, declined to a low of 0.06 y^{-1} in 2003 and increased slightly to ~0.1 y^{-1} in 2004 and 5 (Figure 2). The estimated recreational yield of lake trout in Grand Traverse Bay had been consistent during the years 1992 to 1996 averaging 39,000 lb. In response, at least in part to reductions in size limits, the recreational yield of lake trout from 1996 to 1998 increased, reaching 93,000 pounds by 1998. Subsequently, yield declined each year to an all time low of 12,000 pounds in 2003 and has increased to 35,500 pounds in 2005. 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 7,000 fish in 2005 (Figure 1). Effort levels have remained relatively stable over the last 10 years (1996-2005), averaging 202 thousand angler hours per year (range=174-238 thousand 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 0.09 y^{-1}. Wounding rates increased to 0.21 y^{-1} in 1997, went down to 0.06 y^{-1} by 2001, and in recent years have been increasing, reaching 0.17 y^{-1} in 2003. However, lamprey wounding rates in 2004 are lower at 0.09 y^{-1}. In 2003, lampreys were estimated to have killed over 22,000 lake trout, whereas 15,000 were killed in 2004.

In the Grand Traverse Bay management unit, lake trout are recruited into sport fisheries and commercial fisheries by age 7. Female lake trout first spawn at age 3, and 50 percent or more are spawning by age 6. The total biomass of lake trout over age 3 peaked in 1987 at 1.0 million pounds. Biomass increased from a low of 700,000 pounds in 1990 to 953, 000 pounds in 1998. After which, biomass again declined to 376,000 pounds in 2001. In recent years the population appears to be recovering; biomass has increased to 722,000 pounds in 2005.

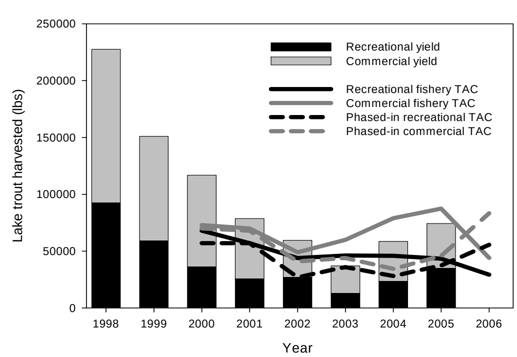
Fig. 3. Estimated lake trout biomass in MM-4



The spawning stock biomass produced per recruit is below the target value indicating that mortality rates exceeded targets in Grand Traverse Bay. The recommended harvest limit for 2006 in the Grand Traverse Bay management unit is 139,000 pounds, of which 83,400 pounds was allocated to the State recreational fishery and 55,600 pounds to the tribal commercial/subsistence fishery.

Grand Traverse Bay represents an area where unique phase-in requirements defined in the 2000 Consent Decree were considered in establishing yield limits (Figure 4). From 2001 to 2005 commercial limits are to be set in Grand Traverse Bay based on mean yield and effort values from 1997 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 were to be set to meet the target mortality rate for the management unit of 45%, with a 40 percent allocation to the State of Michigan and a 60 percent allocation to tribal fisheries. By decision of the parties, phase-in practices will continue to be used in 2006 to set TACs. Based on the January 9, 2006 Court Order, the tribal yield limit is 94,300 pounds, and the State yield limit is 44,300 pounds, for a total yield limit of 138,600 pounds.

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



Model evaluation and changes:

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates.

We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass estimates for recent years exist. Retrospective patterns in recruitment indicate that year class strength of a cohort does not stabilize until around age 5 in this SCAA model.

Summary Status MM-4	Value (95% probability interval)
Female maturity	
Size at first spawning	1.08 lb
Age at first spawning	3 y
Size at 50% maturity	6.21 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.306 lb (2.024 – 2.618)
Current SSBR	0.519 lb (0.449 – 0.598)
SSBR at target mortality	0.718 lb (0.655 – 0.784)
Spawning potential reduction	
At target mortality	0.312 (0.278 – 0.347)
Average yield per recruit	0.428 lb (0.385 – 0.476)
Natural mortality (M)	0.286 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	7 y
Sport fishery (2003-2005)	7 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.076 y^{-1} (0.057 – 0.101)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.085 y^{-1} (0.064 – 0.111)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.137 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.584 y^{-1} (0.545 – 0.629)
Recruitment (age-1)	
Average 1996-2005	195,030 fish (174,154 – 218,925)
Biomass (age 3+)	
Average 1996-2005	714,030 lb (630,392 – 804,831)
Spawning biomass	
Average 1996-2005	107,952 lb (93,303 – 124,248)
MSC recommended yield limit in 2006	73,400 lbs
(based on fully-phased rates)	
Actual yield limit in 2006	138,600 lbs
(based on January 9, 2006 Court Order)	

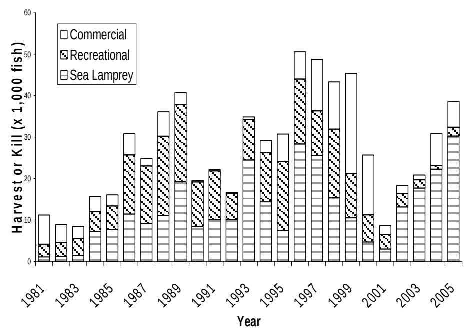
MM-5 (Leelanau Peninsula to Arcadia)

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

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

The recruitment of harvestable lake trout in the MM-5 management unit of Lake Michigan is based entirely on stocking. The U.S. Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. Over the last ten years, on average, 206,600 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 (1996-2005) the recruitment to age one has averaged 319,009 fish in MM-5.

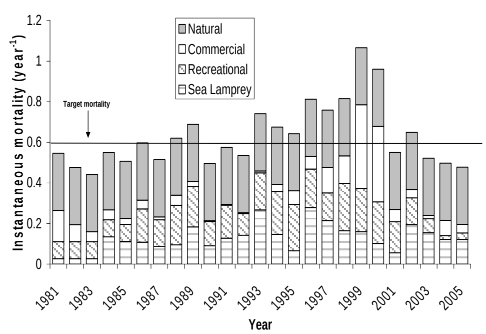
Fig. 1. Number of lake trout killed by source in MM-5



Although both State and tribal commercial fishermen harvest fish in the management unit, State-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish. State-licensed fishermen are not permitted to harvest lake trout, and as a result, are not included in lake trout harvest allocations. The Chippewa Ottawa Resource Authority oversees three types of tribal commercial fisheries in this area including large-mesh gillnet, small-mesh gillnet, and trap net. The large-mesh gillnet fishery, while primarily targeting lake whitefish, is generally responsible for the greatest number of harvested lake trout. The 2000 Consent Decree resulted in the conversion of the regions largest gill-net fishers to trap-net operations and recently the market value of lake trout has been low. As a result, commercial harvest and mortality of lake trout have decreased considerably. 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 0.41 and $0.37y^{-1}$, respectively. In 1999, over 24,000 fish were harvested in commercial fisheries. After the year 2000, the commercial harvest decreased significantly with only 1,200 lake trout harvested in 2003 and an associated mortality rate of $0.02y^{-1}$. In 2004 and 2005, harvest increased to 6,000 to 7,000 fish (Figures 1 and 2). The yield of lake trout in commercial fisheries rose precipitously from 3,800 pounds in 1993 to 184,900 pounds in 1999. From 2001 to 2003, the yield was extremely low, averaging 8,800 lb. In 2004 and 2005, yield has increased slightly averaging 28,400 lb. Large-mesh gill-net effort in tribal fisheries reflected patterns similar to those observed in mortality, harvest, and yield. Gill-net effort rose from 22,000 feet in 1993 to 2 million in 1999. From 2001 to 2003 gill-net effort averaged 115,000 feet of net and increased to over 500,000 feet in 2004 and 2005.

Recreational fisheries for lake trout are primarily managed by the State of Michigan and include both charter and sport anglers. From 1986 until 1999, recreational fishing mortality exceeded or equaled commercial fishing mortality in the MM-5 management unit. Mortality (averaged over ages 6-11) from recreational fishing has been declining since 1998 from $0.23y^{-1}$ to $0.02y^{-1}$ in 2004 and is up slightly in 2005 to $0.03y^{-1}$. The recreational fishery yield declined from 88,500 pounds in 1998 to 3,800 pounds in 2004. In 2005, the yield had increased to 12,500 lb. The number of lake trout harvested has also declined in recent years, dropping 96 percent between 1998 (18,000 fish) and 2004 (765 fish). In 2005, the number of fish harvested has increased to 2,100. Recreational fishing effort had been relatively consistent from 1995 to 1999 averaging 279 thousand angler hours. By 2001, angler effort had increased to 370 thousand angler hours. Angler effort declined to 180 thousand hours in 2003, and has increased in 2004 and 2005, averaging 255 thousand hours. 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 was extended in 2003, shifting from May 1 - Labor Day to May 1 - Sept 30 and the bag limit was raised from 2 to 3 fish.

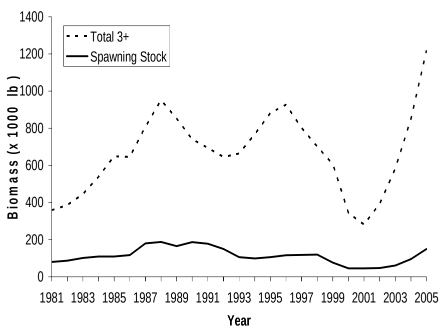
Fig. 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-5



From 1984 to 1992 sea lamprey mortality rates were relatively consistent averaging $0.12y^{-1}$. Rates increased to $0.27y^{-1}$ in 1993 declining over the next two years to $0.07y^{-1}$. Rates increased again in 1996 to 0.28 y^{-1} and steadily declined to $0.06y^{-1}$ in 2001. In 2002, rates rose again to $0.19y^{-1}$ and have declined slightly to $0.12y^{-1}$ in 2004 (Figure 2). Sea lampreys killed only 3,000 lake trout in 2001 and the number killed has increased to 30,300 in 2005. The U.S. Fish and Wildlife Service has initiated efforts to improve controls on lamprey populations in northern Lake Michigan which may have a positive effect on wounding rates in the MM-5 management unit.

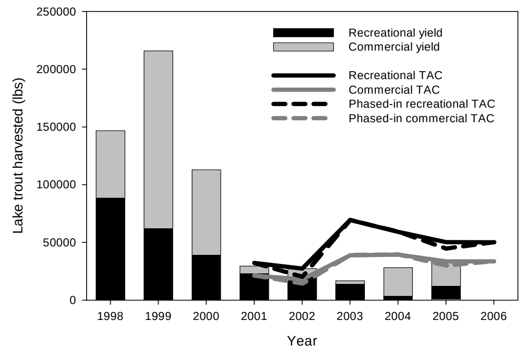
Fifty percent of lake trout are spawning by age 6 in MM-5. By age 8 they are fully recruited into commercial fisheries, and by age 12 into recreational fisheries. The biomass of lake trout older than age 3 was 926 thousand pounds in 1996, declining to 282,100 pounds in 2001 and has since increased to 1.2 million pounds in 2005 (Figure 3). The biomass of spawners has increased from 45,300 pounds in 2000 to 150,000 pounds in 2005.

Fig. 3. Estimated lake trout biomass in MM-5



The spawning stock biomass produced per recruit has been improving in this unit and is now above the target value, indicating that mortality is at acceptable levels in MM-5. The recommended yield limit for 2006 is 83,200 pounds, and is based on a target mortality rate of 45%. Of this yield, 49,900 pounds were allocated to the State recreational fishery and 33,300 pounds to the tribal commercial and subsistence fisheries. Allocations were based on a 60 percent allotment for the State of Michigan and 40 percent to tribal fisheries. The actual yield limit, based on the June 19, 2006 Court Order, is 89,100 pounds, of which 39,200 pounds is allocated for the tribal fisheries, and 49,900 pounds for the State fishery.

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



Model evaluation and changes:

For this year's assessment, the SCAA model reached convergence with acceptable maximum gradient components and reasonable asymptotic standard errors on parameter estimates. We did not observe any major patterns in residuals for fit to observed data sources. The MCMC simulations yielded good results without autocorrelations and no drift in the trace plots for all quantities evaluated. The retrospective analysis of this year's model did not show any systematic temporal patterns in biomass estimates, although modest differences in biomass estimates for recent years exist. Retrospective patterns in recruitment indicate that year class strength of a cohort does not stabilize until around age 5 in this SCAA model.

Summary Status MM-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	1.985 lb (1.736 – 2.263)
Current SSBR	0.730 lb (0.606 – 0.861)
SSBR at target mortality	0.639 lb (0.572 – 0.709)
Spawning potential reduction	
At target mortality	0.323 (0.296 – 0.350)
Average yield per recruit	0.163 lb (0.133 – 0.197)
Natural mortality (M)	0.281 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	8 y
Sport fishery (2003-2005)	12 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.046 y^{-1} (0.032 – 0.064)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.040 y^{-1} (0.028 – 0.056)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.157 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.512 y^{-1} (0.484 – 0.545)
Recruitment (age-1)	
Average 1996-2005	319,009 fish (261,270 – 388,436)
Biomass (age 3+)	
Average 1996-2005	750,157 lb (633,093 – 884,576)
Spawning biomass	
Average 1996-2005	89,620 lb (74,244 – 107,044)
MSC recommended yield limit in 2006	83,200 lb
Actual yield limit in 2006	89,100 lb
(Based on June 19, 2006 Court Order)	

MM-67 (Manistee - Ludington)

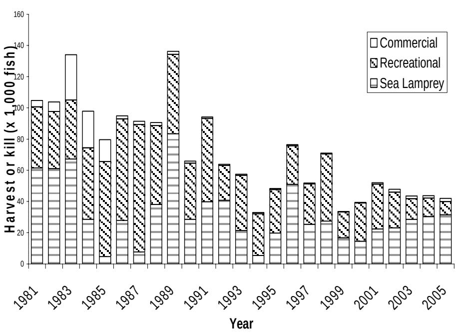
Prepared by Jory L. Jonas, John K. Netto, and Archie W. Martell Jr.

Lake trout management unit MM-67 is located in eastern central Lake Michigan, and is made up of statistical districts MM-6 and MM-7. The area covers Michigan's waters of Lake Michigan from Arcadia to Holland, extending to the State line bisecting the middle of the lake. The management unit covers a total area of 4,460 square miles, of which 930 square miles are less than 240 feet in depth. The northern section of the region (MM-6) is deeper ranging in depth from 0 up to 900 feet and is characterized by greater slope than the southern section (MM-7). For the most part, water depths in MM-7 are less than 400 feet. There are no islands or structures in southern Treaty waters, and there is little lake trout spawning habitat with the exception of offshore deepwater spawning reefs located within the mid-lake refuge. Stocked lake trout almost certainly attempt to spawn in the nearshore zones. However, the likelihood of successful recruitment is negligible. The southern Treaty management unit is not entirely comprised of 1836 waters, the northern section (MM-6) is entirely Treaty-ceded territory while only the northern two-thirds of the southern section (MM-7) is within Treaty territory. A total of 690 square miles in the unit are outside Treaty waters. A line running parallel to the northern side of the Grand River (located approximately ¾ of the way through grids in the 1900 series) out to the State line in the middle of the lake delineates the southern boundary of Treaty territories in the unit. Management unit MM-67 contains a portion of the deepwater mid-lake lake trout refuge, which comprises 850 square miles of the unit (grids 1606, 1607, 1706, 1707, 1806, 1807, 1906 and 1907). It is illegal for recreational, commercial and subsistence fishers to retain lake trout when fishing in the refuge area. Gill-net fishing (both commercial and subsistence) is prohibited in the refuge. Some State and tribal licensed commercial trap-net operations are permitted; however, the retention of lake trout is prohibited. As of 2004, there was no tribal commercial fishing effort in management unit MM-7 and limited tribal fishing existed in MM-6.

The recruitment of lake trout in the southern Treaty waters of Lake Michigan is based entirely on stocking. During the past ten years, an average of 204,400 yearling lake trout have been stocked into non-refuge southern Treaty waters, while an additional 282,000 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 319,800 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 2005, the commercial fishery in southern Treaty waters of Lake Michigan was comprised of one State-licensed commercial fisher, two permitted tribal trap-net operations, and two permitted tribal small-mesh gill-net operations. State and tribal commercial fisheries primarily target lake whitefish and chubs, tribal trap-net operations are allowed 100 pounds per day lake trout bycatch and State-licensed operations are not permitted to harvest lake trout. As a result, State commercial fishermen are not included in lake trout harvest allocations. The yield of lake trout in commercial fisheries has averaged 2,600 pounds over the last 20 years (1986-2005). During the recent three years (2003 to 2005) commercial fisheries on average have harvested 1,800 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.

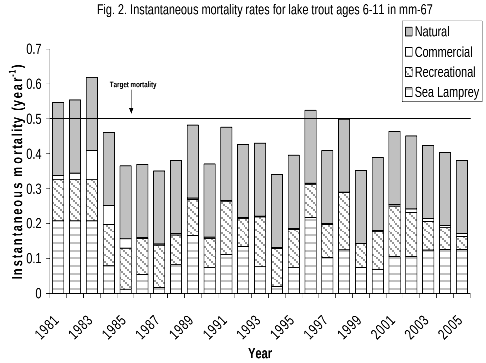
Fig. 1. Number of lake trout killed by source in mm-67



State recreational fisheries for lake trout are comprised of both charter and sport anglers. Recreational fishing mortality is generally higher than commercial fishing mortality (Figure 2). During the last five years, observed recreational fishing mortality rates have been declining from 0.14y^{-1} in 2001 to 0.04y^{-1} in 2005. The yield of lake trout in recreational fisheries has also declined from 177,800 pounds in 2001 to 45,600 pounds in 2005. The highest recreational yield was observed in 1987 at 474,400 lb. The numbers of lake trout harvested have declined by nearly 59 percent in recent years, from 28,700 fish in 2001 to 8,000 fish in 2005, a trend which is continuing since1987 (81,200 fish; Figure 1). Effort levels have been relatively consistent since 1990 averaging 1,176,000 angler hours. Size and bag limits did not change from 1981 until 2003. The fishing season had changed twice, once in 1984 which restricted it from the entire year to May 1 through August 15th, and again in 1989 when the season was extended through Labor Day. In 2003, the bag limit was increased from 2 to 3 fish, the minimum 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 0.22 during the last 20 years (Figure 2). In the recent four years (2002-2005), the number of lake trout killed by lampreys has averaged 28,400 fish (Figure 1).

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



The majority of lake trout in MM-67 are spawning by age 6, have recruited into recreational fisheries by age 7, and have recruited into commercial fisheries by age 8. The biomass of lake trout age 3 and older is high, averaging over 1.9 million pounds during the recent ten years (1996-2005; Figure 3). Spawning lake trout comprise a relatively high proportion of the total biomass in this unit (Figure 3), averaging over 498,000 pounds from 1996-2005.

The spawning stock biomass produced per recruit is above the target value, indicating that target mortality rates have been achieved in MM-67 (Summary table). The recommended yield limit for 2006 is 246,400 lb, of which 221,800 pounds is allocated to the State fishery and 24,600 pounds to the tribal fisheries. The actual yield limits were limited to -15% deviations from the 2005 harvest limits, resulting in a total yield limit of 312,200 pounds, of which 281,000 pounds is allocated for the State and 31,200 pounds if for the tribes. The yield limit and allocations in this management unit are set to achieve a total mortality rate target of 40% and establish a 90 percent allocation to the State of Michigan and a 10 percent allocation to tribal fisheries. Both recreational and commercial fisheries are well below established TAC levels (Figure 4).

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

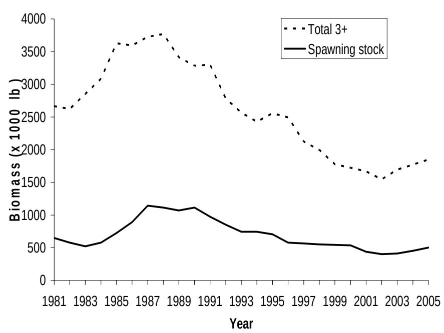
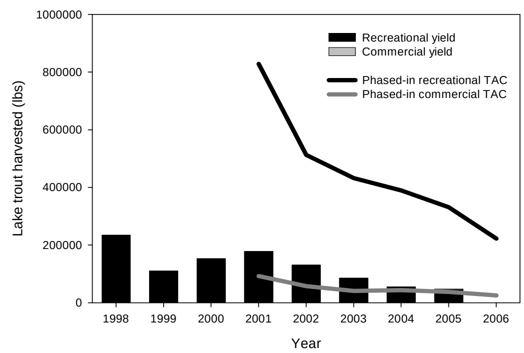


Fig. 4. Comparison of actual harvest vs. TAC decision



Model adjustments and changes:

MM-67 converged but provided poor output for MCMC simulations. We evaluated parameter estimates and correlations. We discovered problems with the ln_initial age 13, 14, and 15 estimates- there likely weren't enough data at the start of the model to estimate older fish. Some correlations within the F_CbyA estimates are not explained yet. The problem with convergence appeared to be resolved (much better gradient and objective function values) when the lnselsv_p2 parameter was set to a fixed value. The data indicate a knife-edge increase in selectivity early in the series. To solve estimation problems, we fixed the lnselsv_p2 value at 3 in the model and do not estimate the value.

