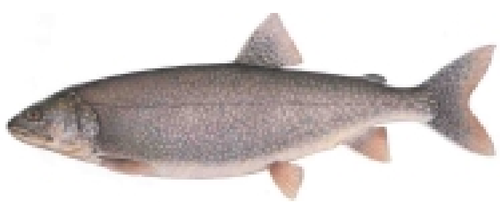
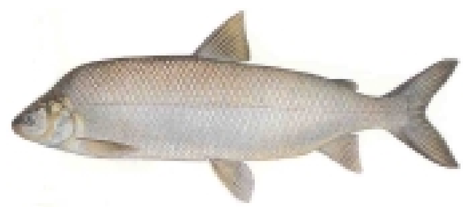
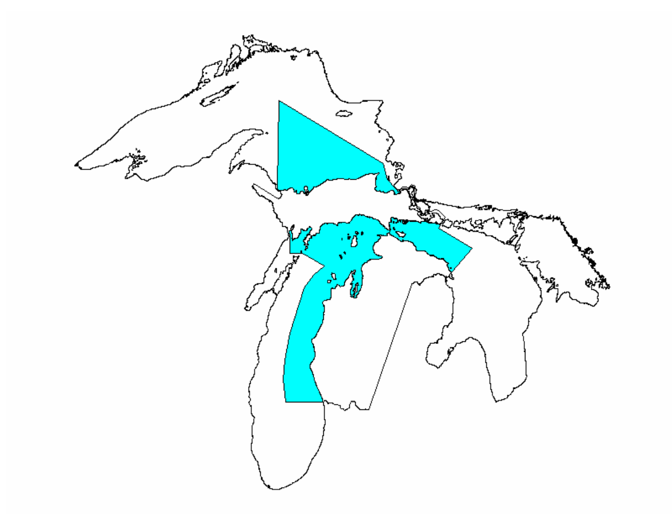
Technical Fisheries Committee Administrative Report 2002: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan in 2001, with recommended yield and effort levels for 2002





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

J.R. Bence (Michigan State University),
M.P. Ebener (Chippewa/Ottawa Resource Authority),
S.P. Sitar (Michigan Department of Natural Resources),
and A.P. Woldt (United States Fish and Wildlife Service)
Editors



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EXECUTIVE SUMMARY

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

In August 2000 the State of Michigan's Department of Natural Resources (MDNR), five tribes that are currently members 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 their differences concerning 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 throughout the 1836 Treaty-ceded waters. In management units in which the state and tribes share 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 to develop the yield and effort limits required in the Consent Decree.

We, the MSC, assessed population status and mortality rates for 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 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. When SCAA models could be developed, the resulting estimates of abundance and mortality were combined in a spreadsheet with growth and maturity data for whitefish and lake trout in each stock or management unit, and recommended yield levels (upper bounds) were projected for calendar year 2002. Recommended yield limits were obtained by either limiting mortality to a maximum rate, achieving a minimum spawning potential reduction in 2002, 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 (when applicable) on lake trout was either 40 or 45%. In some areas there was no total mortality rate limit for lake trout, and yields were 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 in each stock following the percentages written in the Consent Decree. Recommended harvest and effort limits for each whitefish stock or lake trout management unit are given below.

Species	Lake	Management unit	Yield limit or HRG (lb)	Gill-net limit (ft)
Lake trout	Superior	MI-5	130,700	NA
		MI-6	28,400	0.6 million
		MI-7	132,600	7.2 million
	Michigan	MM-1,2,3	532,000	8.4 million
		MM-4	93,000	0.9 million
		MM-5	45,100	0.3 million
		MM-6,7	782,000	NA
	Huron	MH-1	95,400	5.9 million
		MH-2	23,300	NA
Lake whitefish	Superior	WFS-04	296,000	NA
		WFS-05	642,000	NA
		WFS-06	52,000	NA
		WFS-07	302,000	NA
		WFS-08	81,000	NA
	Michigan	WFM-01	703,000	NA
		WFM-02	186,000	NA
		WFM-03	1,313,000	NA
		WFM-04	639,000	NA
		WFM-05	244,000	NA
		WFM-06	222,000	NA
		WFM-08	1,861,000	NA
	Huron	WFH-01	248,000	NA
		WFH-02	325,000	NA
		WFH-03	293,000	NA
		WFH-04	634,000	NA
		WFH-05	670,000	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). Because in MI-6 and MI-7 siscowet and lean yield are mixed in commercial catch reports, allowable total yield (leans and siscowets) can exceed the values in the above table by 14% and 35% respectively. In MI-6 recent mortality rates have been below target rates, but recreational harvest continues to exceed the harvest limit despite strict regulation of the recreational fishery. Work continues on the MI-6 model to verify its accuracy. In the other two management areas recent mortality rates have been below targets, and increases in yield are possible. No stock assessment model was developed for lake trout in MI-8 of Lake Superior because this was 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, while in MH-2 mortality rates are near or below target rates. Phased-in reductions in fishing mortality resulting from reduced commercial effort and a higher recreational minimum size limit should improve the situation in MH-1. Changes in fishery regulations will have a relatively smaller effect in MH-2, as fishery exploitation is less than sea lamprey predation as a source of mortality there. Decreases in sea lamprey mortality are necessary in both areas in Lake Huron in order to meet mortality rate targets. This will depend upon success of the treatment of the St. Marys River in reducing sea lamprey abundance over the next several years. Early indicators for Lake Huron show substantial decreases in sea lamprey induced mortality due to treatment of the St. Marys River. Success in controlling sea lamprey should allow increases in lake trout yield in Lake Huron.

In Lake Michigan, only in the southern most area are lake trout mortality rates well below target rates, allowing the potential for substantial increases in yield in southern Lake Michigan. In northern Lake Michigan unit MM-123 recent mortality rates have been near target rates. However, projected declines in abundance and the Consent Decree's requirement for phased-in yield limits would result in higher mortality rates in the near term. In MM-4 and MM-5 recent mortality rates have been higher than target rates. Recommended yield limits for 2002 are below recent observed yields in those areas. Substantial decreases in commercial fishing effort and increases in the minimum size limit for the recreational fishery should help to achieve the mortality targets in the future. The effect of sea lamprey control in the St. Marys River on lake trout mortality in Lake Michigan is not yet known, but early indicators do not look promising. Lake Michigan researchers suspect that another stream(s) may be producing large numbers of sea lamprey in northern Lake Michigan.

In general, fishery exploitation has not been excessive on lake whitefish stocks in recent years. 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 some notable cases (WFH-04, WFM-01, and WFM-02) estimated declines in size-at-age and recruitment were so pronounced that we projected declines in yields for 2002 for mortality set to the target rate, even though this represented an increase in fishing (and total) mortality from that of recent years. Essentially, fishers are able to set more gear and catch higher numbers of fish, but individual fish are smaller and the total catch represents a smaller yield than catches of similar numbers of fish when compared to previous years. In WFH-04 and WFM-02 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. No summary report is included for WFM-07 even though it is a management zone within the 1836 Treaty waters. It has not been fished commercially since 1985, and there are no data available to model the lake whitefish populations in this zone.

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 James R. Bence and Shawn P. Sitar

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 2002 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 is fit to available data. These models consisted of two components. The first was a submodel describing the population dynamics of the stock. The second was a submodel that predicts 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-net 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 from 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 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 fish, 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.

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. From no parameters (whitefish) up to two parameters (stocked lake trout) were estimated 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 that was being modeled each year 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, and for the lake trout models survey catch per unit effort (CPUE) by age. 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 catch-per-effort was predicted assuming proportionality between population abundance and expected catch-per-effort, with selectivity following a logistic or double logistic function of age:

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

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 the maximum amount of yield that could be taken, consistent with a specific upper bound on total mortality, was determined. 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" 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 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 2002 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 one year behind the TAC year. 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 2002 Fishing Season

Starting with the estimates or projections of age-specific abundance at the start of 2002, 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 2002, but did not in 2002, 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 2002

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 increases 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 MM- 67 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 MM-67 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 net and gill net 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.

References cited:

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

RECOMMENDATIONS AND FUTURE DIRECTIONS TO IMPROVE ASSESSMENTS

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

In Fall 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 wide 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

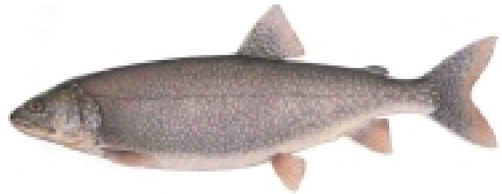
- The MSC recommends that in addition to this status of the stocks report (termed short report), a second report for the 2001 assessments be written that documents and describes in detail the modeling methods used (termed long report). The 2001 long report is currently being written. We recommend the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

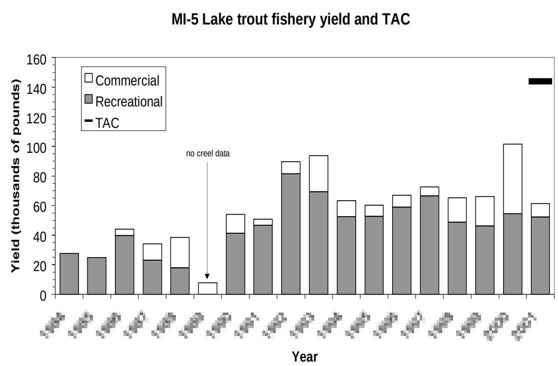
MI-5 (Marquette-Big Bay Stock)

Prepared by Shawn P. Sitar

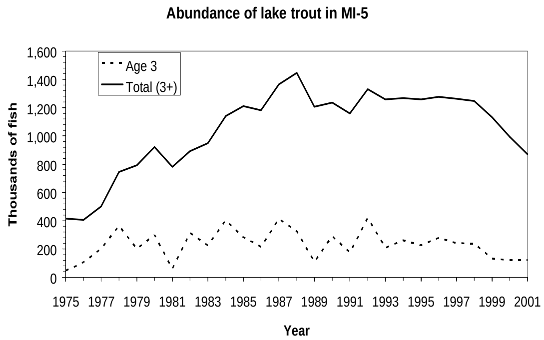
Lake trout management unit MI-5 extends from Pine River Point (west of Big Bay) to Laughing Fish Point (east of Marquette), covering 924,017 acres. The management unit includes Stannard Rock, an offshore shoal about 72 km north of Marquette, and is in both the 1836 (618,352 acres) and 1842 Treaty waters (305,665 acres). 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 greater than 780 feet, and with 186,732 acres shallower than 240 feet.

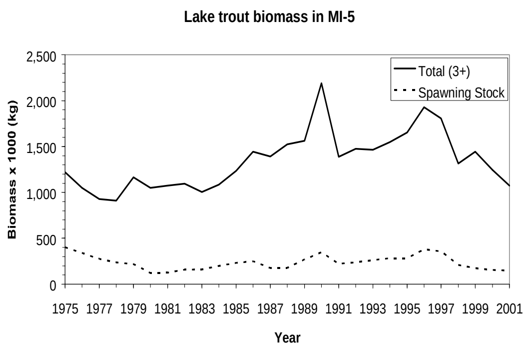
The only tribal commercial fishery is a large-mesh gill-net fishery that is centered around Marquette and Big Bay in 1842 Treaty waters. This fishery is mainly targeting lake whitefish with lake trout as bycatch. There have been some low levels of tribal subsistence gill-net fishing in 1836 treaty waters. Tribal commercial yield of wild lake trout (in 1842 treaty waters) has ranged from 3,100 lb in 1986 to 42,100 lb in 2000. From 1997 to 2001, tribal yield averaged 17,200 lb and tribal large-mesh gill-net effort averaged 275,000 ft.

Recreational harvest of lake trout comprises both charter and sport angling. 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 to14,600 fish (52,300 lb) in 2001 and has averaged 12,000 fish (47,300 lb) annually. Recreational effort has declined from 146,000 angler hours in 1986 to 47,900 angler hours in 2001.

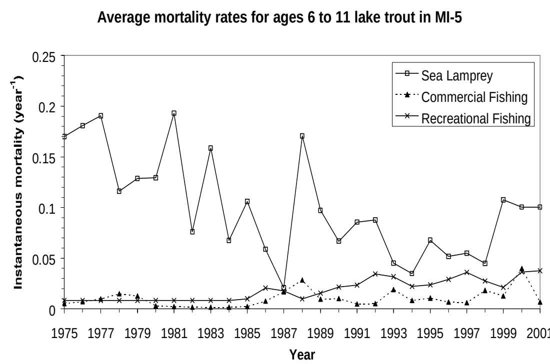


Abundance of age-3 and older wild lake trout increased over two-fold since 1975, though it has declined from the peak of about 1.4 million fish in 1988. Total biomass of age-3 and older lake trout averaged 3.3 million lb (1.5 million kg) during 1992-2001. Lake trout biomass declined from 4.8 million lb (2.2 million kg) in 1990 to 2.4 million lb (1.1 million kg) in 2001. Spawning stock biomass averaged 548,000 lb (249,000 kg) from 1992 to 2001. 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 the period from 1975 to 2001, 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 1975-1978 to 28% during 1999-2001. Spawning stock biomass produced per recruit during the period from 1999 to 2001 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 130,700 lb, allocated as 124,200 lb for the state recreational fishery and 6,500 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 76,200 lb during 1999-2001), reflecting the fact that recent mortality rates have been well below target rates.



Summary Status MI-5	
Female maturity	
Size at first spawning	2.50 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	3.753 lb
	(SE 0.456)
Current SSBR	0.98 lb
	(SE 0.1)
SSBR at target mortality	0.529 lb
	(SE 0.020)
Spawning potential reduction	
At target mortality	0.261
	(SE 0.016)
Average yield per recruit	0.326 lb
	(SE 0.045)
Natural Mortality (M)	0.174 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (1999-2001)	15
Age of full selection	
Sport fishery (1999-2001)	9
Commercial Fishing mortality (F)	
(average 1999-2001, ages 6-11)	0.02 y^{-1}
	(SE 0.004)
Sport fishery F	
(average 1999-2001, ages 6-11)	0.032 y^{-1}
	(SE 0.005)
Sea lamprey mortality (ML)	
(average ages 6-11,1999-2001)	0.103 y^{-1}
Total mortality (Z)	
(average ages 6-11,1999-2001)	0.329 y^{-1}
	(SE 0.013)
Recruitment (age-3)	
(1992-2001 average)	225,040 fish
	(SE 37,725)
Biomass (age 3+)	
(1992-2001 average)	3,297,200 lb
	(SE 430,880)
Spawning biomass	
(1992-2001 average)	548,280 lb
	(SE 72,606)
Recommended yield limit in 2002	130,700 lb

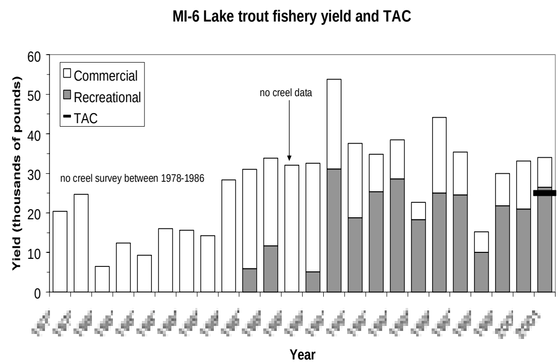
MI-6 (Au Train-Munising stock)

Prepared by Shawn P. Sitar

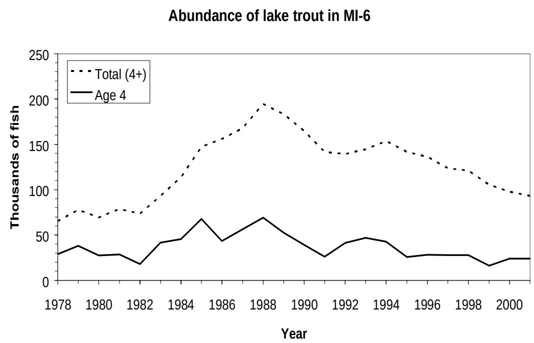
Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 1.8 million acres. The management unit includes Big Reef, an offshore reef complex about 20 mi northeast of Munising. This management unit contains the deepest waters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

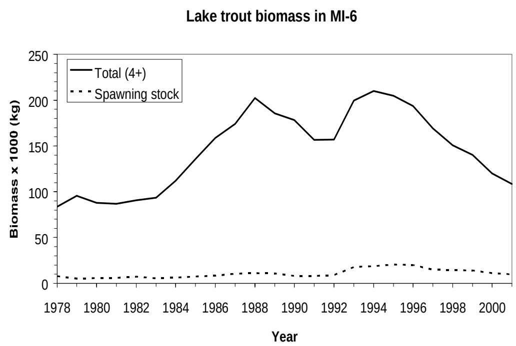
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is centered east of Grand Island. This fishery mainly targets lake whitefish with lake trout as bycatch. Tribal commercial yield of wild lake trout peaked in 1989 at 32,100 lb and declined to an average of 9,500 lb during the period from 1997 to 2001. 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 940,000 ft in 2001.

Recreational harvest of lake trout comprises fish caught by both charter and sport angling. Most of the recreational harvest was from the Au Train Bay and Grand Island areas, although some harvest was also from Big Reef. Recreational harvest of wild lake trout has increased from 980 fish (5,900 lb) in 1987 to 5,100 fish (26,000 lb) in 2001 and averaged 4,000 fish (17,500 lb) per year. 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 (7%). Recreational effort has declined from 72,000 angler hours in 1988 to 34,700 angler hours in 2001.



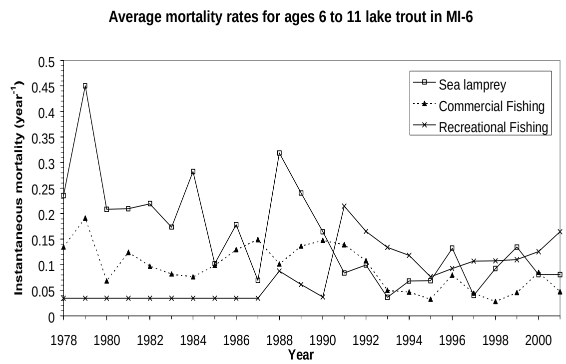
Abundance of age-4 and older wild lake trout declined from 194,000 fish in 1988 to 93,000 fish in 2001. Recruitment at age 4 has declined during the period from 1992 to 2001 and averaged 30,400 fish during this period. The decline in abundance is related to increases in mortality rates starting in 1995 and the decline observed in recruitment. Total biomass of age-4 and older lake trout has averaged 365,000 lb (165,000 kg) during the period from 1992 to 2001. Biomass has declined from 463,000 lb (210,000 kg) in 1994 to 239,000 lb (108,000 kg) in 2001. Spawning stock biomass averaged 33,100 lb (15,000 kg) during the period from 1992 to 2001 and represented 9% of total stock biomass.





