Technical Fisheries Committee Administrative Report 2003: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2002, with recommended yield and effort levels for 2003

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

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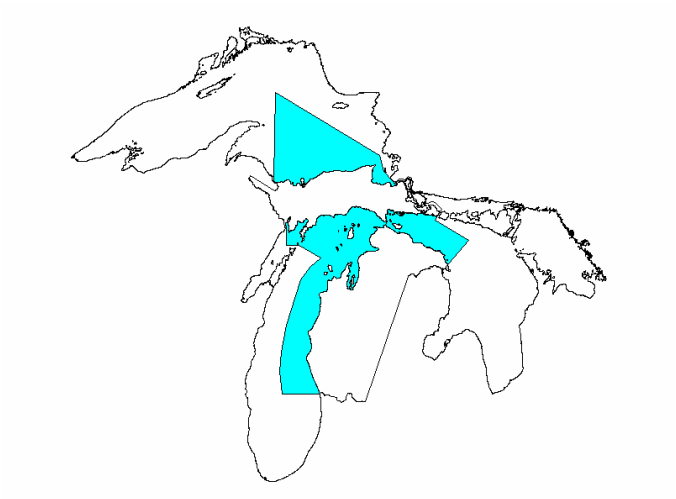

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EXECUTIVE SUMMARY

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

In August 2000 the State of Michigan's Department of Natural Resources (MDNR), five tribes of the Chippewa/Ottawa Resource Authority (CORA), and United States Department of Interior's U.S. Fish and Wildlife Service negotiated an agreement (Consent Decree) to resolve issues of allocation, management, and regulation of fishing in 1836 Treaty 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 16 different stocks of lake whitefish and ten 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 some cases 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 2003. 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 MSC's recommended harvest and effort limits for whitefish and lake trout are provided in the table below. The actual harvest limits that were imposed, based on terms of the Consent Decree, or harvest regulation guidelines (HRGs) are detailed later in the text and summary table for each management unit. Asterisks in the table below depict units where the recommended yield limit differed from the actual yield limit.

Species	Lake	Management unit	Yield limit (lb)	Gill-net limit (ft)
Lake trout	Superior	MI-5	119,100	NA
		MI-6	50,700	2.98 million
		MI-7	*88,300	4.05 million
	Michigan	MM-1,2,3	*287,700	9.36 million
		MM-4	*80,000	1.03 million
		MM-5	107,800	0.57 million
		MM-6,7	471,700	NA
	Huron	MH-1	163,000	8.67 million
		MH-2	82,100	NA
Lake whitefish	Superior	WFS-04	200,000	NA
		WFS-05	745,000	NA
		WFS-06	98,000	NA
		WFS-07	502,000	NA
		WFS-08	*67,000	NA
	Michigan	WFM-01	1,018,000	NA
		WFM-02	514,000	NA
		WFM-03	1,462,000	NA
		WFM-04	540,000	NA
		WFM-05	345,000	NA
		WFM-06	221,000	NA
		WFM-07	no estimate	NA
		WFM-08	1,852,000	NA
	Huron	WFH-01	375,000	NA
		WFH-02	*221,000	NA
		WFH-03	no estimate	NA
		WFH-04	*333,000	NA
		WFH-05	875,000	NA

In Lake Superior there are self-sustaining stocks of lean lake trout, and the SCAA models and target mortality rates apply to these wild fish in three management areas (MI-5, MI-6, and MI-7). In MI-6 and MI-7 siscowet and lean yield are combined in commercial catch reports, thus allowable total yield (leans and siscowets) can exceed the values in the above table by 13% and 41% respectively. In MI-6 recent mortality rates have been below the target, but recreational harvest exceeded the harvest limit (2002) despite strict regulation of the recreational fishery. Work continues on the MI-6 model to verify its performance and stability. In MI-5 and MI-7 recent mortality rates have been below targets, and increases in yield are possible. There have been no efforts to fit a stock assessment model for lake trout in MI-8 of Lake Superior because this is a deferred area. There has been a general decline in size-at-age of lake trout across Lake Superior over the past 20 years, and tied to this is a shift toward later maturity. These changes in growth and maturation

probably reflect increases in predator fish abundance and declines in the abundance of prey fish, most of which are less abundant than 20 years ago. Competitive effects of siscowet lake trout may also play a role.

In the Lake Huron and Lake Michigan management areas, wild lake trout are scarce and the assessment models and target mortality rates apply to stocked fish. In MH-1 lake trout mortality rates are above target rates but have been declining, while in MH-2 mortality rates are below target rates. Phased-in reductions in fishing mortality resulting from reduced commercial effort and a more restrictive minimum size limit (slot) in the recreational fishery should continue to improve the situation in MH-1. The recent decline in sea lamprey mortality in MH-2 is the main reason that total mortality is below target in this area. Continued decline of sea lamprey mortality in MH-1 and MH-2 is probably necessary to reach or maintain mortality rate targets. Indicators for Lake Huron show substantial decreases in sea lamprey-induced mortality due to treatment of the St. Marys River. Future success in controlling sea lamprey may allow increases in lake trout yield in Lake Huron.

In Lake Michigan lake trout mortality rates are well below target rates in the southern most area. Northern Lake Michigan unit MM-123 lake trout mortality rates have been near target rates. However, estimated declines in abundance and the Consent Decree's requirement for phased-in yield limits result in potentially higher mortality rates in the near term. In MM-4, mortality rates have been higher than the target rate. As a result, the 2003 recommended yield limit for MM-4 is below recent observed yields in this area. Decreases in commercial fishing effort and increases in the minimum size limit for the recreational fishery should help to achieve mortality targets. In MM-5, mortality rates have been less than the target rate. Lamprey mortality is not declining in Northern Lake Michigan. Lake Michigan researchers suspect that another stream(s) like the Manistique River may be producing large numbers of sea lamprey in northern Lake Michigan. It is hoped that future treatment of the Manistique River will lead to reduced levels of sea lamprey induced mortality in northern Lake Michigan.

In general, fishery exploitation in recent years has not been excessive on lake whitefish stocks. However, size at age 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 seen for some stocks in Lake Superior, but are most evident in Lake Michigan and Lake Huron management areas. Many stocks experienced a decline in recruitment near the end of the time series used in the assessments. Again this pattern was most prevalent in Lake Michigan and Lake Huron. In WFS-08, WFH-02, WFH-03, and WFH-04 harvest regulation guidelines were set based on recent yield levels. If harvest is maintained at recent levels in the face of declining recruitment and growth, mortality rates will be excessive and will decrease population abundance and further reduce yield. In addition, widespread declines in growth rates of lake whitefish are a concern, and further research on this is important for supporting management strategies. A summary report is included for WFM-

07, but modeling efforts to describe this stock currently have little utility for estimating allowable harvest due to lack of data. This area was not fished commercially between 1985 and 2000. Since 2001, there has been a small amount of tribal commercial harvest in WFM-07 by the Little River Band of Ottawa Indians.

In 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 developing fishery-independent surveys to assess abundance of lake whitefish, delineating stock boundaries and movement patterns, determining under-reporting and discarding rates, improving natural mortality estimates, refining estimates of hooking mortality on lake trout and incorporating hooking mortality into all lake trout models, 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.

We also recommend a process that will allow us to provide timely stock assessment results. In part this is targeted at meeting deadlines imposed by the Consent Decree. This process involves using the projected yield for the last few months of the year based on historic patterns of the yield, modifying the commercial yield compilation process, and forgoing the most recent year's age composition data when it cannot be available by the deadline. We duly note that annual harvest referred to in this report occasionally deviates from the true harvest. This is due to the cut-off date for data inclusion in models that requires the MSC to occasionally use preliminary harvest numbers. The proposed procedures for handling yield and age composition data are aimed at ensuring adequate time after the data are available for analysis, modeling, and diagnostics. We also believe that the parties should consider revisions to the time line for preparing stock assessments. First, we believe it would be more efficient if the whitefish stock assessment models and the lake trout models followed the same time schedule. Second, we think there needs to be more time between when the MSC obtains data from the parties, provides initial yield and effort limits to the TFC, and when the TFC provides those numbers to the parties. This would allow the MSC time to review procedures for problematic estimates, conduct adequate model diagnostic analyses, and to explore different options suggested by the TFC.

STOCK ASSESSMENT MODELS

Prepared by Shawn P. Sitar and James R. Bence

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 2003 fishing season, accounting for expected fishing and natural mortality and projecting the associated harvest and yield. The fishing mortality rates were adjusted in these projections to match upper bounds on fishing effort, fishery harvest, or total mortality while satisfying state and tribal allocation as defined in the Consent Decree.

Statistical Catch-Age Analysis

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

Population submodel

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

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

The proportion surviving was modeled as

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

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

in terms of *A*, but could be expressed in terms of the equivalent *Z*.

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

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

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

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

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

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

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

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

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

was estimated during model fitting, deviations from prior estimates, based on the same relationship used for whitefish, were penalized.

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

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

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

Lake Huron sea lamprey-induced mortality on lake whitefish

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

The method for calculating sea lamprey-induced mortality of whitefish in Lake Huron changed in the 2003 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:

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

where m is the average number of sea lamprey marks per fish, a is age class, t is year, and y is the time series under consideration. The time series varied somewhat by management unit but typically covered 1980-2001 in Lake Huron units. Essentially, the average marking rate on an age class was a function of the annual deviation in sea lamprey marking in a management from the long-term average marking rate in that unit and the average long-term marking rate on each age class. Sea lamprey-induced mortality was then calculated as in past years (Bence 2002) given a probability of survival of 0.25 from a sea lamprey attack.

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

In order to complete the population model and describe stock dynamics over

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

Movement Matrices and the calculation of yearling equivalents stocked

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

The observation submodel

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

Fishery kill was predicted using Baranov's catch equation:

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

Note that no additional parameters not already needed for the population submodel needed to be estimated.

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

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

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

The Likelihood (defining the best fit)

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

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

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

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

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

With these relationships in mind the modeling group considered information on the likely measurement error associated with the various data sources and specified default variances for each

type of data, which were adjusted in cases where additional information was available on data quality.

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

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

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

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

Target Mortality Rates

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

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

first applied varied among areas depending upon maturity schedules and precedent.

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

Population at the Start of the 2003 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 2003 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2003, 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 2003, but did not in 2003, 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 2003

Fishing mortality rates were adjusted depending on specific details of how an area was designated in the Consent Decree. We begin by considering lake trout. The simplest case was for areas calculated under the assumption of no phase-in (also called 'fully phased-in' areas) and meeting Consent Decree mortality rate and allocation standards: MM-5, MM-67, MH-2, MI-5, MI-6, and MI-7. Additionally, MH-1 was considered partially phased-in. This was accomplished by setting the multipliers for the recreational and commercial fisheries so as to simultaneously meet the mortality target (expressed in terms of SSBR) and the designated allocation. The process of finding the correct multipliers was expedited by making use of the Solver utility within Microsoft Excel spreadsheets. In MM-5 the target mortality rate was 45% and the allocation was 60% state and 40% tribal. In MM-67 the target mortality rate was 40% and the allocation was 90% state, 10% tribal. In MH-1, the interim target mortality was 47%, and the allocation was 8% state and 92% tribal. In MH-2 the target mortality rate was 40% and the allocation was 95% state and 5% tribal. In MI-5 the target mortality rate was 45% and the allocation was 95% state and 5% tribal. In MI-6 the target mortality rate was 45% and the allocation was 50% state and 50% tribal. In MI-7, the target mortality rate was 45% and the allocation was 30% state and 70% tribal

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

was reported for lean lake trout. In MI-5, commercial yield was reported separately for lean lake trout. In MI-6 and MI-7 reported commercial yield included both lean and siscowet lake trout. The lean-siscowet composition was measured in commercial monitoring. Thus total yield can be 114% and 135% of the recommended yield limits for lean lake trout that we table. (Note that the harvest and survey data were adjusted so it reflected only lean, wild fish before they were compared with model predictions.)

The TAC for MM-4 was calculated under a phase-in of effort guidelines for commercial effort, recreational regulations, and associated harvest limits. The base period for commercial effort was 1997-1999. Hence we adjusted the average commercial fishing mortality rates during that period by multiplying them by the proportion of 1997-1999 large-mesh gill-net effort that was remaining after conversion of gill-net fishers to trap nets. Recreational effort was the average of 2000-2002 values, adjusted for any change in size limits. There was no change in size limit for MM-4 during 2002, however, the size limit increased to 22" in 2003. Commercial TACs were based on predicted kill adjusted to account for any under-reporting**.** The estimated allowable commercial yield was greater than the 20% change allowed in the Consent Decree, and the TFC agreed to accept the higher estimated TAC.

TAC calculations for MM-123 were more complicated than for other areas because of special provisions in the Consent Decree. Potential TACs were calculated three ways. First, TACs were calculated assuming that target mortality rates and allocation were fully phased in (40% mortality, Allocation 10% state: 90% tribal). Second, TACs were calculated using a phase-in approach that is based on the previous years' harvest, less the reduction in lake trout harvest projected from gill-net reductions. Finally TACs were calculated assuming the tribal TAC would be 450,000 pounds. Then, the largest tribal TAC among these three options was chosen. The state TAC was estimated as though the model were fully phased-in. Thus for the second and third option we followed the same approach as we used in other areas (i.e., based on 2000-2002 effort and any regulation change). The phase-in approach was guided by the Consent Decree's requirement that the tribal TAC be set to the 1997-1999 harvest adjusted for any change in effort. We did this by first calculating a 2003 yield based on no-conversion of gear (1997-1999 effort) and then calculating taking into account the proportion of large-mesh gill net that was converted (as for phase-in rules in other areas).

TAC estimates for fully phased-in units MM-5 and MI-7 were calculated as per the consent decree. The 2003 TACs for both management units changed by more than 15% compared to the 2002 TACs. The TAC for MM-5 increased from last year and the TFC agreed to accept the higher estimated TAC. The 2003 TAC for MI-7 decreased by more than 15% and the TFC agreed to accept the limit (15 % less than the 2002 TAC) as stipulated by the decree instead of the estimated TAC.

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 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

In 2002, the MSC revised its list of recommendations to improve stock assessments. The revised list reflects improvements made since the assessments used to determine 2001 harvest limits, ongoing work to address assessment needs, and a prioritized ranking (HIGH, MEDIUM, LOW) of recommendations.

Data collection and processing

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

  i. the significance of subsistence fishery harvests

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

  ii. the magnitude of under-reporting of lake trout in commercial fisheries

     CORA now compares all tribal catch and wholesale reports and updates catch reports to match the wholesale reports. This may make the under-reporting vector in the models unnecessary for recent years' data.

  iii. 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.

  iv. 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. The MSC also asked Michigan if it would be possible to conduct more winter creel surveys in Treaty waters to estimate lake whitefish harvest in the ice fishery, especially in the above units.

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

     In 2002, Michigan began modifying its creel program to

quantify released lake trout of both legal and non-legal size. Also in 2002, the MSC appointed a subcommittee to draft a study design to quantify hooking mortality. In the future, the MSC will use creel catch and release estimates along with the hooking mortality to better quantify discard mortalities in the recreational fishery.

- 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 have been funded starting in 2003 and will help yield estimates of *M*.

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

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

- We recommend the development of a consistent protocol for sampling, processing, and storing data. The approaches by which data used in the models were collected and processed need to be carefully and completely documented. The MSC assigned a HIGH priority to this recommendation.

- Last year's report identified the need for lake whitefish "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.

- In Lake Michigan sea lamprey mortality rates are based on fall (instead of spring) marking and are based on rates summarized for broad length categories of lake trout. The approach used on the other lakes (using spring data and estimating wounding as a function of length) should be adopted when possible. Spring wounding data are now being collected in Lake Michigan. The MSC assigned a MEDIUM priority to this recommendation.

- 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

- All lake trout models should account for sport fishery hooking mortality. The models should integrate hooking mortality parameters or include creel survey estimates of deaths due to hooking mortality. The MSC assigned a HIGH priority to this recommendation.

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

A graduate student at MSU is currently exploring this issue.

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

  A graduate student at MSU is currently exploring this issue

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

  A graduate student at MSU is currently exploring this issue

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

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

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

- The age-specific maturity schedules are assumed to be temporally constant in lakes Michigan and Huron lake trout models. Alternative approaches that allow temporal changes due to changes in growth should be evaluated. 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. Issues associated with individual data sources and plans for improving timeliness of assessments include:

1. Harvest/Yield:
   a. Commercial yield - Currently CORA and the State cannot be ready by February 15. These numbers need to be made available in a more timely and accurate fashion.

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

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

3. Biological data-recreational:
   These data can be available by February 15. Occasionally Lake Superior data are not available by the deadline. If not ready by March 1 we will proceed without it and use the data the next year. We use age composition, mean weight of harvested fish, and composition of wild and hatchery fish.

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

5. Survey data:
   a. Survey CPUE – These data can be ready by February 15. Often the mixed model analysis can be completed by February 15. We will use a general linear model to estimate CPUE.

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

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

   d. Sea lamprey marking – These data can be ready by February 15 and estimates of mortality can be ready by February 15.

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

Lake whitefish

The Consent Decree sets October 1 as the deadline for the previous year's data. The MSC moved this deadline to September 1 to allow additional time for calculating harvest limits. Because of the one year time lag, data are usually available by the data submission

deadline. The MSC also set the third full week in September for its annual meeting to produce preliminary lake whitefish harvest limits. This allows for group discussion of model output and diagnostics before the November 1 deadline for preliminary harvest limits.

More general comments

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

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

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

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

STATUS OF LAKE TROUT POPULATIONS

Lake Superior

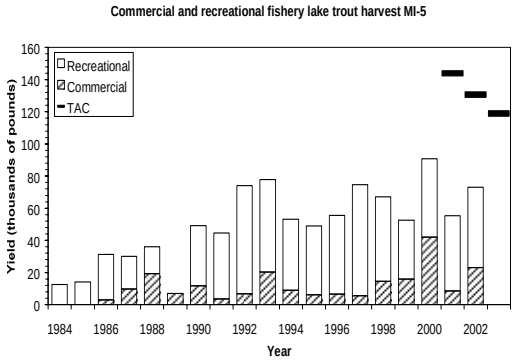
MI-5 (Marquette - Big Bay)

Prepared by Shawn P. Sitar

Lake trout management unit MI-5 extends from Pine River Point (west of Big Bay) to Laughing Fish Point (east of Marquette), covering 374,096 hectares. The management unit includes Stannard Rock, an offshore shoal about 72 km north of Marquette, and is in both the 1836 (250,345 hectares) and 1842 Treaty waters (123,751 hectares). The 1836 Treaty waters extend east from the north-south line established by the western boundaries of grids 1130, 1230, 1330, 1430, and 1530. This unit has a wide bathymetric range with depths down past 240 meters, and with 75,600 hectares with bottom depths of 73.2 m (240 ft) or less.

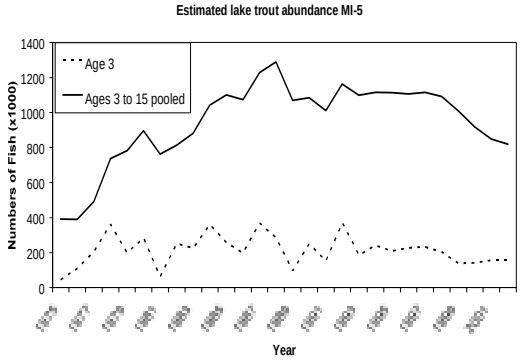
The only tribal commercial fishery is a large-mesh gill-net fishery that is centered around Marquette and Big Bay in 1842 Treaty waters. This fishery mainly targets lake whitefish with lake trout as bycatch. There have been some low levels of tribal subsistence gill-net fishing in 1836 treaty waters. Tribal commercial yield of wild lake trout (in 1842 treaty waters) has ranged from 3,100 lb in 1986 to a peak of 42,100 lb in 2000. During 1998 to 2002, tribal yield averaged 20,800 lb and tribal large-mesh gill-net effort averaged 365,000 ft per year.

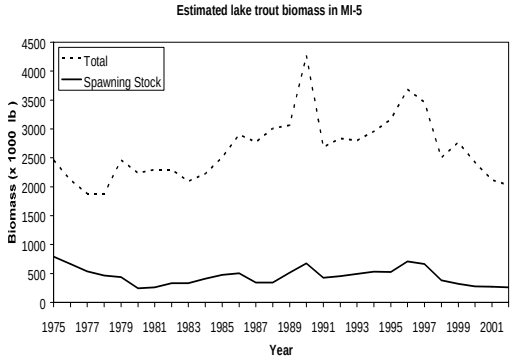
Recreational harvest of lake trout comprises both charter and sport angler trolling. Most of this activity is centered around the port of Marquette, though some lake trout are harvested at Stannard Rock. There are no seasonal restrictions on the sport fishery, though most of the fishery occurs during the months of May through October. Recreational harvest of wild lake trout has increased from 4,400 fish (39,800 lb) in 1986 to a peak of 15,000 fish (67,500 lb) in 1997 and has averaged 12,100 fish (47,000 lb) per year during the last five years. Recreational effort has declined from 146,000 angler hours in 1986 to 56,000 angler hours in 2002.



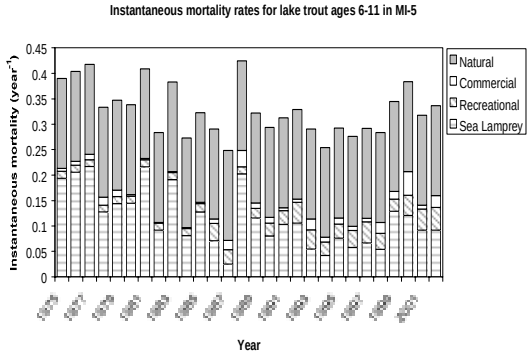
Abundance of age-3 and older wild lake trout increased over two-fold since 1975 and has recently declined from a peaked of about 1.3 million fish in 1988. Total biomass of age-3 and older lake trout averaged 2.8 million lb (1.3 million kg) during 1993-2002. Lake trout biomass declined from 4.3 million lb (2 million kg) in 1990 to 2 million lb (900,000 kg) in 2002. Spawning stock biomass averaged 446,000 lb (202,000 kg) during 1993 to 2002. Although lake trout abundance has increased since the mid-1970s, spawning stock biomass has declined due to significant decreases in growth. This is likely to continue with

declines in growth and increases in mortality rates.





During 1975 to 2002, sea lamprey-induced mortality was the dominant mortality source, although mortality from this source has declined since the mid-1980s. With the exception of 1988 and 2000, recreational fishing mortality has been higher than commercial fishing mortality since 1986. Average total annual mortality (A) for ages 6-11 lake trout has declined from 31% during 1975 to 1978 to 28% during 2000 to 2002. Spawning stock biomass produced per recruit during 2000 to 2002 has been above the target value indicating that mortality rates are low and there is good population reproductive potential. The recommended yield limit for 1836 Treaty waters was 119,100 lb, allocated as 113,600 lb for the state recreational fishery and 5,500 lb for the tribal commercial/subsistence fishery. This recommended yield limit is based on the target mortality rate of 40% 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 approximately 90% of the total yield. The recommended limit exceeds recent yields in 1836 Treaty waters (e.g., an average of 73,100 lb during 2000-2002), reflecting the fact that recent mortality rates have been well below target rates.



Summary Status MI-5 Lake Trout	
Female maturity	
Size at first spawning	2.38 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	3.689 lb (SE 0.455)
Current SSBR	0.97 lb (SE 0.12)
SSBR at target mortality	0.509 lb (SE 0.019)
Spawning potential reduction	
At target mortality	0.264 (SE 0.020)
Average yield per recruit	0.450 lb (SE 0.056)
Natural Mortality (M)	0.177 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2000-2002)	15
Age of full selection	
Sport fishery (2000-2002)	9
Commercial Fishing mortality (F)	
(average 2000-2002, ages 6-11)	0.026 y^{-1} (SE 0.005)
Sport fishery F	
(average 2000-2002, ages 6-11)	0.042 y^{-1} (SE 0.007)
Sea lamprey mortality (ML)	
(average ages 6-11,2000-2002)	0.084 y^{-1}
Total mortality (Z)	
(average ages 6-11,2000-2002)	0.329 y^{-1} (SE 0.015)
Recruitment (age-3)	
(1993-2002 average)	189,690 fish (SE 32,022)
Biomass (age 3+)	
(1993-2002 average)	2,791,400 lb (SE 365,800)
Spawning biomass	
(1993-2002 average)	445,460 lb (SE 60,995)
MSC recommended yield limit for 2003	119,100 lb
Actual yield limit for 2003	119,100 lb

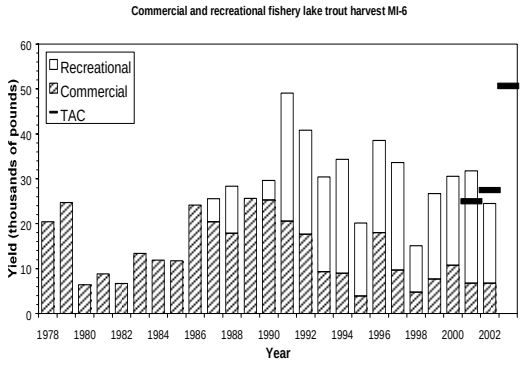
MI-6 (Au Train - Munising)

Prepared by Shawn P. Sitar

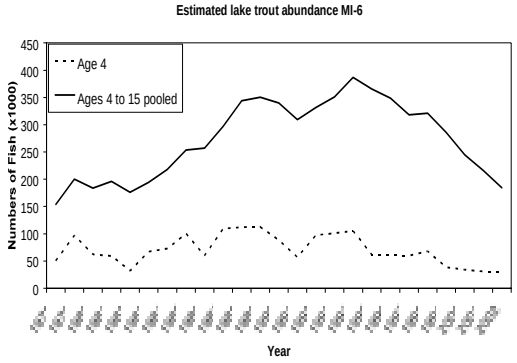
Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 1.8 million acres. The management unit includes Big Reef, an offshore reef complex about 20 mi northeast of Munising. This management unit contains the deepest waters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

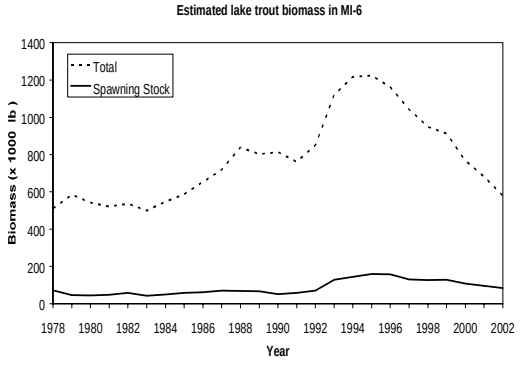
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is centered east of Grand Island. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout peaked in 1989 at 25,600 lb and declined to an average of 7,300 lb during 1998 to 2002. In addition to wild lean lake trout the tribal fishery also harvests siscowet and hatchery lake trout. In recent years wild fish composed 78% of the total lake trout yield, with 13% siscowet and 7% hatchery fish. Tribal large-mesh gill-net effort decreased from a peak of 3.6 million ft in 1983 to 487,000 ft in 2002.

Recreational harvest of lake trout comprises fish caught by both charter and sport angler trolling. Most of the recreational harvest was from the Au Train Bay and Grand Island areas, although some harvest was also from Big Reef. Recreational harvest of wild lake trout has increased from 970 fish (5,100 lb) in 1987 to 5,300 fish (17,800 lb) in 2002 and averaged 4,200 fish (18,000 lb) per year since 1987. In the last five years, wild lake trout composes 93% of the total recreational harvest of lean lake trout. The remainder was of hatchery origin. Recreational effort has declined from 72,000 angler hours in 1988 to 41,000 angler hours in 2002.



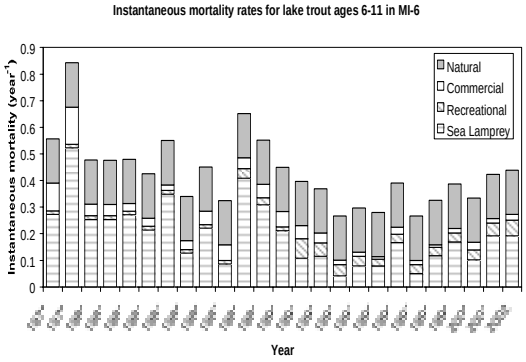
Abundance of age-4 and older wild lake trout declined from 350,000 fish in 1989 to 184,000 fish in 2002. Recruitment at age 4 has declined during 1993-2002 and averaged 58,900 fish during this period. The decline in abundance is related to increases in mortality rates starting in 1996 and declines observed in recruitment starting in 1995. Total biomass of age 4 and older lake trout has averaged 965,600 lb (438,000 kg) during 1993 to 2002. Biomass has declined from 1.2 million lb (540,000 kg) in 1995 to 579,000 lb (263,000 kg) in 2002. Spawning stock biomass averaged 126,000 lb (57,200 kg) during 1993 to 2002 and represented 13% of total stock biomass.





Excluding background natural mortality, sea lamprey predation was the highest mortality source for age 6 to 11 lake trout in MI-6. Recreational fishing mortality has been higher than commercial fishing mortality since 1991. During 1978 to 2002, total annual mortality (*A*) was the highest in 1979 at 57% and declined to 23% in 1993. Subsequently, *A* increased to an average of 30% during 2000 to 2002.

The MSC recommended yield limit for 2003 is 50,700 lb of which 27,500 lb is allocated for state recreational yield and 23,200 lb for tribal commercial yield. While mortality rates apply only to wild lean trout, the yield limit applies to all lean trout. In calculating the limit the Modeling Subcommittee assumed that 6% of the yield would be hatchery fish. During 2002, recreational release of lake trout in MI-6 was measured in the creel survey. Catch and release mortality was estimated by multiplying the creel survey estimates of released lake trout by 15%, which was based on Loftus et al. (1988). Reported total recreational harvest included estimated harvest and hooking deaths. There were 650 lake trout (2,100 lb) released during 2002.



Due to state overharvest in MI-6 in 2002, the TFC applied penalty provisions outlined in Sections VII.B.4.a and VII.B.4.b of the Consent Decree and re-allocated the 2003 harvest limits as follows: **22,900 lb to the state and 27,800 lb to the tribes**.

Addendum*:* In the 2001 Status of the Stocks Report we described female maturity for MI-6 by the length at first spawning. For the 2002 report, and from now on, we will use weight at first spawning so that the same metric is reported for all units.