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	5.066 lb (3.918 – 6.425)
Current SSBR combined w/	1.757 lb (1.272 – 2.298)
SSBR at target mortality	1.173 lb (0.987 – 1.375)
Spawning potential reduction	
At target mortality	0.233 (0.201 – 0.270)
Average yield per recruit	0.308 lb (0.270 – 0.351)
Natural mortality (M)	0.209 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2003-2005)	8 y
Sport fishery (2003-2005)	7 y
Commercial fishing mortality (F)	
Average 2003-2005, ages 6-11	0.008 y^{-1} (0.006 – 0.011)
Sport fishing mortality (F)	
Average 2003-2005, ages 6-11	0.064 y^{-1} (0.045 – 0.093)
Sea lamprey mortality (ML)	
Average 2002-2004, ages 6-11	0.119 y^{-1}
Total mortality (Z)	
Average 2003-2005, ages 6-11	0.402 y^{-1} (0.366 – 0.445)
Recruitment (age-1)	
Average 1996-2005	319,816 fish (299,742 – 341,462)
Biomass (age 3+)	
Average 1996-2005	1,945,472 lb (1,465,040 –
Spawning biomass	
Average 1996-2005	488,459 lb (333,703 – 673,156)
MSC recommended yield limit in 2006	246,400 lb
Actual yield limit in 2006 (based on 15% rule)	312,200 lb

STATUS OF LAKE WHITEFISH POPULATIONS

Lake Superior

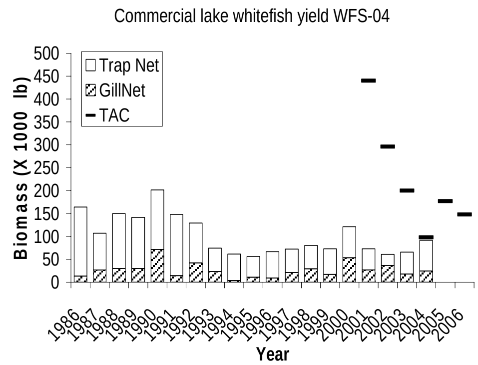
WFS-04 (Marquette - Big Bay)

Prepared by Philip J. Schneeberger

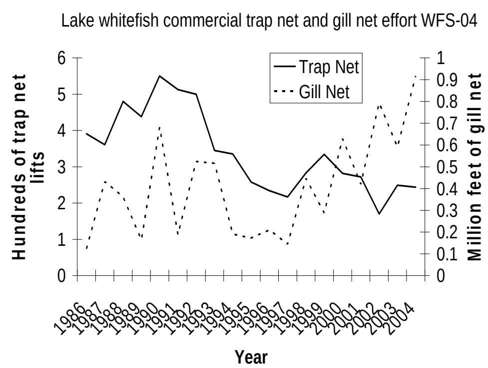
Lake whitefish unit WFS-04 (1,201,498 surface acres) is located in Lake Superior roughly between Big Bay and Laughing Fish Point east of Marquette. Fishable grids in this unit include 1326-1327, 1428-1429, and 1529-1531. Near shoreline features of this zone include many points, bays, islands, and in-flowing 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 area. More than 70% of trap-net effort and yield, and more than 80% of gill-net effort and yield are taken west of the Treaty line, outside of 1836 waters.

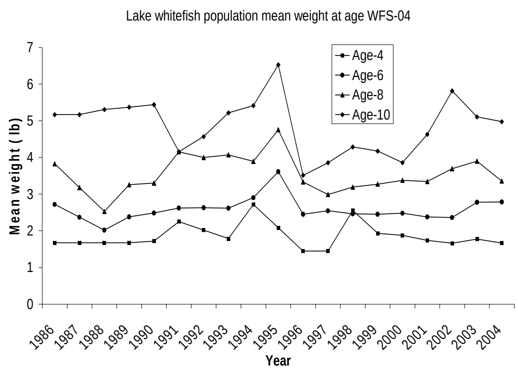
Yield during 2004 was 91,284 pounds with 67,015 pounds (73%) caught in trap nets and 24,268 pounds (27%) in gill nets. Trap-net yield in 2004 was the second highest value since 1993. Gill-net yield fluctuated between 17,000 and 53,000 pounds between 1999 and 2003. From 1986 through 2004, trap nets have caught 73% of the annual yield, on average, and gill nets have caught 27%.



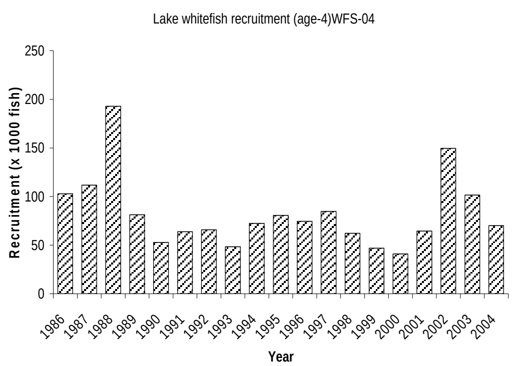
The 2004 trap-net effort (244 lifts) was 7% below the 1999-2003 average. Fishing effort with gill nets was 41% higher in 2004 than the 1999-2003 average.



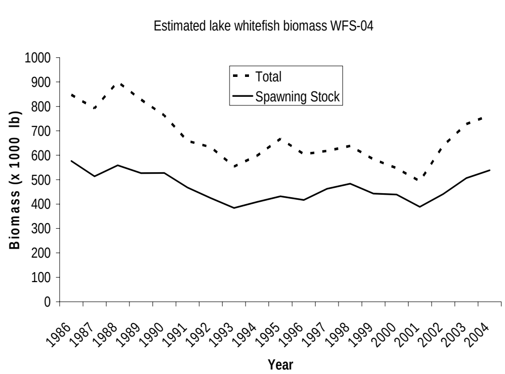
Between 2003 and 2004, calculations of mean weight-at-age decreased by an average of 6% for ages 3-12+. Overall, weight-at-age values in 2004 were 4% lower than 1986-2003 averages for ages 3-12+.



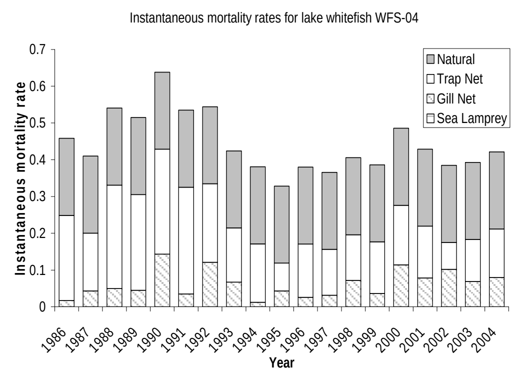
Recruitment (number of age-4 lake whitefish) was estimated at 70,000 in 2004. Highest estimated recruitment during the last 10 years was 150,000 in 2002. The 2004 recruitment estimate was 11% below the 1994-2003 average.



Both fishable biomass and spawning stock biomass increased since 2001. Estimated fishable biomass was 762,000 pounds and spawning stock biomass was 539,000 pounds in 2004. The 2004 ratio of spawning stock biomass to fishable biomass was 0.71.



Total instantaneous mortality rates (Z) remained below 0.50 y^{-1} as they have since 1993. Estimated instantaneous fishing mortality rates (F) were 0.08 y^{-1} for gill nets and 0.13 y^{-1} for trap nets in 2004. Instantaneous natural mortality rate was estimated at 0.21 y^{-1}.



The recommended yield limit for 2006 is 148,000 pounds in WFS-04– a 16.4% decrease from the 2005 limit of 177,000 lbs. Despite increasing biomass estimates, the decreased yield limit was caused by increased mortality, decreased recruitment, and decreased weight-at-age.

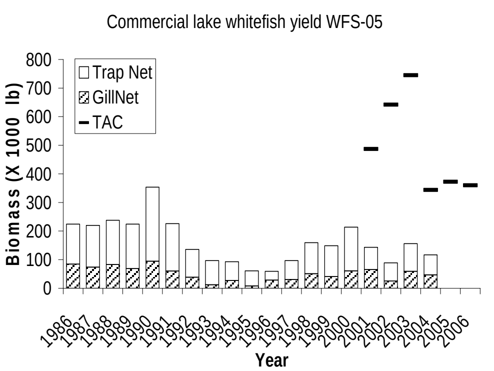
Summary Status WFS-04 Whitefish		Value (95% probability interval)
Female maturity		
	Size at first spawning	1.70 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.05 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	6.447 lb (6.425 - 6.470)
	Current SSBR	2.441 lb (2.257 - 2.630)
	SSBR at target mortality	0.240 lb
Spawning potential reduction		
	At target mortality	0.379 (0.350 - 0.408)
Average yield per recruit		1.289 lb (1.251 - 1.323)
Natural Mortality (M)		0.210 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.094 y^{-1} (0.081 - 0.110)
	Average trap net F, ages 4+	0.111 y^{-1} (0.096 - 0.127)
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.414 y^{-1} (0.389 - 0.443)
Recruitment (age-4)	(1995-2004 average)	78,500 fish (68,182 - 91,309)
Biomass (age 3+)	(1995-2004 average)	634,154 lb (576,820 - 699,247)
Spawning biomass	(1995-2004 average)	459,601 lb (418,627 - 504,746)
MSC recommended yield limit in 2006		148,000 lb
Actual yield limit in 2006		148,000 lb

WFS-05 (Munising)

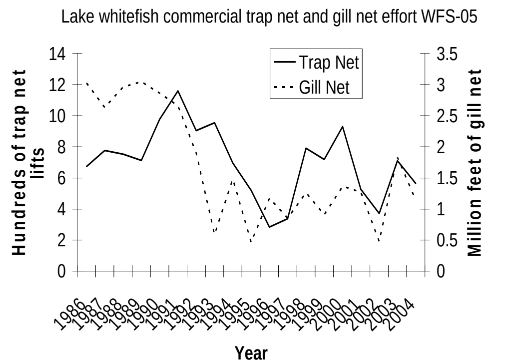
Prepared by Philip J. Schneeberger

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

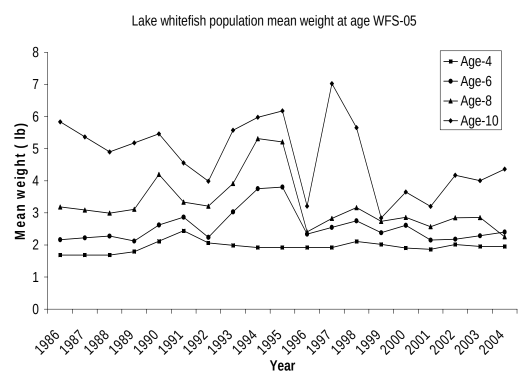
Total yield of lake whitefish in WFS-05 for 2004 was 117,000 lbs, down 25% from 156,000 pounds in 2003. The 2004 yield was 28% less than the average for 1986-2003. Trap nets accounted for 60% of the lake whitefish yield during 2004, and gill nets took the remaining 40%. Trap-net and gill-net yields in 2004 were 38% below and 8% below the 1986-2003 averages for each gear type, respectively.



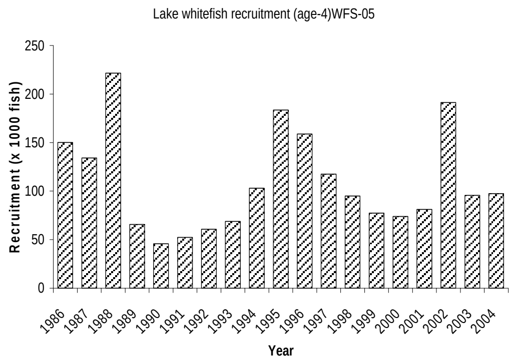
Fishing effort decreased 25% for trap nets and 60% for gill nets between 2003 and 2004. Fishing effort in 2004 was lower than 1986-2003 averages for trap nets (-25%), and gill nets (-33%).



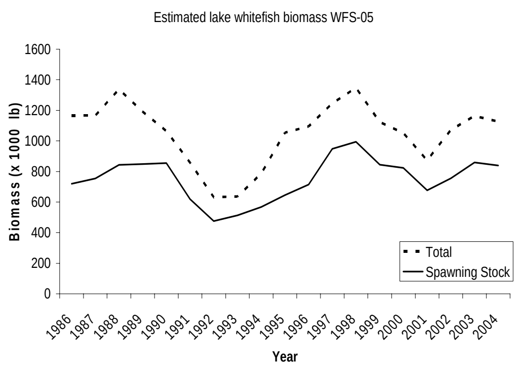
Mean weights at age have remained relatively static since 1999, with some recent downturns, for fish aged 3-8. In contrast, older aged fish (9-12+) have shown increasing weights at age since about the turn of the century.



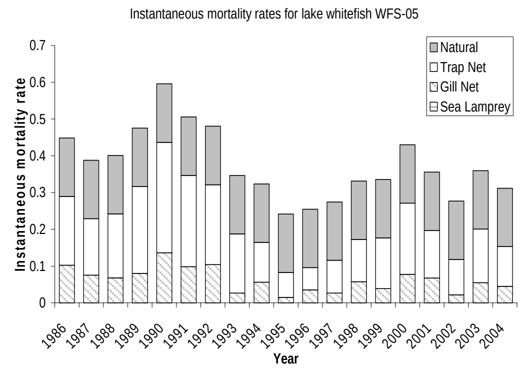
The 2004 estimate of recruitment, reported as annual numbers of age-4 lake whitefish in the population, was 97,500 fish, similar to estimates for four of the last five years, but lower than the 2002 recruitment estimate of 191,000. Recruitment estimates are subject to revision in subsequent years.



Biomass estimates in 2004 were 1.126 million pounds for the fishable stock (lake whitefish age-4 and older) and 839,000 pounds for the spawning stock. Both of these values were just slightly lower than 2003 estimates. Spawning stock biomass was 75% of fishable biomass in 2004, slightly higher than the 1986-2003 average of 72%.



Estimates for total instantaneous mortality rate (Z) have remained consistently below 0.45 y^{-1} during 1993-2004. The estimate for Z was 0.31 y^{-1} in 2004. Natural mortality rate (M) was the largest component (16%) of Z in WFS-05. Instantaneous fishing mortality (F) rate was 0.04 y^{-1} for gill nets and 0.11 y^{-1} for trap nets.



The recommended yield limit for 2006 is 360,000 lbs, a 3.3% decrease from the yield limit for 2005. 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	1.97 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.13 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	11.57 lb (11.53 - 11.61)
	Current SSBR	3.35 lb (3.01 - 3.71)
	SSBR at target mortality	0.241 lb
Spawning potential reduction		
	At target mortality	0.290 (0.260 - 0.321)
Average yield per recruit		1.506 lb (1.48 - 1.53)
Natural Mortality (M)		0.159 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.042 y^{-1} (0.037 - 0.047)
	Average trap net F, ages 4+	0.122 y^{-1} (0.106 - 0.139)
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.322 y^{-1} (0.303 - 0.344)
Recruitment (age-4)	(1995-2004 average)	118,308 fish (108,841 - 129,512)
Biomass (age 3+)	(1995-2004 average)	1,122,062 lb (1,031,520 - 1,222,050)
Spawning biomass	(1995-2004 average)	815,052 lb (741,026 - 897,594)
MSC recommended yield limit in 2006		360,000 lb
Actual yield limit in 2006		360,000 lb

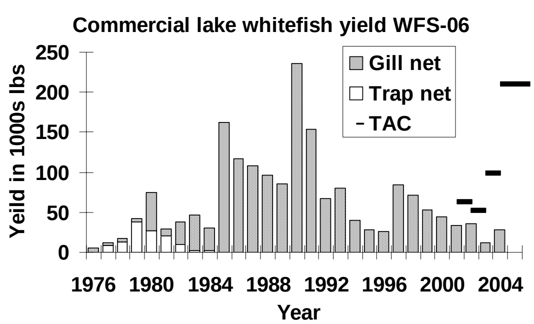
WFS-06 (Grand Marais)

Prepared by Mark P. Ebener

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

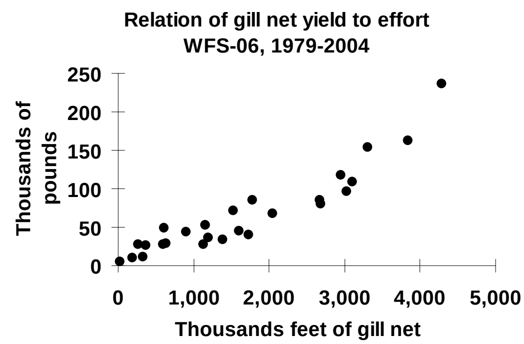
WFS-06 has been an exclusive commercial fishing zone for CORA fishers since 1985. Because the unit is so exposed to the open water of Lake Superior, and because access to the unit is limited mainly to the Grand Marais area, only large-boat gill-net fisheries typically operate here. A sizeable sport fishery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

The commercial yield of lake whitefish from WFS-06 has averaged only 64,000 pounds during from 1976 to 2004. The peak yield was 236,000 pounds in 1990 and the lowest yield was 4,900 pounds in 1976. The commercial fishery yield of whitefish was 27,853 pounds in 2004.



The large-mesh gill-net fishery has accounted for 93% of the entire yield from 1976 to 2004. Peak gill-net effort was 4.2 million ft in 1990 and the lowest effort was 0.33 million ft in 2003.

There was a direct linear relationship between gill-net effort and yield of whitefish in WFS-06 during 1976-2004. Gill-net effort explained 86% of the variation in gill-net yield during 1976-2004.



No stock assessment was conducted on whitefish in WFS-06 for 2004 because little sampling of the commercial catch occurred from 2000 to 2004. The harvest regulating guideline for 2006 was **210,000 pounds** and represents the same value as in 2005.

WFS-07 (Tahquamenon Bay)

Prepared by Mark P. Ebener

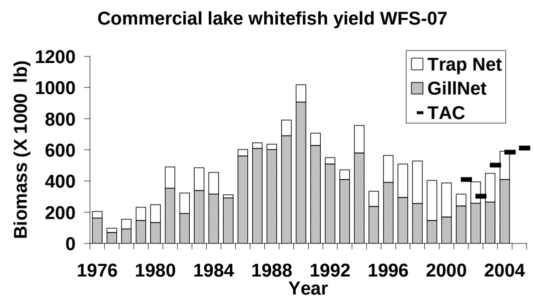
WFS-07 is located in the Whitefish Bay area of Lake Superior and contains 371,000 surface acres of water less than 240 ft deep. There is a substantial commercial fishery in adjacent Canadian management unit 33.

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, but many also remain in Whitefish Bay and some move into Canadian waters.

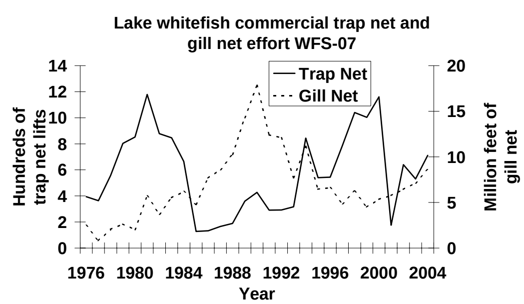
WFS-07 is an important fishing ground for the CORA fishery, and has been an exclusive CORA fishing area since 1985. Large- and small-boat gill-net fisheries as well as several trap-net fisheries operate in WFS-07. An ice fishery also takes place nearly every winter. There are a large number of relatively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

The commercial yield of whitefish from WFS-07 has averaged 471,000 pounds from 1976 to 2004 and 445,000 pounds from 1995 to 2004. A peak yield of one million pounds occurred in 1990 and the lowest reported yield was 98,000 pounds in 1977. The 2004 yield was 591,400 pounds and the TAC was 585,000 lb.

The large-mesh gill-net fishery accounted for 75% of the whitefish yield from WFS-07 from 1976 to 2004. The trap-net fishery harvested more whitefish from the unit than the gill-net fishery only during 1998-2000. The yield in 2004 was 409,500 pounds from the gill-net fishery and 181,900 pounds from the trap-net fishery.



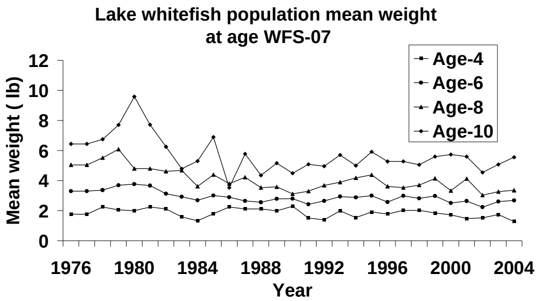
Yield of whitefish from WFS-07 has mirrored changes in fishing effort from 1976 to 2004. After peaking at 17.8 million ft in 1990, large-mesh gill-net effort declined to between four and seven million ft from 1996 to 2004. Gill-net effort was 8.6 million ft in 2004. Trap-net effort increased from 128 lifts in 1985 to 1,161 lifts in 2000, declined to 175 lifts in 2001, and then increased to 711 lifts in 2004.



Whitefish caught in WFS-07 are of moderate to large size. Mean weight of a harvested whitefish averaged 3.3 pounds in the gill-net fishery and 2.8 pounds in the trap-net fishery during 1976-2004. Mean weight of a harvested whitefish in 2004 was 3.4 pounds in the gill-net fishery and 2.8 pounds in the trap-net fishery.