During the period from 1978 to 1990 sea lamprey and commercial fishing were the highest mortality sources for ages 6-11 lake trout in MI-6. Recreational fishing mortality has been the highest mortality source in all years since 1991, except in 1996 and 1999. During the period from 1978 to 2001, total annual mortality (*A*) was the highest in 1979 at 57% and declined to 29% in 1995. Subsequently, *A* increased to 36% in 2001. Initially, the recommended yield limit for 2002 was calculated as 27,500 lb of which 15,200 lb was allocated for state recreational harvest and 12,300 lb for tribal commercial harvest. This yield limit accounted for pounds killed from hooking mortality by removing a portion from the recreational harvest limit. Subsequently, at the April 17, 2003 TFC meeting the 2002 harvest limit was altered to add back in the hooking mortality as the State had already included the kill from this source of mortality in the reported harvest number. The adjusted harvest limit is 28,400 lb of which 16,100 lb was allocated for state recreational yield and 12,300 lb for tribal commercial yield. In the future, the state will measure hooking mortality and report it as part of total harvest.

While mortality rates apply only to wild lean trout, the yield limit applies to all lean trout. In calculating the limit the Modeling Subcommittee assumed that 5.5% of the yield would be hatchery fish.



Summary Status MI-6	
Female maturity	
Size at first spawning	2.42 lb
Age at First Spawning	6 y
Size at 50% maturity	4.48 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	4.851 lb
	(SE 0.568)
Current SSBR	0.69 lb
	(SE 0.12)
SSBR at target mortality	0.612 lb
	(SE 0.017)
Spawning potential reduction	
At target mortality	0.142
	(SE 0.026)
Average yield per recruit	0.786 lb
	(SE 0.097)
Natural Mortality (M)	0.170 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (1999-2001)	8
Age of full selection	
Sport fishery (1999-2001)	10
Commercial Fishing mortality (F)	
(average 1999-2001, ages 6-11)	0.059 y^{-1}
	(SE 0.017)
Sport fishery F	
(average 1999-2001, ages 6-11)	0.12 y^{-1}
	(SE 0.027)
Sea lamprey mortality (ML)	
(average ages 6-11,1999-2001)	0.098 y^{-1}
Total mortality (Z)	
(average ages 6-11,1999-2001)	0.448 y^{-1}
	(SE 0.036)
Recruitment (age-4)	
(1992-2001 average)	30,389 fish
	(SE 4,431)
Biomass (age 3+)	
(1992-2001 average)	364,500 lb
	(SE 49,822)
Spawning biomass	
(1992-2001 average)	33,142 lb
	(SE 5,546)
Recommended yield limit in 2002	27,500 lb

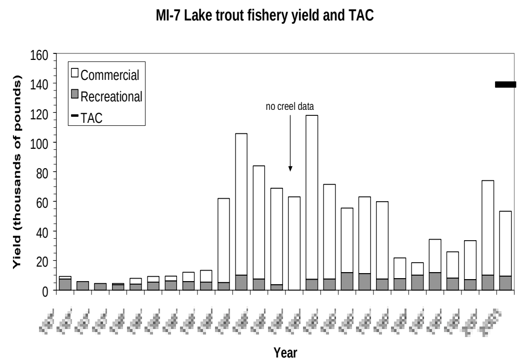
MI-7 (Grand Marais stock)

Prepared by Shawn P. Sitar

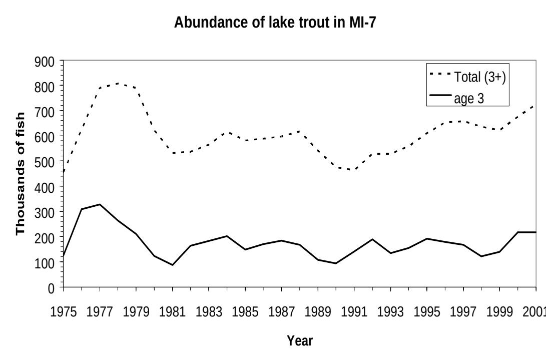
Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 987,000 acres. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There are approximately 92,000 acres of lean lake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

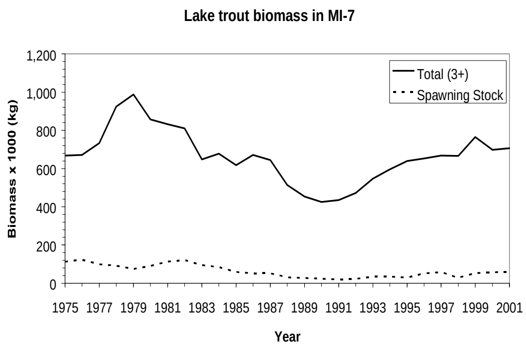
The commercial fishery that harvests lake trout is a tribal large-mesh gill-net fishery that is mostly based out of Grand Marais. This fishery mainly targets lake whitefish with lake trout as bycatch. During the period from 1975 to 2001, tribal commercial yield of wild lake trout peaked in 1990 at 117,000 lb and had declined to 21,200 lb in 1996. Subsequently, tribal yield increased to an average of 44,700 lb in the last three years. In recent years these yields of wild lean lake trout compose about 61% of the total lake trout yield, with the rest consisting of siscowet (35%) and hatchery lake trout (4%). Tribal large-mesh gill-net effort has shown the same temporal pattern as commercial yield, with a peak effort of 8.2 million feet of net in 1990.

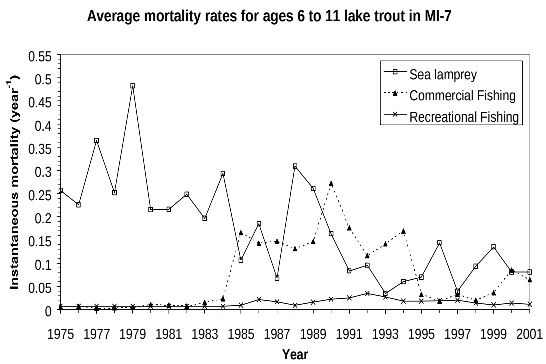
Creel surveys were not conducted in MI-7 between 1982 and 2000. Standardized creel survey began at Grand Marais in 2001. Sport harvest and effort in MI-7 for years prior to 2001 were estimated using the average sport CPUE and effort index ratio between MI-7 to MI-5 from MIDNR creel mail survey data from 1971 to 82 applied to MI-5 sport harvest and effort during the period from 1984 to 2000. The estimates from this procedure indicate that recreational harvests in MI-7 are about half those of MI-6. This procedure required strong and somewhat questionable assumptions, hence there is much uncertainty regarding the true magnitude of the recreational harvest in MI-7 prior to 2001.



Abundance of age 3 and older wild lake trout averaged 619,000 fish during the period from 1992 to 2001 and has increased from 529,000 fish in 1992 to 724,000 fish in 2001. Recruitment at age 3 averaged 171,200 fish during 1992-2001. Spawning stock biomass averaged 94,700 lb during the last ten years (1992-2001) and represented 7% 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 from 1995 to 1998, but has been increasing since 1998. During the period from 1982 to 1991, total annual mortality (*A*) averaged 42% for ages 6-11 lake trout. From 1992 to 2001, average *A* was 32%. Total annual mortality has increased from 26% in 1997 to 31% in 2001. 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 recommended yield limit for the year 2002 is 132,600 lb of which 39,800 lb is allocated for state recreational yield and 92,800 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 6.2% 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 35%, 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.

Summary Status MI-7	
Female maturity	
Size at first spawning	2.89 lb
Age at First Spawning	6 y
Size at 50% maturity	4.86 lb
Age at 50% maturity	10 y
Spawning biomass per recruit	
Base SSBR	2.721 lb
	(SE 0.359)
Current SSBR	0.76 lb
	(SE 0.12)
SSBR at target mortality	0.424 lb
	(SE 0.019)
Spawning potential reduction	
At target mortality	0.279
	(SE 0.042)
Average yield per recruit	0.348 lb
	(SE 0.109)
Natural Mortality (M)	0.210 y^{-1}
Fishing Mortality	
Age of full selection	
Commercial Fishery (1999-2001)	13
Age of full selection	
Sport fishery (1999-2001)	10
Commercial Fishing mortality (F)	
(average 1999-2001, ages 6-11)	0.062 y^{-1}
	(SE 0.022)
Sport fishery F	
(average 1999-2001, ages 6-11)	0.012 y^{-1}
	(SE 0.004)
Sea lamprey mortality (ML)	
(average ages 6-11,1999-2001)	0.099 y^{-1}
Total mortality (Z)	
(average ages 6-11,1999-2001)	0.383 y^{-1}
	(SE 0.027)
Recruitment (age-3)	
(1992-2001 average)	171,230 fish
	(SE 59,406)
Biomass (age 3+)	
(1992-2001 average)	1,413,300 lb
	(SE 432,720)
Spawning biomass	
(1992-2001 average)	94,710 lb
	(SE 35,002)
Recommended yield limit in 2002	132,600 lb

Lake Huron

MH-1 (Northern Lake Huron)

Prepared by Aaron P. Woldt

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 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 supports large spawning runs of sea lamprey and until recently 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 should reduce the number of sea lamprey produced in the St. Marys River in the future. 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.

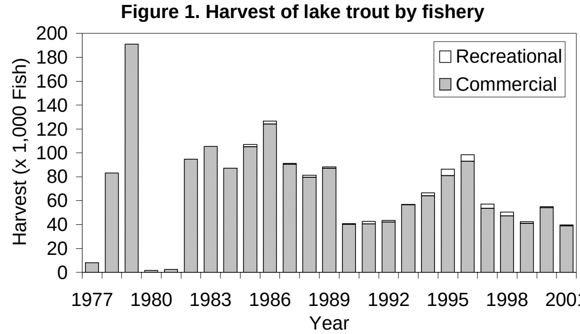
There is little or no natural recruitment of lake trout in northern Lake Huron. As a result, nearly all the lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-1. From 1997 to 2001, approximately 290,000 yearling lake trout were 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 2001, approximately 437,000 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 estimates 397,000 yearling lake trout recruits in MH-1 for 2001.

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 1997 to 2001, tribal commercial yield of lake trout averaged 123,000 lb, while Canadian commercial yield averaged 24,000 lb. The majority of tribal lake trout yield (89%) came from the large-mesh gill-net fishery. Tribal large-mesh gill-net effort averaged 11.8 million ft from 1997 to 2001, while Canadian large-mesh gill-net effort averaged 3.1 million ft. With the implementation of the Consent Decree, tribal large-mesh gill-net catch and effort dropped substantially in 2001. Large-mesh gill-net harvest dropped by 34,000 lb, and large-mesh gill-net effort dropped by 4.6 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 (Figure 1). From 1997 to 2001, recreational yield of lake trout averaged 6,200 lb. In 2001, recreational harvest was only 2,800 lb in MH-1. 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. This new regulation was intended to keep harvest below the 2001 state share of the MH-1 harvest limit.

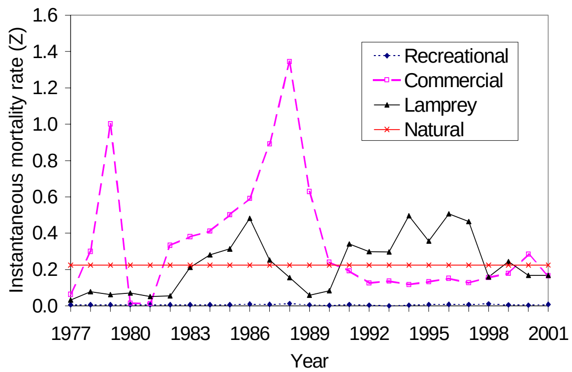
Figure 1. Harvest of lake trout by fishery



Instantaneous mortality rates have been variable and relatively high in northern Lake Huron (Figure 2). From 1977 to 1990, commercial fishing mortality was the leading source of lake trout mortality. After 1990, commercial fishing mortality decreased as sea lamprey-induced mortality increased. Sea lamprey were the largest source of lake trout mortality in the 1990s, until 1998 when sea lamprey-induced mortality decreased. From 1997 to 2001, lamprey-induced instantaneous mortality averaged 0.24 y^{-1} and commercial fishing instantaneous mortality averaged 0.18 y^{-1}. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2001 decreased 58% from the average of 1994-1998 levels. This decline may be due in part to the treatment of the St. Marys River, but more data is needed to support this hypothesis. Recreational fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron (Figure 2).

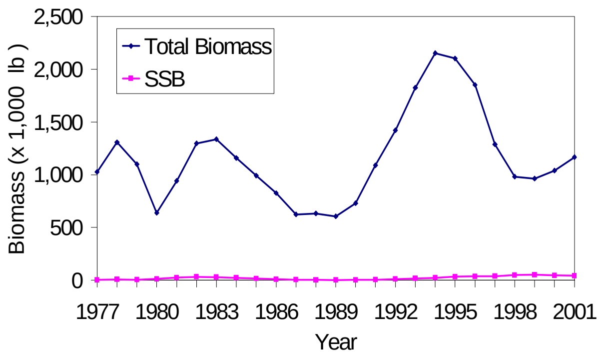
The high rates of both sea lamprey-induced and commercial fishing mortality caused the age structure in northern Lake Huron to be truncated just before the age of first maturity. As a result, spawning stock biomass (SSB) is

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



extremely low in northern Lake Huron, and total lake trout biomass varied around a 20-year average of 1,204,113 lb (Figure 3).

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



The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 95,400 lb for MH-1 in 2002. 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 8,900 lb to the state and 86,500 lb to the tribes.

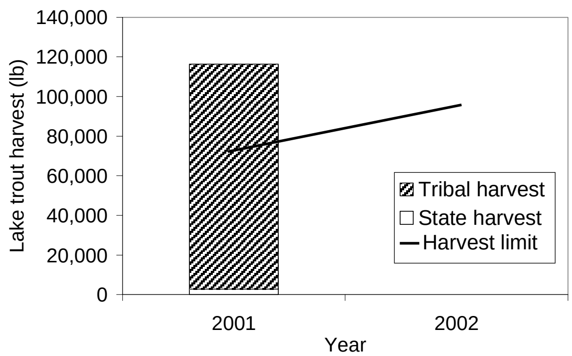
The 2001 harvest limit was calculated based on the phase-in described in the Consent Decree. In particular, it was based on the average effort during 1997 to 1999, either adjusted for gill-net operations converted to trap nets under provisions of the Consent Decree (tribal commercial fishery) or changes 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 harvest limit 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 re-calculate 2002 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. So, the MSC revised the April 2002 MH-1 harvest limit of 66,000 lb based the Executive Council's instructions.

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 2001 (Figure 4), but still represented a decline in harvest from previous years. State harvest was below the state harvest limit in 2001. The total harvest limit increased 23,400 lb from 2001 to 2002 (Figure 4).

Figure 4. Yearly harvest and harvest limits



Summary Status—MH-1	
Female maturity	
Size at first spawning	3.33 lb
Age at first spawning	5 y
Size at 50% maturity	5.94 lb
Age at 50% maturity	8 y
Spawning stock biomass per recruit	
Base SSBR	2.479 lb
	(SE 0.278)
Current SSBR	0.180 lb
	(SE 0.044)
SSBR at target mortality	0.294 lb
	(0.015)
Spawning potential reduction	
At target mortality	0.073
	(SE 0.014)
Average yield per recruit	0.496 lb
	(SE 0.033)
Natural mortality (M)	0.224 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (1999-2001)	6 y
Age of full selection	
Sport fishery (1999-2001)	7 y
Commercial fishing mortality F	
(average 1999-2001, ages 6-11)	0.209 y^{-1}
	(SE 0.047)
Sport fishery F	
(average 1999-2001, ages 6-11)	0.005 y^{-1}
	(SE 0.001)
Sea lamprey mortality (ML)	
(average ages 6-11, 1999-2001)	0.193 y^{-1}
Total mortality rate (Z)	
(average ages 6-11, 1999-2001)	0.631 y^{-1}
	(SE 0.052)
Recruitment (age-1)	420,490 fish
(1992-2001 average)	(SE 24,102)
Biomass (age 3+)	1,307,274 lb
(1992-2001 average)	(SE 145,785)
Spawning biomass	35,104 lb
(1992-2001 average)	(SE 9,931)
Recommended yield limit in 2002	95,400 lb

MH-2 (North-central Lake Huron)

Prepared by Aaron P. Woldt

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 supports large spawning runs of sea lamprey and until recently 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 should reduce the number of sea lamprey produced in the St. Marys River in the future. 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.

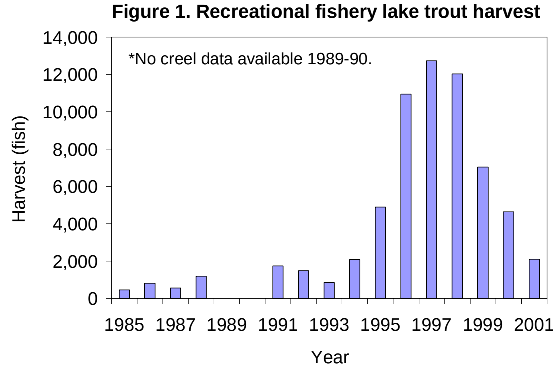
There is little or no natural recruitment of lake trout in north-central Lake Huron. Only one site off North Point has yielded consistent, yearly production of wild juvenile lake trout in MH-2. As a result, nearly all lake trout harvest is comprised of hatchery fish. The United States Fish and Wildlife Service annually plants lake trout in MH-2. From 1997 to 2001, approximately 289,000 yearling lake trout per year were planted annually in near-shore areas of MH-2, and 285,000 yearling lake trout were planted annually on Six Fathom Bank/Yankee Reef. Approximately 206,000 yearling lake trout were planted annually in Canadian management area 4-3 from 1997 to 2001. Starting in 2002, stocking on the Six Fathom Bank/Yankee Reef Complex will cease, and these lake trout will be re-allocated to nearshore stocking sites. After adjusting for post stocking survival and immigration and emigration based on coded-wire-tag data, the MH-2 model estimates 395,000 yearling lake trout recruits in MH-2 for 2001.

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.