Summary Status MI-6 Lake Trout	
Female maturity	
Size at first spawning	2.37 lb
Age at First Spawning	6 y
Size at 50% maturity	4.38 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	4.816 lb
	(SE 0.552)
Current SSBR	0.91 lb
	(SE 0.09)
SSBR at target mortality	0.409 lb
	(SE 0.011)
Spawning potential reduction	
At target mortality	0.188
	(SE 0.012)
Average yield per recruit	0.386 lb
	(SE 0.046)
Natural Mortality (M)	0.166 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2000-2002)	8
Age of full selection	
Sport fishery (2000-2002)	9
Commercial Fishing mortality (F)	
(average 2000-2002, ages 6-11)	0.022 y^{-1}
	(SE 0.004)
Sport fishery F	
(average 2000-2002, ages 6-11)	0.046 y^{-1}
	(SE 0.007)
Sea lamprey mortality (ML)	
(average ages 6-11,2000-2002)	0.129 y^{-1}
Total mortality (Z)	
(average ages 6-11,2000-2002)	0.363 y^{-1}
	(SE 0.014)
Recruitment (age-4)	
(1993-2002 average)	58,849 fish
	(SE 6,473)
Biomass (age 4+)	
(1993-2002 average)	965,610 lb
	(SE 93,219)
Spawning biomass	
(1993-2002 average)	125,920 lb
	(SE 15,072)
MSC recommended yield limit for 2003	50,700 lb
Actual yield limit for 2003	50,700 lb

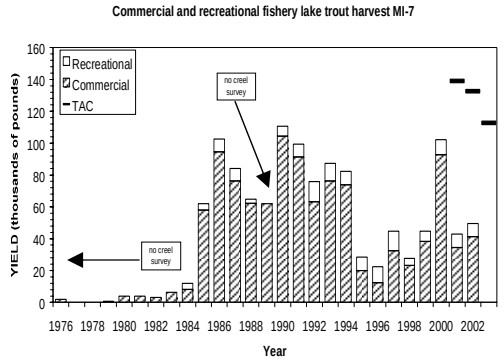
MI-7 (Grand Marais)

Prepared by Shawn P. Sitar

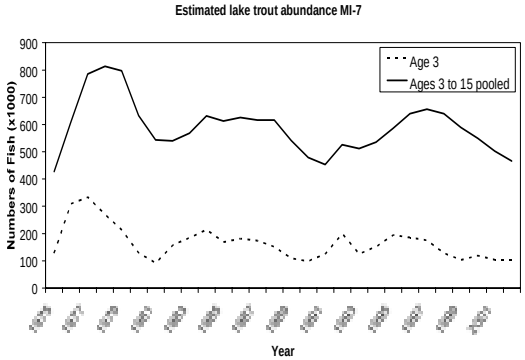
Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 987,000 acres. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There is approximately 92,000 acres of lean lake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

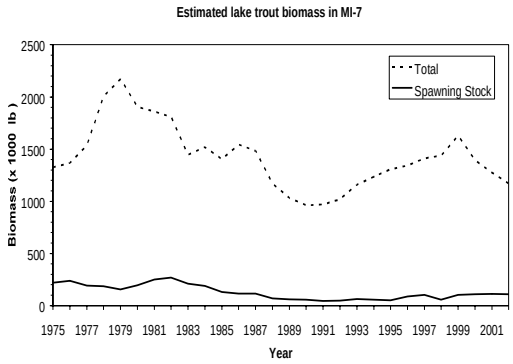
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is mostly based out of Grand Marais. This fishery mainly targets lake whitefish with lake trout as bycatch. During 1975 to 2002, tribal commercial yield of wild lake trout peaked in 1990 at 104,400 lb and declined to 12,400 lb in 1996. Subsequently, tribal yield increased to an average of 56,000 lb in the last three years. In recent years these yields of wild lean lake trout compose about 53.7% of the total lake trout yield, with the rest consisting of siscowet (41%) and hatchery lake trout (5.3%). 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.

The standardized creel survey began at Grand Marais in 2001. Sport harvest and effort in MI-7 for years prior to 2001 were estimated using the average sport CPUE and effort index ratio between MI-7 to MI-5 from MIDNR creel mail survey data 1971 to 1982 applied to MI-5 sport harvest and effort during 1984-2000. The estimates from this procedure indicate that recreational harvests in MI-7 are about half those of MI-6. This procedure required strong and somewhat questionable assumptions, hence there is much uncertainty regarding the true magnitude of the recreational harvest in MI-7 prior to 2001. However, the residuals between the ratio procedure's estimates of harvest and actual creel survey estimates since 2001 were -16% (365 fish) in 2001 and 3.1% (76 fish) in 2002.



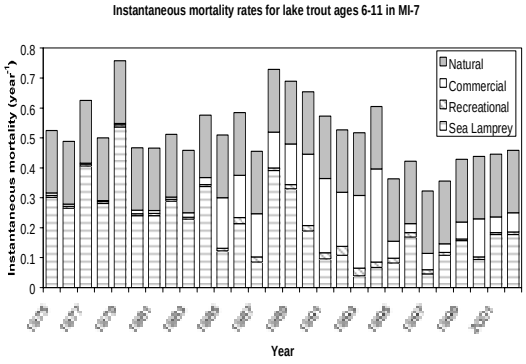
Abundance of age-3 and older wild lake trout averaged 567,000 fish during 1993 to 2002 and has declined from 656,000 fish in 1997 to an average of 466,000 fish in 2002. Recruitment at age 3 averaged 139,000 fish during 1993 to 2002. Spawning stock biomass averaged 86,000 lb during the last ten years and represented 6.4% of total stock biomass.





Sea lampreys were the dominant mortality source for lake trout in MI-7 from 1975 to 1989. Commercial fishing mortality increased significantly in 1985 and exceeded sea lamprey-induced mortality from 1990 to 1994. Commercial fishing mortality declined during 1995 to 1998, but has been increasing since 1998. During 1975 to 1979, total annual mortality (*A*) for age-6 to -11 lake trout averaged 43.6%. During the last five years, average *A* was 34.6%. 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. The model-generated, recommended yield limit for the year 2003 is 88,300 lb of which 29,800 lb is allocated for state recreational yield and 58,500 lb for tribal commercial yield. These limits were calculated on the basis of the target mortality rate (A) of 40% 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 11.2% of the lean lake trout yield would be hatchery fish. The yield limit does not include siscowet lake trout so actual yields can exceed this limit by 41%, to allow for the portion of the yield that siscowet are expected to compose. The recommended total yield limit is higher than observed yields from recent years reflecting the fact that mortality rates have been below target limits.

The 2003 model-generated, recommended yield limit for this unit is more than 15% lower than the 2002 final lake trout harvest limit. As a result, the TFC invoked Section VII.A.6 of the Consent Decree and set the 2003 final harvest limit for this unit to **112,700 lb** of which 33,800 lb was allocated for state recreational yield and 78,900 lb for tribal commercial yield. This final 2003 harvest limit is 15% lower than the 2002 final harvest limit.



Summary Status MI-7 Lake Trout	
Female maturity	
Size at first spawning	2.77 lb
Age at First Spawning	6 y
Size at 50% maturity	4.95 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	2.947 lb
	(SE 0.397)
Current SSBR	0.58 lb
	(SE 0.09)
SSBR at target mortality	0.421 lb
	(SE 0.019)
Spawning potential reduction	
At target mortality	0.196
	(SE 0.031)
Average yield per recruit	0.382 lb
	(SE 0.095)
Natural Mortality (M)	0.209 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2000-2002)	13
Age of full selection	
Sport fishery (2000-2002)	6
Commercial Fishing mortality (F)	
(average 2000-2002, ages 6-11)	0.081 y^{-1}
	(SE 0.025)
Sport fishery F	
(average 2000-2002, ages 6-11)	0.008 y^{-1}
	(SE 0.002)
Sea lamprey mortality (ML)	
(average ages 6-11,2000-2002)	0.13 y^{-1}
Total mortality (Z)	
(average ages 6-11,2000-2002)	0.428 y^{-1}
	(SE 0.028)
Recruitment (age-3)	
(1993-2002 average)	138,740 fish
	(SE 37,438)
Biomass (age 3+)	
(1993-2002 average)	1,335,900 lb
	(SE 332,860)
Spawning biomass	
(1993-2002 average)	86,077 lb
	(SE 27,129)
MSC recommended yield limit for 2003	88,300 lb
Actual yield limit for 2003 (15% rule invoked)	112,700 lb

Lake Huron

MH-1 (Northern Lake Huron)

Prepared by Aaron P. Woldt and Ji X. He

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

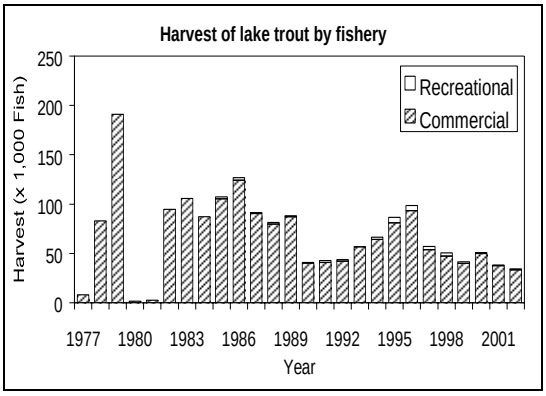
There is little or no natural recruitment of lake trout in northern Lake Huron. As a result, nearly all the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-1. From 1998 to 2002, approximately 360,000 yearling lake trout were 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 2002, approximately 486,000 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 443,000 yearling lake trout recruits in MH-1 for 2002.

Both commercial and recreational lake trout fisheries exist in MH-1. Tribal commercial fishers deploy trap nets and large-mesh gill nets (4.5 inch stretch) that target lake whitefish and salmon, and small-mesh gill nets (2.5-3.0 inch stretch) that target bloater chubs. Lake trout are caught in these fisheries as bycatch and can be marketed by tribal fishers under CORA regulations. No state-licensed commercial fishers operate in MH-1. The Consent Decree prohibits state-licensed commercial fishing north of the 45th parallel. Previous to August 2000 one state-licensed fisher, Gauthier and Spaulding Fisheries, operated a trap-net

operation in MH-1. This operation targeted lake whitefish and was not allowed to market lake trout bycatch. All lake trout were returned to the water, regardless of condition.

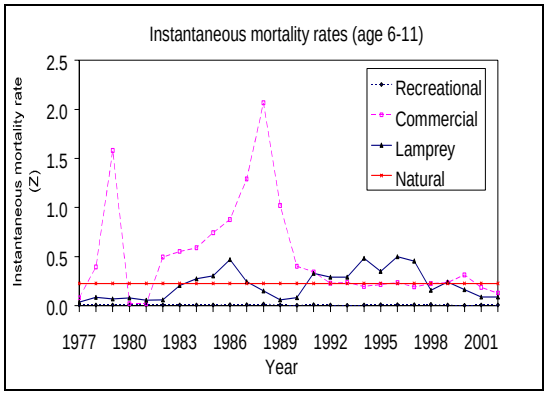
Because there is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-1, although few lake trout have been stocked there, this region was included in the assessment model. This means that lake trout extractions from Canadian management area 4-1 were included in the data, and estimates of yields and recruitment into this area (primarily the result of movement from other areas) were also included. From 1998 to 2002, tribal commercial yield of lake trout averaged 105,000 lb, while Canadian commercial yield averaged 19,000 lb. Due to a 400 lb daily bag limit enacted by CORA for tribal large-mesh gill-net fishers in US waters of MH-1, 2002 tribal harvest includes an estimate of throwback mortality (i.e. fish that were thrown back but later died due to handling). The majority of tribal lake trout yield (89%) came from the large-mesh gill-net fishery. Tribal large-mesh gill-net effort averaged 10.4 million ft from 1998 to 2002, while Canadian large-mesh gill-net effort averaged 1.9 million ft. With the implementation of the 2000 Consent Decree, tribal large-mesh gill-net catch and effort is declining. In 2002, large-mesh gill-net harvest dropped by 18,000 lb from 2000, and large-mesh gill-net effort dropped by 7.1 million feet from 2000.

The state-licensed recreational fishery in MH-1 is composed of both charter and non-charter anglers. Lake trout are frequently caught as bycatch by salmon anglers trolling at or near the surface, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty waters. Recreational harvest represents a small portion of the total fishery harvest in MH-1. From 1998 to 2002, recreational yield of lake trout averaged 4,600 lb. In 2002, recreational harvest was only 3,100 lb in MH-1. Starting in 2001, the state of Michigan raised the minimum size limit for lake trout in the recreational fishery from 10” to 20” in areas north of 44° 50’ N latitude. Starting in 2003, the state of Michigan imposed a 15” to 19” slot limit in MH-1. All fish outside the slot must be released, except for one fish daily that may be 34” or larger. These new regulations are intended to keep harvest below the state share of the MH-1 harvest limit.

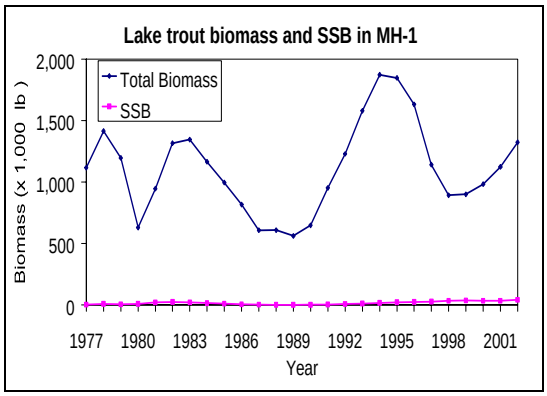


Instantaneous mortality rates have been variable and relatively high in northern Lake Huron. From 1977 to 1990, commercial fishing mortality was the leading source of lake trout mortality. After 1990, commercial fishing mortality decreased as sea lamprey-induced mortality increased. Sea lamprey were the largest source of lake trout mortality in the 1990s, until 1998 when sea lamprey-induced mortality decreased. From 1998 to 2002, lamprey-induced instantaneous mortality averaged 0.15 y^{-1} and commercial fishing instantaneous mortality averaged 0.22 y^{-1}. Sea

lamprey-induced mortality rates for age 6-11 lake trout in 2002 decreased 77% from the average of 1994-1998 levels. This decline is likely due to the treatment of the St. Marys River. Recreational fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron.



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) is extremely low in northern Lake Huron, and total lake trout biomass varied around a 20-year average of 1,111,100 lb.



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 163,000 lb for MH-1 in 2003. This harvest was calculated using the interim-target total annual mortality rate of 47% and 2006 allocation percentage (92% for tribal harvest and 8% for the state) as outlined in Section VII.A.7.d of the Consent Decree. Based on these calculations, the total yield was allocated 15,300 lb to the state and 147,000 lb to the tribes. Due to tribal overharvest in MH-1 in 2002, the TFC applied penalty provisions outlined in Sections VII.B.4.a and VII.B.4.b of the Consent Decree and re-allocated the 2003 harvest limits as follows: **31,800 lb to the state and 131,200 lb to the tribes.**

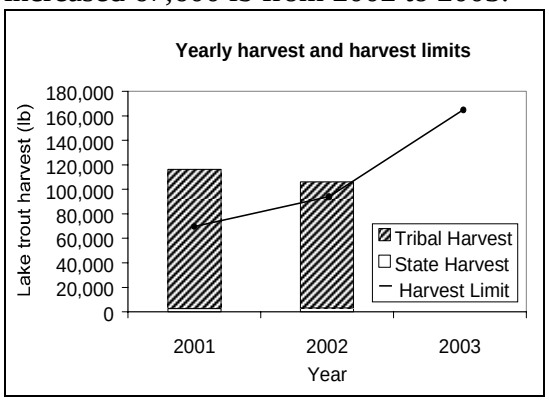
The 2001 harvest limit was calculated based on the phase-in described in the Consent Decree. In particular, it was based on the average effort during 1997 to 1999, either adjusted for gill-net operations converted to trap nets under provisions of the Consent Decree (tribal commercial fishery) or changes in regulations (state recreational fishery). The Consent Decree states that this technique should be used to calculate the MH-1 harvest limit through 2005. However, due to changes in lake trout stock dynamics in MH-1 caused by larger than expected decreases in sea lamprey-induced mortality, calculating the 2002 and 2003 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.

Model projections indicate that 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, should allow the lake trout population in MH-1 to progress towards rehabilitation.

Tribal harvest was significantly higher than the tribal harvest limit in 2002, but still represented a decline in harvest from previous years. State harvest was well below the state harvest limit in 2002. The total harvest limit increased 67,600 lb from 2002 to 2003.



Summary Status MH-1 Lake Trout	
Female maturity	
Size at first spawning	3.33 lb
Age at First Spawning	5 y
Size at 50% maturity	5.94 lb
Age at 50% maturity	8 y
Spawning biomass per recruit	
Base SSBR	2.395 lb
	(SE 0.25)
Current SSBR	0.24 lb
	(SE 0.06)
SSBR at target mortality	0.284 lb
	(SE 0.013)
Spawning potential reduction	
At target mortality	0.099
	(SE 0.022)
Average yield per recruit	0.566 lb
	(SE 0.035)
Natural Mortality (M)	0.224 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2000-2002)	6
Age of full selection	
Sport fishery (2000-2002)	7
Commercial Fishing mortality (F)	
(average 2000-2002, ages 6-11)	0.208 y^{-1}
	(SE 0.048)
Sport fishery F	
(average 2000-2002, ages 6-11)	0.005 y^{-1}
	(SE 0.001)
Sea lamprey mortality (ML)	
(average ages 6-11,2000-2002)	0.113 y^{-1}
Total mortality (Z)	
(average ages 6-11,2000-2002)	0.55 y^{-1}
	(SE 0.052)
Recruitment (age-1)	
(1993-2002 average)	365,960 fish
	(SE 25,050)
Biomass (age 3+)	
(1993-2002 average)	1,329,200 lb
	(SE 103,920)
Spawning biomass	
(1993-2002 average)	28,195 lb
	(SE 6,340)
MSC recommended yield limit for 2003	163,000 lb
Actual yield limit for 2003	163,000 lb

MH-2 (North-central Lake Huron)

Prepared by Aaron P. Woldt and Ji X. He

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

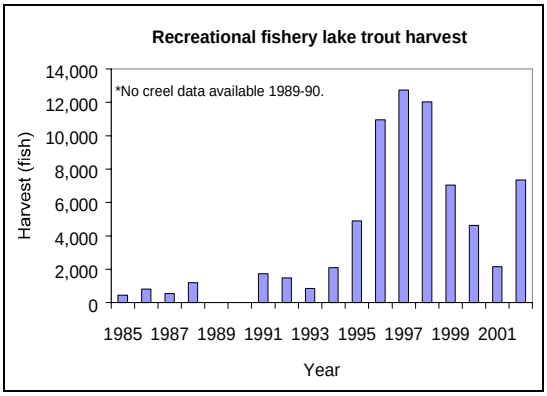
There is little or no natural recruitment of lake trout in north-central Lake Huron. Only one site off North Point has yielded consistent, yearly production of wild juvenile lake trout in MH-2 since 1985, but trawl catches at this site have disappeared in recent years. As a result, nearly all lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-2. From 1998 to 2002, approximately 280,000 yearling lake trout per year were planted annually in near-shore areas of MH-2. For the first time since 1987, no lake trout were planted offshore on Six Fathom Bank/Yankee Reef in 2002. These fish were re-allocated to nearshore stocking sites and may return to the mid-lake reefs as part of a pulse stocking regime being considered by the Lake Huron Technical Committee. Approximately

213,000 yearling lake trout were planted annually in Canadian management area 4-3 from 1998 to 2002. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 367,000 yearling lake trout recruits in MH-2 for 2002.

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

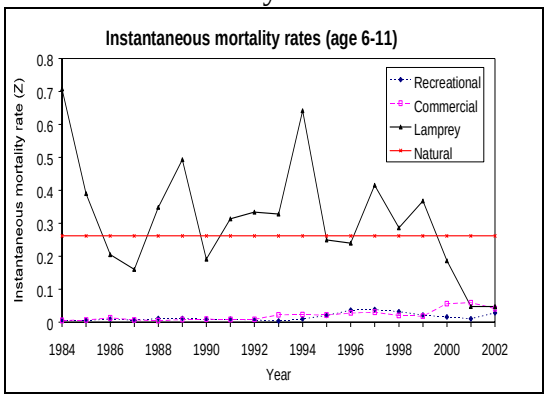
There is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-2 (areas 4-2, 4-3, and 4-7) that we included in our assessment. From 1998 to 2002, total Canadian commercial lake trout yield in these areas averaged 44,600 lb per year. The majority of this yield came from the large-mesh gill-net fishery. Canadian large-mesh gill-net effort averaged 6.5 million ft per year from 1998 to 2002.

The state-licensed recreational fishery in MH-2 is composed of both charter and non-charter anglers. Lake trout are frequently caught as bycatch by salmon anglers trolling at or near the surface, but some anglers target lake trout by fishing the lower parts of the water column. A limited number of subsistence fishing permits are also issued to tribal members in 1836 Treaty waters. The magnitude of recreational harvest varies from year to year and has averaged 6,600 fish from 1998 to 2002. From 1998 to 2002, recreational yield of lake trout averaged 26,200 lb, and in 2002 recreational harvest was 39,700 lb in MH-2. Starting in 2001, the state of Michigan raised the minimum size limit of lake trout in the recreational fishery from 10” to 20” in areas north of 44° 50’ N latitude. Starting in 2003, the state of Michigan raised the minimum size limit of lake trout in the recreational fishery from 20” to 22” in MH-2. These new regulations are intended to keep recreational harvest below the state share of the MH-2 harvest limit.

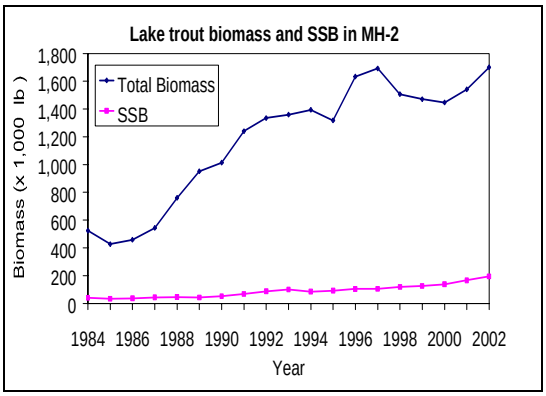


In most years, the dominant source of mortality for lake trout in MH-2 was sea lamprey. Sea lamprey-induced mortality was greater than all other mortality sources from 1984 to 1999 with the exception of 1986, 1987, 1990, 1995, and 1996 when natural mortality was the largest single mortality source. Sea lamprey mortality rates have been cyclic in north-central Lake Huron, reaching peaks in 1989, 1994, 1997, and 1999. From 1998 to 2002, sea lamprey-induced mortality averaged

0.19 y^{-1}, and sea lamprey-induced mortality rates have been declining drastically since 1999. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2002 decreased 87% from the average of 1994-1998 levels. This decline is likely due to the treatment of the St. Marys River. Recreational and commercial fishing mortality were low in most years relative to lamprey-induced mortality; however, increases in commercial harvest of lake trout in Canadian waters have caused the commercial fishing mortality rate to increase substantially since 1999.



The high rate of 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 is low in north-central Lake Huron. Total lake trout biomass has steadily increased since 1984, averaging 1,533,700 lb from 1998 to 2002; however, the majority of this biomass is young, immature, hatchery fish. From 1998-2002, spawning stock biomass (SSB) averaged only 148,700 lb in MH-2.

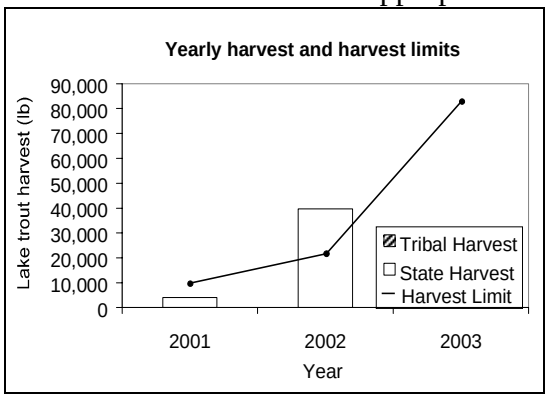


The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 82,100 lb for MH-2 in 2003. This harvest was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the state and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the Consent Decree. Based on these calculations, the total yield was allocated 78,600 lb to the state and 3,500 lb to the tribes. Due to state overharvest in MH-2 in 2002, the TFC applied penalty provisions outlined in Sections VII.B.4.a and VII.B.4.b of the Consent Decree and re-allocated the 2003 harvest limits as follows: **61,000 lb to the state and 21,100 lb to the tribes**.

Current spawning stock biomass per recruit (SSBR) is above SSBR at target mortality, indicating total annual mortality rates are below the target of 40% total annual mortality. This is due to the large declines in sea lamprey-induced mortality rates in 2000, 2001, and 2002. If sea lamprey-induced mortality remains low, spawning stock biomass and SSBR should increase.

State harvest was significantly higher than the state harvest limit in 2002. No tribal harvest was reported in MH-2 in 2002. All tribal fishers in MH-2 fish trap nets and are required to release all lake trout regardless of condition.

The total harvest limit increased significantly from 2002 to 2003. This is due to the large declines in sea lamprey-induced mortality rates from 2000-2002. 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 2003 all parties agreed that increasing the harvest limit by greater than the 15% threshold was appropriate.



Summary Status MH-2 Lake Trout	
Female maturity	
Size at first spawning	1.99 lb
Age at First Spawning	4 y
Size at 50% maturity	6.04 lb
Age at 50% maturity	7 y
Spawning biomass per recruit	
Base SSBR	2.572 lb
	(SE 0.385)
Current SSBR	0.85 lb
	(SE 0.16)
SSBR at target mortality	0.646 lb
	(SE 0.051)
Spawning potential reduction	
At target mortality	0.331
	(SE 0.022)
Average yield per recruit	0.265 lb
	(SE 0.026)
Natural Mortality (M)	0.262 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (2000-2002)	6
Age of full selection	
Sport fishery (2000-2002)	6
Commercial Fishing mortality (F)	
(average 2000-2002, ages 6-11)	0.052 y^{-1}
	(SE 0.011)
Sport fishery F	
(average 2000-2002, ages 6-11)	0.017 y^{-1}
	(SE 0.003)
Sea lamprey mortality (ML)	
(average ages 6-11,2000-2002)	0.094 y^{-1}
Total mortality (Z)	
(average ages 6-11,2000-2002)	0.425 y^{-1}
	(SE 0.023)
Recruitment (age-1)	
(1993-2002 average)	411,280 fish
	(SE 22,271)
Biomass (age 3+)	
(1993-2002 average)	1,506,500 lb
	(SE 136,180)
Spawning biomass	
(1993-2002 average)	122,810 lb
	(SE 17,692)
MSC recommended yield limit for 2003	82,100 lb
Actual yield limit for 2003	82,100 lb

Lake Michigan

MM-123 (Northern Lake Michigan)

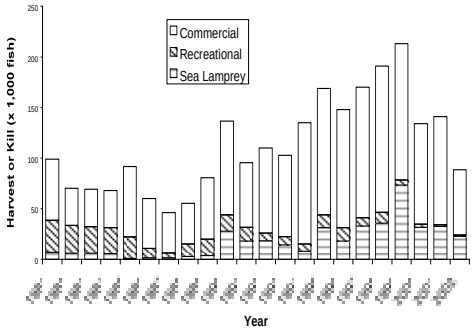
Prepared by Jory L. Jonas, John Netto, Erik J. Olsen, Steve Lenart, and Mark Ebener

Lake trout management unit MM-123 is made up of statistical districts MM-1, MM-2 and MM-3 and encompasses Michigan's waters of northern Lake Michigan and northern Green Bay. This management unit covers 5,000 square miles. Water depths in more northern waters are for the most part less than 150 feet, and approximately 3,800 square miles (two-thirds of the area) are less than 240 feet. In southern portions of the unit, depths can be greater than 550 feet. Most of the historically important lake trout spawning reefs in Lake Michigan are located in MM-123. The unit also contains many islands including the Beaver Island complex (Beaver, Hat, Garden, Whiskey, Trout, High and Squaw Islands), North and South Fox Islands, and Gull Island in Lake Michigan. Another series of islands form a line separating Green Bay from Lake Michigan; these include Little Gull, Gravely, St. Martins, Summer and Poverty Islands. This management unit is entirely in 1836 Treaty waters, and contains a lake trout refuge. The northern refuge is nearly 900 square miles and occupies the southern ½ of grids 313 and 314, grids 413, 414, 513-516, the northwest quarter of grid 517, grid 613, and the northern ½ of grid 614. It is illegal for recreational fishers to retain lake trout when fishing in the refuge. Gill-net fishing (both commercial and subsistence) is also prohibited. Commercial trap-net operations are permitted; however, the retention of lake trout is not allowed. Commercial fishing is also restricted in the innermost area of Little Traverse Bay (grid 519) and portions of grid 306 in northern Green Bay.

Recruitment of lake trout in the northern management unit of Lake Michigan is currently based entirely on stocking. In each of the last ten years, approximately 682,000 yearling lake trout have been stocked into northern Lake Michigan and approximately 87 percent of these fish are stocked into the northern refuge area. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for mortality and movement among the various regions in the lake. Over the last 10 years (1993-2002) the recruitment to age one has averaged 531,500 fish in northern Lake Michigan.

Both state and tribal commercial fisheries operate in northern Lake Michigan. State-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish and are not permitted to harvest lake trout. Therefore this harvest is considered in lake trout harvest allocations. While the current tribal commercial fishery primarily targets lake whitefish, lake trout are sometimes targeted or kept as by-catch. Since 1981 commercial fishing has killed more harvestable lake trout (fish > 17 in.) than other sources of mortality in northern Lake Michigan (Figure 1).

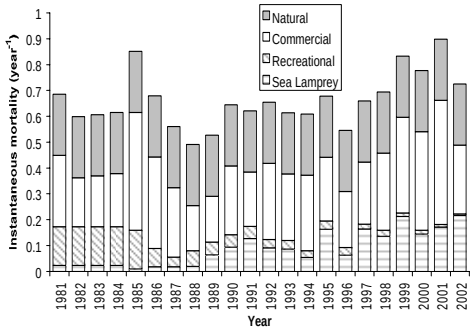
Figure 1. Number of lake trout killed by source in MM-123



There are three types of tribal commercial fisheries, large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery accounts for the majority of the yield. Predicted tribal commercial yield increased from 370,000 lb in 1991 to 840,000 lb in 1998. After the implementation of the 2000 Consent Decree, yield fell to 591,000 lb in 2001 and 320,000 lb in 2002. Large-mesh gill-net effort in tribal fisheries has been steadily declining from 23 million feet in 1992 and 1993 to 5 million feet in 2002. The number of lake trout harvested in northern Lake Michigan tribal fisheries had increased from 1991 (62,000 fish) until 1998 (144,000 fish). More recently harvest numbers have declined to 65,000 fish in the year 2002 (Figure 1). Lake trout harvest in the region is not likely to experience further declines until 2006 when harvest requirements are fully phased in as part of the established 2000 Consent Decree.