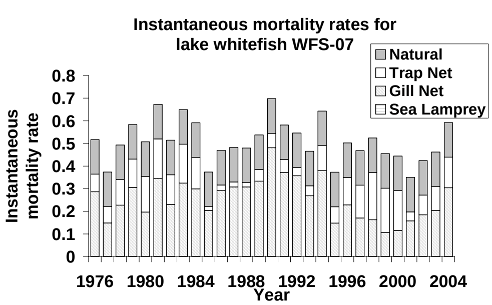
After declining from 1976 to 1990, mean weight at age of whitefish from WFS-07 has remained very constant through time. Mean weight of age 4-9 whitefish has varied little since

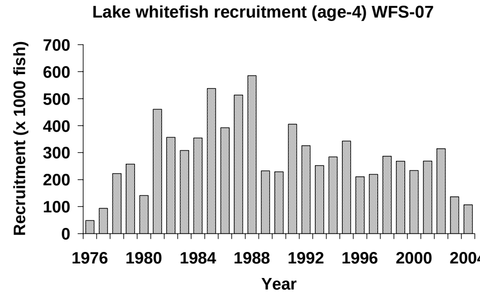
1990, while mean weight of age 10 and older fish has generally increased since 1990.



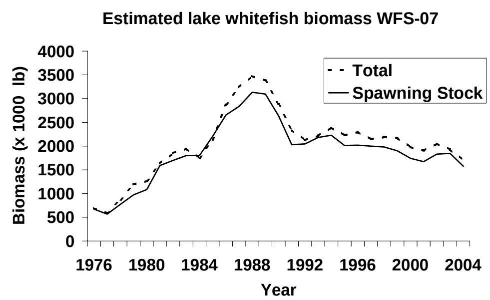
Sexual maturity of whitefish in WFS-07 occurs at a small size and young age, but complete maturity of females occurs at a large size and old age. Female whitefish begin reaching sexual maturity at age 3 and about 15 inches long, and by age 5 over 50% of females are sexually mature. After age 5, however,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

Estimated recruitment of age-4 whitefish to the fishable population peaked in 1988 then declined slowly thereafter. The stock assessment model estimated that an average of 289,000 age-4 whitefish recruited to the fishable population each year from 1976 to 2004. Recruitment varied from 49,000 fish in 1976 to 585,000 fish in 1988. Recruitment was estimated to be 107,000 age-4 whitefish in 2004.





Average total biomass of age-4 and older whitefish peaked at 3.74 million pounds in 1988 and has declined ever since. The total biomass was 1.7 million pounds in 2004, compared to a spawning biomass of 1.6 million lb. The estimated biomass of whitefish in 2004 was equal to levels observed in the early 1980s.



Instantaneous total annual mortality of age-4 and older whitefish showed little change from 1976 to 2004. The variations in total mortality were driven largely by changes in large-mesh gill-net effort. Instantaneous total annual mortality on age-4 and older fish averaged 0.51 y^{-1} during 1976-2004 and ranged from 0.35 y^{-1} in 2001 to 0.69 y^{-1} in 1990. Fishing mortality averaged 0.36 y^{-1} during 1976-2004, while natural mortality was estimated to be 0.15 y^{-1}. Gill-net mortality averaged 0.26 y^{-1} and trap-net mortality 0.10 y^{-1} during 1976-2004. Fishing mortality in 2004 was 0.43 y^{-1}, with gill-net mortality being 0.30 y^{-1} and trap-net mortality 0.13 y^{-1}.

The projection model estimated that the target total annual mortality rate on the most fully vulnerable age class could be no more than 1.01 y^{-1} in 2006. As a consequence, the projection model estimated that gill-net mortality should be reduced by 14% while trap-net fishing mortality could be increased by 42%. As a consequence, the recommended yield limit was estimated to be **367,000 pounds** in 2006. The actual yield limit, which is a harvest regulation guideline, was also 367,000 lb. The recommended yield limits were 611,000 pounds in 2005, 585,000 pounds in 2004, 502,000 pounds in 2003, 302,000 in 2002, and 409,000 pounds in 2001.

Summary Status WFS-07 Whitefish		Value & units
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	1.51 lb
	Age at first spawning	4 y
	Size at 50% maturity	2.01 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	10.039 lb (SE 0.002)
	Current SSBR	1.46 lb (SE 0.11)
	SSBR at target mortality	0.227 lb (SE 0.000)
Spawning potential reduction	At target mortality	0.145 (SE 0.011)
Average yield per recruit		1.697 lb (SE 0.009)
Natural Mortality (M)		0.153 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	6
	Fully selected age to trap nets	6
	Average gill net F ages 4+	0.231 y^{-1} (SE 0.018)
	Average trap net F ages 4+	0.109 y^{-1} (SE 0.007)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	N/A
Total mortality (Z)	Average ages 4+ 2002-2004	0.493 y^{-1} (SE 0.024)
Recruitment	Average @ age 4 1995-2004	238,760 fish (SE 8,056)
Biomass	Average ages 4+ 1995-2004	2,059,400 lb (SE 80,967)
Spawning biomass	Average ages 4+ 1995-2004	1,858,200 lb (SE 77,085)
MSC recommended yield limit in 2006		367,000 lb
Actual yield limit in 2006 (HRG)		367,000 lb

WFS-08 (Brimley)

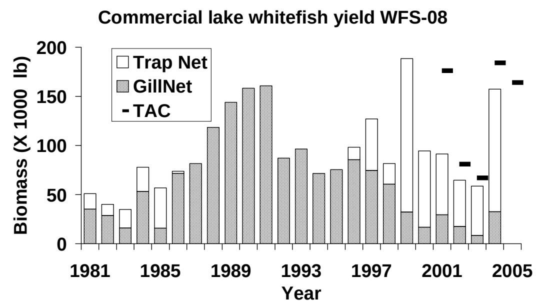
Prepared by Mark P. Ebener

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

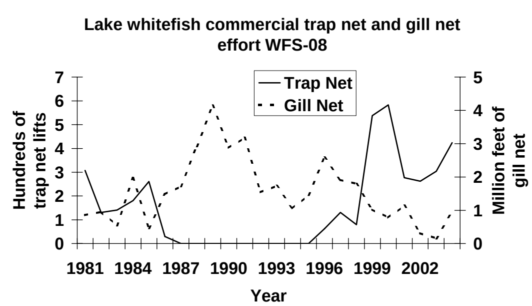
There are probably four reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Whitefish that spawn in WFS-07 are caught in the commercial fishery of WFS-08. The areas off Birch Point and Iroquois Island are both whitefish spawning grounds that contribute to 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 95,400 pounds from 1981 to 2004. Annual yields ranged from 35,000 pounds in 1983 to 188,000 pounds in 1999. The peak yield of 195,000 pounds occurred in 1979, just prior to the creation of CORA. The large-mesh gill-net fishery accounted for 69% of the yield from 1981 to 2004. There was no trap-net yield from 1987 to 1995. The trap-net yield in 2004 was 124,600 lb, while the gill-net yield was 32,700 lb.

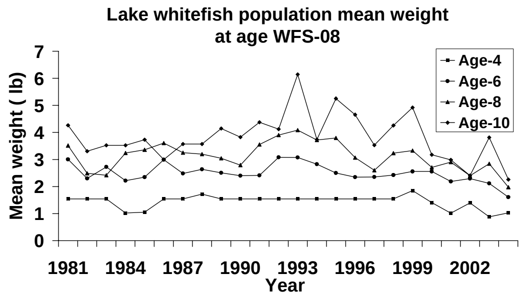


Gill-net effort has been declining in WFS-08 while trap-net effort has increased tremendously. Peak gill-net effort was 4.1 million ft in 1989, but it declined to 0.95 million ft in 2004. Trap-net effort peaked at 738 lifts in 1979, declined to zero during 1987-1995, and increased to 583 lifts in 2000. Trap-net effort was 424 lifts in 2004.



Whitefish in WFS-08 are of moderate to large size. Mean weight of a harvested whitefish in the gill-net fishery averaged 3.0 pounds and mean weight in the trap-net fishery averaged

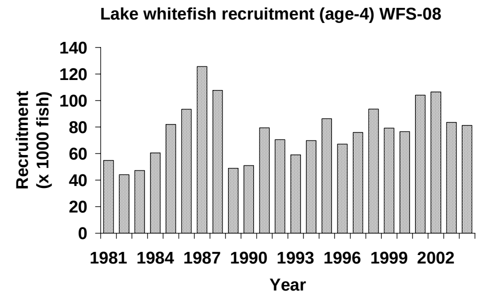
2.2 pounds during 1981-2004. Mean weight of a harvested whitefish in 2004 was 1.8 pounds in the trap-net fishery and 2.6 pounds in the gill-net fishery.



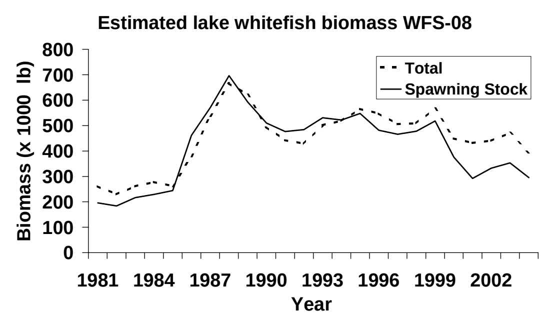
Growth in weight of whitefish in WFS-08 has remained fairly stable from 1981 to 2003, but has declined over the period from 1994 to 2004 unlike in adjacent WFS-07. Mean weight of age-5 and older whitefish was lower in 2004 than in any other year from 1981 to 2004.

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.

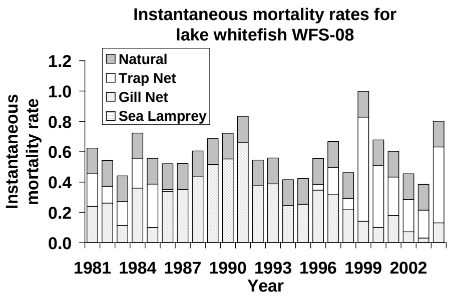
Recruitment of age-4 whitefish to the fishable population in WFS-08 has been less variable than in adjacent unit WFS-07, and has increased during the last decade unlike in WFS-07. The stock assessment model estimated that an average of 77,000 age-4 whitefish recruited to the fishable population in WFS-08 each year from 1981 to 2004. Recruitment peaked in 1987 at 126,000 age-4 whitefish. Recruitment appeared to increase slowly from 1988 to 2004 varying from 49,000 to 106,500 fish during the time period. Recruitment was estimated to be 81,200 age-4 whitefish in 2004.



Because of the decline in mean weight at age after 1999, spawning stock biomass of whitefish in WFS-08 has declined faster than total biomass. Total biomass of age-4 and older whitefish averaged 448,000 pounds from 1981 to 2004 and ranged from 230,000 pounds in 1982 to 667,000 pounds 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 394,500 pounds and spawning biomass was estimated to be 295,000 pounds in 2004.



Total annual mortality of age-4 and older whitefish increased substantially from 2003 to 2004 in WFS-08. Annual instantaneous total annual mortality of age-4 and older whitefish was 1.00 y^{-1} in 1999 and declined to 0.38 y^{-1} in 2003. Estimated total annual mortality of whitefish was 0.80 y^{-1} in 2004. The trap-net fishery has inflicted the majority of fishing mortality on whitefish in WFS-08 since 1999. Trap-net mortality was 0.50 y^{-1}, gill-net mortality 0.13 y^{-1}, and natural mortality 0.17 y^{-1} in 2004.



Total annual mortality on age-4 and older whitefish was less than the target rate of 1.05 y^{-1} from 2002 to 2004. The SPR value at the target mortality rate was 0.30 and greater than the target SPR value of 0.20. Thus the projection model estimated that fishing mortality rate in 2006 could be increased 1.71 times from levels experienced during 2002-2004. The recommended yield limit at this increased rate of fishing was estimated to be **148,000 pounds** in 2006. The HRG was set equal to the recommendation. Recommended yield limits in WFS-08 were 164,000 pounds in 2005, 184,000 pounds in 2004, 67,000 pounds in 2003, 81,000 pounds in 2002, and 176,000 pounds in 2001.

Summary Status WFS-08 Whitefish		Value & units (95% probability interval)
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	1.10 lb
	Age at first spawning	4 y
	Size at 50% maturity	1.61 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	3.039 lb (SE 0.004)
	Current SSBR	0.75 lb (SE 0.03)
	SSBR at target mortality	0.115 lb (SE 0.000)
Spawning potential reduction	At target mortality	0.248 (SE 0.011)
Average yield per recruit		0.917 lb (SE 0.008)
Natural Mortality (M)		0.170 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.078 y^{-1} (0.069 - 0.092)
	Average trap net F, ages 4+	0.298 y^{-1} (0.265 - 0.340)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	N/A
Total mortality (Z)	Average ages 4+ 2002-2004	0.547 y^{-1} (0.508 - 0.599)
Recruitment	Average @ age 4 1995-2004	85,385 fish (78,792 - 93,309)
Biomass	Average ages 4+ 1995-2004	488,310 lb (460,311 - 518,348)
Spawning biomass	Average ages 4+ 1995-2004	413,980 lb (390,794 - 438,820)
MSC recommended yield limit in 2006		148,000 lb
Actual yield limit in 2006 (HRG)		148,000 lb

Lake Huron

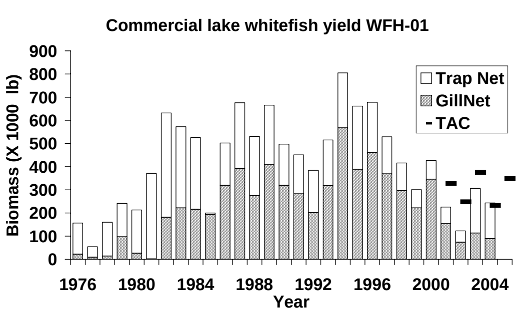
WFH-01 (St. Ignace)

Prepared by Mark P. Ebener

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

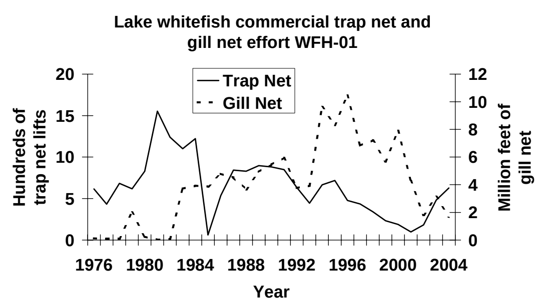
There are probably several reproductively isolated stocks of lake whitefish that inhabit WFH-01. One stock is located near Cheboygan, MI, another stock spawns north of St. Ignace near Rabbitsback and Horseshoe Bay, and third stock spawns in St. Martin Bay. A fourth stock probably spawns near Hessel, 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 pounds in 1977 to a high of 806,000 pounds in 1994 and averaged 416,000 pounds from 1976 to 2004. The commercial yield was 243,600 pounds in 2004 compared to 306,300 pounds in 2003. The commercial yield in 2004 was slightly more than the recommended harvest limit of 232,000 lb.



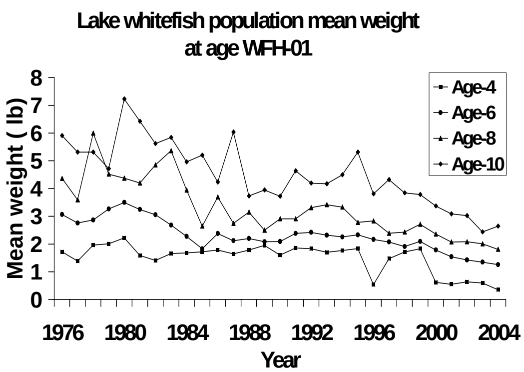
The large-mesh gill-net fishery has accounted for the majority of the commercial yield from 1976 to 2004. From 1976 to 1984 large-mesh gill nets accounted for 0-41% of the annual yield, while after 1985 gill nets accounted for 37-81% of the annual yield. The gill-net fishery harvested 89,900 pounds in 2004 compared to 153,700 pounds for the trap-net fishery.

Gill-net effort continued its long-term decline in WFH-01 in 2004, while trap-net effort increased. Trap-net effort peaked at 1,357 lifts in 1981 and declined to only 98 lifts in 2001 before increasing to 628 lifts in 2004. 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 1.7 million ft in 2004.



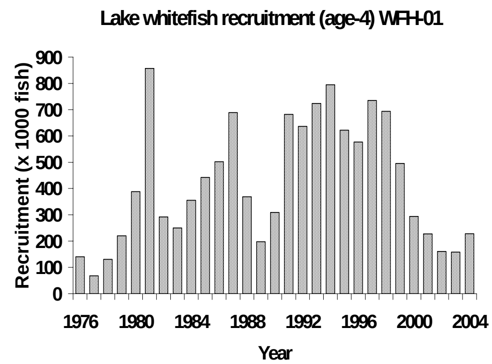
Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No1 fish. Mean weight of whitefish in the trap-net fishery ranged from 2.1 to 2.3 pounds during 1980-2004. Mean weight of whitefish in the gill-net fishery ranged from 2.2 to 3.0 pounds from 1982 to 2004. Mean weight of a harvested whitefish was 2.5 pounds in the gill-net fishery and 2.2 pounds in the trap-net fishery in 2004.

Growth of lake whitefish in 2004, expressed as mean weight at age, continued to decline. Mean weight of ages 3-6 and ages 8-9 whitefish declined 6-41% from 2003 to 2004, with most age classes experiencing a 6-13% decline. Mean weight of age-7 and age-10 whitefish increased 3% and 9%, respectively from 2003 to 2004. Mean weight of ages 3-6 and ages 8-9 were lower in 2004 than any other year from 1976 to 2004.

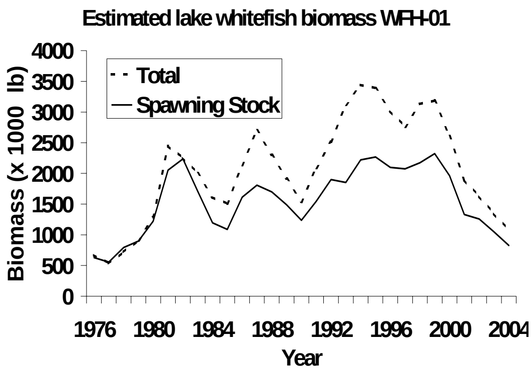


The decline in growth has had a profound effect on sexual maturity of whitefish in WFH-01. All female whitefish of age-6 and older were sexually mature from 1976 to 1980. Since then the proportion of mature females at any age has declined dramatically. For example, the proportion of sexually mature age-4 female whitefish was: 66% during the period from 1976 to 1982, 45% during the period from 1983 to 1992, 24% during the period from 1993 to 2000, and 6% during the period from 2001 to 2004. From 2001 to 2004 the proportion of mature females was 27% at age-5, 58% at age-6, 73% at age-7, 81% at age-8, and 92% for ages 9 and older.

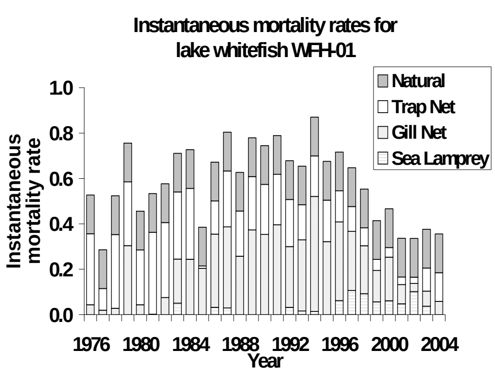
Large year-classes of whitefish were produced from 1987 to 1994 in WFH-01. These large year-classes produced the highest yield of 806,000 pounds in 1994 and also probably helped suppress growth of whitefish in the unit. An estimated average of 422,000 age-4 whitefish recruited the population each year from 1976 to 2004. Recruitment varied from a low of 68,000 in 1977 (1973 year class) to a high of 857,000 age-4 whitefish in 1981 (1977 year class). Estimated recruitment of age-4 whitefish was 228,000 in 2004.



Because of the declines in growth and recruitment in WFH-01, biomass declined to a low level in 2004. 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 2004 was lower than in all other years except 1979. Total biomass of age-4 and older fish declined from 3.4 million pounds in 1994 to 1.1 million pounds in 2004. Spawning biomass declined from 2.3 million pounds in 1999 to 0.83 million pounds in 2004.

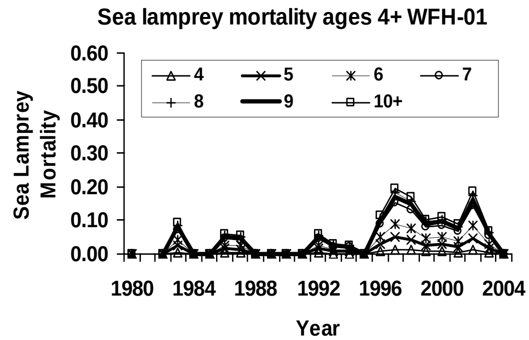


Total annual mortality of age-4 and older whitefish in WFH-01 was considerably less from 2001 to 2004 than in other years. Total annual mortality ranged from 0.34 y^{-1} to 0.38 y^{-1} during 2001-2004, compared to 0.29 y^{-1} to 0.87 y^{-1} prior to 2001. Total mortality was 0.36 y^{-1} in 2004. Gill-net mortality of age-4 and older whitefish ranged from 0.00 y^{-1} to 0.50 y^{-1} from 1976 to 2004, whereas trap-net mortality ranged from 0.02 y^{-1} to 0.36 y^{-1} from 1976 to 2004. In 2004 gill-net mortality was 0.06 y^{-1} and trap-net mortality was 0.13 y^{-1}.