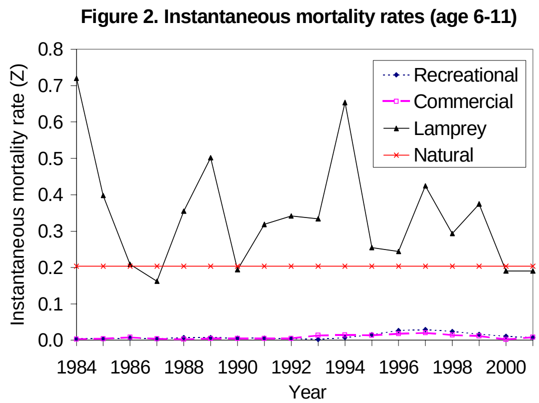
There is a substantial commercial fishery for lake trout in Canadian waters adjacent to MH-2 (areas 4-2, 4-3, and 4-7) that we included in our assessment. From 1997 to 2001, total Canadian commercial lake trout yield in these areas averaged 27,700 lb per year. The majority of this yield came from the large-mesh gill-net fishery. Canadian large-mesh gill-net effort averaged 5.0 million ft per year from 1997 to 2001.

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 7,700 fish from 1997 to 2001 (Figure 1). From 1997 to 2001, recreational yield of lake trout averaged 28,300 lb, but in 2001 recreational harvest was only 4,100 lb in MH-2. 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. This new regulation was placed on the recreational fishery to keep harvest below the 2001 state share of the MH-2 harvest limit.

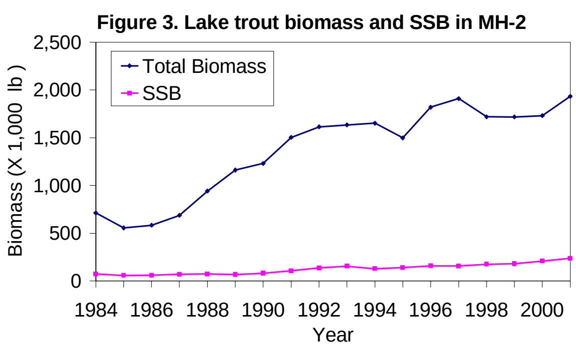
Figure 1. Recreational fishery lake trout harvest



The dominant source of mortality for lake trout in MH-2 was sea lamprey (Figure 2). Sea lamprey-induced mortality was greater than all other mortality sources from 1984 to 2001 with the exception of 1987, 1990, 2000, and 2001 when natural mortality was the largest single mortality source (Figure 2). Sea lamprey mortality rates have been cyclic in north-central Lake Huron, reaching peaks in 1989, 1994, 1997, and 1999 (Figure 2). From 1997 to 2001, sea lamprey-induced mortality averaged 0.39 y^{-1}. Sea lamprey-induced mortality rates for age 6-11 lake trout in 2001 decreased 49% from the average of 1994-1998 levels. This decline may be due in part to the treatment of the St. Marys River, but more data is needed to support this hypothesis. Recreational and commercial fishing mortality were low in all years relative to lamprey-induced mortality (Figure 2).



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 (Figure 3). Total lake trout biomass has steadily increased since 1984, averaging 1,802,400 lb from 1997 to 2001 (Figure 3); however, the majority of this biomass is young, immature, hatchery fish.

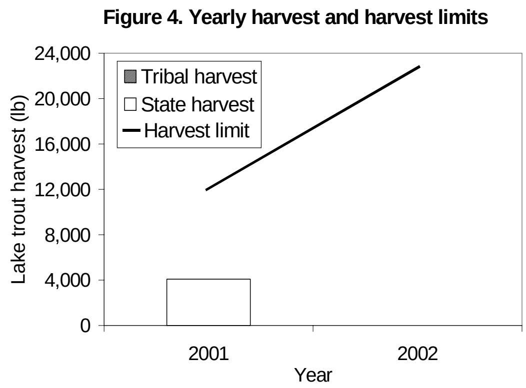


The Modeling Subcommittee of the TFC recommends a lake trout harvest limit of 23,300 lb for MH-2 in 2002. This harvest was calculated using the target total annual mortality rate of 40% and allocating 95% of the harvest to the state and 5% of the harvest to the tribes as outlined in Sections VII.A.3 and VII.A.4 of the Consent Decree. Based on these calculations, the total yield was allocated 22,100 lb to the state and 1,200 lb to the tribes. These calculations were done assuming status quo sea lamprey mortality levels (average rate observed in recent years), because of the uncertainty of the effects of the St. Marys River lamprey treatments. Projected recreational mortality rates for 2002 include the 20" minimum size limit first imposed by the state of Michigan in 2001.

Current spawning stock biomass per recruit (SSBR) is above SSBR at target mortality, indicating total annual mortality rates are near or below the target of 40% total annual mortality. The average projected total annual mortality rate during 2002 for age 6-11 lake trout is 33.6%. This is due to the large declines in sea lamprey-induced mortality rates in 2000 and 2001. If sea lamprey-induced mortality remains low, spawning stock biomass and SSBR should increase.

State harvest was significantly below the harvest limit in 2001 (Figure 4). No tribal harvest was reported in MH-2 in 2001. 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 2001 to 2002. This is due to the large declines in sea lamprey-induced mortality rates in 2000 and 2001. Section VII.A.6 of the Consent Decree states that "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 2002 all parties agreed that increasing the harvest limit by greater than the 15% threshold was appropriate.



Summary Status – MH-2	
Female maturity	
Size at first spawning	1.99 lb
Age at first spawning	4 y
Size at 50% maturity	6.04 lb
Age at 50% maturity	7 y
Spawning stock biomass per recruit	
Base SSBR	4.653 lb
	(SE 0.666)
Current SSBR	0.767 lb
	(SE 0.095)
SSBR at target mortality	0.750 lb
	(SE 0.060)
Spawning potential reduction	
At target mortality	0.165
	(SE 0.006)
Average yield per recruit	0.076 lb
	(SE 0.007)
Natural mortality (M)	0.203 y^{-1}
Fishing mortality	
Age of full selection	
Commercial fishery (1999-2001)	6 y
Age of full selection	
Sport fishery (1999-2001)	6 y
Commercial fishing mortality F	
(average 1999-2001, ages 6-11)	0.007 y^{-1}
	(SE 0.001)
Sport fishery F	
(average 1999-2001, ages 6-11)	0.011 y^{-1}
	(SE 0.002)
Sea lamprey mortality (ML)	
(average ages 6-11, 1999-2001)	0.252 y^{-1}
Total mortality rate (Z)	
(average ages 6-11, 1999-2001)	0.473 y^{-1}
	(SE 0.013)
Recruitment (age-1)	424,420 fish
(1992-2001 average)	(SE 20,534)
Biomass (age 3+)	1,593,732 lb
(1992-2001 average)	(SE 46,180)
Spawning biomass	168,320 lb
(1992-2001 average)	(SE 21,407)
Recommended yield limit in 2002	23,300 lb

Lake Michigan

MM-123 (Northern Treaty Waters-Lake Michigan)

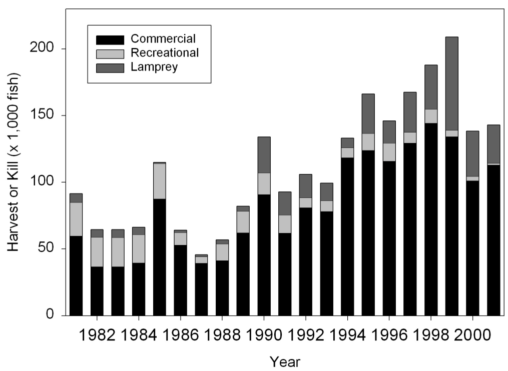
Prepared by Jory L. Jonas, James R. Bence, Erik J. Olsen, and Randall M. Claramunt

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 the northern management unit are for the most part less than 150 feet, and approximately 3,800 square miles are less than 240 feet. In the southern portions of the unit, depths can, reach depth greater than 550 feet. Most of the historically important lake trout spawning reefs in Lake Michigan are located in MM123. 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 occupies 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 anglers to retain lake trout when fishing in the refuge area. Gillnet fishing (both commercial and subsistence) is also prohibited in the refuge. Commercial trap net operations are permitted; however, the retention of lake trout is prohibited. Commercial fishing is also prohibited in the innermost area of Little Traverse Bay (grid 519) and portions of grid 306 in northern Green Bay.

Recruitment of lake trout in the northern management unit of Lake Michigan is currently based entirely on stocking. In each of the last ten years, approximately 720,000 yearling lake trout have been stocked into northern Lake Michigan and approximately 88 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 (1992-2001) the recruitment to age 1 has averaged 562,000 fish in northern Lake Michigan.

Both state and tribal commercial fisheries operate in northern Lake Michigan. State-licensed commercial fishers are not permitted to harvest lake trout and therefore are not included in lake trout harvest allocations. While the current tribal commercial fishery primarily targets lake whitefish, lake trout are sometimes targeted or kept as bycatch. Since 1981 commercial fishing has killed more harvestable lake trout (fish > 17 in.) than other sources of mortality in northern Lake Michigan (Figure 1).

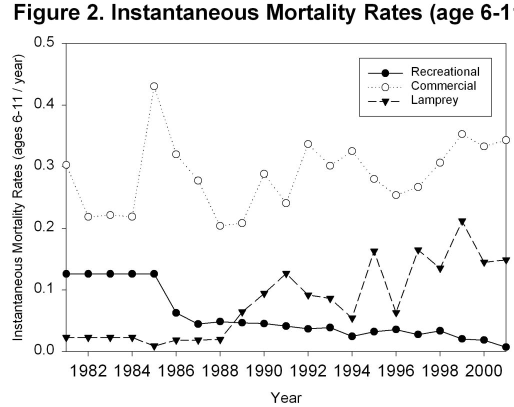
Figure 1. Numbers of Lake Trout Killed



There are three types of tribal commercial fisheries in the unit: 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 270,000 lb in 1991 to 734,000 lb in 1999. After the implementation of the 2000 Consent Decree, yield fell to 468,000 lb in 2000 and 432,000 lb in 2001. Large-mesh gill-net effort in tribal fisheries has been steadily declining from 23 million feet in 1992 and 1993 to 8 million feet in 2001. The number of lake trout harvested in northern Lake Michigan tribal fisheries had been increasing from 1991 (62,000 fish) until 1998 (144,000 fish). After 1998, harvest numbers had declined to 101,000 fish by the year 2000. In 2001, harvest numbers were up slightly to 113,000 fish (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 15 year agreement.

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, and a modest decline in recreational yield resulted. In recent years, the estimated recreational yield of lake trout has declined further, by over 70 percent from 1998 (76,000 lb) to 2000 (22,000 lb) and an additional 16 percent reduction occurred in 2001 (10,000 lb). The numbers harvested declined similarly (Figure 1). This more recent decline is at least partly due to a decline in recreational fishing effort, as angler hours decreased nearly 79 %, from 94,000 in 1998 to 20,000 in 2001.

Figure 2. Instantaneous Mortality Rates (age 6-11)



During the period from 1989 to 2001, sea lamprey-induced mortality has been the second highest source of mortality for lake trout in northern Lake Michigan. In general, lamprey mortality rates appear to be rising since 1996 and have remained at a stable high for the recent three years (Figure 2). The number of lake trout killed by sea lamprey has increased from an average of 4,900 during the period from 1981 to 1985 to an average just over 35,000 during the period from 1996 to 2001 (Figure 1). When recommending a yield limit for northern Lake Michigan for the year 2001, no adjustments were made for potential reductions in sea lamprey induced mortality.

In northern Lake Michigan, lake trout generally are both spawning and recruited into commercial and recreational fisheries by age 6 (Summary table). The biomass of lake trout had been increasing in northern Lake Michigan since 1987, but has decreased since 1997 (Figure 3). Spawning biomass shows a similar pattern with a less pronounced peak in 1997. The decline since 1997 is more pronounced when only considering fish outside the refuge. The total biomass of lake trout outside the refuge averaged 3.3 million lb during the period from 1992 to 2001, rising from 1.4 million lb in 1987 to 4.0 million lb in 1997 and then declining to 2.5 million lb in 2001.

The spawning stock biomass produced per recruit (including the refuge population) during the period from 1998 to 2000 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 46,000 pounds for the state recreational fishery and 486,000 pounds for the tribal commercial/subsistence fishery. These values reflect phase-in requirements specified in the 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 2001, two options were considered: 1) the modeled allowable yield (26,000 lb state and 237,000 lb tribal); or 2) the average of the yield from 1997-1999 less the reduction due to gill-net conversions in the area (46,000 lb state and 486,000 lb tribal). Consistent with the Consent Decree specifications, option two was selected and approved by the TFC because it provided the highest tribal yield of lake trout. This specific phase-in option actually allows a temporary increase in mortality rates above the 40% target (Figure 4).

Figure 3. SCAA Estimated Biomass (Age 1 and Older) Includes Refuge

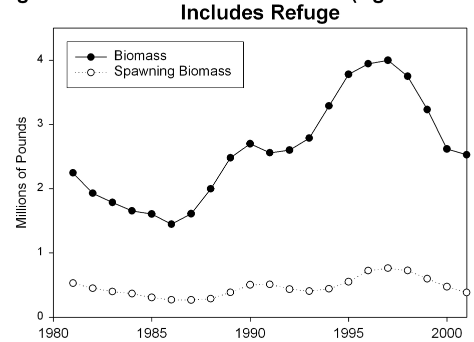
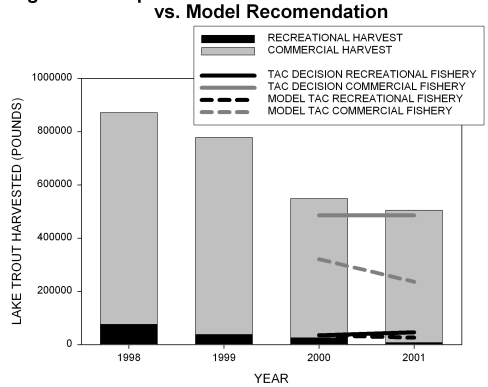


Figure 4. Comparison of Actual Harvest vs. TAC Decision vs. Model Recomendation



Summary Status – MM-123	
Female maturity	
Length at first spawning	16.4 in.
Age at first spawning	3 y
Length at 50% maturity	24.3 in.
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	8.041 lb (SE 0.714)
Current SSBR combined w/ refuge	2.225 lb (SE 0.198)
SSBR at target mortality	2.334 lb (SE 0.187)
Spawning potential reduction	
At target mortality	0.290 (SE 0.017)
Average yield per recruit	1.234 lb (SE 0.096)
Natural mortality (M)	0.233 y^{-1}
Fishing mortality	
Age of full selection Commercial fishery (1999-2001)	6 y
Age of full selection Sport fishery (1999-2001)	6 y
Commercial fishery F (average 1999-2001, ages 6-11)	0.341 y^{-1} (SE 0.034)
Sport fishery F (average 1999-2001, ages 6-11)	0.015 y^{-1} (SE 0.002)
Sea Lamprey Mortality (ML) (average 1999-2001, ages 6-11)	0.168 y^{-1}
Total Mortality rate (Z) (average 1999-2001, ages 6-11)	0.757 y^{-1} (SE 0.035)
Average recruitment (age 1) (1992-2001 average)	561,900 fish (SE 81,000)
Average biomass (age >2) (1992-2001 average)	3,243,400 lb (SE 198,000)
Spawning stock biomass (1992-2001 average)	547,000 lb (SE 43,700)
TFC recommended yield limit (Phase)	532,000 lb

MM-4 (Grand Traverse Bay-Lake Michigan)

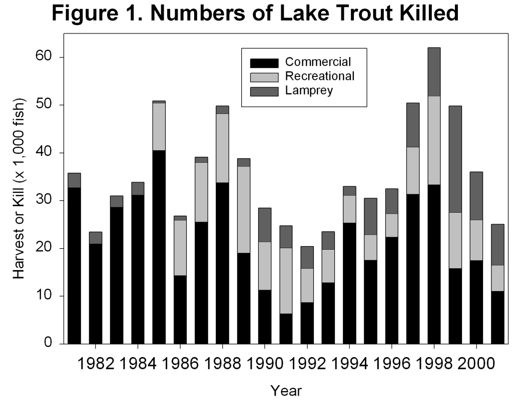
Prepared by Jory L. Jonas, James R. Bence, and Erik J. Olsen

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, and 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 and 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 (1992-2001) the recruitment to age one has averaged 255,400 fish in the Grand Traverse management unit (Summary table).

From 1993 until 1997 more lake trout were killed by commercial fishing than by either sea lamprey or sport fishing (Figure 1). However, during 1998-2001 the numbers killed by the three mortality sources were more similar. Commercial fishing mortality in Grand Traverse Bay peaked in 1994 at 0.46 y^{-1}, remained stable over the next several years (average of 0.21 y^{-1}), declined in 1999 to 0.16 y^{-1}, and rose again to an average 0.21 y^{-1} in 2000 and 2001 (Figure 2).

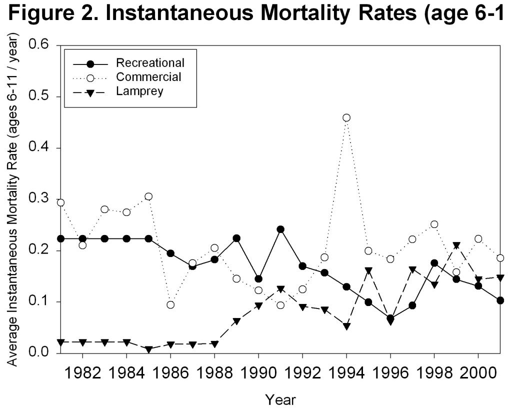
Figure 1. Numbers of Lake Trout Killed



Only tribal fishers commercially harvest fish in this management unit.

There are three types of tribal commercial fisheries: large-mesh gill-net, small-mesh gill-net, and trap-net. The large-mesh gill-net fishery 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 11 thousand fish were harvested in 2001. The yield of lake trout captured in tribal commercial fisheries peaked in 1998 at 135,000 lb and has declined by over 60% to 53,000 lb in 2001. Large-mesh gill-net effort in tribal fisheries has also been declining from 2 million feet in 1996 to 0.7 million feet in 2001. 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 (age 6-11)

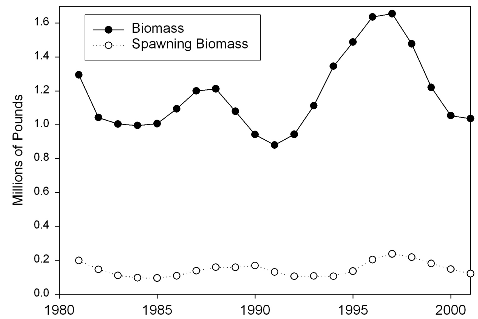


The management of recreational fisheries for lake trout is the primary responsibility of the state of Michigan and fisheries are comprised of both charter and sport anglers. The sportfishing harvest regulations in the Grand Traverse Bay management unit have changed significantly over the last 10 years, affecting recreational fishing mortality rates and harvest levels. From 1992 to 1996 the minimum size limit for lake trout harvest increased from 10 to 24 inches. In 1996 the season for harvesting lake trout was lengthened, so that it extended from Jan 1 through September 30 in contrast to the previous season of May 1 through Labor Day. Mid-way through the year in 1997 the minimum size limit was decreased to 20 inches and has remained so through the year 2001. The mortality rates of lake trout resulting from recreational fishing have steadily declined from 1991 (0.24 y^{-1}) to 1996 (0.07 y^{-1}). Since 1996 mortality rates have increased to 0.18 y^{-1} in 1998 and have again declined to near the 1996 low at 0.10 y^{-1} in 2001. The estimated recreational yield of lake trout in Grand Traverse Bay had been consistent during the years 1992-1996 averaging 39,000 lb. However, from 1996 to 1998 the recreational yield of lake trout increased dramatically to 93,000 lb. In recent years (1999-2001) yield has declined, falling to an all time low of 23,000 lb in 2001. The number of lake trout harvested followed a similar pattern 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. Recreational fishing effort levels have remained relatively stable over the last 10 years (1991-2001) averaging 205 thousand angler hours (range = 180-240 thousand angler hours). The effort value observed in 2001 was 186 thousand angler hours falling below the ten year average and on the low end of the described 10 year range.