The management of recreational fisheries for lake trout is the primary responsibility of the state of Michigan and fisheries are comprised of both charter and sport anglers. The mortality rate of lake trout resulting from recreational fishing in the northern management unit of Lake Michigan is significantly lower than rates associated with commercial fishing or sea lamprey predation (Figure 2). In 1991, the minimum size limit for sport fishing in the northern management unit of Lake Michigan was increased from 10 to 24 inches, a modest decline in recreational yield resulted. In recent years, the estimated recreational yield of lake trout has declined further, by over 89 percent from 1998 (67,000 lb) to 2002 (7,000 lb). The numbers harvested declined similarly, 44 percent fewer fish were harvested in 2002 (Figure 1). More recent declines are due in part to declines in recreational fishing effort, as angler hours decreased nearly 72 percent, from 87,000 in 1998 to 25,000 in 2002.

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



Since 1989 sea lamprey-induced mortality has been the second highest source of mortality for lake trout in northern Lake Michigan. During the recent six years (1997 to 2002) lamprey mortality rates have been higher than during the previous sixteen years (Figure 2). The number of lake trout killed by sea lamprey has increased from an average of 4,000 fish per year during 1981-1989 to over 38,000 fish per year during 1997-2002 (Figure 1).

In northern Lake Michigan, lake trout generally are both spawning and recruited into commercial and recreational fisheries by age 7 (Summary table). The biomass of lake trout in northern Lake Michigan had nearly

tripled from 1986 to 1997 increasing from 1.5 to 4.3 million pounds. Since 1997, the biomass of lake trout has steadily decreased. In 2002 levels were almost half those observed in 1997 (2.1 million pounds; Figure 3). The total biomass of lake trout outside the refuge has averaged 2.9 million lb during the last five years (1998-2002). Spawning biomass showed similar patterns in abundance with a less pronounced peak in 1997. Declines in biomass since 1997 are more pronounced when only considering fish outside the refuge.

The spawning stock biomass produced per recruit (including the refuge population) during 2002 is similar to the target value indicating that mortality rates for the combined refuge/non-refuge population are near the 40% mortality target for this area.

The recommended yield limit for 1836 Treaty waters in 2002 is 28,700 pounds for the state recreational fishery and 453,000 pounds for the tribal commercial/subsistence fishery. These values reflect phase-in requirements specified in the 2000 Consent Decree. When fully phased in, yield allocations in this management unit will allot 10% to the state of Michigan and a 90% to tribal fisheries, while meeting the 40% mortality target. In 2002, two options were considered: 1) the modeled allowable yield (259,000 lbs tribal); or 2) the average of the yield from 1997-1999 less the reduction due to gill-net conversions in the area (453,000 lbs tribal). Consistent with the Consent Decree specifications, option two was selected and approved by the TFC because it provided the highest tribal yield of lake trout. This specific phase-in option actually allows a temporary increase in mortality rates above the 40% target (Figure 4).

Figure 3. Estimated lake trout biomass in MM-123

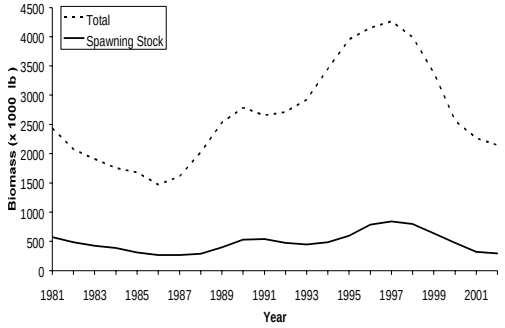
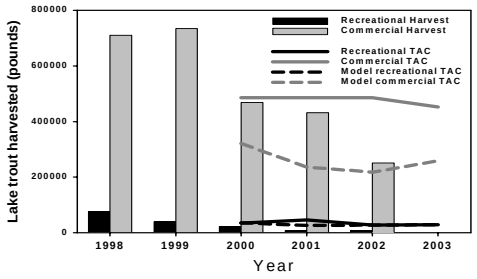


Figure 4. Comparison of actual harvest vs. TAC decision vs. model recomendation



Summary Status MM-123	**Value (95% probability interval)**
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	7.196 lb (6.079 – 8.244)
Current SSBR combined w/ refuge	1.94 lb (0.93 – 1.75)
SSBR at target mortality	2.145 lb (1.866 – 2.431)
Spawning potential reduction	
At target mortality	0.298 (0.268 – 0.337)
Average yield per recruit	1.280 lb (1.166 – 1.400)
Natural mortality (M)	0.236 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2000-2002)	7 y
Sport fishery (2000-2002)	7 y
Commercial fishing mortality (F)	
Average 2000-2002, ages 6-11	0.377 y^{-1} (0.293 – 0.506)
Sport fishing mortality (F)	
Average 2000-2002, ages 6-11	0.01 y^{-1} (0.008 – 0.015)
Sea lamprey mortality (ML)	
Average 2000-2002, ages 6-11	0.178 y^{-1}
Total mortality (Z)	
Average 2000-2002, ages 6-11	0.801 y^{-1} (0.717 – 0.935)
Recruitment (age-1)	
Average 1993-2002	531,460 fish (421,654 – 708,500)
Biomass (age 3+)	
Average 1993-2002	3,309,700 lb (2,831,840 - 3,738,790)
Spawning biomass	
Average 1993-2002	568,350 lb (456,295 – 647,133)
MSC recommended yield limit for 2003 (model-generated)	287,700 lb
Actual yield limit for 2003 (phase-in requirements)	481,700 lb

MM-4 (Grand Traverse Bay)

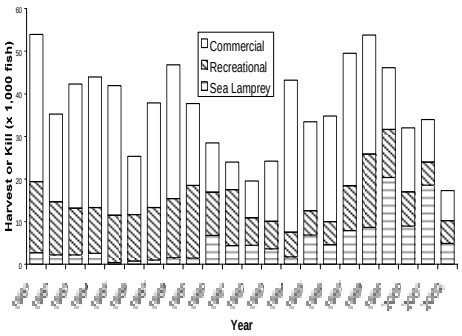
Prepared by Jory L. Jonas, John Netto, and Erik J. Olsen

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

The recruitment of lake trout in Grand Traverse Bay is based entirely on stocking. The U.S Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. In each of the last ten years, on average, 255,000 yearling lake trout have been stocked into Grand Traverse Bay. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for variations in mortality and movement among the various regions in the lake. Over the last 10 years (1993-2002) the recruitment to age one has averaged 227,000 fish in the Grand Traverse management unit (Summary table).

From 1993 until 1998 more lake trout were killed by commercial fishing than by either sea lamprey or sport fishing (Figure 1). However, during 1999-2002 the numbers killed by the three mortality sources were more similar and lamprey wounding had increased. Commercial fishing mortality in Grand Traverse Bay peaked in 1994 at 0.56 y^{-1}, remained stable over the next six years averaging of 0.24 y^{-1}, and in the recent few years has declined to a level of 0.12 y^{-1} in 2002 (Figure 2).

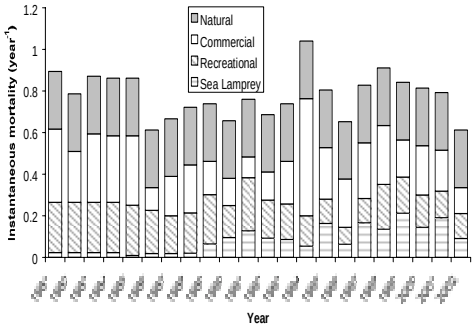
Figure 1. Number of lake trout killed by source in MM-4



Only tribal fishermen commercially harvest fish in this management unit. There are three types of tribal commercial fisheries, large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery

while primarily targeting lake whitefish is responsible for the greatest number of harvested lake trout. The commercial harvest of lake trout in tribal large-mesh gill-net fisheries rose from a low of 6 thousand fish in 1991 to 33 thousand fish harvested in 1998. In recent years, harvest has been declining, and an estimated 7 thousand fish were harvested in 2002. The yield of lake trout captured in tribal commercial fisheries peaked in 1998 at 135,000 lb and has declined by nearly 80% to 31,000 lb in 2002. Large-mesh gill-net effort in tribal fisheries has also been declining from 2 million feet in 1996 to an average of 0.75 million feet during the last two years (2001 and 2002). It is expected that major decreases in the commercial harvest of lake trout in the Grand Traverse Bay management unit will be sustained in future years as a result of converting the regions largest gill-net fishers to trap-net operations.

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



The management of recreational fisheries for lake trout is the primary responsibility of the state of Michigan and fisheries are comprised of both charter and sport anglers. The sportfishing harvest regulations in the Grand Traverse Bay management unit have changed significantly over the last 10 years, affecting recreational fishing mortality rates and harvest levels. From 1992-1996 the minimum size limit for lake trout harvest increased from 10 to 24 inches. In 1996 the season for harvesting lake trout was lengthened, so that it extended from Jan 1 through September 30 in contrast to the previous season of May 1 through Labor Day. Mid-way through the year in 1997 the minimum size limit was decreased to 20 inches and has remained so through 2002. The mortality rates of lake trout resulting from recreational fishing steadily declined from 1991 (0.26 y^{-1}) to 1996 (0.08 y^{-1}). Increases in recreational fishing mortality were observed in 1998 to 0.26 y^{-1} in response to reductions in the size regulations. Despite lower size regulations, mortality has declined averaging 0.26 y^{-1} during the recent three years (2000-2002; Figure 2). The estimated recreational yield of lake trout in Grand Traverse Bay had been consistent during the years 1992-1996 averaging 39,000 lb. In response to changes in size regulations from 1996 to 1998 the recreational yield of lake trout increased dramatically to 93,000 lb. In recent years (2001-2002) yield has declined, falling to 35,000 lb. The numbers of lake trout harvested followed similar patterns to that observed for yield. Harvest remained stable from 1992 through 1996 averaging 6 thousand fish. Harvest then increased dramatically peaking at 19 thousand fish in 1998. More recently, the harvest of lake trout has declined, falling to 5 thousand fish in 2001 and 2002 (Figure 1). Recreational fishing effort levels have remained relatively stable over the last 10 years (1993-2002) averaging 202 thousand angler hours (range=180-240 thousand angler hours).

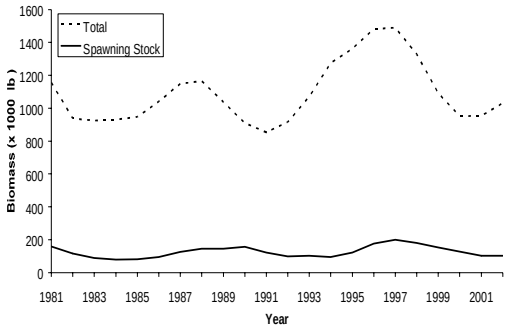
From 1981-1988 sea lamprey-induced mortality was the lowest source of mortality in the Grand Traverse Bay management unit with instantaneous rates averaging 0.02 y^{-1}. Rates gradually

increased to 0.13 y^{-1} by 1991, and declined to 0.05 y^{-1} in 1994. After 1994 rates were variable and generally increasing. The highest lamprey mortality rate was observed in 1999 at 0.21 y^{-1}. In 1999, lampreys were estimated to have killed over 20,000 lake trout from the management unit. From 1999-2001, mortality rates from sea lamprey remained high averaging 0.18 y^{-1}. The results of increased lamprey control efforts were potentially realized in 2002 as reported mortality rates were significantly lower at 0.09 y^{-1}. Lamprey killed approximately 5,000 lake trout in 2002 significantly fewer than had previously been observed.

In the Grand Traverse Bay management unit, lake trout are recruited into commercial fisheries by age 6 and recreational fisheries by age 7. Female lake trout in this management unit first spawn at age 3 and 50 percent or more are spawning by age 6. The total biomass of lake trout has averaged 925,000 pounds during the last 10 years (1993-2002). Lake trout biomass rose from a low of 0.9 million lb in 1991 to a high of 1.5 million pounds in 1997. After the peak in 1997, lake trout biomass declined to 953,000 lb by 2001. In 2002 the biomass of age 3 and older fish appears to be rising at approximately 1.0 million lb. In 1997, it was estimated that the spawning stock biomass was 200,000 lb by the year 2002 the estimate had decreased to 103,000 lb. The biomass of spawning lake trout in the management unit has averaged 136,000 lb during the last ten years (1993-2002).

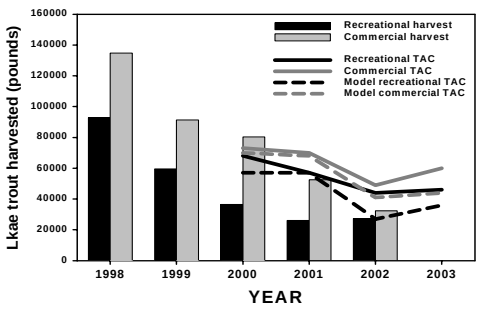
The spawning stock biomass produced per recruit is below the target value indicating that the mortality rate is too high in Grand Traverse Bay. The recommended harvest limit for the year 2003 in the Grand Traverse Bay management unit is 106,100 pounds of which 46,100 pounds was allocated to the state recreational fishery and 60,000 pounds to the tribal commercial/subsistence fishery.

Figure 3. Estimated lake trout biomass in MM-4



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

Figure 4. Comparison of actual harvest vs. TAC decision vs. model recomendation



Summary Status MM-4	Value (95% probability interval)
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.952 lb (2.587 – 3.374)
Current SSBR	0.670 lb (0.579 – 0.776)
SSBR at target mortality	0.850 lb (0.780 – 0.926)
Spawning potential reduction	
At target mortality	0.226 (0.256 – 0.323)
Average yield per recruit	0.599 lb (0.542 – 0.660)
Natural mortality (M)	0.277 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2000-2002)	7 y
Sport fishery (2000-2002)	7 y
Commercial fishing mortality (F)	
Average 2000-2002, ages 6-11	0.187 y^{-1} (0.149 – 0.233)
Sport fishing mortality (F)	
Average 2000-2002, ages 6-11	0.135 y^{-1} (0.105 – 0.159)
Sea lamprey mortality (ML)	
Average 2000-2002, ages 6-11	0.141 y^{-1}
Total mortality (Z)	
Average 2000-2002, ages 6-11	0.744 y^{-1} (0.680 – 0.806)
Recruitment (age-1)	
Average 1993-2002	227,000 fish (208,000 – 249,000)
Biomass (age 3+)	
Average 1993-2002	925,000 lb (847,000 – 1,030,000)
Spawning biomass	
Average 1993-2002	136,000 lb (123,000 – 157,000)
MSC recommended yield limit for 2003 (model-generated)	80,000 lb
Actual yield limit for 2003 (phase-in requirements)	106,100 lb

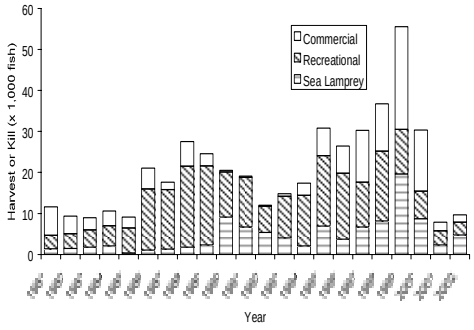
MM-5 (Leelanau Peninsula to Arcadia)

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

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

The recruitment of harvestable lake trout in the MM-5 management unit of Lake Michigan is based entirely on stocking. The U.S. Fish and Wildlife Service is the primary agency responsible for stocking lake trout in Lake Michigan. Over the last ten years, on average, 240,000 yearling lake trout were stocked into the MM-5 management unit annually. To more accurately estimate recruitment in the model, the number of fish stocked is adjusted to account for variations in mortality and for movement among the various regions in the lake. Over the last 10 years (1993-2002) the recruitment to age one has averaged 237,000 fish in MM-5.

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

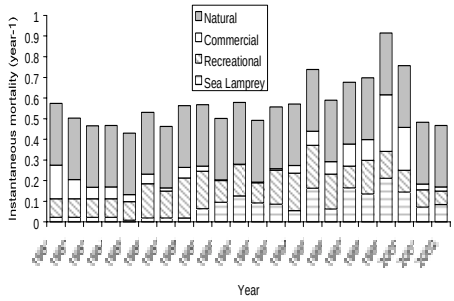


Although both state and tribal commercial fishermen harvest fish in the management unit, state-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish. State-licensed fishermen are not permitted to harvest lake trout, and as a result, are not included in lake trout harvest allocations. There are three types of tribal commercial fisheries, large-mesh gill net, small-mesh gill net, and trap net. The large-mesh gill-net fishery while primarily targeting lake whitefish, has been responsible for the greatest number of harvested lake trout in commercial fisheries. With the conversion of the regions largest gill-net fishers to trap-net operations and because lake trout were of low market value; the commercial harvest and mortality of lake trout have decreased considerably in recent years. From 1990 to 1993, mortality from commercial fishing was extremely low, averaging 0.003 y^{-1}. Mortality rates increased over the next seven years, the highest commercial fishing mortalities were observed in 1999 and 2000 at 0.27 and 0.20 y^{-1}, respectively. In 1999 over

25,000 fish were harvested in commercial fisheries. Since implementing the 2000 Consent Decree, reductions in mortalities have been realized. Only around 2,000 lake trout were harvested each year in 2001 and 2002 and mortality rates averaged 0.02 y^{-1} (Figures 1 and 2). The tribal commercial yield of lake trout rose precipitously from 0 lb in 1993 to 154,000 lb in 1999. In recent years yield has declined to near former lows averaging 6,500 lb. Large-mesh gill-net effort in tribal fisheries reflected similar patterns to those observed for mortality, harvest and yield after 1993. Effort rose from 0 to 2 million feet in 1999 and by 2002 effort was down to 70 thousand feet of net.

The recreational fisheries for lake trout are comprised of both charter and sport anglers. From 1983 until the late 1990's, recreational fishing was the highest source of mortality in the MM-5 management unit, exceeding both sea lamprey and commercial fishing mortality. In recent years however, recreational fishing mortality rates on lake trout (averaged over ages 6-11) have dropped significantly from the high level of 0.21 y^{-1} observed in 1995 to a low of 0.06 y^{-1} in 2002. The yield of lake trout in recreational fisheries averaged 82,000 lb over the 13-year period between 1985 and 1998. In recent years recreational yield has declined from 89,000 lb in 1998 to 21,000 lb in 2002. The number of lake trout harvested in recreational fisheries have also declined in recent years, dropping by over 85 percent from 1998 (17,000 fish) to 2002 (3,000 fish). Recreational fishing effort had been relatively constant for seven years (1995-2001) averaging 300 thousand angler hours, an indication that low harvest levels were likely reflecting declines in the abundance of lake trout. Between the years 2001 and 2002 angler hours declined to 236 thousand in response to poor catch rates and increases in size regulations. 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. As a result, a reduction in recreational harvest in the MM-5 management unit of Lake Michigan should continue to be realized in future years.

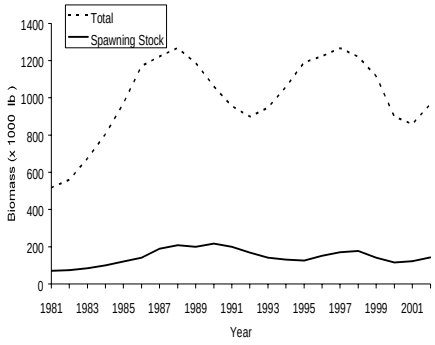
Figure 2. Instantaneous mortality rates for lake trout ages 6-11 in MM-5



From 1981 to 1988 sea lamprey mortality was less than either recreational or commercial mortality. From 1996 to 2000 sea lamprey mortality rates increased substantially in the MM-5 management unit. It appears that sea lamprey induced mortality is decreasing in recent years (2001 and 2002). Mortality rates have fallen from a high of 0.21 y^{-1} in 1999 to 0.08 in 2002 (Figure 2). Sea lamprey killed over 20,000 lake trout in 1999 and 5,000 in 2002. During the last 13 years (1990 to 2002), lampreys have killed an average of 6,800 lake trout y^{-1}. Prior to 1990 lamprey were only responsible for killing 1,500 lake trout y^{-1}. The U.S. Fish and Wildlife Service has initiated efforts to improve controls on lamprey populations in northern Lake Michigan.

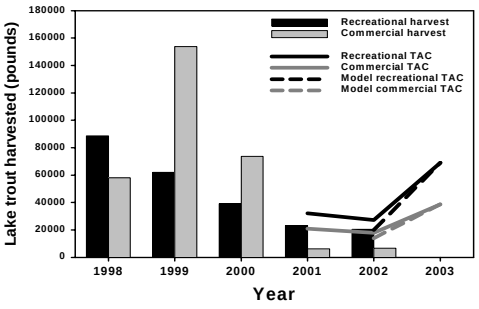
In general, 50 percent of lake trout in MM-5 are spawning by age 6 and recruited into commercial fisheries by age 7 and recreational fisheries by age 9. The total biomass rose to a peak in 1988, declined, in the late 1980s and early 1990s and then rose to a high value in 1997, before declining to levels below 1 million pounds in 2001 and 2002 (Figure 3). The biomass of spawners in the MM-5 showed similar temporal patterns with less pronounced peaks.

Figure 3. Estimated lake trout biomass in MM-5



The spawning stock biomass produced per recruit has improved in this region and is now more similar to and slightly above the target value, an indication that mortality is being controlled in MM-5. The recommended yield limit for the year 2003 in Unit MM-5 is 107,800 pounds, which was estimated based on a target mortality rate of 45%. Of this yield, 69,100 pounds were allocated to the state recreational fishery and 38,700 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. Language in the negotiated 2000 Consent Decree states that fisheries TAC limits will not vary by more than 15 percent from year to year. In 2002, harvest limits increased and were higher than 15% different from the previous year, an indication that lake trout populations were improving. As a result, the 15 percent rule was not invoked.

Figure 4. Comparison of actual harvest vs. TAC decision vs. model recomendation



Summary Status MM-5	Value (95% probability interval)
Female maturity	
Size at first spawning	1.51 lb
Age at first spawning	3 y
Size at 50% maturity	6.50 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	1.974 lb (1.647 – 2.257)
Current SSBR	0.790 lb (0.598 – 0.991)
SSBR at target mortality	0.636 lb (0.559 – 0.722)
Spawning potential reduction	
At target mortality	0.322 (0.301 – 0.360)
Average yield per recruit	0.347 lb (0.293 – 0.397)
Natural mortality (M)	0.298 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2000-2002)	7 y
Sport fishery (2000-2002)	9 y
Commercial fishing mortality (F)	
Average 2000-2002, ages 6-11	0.085 y^{-1} (0.060 – 0.119)
Sport fishing mortality (F)	
Average 2000-2002, ages 6-11	0.085 y^{-1} (0.061 – 0.121)
Sea lamprey mortality (ML)	
Average 2000-2002, ages 6-11	0.100 y^{-1}
Total mortality (Z)	
Average 2000-2002, ages 6-11	0.548 y^{-1} (0.507 – 0.613)
Recruitment (age-1)	
Average 1993-2002	237,000 fish (218,000 – 270,000)
Biomass (age 3+)	
Average 1993-2002	839,000 lb (721,000 – 993,000)
Spawning biomass	
Average 1993-2002	143,000 lb (115,000 – 173,000)
MSC recommended yield limit for 2003	107,800 lb
Actual yield limit for 2003	107,800 lb

MM-67 (Manistee - Ludington)

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

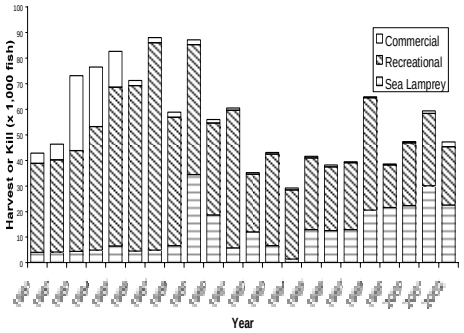
Lake trout management unit MM-67 is located in eastern central Lake Michigan, and is made up of statistical districts MM-6 and MM-7. The area covers Michigan's waters of Lake Michigan from Arcadia to Holland, extending to the state line bisecting the middle of the lake. The management unit covers a total 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-treaty waters, the northern section (MM-6) is entirely treaty ceded territory while only the northern two-thirds of the southern section (MM-7) is within treaty territory. A total of 690 square miles in the unit are outside treaty waters. A line running parallel to the northern side of the Grand River (located approximately ¾ of the way through grids in the 1900 series) out to the state line in the middle of the lake delineates the southern boundary of treaty territories in the unit. Management unit MM-67 contains a portion of the deepwater mid-lake lake trout refuge, which comprises 850 square miles of the unit (grids 1606, 1607, 1706, 1707, 1806, 1807, 1906 and 1907). It is illegal for recreational fishers to retain lake trout when fishing in the refuge area. Gill-net fishing (both commercial and subsistence) are prohibited in the refuge, some state and tribal licensed commercial trap-net operations are permitted, however, the retention of lake trout is prohibited. As of the year 2002 there was no tribal commercial fishing effort in management unit MM-7 and limited tribal fishing existed in MM-6.

The recruitment of lake trout in the southern treaty waters of Lake Michigan is based entirely on stocking. During the past ten years, an average of 192,000 yearling lake trout have been stocked into non-refuge southern treaty waters, while an additional 319,000 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 (1993-2002) the recruitment of lake trout to age one has averaged 378,000 fish in the southern treaty management unit of Lake Michigan.

Since 1986 commercial fishing has killed many fewer lake trout of harvestable size in the southern unit (MM-67) than either recreational fishing or sea lamprey (Figure 1). In the year 2002, the commercial fishery in southern treaty waters of Lake Michigan was comprised of only a few state-licensed commercial fishers and one tribal trap-net operation. State and tribal licensed commercial fisheries primarily target lake whitefish and chubs, and they are not permitted to

harvest lake trout. As a result, state and tribal commercial fishermen are not included in lake trout harvest allocations. The yield of lake trout in commercial fisheries has averaged 2,300 pounds over the last 17 years (1986-2002) in management unit MM67. On average commercial fishers have harvested around 800 fish/year from 1998-2002. As a result of stipulations of the 2000 consent decree, this area will experience greater commercial fishing effort from tribal interests in the future.

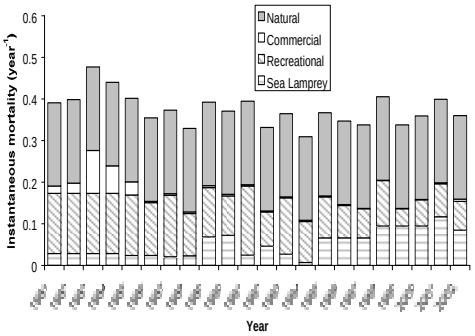
Figure 1. Number of lake trout killed by source in mm-67



State recreational fisheries for lake trout are comprised of both charter and sport anglers. In general, recreational fishing mortality has been higher than either commercial fishing mortality or mortality due to sea lamprey (Figure 2). From 1998 to 1999 observed recreational fishing mortality rates dropped by nearly 64 percent from 0.11 to 0.02 y^{-1}. By 2002 recreational fisheries had recovered, and the mortality rate had increased to near former levels (0.07 y^{-1}). The yield of lake trout in recreational fisheries peaked in 1987 at 474,000 lb, declined to 113,000 lb in 1999, rose to 178,000 lb in 2001 and was down again in 2002 (132,000 lb). The numbers of lake trout harvested had declined by nearly 80 percent from 1987 to 1999 with a peak of 81,000 fish in 1987 and a low of 17,000 fish in 1999 (Figure 1). In recent years the recreational harvest of lake trout is somewhat higher averaging 25,000 fish in the last three years (2000 to 2002). Fluctuations in effort mirror harvest fluctuations in this management unit, declining from 1987 to 1999 and increasing slightly in recent years. The minimum size limit for lake trout in the MM67 management unit is 10-inches, the bag limit is two fish per day, and the recreational fishing season extends from January 1 until Labor Day. The size and bag limits have not changed since 1981. However, the fishing season has changed twice, once in 1984 where the season was restricted from the entire year to May 1 through August 15th, and again in 1989 when the season was extended through Labor Day.

Sea lamprey-induced mortality is lower in southern treaty waters of Lake Michigan, when compared with rates observed in the northern units. Rates ranged from 0.007 to 0.12 (Figure 2). In the last five years (1998-2002), the number of lake trout killed by lamprey averaged 23,000 fish (Figure 1).

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



In general in MM-67 lake trout are both spawning and recruited into commercial and recreational fisheries by age 6. The total biomass of lake trout averaged over 3 million lb during the recent ten years (1993-2002; Figure 3). Spawning lake trout comprise a relatively high proportion of the total biomass in this unit (Figure 3), averaging nearly 1.0 million lb from 1993-2002. The spawning biomass of lake trout in MM-67 followed

similar temporal patterns to those observed for total biomass.

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

The recommended yield limit for the year 2003 in MM-67 is 471,700 lb. Of this, 431,400 pounds are allocated to the state recreational fishery and 40,300 pounds to the tribal fishery. The yield limit and allocations in this management unit are set to achieve a total mortality rate target of 40% and establish a 90 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).