Natural mortality rate, including sea lamprey-induced mortality, was about the same as fishing mortality during the last five years in WFH-01. Natural mortality was estimated to be 0.195 $y^{-1,}$ while sea lamprey mortality ranged from 0.0 y^{-1} to 0.10 y^{-1} from 2000 to 2004. Fishing mortality ranged from 0.06 y^{-1} to 0.23 y^{-1} during the same time.

In 2004 sea lamprey mortality was estimated to be 0.00 y^{-1}.



The current spawning potential reduction value of 0.34 in WFH-01 from 2002 to 2004 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 3.0 times above the 2002-2004 values. The increase in fishing effort produced a recommended yield limit of **395,000 pounds** for 2006. The HRG was set equal to this recommendation. The yield limit was 348,000 pounds in 2005, 232,000 pounds in 2004, 375,000 in 2003, 248,000 pounds in 2002, and 327,000 pounds in 2001.

Summary Status WFH-01 Whitefish		Value & units (95% probability interval)
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	0.53 lb
	Age at first spawning	4 y
	Size at 50% maturity	1.34 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	2.379 lb (SE 0.004)
	Current SSBR	0.72 lb (SE 0.03)
	SSBR at target mortality	0.049 lb (SE 0.000)
Spawning potential reduction	At target mortality	0.303 (SE 0.013)
Average yield per recruit		0.562 lb (SE 0.015)
Natural Mortality (M)		0.195 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.061 y^{-1} (0.052 - 0.072)
	Average trap net F, ages 4+	0.097 y^{-1} (0.083 - 0.113)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	0.053 y^{-1}
Total mortality (Z)	Average ages 4+ 2002-2004	0.407 y^{-1} (0.385 - 0.432)
Recruitment	Average @ age-4 1995-2004	419,120 fish (385,353 - 475, 229)
Biomass	Average ages 4+ 1995-2004	2,402,300 lb (2,242,280 - 2,594,990)
Spawning biomass	Average ages 4+ 1995-2004	1,736,000 lb (1,615,810 - 1,691,920)
MSC recommended yield limit in 2006		395,000 lb
Actual yield limit in 2006 (HRG)		395,000 lb

WFH-02 (Detour)

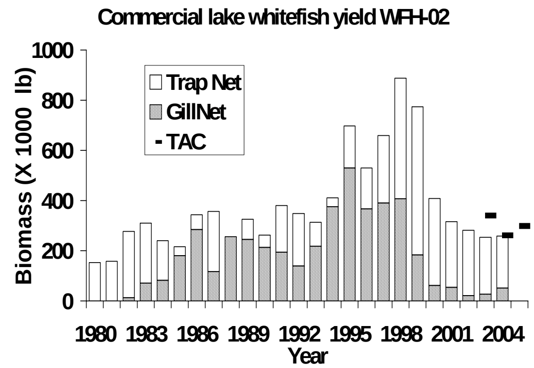
Prepared by Mark P. Ebener

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

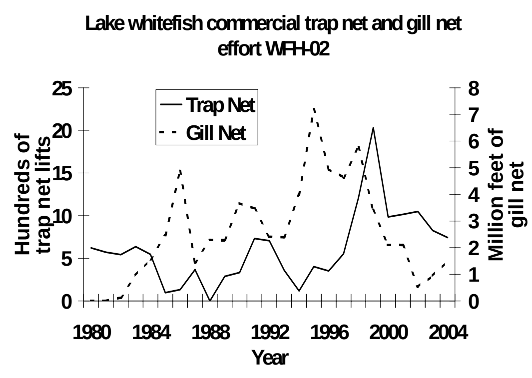
Because the shoreline of WFH-02 is highly irregular and rocky, nearly the entire unit contains habitat suitable for reproduction and survival of young. Spawning concentrations of whitefish can be found from Beavertail Point in the west portion of the unit to St. Vitals Point in the middle of the unit. 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 averaged 376,400 pounds during 1980-2004 and ranged from a low of 152,000 pounds in 1980 to a high of 888,000 pounds in 1998. The fishery yield averaged 506,300 pounds during 1995-2004.

The allocation of the harvest among fishing gears has changed dramatically in WFH-02 over the past few years. From 1985 to 1997 the large-mesh gill-net fishery accounted for the majority of harvest. After 1997 the trap-net fishery accounted for the largest proportion of the harvest. The trap-net fishery harvested 207,000 pounds of whitefish in 2004, while the gill-net fishery harvested only 51,200 lb.



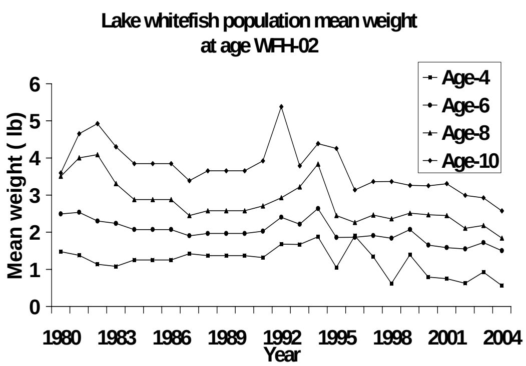
Both large-mesh gill-net and trap-net effort have changed markedly in WFH-02 since 1980. Trap-net effort ranged from 0 to 713 lifts between 1980 and 1997, thereafter effort increased to 2,033 lifts in 1999, then declined by half and stabilized between 744 and 1,050 lifts from 2000 to 2004. Large-mesh gill-net effort increased from zero in 1981 to 7.2 million ft in 1995, since then gill-net effort has declined to 0.9 million ft in 2003. Trap-net effort was 744 lifts and gill-net effort was 1.5 million ft in 2004.



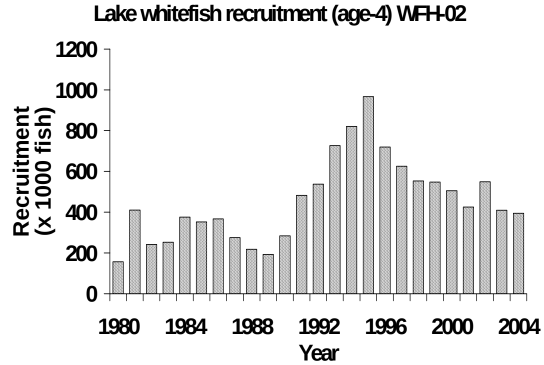
Whitefish in WFH-02 have always been of small size. No1 fish make up 90% of the harvest from the unit during 1980-2004. Mean weight in the trap-net harvest has ranged from 2.0 to 2.3 pounds and mean weight in the gill-net harvest ranged from 1.9 to 2.8 pounds during 1980-2004. Mean weight of a harvested whitefish was 2.1 pounds in the trap-net fishery and 2.5 pounds in the gill-net fishery in 2004.

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.

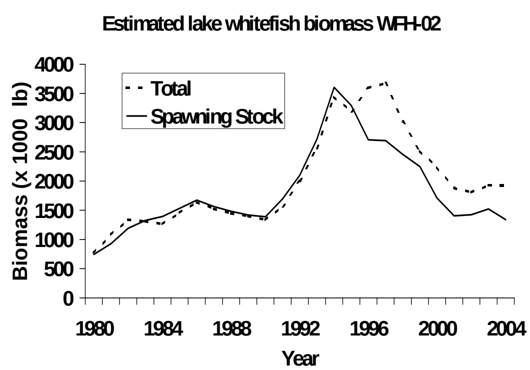
Unlike other units in Lake Huron, growth of whitefish in WFH-02 remained stable through 2000. There was a slight decline in mean weight at age from 1980 to 1984, but it was not as steep as in WFH-01, WFH-04, and WFH-05. Mean weight of almost all ages declined from 2003 to 2004 and was lower in 2004 than other years.



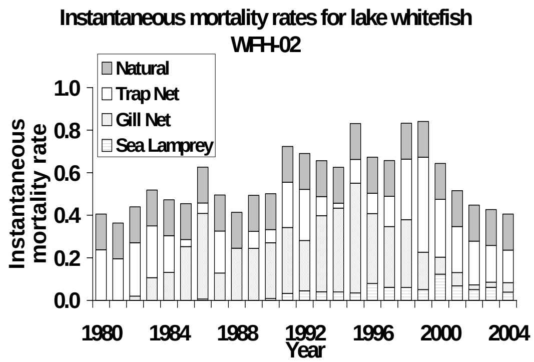
The increase in commercial fishery yield during the mid 1990s was driven largely by increased recruitment. The 1989-1993 year classes of whitefish were substantially larger than preceding and subsequent year classes. The stock assessment model estimated that the 1991 year class contained 0.97 million fish when it recruited to the fishery at age 4 in 1995. Recruitment averaged 460,000 fish from 1980 to 2004 and was estimated to be 390,000 fish in 2004.



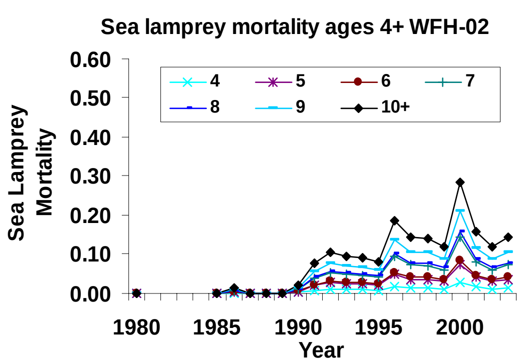
The large increase in recruitment during the mid 1990s nearly tripled biomass of whitefish in WFH-02. Total biomass of age-4 and older whitefish increased from 1.30 million pounds in 1990 to 3.7 million pounds in 1997. Total and spawning biomass were nearly equivalent in WFH-02 through 1994 because the fish matured at such a small size and because growth had not declined much. With the decline in growth that began in the mid 1990s the difference between total and spawning biomass became much larger. Total biomass was estimated to be 1.9 million pounds and spawning biomass 1.3 million pounds in 2004.



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 increased from 0.36 y^{-1} in 1981 to 0.84 y^{-1} in 1999, then declined to 0.40 y^{-1} in 2004.



The increase in total mortality was due to substantial increases in fishing mortality through 1999 and increased sea lamprey predation since 1990. Fishing mortality increased from 0.20 y^{-1} in 1981 to 0.60 y^{-1} in 1998, then declined to 0.20 y^{-1} in 2004. Gill-net mortality was 0.04 y^{-1} and trap-net mortality was 0.15 y^{-1} in 2004. Sea lamprey mortality of age-4 and older whitefish increased from 0.01 y^{-1} in 1990 to 0.12 y^{-1} in 2000, then stabilized at about 0.07 y^{-1} during 2001-2004.



Total annual mortality of age-4 and older whitefish averaged 0.487 y^{-1} from 2002 to 2004. Spawning potential reduction at the current mortality rate was 0.34 and considerably greater than the target of 0.20. The projection model estimated that fishing mortality rate could be increased 1.57 times to achieve the target mortality rate. As a consequence, the projection model estimated a yield limit of **454,000 pounds** for 2006. The HRG was set equal to this recommendation. In comparison, harvest limits were 298,000 pounds in 2005, 261,000 pounds in 2004 and 221,000 pounds in 2003.

Summary Status WFH-02 Whitefish		Value & units (95% probability interval)
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	0.71 lb
	Age at first spawning	4 y
	Size at 50% maturity	1.26 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.842 lb (SE 0.004)
	Current SSBR	0.86 lb (SE 0.03)
	SSBR at target mortality	0.089 lb (SE 0.000)
Spawning potential reduction	At target mortality	0.301 (SE 0.009)
Average yield per recruit		0.654 lb (SE 0.011)
Natural Mortality (M)		0.193 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.034 y^{-1} (0.029 - 0.042)
	Average trap net F, ages 4+	0.203 y^{-1} (0.179 - 0.231)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	0.058 y^{-1}
Total mortality (Z)	Average ages 4+ 2002-2004	0.487 y^{-1} (0.459 - 0.522)
Recruitment	Average @ age 4 1995-2004	569,670 fish (514,159 - 646,764)
Biomass	Average ages 4+ 1995-2004	2,577,700 lb (2,417,370 - 2,775,520)
Spawning biomass	Average ages 4+ 1995-2004	2,079,600 lb (1,957,030 - 2,227,590)
MSC recommended yield limit in 2006		454,000 lb
Actual yield limit in 2006 (HRG)		454,000 lb

WFH-03 (Drummond Island)

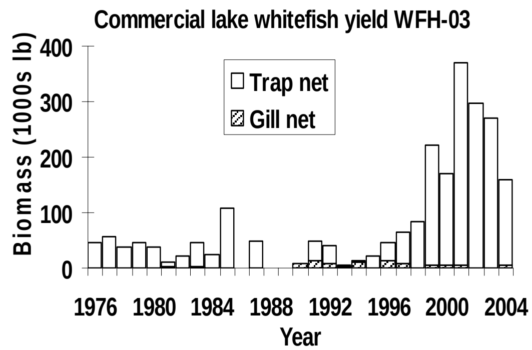
Prepared by Mark P. Ebener

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

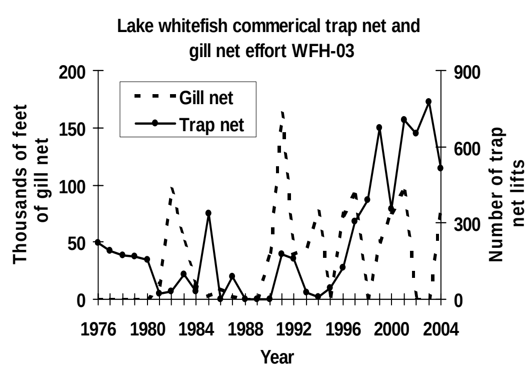
The spawning shoals for lake whitefish in WFH-03 are located primarily along the south shore of Drummond Island in the main basin of Lake Huron. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal during gill-net surveys in October and early November of 1991-2004.

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 pounds only in 1985. After 1998 the commercial yield increased from 82,000 pounds in 1999 to 296,000 pounds in 2002, but then declined to 159,800 pounds in 2004. Ninety-nine percent of the yield was taken with trap-nets from 1999 to 2004. The harvest regulating guideline ranged from 250,000 to 318,000 pounds from 1999 to 2003 and was 305,500 in 2004.



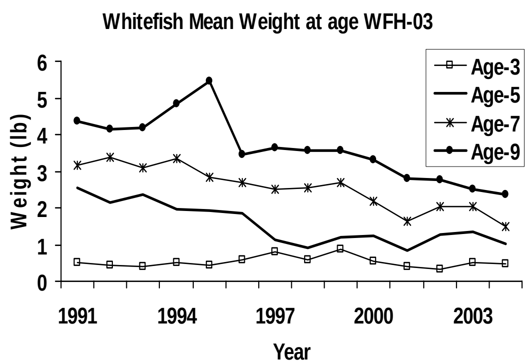
The large-increase in harvest during the period from 1999 to 2003 was directly related to increased trap-net effort. Trap-net effort ranged from 0 to 337 lifts during 1976-1997, thereafter trap-net effort increased to between 356 and 774 lifts. Gill-net effort was highly variable and low in WFH-03 ranging from 0 to 162,000 ft. during 1976-2004. Gill-net effort was only 80,000 ft in 2004, while trap-net effort was 514 lifts.



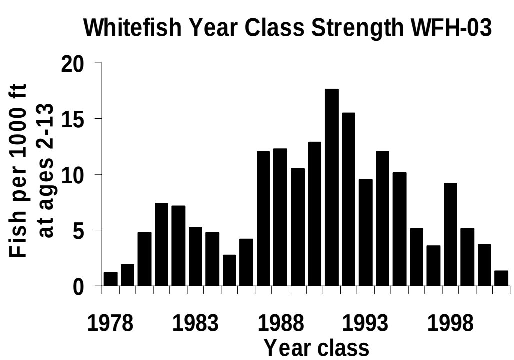
Whitefish caught in the fishery of WFH-03 are of moderate size. From 1987 to 2004 69% of the whitefish harvested were No1 fish, 24% were mediums and 7% were jumbos. Mean weight of whitefish in the trap-net harvest ranged from 2.0 to 2.8 pounds and averaged 2.5 pounds from 1991 to

2004. Mean weight in the gill-net fishery ranged from 2.3 to 3.0 pounds and averaged 2.6 lb. Mean weight of whitefish was 2.4 pounds in the trap-net fishery and 2.5 pounds in the gill-net fishery in 2004.

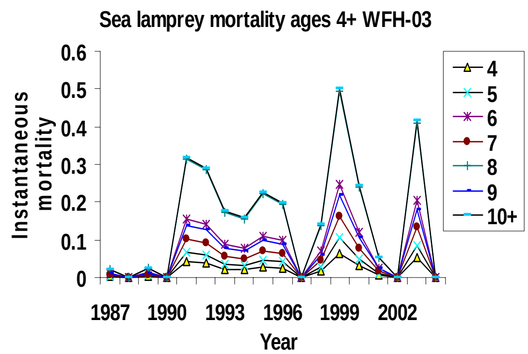
Growth of whitefish in WFH-03 continued its slow long-term decline in 2004. Mean weight of age-7 and older whitefish was less in 2004 than any year from 1991 to 2004, Mean weight of age-2 to age-5 declined from 2003 to 2004, but values in 2004 were not appreciably less than during the previous five years.



Recruitment of whitefish in WFH-03 appears very similar to that in WFH-02. The 1987-1995 year classes were very abundant, whereas the 1996 and 1997 year classes, as well as the 1985 and 1986 year classes, were not very abundant. 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 very abundant.



Sea lamprey-induced mortality of whitefish declined to zero in 2004 after being very high in 2003. Sea lamprey-induced mortality averaged 0.08 y^{-1} during late summer and fall of 1987-2004. Small sample sizes may have influenced the 2004 estimate of sea lamprey mortality in WFH-03.



No attempt was made to develop a stock assessment of whitefish this unit in 2004 because past attempts to do so were unsuccessful. Reasonable and consistent estimates of abundance and mortality could not be produced with the stock assessment model because they would change, by an order of magnitude in some cases, after only small changes were made to starting values of the input parameters.

A harvest regulating guideline of **306,000 pounds** was established for WFH-03 in 2006 and is identical to the 2004 and 2005 harvest regulating guidelines.

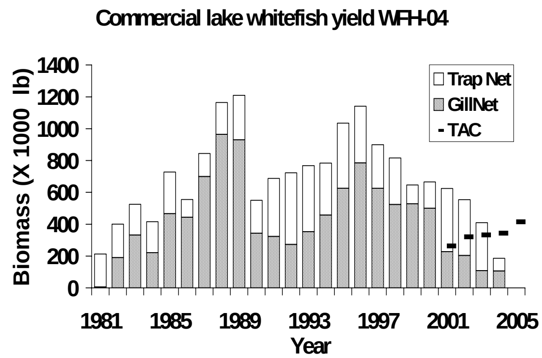
WFH-04 (Hammond Bay)

Prepared by Mark P. Ebener

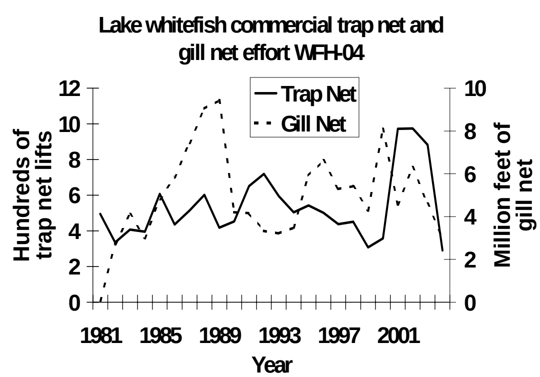
WFH-04 is the largest whitefish management unit in the 1836 Treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water less than 240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found from Cheboygan, MI to Hammond Bay.

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

The CORA large-mesh gill-net fishery accounted 62% of the whitefish harvest from 1981 to 2004. The annual yield from WFH-04 ranged from a high of 1.2 million pounds in 1989 to a low of 186,200 pounds in 2004. The annual yield of whitefish from the unit averaged 698,000 pounds from 1995 to 2004. The trap-net fishery harvested 79,400 pounds of whitefish in 2004 compared to 106,800 pounds for the gill-net fishery. The 2004 yield of 186,200 pounds was less than both the predicted harvest limit of 343,000 pounds and the harvest regulating guideline of 518,000 lb.



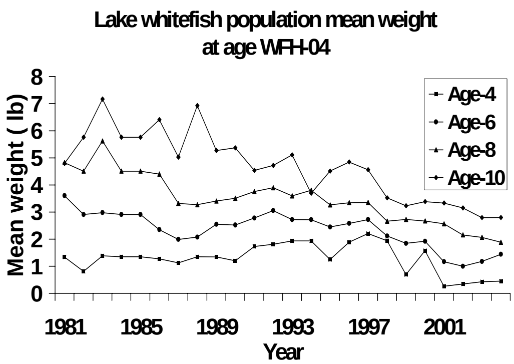
Both trap-net and gill-net effort declined substantially in the unit from 2003 to 2004. Trap-net effort peaked at 719 lifts in 1992, declined to 308 lifts in 1999, increased to 974 lifts in 2002, but then declined to 291 lifts in 2004. Large-mesh gill-net effort peaked at 7.7 million ft in 1989 and 5.2 million ft in 2000, and was only 3.0 million ft in 2004.