From 1981 to 1988 sea lamprey-induced mortality was the lowest source of mortality in the Grand Traverse Bay management unit with instantaneous rates averaging 0.02 y^{-1}. Rates gradually increased to 0.13 y^{-1} by 1991, declining to 0.05 y^{-1} in 1994. After 1994 rates were variable and appeared to be generally increasing. The highest lamprey mortality rate was observed in 1999 at 0.21 y^{-1}. In recent years (1999-2001), the mortality rates from all three sources (commercial, recreational and lamprey) are more similar. The recent three-year (1999-2001) average lamprey mortality rate for lake trout age 6-11 is 0.17 y^{-1}. In 1999, lampreys are estimated to have killed over 22,000 lake trout from the management unit. The number of lake trout killed by sea lamprey during the last several years has been lower at an average of 9,300 fish per year.

Generally, lake trout in the Grand Traverse Bay management unit are recruited into commercial fisheries by age 6 and to recreational fisheries by age 7. 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 1.3 million pounds during the last 10 years (1992-2001). Biomass of lake trout rose from a low of 0.9 million lb in 1991 to a high of 1.6 million pounds in 1996 and has since declined to 1.0 million pounds in 2001. The biomass of spawning lake trout in Grand Traverse Bay has been declining since 1997. In 1997, it was estimated that the spawning stock biomass was 237,000 lb and by the year 2001 the estimate had decreased to 121,000 lb. The biomass of spawning lake trout in the management unit has averaged 156,000 lb during the last ten years (1992-2001).

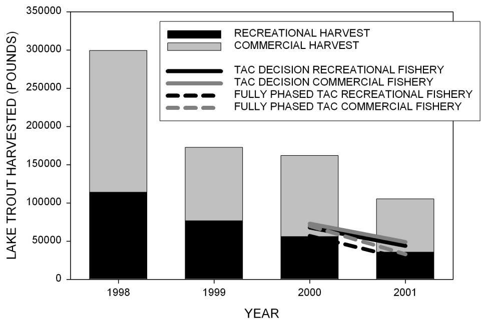
Figure 3. SCAA Estimated Biomass (Age 1 and Older)



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 2002 in the Grand Traverse Bay management unit is 93,000 pounds of which 44,000 pounds was allocated to the state recreational fishery and 49,000 pounds to the tribal commercial/subsistence fishery.

Grand Traverse Bay represents an area where unique phase-in requirements were considered in establishing yield limits (Figure 4). From 2001 to 2005 commercial yield limits for Grand Traverse Bay are to be set based on the mean yield and effort from the period of 1997 to 1999. For commercial fishing, the yield and effort limit is determined as the mean 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. After 2005 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.

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



Summary Status – MM-4	
Female maturity	
Length at first spawning	15.4 in
Age at first spawning	3 y
Length at 50% maturity	24.9 in
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	2.824 lb (SE 0.196)
Current SSBR	0.640 lb (SE 0.054)
SSBR at target mortality	0.824 lb (SE 0.039)
Spawning potential reduction	
At target mortality	0.292 (SE 0.018)
Average yield per recruit	0.547 lb (SE 0.028)
Natural mortality (M)	0.279 y^{-1}
Fishing mortality	
Age of full selection Commercial fishery (1999-2001)	6 y
Age of full selection Sport fishery (1999-2001)	7 y
Commercial fishery F (average 1999-2001, ages 6-11)	0.189 y^{-1} (SE 0.024)
Sport fishery F (average 1999-2001, ages 6-11)	0.126 y^{-1} (SE 0.014)
Sea Lamprey Mortality (ML) (average 1999-2001, ages 6-11)	0.168 y^{-1}
Total Mortality rate (Z) (average 1999-2001, ages 6-11)	0.763 y^{-1} (SE 0.035)
Average recruitment (age 1) (1992-2001 average)	255,400 fish (SE 10,600)
Average biomass (age >2) (1992-2001 average)	1,001,700 lb (SE 57,100)
Spawning stock biomass (1992-2001 average)	155,700 lb (SE 11,400)
TFC recommended yield limit(phase)	93,000 lb

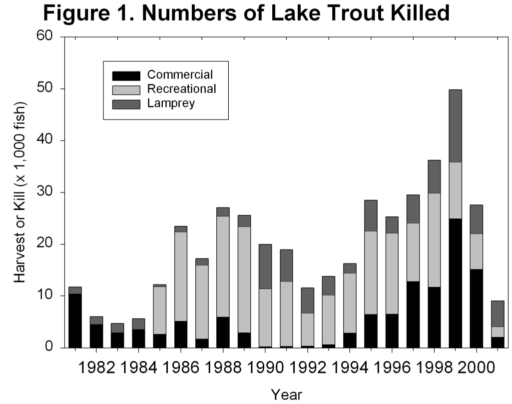
MM-5 (Leelanau Peninsula to Arcadia-Lake Michigan)

Prepared by Jory L. Jonas, James R. Bence, 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, 222,000 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 (1992-2001) the recruitment to age one has averaged 245,000 fish in MM-5.

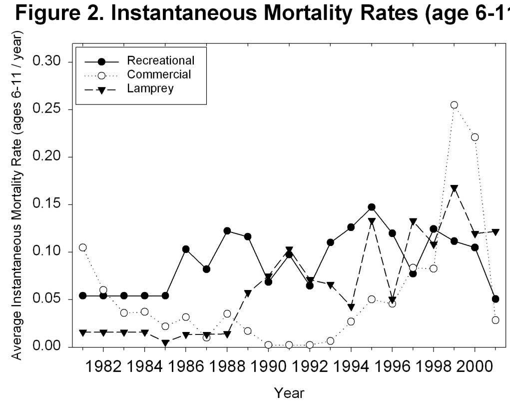
Figure 1. Numbers of Lake Trout Killed



From 1993 to 1999, mortality from commercial fishing was increasing. Since implementing the 2000 Consent Decree, a dramatic reduction in the mortality rate on fully recruited lake trout has been realized. Mortality rates declined from a maximum of 0.26 y^{-1} in 1999 to 0.03 y^{-1} in 2001 (Figure 2). The number of commercially harvested lake trout was also down considerably in 2000 and 2001 (Figure 1). Although both state and tribal commercial fishers harvest fish in the management unit, state-licensed commercial fisheries are primarily trap-net operations targeting lake whitefish. State-licensed anglers 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 is responsible for the greatest number of harvested lake trout. From 1992 to 1999, the harvest of lake trout in tribal large-mesh gill-net fisheries had been increasing. 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 had decreased considerably in 2001. The tribal commercial yield of lake trout was basically 0 lb in 1993 and rose precipitously to 154,000 lb in 1999. By 2001 yield had again declined to near former lows at 6,000 lb. Large-mesh gill-net effort in tribal fisheries also increased significantly after 1993 rising from 0 to 2 million feet in 1999. Mirroring yield values, effort declined significantly in 2001 falling to 180 thousand feet.

The recreational fisheries for lake trout are comprised of both charter and sport anglers. Until the late 1990's, recreational fishing mortality had exceeded sea lamprey and commercial fishing mortality in MM-5. In recent years however, recreational fishing mortality rates on lake trout (averaged over ages 6-11) have dropped significantly from the high of 0.15 y^{-1} observed in 1995 to a low of 0.05 y^{-1} in 2001. The recreational yield of lake trout has been variable and high over the 13-year period between 1985 and 1998 averaging 82,000 lb. In recent years a steady decline in this yield has been observed, dropping to 12,000 lb in 2001. The number of lake trout harvested by the recreational fishery has declined by over 88 percent from 1998 (18,000 fish) to 2001 (2,000 fish). Recreational fishing effort has been relatively constant over the last seven years (1995-2001) averaging 294 thousand angler hours. The sportfishing harvest regulations in the MM-5 management unit of Lake Michigan have historically allowed for the take of 10-inch lake trout, however, in the year 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 be realized in future years.

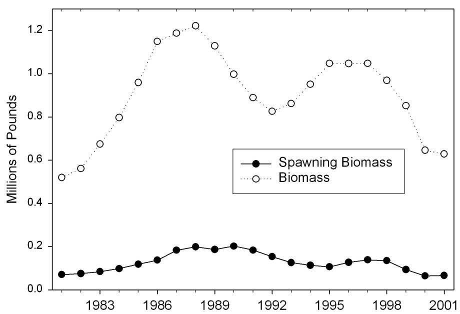
Figure 2. Instantaneous Mortality Rates (age 6-11)



Sea lamprey-induced mortality has increased in recent years in MM-5. From 1981 to 1988 sea lamprey mortality was less than either recreational or commercial mortality. From 1988 to 1991 sea lamprey mortality rates have steadily increased; the rates remained high and were much more variable from 1991 to 2001 (Figure 2). Peak sea lamprey mortality rates in the management unit were observed in 1999 at 0.17 y^{-1} (Figure 2). The recent three-year (1998-2001) average sea lamprey-induced lake trout mortality (averaged over ages 6-11) is 0.13 y^{-1}. The average number of deaths of lake trout from sea lamprey during 1996-2001 (omitting the extreme case of 1999) has been 5,000 fish (Figure 1). In 1999 lamprey are estimated to have killed nearly 14,000 lake trout from the management unit.

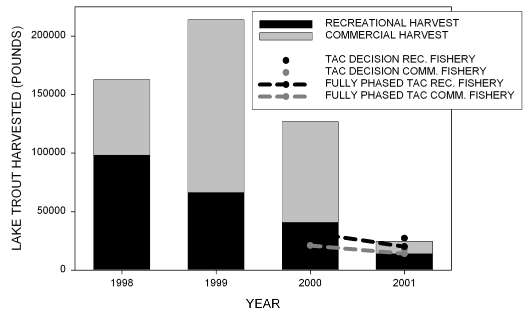
In general, lake trout in MM-5 are both spawning and recruited into commercial and recreational fisheries by age 6. The total biomass rose to a peak in 1988, declined, in the late 1980s and early 1990s and then rose to a high value in 1997, before declining to levels below 1 million pounds in 2000 and 2001 (Figure 3). The biomass of spawners in the MM-5 showed a similar temporal pattern with peaks lagging those of total biomass by 1-2 years.

Figure 3. SCAA Estimated Biomass (Age 1 and Older)



The spawning stock biomass produced per recruit is below the target value indicating that the mortality rate is too high in MM-5. The recommended yield limit for the year 2002 in Unit MM-5 is 34,000 pounds, which was set to match the target mortality rate of 45%. Of this yield, 20,000 pounds were allocated to the state recreational fishery and 14,000 pounds to the tribal commercial and subsistence fishery. Fisheries are allocated at 60 percent to the state of Michigan and 40 percent to tribal fisheries. Language in the negotiated Consent Decree states that harvest limits will not vary by more than 15 percent among years. Because of this specific language, harvest limits for 2002 were set at 45,100 lb and were distributed to the tribal fisheries at 17,900 lb and to state fisheries at 27,200 lb (Figure 4).

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



Summary Status – MM-5	
Female maturity	
Length at first spawning	15.4 in
Age at first spawning	3 y
Length at 50% maturity	25.5 in
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	1.738 lb (SE 0.145)
Current SSBR	0.321 lb (SE 0.059)
SSBR at target mortality	0.575 lb (SE 0.040)
Spawning potential reduction	
At target mortality	0.338 (SE 0.015)
Average yield per recruit	0.434 lb (SE 0.025)
Natural mortality (M)	0.304 y^{-1}
Fishing mortality (F)	
Age of full selection Commercial fishery (1999-2001)	6 y
Age of full selection Sport fishery (1999-2001)	6 y
Commercial fishery F (average 1999-2001, ages 6-11)	0.259 y^{-1} (SE 0.043)
Sport fishery F (average 1999-2001, ages 6-11)	0.151 y^{-1} (SE 0.028)
Sea Lamprey Mortality (ML) (average 1999-2001, ages 6-11)	0.126 y^{-1}
Total Mortality rate (Z) (average 1999-2001, ages 6-11)	0.822 y^{-1} (SE 0.057)
Average recruitment (age 1) (1992-2001 average)	245,000 fish (SE 13,621)
Average biomass (age >2) (1992-2001 average)	693,000 lb (SE 51,480)
Spawning stock biomass (1992-2001 average)	112,000 lb (SE 11,000)
TFC recommended yield limit	53,000 lb.

MM-67 (Southern Treaty Waters-Lake Michigan)

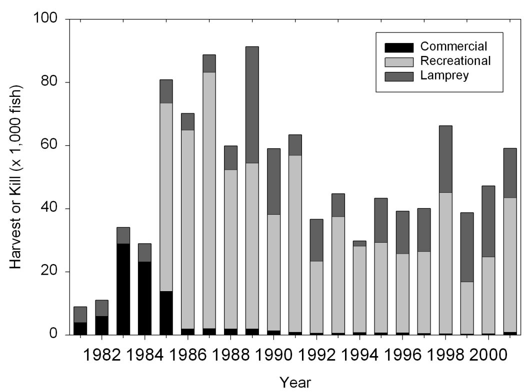
Prepared by Jory L. Jonas, James R. Bence, and Archie W. Martell Jr.

Lake trout management unit MM-67 is located in eastern central Lake Michigan, and is made up of statistical districts MM-6 and MM-7. The area covers Michigan's waters of Lake Michigan from Arcadia to Holland, extending to the state line bisecting the middle of the lake. The management unit covers a total area of 4,460 square miles, of which 930 square miles are less than 240 feet in depth. The northern section of the region (MM-6) is deeper ranging in depth from 0 up to 900 feet and is characterized by greater slope than the southern section (MM-7). For the most part water depths in MM-7 are less than 400 feet. There are no islands or structures in southern treaty waters, and there is little lake trout spawning habitat with the exception of offshore deepwater spawning reefs located within the mid-lake refuge. Stocked lake trout almost certainly attempt to spawn in the nearshore zones. However, the likelihood of successful recruitment is negligible. The southern treaty management unit is not entirely comprised of 1836 waters, the northern section (MM-6) is entirely treaty ceded territory while only the northern two-thirds of the southern section (MM-7) is within treaty territory. A total of 690 square miles in the unit are outside treaty waters. A line running parallel to the northern side of the Grand River (located approximately ¾ of the way through grids in the 1900 series) out to the state line in the middle of the lake delineates the southern boundary of treaty territories in the unit. Management unit MM67 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 anglers 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 2001 there was no tribal commercial fishing effort in management unit MM7 and limited tribal fishing existed in MM6.

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 171,000 yearling lake trout have been stocked into non-refuge southern treaty waters, while an additional 375,000 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 (1992-2001) the recruitment of lake trout to age 1 has averaged 404,000 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 2001, 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 fishers are not included in lake trout harvest allocations. The yield of lake trout in commercial fisheries has averaged 1,500 pounds over the last 16 years (1986-2001) in management unit MM67. On average commercial fishers have harvested around 500 fish/year from 1997 to 2001. As a result of stipulations of the 2000 consent decree, this area will experience greater commercial fishing effort from tribal interests in the future.

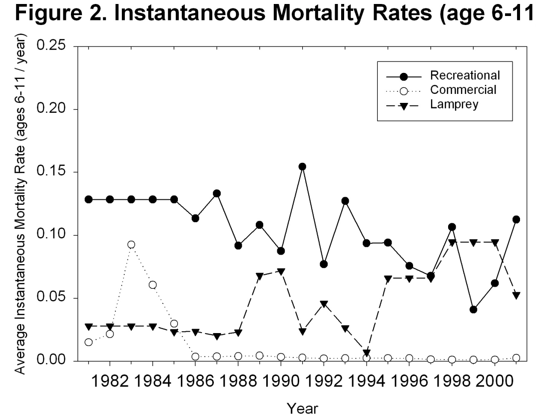
Figure 1. Numbers of Lake Trout Killed



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). However, from 1998 to 1999 observed recreational fishing mortality rates dropped by nearly 64 percent to 0.02 y^{-1}. By 2001 recreational fisheries had recovered, and the mortality rate had increased to near former levels (0.06 y^{-1}). The yield of lake trout in recreational fisheries peaked in 1987 at 474,000 lb, declined to 108,000 lb in 1999, and rose again to 266,000 lb in 2001. 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 has been on the rise, increasing to 43,000 fish in 2001. Fluctuations in effort mirror harvest fluctuations in this management unit, and also generally declined from 1987 to 1999 with a slight increase 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. These rates ranged from 0.005 to 0.08 (Figure 2). In the last five years (1997-2001), the number of lake trout killed by lamprey averaged 14,000 fish (Figure 1).

Figure 2. Instantaneous Mortality Rates (age 6-11)



Lake trout in MM-67 are generally both spawning and recruited to commercial and recreational fisheries by age 6. The total biomass of lake trout averaged over 3 million lb during the last ten years (1992-2001; 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 1992 to 2001. The spawning biomass of lake trout in MM-67 has followed a similar temporal pattern to that 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 2002 in MM-67 is 569,000 lb. Of this, 512,000 pounds are allocated to the state recreational fishery and 57,000 pounds to the tribal fishery. The yield limit and allocations in this management unit are set to achieve a total mortality rate target of 40% and establish a 90% allocation to the state of Michigan and a 10% allocation to tribal fisheries. Both recreational and commercial fisheries are well below established TAC levels (Figure 4).