Figure 3. Estimated lake trout biomass in mm-67

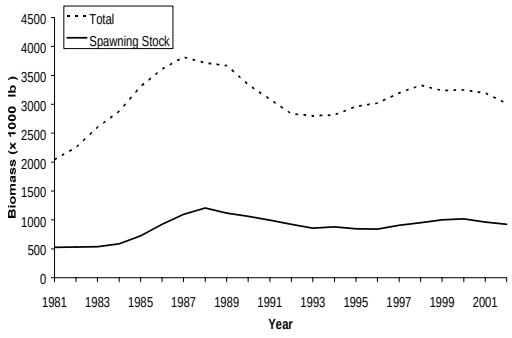
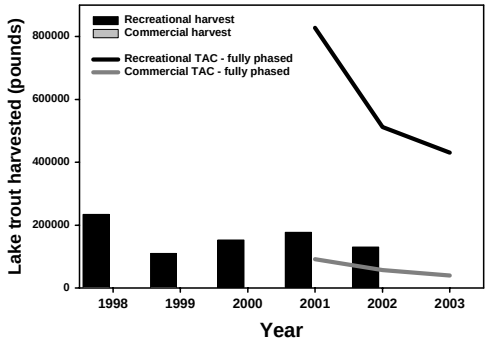


Figure 4. Comparison of actual harvest vs. TAC decision



Summary Status MM-67	Value (95% probability interval)
Female maturity	
Size at first spawning	1.34 lb
Age at first spawning	3 y
Size at 50% maturity	6.14 lb
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	5.800 lb (4.539 – 7.176)
Current SSBR combined w/ refuge	2.390 lb (1.716 – 2.966)
SSBR at target mortality	1.272 lb (1.062 – 1.465)
Spawning potential reduction	
At target mortality	0.219 (0.191 – 0.253)
Average yield per recruit	0.439 lb (0.396 – 0.487)
Natural mortality (M)	0.201 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (2000-2002)	6 y
Sport fishery (2000-2002)	6 y
Commercial fishing mortality (F)	
Average 2000-2002, ages 6-11	0.003 y^{-1} (0.002 – 0.004)
Sport fishing mortality (F)	
Average 2000-2002, ages 6-11	0.070 y^{-1} (0.054 – 0.100)
Sea lamprey mortality (ML)	
Average 2000-2002, ages 6-11	0.099 y^{-1}
Total mortality (Z)	
Average 2000-2002, ages 6-11	0.373 y^{-1} (0.344 – 0.414)
Recruitment (age-1)	
Average 1993-2002	378,000 fish (357,000 – 404,000)
Biomass (age 3+)	
Average 1993-2002	3,081,000 lb (2,295,000 – 3,898,000)
Spawning biomass	
Average 1993-2002	919,000 lb (635,000 – 1,220,000)
MSC recommended yield limit for 2003	471,700 lb
Actual yield limit for 2003	471,700 lb

STATUS OF LAKE WHITEFISH POPULATIONS

Lake Superior

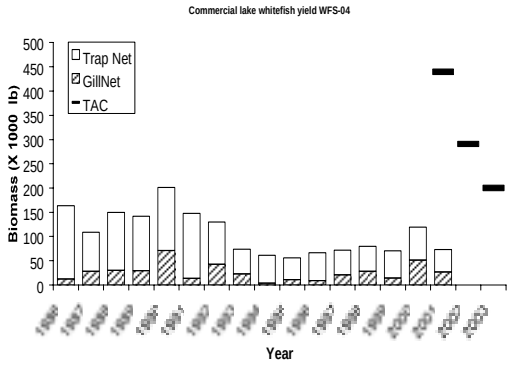
WFS-04 (Marquette - Big Bay)

Prepared by Philip J. Schneeberger

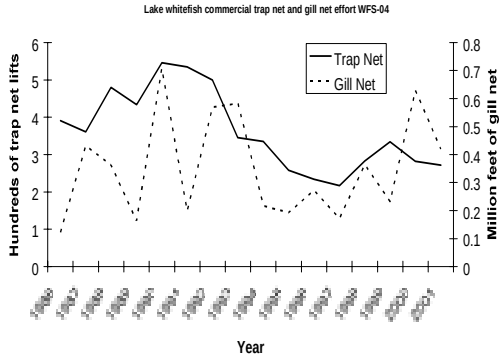
Lake whitefish unit WFS-04 (1,201,498 surface acres) is located in Lake Superior roughly between Big Bay and Laughing Fish Point east of Marquette. Fishable grids in this unit include 1326-1327, 1428-1429, and 1529-1531. Near shoreline features of this zone includes many points, bays, islands, and in-flowing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

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

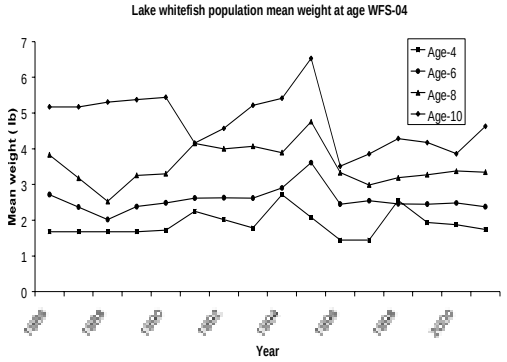
Yield during 2001 was 73 thousand lbs with 46 thousand lbs (63%) caught in trap nets and 27 thousand lbs (37%) in gill nets. Trap-net yield was low but gill-net yield was slightly higher compared to averages from 1986 through 2000. On average, trap nets have caught about three-quarters of the annual yield from 1986 through 2001.



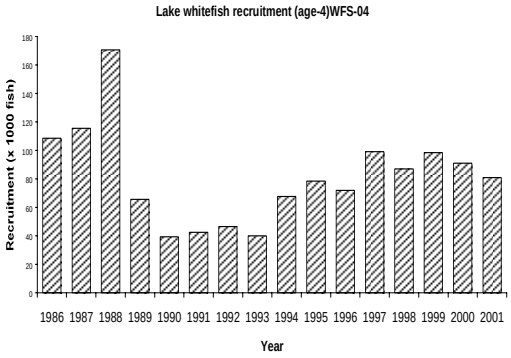
Fishing effort declined for both types of commercial gear. Trap-net effort in 2001 (272 lifts) was lower than for any year since 1997. Gill-net effort (420 thousand ft) was 35% above the 1991-99 average but was 33% below the value for 2000.



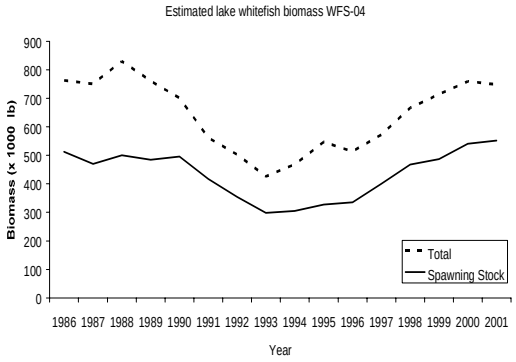
Calculations of mean weight-at-age were lower in 2001 than in 2000 for ages 4-8 and 12+. Values were lower for all ages in 2001 compared to 1986-2000 averages.



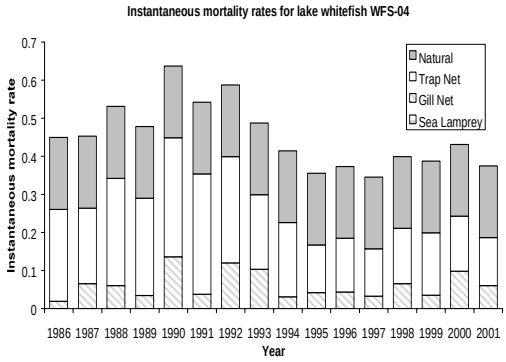
Recruitment (number of age-4 lake whitefish) was estimated at 81,000 in 2001. Estimates of recruitment have been stable from 1994 through 2001.



A seven-year positive trend continued in 2001 for estimates of both fishable biomass and spawning stock biomass. Estimated fishable biomass was 748 thousand lbs and spawning stock biomass was 552 thousand lbs in 2001. The ratio of spawning stock biomass to fishable biomass was 0.74.



Total instantaneous mortality rates (Z) have been stable and low over the last eight years relative to the period from 1988 through 1993. Estimated instantaneous fishing mortality rates (F) were 0.06 y^{-1} for gill nets and 0.12 y^{-1} for trap nets in 2001. Instantaneous natural mortality rate was 0.19 y^{-1}.



The calculated yield limit for 2003 is 200,000 lbs in WFS-04. Yield limits have decreased each year since 2001. It is a struggle to understand these decreases since indicators and trends appear to be generally favorable.

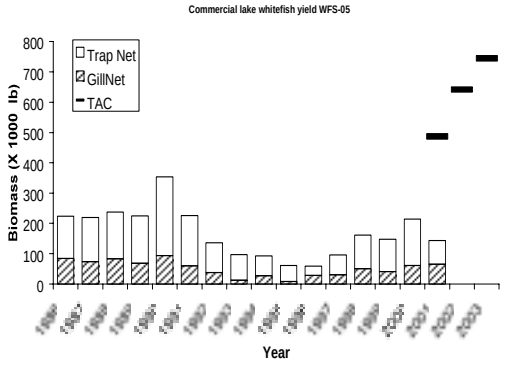
Summary Status WFS-04 Whitefish		
Female maturity		
	Size at first spawning	1.85 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.00 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	7.352 lb
		(SE 0.012)
	Current SSBR	2.46 lb
		(SE 0.07)
	SSBR at target mortality	0.231 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.334
		(SE 0.010)
Average yield per recruit		1.376 lb
		(SE 0.010)
Natural Mortality (M)		$0.188\ y^{-1}$
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	$0.07\ y^{-1}$
		(SE 0.004)
	Average trap net F, ages 4+	$0.153\ y^{-1}$
		(SE 0.007)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	$0.412\ y^{-1}$
		(SE 0.01)
Recruitment (age-4)	(1992-2001 average)	76,161 fish
		(SE 3,882)
Biomass (age 3+)	(1992-2001 average)	591,980 lb
		(SE 23,762)
Spawning biomass	(1992-2001 average)	406,830 lb
		(SE 17,057)
MSC recommended yield limit for 2003		200,000 lb
Actual yield limit for 2003		200,000 lb

WFS-05 (Munising)

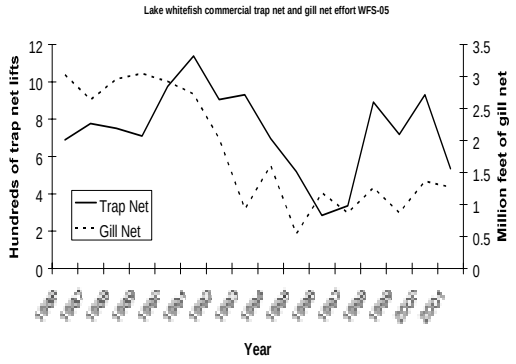
Prepared by Philip J. Schneeberger

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

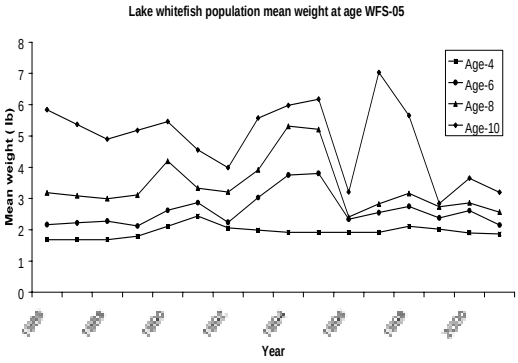
Total yield of lake whitefish in WFS-05 for 2001 was 144 thousand lbs. This represented a 33% decrease from the yield in 2000 and a 15% decrease over the average yield from 1986 through 2000. Trap nets accounted for 55% of the lake whitefish yield during 2001, and gill nets took the remaining 45%. Trap-net yield has varied without trend since the early 1990s whereas gill-net yield has shown an increasing trend since 1995.



Trap-net effort fell 42% from 2000 (930 lifts) to 2001 (535 lifts), while gill-net effort went down 6% (from 1.36 to 1.27 million ft). From 1996 to 2001, trap-net effort has fluctuated considerably but gill-net effort has been relatively steady. Compared to 1986-2000 averages, fishing effort during 2001 was lower by 29% for the trap-net fishery and by 32% for the gill-net fishery.

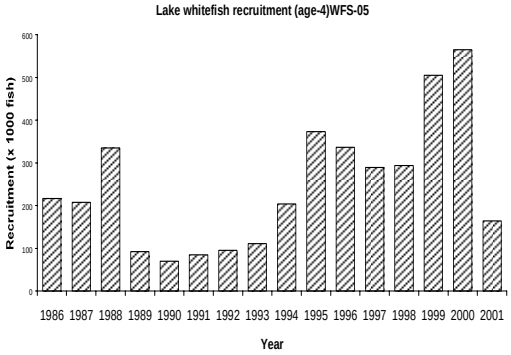


Mean weight-at-age values were less in 2001 than in 2000 for ages 4-12+. These lower values reflect an on-going decline in whitefish weight-at-age that has been evident throughout the 1986-2001 data series.

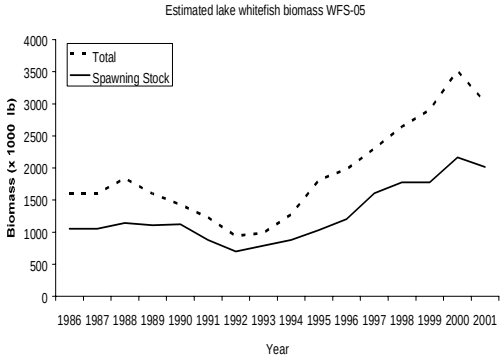


The 2001 estimate of recruitment, measured as annual estimated numbers of age-4 lake whitefish in the population, dropped precipitously from current estimates for

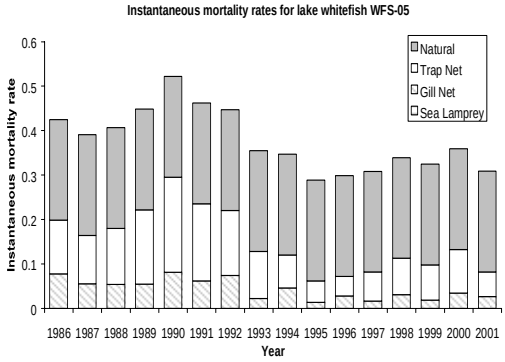
1999 and 2000. Estimated recruitment in 2001 was 164,000 fish, but prior experience dictates that this estimate is subject to revision in subsequent years. For example, the recruitment estimate in 2000 using the 1986-2000 data set was 155,000, but adding one more year of data (1986-2001 data set) changed the 2000 estimate to 565,000.



Biomass estimates in 2001 were 3.02 million lbs for the fishable stock (lake whitefish age-4 and older) and 2.02 million lbs for the spawning stock. These values represent declines from estimates for 2000 and mark the end of increasing trends for biomass estimated for 1992 through 2000. Spawning stock biomass was 67% of fishable biomass in 2001, consistent with the 1986-2000 average.



Estimates for total instantaneous mortality rate (Z) have remained consistently low since 1993. The estimate for Z was 0.31 y^{-1} in 2001. Natural mortality rate (M) was the largest component (73%) of Z in WFS-05. Instantaneous fishing mortality (F) rate was 0.03 y^{-1} for gill nets and 0.06 y^{-1} for trap nets.



The calculated 2003 yield limit for WFS-05 was 745,000 lbs, a 16% increase from the yield limit in 2002. Increased effort and yield from the gill-net fishery would be necessary to reach the 2003 TAC while maintaining the mandated split between tribal and state-licensed fishers.

Summary Status WFS-05 Whitefish		
Female maturity		
	Size at first spawning	1.93 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.34 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	3.733 lb (SE 0.007)
	Current SSBR	1.98 lb (SE 0.08)
	SSBR at target mortality	0.174 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.53 (SE 0.022)
Average yield per recruit		0.739 lb (SE 0.030)
Natural Mortality (M)		0.227 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	11
	Fully selected age to trap nets	11
	Average gill net F, ages 4+	0.025 y^{-1} (SE 0.002)
	Average trap net F, ages 4+	0.083 y^{-1} (SE 0.008)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.334 y^{-1} (SE 0.01)
Recruitment (age-4)	(1992-2001 average)	293,700 fish (SE 42,319)
Biomass (age 3+)	(1992-2001 average)	2,138,500 lb (SE 207,730)
Spawning biomass	(1992-2001 average)	1,393,100 lb (SE 121,310)
MSC recommended yield limit for 2003		745,000 lb
Actual yield limit for 2003		745,000 lb

WFS-06 (Grand Marais)

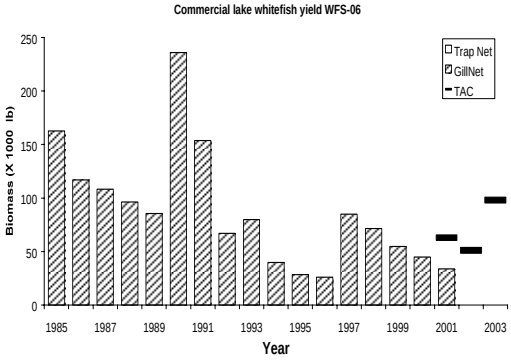
Prepared by Mark P. Ebener

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

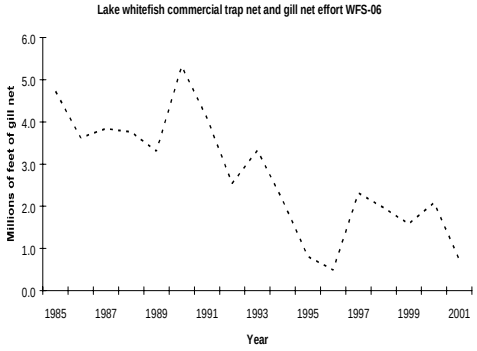
There is little habitat for whitefish reproduction in WFS-06. The entire shoreline is relatively straight and is composed of sand with lesser amounts of small-sized gravel and scattered cobble that are found only on the immediate shoreline. It is likely that many of the lake whitefish that inhabit WFS-06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

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

The commercial yield of lake whitefish from WFS-06 has averaged only 87,600 lb during 1985-2001. The peak yield was 236,000 lb in 1990 and the lowest yield was 26,000 lb in 1996. The yield of whitefish was 33,600 lb in 2001.



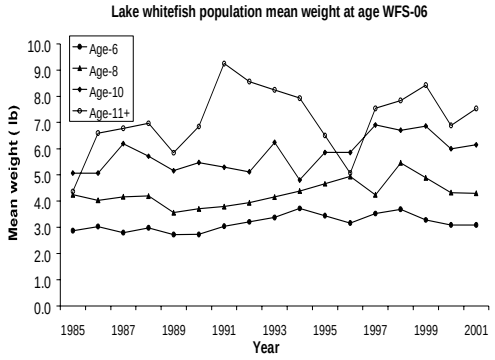
The large-mesh gill-net fishery has accounted for the entire yield from WFS-06 since 1985. Effort averaged 2.7 million ft during 1985-2001 and ranged from 5.3 million ft in 1990 to 0.5 million ft in 1996. Large-mesh gill-net effort has averaged only 1.4 million ft since 1996 and was 0.7 million ft in 2001. Much of the gill-net effort in made up of 5 ¼ and 5 ½ inch stretched mesh.



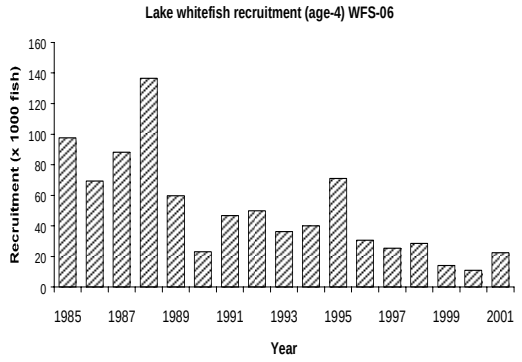
Whitefish caught in WFS-06 are large so the fishery targets them with the large mesh because fishers are paid more per pound for mediums and jumbos than for No.1 whitefish. Annual mean weight of whitefish in the gill-net yield from WFS-06 ranged from 3.0 to 5.6 lb and averaged 3.8 lb during 1985-2001. Mean weight of whitefish in the gill-net harvest averaged 5.3 lb in 2001. The proportion of medium and jumbo whitefish in the harvest from WFS-06 is

greater than nearly all other units in the 1836 ceded waters.

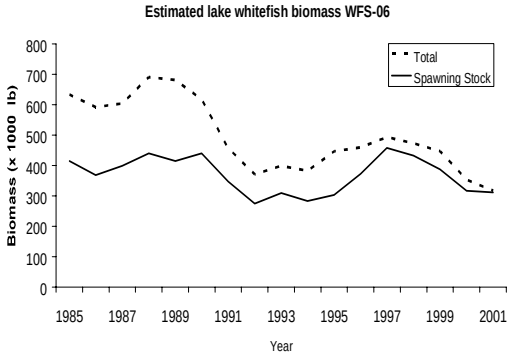
Growth of whitefish in WFS-06 has remained constant through time or slightly increased. Mean weight of nearly all age-classes in 2001 was equal to or greater than prior to the mid 1980s.



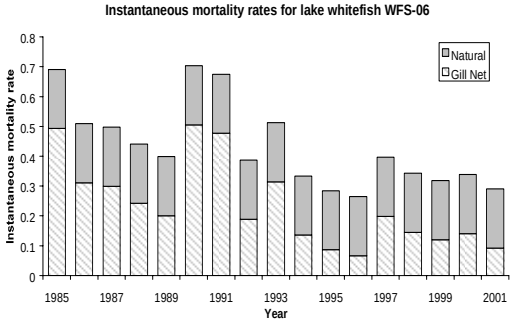
Recruitment to the fishable population of whitefish in WFS-06 has been declining through time based on the stock assessment model. Recruitment of age-4 whitefish was estimated to range from 136,000 fish in 1988 to 11,000 in 2000. Recruitment was estimated to be 23,000 age-4 whitefish in 2001, which represents an increase over 2000, but still less than the long-term average of 50,000 fish.



Biomass of the fishable stock of whitefish in WFS-06 has also declined through time primarily because of declines in recruitment to the fishery. Biomass of whitefish peaked at 691,000 lb in 1988 and 493,000 lb in 1997. Biomass of whitefish in WFS-06 was estimated to be 317,000 lb in 2001. Biomass averaged 414,000 lb during the last decade in WFS-06. Spawning biomass has made up a larger proportion of total biomass in the last few years primarily because of the increases in growth of whitefish in WFS-06.



Total annual mortality of whitefish has declined through time based on the stock assessment model. Total mortality averaged only 0.32 y^{-1} on age-4 and older whitefish in WFS-06 during 1999-2001 and was lower in 2001 than most other years. Fishing mortality rate averaged 0.12 y^{-1} during 1999-2001 and was 0.09 y^{-1} in 2001. Because total mortality was substantially less than the target rate of 1.05 y^{-1} the projection model estimated that fishing mortality could be increased three times from the current level to produce an annual mortality of 0.71 y^{-1}. The recommended yield limit at the increased level of fishing was estimated to be 98,000 lb.



Summary Status WFS-06 Whitefish		
Female maturity		
	Size at first spawning	1.85 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.88 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	10.057 lb
		(SE 0.002)
	Current SSBR	4.76 lb
		(SE 0.44)
	SSBR at target mortality	0.378 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.474
		(SE 0.044)
Average yield per recruit		1.406 lb
		(SE 0.119)
Natural Mortality (M)		0.198 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	7
	Fully selected age to trap nets	
	Average gill net F, ages 4+	0.118 y^{-1}
		(SE 0.019)
	Average trap net F, ages 4+	0.0 y^{-1}
		(SE 0.0)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.316 y^{-1}
		(SE 0.019)
Recruitment (age-4)	(1992-2001 average)	32,975 fish
		(SE 3,041)
Biomass (age 3+)	(1992-2001 average)	414,390 lb
		(SE 55,578)
Spawning biomass	(1992-2001 average)	345,080 lb
		(SE 50,180)
MSC recommended yield limit for 2003		98,000 lb
Actual yield limit for 2003 (HRG)		98,000 lb

WFS-07 (Tahquamenon Bay)

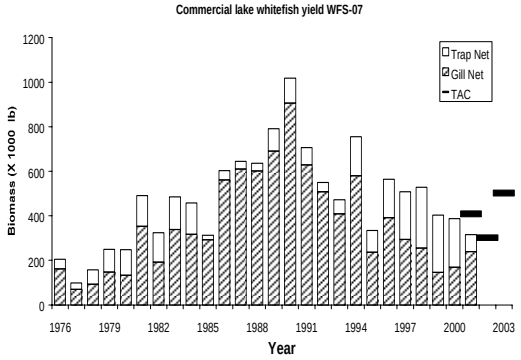
Prepared by Mark P. Ebener

WFS-07 is located in the Whitefish Bay area of Lake Superior. The primary geographic feature of WFS-07 is Whitefish Point. West and north of Whitefish Point is the open water of Lake Superior, while south of the Point includes western Whitefish Bay and a large amount of shallow water. WFS-07 contains 371,000 surface acres of water 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, whitefish disperse north and west to Whitefish Point and areas of the main part of Lake Superior. Many whitefish also remain in Whitefish Bay and some move into Canadian waters.

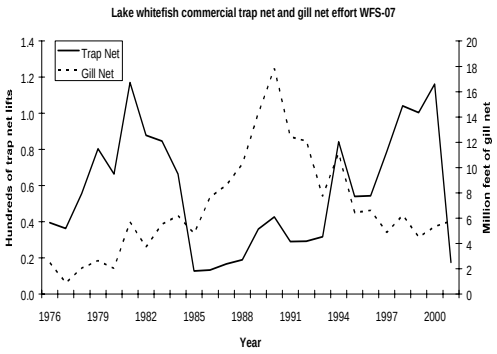
This unit is a very important fishing ground for the CORA fishery, and has been an exclusive CORA fishing area since 1985. Large- and small-boat gill-net fisheries as well as several trap-net fisheries operate in WFS-07. An ice fishery also takes place nearly every winter. There are a large number of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

The commercial yield of whitefish from WFS-07 has averaged 411,000 lb during 1976-2001. A peak yield of one million pounds occurred in 1990 and the lowest reported yield was 98,000 lb in 1977. The 2001 yield was 316,000.



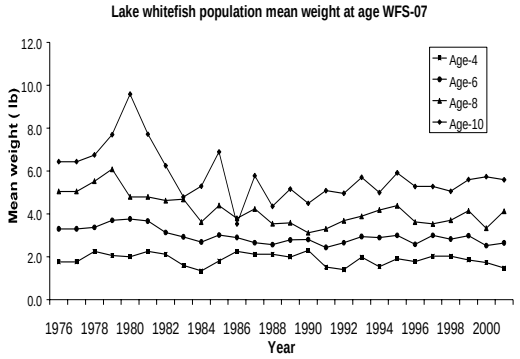
The large-mesh gill-net fishery accounted for 76% of the whitefish yield from WFS-07 during 1976-2001. Since 1998 the trap-net fishery has harvested more whitefish from the unit than the gill-net fishery, except in 2001. The yield in 2001 was 240,000 lb from the gill-net fishery and 76,000 lb from the trap-net fishery.

Yield of whitefish from WFS-07 has mirrored changes in fishing effort during 1976-2001. After peaking at 17.8 million ft in 1990, large-mesh gill-net effort declined to between four and six million ft during 1996-2001. Gill-net effort was 5.8 million ft in 2001. Trap-net effort increased almost annually from 128 lifts in 1985 to 1,161 lifts in 2000. Trap-net effort was only 175 lifts in 2001 because several commercial operations moved to fish in new areas of Lake Huron after the 2000 Consent Decree.



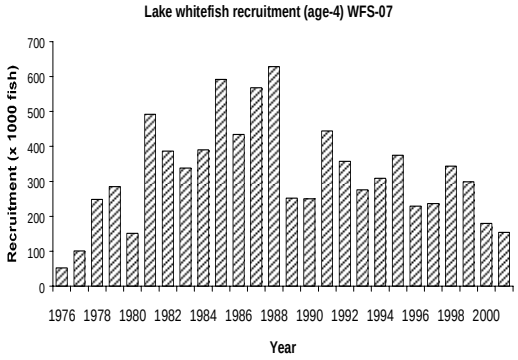
Whitefish caught in WFS-07 are of moderate to large size. Mean weight of a harvested whitefish averaged 3.2 lb in the gill-net fishery and 2.8 lb in the trap-net fishery during 1976-2001. Mean weight of a harvested whitefish in 2001 averaged 3.6 lb in the gill-net fishery and 3.2 lb in the trap-net fishery.

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

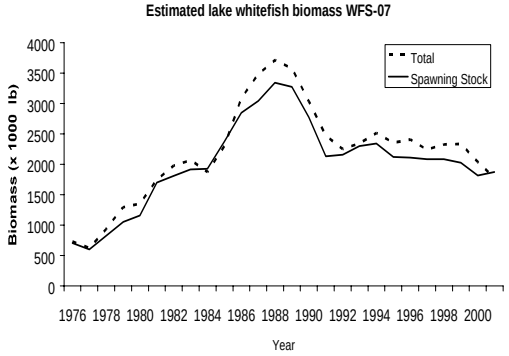


Sexual maturity of whitefish in WFS-07 occurs at a small size and young age, but complete maturity of females occurs at a large size and old age. Female whitefish begin reaching sexual maturity at age 3 and about 15 inches long, and by age 5 over 50% of females are sexually mature. After age 5, however,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

Estimated recruitment of age-4 whitefish to the fishable population has gone through at least two significant changes during 1976-2001. Recruitment increased through time from 1976-1988, thereafter, recruitment declined by one-half and has been slowly declining since 1991. The stock assessment model estimated that an average of 322,000 age-4 whitefish recruited to the fishable population each year during 1976-2001. Recruitment varied from 52,000 fish in 1976 to 628,000 fish in 1988. About 276,000 age-4 whitefish have recruited to the fishable population each year during 1992-2001. Recruitment was estimated to be 154,000 age-4 whitefish in 2001.

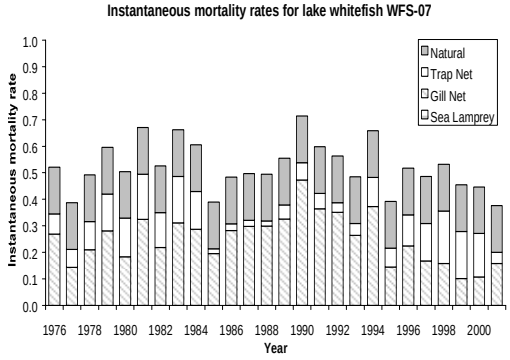


Average fishable biomass of age-4 and older whitefish peaked at 3.6 million lb in 1989 and has declined and stabilized since then. The fishable stock biomass was 1.8 million lb in 2001, compared to a spawning biomass of 1.9 million lb in 2001. Biomass declined by 600,000 lb from 1999 to 2000 and 2001, and the 2001 biomass was equal to levels observed in the mid 1980s in WFS-07.



Instantaneous total annual mortality of age-4 and older whitefish showed little change through time from 1976-2000. The variations in total mortality were driven largely by changes in fishing effort, particularly large-mesh gill-net effort. Instantaneous total annual mortality on age-4 and older fish averaged 0.52 y^{-1} during 1976-2001. Annual estimated mortality ranged from

0.71 y^{-1} in 1990 to 0.38 y^{-1} in 2001. Fishing mortality averaged 0.34 y^{-1} during 1976-2001. Gill-net mortality averaged 0.25 y^{-1} and trap-net mortality 0.09 y^{-1} during 1976-2001. Fishing mortality in 2001 was 0.20 y^{-1}, with gill-net mortality being 0.16 y^{-1} and trap-net mortality 0.04 y^{-1}.



Since total annual mortality was less than the target rate of 1.05 y^{-1} in WFS-07 in 2001, the projection model estimated that fishing mortality could be increased 1.4 times from the levels experience during 1999-2001. As a consequence, the recommended yield limit was estimated to be 502,000 lb. The recommended yield limit was 302,000 lb in 2001 and 409,000 lb in 2000.