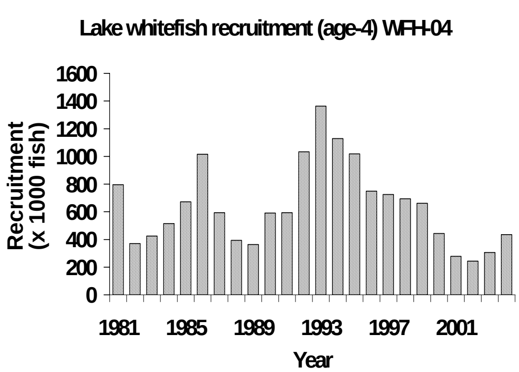
Whitefish from WFH-04 are of moderate size. The commercial harvest from WFH-04 was composed of 65% No1 whitefish, 26% mediums, and 9% jumbos during 1982-2004. Annual mean weight of whitefish caught in the gill-net fishery ranged from 2.5 to 3.0 pounds from 1982 to 2004, while mean weight in the trap-net fishery ranged from 2.4 to 3.6 pounds from 1982 to 2004. Mean weight in the harvest in 2004 was 2.3

pounds for the trap-net fishery and 2.7 pounds for the gill-net fishery.

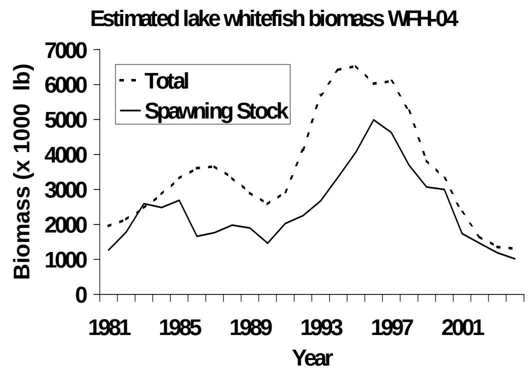
Growth of whitefish in WFH-04 actually stabilized among most age classes in 2004. Growth, expressed as mean weight at age, had been declining for most age classes through 2003, but in 2004 mean weight at age increased for ages 3-7 and age-10 and older. Growth declined from 2003 to 2004 for age-8 and age-9 whitefish, but only by 9% and 1%, respectively.



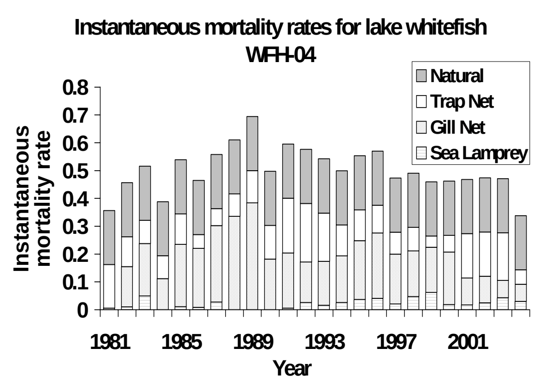
The declines in harvests from WFH-04 that occurred after 1996 were largely being driven by declines in both mean weights at age and recruitment. The 1988-1991 year classes of whitefish were very abundant ranging from 1.0 to 1.4 million fish at age-4. The 1997 and 1998 year classes were the least abundant at 273,000 and 243,000 fish, respectively, from 1981 to 2004. The 2000 year class was estimated to contain 435,000 fish at age 4 in 2004.



The combined effects of reduced recruitment and growth has meant that biomass of whitefish in WFH-04 was lower in 2003 than at any other time during the last 24 years. After peaking at 6.5 million pounds in 1995, total biomass declined nearly annually to only 1.3 million pounds in 2004. Spawning stock biomass declined from 5.0 million pounds in 1996 to 1.0 million pounds in 2004. Given that the 1999-2000 year classes do not appear to be very abundant, biomass of whitefish in WFH-04 can be expected to remain low for a few years.



Total annual mortality of age-4 and older whitefish averaged 0.46 y^{-1} during 2002-2004. Gill-net mortality averaged 0.08 y^{-1}, trap-net mortality 0.14 y^{-1}, and sea lamprey mortality 0.04 y^{-1} during 2002-2004. In 2004 gill-net mortality was 0.07 y^{-1}, trap-net mortality 0.05 y^{-1}, and sea lamprey mortality 0.03 y^{-1} on age-4 and older whitefish. Natural mortality was estimated to be 0.195 y^{-1}.



Since total annual mortality on all age classes of whitefish was less than the target of 1.05 y^{-1}, the projection model estimated that fishing mortality could be increased 1.76 times in 2006 over that experienced from 2002 to 2004. The SPR value at the target-fishing rate was 0.27. The recommended harvest level for WFH-04 in 2006 was **460,000** pounds compared to 415,000 in 2005. The HRG was set equal to this recommendation.

Summary Status WFH-04 Whitefish		Value & units (95% probability interval)
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	0.41 lb
	Age at first spawning	4 y
	Size at 50% maturity	1.72 lb
	Age at 50% maturity	7 y
Spawning biomass per recruit		
	Base SSBR	2.555 lb (SE 0.0)
	Current SSBR	0.69 lb (SE 0.03)
	SSBR at target mortality	0.120 lb (SE 0.00)
Spawning potential reduction	At target mortality	0.271 (SE 0.012)
Average yield per recruit		0.727 lb (SE 0.011)
Natural Mortality (M)		0.195 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.084 y^{-1} (0.071 - 0.100)
	Average trap net F, ages 4+	0.145 y^{-1} (0.126 - 0.168)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	0.037 y^{-1}
Total mortality (Z)	Average ages 4+ 2002-2004	0.461 y^{-1} (0.430 - 0.498)
Recruitment	Average @ age 4 1995-2004	555,140 fish (512,214 - 610,425)
Biomass	Average ages 4+ 1995-2004	3,771,700 lb (3,565,250 - 4,022,870)
Spawning biomass	Average ages 4+ 1995-2004	2,886,300 lb (2,716,580 - 3,092,830)
MSC recommended yield limit in 2006		460,000 lb
Actual yield limit in 2006 (HRG)		460,000 lb

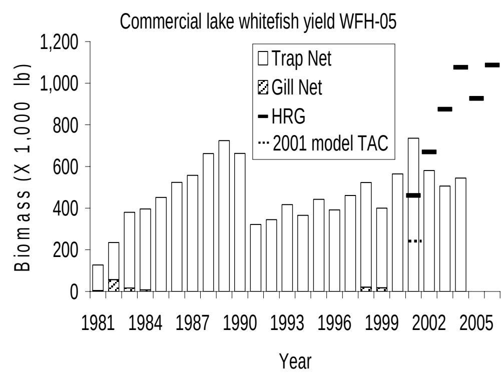
WFH-05 (Alpena)

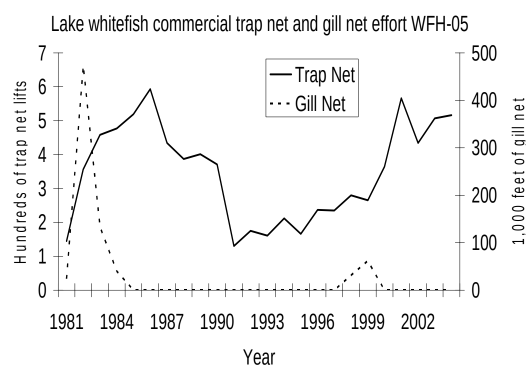
Prepared by Aaron P. Woldt and Mark P. Ebener

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.

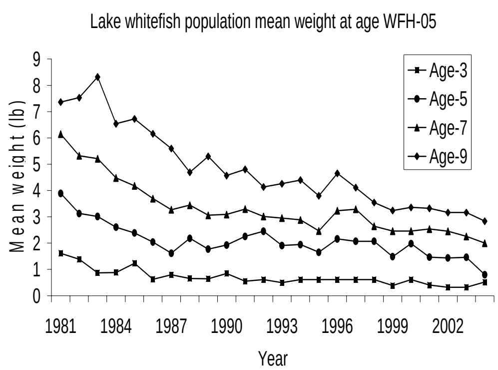
Annual commercial trap-net yield has ranged from 124,000 pounds in 1981 to 736,000 pounds in 2001 and averaged 466,000 pounds from 1981 to 2004. In general, trap-net harvest and effort have been directly related over the modeled time series and have been especially linked since 1991. As trap-net effort increased from 130 lifts in 1991 to 566 lifts in 2001, the yield increased from 322,000 pounds in 1991 to 736,000 pounds in 2001. Trap-net effort and yield declined in 2002. In 2003 and 2004, however, trap-net effort did increase (507 and 516 lifts respectively) while trap-net yield declined (506,000 and 545,000 pounds respectively). The decrease in yield may be linked to low wholesale prices and demand for lake whitefish in 2003 and 2004, but could also be the result of decreased lake whitefish size at age.



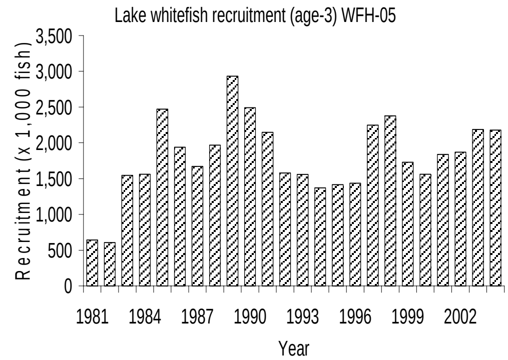


Whitefish in WFH-05 are of similar size to those in WFH-04. The commercial harvest from WFH-05 was made up of approximately 70% No. 1 whitefish (< 3 lb), 23% mediums (3-4 lb), and 7% jumbos (≥ 4 lb). Mean weight of a harvested whitefish was 2.4 pounds in WFH-05 in 2004. Mean weight of a harvested whitefish has been steadily decreasing since 1998.

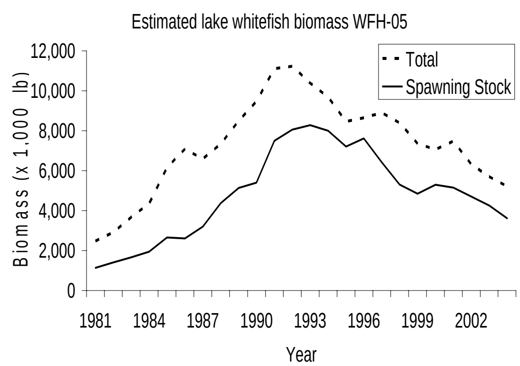
Weight-at-age of whitefish in WFH-05 has stabilized over the last few years after continually declining from 1981 to 1999. Prior to 1984, age-9 and older whitefish weighed between 7 and 8 lb, but by 2004 they weighed about 2.8 lb. This large decrease in average weight for older fish is likely due to decreased growth rates. Mean weight of all age classes in 2004 was similar to mean weight in 1999, 2000, 2001, 2002 and 2003. However, mean weight-at-age of age-3 fish increased slightly in 2004, while mean weight-at-age of age-5 fish decreased slightly in 2004.



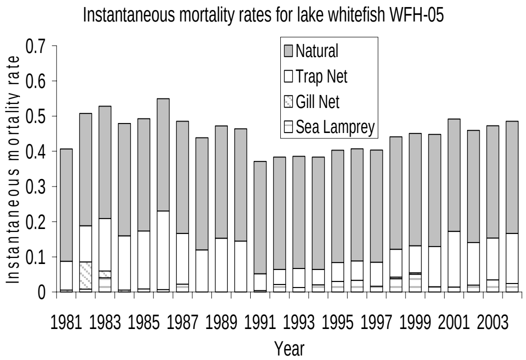
Recruitment of age-3 whitefish to the fishable population in WFH-05 has increased and remained relatively constant since 1997. Recruitment peaked at 2.9 million age-3 whitefish in 1989 and then declined annually to about 1.4 million age-3 whitefish in 1996 (1993 year class). From 1997 through 2004 estimated recruitment averaged about 2.00 million age-3 whitefish. The stock assessment model estimated that 2.18 million age-3 whitefish were present in the population during 2004.



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 11.2 million pounds in 1992 and has since declined to 5.2 million pounds in 2004. Spawning stock biomass peaked at 8.3 million pounds in 1993 and then declined to 3.6 million pounds in 2004.



Natural mortality has consistently been the most significant source of mortality affecting age-4 and older whitefish in WFH-05. Natural mortality was greater than fishing and sea lamprey mortality combined in all years in WFH-05 and was estimated to be 0.319 y^{-1}. In general, trap-net fishing mortality has been increasing in WFH-05 over the last decade and was estimated to be 0.142 y^{-1} in 2004. 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 2004.



Total annual mortality was estimated to be 0.458 y^{-1} on age-4 and older whitefish in WFH-05 during 2002-2004. Total mortality was estimated to be 0.485 y^{-1} in 2004. 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 2.70 times over the 2002-2004 levels. The recommended yield limit at this increased rate of fishing was estimated to be 1,087,000 pounds in WFH-05 for 2006. The recommended yield limit in 2005 was 927,000 lb. In general, the harvest limit in this unit has been steadily increasing under the 2000 Consent Decree, but the 2005 recommended limit was lower than the 2004 and 2006 harvest limits. Also, the 2006 harvest limit is roughly equal to the 2004 harvest limit. Total tribal trap-net harvest was below the HRG in 2004.

Summary Status WFH-05 Whitefish	Value (95% probability interval)
Female maturity	
Size at first spawning	0.39 lb
Age at first spawning	3 y
Size at 50% maturity	1.74 lb
Age at 50% maturity	6 y
Spawning biomass per recruit	
Base SSBR	0.943 lb (0.943 – 0.943)
Current SSBR	0.490 lb (0.444 – 0.538)
SSBR at target mortality	0.130 lb (0.130 – 0.130)
Spawning potential reduction	
At target mortality	0.515 (0.515 – 0.515)
Average yield per recruit	0.290 lb (0.241 – 0.325)
Natural Mortality (M)	0.319 y^{-1}
Fishing mortality rate 2002-2004	
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+	0.109 y^{-1} (0.079 – 0.138)
Sea lamprey mortality (ML)	
Average ages 4+, 2002-2004	0.035 y^{-1}
Total mortality (Z)	
Average ages 4+, 2002-2004	0.458 y^{-1} (0.428 – 0.487)
Recruitment (age-3)	
Average 1995-2004	1,883,600 fish (1,577,060 – 2,445,750)
Biomass (age 3+)	
Average 1995-2004	7,351,900 lb (6,240,330 – 9,449,280)
Spawning biomass	
Average 1995-2004	5,441,000 lb (4,587,250 – 7,037,310)
MSC recommended yield limit for 2006	1,087,000 lb
Actual yield limit for 2006 (HRG)	1,087,000 lb

Lake Michigan

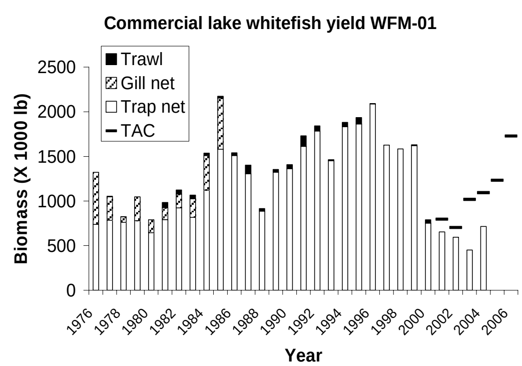
WFM-01 (Bays de Noc)

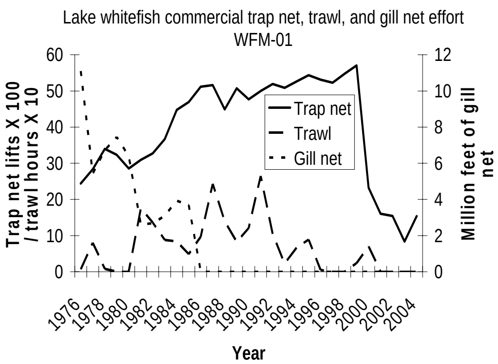
Prepared by Philip J. Schneeberger

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

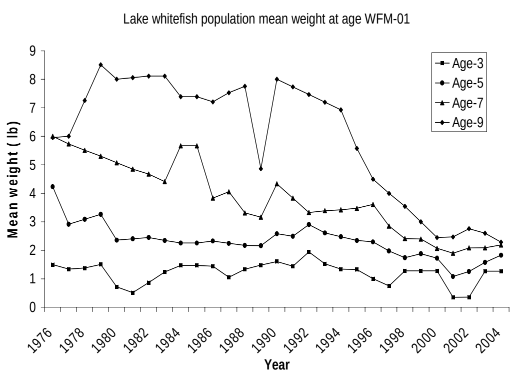
Waters in WFM-01 (380,652 total surface acres) offer extensive areas where suitable habitat is available and is likely used by spawning whitefish. The Big Bay de Noc Shoal is documented as being a very important area for lake whitefish reproduction. Fairly consistent favorable conditions on this shoal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

Trap-net yield for lake whitefish in WFM-01 was 715,000 pounds during 2004, up from 450,000 pounds in 2003. On a similar trajectory, trap-net effort was 1,541 lifts in 2004, up from 835 lifts in 2003. Both yield and effort declined between 1999 and 2003, before rebounding in 2004. Catch-per-unit effort decreased from 539 lbs/lift in 2003 to 464 lbs/lift in 2004, but was considerably higher than the 1976-2002 average CPUE of 294 lbs/lift. Commercial gill-netting in this management zone ceased after 1985.

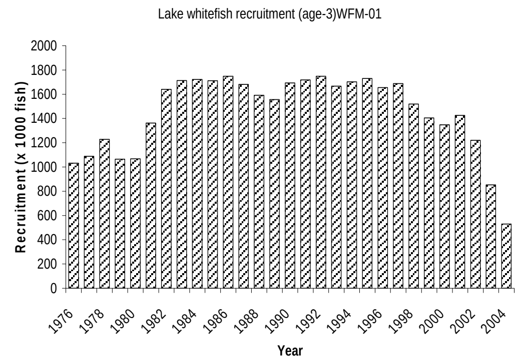




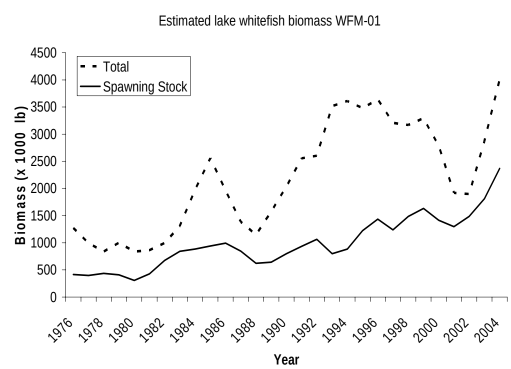
Compared to 2003, weight-at-age for WFM-01 lake whitefish in 2004 improved by an average of 11% across ages 5-7 and declined by an average of 4% for other ages. Weight-at-age values in 2004 were greater than 1996-2000 averages for young ages 2-3, but less than averages for ages 4-9+.



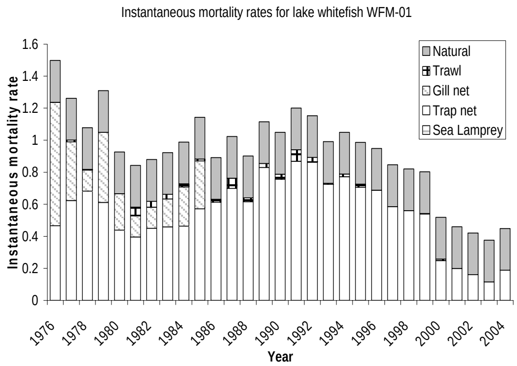
Estimated recruitment (numbers of age-3 fish) has decreased precipitously since 1997. The 2004 recruitment estimate of 530,000 lake whitefish was 58% less than average recruitment estimated for the previous 5-year period, 1999-2003.



Based on the latest model estimates, fishable biomass was 4.0 million pounds in 2004 and of this total, spawning stock biomass (2.4 million lbs) represented 59%. Fishable biomass fluctuated through the data series, trending consistently upward during the last three years. Spawning stock biomass has generally shown an increasing trend over the whole time series.



The 2004 estimate of total instantaneous mortality rate increased 16% from 2003, but was only half the average rate for the five years prior to the 2000 Consent Decree (1995-1999). Total instantaneous mortality rate (Z) was estimated at 0.45 y^{-1} in 2004, with 0.26 y^{-1} attributable to instantaneous natural mortality rate (M) and 0.19 y^{-1} attributable to instantaneous fishing mortality rate (F). Instantaneous total mortality rates were considered excessively high from 1976 through 2000.



The projected 2006 yield limit for WFM-01 is 1.73 million lbs. This value is a 40% increase from the 2005 yield limit of 1.23 million lbs. The increase was influenced by low harvest in 2004 relative to the yield limit (715,000 pounds vs. 1,093,000 lbs), continued low estimated mortality rates, and increasing biomass that offsets low estimated recruitment.