Figure 3. SCAA Estimated Biomass (Age 1 and Older) Includes Refuge

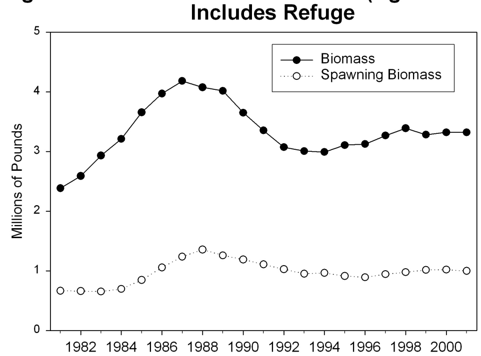
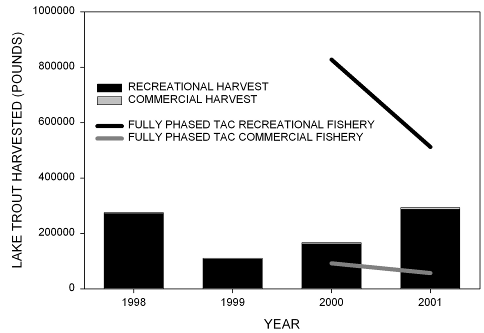
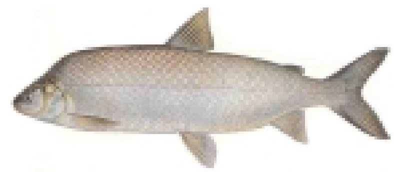


Figure 4. Comparison of Actual Harvest vs. TAC Decision



Summary Status – MM-67	
Female maturity	
Length at first spawning	15.5 in
Age at first spawning	3 y
Length at 50% maturity	24.0 in
Age at 50% maturity	6 y
Spawning stock biomass per recruit	
Base SSBR	5.942 lb (SE 0.695)
Current SSBR combined w/ refuge	2.633 lb (SE 0.365)
SSBR at target mortality	1.289 lb (SE 0.104)
Spawning potential reduction	
At target mortality	0.443 (SE 0.019)
Average yield per recruit	0.471 lb (SE 0.026)
Natural mortality (M)	0.199 y^{-1}
Fishing mortality	
Age of full selection Commercial fishery (1999-2001)	6 y
Age of full selection Sport fishery (1999-2001)	6 y
Commercial fishery F (average 1999-2001, ages 6-11)	0.002 y^{-1} (SE 0.000)
Sport fishery F (average 1999-2001, ages 6-11)	0.072 y^{-1} (SE 0.011)
Sea Lamprey Mortality (ML) (average 1999-2001, ages 6-11)	0.081 y^{-1}
Total Mortality rate (Z) (average 1999-2001, ages 6-11)	0.353 y^{-1} (SE 0.017)
Average recruitment (age 1) (1992-2001 average)	404,000 fish (SE 13,000)
Average biomass (age >2) (1992-2001 average)	3,188,000 lb (SE 427,000)
Spawning stock biomass (1992-2001 average)	969,000 lb (SE 160,000)
Recommended yield limit	569,000 lb

STATUS OF LAKE WHITEFISH POPULATIONS

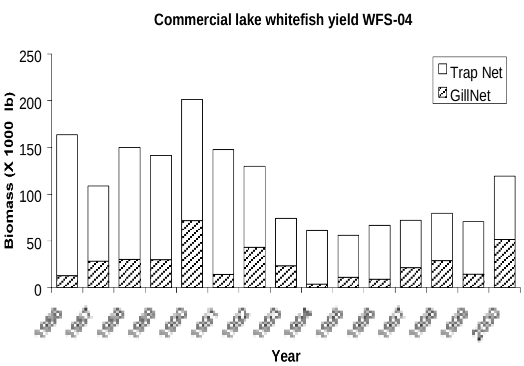


Lake Superior

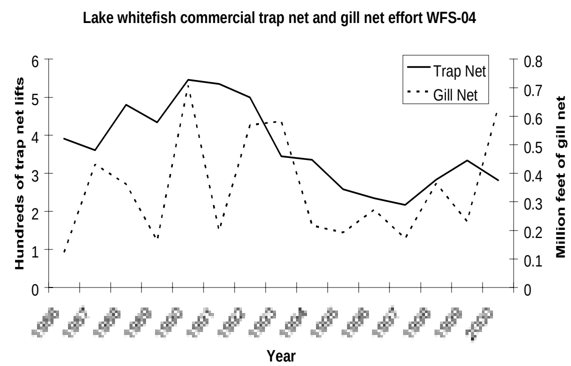
WFS-04 (Big Bay, Marquette)

Prepared by Philip J. Schneeberger

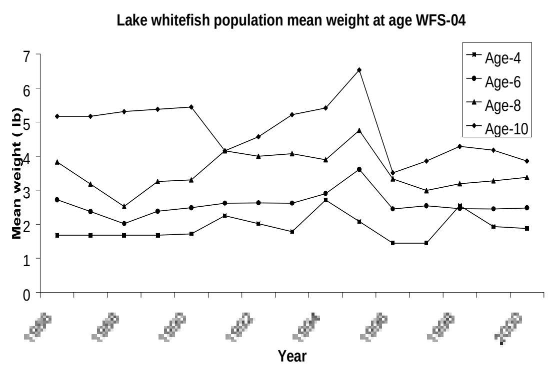
Yield during 2000 was 68,000 lb from trap nets, 51,000 lb from gill nets, and 119,000 lb total. Trap-net yield was down 20% from the 1986-99 average, but gill-net yield was up 111% and total yield up 10%. Total yield has exhibited a rising trend since 1995. Trap nets accounted for 78% of the WFS-04 commercial yield during 1986-99, but in 2000 the percentage was only 57%.



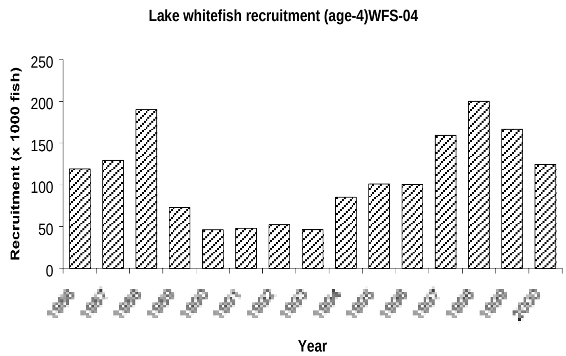
Trap-net effort increased from 1997 through 1999 before declining in 2000 to 282 lifts. Compared to the 1986-99 average, trap-net effort in 2000 was down 25%. Gill-net effort has fluctuated considerably over the study period, rising in 2000 to 629,000 feet, higher than any level since a peak in 1990. Gill-net effort in 2000 was 92% higher than the average for 1986-99.



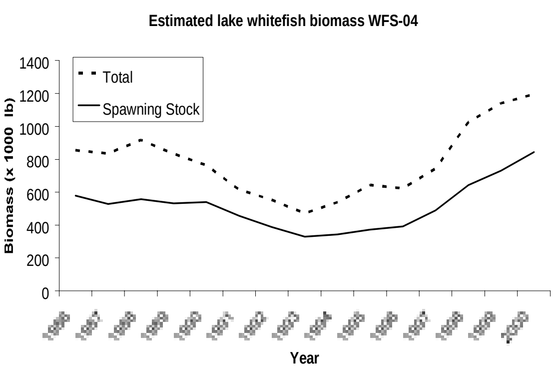
Mean weights of age-5 and age-6 lake whitefish were greater in 2000 than averages for 1986-99, but mean weights for all other ages were lower than averages during the previous 14 years.



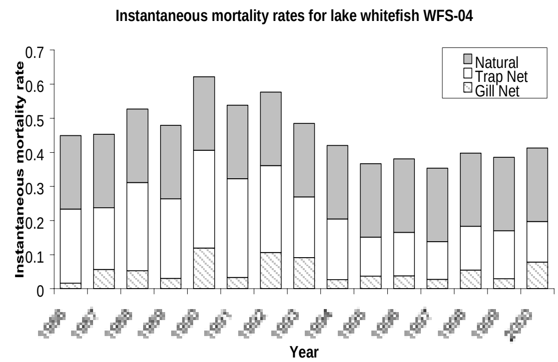
Recruitment (estimated numbers of age-4 lake whitefish) decreased in 2000 for the second year in a row. However, the estimate of 124,000 fish in 2000 was 15% higher than the 1986-99 average and estimated recruitment for 1997-2000 was higher than for any other consecutive 4-yr period.



Both fishable biomass and spawning stock biomass increased in 2000, continuing trends that began in 1993. Estimated fishable biomass was 1.2 million lb in 2000, 58% higher than the 1986-99 average. Spawning stock biomass was estimated at 843,000 lb which was 72% higher than the 1986-99 average. The ratio of spawning stock biomass to fishable biomass was 0.71, higher than the average for previous years.



Instantaneous fishing mortality rates (F) reflected the decrease in trap-net effort and the increase in gill-net effort in 2000. Fishing mortality rate was 0.08 y^{-1} for gill nets, 52% higher than the 1986-99 average, and trap-net F was 0.12 y^{-1}, 38% lower than the 1986-99 average. The net effect was evident from the total instantaneous mortality rate (Z), which was estimated to be 0.41 y^{-1} in 2000, down 10% from the 1986-99 average. Estimates of Z have been relatively low and stable since 1995.



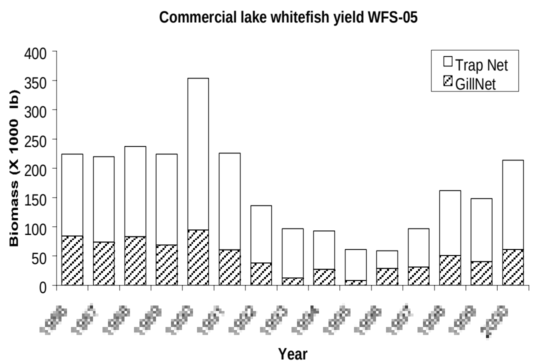
Despite increased biomass estimates, general decreases in weight-at-age along with a dip in recruitment for 2000 resulted in the 2002 yield limit (296,000 lb) being 33% lower than that for 2001 (440,000 lb). The state harvest limit is 25,000 lb and the tribal harvest limit is 271,000 lb. The projection model indicated that splitting the 2002 yield limit according to the terms of the Consent Decree would be achieved by reducing trap-net effort by 62% and increasing gill-net effort 7 fold.

Summary Status – WFS-04	
Female maturity	
Size at first spawning	2.12 lb
Age at First Spawning	4 y
Size at 50% maturity	2.00 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	4.96 lb (SE 0.009)
Current SSBR	1.91 lb (SE 0.05)
SSBR at target mortality	0.193 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.385 (SE 0.011)
Average yield per recruit	1.181 lb (SE 0.013)
Natural Mortality (M)	0.215 y^{-1}
Fishing mortality rate 1998-2000	
Fully selected age to Gill Nets	10
Fully selected age to trap nets	9
Average gill net F, ages 4+	0.059 y^{-1} (SE 0.004)
Average trap net F, ages 4+	0.137 y^{-1} (SE 0.006)
Sea lamprey mortality (ML)	
(average ages 4+,1998-2000)	N/A
Total mortality (Z)	
Average ages 4+,1998-2000	0.411 y^{-1} (SE 0.01)
Recruitment (age-4)	
(1991-2000 average)	108,340 fish (SE 9,012)
Biomass (age 3+)	
(1991-2000 average)	755,120 lb (SE 44,313)
Spawning biomass	
(1991-2000 average)	498,760 lb (SE 27,476)
Recommended yield limit in 2002	296,000

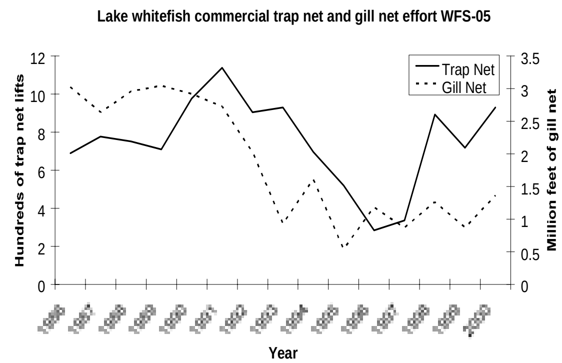
WFS-05 (Munising)

Prepared by Philip J. Schneeberger

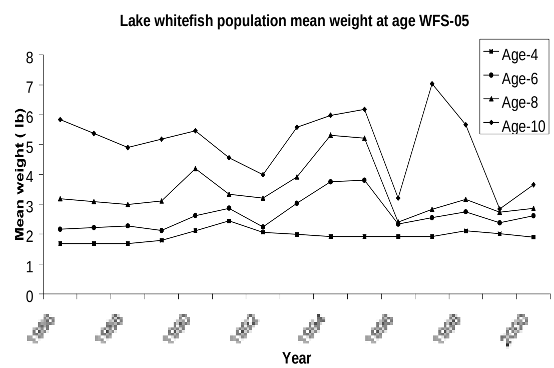
Total yield of lake whitefish in WFS-05 for 2000 was 214,000 lb. This represented a 28% increase over the average yield from 1986 through 1999. Trap nets accounted for 72% of the lake whitefish yield during 2000, and gill nets took the remaining 28%. Yield increased for both gear types over 1986-99 averages, up 31% for trap nets and up 21% for gill nets. Total yield for 2000 was 60% of the peak yield of 354,000 lb taken in 1990. Lake whitefish yield has increased since the mid 1990s.



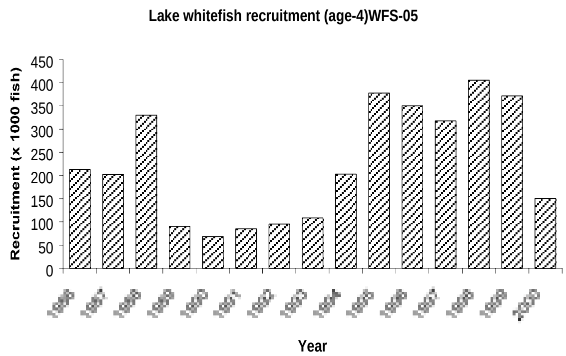
Trends in fishing effort have mirrored yield and in general have been similar for both gear types with peaks around the early 1990s, lows in the mid 1990s, and increases thereafter. Compared to 1986-99 averages, trap-net effort was 26% higher in 2000 but gill-net effort was 28% lower.



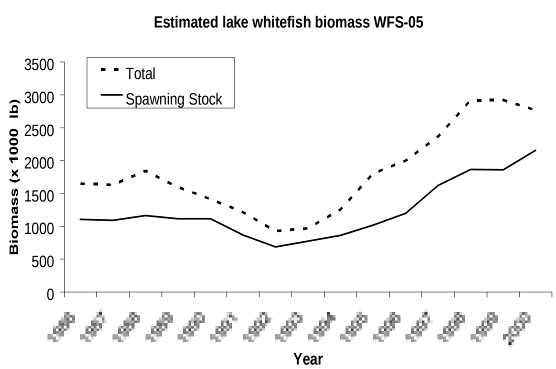
Mean weight-at-age has fluctuated during 1986-2000. Values in 2000 were generally lower (by 1-28%) compared to both long-term (1986-99) and short-term (1997-99) averages. However, mean weight-at-age generally increased in 2000 from 1999 values.



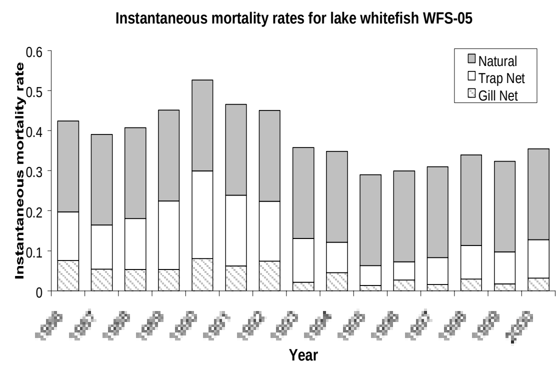
Recruitment, measured as annual estimated numbers of age-4 lake whitefish in the population, dropped in 2000 following 5 straight years of above average values. Estimated recruitment in 2000 was 151,000 fish, down 34% from the 1986-99 average of 230,000.



Fishable biomass of lake whitefish age-4 and older was estimated at 2,767,000 lb in 2000 and spawning stock biomass was 2,155,000 lb. Fishable biomass declined slightly from 1998-99 average values, but both fishable biomass and spawning stock biomass showed increasing trends since 1993. Compared to 1986-1999 averages, 2000 values were higher by 58% for fishable biomass and by 85% for spawning stock biomass. Spawning stock biomass represented 78% of fishable biomass in 2000, compared to an average of 67% for 1986-99.



Mortality rates remained low for lake whitefish in WFS-05. Instantaneous fishing mortality (F) rate was 0.03 y^{-1} for gill nets and 0.10 y^{-1} for trap nets in 2000. The estimated value for total instantaneous mortality rate (Z), 0.35 y^{-1}, was 8% below the 1986-99 average value, and well below the target maximum value.



The calculated 2002 TAC for WFS-05 was 642,000 lb, an increase of 32% over the 2001 TAC. The increase is most likely due to improvement in weight-at-age during 2000 compared to 1999. The state harvest limit is 103,000 lb and the tribal harvest limit is 593,000 lb. The projection model indicated that trap net effort would need to be reduced by 28% and gill-net effort would need to increase more than 12 fold in order for the 2002 TAC to be reached while maintaining the mandated split between tribal and state-licensed fishers.

Summary Status – WFS-05	
Female maturity	
Size at first spawning	2.01 lb
Age at First Spawning	4 y
Size at 50% maturity	2.44 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	4.521 lb (SE 0.008)
Current SSBR	2.33 lb (SE 0.09)
SSBR at target mortality	0.205 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.516 (SE 0.021)
Average yield per recruit	0.867 lb (SE 0.031)
Natural Mortality (M)	0.227 y^{-1}
Fishing mortality rate 1998-2000	
Fully selected age to Gill Nets	8
Fully selected age to trap nets	10
Average gill net F, ages 4+	0.024 y^{-1} (SE 0.002)
Average trap net F, ages 4+	0.092 y^{-1} (SE 0.008)
Sea lamprey mortality (ML)	
(average ages 4+,1998-2000)	N/A
Total mortality (Z)	
Average ages 4+,1998-2000	0.343 y^{-1} (SE 0.01)
Recruitment (age-4)	
(1991-2000 average)	246,700 fish (SE 27,345)
Biomass (age 4+)	
(1991-2000 average)	1,914,500 lb (SE 155,420)
Spawning biomass	
(1991-2000 average)	1,290,800 lb (SE 98,448)
Recommended yield limit in 2002	642,000 lb

WFS-06 (Grand Marais Stock)

Prepared by Mark P. Ebener

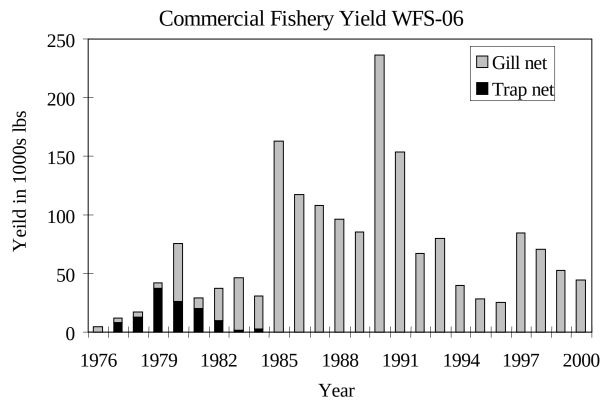
WFS-06 is located in the center of the 1836 treaty-ceded waters of Lake Superior. The unit is part of the open water of Lake Superior and contains no islands or bays. WFS-06 contains a small relatively shallow water area <120 ft. The majority of the unit is deeper than 400 ft and the deepest part of WFS-06 is 908 ft. There are 18 statistical grids that make up WFS-06, but there is only 88,600 surface acres of waters <240 ft deep in the unit.