Summary Status WFS-07 Whitefish		
Female maturity		
	Size at first spawning	1.68 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.21 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	7.958 lb (SE 0.001)
	Current SSBR	2.16 lb (SE 0.13)
	SSBR at target mortality	0.291 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.271 (SE 0.016)
Average yield per recruit		1.661 lb (SE 0.015)
Natural Mortality (M)		0.176 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.122 y^{-1} (SE 0.01)
	Average trap net F, ages 4+	0.127 y^{-1} (SE 0.008)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.426 y^{-1} (SE 0.017)
Recruitment (age-4)	(1992-2001 average)	275,870 fish (SE 10,185)
Biomass (age 3+)	(1992-2001 average)	2,259,400 lb (SE 87,023)
Spawning biomass	(1992-2001 average)	2,092,900 lb (SE 83,535)
MSC recommended yield limit for 2003		502,000 lb
Actual yield limit for 2003 (HRG)		502,000 lb

WFS-08 (Brimley)

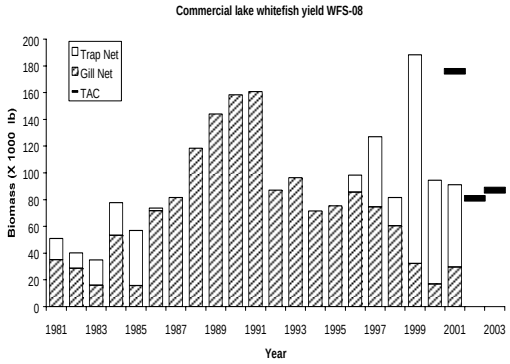
Prepared by Mark P. Ebener

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

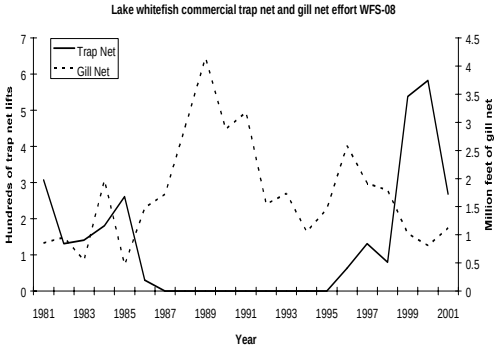
There are probably four reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Whitefish that spawn in WFS-07 are caught in the commercial fishery of WFS-08. The areas off Birch Point and Iroquois Island are both whitefish spawning grounds that contribute to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

WFS-08 has been and continues to be a traditional commercial fishing area for the CORA small-boat and gill-net ice fishery. WFS-08 has been an exclusive fishing zone for the CORA fishery since 1985. There are seven or eight undeveloped landing sites that are commonly use 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 95,700 lb during 1981-2001. Annual yields ranged from 35,000 lb in 1983 to 188,000 lb in 1999. The peak yield of 195,000 lb occurred in 1979, just prior to the creation of CORA. The large-mesh gill-net fishery accounted for 75% of the whitefish yield from WFS-08 during 1981-2001. There was no trap-net yield from WFS-08 during 1987-1995. The trap-net yield in 2001 was 61,800 lb, while the gill-net yield was 29,500 lb.



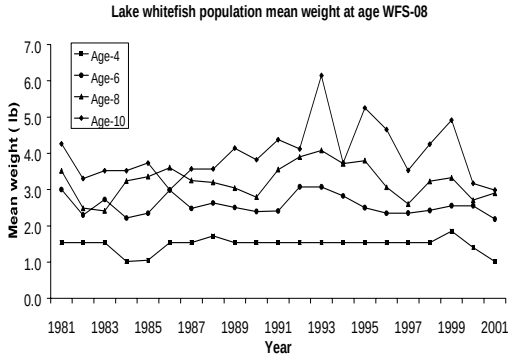
Gill-net effort has been declining in WFS-08 while trap-net effort has increased tremendously. Peak gill-net effort was 4.1 million ft in 1989 but has declined to an average of one million ft during 1999-2001. Gill-net effort was 1.1 million ft in 2001. Trap-net effort peaked at 738 lifts in 1979, declined to zero during 1987-1995, and increased to 583 lifts in 2000. Trap-net effort was 268 lifts in 2001.



Whitefish in WFS-08 are of moderate to large size. Mean weight of

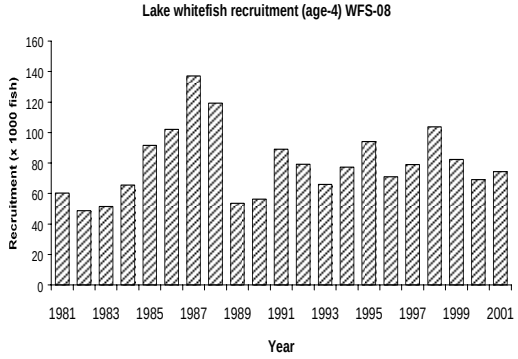
a harvested whitefish in the gill-net fishery averaged 3.0 lb and mean weight in the trap-net fishery averaged 2.3 lb during 1981-2001. Mean weight of a harvested whitefish in 2001 was 2.5 lb in the trap-net fishery and 2.7 lb in the gill-net fishery.

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

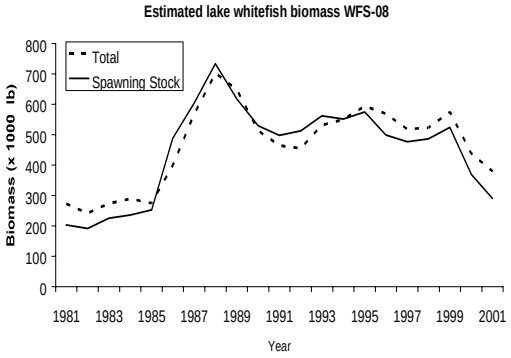


Whitefish in WFS-08 mature at smaller sizes and ages than in WFS-07. Female whitefish in WFS-08 begin maturing at 15 inches total length and at age 3. Two-thirds of whitefish in WFS-08 are sexually mature by age 4. Complete maturity is reached at 23 inches total length and age 11.

Recruitment of age-4 whitefish to the fishable population in WFS-08 has been less variable and stable than in adjacent unit WFS-07. The stock assessment model estimated that an average of 80,000 age-4 whitefish recruited to the fishable population in WFS-08 each year during 1981-2001. Recruitment peaked in 1987 and 1988 at 137,000 and 119,000 age-4 fish, respectively. Thereafter, recruitment was fairly stable ranging from 54,000 to 113,000 lb during 1989-2001. Recruitment was estimated to be 74,000 age-4 whitefish in 2001.

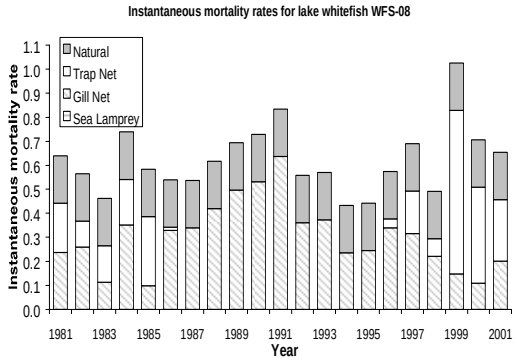


Because whitefish in WFS-08 mature at a young age and small size, fishable and spawning stock biomass vary concurrently and are nearly equal. Fishable stock biomass in WFS-08 averaged 466,000 lb during 1981-2001 and ranged from 241,000 lb in 1982 to 702,000 lb in 1988. Fishable stock biomass was stable between 1992 and 2000 ranging from 438,000 lb to 594,000 lb. Both fishable and spawning stock biomass was lower in 2001 than the previous 15 years at 380,000 and 290,000 lb, respectively.



The large-mesh gill-net fishery accounted for the largest single source of mortality in whitefish from WFS-08. Annual instantaneous total annual mortality of age-4 and older whitefish averaged 0.62 y^{-1} during 1981-2001 and ranged from 0.43 y^{-1} to 1.02 y^{-1}. Total mortality rate was 0.65 y-1 in 2001. Average gill-net mortality was 0.30 y^{-1} compared to 0.12 y^{-1} for the trap-net

fishery during 1981-2001. Trap-nets were the largest single source of mortality during 1999-2001. Trap-net mortality was 0.26 y^{-1} and gill-net mortality 0.20 y^{-1} in 2001.



Total annual mortality on age-4 and older whitefish was less than the target rate of 1.05 y^{-1} during 2000 and 2001. Unfortunately, the SPR value at the target mortality rate was only 0.12 and less than the target SPR value of 0.20. Thus the projection model estimated that fishing mortality rate should be reduced 42% from levels experienced during 1999-2001. The recommended yield limit was estimated to be 67,000 lb in 2003. The recommended yield limit was 176,000 in 2001 and 81,000 lb in 2002. A harvest regulating guideline of **87,000 lb** was used as the yield limit for 2003 and represents the average yield during 1999-2002.

Summary Status WFS-08 Whitefish		
Female maturity		
	Size at first spawning	1.43 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.04 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	5.489 lb (SE 0.01)
	Current SSBR	0.72 lb (SE 0.03)
	SSBR at target mortality	0.168 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.132 (SE 0.006)
Average yield per recruit		1.308 lb (SE 0.003)
Natural Mortality (M)		0.197 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.152 y^{-1} (SE 0.014)
	Average trap net F, ages 4+	0.446 y^{-1} (SE 0.025)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.795 y^{-1} (SE 0.036)
Recruitment (age-4)	(1992-2001 average)	79,570 fish (SE 3,364)
Biomass (age 3+)	(1992-2001 average)	513,550 lb (SE 16,985)
Spawning biomass	(1992-2001 average)	484,920 lb (SE 15,855)
MSC recommended yield limit for 2003		67,000 lb
Actual yield limit for 2003 (HRG = 1999-2002 average yield)		87,000 lb

Lake Huron

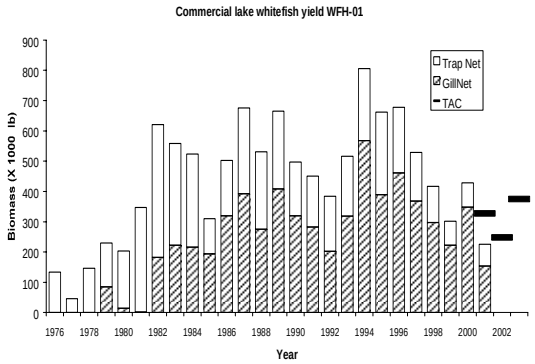
WFH-01 (St. Ignace)

Prepared by Mark P. Ebener

Management unit WFH-01 is located in the northwest portion of the main basin of Lake Huron. The unit is relatively shallow as most water is <150 ft deep. WFH-01 contains 232,275 surface acres of water <240 ft deep.

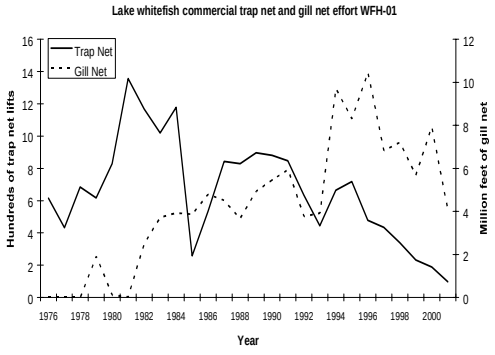
There are probably several reproductively isolated stocks of lake whitefish that inhabit WFH-01. One stock is located near Cheboygan, MI, another stock spawns north of St. Ignace near Rabbitsback and Horseshoe Bay, and third stock spawns in St. Martin Bay. A fourth stock probably spawns near Hessel, MI.

WFH-01 has been an exclusive fishing zone for the CORA fishery since 1985 and is a favored fishing area for small-boat gill-net fishers, especially during the early spring and fall. In most years some gill-net fishing occurs under the ice in St. Martin Bay. Commercial fishery yield has ranged from a low of 46,000 lb in 1977 to 806,000 lb in 1994 and averaged 495,000 lb during 1992-2001. The commercial yield was 226,000 lb in 2001 compared to 428,000 lb in 2000 and the commercial yield in 2001 was less than the recommended harvest limit of 327,000 lb.



The large-mesh gill-net fishery has accounted for the majority of the commercial yield from WFH-01 during 1976-2001. From 1976-1984 large-mesh gill nets accounted for 0-41% of the annual fishery yield, while after 1985 gill-net accounted for 52-81% of the annual yield. The gill-net fishery accounted for 67% of the commercial yield of lake whitefish from WFH-01 during 1992-2001. The gill-net fishery harvested 154,000 lb in 2001 compared to 72,000 for the trap-net fishery.

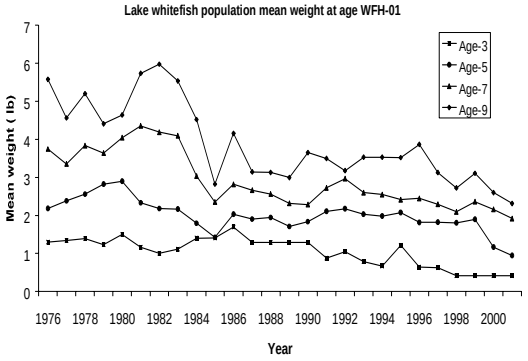
Both gill-net and trap-net fishing effort has been declining in WFH-01. Trap-net effort peaked at 1,357 lifts in 1981 and since then it has declined almost annually reaching a low of 98 lifts in 2001. Gill-net effort was stable at about 4 million ft from 1983 to 1993, increased to 10.5 million ft in 1996, and has declined since to 4.1 million ft in 2001.



Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No1 fish (<3 lb). Mean weight of whitefish in the trap-net fishery ranged from 2.1 to 2.3 lb during 1992-2001. Mean weight of whitefish in the gill-net fishery ranged

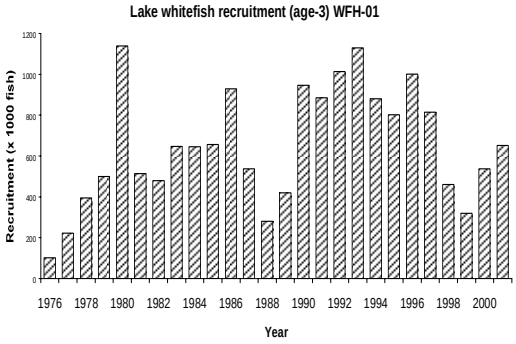
from 2.2 to 2.5 lb during 1992-2001. Mean weight of a harvested whitefish was 2.3 lb in the gill-net fishery and 2.1 lb in the trap-net fishery in 2001.

Growth of lake whitefish, expressed as mean weight at age, continued to decline in WFH-01 during 2001. The decline in mean weight at age has been most pronounced for whitefish of age 5 and older, while growth of younger fish appeared to stabilize in 2001.

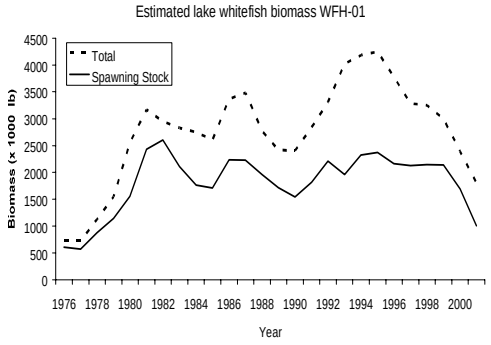


The decline in growth has had a profound effect on sexual maturity of whitefish in WFH-01. The proportion of sexually mature age-4 female whitefish declined from 66% during 1976-1982 to 45% during 1983-1992, then to 24% during 1993-2000. Only 3% of age-4 female whitefish were sexually mature in 2001.

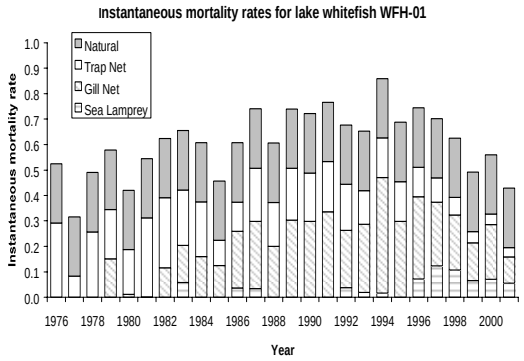
Large year-classes of whitefish were produced during 1987-1994 in WH-01, and then recruitment declined. These large year-classes produced the large yield of 806,000 lb in 1994 and also probably helped suppress growth of whitefish in the unit. The long-term trend in recruitment in WFH-01 appears be one of stable and good recruitment for 8-9 yr then declines of 3-4 yr before increasing again.



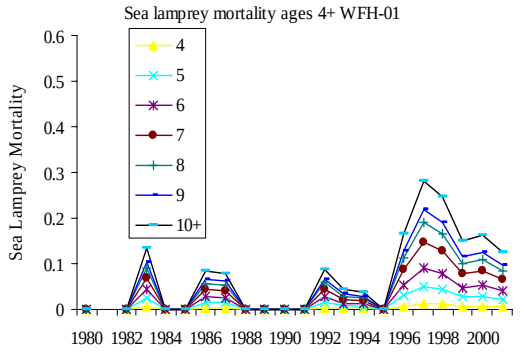
Because of the declines in growth and recruitment in WFH-01, biomass declined to a low level in 2001. Spawning stock biomass of whitefish in WFH-01 has always been considerably less than total biomass, in comparison to some other units in Lake Huron, but the biomass of one million lb in 2001 was lower than all years except prior to 1979. Total stock biomass declined from 2.4 million lb in 2000 to 1.8 million lb in 2001.



The large-mesh gill-net fishery has been the single largest source of fishing mortality on whitefish in WFH-01. Gill- net fishing mortality rate of age-4 and older whitefish ranged from 0.0 y^{-1} to 0.45 y^{-1} during 1976-2001, whereas trap-net fishing mortality rate ranged from 0.04y^{-1} to 0.31 y^{-1} during 1976-2001 on age-4 and older fish. Gill-net fishing mortality rate averaged was 0.18 y^{-1} and trap-net fishing mortality rate average 0.05 y^{-1} during 1999-2001.



Natural mortality rate, including sea lamprey-induced mortality, was greater than fishing mortality during the last five years in WFH-01. Natural mortality including sea lamprey mortality ranged from 0.29 y^{-1} to 0.36 y^{-1} during 1997-2001, whereas total fishing mortality rate declined from 0.35 y^{-1} in 1997 to 0.14 y^{-1} in 2001. From 1997 to 2001 natural mortality averaged 0.23 y^{-1}, gill-net mortality 0.19 y^{-1}, sea lamprey morality 0.08 y^{-1} and trap-net mortality 0.06 y^{-1} on age-4 and older whitefish.



The current spawning potential reduction value of 0.26 in WFH-01 during 1999-2001 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 1.65 times from the 1999-2001 values. The increase in fishing effort produced a recommended yield limit of 375,000 lb round weight, an increase from the 248,000 lb limit in 2002.

Summary Status WFH-01 Whitefish		
Female maturity		
	Size at first spawning	0.42 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.81 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.526 lb
		(SE 0.003)
	Current SSBR	0.4 lb
		(SE 0.02)
	SSBR at target mortality	0.039 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.259
		(SE 0.011)
Average yield per recruit		0.458 lb
		(SE 0.014)
Natural Mortality (M)		$0.233\ y^{-1}$
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	$0.178\ y^{-1}$
		(SE 0.018)
	Average trap net F, ages 4+	$0.046\ y^{-1}$
		(SE 0.003)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	$0.073\ y^{-1}$
Total mortality (Z)		
	Average ages 4+,1999-2001	$0.531\ y^{-1}$
		(SE 0.017)
Recruitment (age-3)	(1992-2001 average)	760,820 fish
		(SE 44,839)
Biomass (age 3+)	(1992-2001 average)	3,326,500 lb
		(SE 114,700)
Spawning biomass	(1992-2001 average)	2,015,200 lb
		(SE 71,679)
MSC recommended yield limit for 2003		375,000 lb
Actual yield limit for 2003 (HRG)		375,000 lb

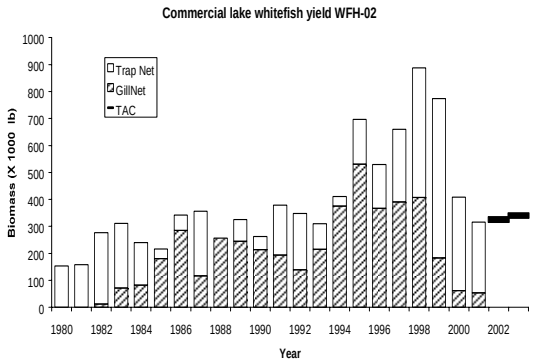
WFH-02 (Detour)

Prepared by Mark P. Ebener

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

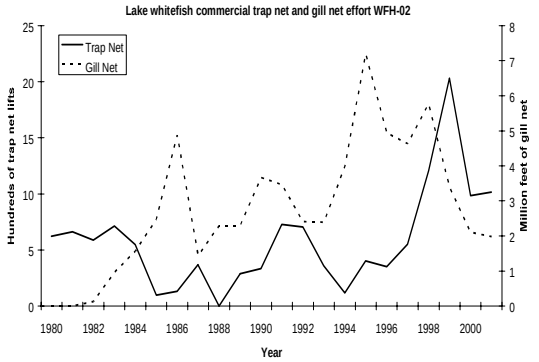
Because the shoreline of WFH-02 is highly irregular and rocky, nearly the entire unit contains habitat suitable for reproduction and survival of young. Spawning concentrations of whitefish can be found throughout the unit from Beavertail Point in the west portion of the unit to St. Vitals Point in the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

WFH-02 has been a CORA exclusive fishing zone since the 1985 Consent Decree. The commercial yield of lake whitefish ranged from a low of 152,000 lb in 1980 to 888,000 lb in 1998. The fishery yield averaged 534,000 lb during 1922-2001. The yield of whitefish from WFH-02 declined from 773,000 lb in 1999 to 408,000 lb in 2000 and to 316,000 lb in 2001.



The allocation of the harvest among fishing gears has changed dramatically in WFH-02 over the past few years. From 1985 through 1997 the large-mesh gill-net fishery accounted for majority of harvest in every year. After 1997 the trap-net fishery accounted for the largest proportion of the harvest. The trap-net fishery harvested 262,000 lb of whitefish in 2001, while the gill-net fishery harvested only 54,000 lb. The gill-net yield in 2001 was lower than every other year except 1982 when the CORA fishery began in WFH-02.

Both large-mesh gill-net and trap-net effort have changed markedly in WFH-02 since 1980. Trap-net effort ranged from 0 to 713 lifts between 1980 and 1997, thereafter effort increased 2,033 lifts in 1999, then declined by half in 2000 and 2001. 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 2.0 million ft in 2001.

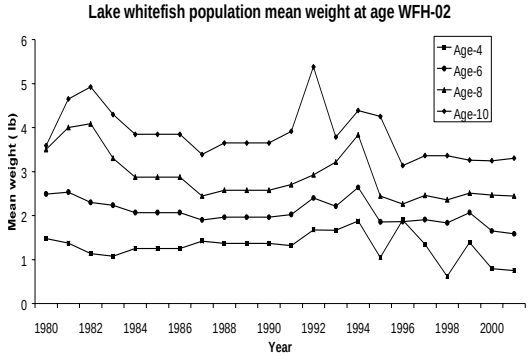


Whitefish in WFH-02 have always been of small size. No. 1 fish make up 90% of the harvest in from the unit. Mean weight in the trap-net harvest has ranged from 2.0 to 2.3 lb and mean weight in the gill-net harvest ranged from 1.9 to 2.8 lb during 1992-2001. Mean weight of a harvested whitefish was 2.2 lb in the trap-net

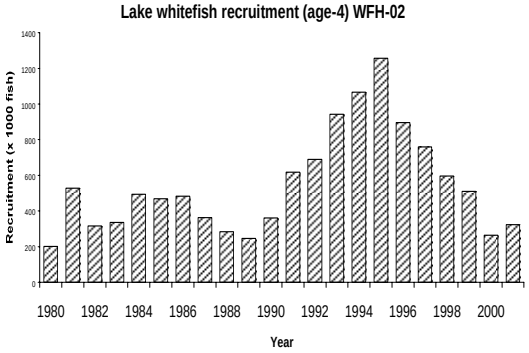
fishery and 2.8 lb in the gill-net fishery in 2001.

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

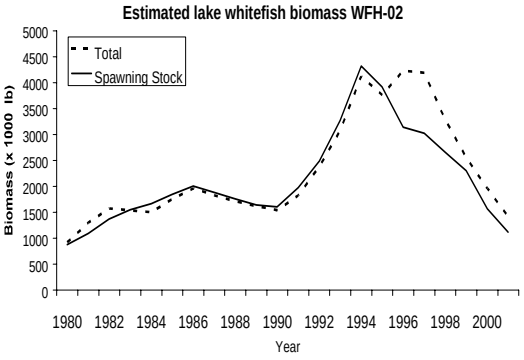
Unlike other units in Lake Huron, growth of whitefish in WFH-02 has remained stable through time. There has been a slight decline mean weight at age since the early 1980s, but the declines have not been nearly as steep as in WFH-01, WFH-04, and WFH-05.



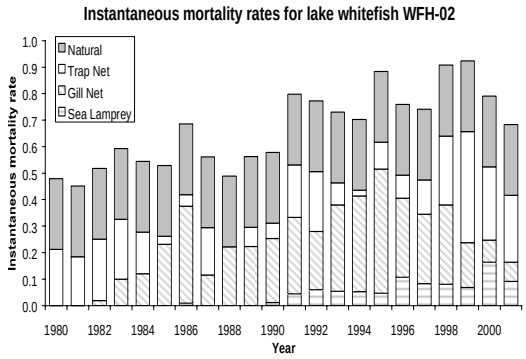
The substantial increase in commercial fishery yield during the mid 1990s in WFH-02 was driven largely by increased recruitment. The 1988-1993 year classes of whitefish were substantially larger than preceding and subsequent year classes in WFH-02. The stock assessment model estimated that the 1991-year class contained 1.26 million fish when it recruited to the fishery at age 4 in 1995. The 1989, 1990, 1992, and 1993 year classes contained between 895,000 and 1.1 million age-4 whitefish when they recruited to the fishery. Prior to 1992 and after 1997 most year classes that recruited to the fishery at age 4 did not exceed 600,000 fish. The 1997 year class was estimated to contain only 323,000 fish at age 4 when it recruited in 2001.



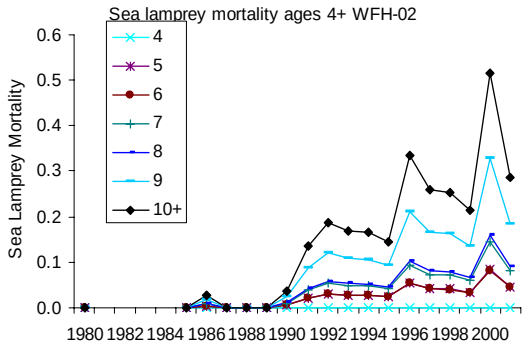
The large increase in recruitment during the mid 1990s more than doubled biomass of whitefish in WFH-02. Fishable biomass of whitefish in WFH-02 increased from 1.5 million lb in 1990 to 4.2 million lb in 1996 and 1997. Fishable and spawning stock biomass are nearly equivalent in WFH-02 because the fish mature at such a small size and because growth has not declined much. Fishable biomass was estimated to be 1.4 million lb and spawning biomass 1.1 million lb in 2001.



Total annual mortality rate on age-4 and older whitefish in WFH-02 has increased nearly annually since 1980. Total annual mortality of age-4 and older whitefish nearly doubled from 0.47 y^{-1} in 1980 to 0.92 y^{-1} in 1999.



The increase in total mortality was due to the substantial increases in fishing effort through 1999 and because of increased sea lamprey predation since 1990. Prior to 1997 trap-net mortality ranged from 0.02 y^{-1} to 0.23 y-1, while after 1997 trap-net mortality ranged from 0.25 y^{-1} to 0.42 y^{-1}. Gill-net mortality ranged from 0.0 y^{-1} to 0.46 y^{-1} prior to 1997 and from 0.07 y^{-1} to 0.30 y^{-1} thereafter. Gill-net mortality was 0.07 y^{-1} and trap-net mortality was 0.25 y^{-1} in 2001. Sea lamprey mortality averaged 0.07 y-1 from 1990-2001, but increased from 0.07 y^{-1} in 1990 to 0.16 y^{-1} in 2000.



Total annual mortality of age-4 and older whitefish averaged 0.875 y^{-1} during 1999-2001, but mortality on fully vulnerable ages-9 and older exceeded the target rate of 1.05 y^{-1}. Spawning potential reduction at the current mortality rates was 0.51 and considerably greater than the target of 0.20. The projection model estimated that fishing mortality rate should be reduced 43% to achieve the target mortality rate on older ages classes even though the SPR was greater than target. As a consequence, the projection model estimated a recommended yield limit of 221,000 lb. The harvest regulating guideline was set at **340,000 lb** and represents the average harvest during 1999-2002.

Summary Status WFH-02 Whitefish		
Female maturity		
	Size at first spawning	0.98 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.44 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.076 lb (SE 0.004)
	Current SSBR	0.51 lb (SE 0.02)
	SSBR at target mortality	0.111 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.247 (SE 0.009)
Average yield per recruit		0.632 lb (SE 0.009)
Natural Mortality (M)		0.267 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	9
	Fully selected age to trap nets	9
	Average gill net F, ages 4+	0.124 y^{-1} (SE 0.013)
	Average trap net F, ages 4+	0.361 y^{-1} (SE 0.024)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	0.123 y^{-1}
Total mortality (Z)		
	Average ages 4+,1999-2001	0.875 y^{-1} (SE 0.035)
Recruitment (age-4)	(1992-2001 average)	730,440 fish (SE 28,969)
Biomass (age 3+)	(1992-2001 average)	3,098,100 lb (SE 93,724)
Spawning biomass	(1992-2001 average)	2,781,200 lb (SE 80,388)
MSC recommended yield limit for 2003		221,000 lb
Actual yield limit for 2003 (HRG = 1999-2002 average yield)		340,000 lb

WFH-03 (Drummond Island)

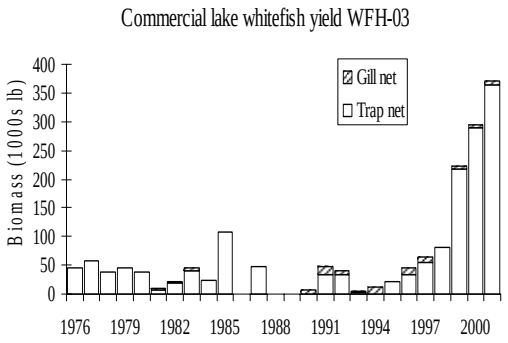
Prepared by Mark P. Ebener

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

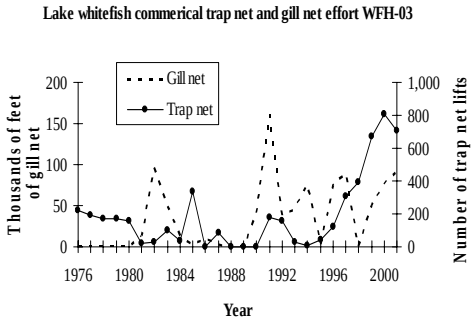
All of WFH-03 lies within the Niagara Escarpment and is composed of dolomite limestone. The spawning shoals for lake whitefish in WFH-03 are located primarily along the south shore of Drummond Island in the main basin of Lake Huron. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal by CORA staff during gill-net surveys in October of 1991-2001.