Summary Status WFM-01 Whitefish		
Female maturity		
	Size at first spawning	1.60 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.98 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	1.806 lb (1.800 - 1.812)
	Current SSBR	1.00 lb (0.94 - 1.06)
	SSBR at target mortality	0.2846 lb (0.2843 - 0.2849)
Spawning potential reduction		
	At target mortality	0.556 (0.523 - 0.587)
Average yield per recruit		0.505 lb (0.472 - 0.538)
Natural Mortality (M)		0.260 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	8
	Fully selected age to trap nets	7
	Fully selected age to trawls	6
	Average gill net F, ages 4+	0. y^{-1}
	Average trap net F, ages 4+	0.132 y^{-1} (0.115 - 0.150)
	Average trawl F, ages 4+	0. y^{-1}
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.392 y^{-1} (0.375 - 0.411)
Recruitment (age-3)	(1995-2004 average)	1,979,754 fish (1,596,060 - 2,547,010)
Biomass (age 3+)	(1995-2004 average)	6,831,273 lb (6,083,700 - 7,819,700)
Spawning biomass	(1995-2004 average)	3,437,083 lb (3,089,360 - 3,846,430)
MSC Recommended yield limit in 2006		1,730,000 lb
Actual yield limit in 2006		1,730,000 lb

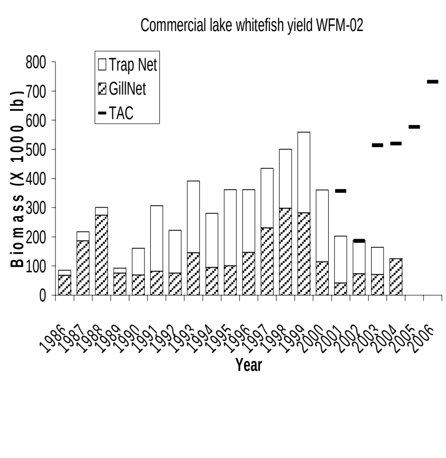
WFM-02 (Manistique)

Prepared by John K. Netto and Mark P. Ebener

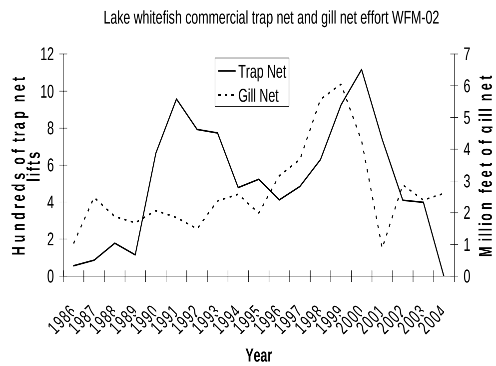
WFM-02 is located in the northwest portion of Lake Michigan. There are 387,000 surface acres of water less than 240 ft deep in the unit. The entire shoreline of WFM-02 lies within the Niagara Escarpment and is composed of dolomite limestone. The only known spawning population of whitefish in WFM-02 is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

WFM-02 has been an exclusive CORA fishing zone since 1985. One trap-net operation and up to four large gill-net boats have regularly fished WFM-02. Very little small-boat gill-net effort occurs in this unit. Besides whitefish, the large-boat gill-net fishery routinely targets bloater chubs in offshore waters. The unit is 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 pounds in 1986 to a maximum yield of 559,000 pounds in 1999. The average yield from 1986 to 2004 was 280,000 lbs.

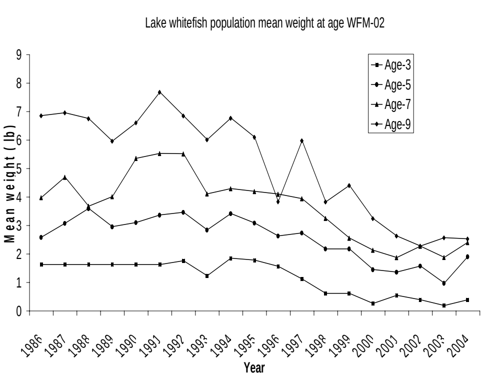


The increase in yield from WFM-02 during the 1990's was due to substantial increases in fishing effort. Large-mesh gill-net effort peaked at 4.5 million ft in 1999, but then declined substantially in subsequent years.



Trap-net effort peaked at 1114 lifts in 2000 then declined to a low of 0 lifts in 2004.

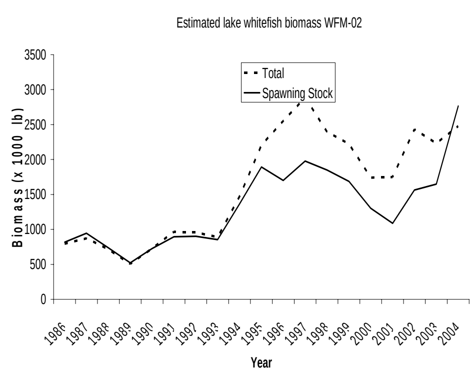
Mean weight of nearly all age classes of whitefish declined continually after 1986 but has remained relatively stable since 2000.



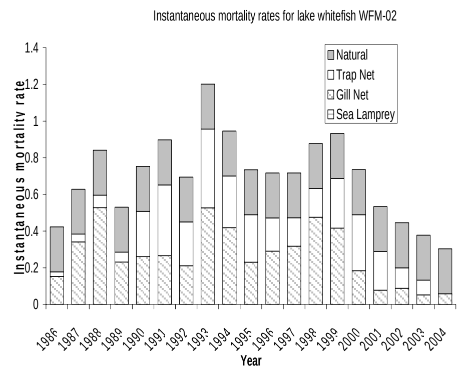
Predicted recruitment of age 3 whitefish to the fishable population in WFM-02 varied 29-fold from 1986 to 2002. The stock assessment model estimated that the 1997-year class contained 945,000 fish at age 3, compared to only 29,000 fish for the 1984-year class at age 3. Recruitment of age 3 whitefish to the fishable population averaged 446,000 fish from 1986 to 2004 and 650,000 fish from 1993 to 2004. 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 2001. The stock assessment model estimated that fishable stock biomass increased from 2002 to the present.

Spawning stock biomass has followed the same trends as population biomass. Spawning stock biomass peaked in 1997 and the estimates for spawning stock biomass from 2002 to 2004 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 0.13 y^{-1} during 2002-2004 compared to a fishing mortality rate of 0.61 y^{-1} from 1990 to 1999.



Total annual mortality of age-4 and older whitefish was lower than the target mortality rate of 1.05 from 2002 to 2004. The projection model estimate for 2006 total allowable harvest was 732,000 lb, which is greater than any single-year harvest in the time series. The HRG for 2006 was set at 577,000 lb, which is equal to the HRG in 2005.

Summary Status WFM-02 Whitefish		
Female maturity		
	Size at first spawning	0.33 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.49 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.521 lb (SE 0.04)
	Current SSBR	1.58 lb (SE 0.04)
	SSBR at target mortality	0.259 lb (SE 0.001)
Spawning potential reduction		
	At target mortality	0.627 (SE 0.016)
Average yield per recruit		0.566 lb (SE 0.023)
Natural Mortality (M)		0.245 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.066 y^{-1} (SE 0.007)
	Average trap net F, ages 4+	0.064 y^{-1} (SE 0.005)
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.376 y^{-1} (SE 0.011)
Recruitment (age-3)	(1995-2004 average)	650,090 fish (SE 77,719)
Biomass (age 3+)	(1995-2004 average)	2,289,800 lb (SE 157,170)
Spawning biomass	(1995-2004 average)	1,748,100 lb (SE 116,510)
MSC recommended yield limit in 2006		732,000 lb
Actual yield limit in 2006 (HRG)		577,000 lb

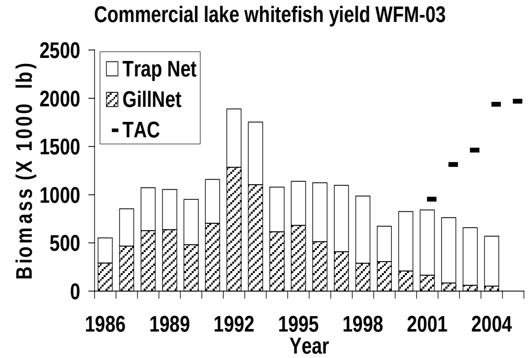
WFM-03 (Naubinway)

Prepared by Mark P. Ebener

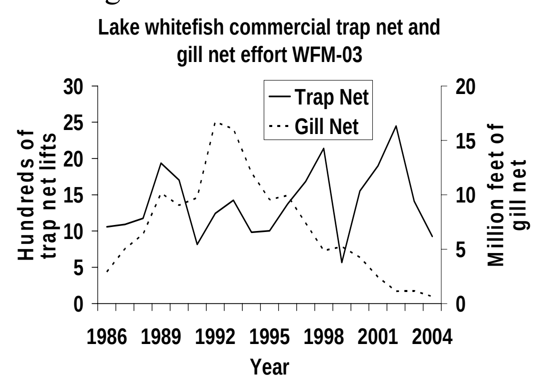
WFM-03 is located in northern Lake Michigan. The unit extends from the Straits of Mackinaw west to Seul Choix Point and is bounded on the south by Beaver Island and complex of shoals and islands that surround the island. Nearly the entire unit is shallow water less than 90 ft deep. There are 483,000 surface acres of water less than 240 ft deep. Large spawning aggregations are associated with the area between Epoufette and Naubinway, Michigan, and in the Straits of Mackinaw along the upper and lower Peninsulas

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

The commercial fishery yield from WFM-03 averaged 1.0 million pounds during 1986-2004. The trap-net fishery yield averaged 529,500 pounds and the gill-net fishery yield averaged 472,800 pounds during 1986-2004. Total fishery yield peaked at 1.89 million pounds in 1992 and 1.75 million pounds in 1993 and declined slowly thereafter. The trap-net yield was 517,000 pounds and the gill-net yield only 52,600 in 2004. The commercial yield in 2004 represented only 29% of the recommended harvest limit.



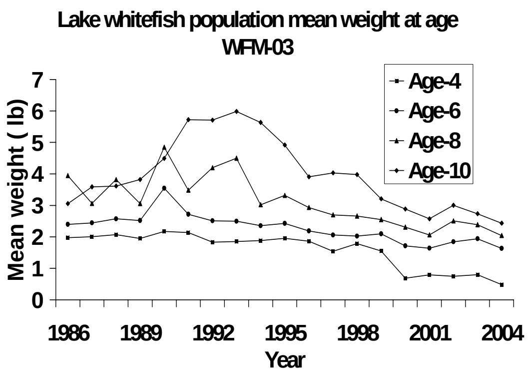
Fishing effort in WFM-03 has been highly variable. Gill-net fishing effort increased from 2.9 million ft in 1986 to 16.7 million ft in 1992 then declined to only 0.6 million ft in 2004. Trap-net effort increased from 817 lifts in 1991 to 2,447 lifts in 2002 before declining to 926 lifts in 2004.



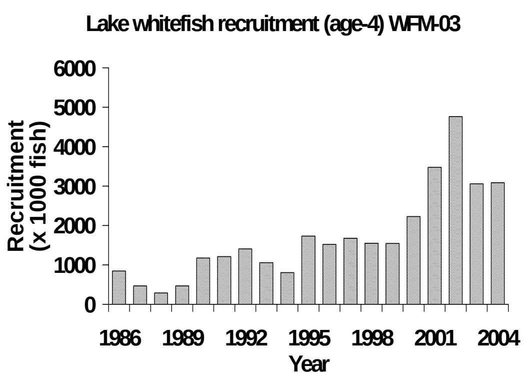
Whitefish in WFM-03 are of small size. During 1986-2004 No1 whitefish made up 84%, mediums 13%, and jumbos 3% of the harvest from WFM-03. Mean weight of a harvested whitefish in 2004 was 2.4 pounds in the gill-net fishery and 2.1 pounds in the trap-net fishery.

Growth of whitefish in WFM-03 continued to decline during 2004. Although growth appeared to stabilize in 2003, mean weight of almost all age classes declined from 2003 to 2004. Mean weight for nearly all age classes was lower in 2004 than other years from

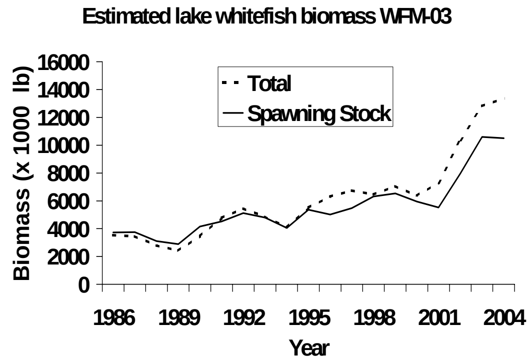
1986 to 2004, with the exception of 2001.



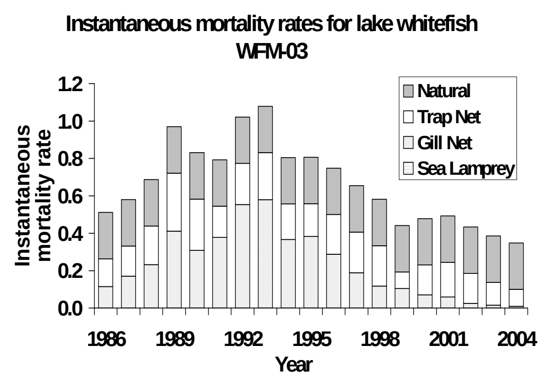
Recruitment of age-4 whitefish was fairly consistent and high in WFM-03. Recruitment increased from an average of 518,000 fish from 1986 to 1989, to 1.1 million from 1990 to 1994, to 1.6 million fish from 1995 to 1999, and 3.3 million from 2000 to 2004. Recruitment of age-4 whitefish was estimated to be 3.1 million fish in 2004.



Biomass of age-4 and older whitefish has been fairly stable in WFM-03. Total biomass ranged from 2.4 to 13.4 million pounds from 1986 to 2004 and averaged 6.2 million lb. Spawning-stock biomass ranged from 2.8 to 10.6 million pounds from 1986 to 2004 and averaged 5.5 million lb. The declines in growth rate since 1993 have meant that spawning biomass of whitefish does not increase at the same rate as recruitment or total biomass. In 2004 total estimated biomass was 13.4 million pounds and spawning biomass was 10.5 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 0.51 y^{-1} in 1986 to 1.08 y^{-1} in 1993, and then declined to 0.35 y^{-1} in 2004. Gill-net induced mortality increased from 0.11 y^{-1} in 1986 to 0.60 y^{-1} in 1993 then declined to 0.01 y^{-1} in 2004. Trap-net mortality was fairly stable ranging from 0.15 y^{-1} to 0.27 y^{-1} during the period from 1986 to 2004. Natural mortality was estimated to be 0.25 y^{-1} in WFM-03 and has been greater than total fishing mortality every year since 1999. Trap-net and gill-net mortality was estimated to be 0.01 y^{-1} and 0.09 y^{-1} in 2004.



Total annual mortality on fully vulnerable age-classes was less than the target rate from 2002 to 2004. Further, the spawning potential reduction at current mortality rates and at the target mortality rate was greater than 0.20.

Consequently, the projection model estimated that fishing mortality could be increased 2.24 times. The projected harvest limit for 2006 under this increased fishing rate was estimated to be 3.35 million pounds. Unfortunately the stock assessment model was not very stable and MCMC simulations did not meet MSC guidelines, consequently a harvest regulating guideline of 1.97 million pounds was adopted by the TFC as the harvest limit in WFM-03 for 2006.

Summary Status WFM-03 Whitefish		Value & units
Population statistic	Description	(standard error)
Female maturity		
	Size at first spawning	0.68 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.33 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.536 lb (SE 0.004)
	Current SSBR	1.38 lb (SE 0.03)
	SSBR at target mortality	0.125 lb (SE 0.000)
Spawning potential reduction	At target mortality	0.544 (SE 0.012)
Average yield per recruit		0.569 lb (SE 0.012)
Natural Mortality (M)		0.248 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to gill nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.02 y^{-1} (SE 0.001)
	Average trap net F, ages 4+	0.142 y^{-1} (SE 0.009)
Sea lamprey mortality (ML)	Average ages 4+ 2002-2004	N/A
Total mortality (Z)	Average ages 4+ 2002-2004	0.409 y^{-1} (SE 0.009)
Recruitment	Average @ age 4 1995-2004	2,462,800 fish (SE 232,300)
Biomass	Average ages 4+ 1995-2004	8,229,100 lb (SE 546,280)
Spawning biomass	Average ages 4+ 1995-2004	6,923,700 lb (SE 412,600)
MSC recommended yield limit in 2006		3,348,000 lb
Actual yield limit in 2006 (HRG)		1,970,000 lb

WFM-04 (Beaver Island)

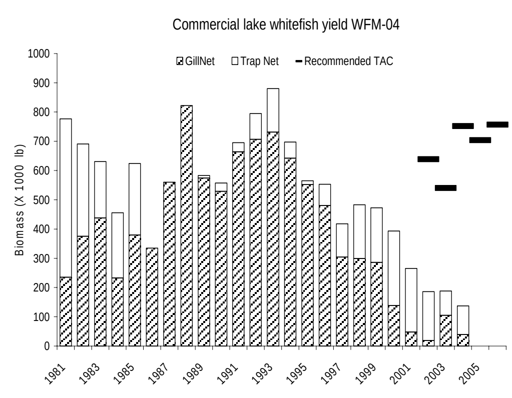
Prepared by Stephen J. Lenart

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

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

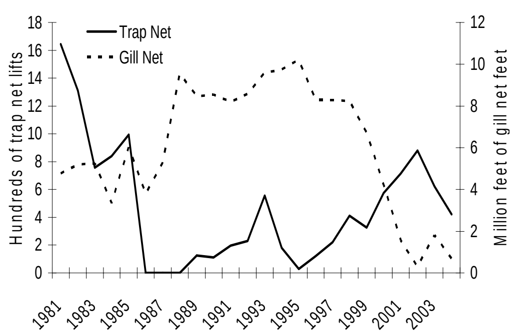
WFM-04 has been an exclusive commercial fishing zone for the CORA fishery since 1985. Much of the western half of the unit is designated as a lake trout refuge where retention of lake trout by recreational or commercial fishers is prohibited. The eastern portion of WFM-04 along the Lower Peninsula of 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 pounds during this period. After 1985, the gill-net fishery dominated, accounting for more than 93% of the total commercial yield from 1986 to 1996 (no trap-net operations were active for the first three years of this period). Commercial yield peaked at 880,000 pounds in 1993, but has steadily declined ever since. This decline can be attributed to a shrinking gill-net fishery, which has harvested, on average, 70,000 pounds of whitefish per year during 2000 to 2004. Total commercial yield was 137,000 pounds in 2004, a low for the time series.



Fishing effort in WFM-04 has been quite variable through the years. After an average of more than 1,100 lifts per year from 1981 to 1985, trap-net effort declined to zero for the first three years following the 1985 Agreement. Effort then remained low through the mid-1990s (average of 200 lifts during 1989 to 1996). During the period from 1997 to 2002, trap-net effort steadily increased, reaching 881 lifts in 2002. Trap-net effort declined to 421 lifts in 2004. In contrast, gill-net effort has progressively declined since 1995, when more than 10 million ft of gill-net effort was reported. The decline in gill-net effort in recent years followed as a consequence of the 2000 Consent Decree with the conversion of gill-net fisheries to trap-net fisheries. From 1985 to 1999, average gill-net effort was approximately 8 million feet per year. Since 2000, average effort has declined to 1.7 million feet per year.

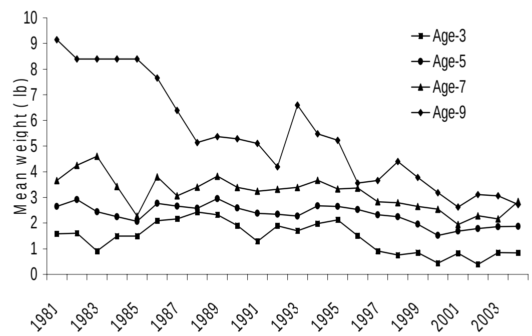
Lake whitefish commercial trap net and gill net effort WFM-04



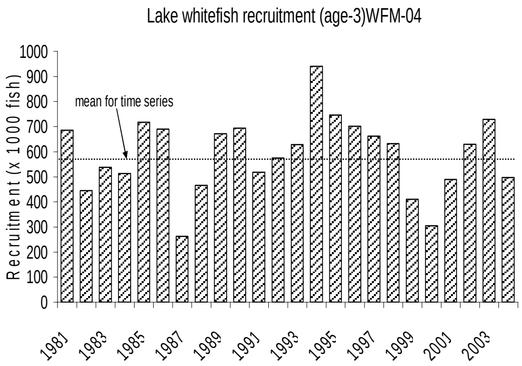
Whitefish in WFM-04 are of moderate size compared to other management units. Annual mean weight of a harvested whitefish in the trap-net fishery ranged from 2.0 to 3.3 pounds during the period from 1981 to 2004. The mean weight of whitefish harvested in the 2004 trap-net fishery was 2.7 lb, the highest since 1996. Annual mean weight of a whitefish harvested in the gill-net fishery ranged from 2.6 to 3.5 pounds during the period from 1981 to 2004. 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 pounds in 1981 to 2.6 pounds 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 2000, however, growth has stabilized or increased slightly for the younger age classes.