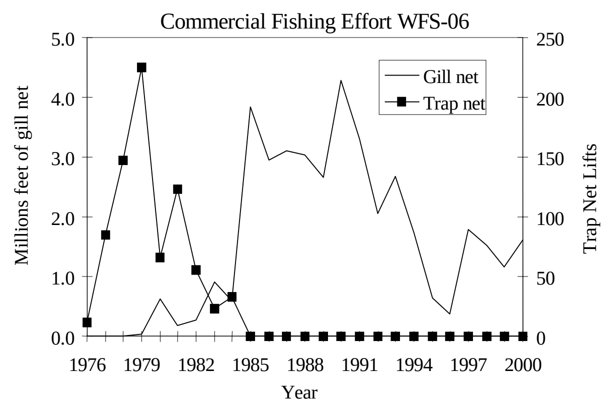
There is little habitat for whitefish reproduction in WFS-06. The entire shoreline is relatively straight and is composed of sand with lesser amounts of small-size gravel and scattered cobble that are found only on the immediate shoreline. There are no rock reefs to support a large concentration of spawning. It is likely that many of the whitefish that inhabit WFS-06 spawn elsewhere.

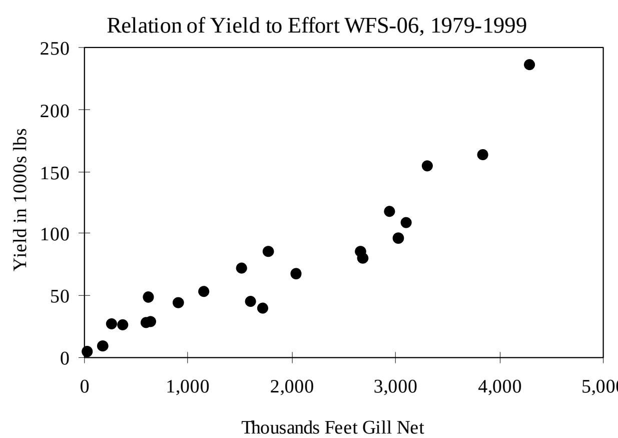
WFS-06 has been an exclusive commercial fishing zone for CORA fishers since 1985. Because the unit is so exposed to the open water of Lake Superior, and because access to the unit is limited to the Grand Marais area, only large-boat gill-net fisheries typically fish here.

The commercial harvest of whitefish from WFS-06 has averaged only 70,000 lb during 1976-2000. The peak harvest was 236,000 lb in 1990 and the lowest harvest was 26,000 lb in 1996. The large-mesh gill-net fishery has accounted for all the harvest from WFS-06 since 1985. The harvest of whitefish from the unit directly parallels changes in large-mesh gill-net effort and there is a strong linear relationship between gill-net effort and harvest in WFS-06.

Large-mesh gill-net effort ranged from three to four million feet during 1985-1991, then declined to less than two million feet during 1994-2000. Much of the large-mesh gill-net effort in WFS-06 is made up of 5 ¼- and 5 ½- inch stretched mesh.





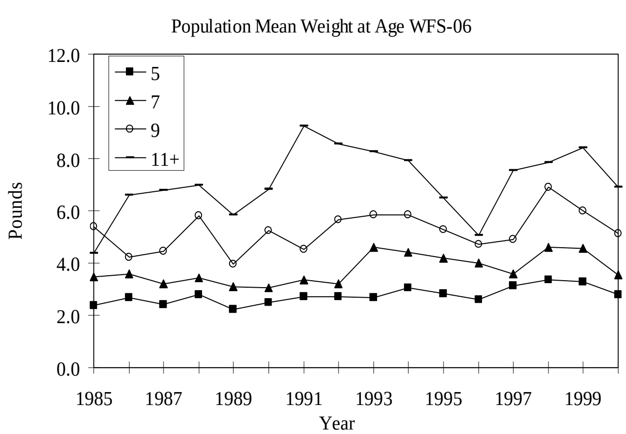


Whitefish caught in WFS-06 are large sized so the fishery targets them with the large mesh because fishers are paid 10-50 cents more per pound for medium and jumbo whitefish than for No.1 whitefish. The commercial gill-net harvest from WFS-06 was made up of 28% No. 1, 35% medium, and 37% jumbo whitefish by weight during 1985-2000. Annual mean weight of whitefish in the commercial gill-net harvest from WFS-06 ranged from 3.0 to 5.6 lb and averaged 3.9 lb during 1985-2000. The proportion of medium and jumbo whitefish in the harvest of WFS-06 is greater than in nearly all other units in the 1836 ceded waters.

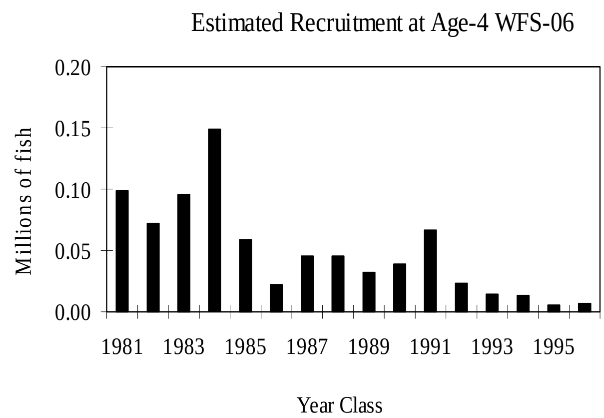
Sexual maturity of whitefish in WFS-06 occurs at larger sizes than for whitefish in lakes Michigan and Huron. Whitefish in WFS-06 don't reach 50% maturity until age 5 and 20 inches long. Complete maturity is not reached until about 24 inches long and age 10.

Growth of whitefish in WFS-06 has remained very constant through time. Mean weight of ages 5-11+ whitefish has either remained the same, or increased slightly during 1985-2000. There may have been a slight increase in mean weight at age of age 5-7 whitefish during the 1990s, but this increase may be because the fishers in WFS-06 have been targeting larger-sized whitefish with the large mesh sizes, thus, only the largest members of the younger age classes are actively selected for by the fishery.

Recruitment to the population in WFS-06



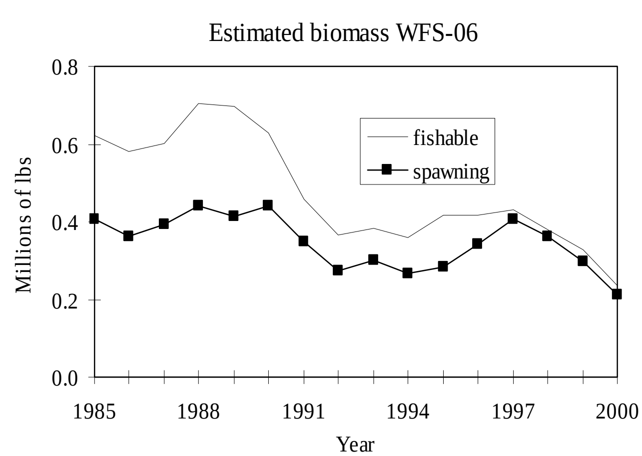
has been declining through time based on the stock assessment model. Recruitment of age-4 whitefish to the population in WFS-06 was estimated to range from 59,000 to 149,000 fish for the 1981-1985 year classes, 22,000 to 67,000 for the 1986-1991 year classes, and less than 24,000 fish for the 1992-1996 year classes. The 1995 and 1996 year classes were estimated to contain only 5,700 and 6,300 fish, respectively.



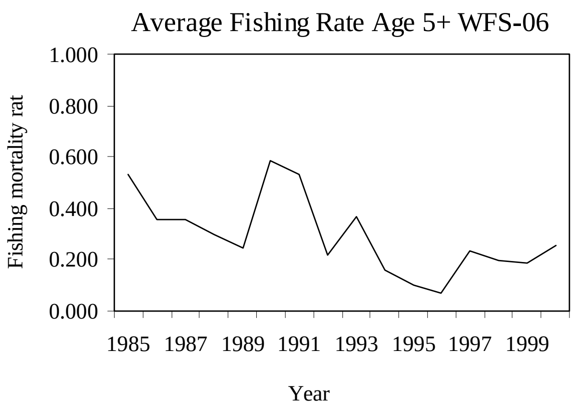
Biomass of the fishable stock of whitefish in WFS-06 has been declining through time because of declines in recruitment. Estimated biomass of whitefish ≥ age 4 at the beginning of each year declined from average of 639,000 lb during 1985-1990, to 315,000 lb during 1998-20009. Fishable stock biomass was estimated to be 401,000 lb during 1991-2000. Fishable biomass in 2000 was only 236,000 lb.

Spawning stock biomass has not changed nearly as much as the fishable stock in WFS-06 during 1985-2000. Spawning stock biomass averaged 409,000 lb during 1985-1990 and 291,000 lb during 1998-2000. Spawning stock biomass averaged 321,000 lb during 1991-2000 and was 213,000 lb in 2000.

Total annual mortality of whitefish in WFS-



06 has declined during 1985-2000 because of the reductions in large-mesh gill-net effort. Average total annual mortality of age-5 and older whitefish ranged from 0.45 to 0.79 y^{-1} during 1985-1991, after 1991 total mortality did not exceed 0.57 y^{-1}. Total mortality in 2000 was 0.46 y^{-1}. Average fishing mortality on age-5 and older whitefish was ranged from 0.25 to 0.59 y^{-1} during 1985-1991 and from 0.07 to 0.37 y^{-1} after 1991. Age-6 whitefish are the most vulnerable to the large-mesh gill-net fishery and fishing mortality on this age class ranged from 0.09 to 0.62 y^{-1} during 1985-2000.



Total annual mortality on whitefish vulnerable to the large-mesh gill-net fishery was considerably less than the target rate in WFS-06 during 1998-2000. Total annual mortality of age-5 and older whitefish was only 0.42 y^{-1} during 1998-2000, but the SPR value during 1998-2000 was 0.30. The SPR value at the target mortality rate of 65% was only 0.07, well below the acceptable level of 0.20. It appears that there is some room for expanded fishing in WFS-06. The projection model estimated that fishing mortality could be increased 1.5 times in WFS-06 and this rate of fishing would produce an average mortality rate of 0.52 y^{-1}. The recommended yield limit at the increased level of fishing was estimated to be 52,000 lb.

Summary Status WFS-06	
Female maturity	
Size at first spawning	18 in
Age at first spawning	3 yr
Size at 50% maturity	20 in
Age at 50% maturity	5 yr
Spawning stock biomass per recruit	
Base SSBR	8.19 lb
Current SSBR	2.48 lb
SSBR at target mortality	0.60 lb
Spawning potential reduction	
At target mortality	0.07
Average yield per recruit	1.59 lb
Natural mortality (M)	0.21 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	6 y
fully selected age to trap nets	
average gill net ages 5+	0.21 y^{-1}
average trap net ages 5+	0 y^{-1}
Total Mortality Rate (Z)	
average 5+ 1998-2000	0.42 y^{-1}
average 5+ 2000	0.46 y^{-1}
average 5+ 2002	0.52 y^{-1}
Average recruitment age-4 1991-2000	29,300 fish
Average biomass age 4+ 1991-2000	401,000 lb
Average spawning biomass 1991-2000	321,000 lb.
Recommended Yield Limit 2002	52,000 lb

WFS-07 (Tahquamenon Bay Stock)

Prepared by Mark P. Ebener

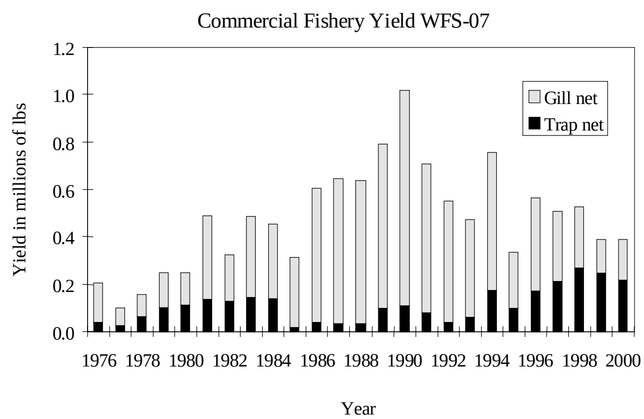
WFS-07 is located in the Whitefish Bay area of Lake Superior. The primary geographic feature of WFS-07 is Whitefish Point. West and north of Whitefish Point is the open water of Lake Superior, while south of the Point includes western Whitefish Bay and a large amount of shallow and relatively warm water for Lake Superior. Maximum depth in the open water portion of WFS-07 is 807 ft, while maximum depth in the Whitefish Bay portion of WFS-07 is 330 ft, but much of the area is less than 120 ft deep. WFS-07 is made up of 12 statistical grids that contain 371,000 surface acres of water <240 ft deep.

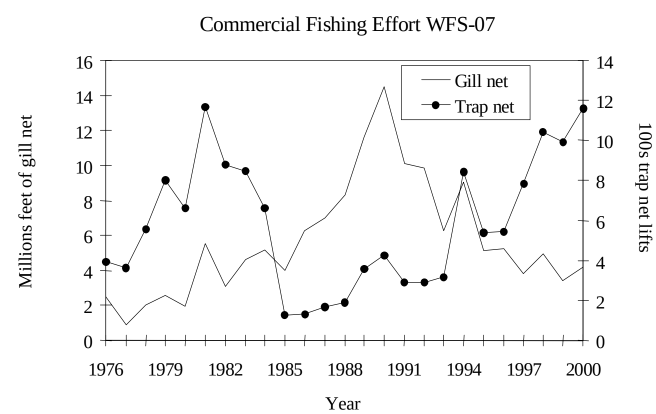
WFS-07 contains a single, large stock of whitefish that spawns in the southwest part of Whitefish Bay. The spawning ground consists of large cobble and rock and extends both north of Naomikong Point into Whitefish Bay and east to Salt Point based on substrate mapping conducted in 1998 and 1999. Mark-recapture data indicated that whitefish tagged in Tahquamenon Bay primarily inhabited U. S. waters of Whitefish Bay and areas west of Whitefish Point. The spawning stock in WFS-07 also contributes some fish to Canadian waters of Whitefish Bay.

WFS-07 has always been and continues to be a very important area for the CORA fishery. WFS-07 is fished by large- and small-boat gill-net fisheries, trap-net fisheries, and a gill-net fishery under the ice usually takes place every winter. There are a large number of relatively good access sites to the fishing grounds, and there is a reasonable amount of protection from wind and waves in the unit. Because of the access and protection, WFS-07 is a favorite fishing area for small-boat gill-net fishers on a year-round basis, but particularly in early spring and fall.

The commercial whitefish harvest from WFS-07 has averaged 477,000 lb during 1976-2000. A peak harvest of one million lb occurred in 1990 and the lowest reported harvest was 98,000 lb in 1977. The 2000 harvest was 388,000 lb and 62% less than the peak harvest in 1990. The large-mesh gill-net fishery has traditionally accounted for most of the whitefish harvested from WFS-07, but during 1998-2000 the trap-net fishery accounted for the majority of the harvest. The 2000 harvest was 219,000 lb from the trap-net fishery and 169,000 lb from the gill-net fishery.

Harvest of whitefish from WFS-07 mirrored changes in fishing effort during 1976-200. Large-mesh gill-net effort increased from an average of 2.3 million ft during 1976-1980 to a peak of 14.5 million ft in 1990, and then declined to 3.4 million ft in 1999. Trap-net effort increased from 370 lifts in 1976-1977 to 1,171 lifts in 1981 then declined to 128 lifts in 1985. After 1985 trap-net effort increased

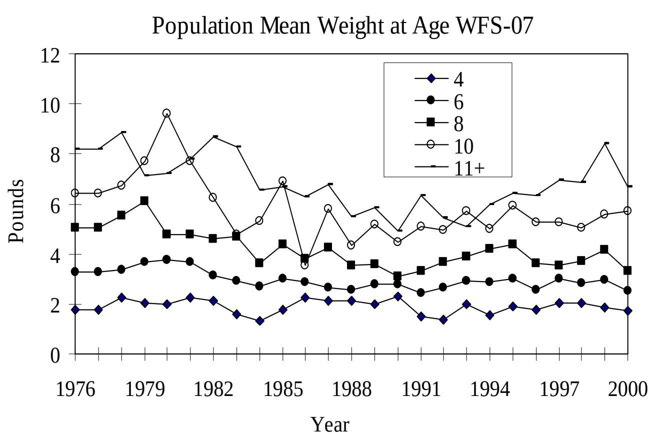




almost annually to 1,161 lifts in 2000. Large-mesh gill-net effort was 4.2 million ft in 2000.

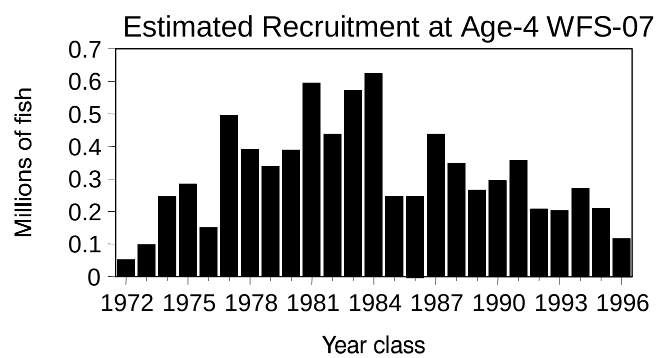
Whitefish caught in WFS-07 are of moderate to large size. The proportion of the harvest made up of the three commercial sizes of whitefish was 43% No. 1, 30% medium, and 26% jumbo whitefish during 1980-2000. Mean weight of whitefish in the gill-net fishery was 3.3 lb during 1976-2000 and annual mean weight ranged from 2.7 to 4.2 lb. Mean weight of whitefish in the trap-net fishery was 2.7 lb during 1976-2000 and annual mean weight ranged from 2.0 to 3.4 lb.