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

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

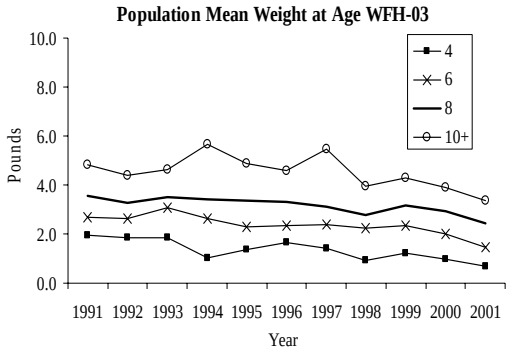


The large-increase in harvest in WFH-03 during 1999-2001 was directly related to increased trap-net effort. Trap-net effort ranged from 0 to 392 lifts in WFH-03 during 1976-1997, thereafter trap-net effort increased to 673 lifts in 1999, 806 lifts in 2000, and 706 lifts in 2001. Gill-net effort was highly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

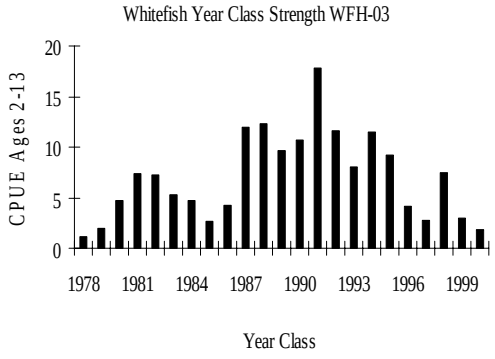


Whitefish caught in the fishery of WFH-03 are moderate size. During 1987-2001 67% of the whitefish harvested were No. 1 fish, 25% were mediums (3-4 lb) and 8% were jumbos (>4 lb). Mean weight of whitefish in the trap-net harvest ranged from 2.0 to 2.8 lb and average 2.7 lb during 1991-2001. Mean weight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

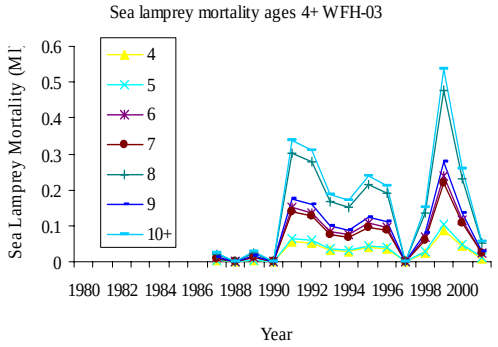
Growth of whitefish in WFH-03 has declined through time, but not at the rate that has occurred in more western areas of Lake Huron. Mean weight at age 4, 6, 8, and 10+ did decline during 1991-2001 based on catches made during CORA graded-mesh gill-net surveys and monitoring of commercial trap-net catches.



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



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



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

A harvest regulating guideline of **318,000 lb** was established for WFH-03 in 2003 and represents the average yield during 1999-2002 from the unit. The harvest regulating guideline was 293,000 lb in 2002 and 220,000 to 250,000 lb in 2001.

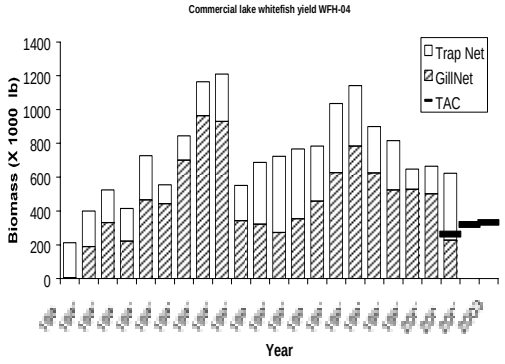
WFH-04 (Hammond Bay)

Prepared by Mark P. Ebener

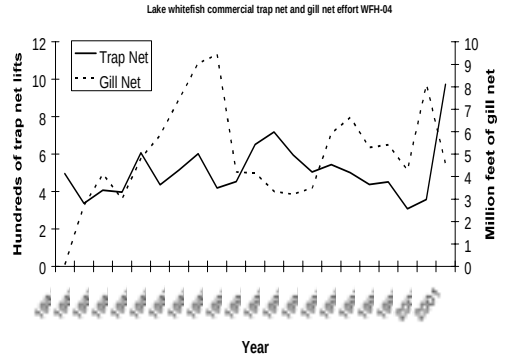
WFH-04 is the largest whitefish management unit in the 1836 treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water <240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found from Cheboygan, MI to Hammond Bay.

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

The CORA large-mesh gill-net fishery accounted for the majority of the whitefish harvest from the unit from 1985-2000. In 2001 the trap-net harvest from WFH-04 exceeded the gill-net harvest for the first time since 1981. The annual yield ranged from a high of 1.2 million lb in 1989 to a low of 231,000 lb in 1981. The annual yield of whitefish from the unit averaged 810,000 lb during 1992-2001. The trap-net harvest of whitefish was 396,000 lb in 2001 compared to 228,000 lb for the large-mesh gill-net fishery. The 2001 yield of 624,000 lb was substantially less than the harvest regulating guideline of 787,000 lb, but substantially greater than the recommended harvest limit of 263,000 lb generated by the projection model.



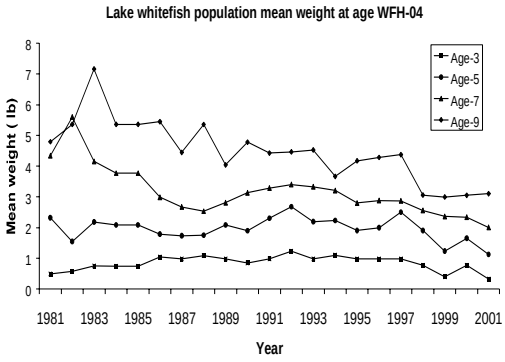
Trap-net effort increased while gill-net effort declined from 2000 to 2001. Large-mesh gill-net effort peaked at 7.7 million ft in 1989 and 5.2 million ft in 2000. Large-mesh gill-net effort was 3.5 million ft in 2001. Trap-net effort peaked at 719 lifts in 1992 then declined to 308 lifts in 1999. Trap-net effort increased from 358 lifts in 2000 to 972 lifts in 2001. The changes in fishing effort occurred largely because two CORA trap-net operations began fishing in WFH-04 during 2001 as part of the gear conversion program stipulated in the 2000 Consent Decree.



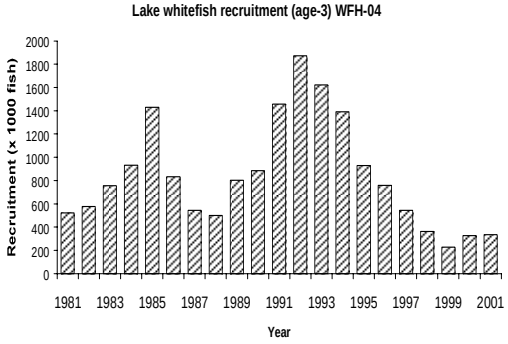
Whitefish from WFH-04 are of moderate size. The commercial harvest from WFH-04 was composed of 65% No. 1 whitefish (<3.0 lb), 26% mediums (3-4 lb), and 9% jumbos (>4.0 lb) during 1982-2001. Annual mean weight of whitefish caught in the gill-net fishery ranged from 2.6 to 3.0 lb during 1982-2001, while mean weight in the trap-net

fishery ranged from 2.4 to 3.6 lb during 1982-2001. Mean weight in the harvest in 2001 was 2.4 lb for the trap-net fishery and 2.6 lb for the gill-net fishery.

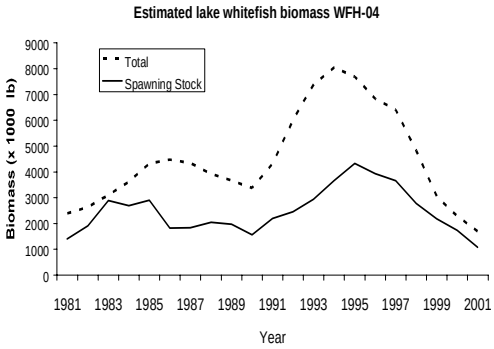
Growth rate of whitefish from WFH-04 continues to decline. Only mean weight of age-9 and older whitefish increased from 2000 to 2001. Mean weight of ages 3-8 was lower in 2001 than any other year during 1981-2001.



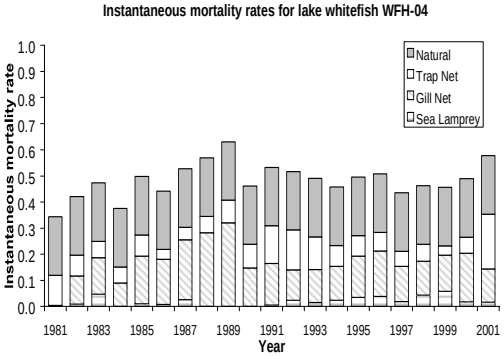
The declines in harvest from WFH-04 that have occurred from 1996 to 2001 are largely being driven by declines in both mean weights at age and recruitment. The 1988-1991 year classes of whitefish were very abundant in WFH-04. Recruitment to the fishery at age 3 ranged from 1.4 to 1.9 million fish for these four year classes. Unfortunately, recruitment declined dramatically after the 1991 year class and the 1995-1997 year classes were the least abundant as they recruited at age 3 to the fishery in WFH-04. Abundance at age 3 for the 1995-1997 year classes ranged from 228,000 to 364,000 fish. The 1998 year class was estimated to contain 335,000 fish when it recruited to the fishery in 2001.

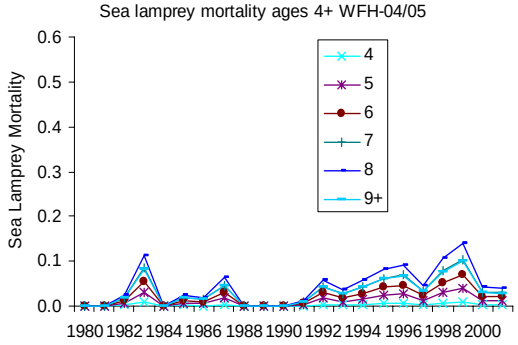


The combined effects of reduced recruitment and growth has meant that biomass of whitefish in WFH-04 was lower in 2001 than any other year during last 21 yr. After peaking at 8.1 million lb in 1994, fishable biomass declined annually to only 1.7 million lb in 2001. Spawning stock biomass declined from 4.3 million lb in 1995 to 1.1 million lb in 2001. Given that the 1998 year class does not appear to be very abundant, biomass of whitefish in WFH-04 can be excepted to continue to decline.



Total annual mortality of age-4 and older whitefish averaged 0.548 y-1 during 1999-2001. Gill-net fishing mortality averaged 0.201 y-1, trap-net fishing mortality 0.136 y-1, and sea lamprey mortality 0.04 y-1 during 1999-2001. Sea lamprey-induced mortality was substantially less in WFH-04 than in other more northerly units in Lake Huron averaging less than 0.1 y-1 during 1981-2001. Gill-net mortality was 0.13 y-1, trap-net mortality 0.21 y-1, and sea lamprey mortality 0.02 y-1 on age-4 and older whitefish in 2001.





Since total annual mortality on all age classes of whitefish was less than the target of 1.05 y-1, the projection model estimated that fishing mortality rate could be increased 1.34 times in 2003 over that experienced during 1999-2001. The SPR value at the target-fishing rate was 0.184. The recommended harvest rate from the projection model was 333,000 lb, but the harvest regulating guideline for WFH-04 was set at **588,000 lb** for 2003.

Summary Status WFH-04 Whitefish		
Female maturity		
	Size at first spawning	0.50 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.78 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.916 lb (SE 0.)
	Current SSBR	0.35 lb (SE 0.02)
	SSBR at target mortality	0.108 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.184 (SE 0.012)
Average yield per recruit		0.679 lb (SE 0.006)
Natural Mortality (M)		0.224 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.201 y^{-1} (SE 0.014)
	Average trap net F, ages 4+	0.136 y^{-1} (SE 0.012)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	0.041 y^{-1}
Total mortality (Z)		
	Average ages 4+,1999-2001	0.548 y^{-1} (SE 0.022)
Recruitment (age-3)	(1992-2001 average)	837,270 fish (SE 26,160)
Biomass (age 3+)	(1992-2001 average)	5,422,800 lb (SE 162,960)
Spawning biomass	(1992-2001 average)	2,876,100 lb (SE 106,460)
MSC recommended yield limit for 2003		333,000 lb
Actual yield limit for 2003 (HRG = 1999-2002 average yield)		588,000 lb

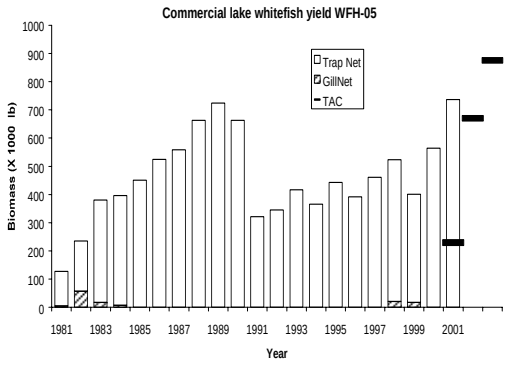
WFH-05 (Alpena)

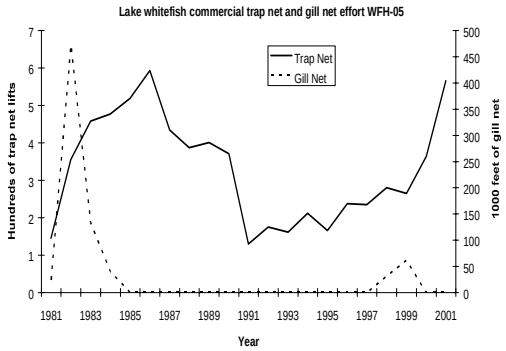
Prepared by Mark P. Ebener

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

The 2000 Consent Decree converted WFH-05 from an exclusive state zone to an exclusive CORA trap-net fishing zone beginning in August 2000. Only four CORA trap-net operations from two tribes can fish WFH-05, and each operation can fish no more than 12 trap-nets. The CORA fishery has a 17-inch minimum length limit, and there is no limit on the depth of water in which trap-nets can be fished. There was a 19-inch minimum length limit, and trap-nets could only be fished in waters < 90 ft deep when WFH-05 was an exclusive state zone.

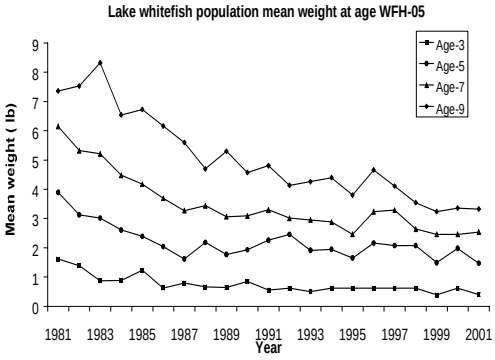
Annual commercial trap-net yields have ranged from 124,000 lb in 1981 to 736,000 lb in 2001 and averaged 455,000 lb during 1981-2001. The changes in harvest are directly related to changes in trap-net effort. As trap-net effort increased from 130 lifts in 1991 to 566 lifts in 2001, the yield increased from 322,000 lb in 1991 to 736,000 lb in 2001.





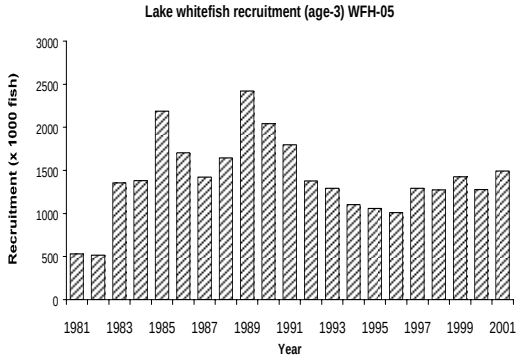
Whitefish in WFH-05 are of similar size to those in WFH-04. The commercial harvest from WFH-05 was made up of 70% No. 1 whitefish, 23% mediums, and 7% jumbos. Mean weight of a harvested whitefish was 2.6 lb in WFH-05 in 2001.

Growth rate of whitefish in WFH-05 has stabilized over the last few years after continually declining from 1981 to 1999. Prior to 1985 age-9 and older whitefish weighed between 7 and 8 lb, but by 1999 they weighed about 3.3 lb. Mean weight of all age-classes in 2001 was similar to mean weight in 1999 and 2000.

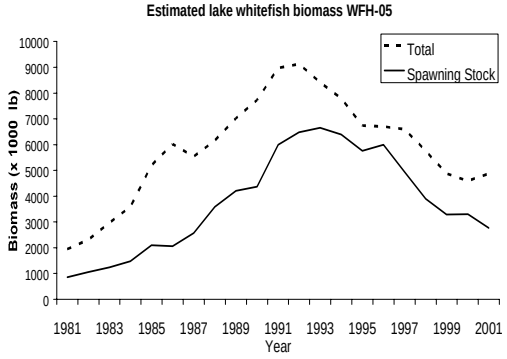


Recruitment of age-3 whitefish to the fishable population in WFH-05 appears to have stabilized over the last few years. Recruitment peaked at 2.4 million age-3 whitefish in 1989 and then declined annually to about one million age-3 whitefish in 1996 (1993 year class). From 1997 through 2001

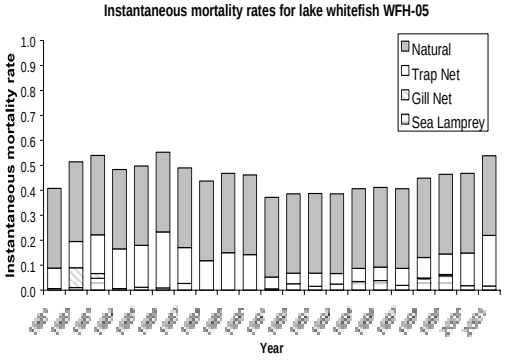
estimated recruitment averaged about 1.35 million age-3 whitefish. The stock assessment model estimated that 1.49 million age-3 whitefish were present in the population during 2001.



Both fishable and spawning stock biomass has been declining in WFH-05 since the early 1990s primarily because of reduced recruitment and growth. Fishable stock size peaked at 9.1 million lb in 1992 and has since declined to 4.9 million lb in 2001. Spawning stock biomass peaked at 6.6 million lb in 1993 and then declined to 2.8 million lb in 2001.



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. Trap-net fishing mortality has been increasing in WFH-05 over the last decade and was 0.20 y-1 in 2001. Sea lamprey mortality has also generally been increasing in WFH-05 over the last decade, but it did not exceed 0.05 y-1 in any year.



Total annual mortality was estimated to be only 0.547 y-1 on age-4 and older whitefish in WFH-05 during 1999-2001. Total mortality was estimated to be 0.581 y-1 in 2001. 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 1.95 times over the 1999-2001 levels. The recommended yield limit at this increased rate of fishing was estimated to be 875,000 lb in WFH-05 for 2003. The recommended yield limit in 2002 was estimated to be 670,000 lb.

Summary Status WFH-05 Whitefish		
Female maturity		
	Size at first spawning	0.47 lb
	Age at First Spawning	3 y
	Size at 50% maturity	2.22 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.131 lb
		(SE 0.)
	Current SSBR	0.49 lb
		(SE 0.03)
	SSBR at target mortality	0.155 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.437
		(SE 0.027)
Average yield per recruit		0.421 lb
		(SE 0.026)
Natural Mortality (M)		0.319 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.002 y^{-1}
		(SE 0.0)
	Average trap net F, ages 4+	0.185 y^{-1}
		(SE 0.027)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	0.041 y^{-1}
Total mortality (Z)		
	Average ages 4+,1999-2001	0.547 y^{-1}
		(SE 0.027)
Recruitment (age-3)	(1992-2001 average)	1,260,200 fish
		(SE 137,370)
Biomass (age 3+)	(1992-2001 average)	6,545,000 lb
		(SE 642,080)
Spawning biomass	(1992-2001 average)	4,946,300 lb
		(SE 495,730)
MSC recommended yield limit for 2003		875,000 lb
Actual yield limit for 2003 (HRG)		875,000 lb

Lake Michigan

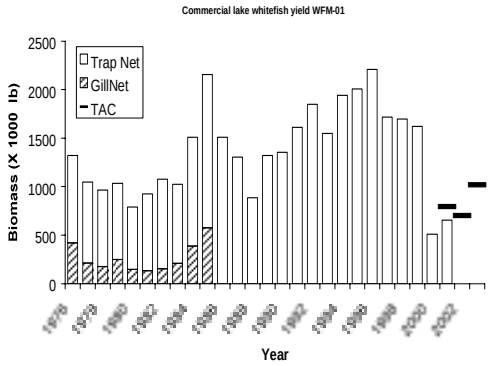
WFM-01 (Bays de Noc)

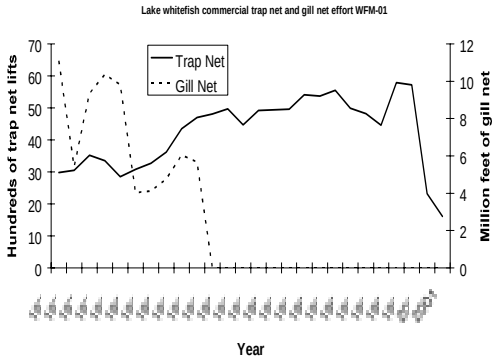
Prepared by Philip J. Schneeberger

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

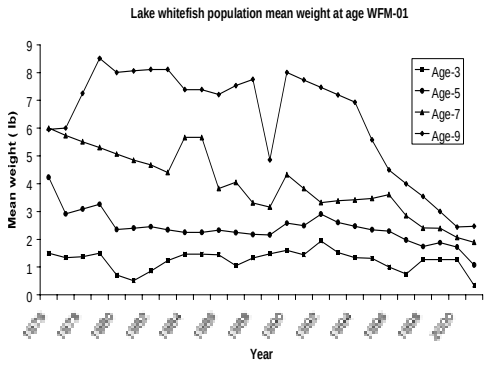
Waters in WFM-01 (380,652 total surface acres) offer extensive areas where suitable habitat is available and is likely used by spawning whitefish. The Big Bay de Noc Shoal is documented as being a very important area for lake whitefish reproduction that exhibits fairly consistent favorable conditions resulting in relatively stable recruitment from year to year. It is speculated that stocks spawning in other areas of WFM-01 are mixed. The bay areas are important nursery grounds for whitefish larvae and fry.

Trap-net yield of lake whitefish in WFM-01 was 654 thousand lbs during 2001. There has been no commercial gill netting in this management zone since 1985. Total yield in 2001 was 49% lower than the short-term (1998-2000) average and 53% lower than the long-term (1976-2000) average. The 2001 yield was 28% higher than in 2000 despite a 31% decrease in effort between years. There were 2,323 trap-net lifts in 2000 and only 1,607 during 2001. Trap-net effort has declined sharply since 1999.

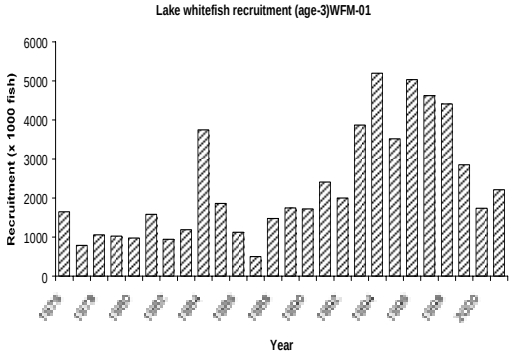




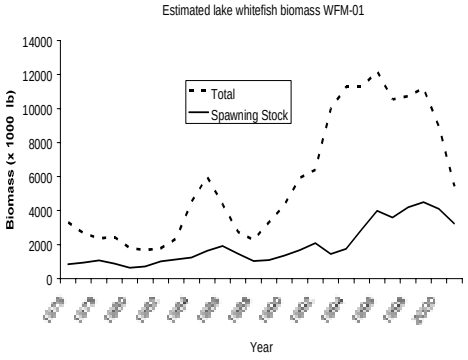
Weight-at-age for WFM-01 lake whitefish continued to decline across all age groups. Declining trends have been evident through the entire data set (1976-2001) for some ages with highest slopes for fish aged 5 and above. Weight-at-age values (ages 3-9+) in 2001 were down between 17 and 72% compared to 1998-2000 averages, and down 48-73% from 1976-2000 averages.



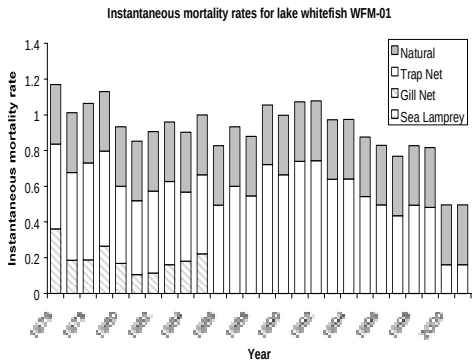
Estimated recruitment (numbers of age-3 fish) increased in 2001 compared to 2000. The 2001 recruitment estimate of 2,208,000 lake whitefish was 45% greater than average recruitment estimated between 1976 and 1992, but was 50% lower than the average for years of highest recruitment, 1993-1998.



Fishable biomass was estimated at 5.4 million lbs in 2001 and of this total, spawning stock biomass (3.2 million lbs) represented 60%. Both fishable biomass and spawning stock biomass estimates for 2001 decreased from 2000 estimates.



Estimates of instantaneous mortality rates were identical for 2000 and 2001. Total instantaneous mortality rate (Z) was estimated at 0.49 y^{-1} in 2001, with 0.33 y^{-1} attributable to instantaneous natural mortality rate (M) and 0.16 y^{-1} attributable to instantaneous fishing mortality rate (F). Instantaneous mortality rates were considered excessively high prior to 2000.



The projected 2003 yield limit for WFM-01 is 1.018 million lbs. This represents a 45% increase from the 2002 yield limit of 703 thousand lbs. The increase was influenced by low harvest in 2001 relative to the yield limit (654 thousand lbs vs. 796 thousand pounds), continued low estimated mortality rates, and an increase in estimated recruitment. Factors that held the yield limit down included decreases in weight-at-age and decreased fishable biomass. Fishing effort documented for 2001 could increase 1.7-fold in 2003 based on projection model outputs.

Summary Status WFM-01 Whitefish		
Female maturity		
	Size at first spawning	1.20 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.56 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	0.573 lb
		(SE 0.001)
	Current SSBR	0.24 lb
		(SE 0.01)
	SSBR at target mortality	0.138 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.425
		(SE 0.016)
Average yield per recruit		0.259 lb
		(SE 0.006)
Natural Mortality (M)		0.445 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0. y^{-1}
		(SE 0.)
	Average trap net F, ages 4+	0.307 y^{-1}
		(SE 0.022)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.752 y^{-1}
		(SE 0.022)
Recruitment (age-3)	(1992-2001 average)	3,543,800 fish
		(SE 342,950)
Biomass (age 3+)	(1992-2001 average)	9,794,100 lb
		(SE 516,450)
Spawning biomass	(1992-2001 average)	3,177,500 lb
		(SE 167,930)
MSC recommended yield limit for 2003		1,018,000 lb
Actual yield limit for 2003		1,018,000 lb

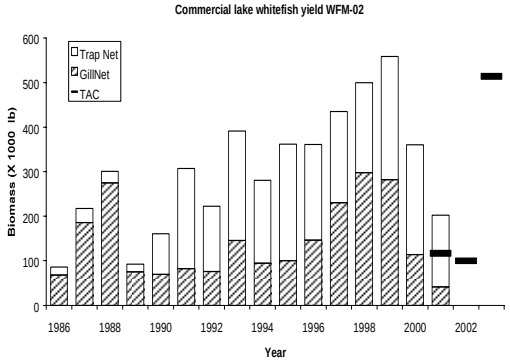
WFM-02 (Manistique)

Prepared by Mark P. Ebener

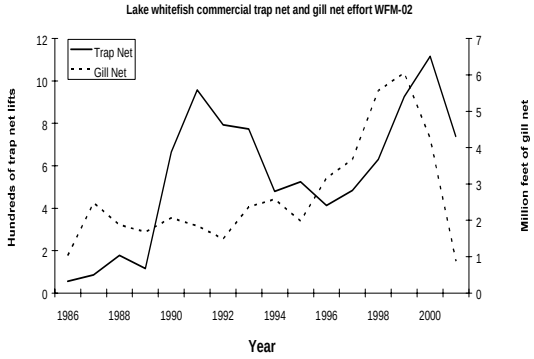
WFM-02 is located in the northwest portion of Lake Michigan. There are 387,000 surface acres of water < 240 ft deep in the unit. The only known spawning population of whitefish in WFM-02 is located in Portage Bay, but this population is not as abundant as other stocks in Lake Michigan. Many of the whitefish that inhabit WFM-02 move into the unit from adjacent units and Wisconsin waters.

WFM-02 has been an exclusive CORA commercial fishing zone since 1985. One trap-net operation and 2-3 large gill-net boats regularly fish WFM-02. Little to no small-boat gill-net effort takes place in WFM-02. Besides whitefish, the large-boat gill-net fishery routinely targets bloater in the offshore waters.

The commercial fishery yield from WFM-02 was 302,000 lb during 1986-2001. The peak harvest from WFM-02 was 559,000 lb in 1999 and the lowest yield was 86,000 lb in 1986. The average yield from the trap-net fishery was 159,600 and average yield from the gill-net fishery was 142,700 lb during 1986-2001. The commercial fishery yield was 202,600 lb in 2001 of which 161,400 lb came from the trap-net fishery and 41,200 lb came from the gill-net fishery.



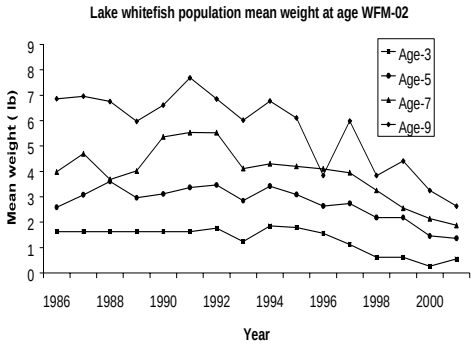
The increase in fishery yield was partly a function of increased fishing effort. Large-mesh gill-net effort increased from 1.0 million ft in 1986 to 6.1 million ft in 1999 then declined to 0.9 million ft in 2001. The associated gill-net yield increased from 68,000 lb in 1986 to 282,000 lb in 1999, then declined to 41,000 lb in 2001. Gill-net effort explained only 54% of the variation in gill-net yield from WFM-02 and the relationship appeared to be linear. Trap-net effort increased from 56 lifts in 1986 to 957 lifts in 1991, declined to 412 lifts in 1996, then increased to 1,116 lifts in 2000. Trap-net fishery yield increased from 18,000 lb in 1986 to 225,000 lb in 1991, then ranged from 146,000 to 276,000 lb during 1992-2001. Trap-net effort explained only 61% of the variation in trap-net yield from WFM-02 and the relationship appeared to be asymptotic since yield did not increase after 500 lifts. Fishery effort in 2001 was made up of 739 trap-net lifts and 0.9 million ft of gill net.