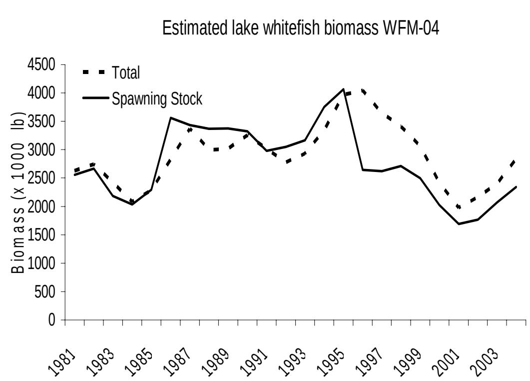
Lake whitefish population mean weight at age WFM-04



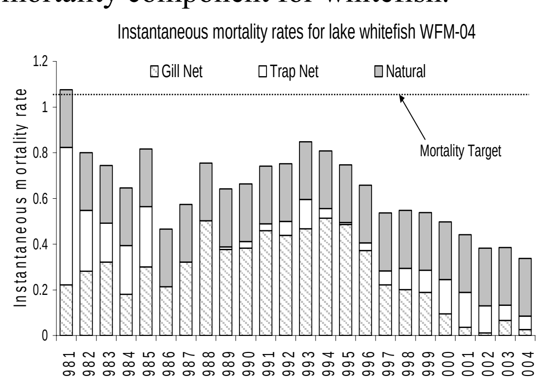
Recruitment of age-3 whitefish to the population in WFM-04 is quite stable, in contrast to other Lake Michigan management units. Average estimated recruitment of age-3 whitefish in WFM-04 was 589,000 fish during 1981 to 2004. Annual recruitment varied from 237,000 to 843,000 fish during this time period. Average estimated recruitment during 2000 to 2004 was 530,000 age-3 fish, slightly lower than the long term average for the unit.



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 pounds during the period from 1981 to 2004, 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 2004, estimated spawning-stock biomass ranged from a high of 3.7 million pounds in 1995 to a low of 1.5 million pounds in 2001. Both spawning stock and total biomass have increased annually since 2001. In 2004, estimated spawning-stock biomass was approximately 2.34 million lb.



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 0.85 y^{-1}. Prior to this, total mortality ranged from 1.08 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 in WFM-04 from 1986 to 1999, when instantaneous gill-net mortality ranged from 0.19 y^{-1} to 0.51 y^{-1} (average 0.37 y^{-1}). From 2000 to 2004, gill-net mortality was significantly lower, averaging 0.05 y^{-1}, and the trap-net fishery was the primary source of fishing mortality (F) in WFM-04 (average trap-net mortality was 0.11 y^{-1} during this period). Trap-net mortality was estimated to be 0.059 y^{-1} in 2004, while estimated gill-net mortality was 0.025 y^{-1}. Natural mortality (estimated to be 0.23 y^{-1}) exceeded total fishing mortality from 2000 to 2004 and was the largest single mortality source in WFM-04 from 1997 to 2004. 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.



The average total mortality rate of age-4+ whitefish was 0.37 y^{-1} during 2002 to 2004, well below the maximum target rate of 1.05 y^{-1}. The spawning potential reduction in 2004 was 0.645. Thus, the projection model estimated that fishing effort could be increased three-fold from the effort levels recorded from 2002 to 2004. The 2006 model-generated yield limit of 757,000 pounds represented a slight increase from the 2005 recommended limit of 704,000 lb. This increase can mainly be attributed to declining mortality rates in recent years.

No substantive changes in model structure were made from last year's assessment. However, selectivity in the gill-net fishery continues to be problematic and future work may include an evaluation of other methods for modeling selectivity. 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 compared to the double-logistic method.

The 2006 recommended yield limit of 757,000 pounds 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	1.50 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.835 lb (2.826 - 2.844)
	Current SSBR	1.83 lb (1.75 - 1.91)
	SSBR at target mortality	0.314 lb (0.3139 - 0.3142)
Spawning potential reduction		
	At target mortality	0.645 (0.620 - 0.672)
Average yield per recruit		0.551 lb (0.511 - 0.585)
Natural Mortality (M)		0.253 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.034 y^{-1} (0.029 - 0.039)
	Average trap net F, ages 4+	0.081 y^{-1} (0.071 - 0.092)
Sea lamprey mortality (ML)		not estimated
Total mortality (Z)		
	Average ages 4+,2002-2004	0.368 y^{-1} (0.354 - 0.382)
Recruitment (age-3)	(1995-2004 average)	580,140 fish (511,500 - 676,900)
Biomass (age 3+)	(1995-2004 average)	2,991,300 lb (2,789,530 - 3,277,990)
Spawning biomass	(1995-2004 average)	2,443,100 lb (2,280,750 - 2,673,720)
MSC Recommended yield limit for 2006		757,000
Harvest Regulation Guideline (HRG) adopted by CORA for 2006		757,000

WFM-05 (Grand Traverse Bay)

Prepared by Mark P. Ebener and Erik J. Olsen

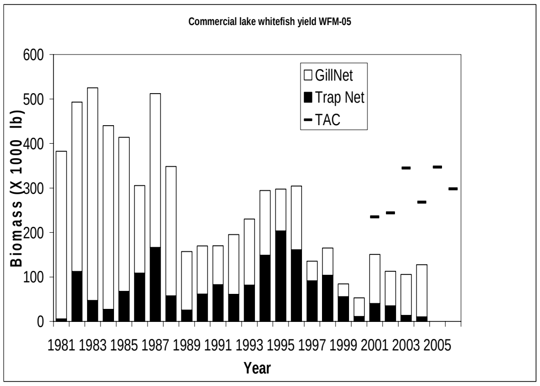
Management unit WFM-05 encompasses the area from Little Traverse Bay through Grand Traverse Bay and offshore waters of Lake Michigan north and west of the Leelanau Peninsula. Much of WFM-05 contains water >240 ft. deep including the both the east and west arms of Grand Traverse Bay. The deepest parts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

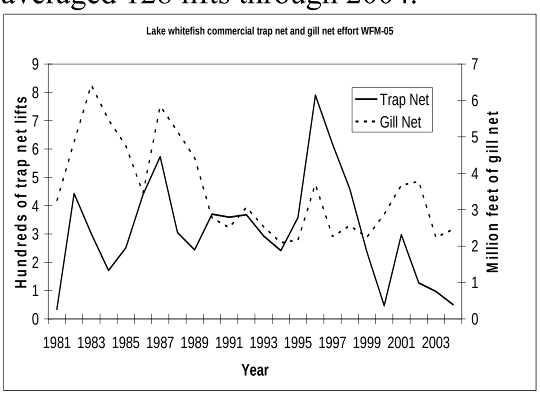
WFM-05 has been an important tribal fishing area since the 1970s. Much of the tribal fishing activity that occurred prior to and immediately after re-affirmation of Treaty-reserved fishing rights took place in Grand Traverse Bay. CORA small-boat fishers relied on Grand Traverse Bay as an important fishing 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 pounds in 1983 and 1984, but by then jumbo whitefish made up only 30% of the yield.

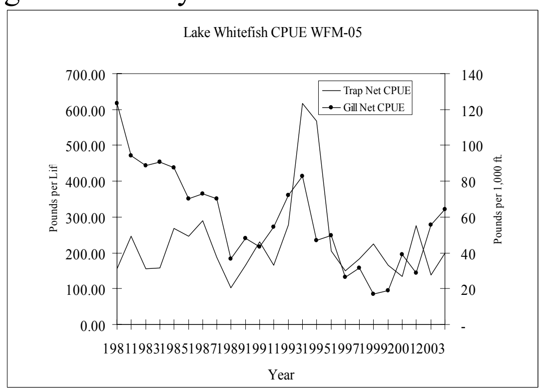
Commercial yields of lake whitefish during the 1990s were substantially less than during the 1980s. The commercial yield averaged 383,000 pounds from 1980 to 1989 and 205,000 pounds fromg 1990 to 1999. The fishery declined through the late 1990s with the lowest recorded yield coming in 2000 at 53,000 lb. The fishery has rebounded slightly through 2004, averaging 124,000 pounds 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 from 1984 to 1989 and has held relatively stable since; whereas trap-net effort has varied, but with a downward trend since 1996. Gill-net effort declined from 6.4 million ft. in 1983 through 1990. Since then, the large-mesh gill-net fishery has averaged 2.7 million feet annually. Trap-net effort has varied annually between 200 and 800 lifts during the period from 1982 to 1999. Through the 1990s, trap-net effort averaged 409 lifts per year, peaking at 790 lifts in 1996. Since reaching a low of 47 lifts in 2000, trap-net effort has averaged 128 lifts through 2004.



The decline in yield of whitefish in WFM-05 has mirrored the decline in lake whitefish recruitment within this management unit. CPUE of whitefish in the large-mesh gill-net fishery declined from 153 pounds per 1,000 ft. of gill net in 1979 to a low of 16 pounds per 1000 ft. in 1999. Since 2000, gill-net CPUE has steadily increased to 64 pounds in 2004. In contrast, from 1981 to 1999 the CPUE of whitefish in the trap-net fishery has been remarkably stable holding between 150 and 300 pounds per lift, except for 1994 and 1995. From 2000 to 2004, trap-net CPUE averaged 183 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 growth that makes the net highly visible to whitefish. Whatever the cause, it is evident that something has reduced catch rates of whitefish to the large-mesh gill-net fishery in the unit.

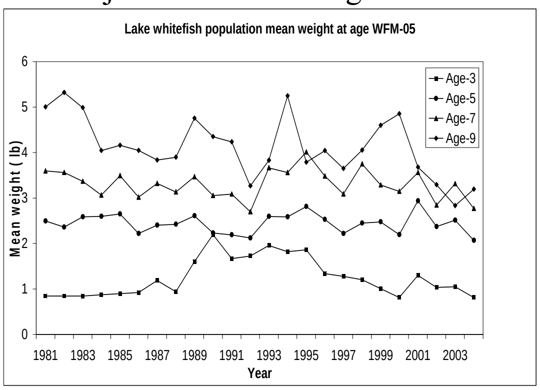


Whitefish from WFM-05 are currently of small to moderate size. From 2000 to 2004, the proportion of the yield made up of the three size classes of whitefish were 73% No.1 (< 3 lb), 21% mediums (3-4 lb), and 6% jumbos (≥ 4 lb). This compares with 65% No.1, 22% mediums, and 13% jumbos from 1980 to 1989 and 65% No.1, 20% mediums, and 15% jumbos from 1990 to 1999.

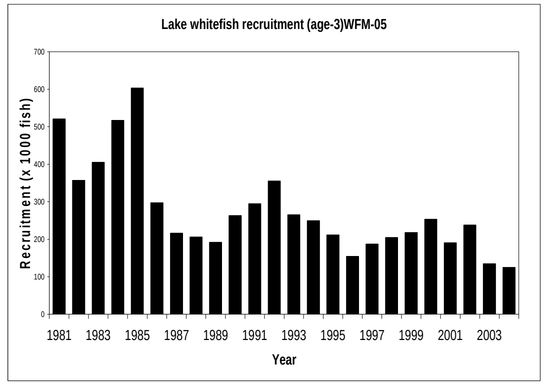
As illustrated earlier, size structure of whitefish in the yield from WFM-05 has changed over time, as the proportion of jumbos declined and the proportion of No.1 whitefish increased. Annual mean weight of whitefish sampled from trap-net harvests ranged from 2.0 to 3.6 pounds since 1979 and averaged 2.1 pounds during the last three years (2002-2004). Annual mean weight of whitefish in the gill-net harvest ranged from 2.4 to 3.5 pounds since 1979 and averaged 2.9

pounds during the last three years (2002-2004).

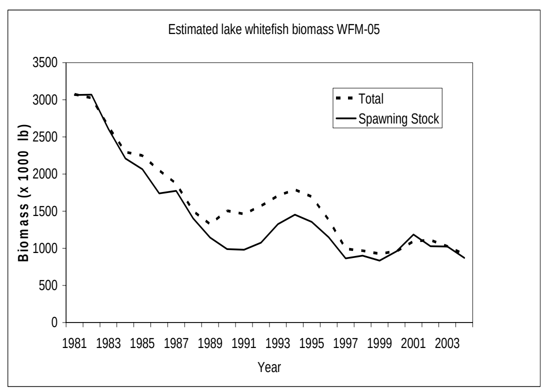
While relatively stable, mean weights of lake whitefish (ages 3-9) from WFM-05 have been slowly declining since 1981. This pattern of declining growth is also being observed in other areas of Lakes Michigan and Huron, including substantial declines in areas adjacent to this management unit.



Recruitment of age-3 whitefish to the population in WFM-05 is highly variable and has generally declined since the 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 1995 to 2004 only 191,600 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 1981-2004 timeframe with 3.1 million lb. This steadily declined to 1.3 million pounds in 1989, rebounded to 1.8 million pounds in 1994 and has leveled out at approximately 999,000 pounds from 1997 to 2004. Spawning stock biomass also followed the same trend, peaking at 3.1 million pounds in 1981 and holding at about 958,000 pounds since 1997.



Fishing mortality (F) in WFM-05 has historically been split about equally between the gill-net and trap-net fisheries. During the period from 2002 to 2004, gill-net mortality has held relatively steady, while trap-net mortality has declined due to reduced effort. Average fishing-induced mortality on whitefish ≥ age 4 averaged 0.13 for the large-mesh gill-net fishery and 0.03 for the trap-net fishery from 2002 to 2004. 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.

Total annual mortality on the fishable stock in WFM-05 during 2002-2004 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 47% from 2002 to 2004 and the spawning potential reduction value was 0.51. Consequently, the projection model estimated that fishing mortality could be increased 3.47 times in WFM-05 in 2006 from the average value during the period from 2002 to 2004. The projected yield associated with this level of fishing was 298,000 lb, and this was also accepted as the HRG in 2006.

Summary Status WFM-05 Whitefish		
		Value (95% Probability Interval)
Female maturity		
	Size at first spawning	0.97 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.63 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.919 lb (2.907 - 2.930)
	Current SSBR	1.5 lb (1.40 - 1.59)
	SSBR at target mortality	0.391 lb (0.3908 - 0.3913)
Spawning potential reduction		
	At target mortality	0.514 (0.479 - 0.545)
Average yield per recruit		0.575 lb (0.544 - 0.612)
Natural Mortality (M)		0.309 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.134 y^{-1} (0.118 - 0.157)
	Average trap net F, ages 4+	0.028 y^{-1} (0.024 - 0.032)
Sea lamprey mortality (ML)		not estimated
Total mortality (Z)		
	Average ages 4+,2002-2004	0.471 y^{-1} (0.467 - 0.518)
Recruitment (age-3)	(1995-2004 average)	191,600 fish (170,906 - 212,942)
Biomass (age 3+)	(1995-2004 average)	1,106,900 lb (1,006,820 - 1,222,250)
Spawning biomass	(1995-2004 average)	1,017,000 lb (922,350 - 1,128,910)
MSC recommended yield limit in 2006		298,000 lb
Actual yield limit in 2006 (HRG)		298,000 lb

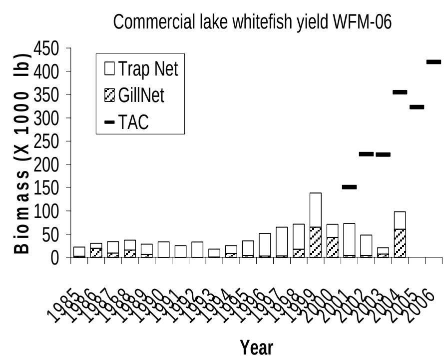
WFM-06 (Leland - Frankfort)

Prepared by Randall M. Claramunt and Philip J. Schneeberger

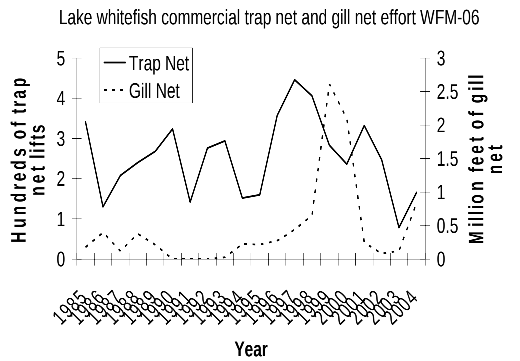
Lake whitefish management unit WFM-06 is located in 1836 Treaty waters west of the Leelanau Peninsula from about Cathead Point south to Arcadia. Surface area for this unit is 945,156 acres (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include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

WFM-06 was reserved for State-licensed commercial trap-net-fishing operations from 1985 through 1999, except that tribal gill-netting was allowed in grid 714. Most State-licensed trap-net effort and harvest is reported from grids 812-814 and 912. Beginning in 2000, WFM-06 became a shared zone in a truer sense of the term, and waters were opened to both State and tribal fishers. Since 2000, State-licensed effort has declined and the majority of yield is from tribal effort (trap and gill nets).

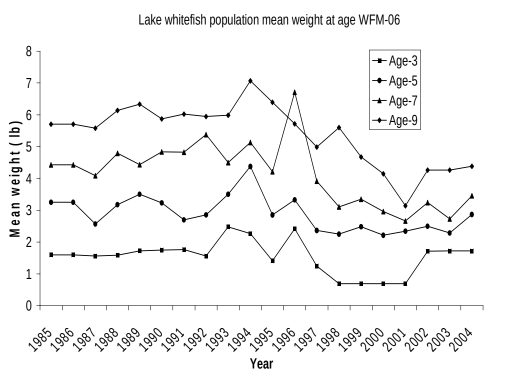
Yield for 2004 was 98 thousand pounds in WFM-06, up from 21 thousand pounds in 2003, and up from the 1985-2003 average of 45.5 thousand lbs. Of the total in 2004, trap-net yield was 37.9 thousand pounds (38.5 %) and gill-net yield was 60.5 thousand pounds (61.5 %). Proportions of yield by gear type have varied considerably from year to year with an average split of 71% from trap nets and 29% from gill nets between 1985 and 2004.



Trap-net effort increased by a factor of 2.1 from 2003 to 2004 while gill-net effort increased by a factor of 6.7. The 2004 trap-net effort (166 lifts) was slightly lower than the 1985-2003 average (259 lifts), and gill-net effort (833,160 ft) was substantially higher in 2004 than for the 1985-2003 average (455,500 ft).

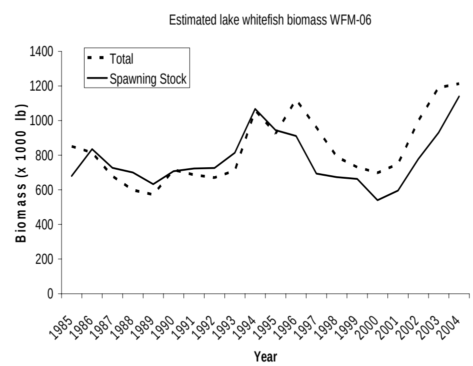


Lake whitefish weight-at-age in 2004 was relatively unchanged for most age groups from the 2003 values. Weight-at-age in 2003 and 2004 had increased from 1998 to 2001 for ages under 7 and from the declines in weight-at-age that was documented for fish ages 7 to 12+ since 1996. However, weight-at-age values in 2004 for fish aged 5-12+ were still 18% lower than the 1985-2003 averages.

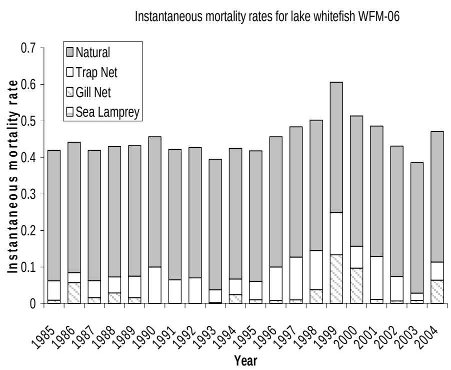


Recruitment, based on estimated numbers of age-3 fish, was lower in 2004 than any year since 1993. Estimates of recruitment were highest from 1994 to 1998 and from 2000 to 2002, and lowest for the time series from 1987 to 1988.

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 2004. Values estimated for 2004 were 1213 thousand pounds for fishable biomass and 1140 thousand pounds for spawning stock biomass. The ratio of spawning stock biomass to fishable biomass was 0.94 in 2004.



Total instantaneous mortality rate (Z) in 2004 was 0.47 y^{-1}, showing an increase in the rate for the first time since 1998. Based on current estimates, the 2004 rate for Z is similar to the average of 0.45 y^{-1} for 1985-2003. Instantaneous fishing mortality rates (F) have varied considerably for trap nets and gill nets throughout the time series. During 2004, F was low and similar for both fishery types. Estimates for F were 0.049 y^{-1} for trap nets and 0.064 y^{-1} for gill nets. The 2004 estimate for instantaneous natural mortality rate was 0.36 y^{-1}, still the largest source of lake whitefish mortality in WFM-06.



The 2006 recommended yield limit is 420 thousand pounds, which is a slight increase from the limit calculated for 2005 of 323 thousand pounds. Based on the 2006 projection model, the level of effort inWFM-06 may increase above that of 2005. The actual yield limit was equal to the recommended limit.

Summary Status WFM-06 Whitefish		
Female maturity		
	Size at first spawning	1.72 lb
	Age at First Spawning	3 y
	Size at 50% maturity	2.21 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.743 lb (SE 0.005)
	Current SSBR	2.13 lb (SE 0.07)
	SSBR at target mortality	0.518 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.776 (SE 0.026)
Average yield per recruit		0.351 lb (SE 0.039)
Natural Mortality (M)		0.357 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.024 y^{-1} (SE 0.004)
	Average trap net F, ages 4+	0.042 y^{-1} (SE 0.006)
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.423 y^{-1} (SE 0.01)
Recruitment (age-3)	(1995-2004 average)	175,640 fish (SE 20,211)
Biomass (age 3+)	(1995-2004 average)	937,780 lb (SE 120,780)
Spawning biomass	(1995-2004 average)	787,060 lb (SE 105,830)
MSC recommended yield limit in 2006		420,000 lb
Actual yield limit in 2006		420,000 lb

WFM-07 (Ludington)

Prepared by Archie W. Martell Jr.