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. After 1990 mean weight-at-age generally increased, but by 2000 no age class weighed more than it did during the late 1970s.

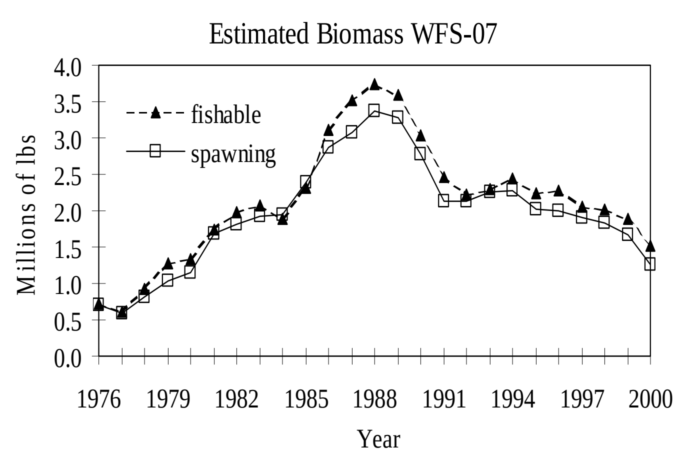


Sexual maturity of whitefish in WFS-07 occurs at a small size and young age, but complete maturity of females occurs at a large size and old age. Female whitefish begin reaching sexual maturity at age 3 and about 15 inches long, and by age 5 over 50% of females are sexually mature. After age 5, however,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

Estimated recruitment of age-4 whitefish to the population of WFS-07 varied by 12-fold during 1976-2000. The stock assessment model estimated that an average of 272,000 age-4 whitefish recruited to the population during 1976-2000. Recruitment varied from only 52,000 fish for the 1972 year class to 623,000 fish for the 1984 year class. Recruitment to the whitefish population increased from the 1972 to 1984 year class, then declined somewhat and stabilized at between 117,000 and 438,000 for the 1985-1996 year classes. The 1996 year class was estimated to contain 117,000 fish.



Estimated biomass of whitefish in WFS-07 peaked just prior to the peak harvest and has declined since. The stock assessment model estimated that biomass of the fishable stock (≥age 4) increased from 613,000 lb in 1977 to 3.7 million lb in 1988, then declined to 2.2 million lb in 1992. Since 1992 fishable stock biomass has been slowly declining and was 1.5 million lb in 2000. Fishable stock biomass of whitefish in WFS-07 averaged 2.1 million lb during 1976-2000 and 1991-2000.



Spawning stock biomass of whitefish in WFS-07 closely followed that of the fishable stock biomass. Spawning stock biomass was 591,000 lb in 1977, it then increased to 3.4 million lb in 1988, declined to 2.1 million lb in 1992, and since 1992 has declined slowly to 1.3 million lb in 2000. Spawning stock biomass averaged 1.95 million lb during 1976-1999 and during 1991-2000.

The stock assessment model estimates of fishing mortality ($\geq$age 5) were surprisingly stable and showed no distinct trends during 1976-2000. Fishing mortality averaged 0.43 y^{-1} and annual rates varied from 0.24 to 0.66 y^{-1} during 1976-2000. Large-mesh gill-net fishing mortality averaged 0.16 y^{-1} and trap-net mortality 0.23 y^{-1} during 1998-2000.

Total mortality of whitefish in WFS-07 was below the maximum target of 65% and the SPR value at current mortality rates was 0.325. The SPR value at the target mortality rates during 1998-2000 was only 0.11. As a consequence, the projection model estimated that fishing mortality should be reduced 14% in 2002 from levels experienced during 1998-2001. The recommended yield limit resulting from a 14% reduction in fishing mortality was estimated to be **302,000 lb**. The recommended yield limit was 409,000 lb in 2001.

Summary Status WFS-07	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 yr
Size at 50% maturity	18 in
Age at 50% maturity	5 yr
Spawning stock biomass per recruit	
Base SSBR	7.63 lb
Current SSBR	2.48 lb
SSBR at target mortality	0.83 lb
Spawning potential reduction	
At target mortality	0.11
Average yield per recruit	1.62 lb
Natural mortality (M)	0.18 y^{-1}
Sea lamprey mortality (M_L) age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	8
fully selected age to trap nets	8
average gill net ages 5+	0.16 y^{-1}
average trap net ages 5+	0.23 y^{-1}
Total Mortality Rate (Z)	
average 5+ 1998-2000	0.57 y^{-1}
average 5+ 2000	0.56 y^{-1}
average 5+ 2002	0.52 y^{-1}
Average recruitment age-4 1991-2000	271,000 fish
Average biomass age 4+ 1991-2000	2,140,000 lb
Average spawning biomass 1991-2000	1,947,000 lb
Recommended Yield Limit 2002	302,000 lb.

WFS-08 (Brimley Stock)

Prepared by Mark P. Ebener

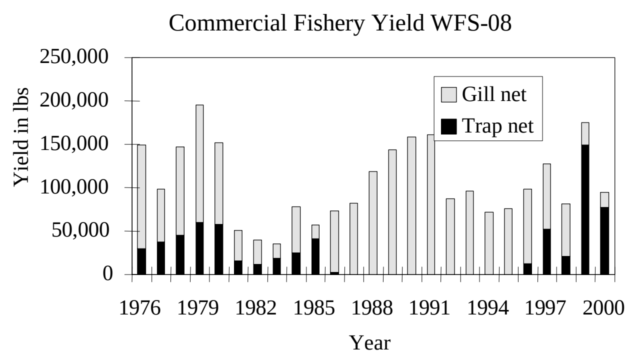
WFS-08 is located in the very southeast portion of Whitefish Bay, Lake Superior. Although WFS-08 is spatially the smallest of the management units in the 1836 treaty-ceded waters of Lake Superior the unit contains 160,000 surface acres of waters <240 ft deep. A substantial commercial fishery targeting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

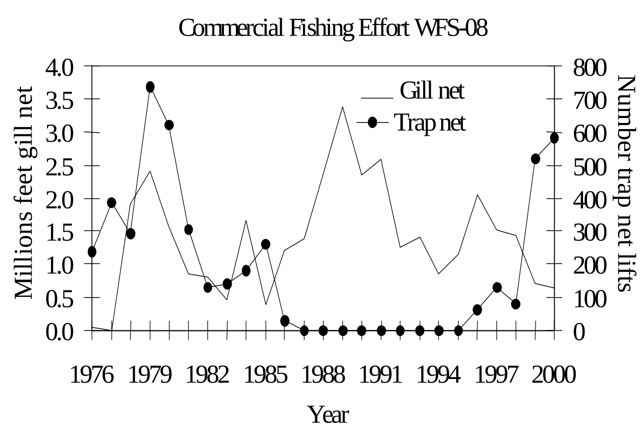
There are probably three reproductively isolated stocks of whitefish that contribute to the commercial fishery in WFS-08. Two areas composed of bedrock, and cobble and rock are located off Iroquois Point and Birch Point in the upper St. Marys River, and small spawning concentrations of whitefish are associated with these areas. In addition, a large spawning concentration of whitefish is found in the Gros Cap area along the Canadian side of the St. Marys River.

WFS-08 has been a traditional commercial fishing area for the CORA small-boat gill-net and gill-net ice fishery since the early 1970s. For that matter, members of the CORA tribes have fished WFS-08 commercially and for subsistence for the better part of the last four centuries. There seven or eight undeveloped landing sites are commonly used by the CORA small-boat fishery in WFS-08 during the entire open-water fishing season.

The commercial harvest of whitefish from WFS-08 has averaged 106,000 lb during 1976-2000. Annual harvests ranged from a low of 35,000 lb. in 1983 to a peak of 195,000 lb in 1979. The large-mesh gill-net fishery caught accounted for 75% of the whitefish harvest from WFS-08 during 1976-2000, but in 1999 and 2000 the trap-net harvest exceeded the gill-net harvest for the first time. The gill-net harvest averaged 80,000 lb and the trap-net harvest averaged 26,000 lb during 1976-2000. The commercial yield in 2000 was made up of 77,800 lb by the trap-net fishery and 17,000 lb from the large-mesh gill-net fishery.

Gill-net effort averaged 1.4 million

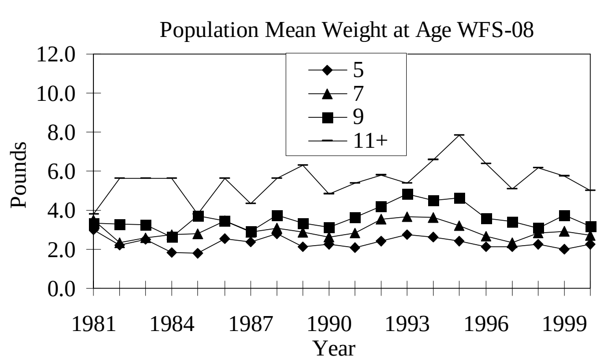




feet during 1976-2000 and annual effort ranged from 0.7 million feet in 2000 to 3.4 million feet in 1989. Trap-net effort averaged 188 lifts during 1976-2000 and annual effort ranged from 63 lifts in 1996 to 738 lifts in 1979. Fishing effort in 2000 was composed of 643,000 ft of large-mesh gill-net and 583 trap-net lifts.

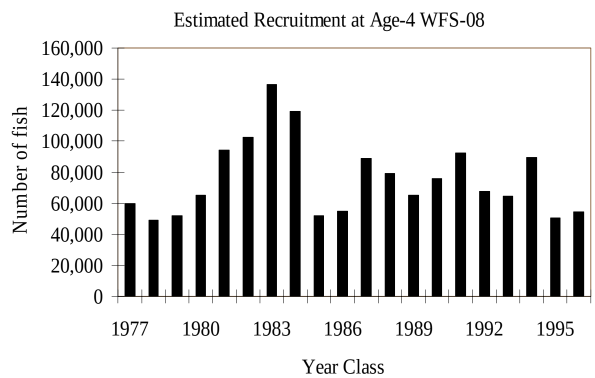
Whitefish caught in WFS-08 are of moderate to large size. The proportion of the commercial harvest by weight was made up of 52% No. 1 whitefish, 22% medium whitefish, and 26% jumbo whitefish during 1981-2000. Mean weight in the gill-net fishery averaged 3.0 lb and annual mean weight ranged from 2.3 to 3.6 lb during 1981-2000. Mean weight in the trap-net fishery averaged 2.4 lb and annual mean weight ranged from 1.9 to 2.8 lb during 1981-2000. Mean weight of fish in the harvest was 2.2 lb for the trap-net fishery and 3.2 lb for the gill-net fishery in 2000.

Growth of whitefish in WFS-08 has remained constant through time. Growth, expressed as mean weight-at-age, did vary somewhat from year to year, but showed no consistent trends through time as in Lake Michigan and Huron, or WFS-07 for that matter.

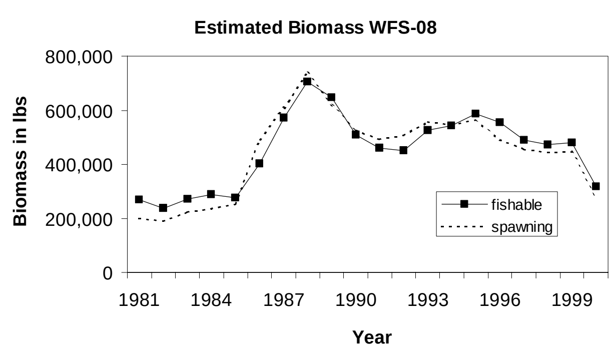


Whitefish in WFS-08 mature earlier and at smaller sizes than in WFS-07. Female whitefish begin maturing at 15 inches and age 3 in WFS-08 and two-thirds are sexually mature by age 4. Complete maturity is reach by 23 inches and age 11 and older.

Recruitment of age-4 whitefish to the population in WFS-08 has been very consistent. Estimated annual recruitment of age-4 whitefish based on the stock assessment model ranged from 49,000 fish in 1978 to 136,000 fish in 1983. Recruitment to the population of WFS-08 was estimated to average 76,000 fish during 1981-2000 and 73,000 fish during 1991-2000. This is surprisingly stable recruitment considering that in other stocks in the 1836 treaty-ceded waters recruitment has varied up to 60 fold.

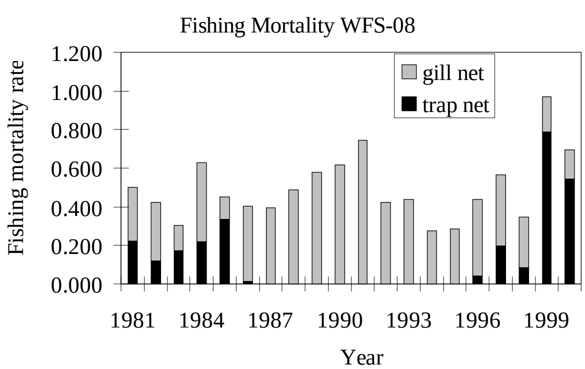


Because whitefish in WFS-08 mature at a young age and small size, biomass of the fishable and spawning stock vary concurrently. Fishable stock biomass averaged 453,000 lb during 1981-2000 and annual fishable biomass ranged from 238,000 lb in 1982 to 704,000 lb in 1988. Spawning stock biomass averaged 442,000 lb during 1981-2000 and annual spawning stock biomass ranged from 188,000 lb in 1982 to 736,000 lb in 1988. Fishable stock biomass was 319,000 lb in 2000 and spawning stock biomass was 273,000 lb.



The large-mesh gill-net fishery accounted for most of the fishing-induced whitefish mortality in WFS-08. Gill-net fishing mortality ranged from 0.13 y^{-1} in 1983 to 0.74 y-1 in 1991, while trap-net mortality ranged from 0.0 y^{-1} during 1987-1995 to 0.79 y^{-1} in 1999. Fishing mortality rate was 0.67 y^{-1} during 1998-2000 with trap-net mortality being 0.40 y^{-1} and gill-net mortality 0.27 y^{-1}.

Total annual mortality rate on age-5+ whitefish was generally less than the target rate of 65% in all years but 1999. Unfortunately, increasing total mortality to the target rate meant that SPR was 0.18 and less than the minimum SPR value of 0.20, consequently the projection model indicted that fishing mortality should be decreased 8% from levels in 1998-2001. The recommended harvest level at the reduced fishing rate was estimated to be **81,000 lb** in 2002. The recommended yield limit was 176,000 lb in 2001.



Summary Status WFS-08	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 yr
Size at 50% maturity	18 in
Age at 50% maturity	4 yr
Spawning stock biomass per recruit	
Base SSBR	5.02 lb
Current SSBR	0.95 lb
SSBR at target mortality	0.83 lb
Spawning potential reduction	
At target mortality	0.18
Average yield per recruit	1.46 lb
Natural mortality (M)	0.20 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	9
fully selected age to trap nets	9
average gill net ages 5+	0.20 y^{-1}
average trap net ages 5+	0.47 y^{-1}
Total Mortality Rate (Z)	
average 5+ 1998-2000	0.87 y^{-1}
average 5+ 2000	0.89 y^{-1}
average 5+ 2002	0.82 y^{-1}
Average recruitment age-4 1991-2000	73,000 fish
Average biomass age 4+ 1991-2000	488,000 lb
Average spawning biomass 1991-2000	477,500 lb
Recommended Yield Limit 2002	81,000 lb

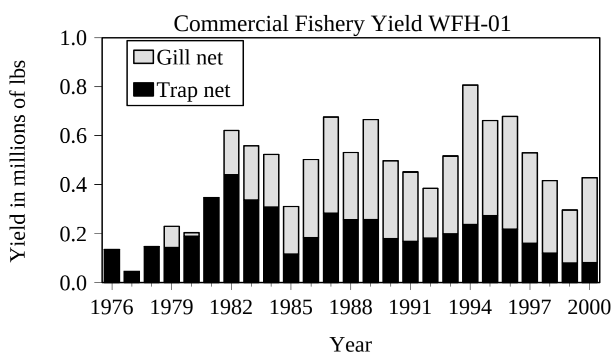
Lake Huron

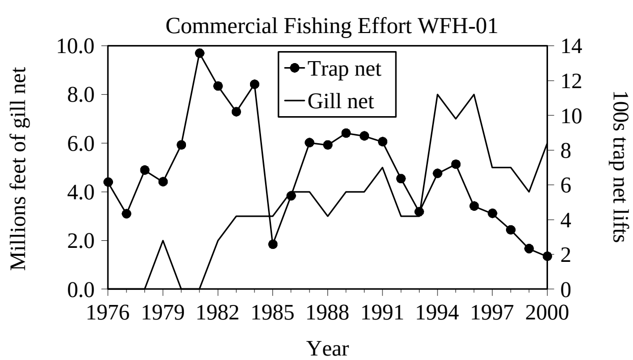
WFH-01 (St. Ignace Stock)

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 less than 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.

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. In most years some gill-net fishing is conducted under the ice in St. Martin Bay. Commercial fishery yields of whitefish have ranged from 46,000 lb in 1977 to 806,000 lb in 1994 and averaged 517,000 lb during 1991-2000. The commercial yield was 428,000 lb in 2000 compared to 296,000 lb in 1999.





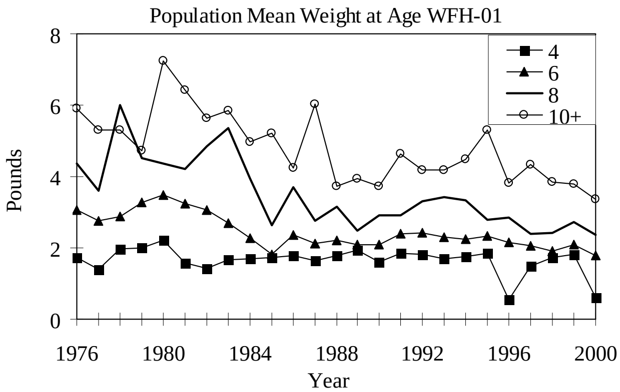
Large-mesh gill nets have harvested the majority of whitefish from WFH-01 during 1976-2000. From 1976-1984 large-mesh gill nets accounted for 0-41% of the annual fishery yield, while after 1985 gill nets accounted for 52-81% of the annual harvest. Large-mesh gill-net effort increased almost annually from 1982 through 2000, but effort in 2000 was lower than during the peak years of 1994-1996. Gill-net effort totaled 6 million ft in 2000.