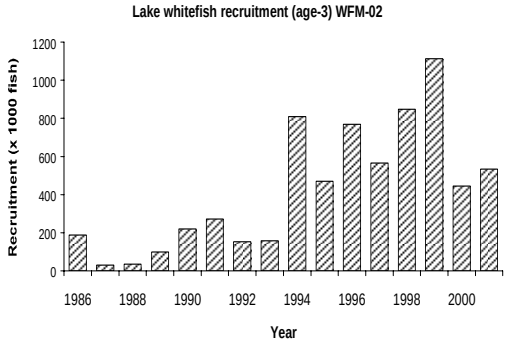
Whitefish in WFM-02 are of moderate size. The harvest by weight was made up of 62% No. 1 whitefish, 25% mediums, and 13% jumbos during 1986-2001. Mean weight of a harvested whitefish in the trap-net fishery ranged

from 1.9 lb in 2001 to 3.3 lb in 1986. Mean weight of a harvested whitefish in the gill-net fishery ranged from 1.9 lb in 2001 to 3.7 lb in 1989. Mean weight of harvested gill-net and trap-net fish was lower in 2001 than any other year.

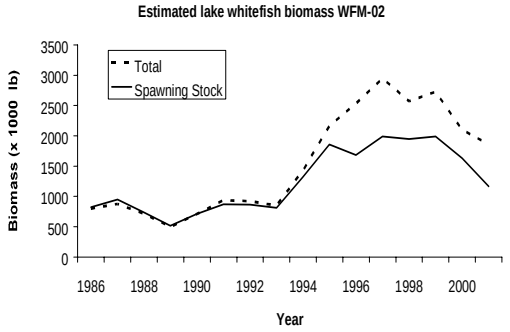
Mean weight of all age classes of whitefish > age 4 continued to decline in 2001 and was lower than in any other year. The declines were greater for older fish than for younger whitefish. Mean weight of age-9 and older whitefish declined from 6.9 lb in 1986 to 2.6 lb in 2001. Mean weight of age-5 whitefish declined from 2.6 lb in 1986 to 1.4 lb in 2001.



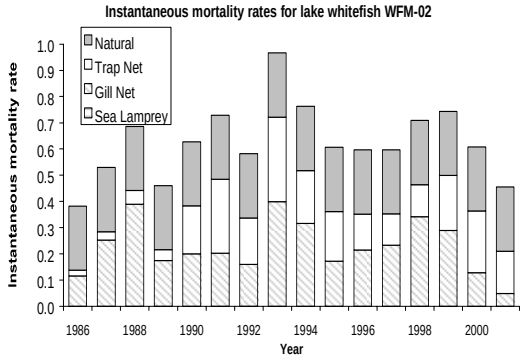
Estimated recruitment in WFM-02 increased substantially through time. Recruitment of age-3 whitefish to the population in WFM-02 averaged 143,000 fish from 1986-1993. After 1993 recruitment of age-3 whitefish averaged 533,000 fish in WFM-02. Recruitment in 2001 was estimated to be 533,000 fish.



Estimated biomass of whitefish changed in response to the increase in recruitment in WFM-02. Fishable stock biomass averaged about 850,000 lb from 1986-1993, then increased to a peak of 2.9 million lb in 1997. After 1997 fishable stock size declined and was 1.9 million lb in 2001. Spawning stock biomass followed a similar course as total biomass but peaked somewhat later. Spawning stock biomass peaked at 1.9 million lb during 1997-1999, and declined to 1.2 million lb in 2001.



Total annual mortality of age 4 and older whitefish increased from 1996 through 1993, then generally declined. Total mortality increased from 0.38 y-1 in 1986 in 0.97 y-1 1993. After 1993 total annual mortality declined to 0.45 y-1 in 2001. Fishing mortality was estimated to be 0.05 y-1 for the gill-net fishery and 0.16 y-1 for the trap-net fishery in WFM-02 in 2001. Natural mortality in WFM-02 was estimated to be 0.245 y-1.



While total annual mortality of age 4 and older whitefish was less than the target rate of 1.05 y-1, estimated mortality of age-8 and age-9 whitefish was greater than the target rate. Consequently, the projection model

estimated that fishing mortality rate should be reduced 6% from the rates observed during 1999-2001. The recommended harvest limit at this reduced rate of fishing was estimated to be 514,000 lb in 2003. The recommended harvest level in 2002 was estimated to be 100,000 lb, but a harvest regulating guideline of 186,000 lb was adopted for 2002.

Summary Status WFM-02 Whitefish		
Female maturity		
	Size at first spawning	0.99 lb
	Age at First Spawning	4 y
	Size at 50% maturity	1.81 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.94 lb (SE 0.037)
	Current SSBR	0.49 lb (SE 0.02)
	SSBR at target mortality	0.116 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.251 (SE 0.010)
Average yield per recruit		0.651 lb (SE 0.008)
Natural Mortality (M)		0.245 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.206 y^{-1} (SE 0.022)
	Average trap net F, ages 4+	0.270 y^{-1} (SE 0.017)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.721 y^{-1} (SE 0.035)
Recruitment (age-3)	(1992-2001 average)	585,860 fish (SE 66,829)
Biomass (age 3+)	(1992-2001 average)	2,011,000 lb (SE 101,770)
Spawning biomass	(1992-2001 average)	1,526,300 lb (SE 66,864)
MSC recommended yield limit for 2003		514,000 lb
Actual yield limit for 2003 (HRG)		514,000 lb

WFM-03 (Naubinway)

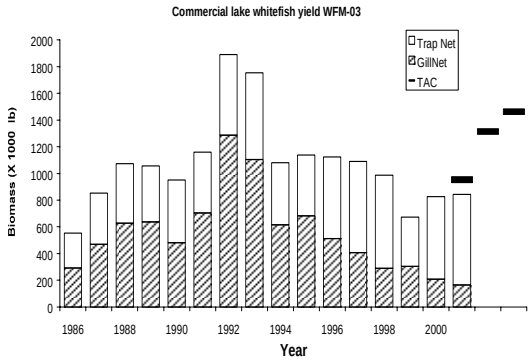
Prepared by Mark P. Ebener

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

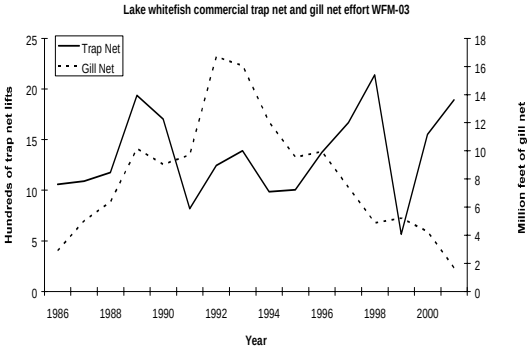
WFM-03 contains several very large spawning aggregations of whitefish. The entire northern shoreline is part of the Niagara Escarpment thus much of the whitefish spawning occurs here. Large spawning aggregations are associated with the area between Epoufette and Naubinway, Michigan, and in the Straits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

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

The commercial fishery yield from WFM-03 averaged 1.065 million lb during 1986-2001. The trap-net fishery yield averaged 516,300 lb and the gill-net fishery yield averaged 509,100 lb during 1986-2001. Total fishery yield peaked at 1.9 million lb in 1993 and 1.8 million lb in 1994 and declined slowly thereafter. The trap-net yield was 677,000 lb and the gill-net yield 165,000 in 2001.



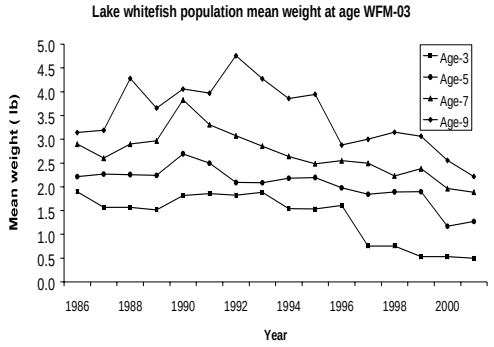
Fishing effort in WFM-03 has been highly variable. Gill-net fishing effort increased from 2.9 million ft in 1986 to 16.7 million ft in 1992 then declined to only 1.7 million ft in 2001. Trap-net effort varied between 565 and 2,139 lifts during 1986 to 2001 without any significant trends. There was a positive linear relationship between gill-net effort and yield where effort explained 86% of the variation in gill-net yield. In contrast, the relationship between trap-net effort and yield was not linear and effort explained only 38% of the variation in trap-net yield. Trap-net yield appeared to be asymptotic after about 1,400 lifts.



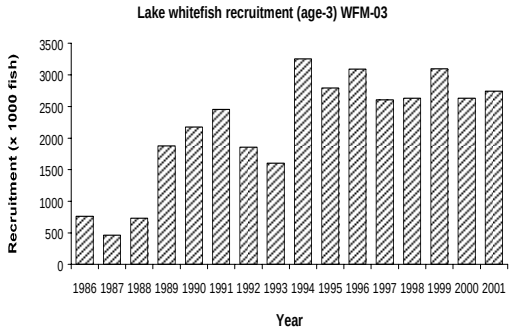
Whitefish in WFM-03 are of small size. During 1985-2001 No. 1 whitefish made up 85%, mediums 12%, and jumbos only 3% of the harvest from WFM-03. Mean weight of a harvested whitefish ranged from 2.0 to 3.6 lb in the gill-net fishery and 2.0 to 2.7 lb in the

trap-net fishery during 1986-2001. Mean weight of a harvested whitefish in 2001 was 2.3 lb in the gill-net fishery and 2.5 lb in the trap-net fishery.

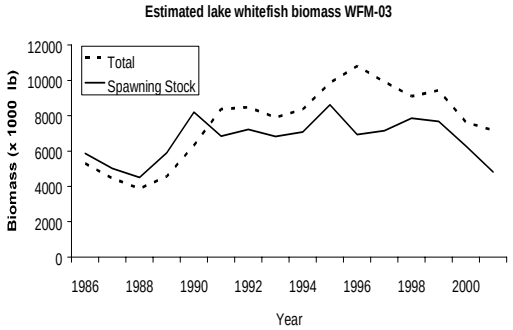
Growth of whitefish in WFM-03 continued to decline in 2001. Mean weight of age-2, age-3, age-7, age-8, and age-9+ whitefish were all lower in 2001 than any other year during 1986-2001. Mean weight of age-4-6 whitefish increased slightly from 2000 to 2001, but mean weight of these age-classes in 2001 was still lower than most other years.



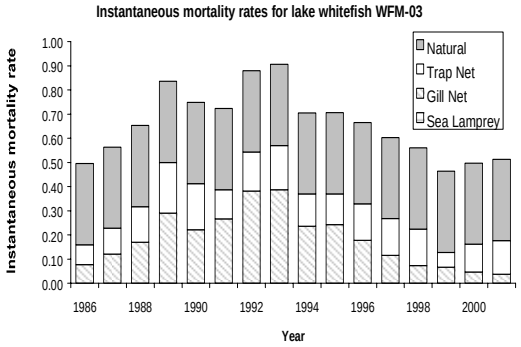
Recruitment of age-3 whitefish was fairly consistent and high in WFM-03. Recruitment increased from roughly 600,000 whitefish in 1986-1988 to an average of 2.0 million fish during 1989-1993, and increased further to 2.9 million fish during 1994-2001.



Biomass of age-3 and older whitefish has been fairly stable through time in WFM-03 compared to other units in the 1836-ceded waters. Total biomass of whitefish in WFM-03 varied less than three-fold from 3.9 to 10.8 million lb during 1986-2001. During 1991-2001 total biomass averaged 8.8 million lb during 1991-2001. Spawning-stock biomass was more stable than total biomass varying less than two-fold from 4.5 to 8.6 million lb during 1986-2001. Spawning stock biomass exceeded total biomass during 1986-1990 before the dramatic declines in growth reduced the proportion of mature females at ages 3-5.



Changing gill-net fishing effort was primarily responsible for the changes in total annual mortality of whitefish in WFM-03. Total mortality of age-4 and older whitefish increased from 0.50 y^{-1} in 1986 to 0.91 y^{-1} in 1993, then declined to 0.51 y^{-1} in 2001. Gill-net fishing mortality increased from 0.08 y^{-1} to 0.38 y^{-1} then declined to 0.04 y^{-1} in 2001. Trap-net fishing mortality was fairly stable ranging from 0.6 to 0.21 y^{-1} during 1986-2001 and averaged 0.13 y^{-1}. Natural mortality was estimated to be 0.336 y^{-1} in WFM-03.



Total annual mortality on fully vulnerable age-classes was less than the target rate during 1999-2001. Further, the spawning potential reduction at

current mortality rates and at the target mortality rate were greater than 0.20. Consequently, the projection model estimated that fishing mortality rate could be increased 1.92 times above the levels experienced during 1999-2001. The recommended yield limit at the increased rate of fishing was estimated to be 1,462,000 lb for 2003. The 2002 recommended yield limit was 1,313,000 lb.

Summary Status WFM-03 Whitefish		
Female maturity		
	Size at first spawning	0.52 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.77 lb
	Age at 50% maturity	6 y
Spawning biomass per recruit		
	Base SSBR	1.103 lb (SE 0.002)
	Current SSBR	0.6 lb (SE 0.02)
	SSBR at target mortality	0.115 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.547 (SE 0.014)
Average yield per recruit		0.341 lb (SE 0.009)
Natural Mortality (M)		0.336 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.067 y^{-1} (SE 0.005)
	Average trap net F, ages 4+	0.141 y^{-1} (SE 0.009)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.543 y^{-1} (SE 0.013)
Recruitment (age-3)	(1992-2001 average)	2,630,800 fish (SE 150,700)
Biomass (age 3+)	(1992-2001 average)	8,864,300 lb (SE 346,060)
Spawning biomass	(1992-2001 average)	7,043,700 lb (SE 262,540)
MSC recommended yield limit for 2003		1,462,000 lb
Actual yield limit for 2003 (HRG)		1,462,000 lb

WFM-04 (Beaver Island)

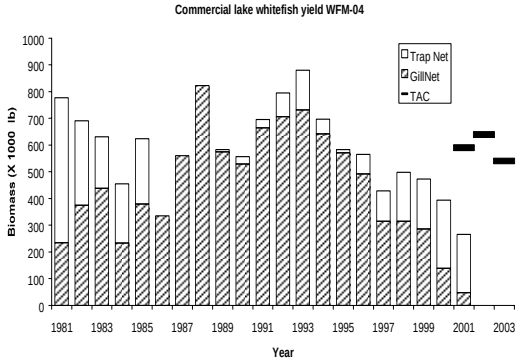
Prepared by Mark P. Ebener

WFM-04 is located in central northern Lake Michigan and contains a very diverse range of habitat. There are seven islands located in the unit mainly along the northern edge of the unit and associated with a large, shallow, rocky reef complex that extends about 15 miles west from Waugoshance Point. The northern reef complex is shallow ranging from 5 to 30 ft deep. To the south of this large reef complex is located many smaller submerged reefs located on the east and west sides of Beaver Island. These latter reefs are surrounded by deep water. WFM-04 contains 577,000 surface acres of water <240 ft deep.

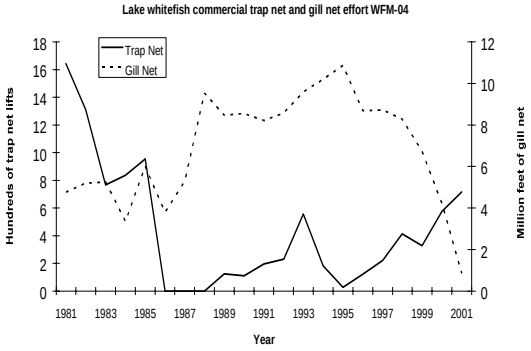
There are at least several reproductively isolated stocks of whitefish that inhabit WFM-04, and most, if not all, of these are associated with the large northern reef complex. One stock spawns in Sturgeon Bay along the northeast side of the unit, while another stock is found at Hog Island.

WFM-04 has been an exclusive commercial fishing zone for the CORA fishery since 1985. Much of the area is designated as a lake trout refuge where retention of lake trout by recreational or commercial fisheries is prohibited. The eastern portion of WFM-04 along the Lower Peninsula of Michigan is a favorite fishing area for CORA small-boat fisheries. The offshore waters of WFM-04 are fished exclusively by large-boat gill-net and trap-net fisheries. Only trap-net fisheries targeting whitefish operate within the refuge.

The commercial fishery yield of whitefish from WFM-04 ranged from a low of 265,000 lb in 2001 to a peak of 880,000 lb in 1993. The average yield of whitefish was 586,000 lb during 1981-2001. The trap-net fishery yield ranged from 0 lb during 1986-1988 to 542,000 lb in 1981 from WFM-04, while the gill-net yield ranged from 48,000 lb in 2001 to 731,000 lb in 1993. The trap-net yield from WFM-04 was 217,000 lb in 2001.

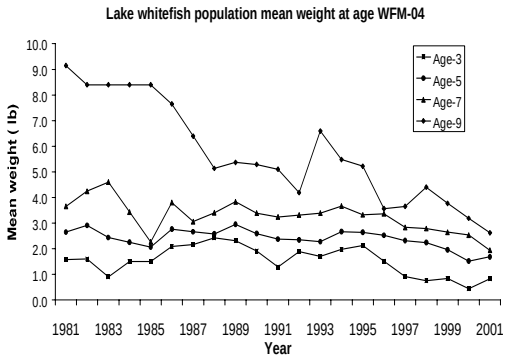


Fishing effort in WFM-04 has varied widely through the years. Trap-net effort peaked at 1,642 lifts in 1981 then declined to zero during 1986-1988. Thereafter, trap-net effort increased slowly and peaked at 715 lifts in 2001. Gill-net effort increased from 4.8 million ft in 1981 to 10.9 million ft in 1995 then declined to a low of 0.85 million ft in 2001. The decline in gill-net effort followed as a consequence of the 2000 Consent Decree that required conversion of gill-net fisheries to trap-net fisheries.

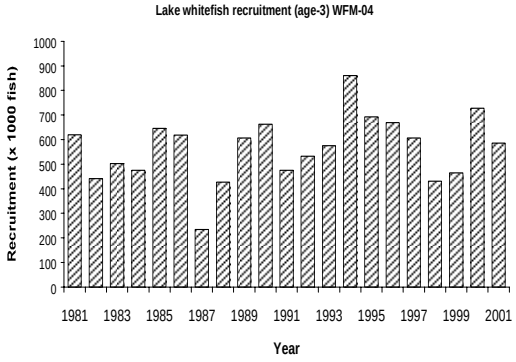


Whitefish in WFM-04 are of moderate size. Whitefish of No. 1 size made up 60%, mediums 24%, and jumbos 15% of the commercial fishery yield from WFM-04 during 1985-2001. Annual mean weight of a harvested whitefish in the trap-net fishery ranged from 2.0 to 3.2 lb during 1981-2001. The mean weight of trap-net harvested whitefish was 2.0 lb in 2001. Annual mean weight of a harvested whitefish in the gill-net fishery ranged from 2.6 to 3.5 lb during 1981-2001. The mean weight of a gill-net harvested whitefish was 2.8 lb in 2001.

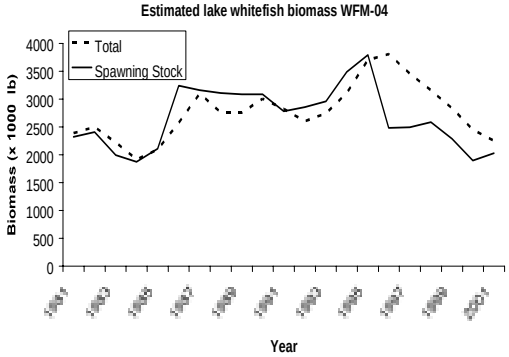
Growth of whitefish in WFM-04 has not declined to the same extent as whitefish in other Lake Michigan units. Age-9 and older whitefish experienced the most significant decline in mean weight as they declined from 9.1 lb in 1981 to 2.6 lb in 2001. The decline in growth of younger age-classes occurred primarily after 1994. Mean weight of age 3-5 whitefish did increase slightly from 2000 to 2001.



Recruitment of age-3 whitefish to the population in WFM-04 was remarkably constant unlike in all other Lake Michigan management units. An average of 564,000 age-3 whitefish recruited to the population of WFM-04 during 1981-2001. Annual recruitment varied only from 234,000 to 861,000 fish during 1981-2001. Whitefish recruitment was estimated to be 586,000 fish in 2001.

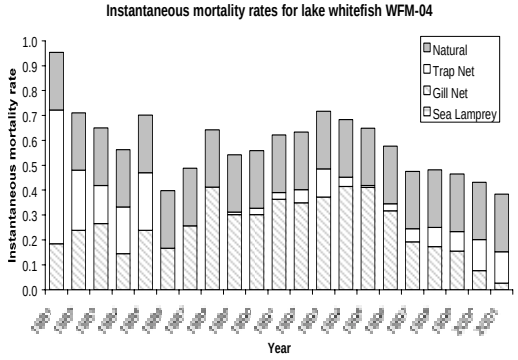


Biomass of age-3 and older whitefish was also fairly stable in WFM-04 as a consequence of the consistent recruitment. Total biomass ranged from 1.9 million lb in 1984 to 3.8 million lb in 1996. Spawning stock biomass ranged from 1.9 million lb in 1984 to 3.8 million lb in 1995. Spawning stock biomass and total biomass were nearly equal in all years prior to 1996, thereafter, spawning biomass was always less than total biomass.



Mortality of age-4 and older whitefish in WFM-04 generally declined through time. Total annual mortality

declined from 0.95 y^{-1} in 1981 to 0.54 y^{-1} in 1989, increased to 0.72 y^{-1} in 1993, then declined to 0.38 y^{-1} in 2001. The gill-net fishery accounted for nearly all the fishing mortality of whitefish in WFM-04 during 1986-1999 when gill-net mortality ranged from 0.15 y^{-1} to 0.41 y^{-1}. Trap-net mortality ranged from 0.0 y^{-1} to 0.54 y^{-1} during 1981-2001. Gill-net mortality was 0.02 y-1 in 2001, whereas trap-net mortality was 0.13 y^{-1} in 2001. Natural mortality was estimated to be 0.231 y^{-1} in WFM-04.



Total annual mortality of all age-classes of whitefish was less than the target rate of 1.05 y^{-1} during 1999-2001. The current spawning potential reduction in 2001 was 0.47 and the spawning potential reduction at the target mortality rate was estimated to be 0.40. The projection model estimated that fishing mortality rate could be increased 1.33 times from the fishing level experienced during 1999-2001. The recommended harvest limit at this increased level of fishing was estimated to be 540,000 lb. The recommended yield limit was 639,000 lb in 2002.

Summary Status WFM-04 Whitefish		
Female maturity		
	Size at first spawning	0.71 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.62 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	2.587 lb (SE 0.004)
	Current SSBR	1.19 lb (SE 0.03)
	SSBR at target mortality	0.354 lb (SE 0.000)
Spawning potential reduction		
	At target mortality	0.458 (SE 0.013)
Average yield per recruit		0.698 lb (SE 0.012)
Natural Mortality (M)		0.231 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	0.114 y^{-1} (SE 0.008)
	Average trap net F, ages 4+	0.146 y^{-1} (SE 0.011)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.492 y^{-1} (SE 0.017)
Recruitment (age-3)	(1992-2001 average)	614,330 fish (SE 40,026)
Biomass (age 3+)	(1992-2001 average)	3,013,200 lb (SE 108,910)
Spawning biomass	(1992-2001 average)	2,688,600 lb (SE 90,474)
MSC recommended yield limit for 2003		540,000 lb
Actual yield limit for 2003 (HRG)		540,000 lb

WFM-05 (Grand Traverse Bay)

Prepared by Mark P. Ebener and Erik J. Olsen

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

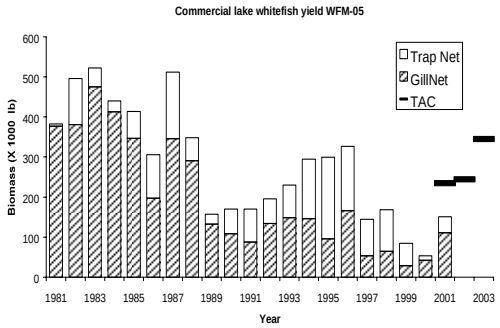
There are at least four reproductively isolated stocks of lake whitefish that inhabit WFM-05. Discrete spawning stocks of whitefish are found in both the east and west arms of Grand Traverse Bay, and in the outer Bay associated with Northport Bay based on mark-recapture studied conducted by Michigan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

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

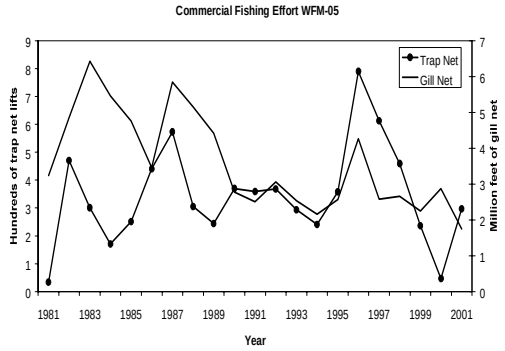
Initial tribal fishing activities in WFM-05 were focused on an exploited population of whitefish. Commercial fishing by state-licensed fisheries had been prohibited in WFM-05 for several decades before tribal small-boat fishermen began fishing the area in the late 1970s. Initial yields in 1978 and 1979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

Commercial yields of lake whitefish were substantially less during the decade of the 1990s than during the 1980s. The commercial yield averaged 384,000 lb from 1980-1989 and 208,000 lb during 1990-1999. The fishery has declined through the late 1990s with the lowest recorded yield coming in 2000 yield at only 53,000 lb. The large-mesh gill-net yield has exceeded the trap-net

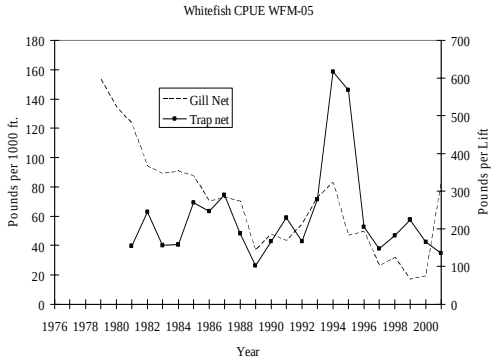
yield in every year except the period from 1994 to 1999.



Large-mesh gill-net effort in WFM-05 declined almost every year since 1984, whereas trap-net effort has varied, but with a downward trend since 1996. Gill-net effort declined from 6.4 million ft. in 1983 to a low of only 1.7 million ft. in 2001. Trap-net effort has varied annually between 200 and 800 lifts during 1982-2001. Since 1991, trap-net effort has averaged 344 lifts per year, peaking out at 790 lifts in 1996, with a low of 66 in 2000.



The decline in yield of whitefish in WFM-05 has mirrored the decline in lake whitefish recruitment within this management unit. In addition, there is an apparent decline in catchability of whitefish to the large-mesh gill-net fishery. CPUE of whitefish in the large-mesh gill-net fishery declined from 153 lb per 1,000 ft. of gill net in 1979 to17 lb per 1000 ft. of gill net in 1999. On the other hand, CPUE of whitefish in the trap-net fishery has been remarkably stable between 150 and 300 lb per lift, except for 1994 and 1995, during 1981-2000. Gill-net fishermen in WFM-05 claim the decline in catchability has been caused in part because the gill nets commonly become coated with an algal slime that makes the net highly visible to whitefish. Whatever the cause, it is obvious that something is reducing catch rates of whitefish to the large-mesh gill-net fishery in the unit.



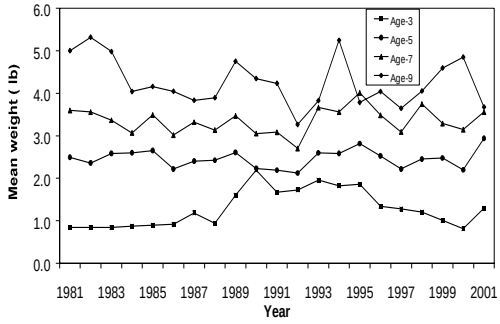
Whitefish from WFM-05 are currently of small to moderate size. The proportion of the yield made up of the three size classes of whitefish were 71% No1 (<3 lb), 22% mediums (3-4 lb), and 7% jumbos (>4 lbs) during 2000-2001. This compares with 65% No1, 22% mediums, and 13% jumbos from 1980-1989 and 65% No1, 20% mediums, and 15% jumbos from 1990-1999.

As illustrated earlier, size structure of whitefish in the yield from WFM-05 has changed over time, as the proportion of jumbos declined and the proportion of No1 whitefish increased. Annual mean weight of whitefish sampled from trap-net harvests ranged from 2.0 to 3.6 lb since 1979 and averaged 3.2 lb during the last three years (1999-2001). Annual mean weight of whitefish in the gill-net harvest ranged from 2.4 to 3.5 lb since 1979 and averaged 2.9 lb during the last three years (1999-2001).

Growth of whitefish from WFM-05 has remained very stable through the

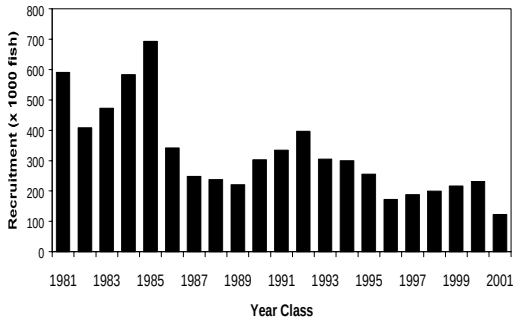
years, unlike the pattern of declining growth seen in other areas of Lakes Michigan and Huron, including substantial declines in areas adjacent to this management unit. Mean weight of ages 3-9 whitefish showed no trends through time in WFM-05 from 1981 to 2001, although some age classes did weigh slightly less in 2001 than in 1981.

Population Mean Weight at Age WFM-05



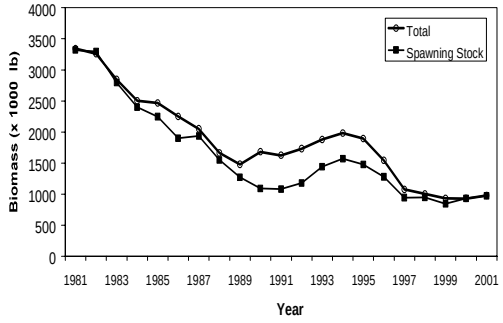
Recruitment of age-3 whitefish to the population in WFM-05 was highly variable and has declined lately based on estimates from the stock assessment model. The number of age-3 whitefish entering the population has declined significantly over time. The 1978-1983 year classes were estimated to range from 340,000 to 591,000 fish. From 1981-1989, the average was still relatively high at 421,000 fish per year. More recently, the average has dropped. From 1992-2001 only 238,230 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.

Estimated Recruitment Age-3 Whitefish WFM-05



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 were peaked at the beginning of the 1981-2001 timeframe with 3.3 million lb. This steadily declined to 1.5 million lb in 1989, rebounded to 2.0 million lb in 1994 and has declined to only 979,000 lb in 2001. Spawning stock biomass also followed the same trend peaking at 3.3 million lb in 1981 and declining to 973,000 lb in 2001.