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

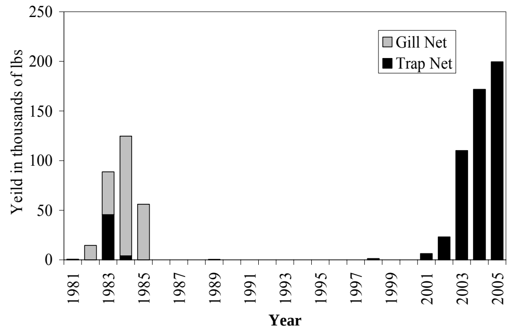
Since 2000, WFM-07 has been a Tribal commercial fishing zone for lake whitefish, part of the Little River Zone with tribal fishing regulated under permitting control of the Little River Band of Ottawa Indians (LRBOI). From 1985 through 2000 there was no significant State commercial fishing effort and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

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 at age information. Pursuant to the 2000 Consent Decree, the tribes had three years of allowable commercial fishing without harvest limits in this unit. During the initial three-year period of Tribal commercial trap-net fishing activity from 2001 to 2003, the tribes were limited to an effort restriction of two trap-net operations with twelve nets each.

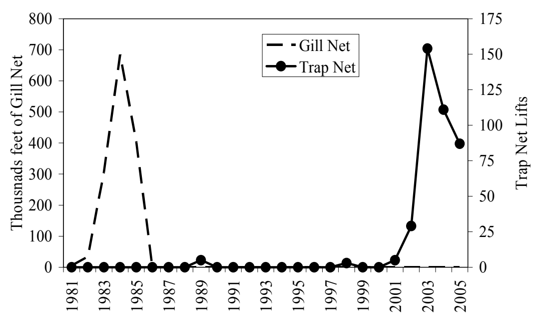
At the conclusion of the 2003 fishing season, three years of commercial trap-net fishing activity for lake whitefish was completed by Tribal fishers within this unit. Pursuant to the 2000 Consent Decree and the Tribal Management Plan, in 2004 an annual Harvest Regulation Guideline (HRG) for lake whitefish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

Commercial fishing harvest of lake whitefish for the period from 1981 to 2005 peaked at 199,570 pounds in 2005 represented by 87 trap-net lifts. 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 pounds from 5 trap-net lifts. In 2002, Tribal commercial harvest was 23,165 pounds with 29 trap-net lifts. In 2003, Tribal commercial harvest was 110,080 pounds with an effort of 154 trap-net lifts. In 2004 Tribal commercial lake whitefish harvest was 171,755 pounds from 112 trap-net lifts.

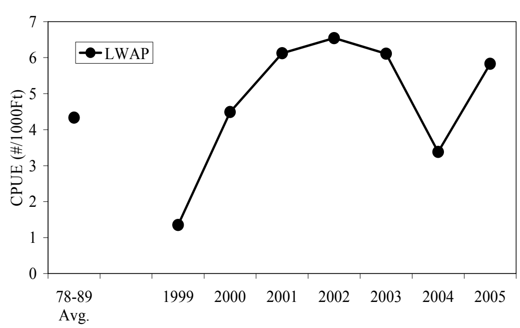
WFM-07 Commercial Fishery LWF Yield



WFM-07 Commercial Fishing Effort



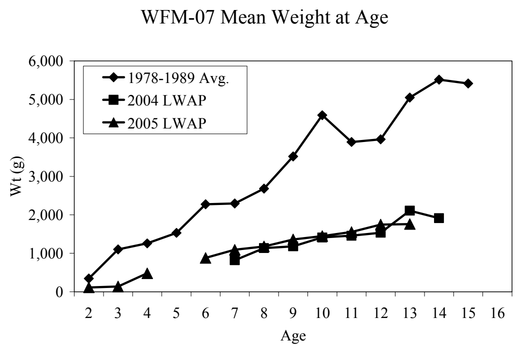
WFM-07 Lake Whitefish Assessment CPUE



Spring LWAP assessment graded-mesh gill-net (GMGN) survey CPUE of lake whitefish in WFM-07 were higher from 2000 to 2003 and in 2005 as compared to historical levels represented by the 1978-1989 average. The 1999 and 2004 LWAP CPUE were lower than both the historical average and the 2000-2003 and 2005 CPUE's for lake whitefish. Historical graded-mesh gill-net CPUE of 4.3/1,000 feet for lake whitefish from spring surveys is represented by the 1978-1989 average. From 1999 through 2005, graded-mesh gill-net surveys CPUE for lake whitefish in spring assessments ranged from 1.4, 4.5, 6.1, 6.5, 6.1, 4.3, and 5.8 per 1,000 feet respectively.

The 2005 mean length of lake whitefish sampled in spring GMGN surveys decreased to just below 18 inches and is lower than seen in previous surveys. The 2004-2005 commercial lake whitefish samples have maintained a mean length of over 20 inches, which is larger than the 2001-2003 samples. The mean length of the lake whitefish within this unit are still below those of the 1978-1989 average and 1983 commercial samples of over 23 inches. The 2005 mean weights of lake whitefish indicated a slight decrease from both GMGN surveys and commercial samples as compared to 2004. The 2005 mean weights of lake whitefish from both the GMGN surveys (2.37 lbs) and commercial samples (2.86 lbs) in this unit are currently lower than the 1978-1989 average (6.84 lbs) and the 1983 commercial samples (5.54lbs). The mean age of lake whitefish for the 2005 GMGN survey was 7.7 yrs and the commercial samples was 10.9 yrs. The current data represents a current lake whitefish population with an older mean age as compared to the 1978-1989 GMGN survey mean of 4.8 yrs and the 1983 commercial sample of 7.3 yrs.

The 2004 and 2005 mean weight-at-age of lake whitefish sampled in spring graded-mesh gill-net surveys is lower as compared to the GMGN survey 1978-1989 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) from the 1978 to 1989 spring graded-mesh gill-net surveys 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 2005 lake whitefish instantaneous total annual mortality rate (Z) from GMGN surveys was 0.19 y^{-1} for ages 7-13. The total annual mortality rates calculated for this lake whitefish stock has been far below the target maximum total annual mortality rate of Z = 0.65 y^{-1} as outlined in the 2000 Consent Decree.

The lake whitefish stocks within WFM-07 are relatively lightly exploited as compared to other management zones in northern Lake Michigan. There are indications that the abundance of lake whitefish are relatively stable and may be decreasing slightly 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 depressed weight at age and an increased mean stock age. Also the stock is showing indications of relatively stable mean lengths and mean weights since 2000 but is currently below historical means for both.

The WFM-07 2006 lake whitefish HRG of 500,000 pounds was developed and recommended by the Little River Band of Ottawa Indians (LRBOI) and adopted by CORA for implementation. The 2006 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 Technical Fisheries Committee's Modeling Sub-Committee 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
2005	GMGN	17.99	2.37	7.7
2005	CF	20.31	2.86	10.9

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

WFM-08 (Muskegon)

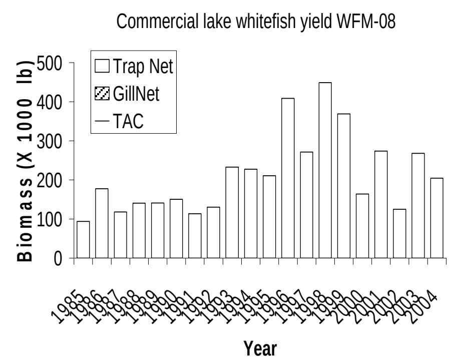
Prepared by Randall M. Claramunt and Philip J. Schneeberger

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 or deeper. More than three quarters of the trap-net effort and over 80% of the trap-net harvest is reported from grid 1810.

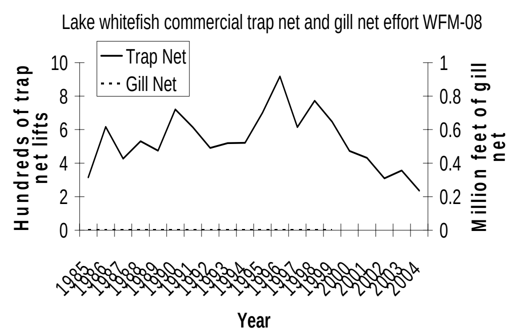
Although commercial exploitation and monitoring have occurred for many years, little is known about reproductive biology of the WFM-08 lake whitefish stock. Fish in this area are near the southern end of the distribution for lake whitefish.

Two State-licensed trap-net fishers operate in WFM-08 where minimum length for whitefish in commercial catches was 19 inches TL through 1999, then changed to 17 inches TL in 2000. Other management zones have had a 17-inch minimum size limit throughout the time series. Through 2004 there has been no gill-net harvest of lake whitefish in WFM-08.

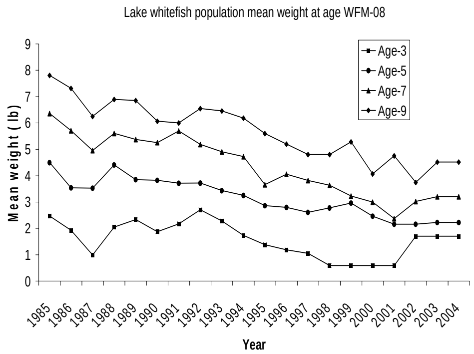
Lake whitefish yield from WFM-08 in 2004 was 204 thousand pounds. In 2004, yield decreased from 2003, but was similar to the 1985-2003 average of 214 thousand pounds. Trap-net effort decreased from 356 lifts in 2003 to 236 lifts in 2004.

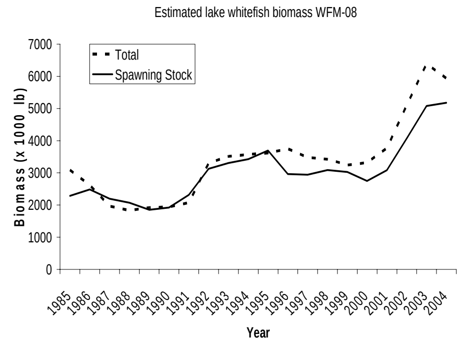


Effort in 2004 remains lower than the average from 1985 to 2003 of 550 lifts.

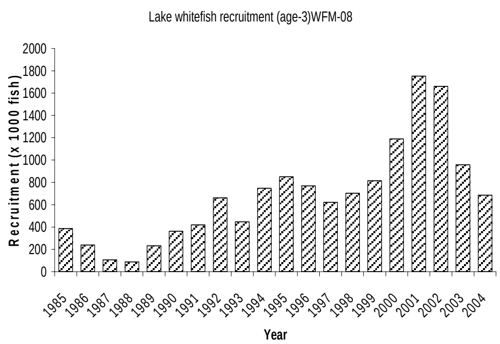


Weight-at-age data have trended downward from 1985 through 2002. In 2003 and 2004, weight-at-age increased or was stable for most of the age groups. Weight-at-age values in 2004 were 10% or less than averages for 1998 to 2002 for ages 4-9, but fish 10-years old and older were generally heavier than for corresponding ages averaged from 1998 to 2002.



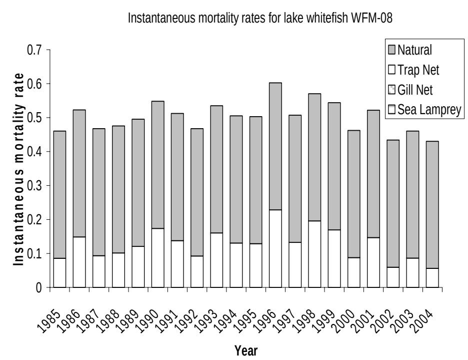


Recruitment, based on the estimated number of age-3 fish, was 686,000 in 2004. Estimates of recruitment were considerably higher (average 1,354,000) during the period from 1999 to 2002, but the estimate for 2004 was very similar to the 1985-2003 average of 684,000 age-3 fish.



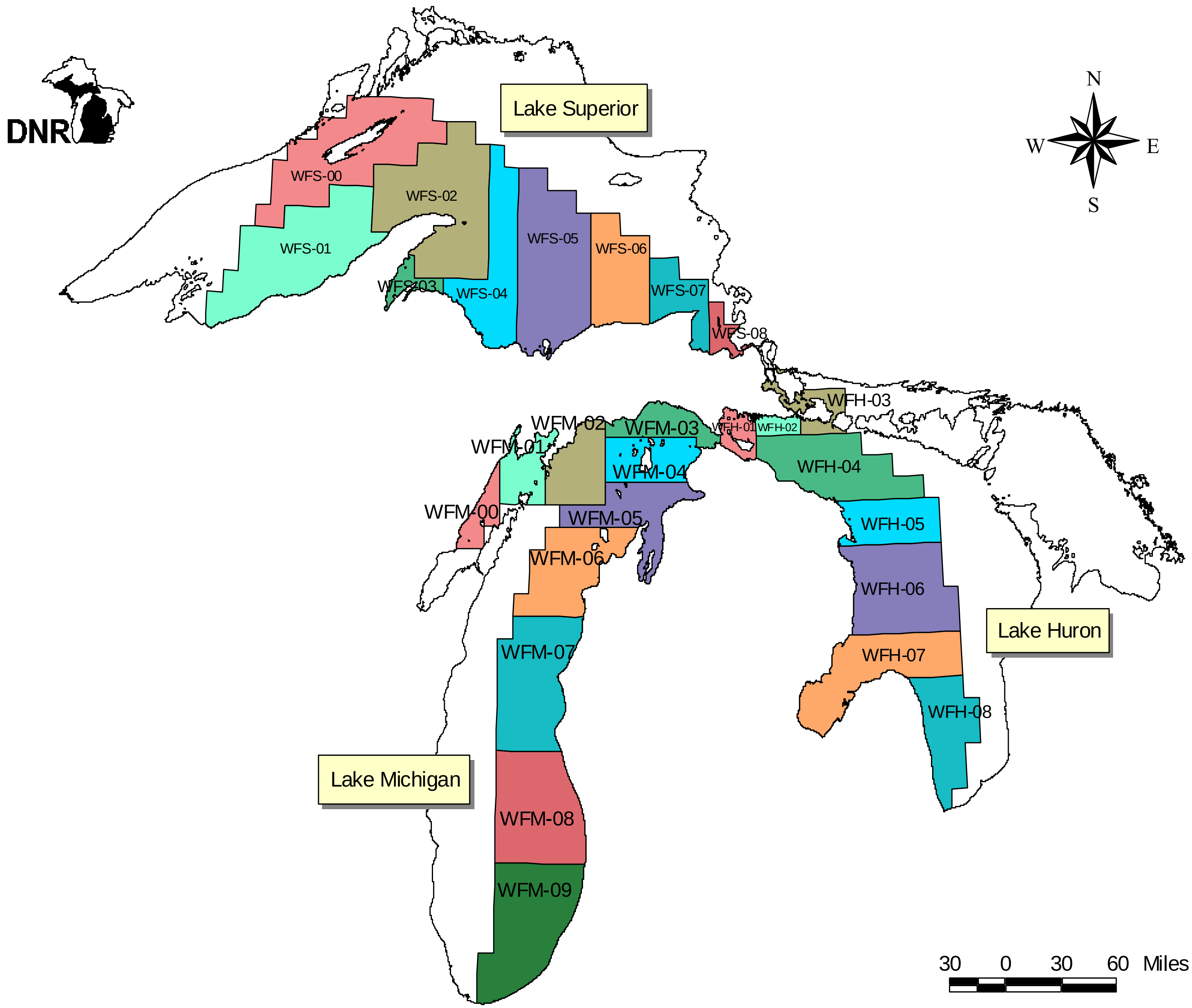
Up to 2003, estimates of fishable biomass and spawning stock biomass continued increasing trends that have persisted since the early 1990s. In 2004, however, fishable biomass and spawning stock biomass appear to have reached a plateau or carrying capacity for this stock. Fishable biomass was estimated at 5.9 million pounds and spawning stock biomass was 5.2 million pounds in 2004. The ratio of spawning stock biomass to fishable biomass was 0.87 in 2004, slightly lower than the 1985-2002 average ratio of 0.94.

Mortality rates have been relatively stable throughout the time series. Instantaneous total mortality rate (Z) was estimated at 0.43 y^{-1} during 2004. Components of the total rate consisted of 0.056 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 to 2004 and the ratio of F to Z averaged 0.25 from 1985 through 2004.

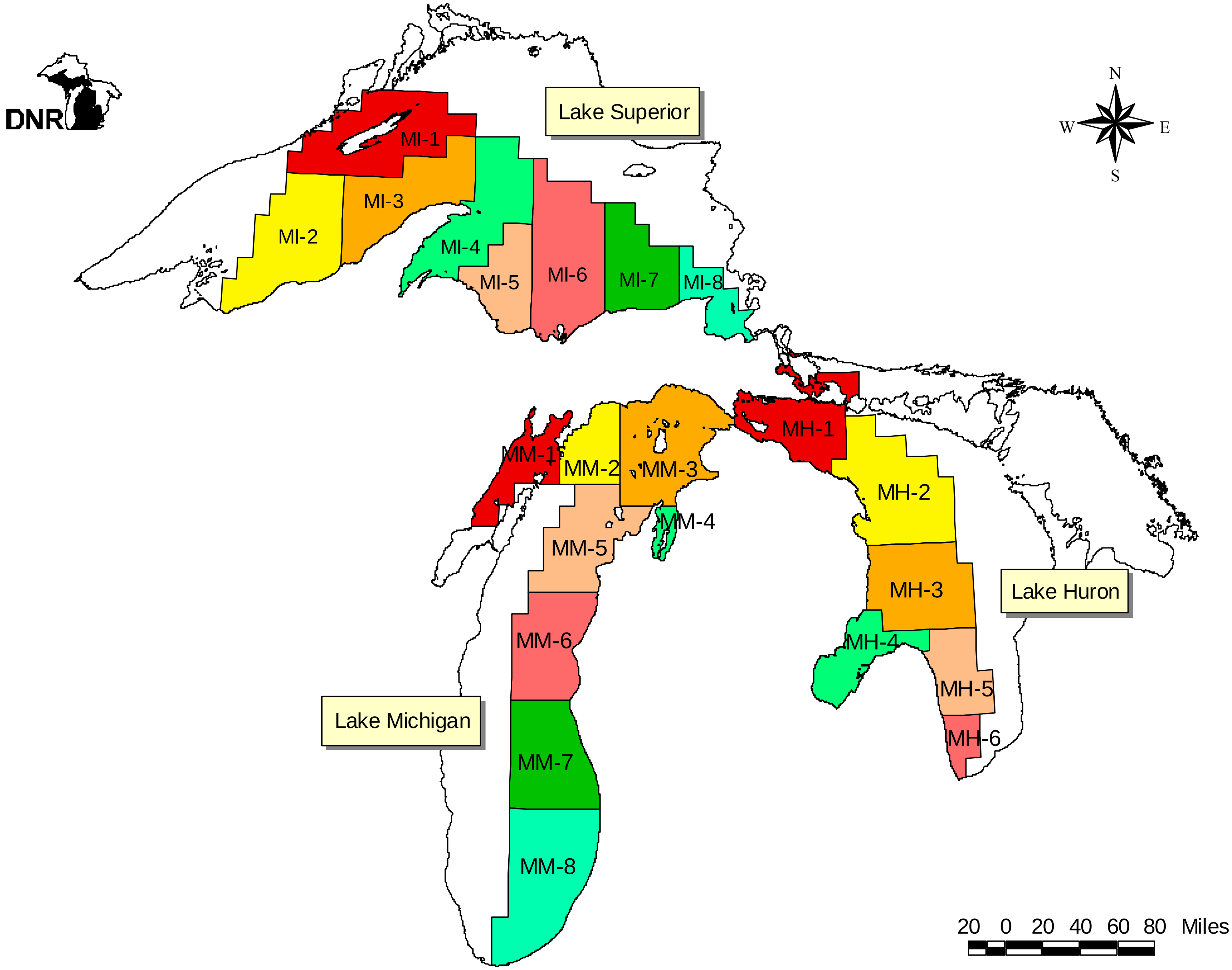


The 2006 recommended yield limit for WFM-08 was 1.588 million lbs, which was accepted as the actual yield limit. This projected yield is close to the limit calculated for 2005 (1.404 million lbs).

Summary Status WFM-08 Whitefish		
Female maturity		
	Size at first spawning	1.70 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	81607. lb (SE 166.49)
	Current SSBR	64294. lb (SE 2641.2)
	SSBR at target mortality	14,161.000 lb (SE 5.263)
Spawning potential reduction		
	At target mortality	0.788 (SE 0.032)
Average yield per recruit		0.249 lb (SE 0.037)
Natural Mortality (M)		0.374 y^{-1}
Fishing mortality rate 2002-2004		
	Fully selected age to Gill Nets	
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0. y^{-1} (SE 0.)
	Average trap net F, ages 4+	0.062 y^{-1} (SE 0.012)
Sea lamprey mortality (ML)		
	(average ages 4+,2002-2004)	N/A
Total mortality (Z)		
	Average ages 4+,2002-2004	0.436 y^{-1} (SE 0.012)
Recruitment (age-3)	(1995-2004 average)	1,000,400 fish (SE 157,460)
Biomass (age 3+)	(1995-2004 average)	4,202,600 lb (SE 694,710)
Spawning biomass	(1995-2004 average)	3,586,200 lb (SE 604,240)
MSC recommended yield limit in 2006		1,588,000 lb
Actual yield limit in 2006		1,588,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.