Estimated Biomass WFM-05



Fishing mortality (F) in WFM-05 has been split about equally between the gill- and trap-net fisheries in recent years. Average fishing-induced mortality on whitefish ≥age 4 averaged 0.10 for the large-mesh gill-net fishery and 0.05 for the trap-net fishery during 1999-2001. Gill net-induced fishing mortality ranged from 0.31 in 1984 to 0.08 in 1999, while trap-net-induced fishing mortality ranged from 0.21 in

1996 to 0.01 in 1981. The gill-and trap-net mortality level has declined from a combined rate of .48 in 1996 to .20 in 2001.

Total annual mortality on the fishable stock in WFM-05 during 1999-2001 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 48% during 1999-2001 and the spawning potential reduction value was 0.59. Consequently, the projection model estimated that fishing mortality could be increased 4.35 times in WFM-05 in 2003 from the average value during 1999-2001. The projected yield associated with this level of fishing was 345,000 lb, and was accepted as the recommended maximum yield in 2003.

Summary Status WFM-05 Whitefish		
Female maturity		
	Size at first spawning	1.90 lb
	Age at First Spawning	4 y
	Size at 50% maturity	2.54 lb
	Age at 50% maturity	5 y
Spawning biomass per recruit		
	Base SSBR	2.562 lb
		(SE 0.)
	Current SSBR	1.51 lb
		(SE 0.05)
	SSBR at target mortality	0.314 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.588
		(SE 0.021)
Average yield per recruit		0.609 lb
		(SE 0.030)
Natural Mortality (M)		0.335 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	10
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0.10 y^{-1}
		(SE 0.01)
	Average trap net F, ages 4+	0.047 y^{-1}
		(SE 0.004)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.482 y^{-1}
		(SE 0.013)
Recruitment (age-3)	(1992-2001 average)	238,260 fish
		(SE 12,886)
Biomass (age 3+)	(1992-2001 average)	1,394,900 lb
		(SE 73,202)
Spawning biomass	(1992-2001 average)	1,158,300 lb
		(SE 66,127)
MSC recommended yield limit for 2003		345,000 lb
Actual yield limit for 2003 (HRG)		345,000 lb

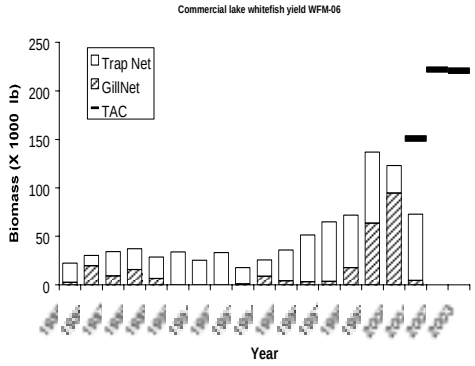
WFM-06 (Leland - Frankfort)

Prepared by Philip J. Schneeberger

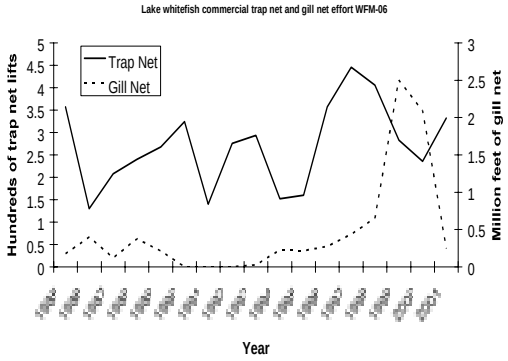
Lake whitefish management unit WFM-06 is located in 1836 Treaty waters west of the Leelanau Peninsula from about Cathead Point south to Arcadia. Surface area for this unit is 945,156 acres (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include Good Harbor Bay, Sleeping Bear Bay, and Platte Bay. Two large islands, North Manitou and South Manitou, are contained in this management zone, as are three large shoal areas including North Manitou Shoal, Pyramid Point Shoal, and Sleeping Bear Shoal. Major rivers flowing into WFM-06 include the Platte, and the Betsie. Betsie Lake is a drowned river mouth formed where the Betsie River flows into Lake Michigan. Except for areas near shore or around the islands, most of the waters in WFM-06 are deep (>200 ft). Bays, islands, and shoal areas offer the best habitat for lake whitefish spawning in this management area. Most trap-net effort and harvest is reported from grids 812-814 and 912 (areas associated with the above-mentioned bays).

WFM-06 was reserved for state-licensed commercial trap-net-fishing operations from 1985 through 1999, except that tribal gill netting was allowed in grid 714. Beginning in 2000, WFM-06 became a shared zone in a truer sense of the term, and waters were opened to both state and tribal fishers.

Yield for 2001 was 73 thousand lbs in WFM-06, down from 123 thousand lbs in 2000, but 51% higher than the 1985-2000 average. Of the total in 2001, trap-net yield was 68.4 thousand lbs (94%) and gill-net yield was 4.5 thousand lbs (6%). Proportions of yield by gear type have varied considerably from year to year with an average split of 77% from trap nets and 23% from gill nets between 1985 and 2001.

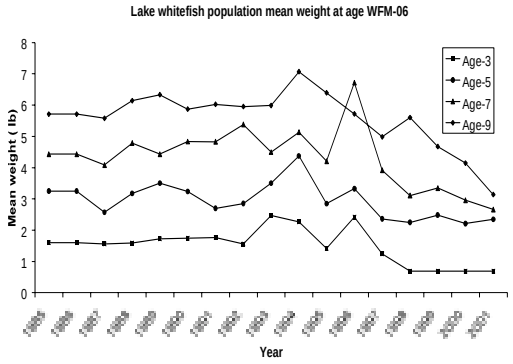


Trap-net effort increased 41% from 2000 to 2001 while gill-net effort decreased 88%. The 2001 trap-net effort (332 lifts) was 24% above the 1985-2000 average, but gill-net effort (246,000 ft) was 49% lower in 2001 than for the 1985-2000 average.

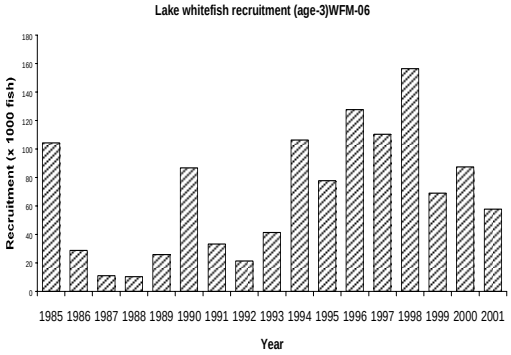


Lake whitefish weight-at-age in 2001 continued to be level with values from 1998 through 2000 for ages under

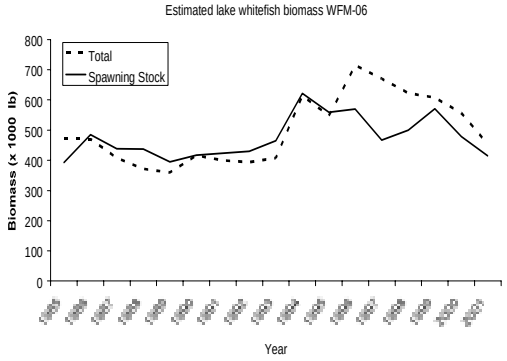
7. Declines in weight-at-age have been documented for fish aged 7 to 12+ over the last six to eight years. Weight-at-age values in 2001 for fish aged 3-12+ were 22-55% lower than 1985-2000 averages.



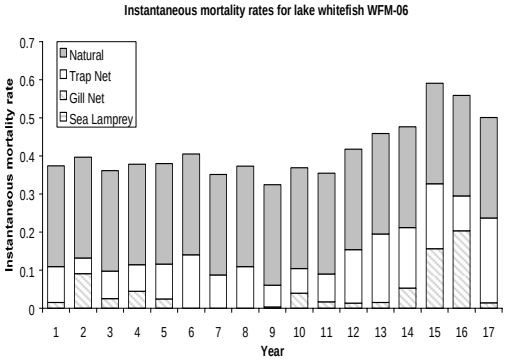
Recruitment, based on estimated numbers of age-3 fish, was lower in 2001 than any year since 1993. Estimates of recruitment were highest during 1994-98 and lowest for the time series during 1987-88.



Estimates of fishable biomass and spawning stock biomass have been stable relative to other management zones, and have roughly paralleled each other from 1985 through 2001. Values estimated for 2001 were 454 thousand lbs for fishable biomass and 415 thousand lbs for spawning stock biomass. The ratio of spawning stock biomass to fishable biomass was 0.92 in 2001. The ratio averaged 0.97 from 1985 to 2000.



Total instantaneous mortality rate (Z) in 2001 was 0.50 y^{-1}, showing a decrease in the rate for the second year in a row. Based on current estimates, the 2001 rate for Z is 22% higher that the average for 1985-2000. Instantaneous fishing mortality rates (F) have varied considerably for trap nets and gill nets throughout the time series. During 2001, F was almost entirely attributable to the trap-net fishery. Estimates for F were 0.22 y^{-1} for trap nets and 0.01 y^{-1} for gill nets. The 2001 estimate for instantaneous natural mortality rate was 0.26 y^{-1}, still the largest source of lake whitefish mortality in WFM-06.



The 2003 yield limit is 221,000 lb - virtually the same as the limit calculated for 2002. The projection model shows that the 2001 level of effort may increase 3.7-fold for gill nets and 1.6-fold for trap nets as one way to reach the 2003 yield limit.

Summary Status WFM-06 Whitefish		
Female maturity		
	Size at first spawning	0.46 lb
	Age at First Spawning	3 y
	Size at 50% maturity	1.19 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	3.929 lb
		(SE 0.007)
	Current SSBR	1.43 lb
		(SE 0.09)
	SSBR at target mortality	0.369 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.363
		(SE 0.022)
Average yield per recruit		0.863 lb
		(SE 0.023)
Natural Mortality (M)		$0.264\ y^{-1}$
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	8
	Fully selected age to trap nets	8
	Average gill net F, ages 4+	$0.113\ y^{-1}$
		(SE 0.01)
	Average trap net F, ages 4+	$0.149\ y^{-1}$
		(SE 0.016)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	$0.526\ y^{-1}$
		(SE 0.026)
Recruitment (age-3)	(1992-2001 average)	85,573 fish
		(SE 6,704)
Biomass (age 3+)	(1992-2001 average)	558,830 lb
		(SE 46,787)
Spawning biomass	(1992-2001 average)	507,660 lb
		(SE 44,942)
MSC recommended yield limit for 2003		221,000 lb
Actual yield limit for 2003		221,000 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). There has not been any tribal or significant state commercial fishing effort for lake whitefish in this unit from 1985 through 2000. The current regulations prohibit the use of large-mesh gill nets and only allow for use of large-mesh trap nets for commercial lake whitefish exploitation. In 2001 LRBOI enacted a 19-inch minimum size limit, rather than 17-inches under the CORA regulations, on lake whitefish harvest within this unit. The larger minimum length limit within this unit has biological implications such as an increase in the average number of spawning opportunities per female. In 2003 LRBOI adopted the CORA 17-inch minimum size limit on lake whitefish for this unit. This decision was based upon review of the length distribution of lake whitefish within the unit and the percent of their relative abundance, from graded mesh surveys, at $\leq$19-inch and $\leq$17-inch minimum size limits. This review indicated that under the $\leq$19-inch minimum size limit that only 44.0% of the population was available for harvest, and 83.4% was available under the $\leq$17-inch minimum size limit. The average size, in length, of a lake whitefish in this unit from graded-mesh gill-net surveys was below the minimum size limit of 19-inches as indicated in the table below for 2000-2002.

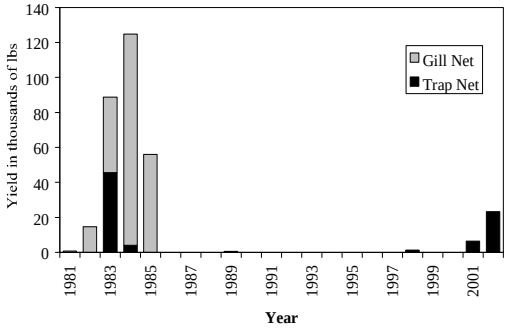
There has been no modeling of lake whitefish stocks in WFM-07 by the Modeling Sub-Committee of the Technical Fisheries Committee due to a lack of current long-term commercial catch information. At this time no harvest limits have been set for this unit. Pursuant to the 2000 Consent Decree, the tribes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

At the conclusion of the 2003 fishing season, Tribal fishers will have conducted three years of commercial fishing activity for lake whitefish within

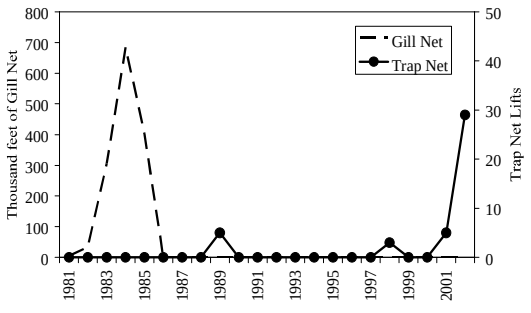
this unit. Pursuant to the 2000 Consent Decree, and the Tribal Management Plan, a Harvest Regulation Guideline (HRG) for lake whitefish will have to be developed for this unit for the 2004 and future fishing seasons.

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

WFM-07 Commercial Fishery Yield

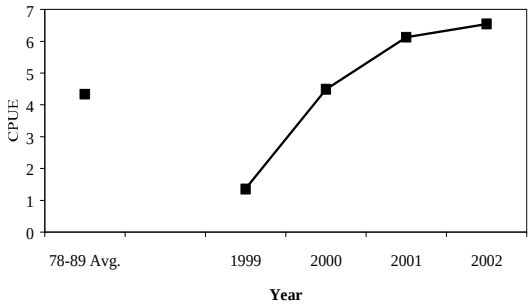


WFM-07 Commercial Fishing Effort



Current relative abundance of lake whitefish in WFM-07 appears to be increasing when compared to historical levels represented by the 1978-1989 average. Historical graded-mesh gill-net CPUE of 4.3/1,000 feet for lake whitefish from spring surveys is represented by the average for 1978-1989. Between 1999 and 2002, graded-mesh gill-net surveys CPUE for lake whitefish in spring assessments ranged from 1.4, 4.5, 6.1, and 6.5/1,000 feet respectively.

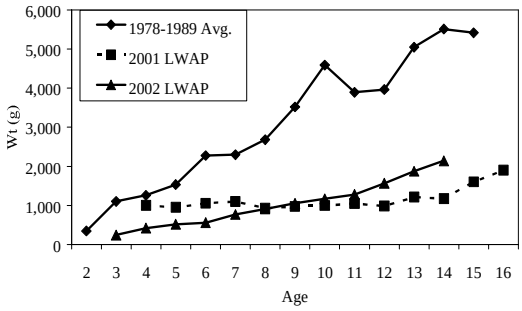
WFM-07 CPUE from Spring LWAP Assessments



Recent (2000-2002) mean weight and mean length of lake whitefish sampled in spring graded-mesh gill-net surveys has declined as compared to the average from 1978-1989. The mean weight and mean length of commercially harvested lake whitefish have declined when comparing 1983 to 2001-2002. The mean age of lake whitefish in spring graded-mesh gill-net surveys has increased for 2000-2002 as compared to the 1978-1989 average. Also, the mean age of lake whitefish from commercial harvests has increased for 2001-2002 as compared to 1983. Mean weight at age for younger age groups is similar from graded-mesh gill-net surveys in 2001 and 2002 compared to the 1978-1989 average. However, the disparity in mean weight at age between recent surveys (2001 and 2002) and the historic average is much greater for older age groups, with the historic average being much larger.

Year	Gear	Mean TL (inch)	Mean Wt (Lb)	Mean Age
1978-1989 Avg.	GMGN	23.34	6.84	4.8
1983	CF	23.32	5.54	7.3
2000	GMGN	18.61	2.22	6.1
2001	CF	19.89	2.76	10.9
2001	GMGN	18.96	2.37	9.9
2002	GMGN	18.44	2.33	8.9
2002	CF	19.34	2.69	9.7

WFM-07 Mean Weight at Age



The instantaneous total annual mortality rates for WFM-07 lake white fish were determined from catch curve analysis. The instantaneous total annual mortality rate (Z) for 1978-1989 spring graded-mesh gill-net survey averaged 0.20 y^{-1} for ages 3 through 15. The instantaneous total annual mortality rate (Z) for 2001 and 2002 spring graded-mesh gill-net survey averaged 0.13 y^{-1} for ages 6 through 16, and 0.03 y^{-1} for ages 5 through 13 respectively.

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

WFM-08 (Muskegon)

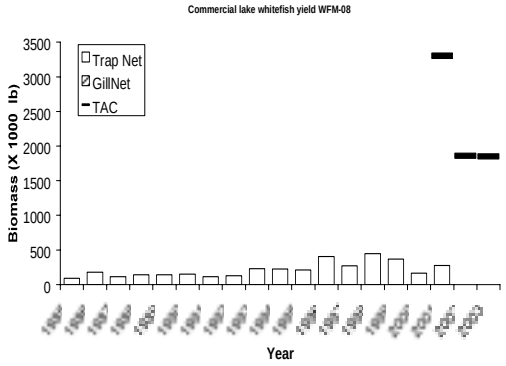
Prepared by Philip J. Schneeberger

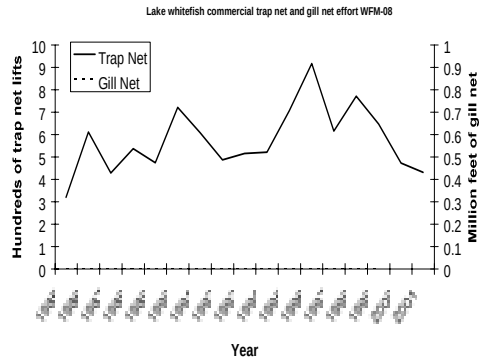
Management unit WFM-08 is the Lake Michigan whitefish zone from about Montague south past Port Sheldon. WFM-08 has a surface area of 1,506,880 acres in Michigan grids 1706-1710, 1806-1810, 1906-1911, and 2006-2011. Apart from the shoreline, inflows from the White, Muskegon, and Grand rivers, and drowned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

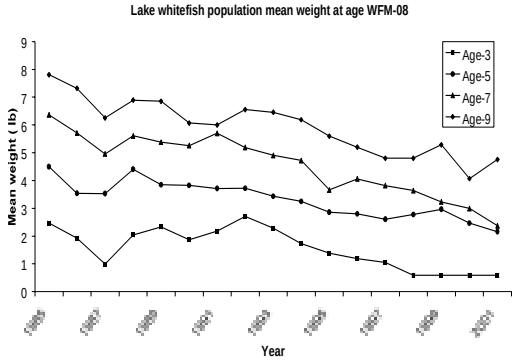
Two state-licensed trap-net fishers operate in WFM-08 where minimum length for whitefish in commercial catches was 19 inches TL through 1999, then changed to 17 inches TL in 2000. Other management zones have had a 17-inch minimum size limit throughout the time series. Through 2001 there has been no gill net harvest of lake whitefish in WFM-08.

Lake whitefish yield from WFM-08 in 2001 was 274 thousand pounds. This yield was a 67% increase over the previous year despite a 10% decrease in effort between 2000 and 2001. Yield during 2001 was 29% higher than the 1985-2000 average, whereas 2001 effort represented a 26% decrease from the average for 1985-2000.



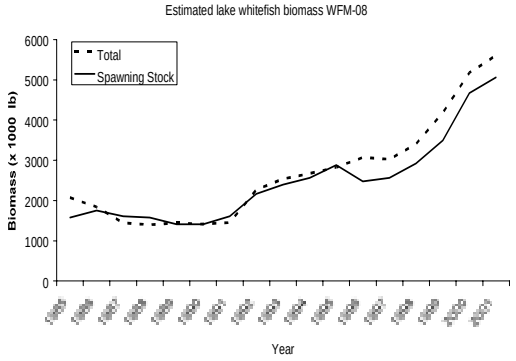


Weight-at-age data have trended downward from 1985 through 2001. Considering a shorter time frame comparison, 2001 weight-at-age values were 11 to 46% less than averages for 1998-2000 for ages 4-8. However, fish 9-years old and older were generally heavier than for corresponding ages averaged from 1998 to 2000.

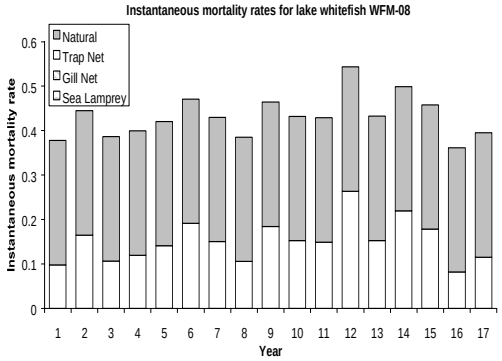


Recruitment, based on the estimated number of age-3 fish, was 622,000 in 2001. Estimates of recruitment were considerably higher (average 1,384) during 1998-2000, but the estimate for 2001 was more than double the 1985-1997 average of 310,000 age-3 fish.

Estimates of fishable biomass and spawning stock biomass continued increasing trends that have persisted since the early 1990s. Fishable biomass was estimated at 5.6 million lbs and spawning stock biomass was 5 million lbs in 2001. The ratio of spawning stock biomass to fishable biomass was 0.90 in 2001, slightly lower than the 1985-2000 average ratio of 0.95.

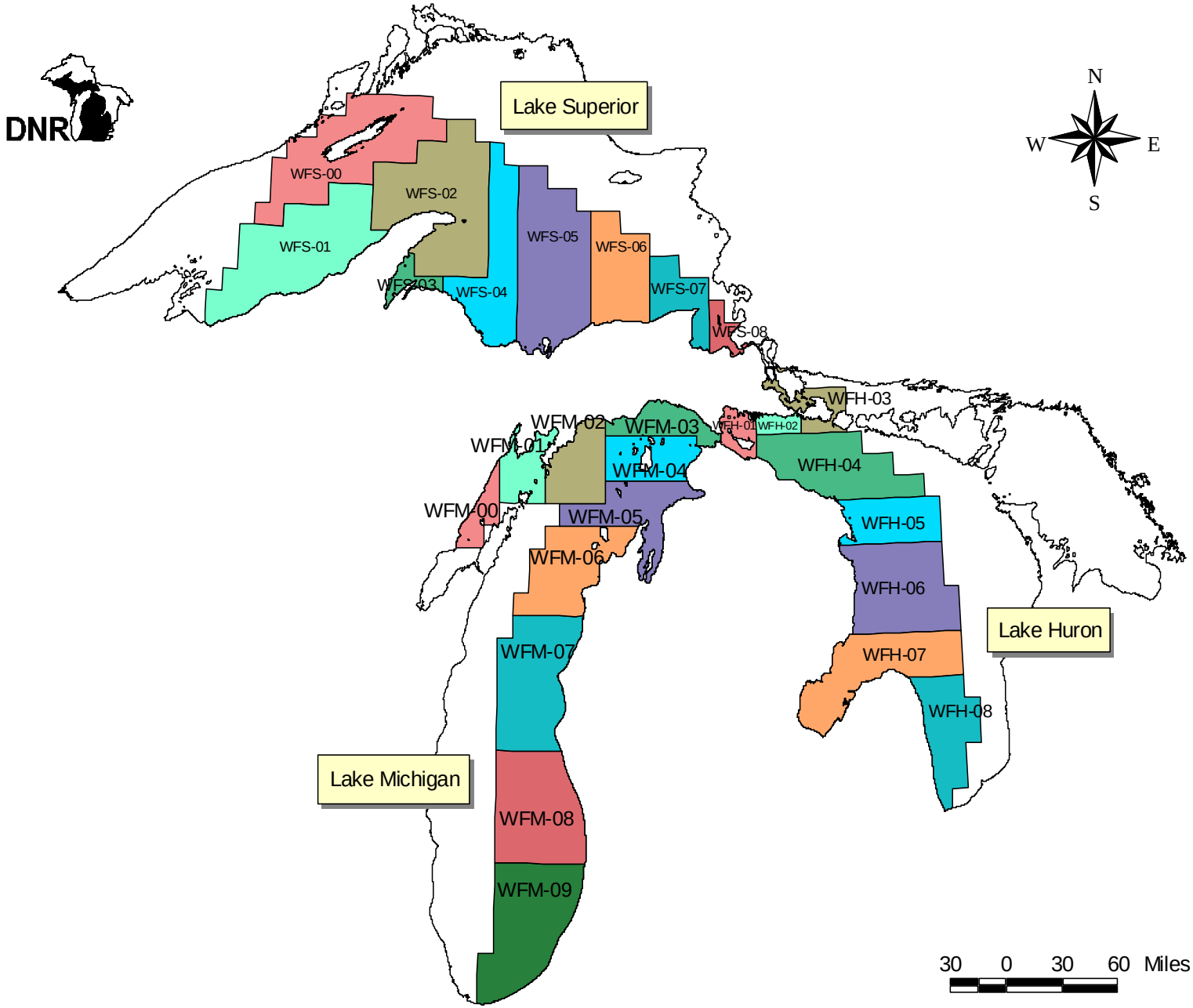


Mortality rates have been relatively stable throughout the time series. Instantaneous total mortality rate (Z) was estimated at 0.40 y^{-1} during 2001. Components of the total rate consisted of 0.12 y^{-1} for instantaneous trap-net-fishing mortality (F) and 0.28 y^{-1} for instantaneous natural mortality (M). The ratio of F to Z averaged 0.34 from 1985 through 2001.

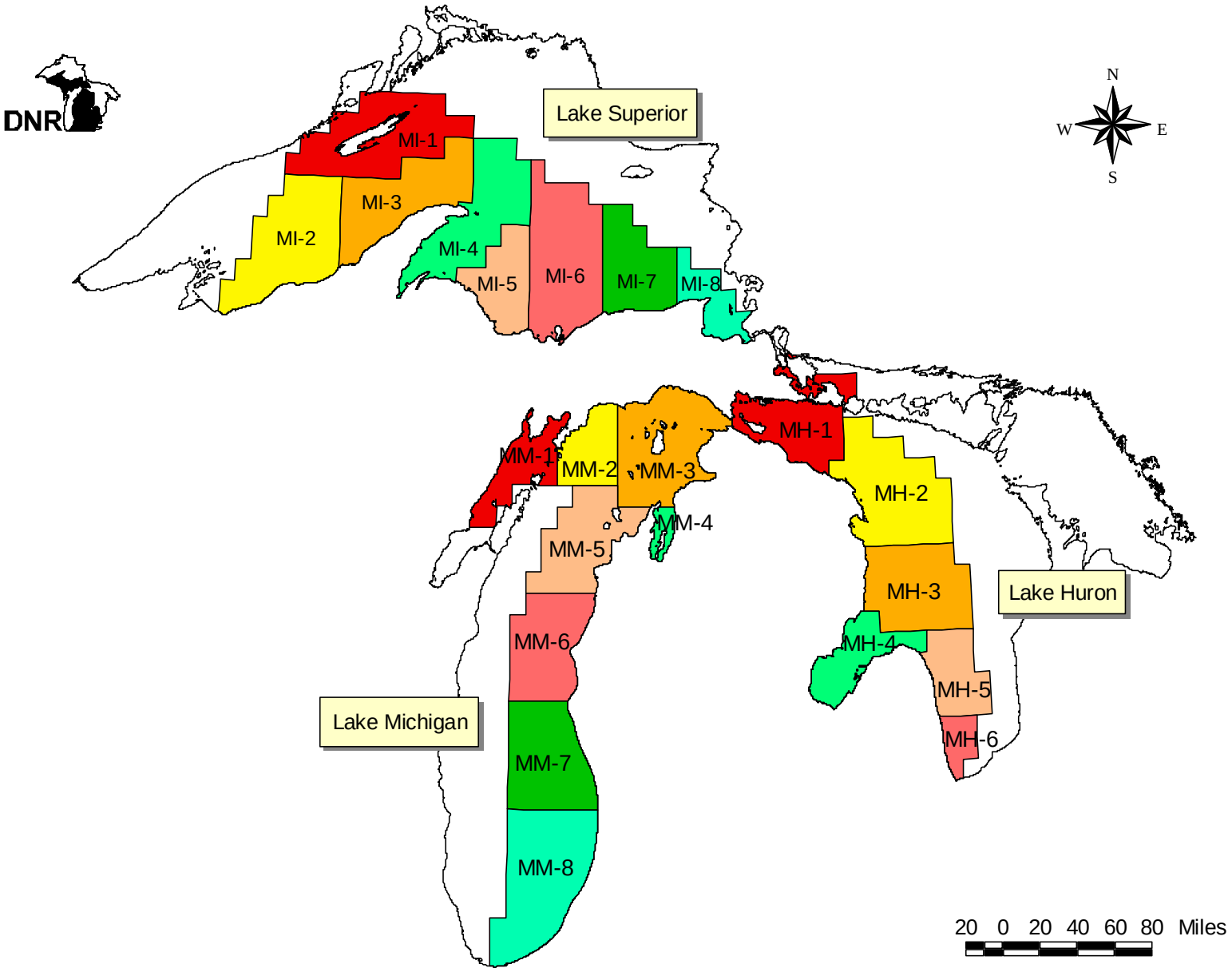


The 2003 yield limit for WFM-08 was 1.852 million lbs, calculated using the projection model. This yield is very close to the limit calculated for 2002. Projection model output indicated that 2001 trap-net effort could be increased by a factor of 4.9 to target the 2003 yield limit.

Summary Status WFM-08 Whitefish		
Female maturity		
	Size at first spawning	0.60 lb
	Age at First Spawning	3 y
	Size at 50% maturity	2.35 lb
	Age at 50% maturity	4 y
Spawning biomass per recruit		
	Base SSBR	3.477 lb
		(SE 0.007)
	Current SSBR	2.05 lb
		(SE 0.11)
	SSBR at target mortality	0.375 lb
		(SE 0.000)
Spawning potential reduction		
	At target mortality	0.589
		(SE 0.032)
Average yield per recruit		0.538 lb
		(SE 0.035)
Natural Mortality (M)		0.280 y^{-1}
Fishing mortality rate 1999-2001		
	Fully selected age to Gill Nets	
	Fully selected age to trap nets	10
	Average gill net F, ages 4+	0. y^{-1}
		(SE 0.)
	Average trap net F, ages 4+	0.116 y^{-1}
		(SE 0.016)
Sea lamprey mortality (ML)		
	(average ages 4+,1999-2001)	N/A
Total mortality (Z)		
	Average ages 4+,1999-2001	0.396 y^{-1}
		(SE 0.016)
Recruitment (age-3)	(1992-2001 average)	774,940 fish
		(SE 127,130)
Biomass (age 3+)	(1992-2001 average)	3,477,900 lb
		(SE 413,680)
Spawning biomass	(1992-2001 average)	3,119,200 lb
		(SE 362,790)
MSC recommended yield limit for 2003		1,852,000 lb
Actual yield limit for 2003		1,852,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.