Since peaking in 1982, the trap-net harvest has continually declined due primarily to reductions in trap-net effort. Trap-net effort ranged from 1,020 to 1,357 lifts during 1981-1984 and from 188 to 477 lifts during 1996-2000. Only 188 trap net lifts were made in WFH-01 in 2000.

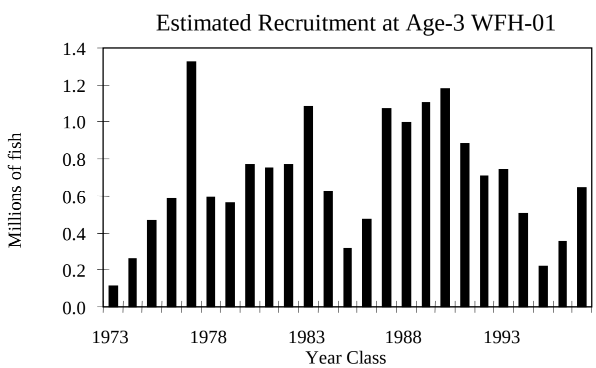
Whitefish in WFH-01 are of small size with over 90% of the harvest by weight being made up of No. 1 fish (<3 lb). Mean weight of whitefish in the trap-net harvest is typically smaller than in the gill-net harvest with annual mean weight ranging from 2.0 to 2.3 lb in the trap-net fishery and 2.2 to 2.6 lb in the gill-net fishery during 1990-2000.

Growth of lake whitefish in WFH-01 has been declining steadily since the late 1970s and this decline has affected recruitment to both the fishable and spawning stock. The decline in growth appears to be greatest for whitefish of age-6 and older. Age-4 whitefish was the modal age class in the trap-net fishery during 1976-1981, but during 1995-2000 age-4 fish were barely represented in the trap-net harvest and the modal age was 6 or 7 years.

The proportion of age-4 female whitefish that were sexually mature declined from 66% during 1976-1982, to 46% during 1983-1992, and to 23% during 1996-2000. All age-6 and older female whitefish were sexually mature during 1976-1982, but only 81% were sexually mature during 1996-2000.

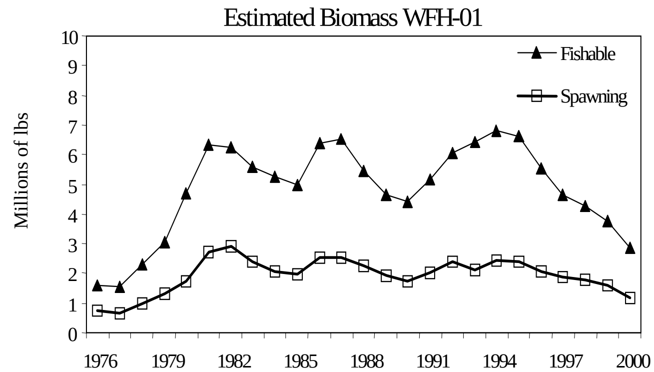


Large year-classes of whitefish were produced during 1987-1991 while average to poor-sized year classes were produced during 1992-1997 in WFH-01. The stock assessment model estimated that recruitment of age-3 whitefish to the population averaged 1.1 million fish for the 1987-1991 year classes, but only 528,000 fish for the 1992-1997 year classes. Average recruitment to the fishery during 1991-2000 was estimated to be 733,000 fish.



Estimated biomass of whitefish ≥ age 3 at the beginning of each year (fishable stock) averaged 3.23 million lb during 1991-2000. Annual estimated biomass of these fish increased from 2.70 million lb in 1990 to 4.35 million lb in 1994, and then declined to 1.73 million lb in 2000.

Spawning stock biomass averaged 1.99 million lb during 1991-2000 and represented about 63% the biomass available at the beginning of the year. Spawning stock biomass increased from 1.73 million lb in 1990 to 2.45 million lb in 1994 then declined to 1.15 million lb in 2000.



Fishing mortality induced by the gill-net fishery was the largest single source of mortality in WFH-01. Instantaneous fishing mortality on age 4+ fish from gill nets was 0.24 y^{-1} during 1998-2000 compared to 0.06 y^{-1} for the trap-net fishery during the same time period. Fishing mortality rate in 2000 was estimated to be 0.06 y^{-1} for trap nets and 0.30 y^{-1} for gill nets.

Total mortality rate (Z) on the fishable stock of age 4+ was less than the target mortality rate of 1.05 y^{-1} during 1998-2000. Instantaneous total annual mortality rate on age 4+ whitefish averaged 0.61 y^{-1} during 1998-2000. Age-specific Z-values ranged from 0.25 y^{-1} for age-3 fish to 1.03 y^{-1} for age-8 fish and averaged 0.68 y^{-1} for age-4+ whitefish in 2000.

The present spawning potential reduction was estimated to be 0.43, well above the minimum acceptable level of 0.20 as defined by the modeling subcommittee. Thus, the projection model indicted that fishing mortality in 2002 could be increased by roughly 1.2 times from the 1998-2001 level. Average total mortality in 2002 was projected to be 0.70 y^{-1}on age-4+ whitefish. This increase in fishing effort produced a recommended yield limit of **248,000 lb** round weight, a lower harvest limit than in 2001 (326,000 lb).

Summary Status WFH-01	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 y
Size at 50% maturity	18 in
Age at 50% maturity	5 y
Spawning stock biomass per recruit	
Base SSBR	1.15 lb
Current SSBR	0.49 lb
SSBR at target mortality	0.37 lb
Spawning potential reduction	
At target mortality	0.32
Average yield per recruit	0.55 lb
Natural mortality (M)	0.25 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0.06 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	8 y
fully selected age to trap nets	8 y
average gill net ages 4+	0.24 y^{-1}
average trap net ages 4+	0.06 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.61 y^{-1}
average 4+ 2000	0.68 y^{-1}
average 4+ 2002	0.70 y^{-1}
Average recruitment age-3 1991-2000	733,000 fish
Average biomass age 3+ 1991-2000	3,225,000 lb
Average spawning biomass 1991-2000	1,991,000 lb
Recommended Yield Limit 2002	248,000 lb

WFH-02 (Detour Stock)

Prepared by Mark P. Ebener

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

In 2000, 4,000 acres of bottom substrates in waters of 1-115 ft were mapped in the area from Detour Shoal to Saddle Bags using the Micro Marine Systems RoxAnn seabed classification device. Eighteen substrate categories were identified during the survey and these were combined into 8 categories:

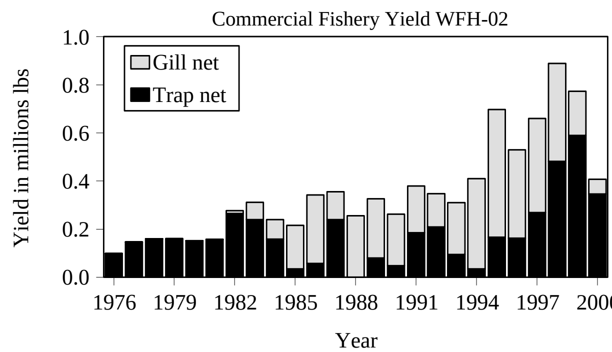
- Fine sand <0.25 mm
- Medium sand 0.25-0.5 mm
- Coarse sand 0.5-2 mm
- Pebbles (16-64 mm) & fine cobbles (64-97 mm) infilled with sand
- Sand and infilled cobbles to boulders
- Small cobbles 97-128 mm
- Mixed gravels (2-16 mm), pebbles and cobbles
- Mixed cobbles (64-256 mm) and boulders >256 mm.

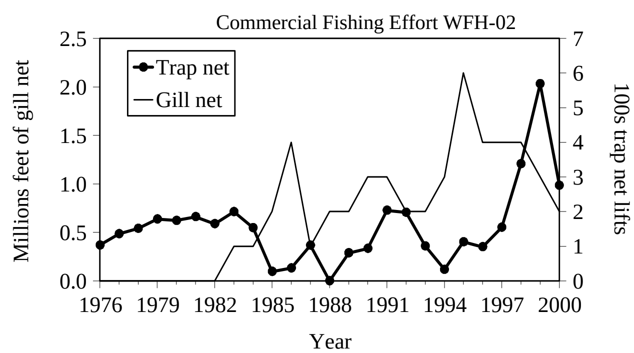
Whitefish spawning habitat composed of mixed gravels, pebbles, and cobbles made up 1,359 acres or 34% of area mapped and was found primary in waters <20 ft deep.

Zebra mussel numbers appeared to be moderate in the study area where bottom substrates were mapped in 2000. The mussels totally colonized any bedrock between the 10 and 20 ft depth contours. Zebra mussels were also found scattered on cobbles and boulders between the 10 and 20 ft contours.

Because the shoreline of WFH-02 is highly irregular and rocky, nearly the entire unit contains suitable habitat for reproduction. The largest concentration of spawning lake whitefish is located in the middle of the unit between Albany Island and Saddle Bag Islands.

WFH-02 has been a CORA exclusive fishing zone since the 1985 Consent Decree. The yield of lake whitefish from WFH-02 increased steadily after 1976 peaking at 888,000 lb in 1998. The fishery yield averaged 355,000 lb during 1976-2000. The yield of whitefish from WFH-02 was 408,000 lb in 2000 compared to 774,000 in 1999.





The allocation of the harvest among gill nets and trap nets has changed through the years. Prior to 1985 trap nets made up 66-100% of the total harvest, while during 1985-1997 large-mesh gill nets made up 36-92% of the harvest. Trap nets made up 85% of the harvest in 2000.

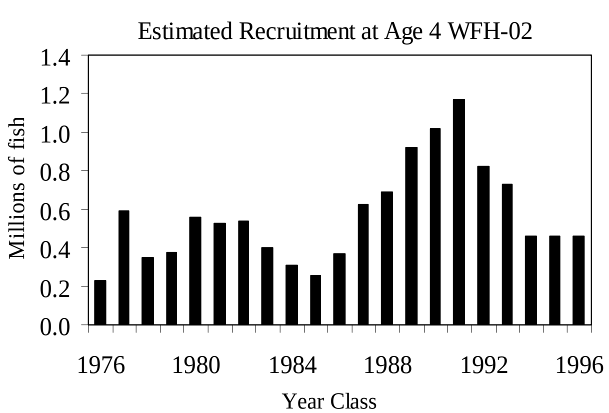
Both large-mesh gill-net and trap-net effort have changed markedly in WFH-02 since 1976. Trap-net effort averaged about 500 lifts annually from 1976-1984, varied between zero and 727 lifts from 1985-1997, then increased dramatically to 1,200 and 2,000 lifts in 1998 and 1999, respectively, before declining to 985 lifts in 2000. Large-mesh gill-net effort increased from 0.8 million ft in 1982 to 5.7 million ft in 1995, then declined to 1.6 million ft in 2000.

Whitefish in WFH-02 are of small size with 90% of the harvest being made up of No. 1 fish during 1980-1999. Whitefish caught in trap nets are usually smaller than those caught in gill nets; annual mean weight ranged from 2.0 to 2.6 lb in the trap-net fishery and ranged from 2.3 to 2.7 lb in the gill-net fishery during 1991-2000. Mean weight of whitefish in both the trap-net and gill-net fishery was 2.5 lb in 2000.

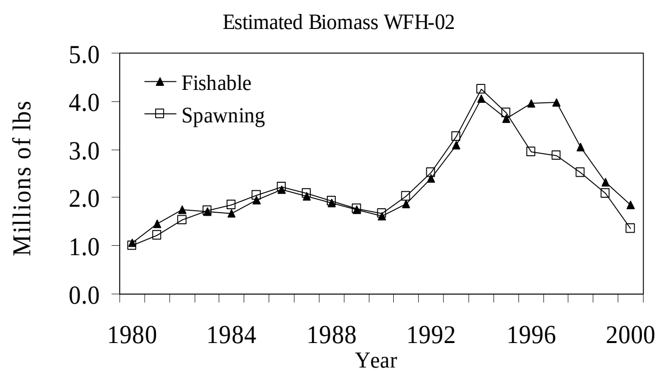
A distinct characteristic of the whitefish stock in WFH-02 is their small size at sexual maturity. Some females are sexually mature by 14 inches and 50% maturity of females occurs at 15.7 inches long. Age at first maturity begins as young as age 3, and the age of 50% maturity is five years.

Growth of whitefish in WFH-02 has declined through time, but not to the extent exhibited by fish from the adjacent unit WFH-01. Mean weight-at-age during 1996-2000 generally remained stable or increased slightly, particularly among older fish, but mean weight during this time was less than it was prior to 1996 for all age classes. Only growth of age-4 whitefish has shown a consistent decline during the last few years.

Good to excellent year classes of whitefish were produced during the late 1980s and early 1990s in WFH-02. Abundance of the 1987-1993 year classes averaged 852,000 fish compared to an average of 500,000 fish for other year classes during 1980-2000. The 1990 and 1991 year classes were estimated to contain one million age-4 whitefish when they recruited to the fishery. Recruitment at age 4 in WFH-02 averaged 736,000 fish during 1991-2000, but was only 463,000 fish in 2000.

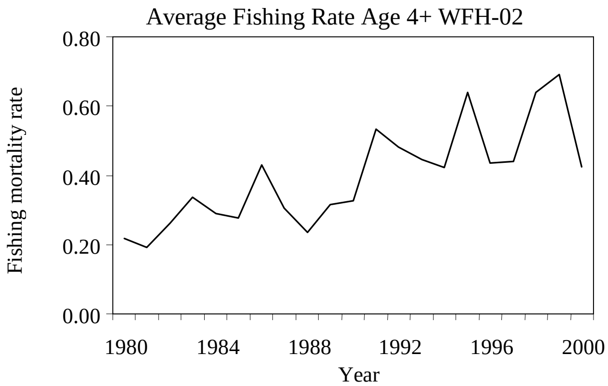


The abundant year classes produced during 1987-1993 doubled the biomass of whitefish in WFH-02 from 1990 to 1994. Fishable biomass was estimated to be 1.61 million lb in 1990 and 4.05 million lb in 1994. Fishable stock biomass was 1.85 million lb in 2000. Average fishable biomass was estimated at 3.0 million lb in WFH-02 during 1991-2000.



Spawning stock and fishable stock biomass were almost equivalent in years prior to 1996. Subsequently, fishable stock biomass exceeded spawning stock biomass as growth rates began to decline. Spawning stocking biomass peaked at 4.2 million lb in 1994, declined to 1.4 million lb in 2000, and averaged 2.8 million lb during 1991-2000.

Estimated annual fishing mortality rate has continuously increased in WFH-02 since the early 1980s. Fishing mortality increased from 0.19 y^{-1} in 1981 to 0.69 y^{-1} in 1999. From 1980 through 1990 annual fishing mortality ranged from 0.19 to 0.43 y^{-1}, whereas after 1990 annual fishing mortality ranged from 0.42 to 0.69 y^{-1}. Trap nets accounted for the largest proportion of fishing mortality during 1998-2000.



Total annual mortality rate on vulnerable age classes exceeded the target rate, thus the projection model indicted that fishing mortality should be reduced in WFH-02. Total annual mortality rate on age 4+ whitefish averaged 0.91 during 1998-2000 and peak total annual mortality of 1.10 occurred on age-9 fish in 2000. The projection model indicated that fishing mortality should be reduced by 33% from the level experienced during 1998-2001. The recommended yield limit at the reduced fishing rate was estimated to **325,000 lb**. Although fishing rates were reduced, the spawning potential reduction value of 0.34 at the target mortality rate still exceeded the minimum acceptable value of 0.20. The harvest regulating guideline was 620,000 to 650,000 lb in 2001.

Summary Status WFH-02	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 y
Size at 50% maturity	17 in
Age at 50% maturity	5 y
Spawning stock biomass per recruit	
Base SSBR	2.57 lb
Current SSBR	0.74 lb
SSBR at target mortality	0.88 lb
Spawning potential reduction	
At target mortality	0.34
Average yield per recruit	0.75 lb
Natural mortality (M)	$0.26\ y^{-1}$
Sea lamprey mortality (M_L)	
age 4+ 1998-2000	$0.06\ y^{-1}$
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	10 y
fully selected age to trap nets	9 y
average gill net ages 4+	$0.21\ y^{-1}$
average trap net ages 4+	$0.37\ y^{-1}$
Total Mortality Rate (Z)	
average 4+ 1998-2000	$0.91\ y^{-1}$
average 4+ 2000	$1.01\ y^{-1}$
average 4+ 2002	$0.72\ y^{-1}$
Average recruitment age-3 1991-2000	736,000 fish
Average biomass age 3+ 1991-2000	3,021,000 lb
Average spawning biomass 1991-2000	2,764,000 lb
Recommended Yield Limit 2002	325,000 lb

WFH-03 (Drummond Island Stock)

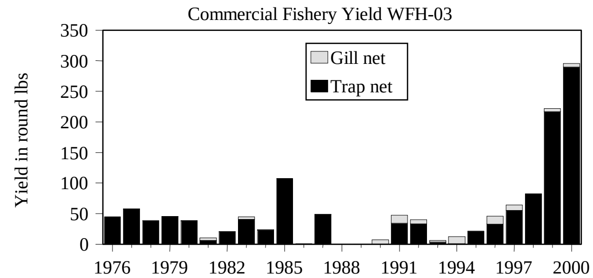
Prepared by Mark P. Ebener

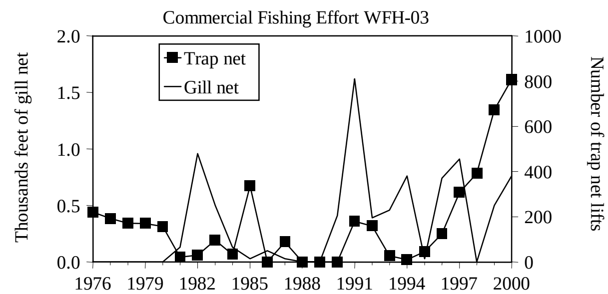
WFH-03 is a small management unit that encompasses all of Drummond Island. A lake trout refuge is located in Lake Huron waters along the southshore of Drummond Island where gill-net fishing is prohibited and retention of lake trout by trap-net fisheries is prohibited. The south side is deep with much of the water exceeding 150 ft deep, whereas the sides of Drummond Island are part of the North Channel and St. Marys River and much shallower and warmer than the south side. 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 this unit are located primarily along the south shore of Drummond Island in the main basin. Adult whitefish in spawning condition have been caught primarily between Seaman Point and Big Shoal by CORA staff during gill-net surveys made in October of 1991-2000.

WFH-03 has been exclusive fishing zone for the CORA fishery since 1985. The unit is primarily a trap-net fishery because gill-net fishing is prohibited in the refuge. A winter gill-net fishery for lake whitefish takes place in the North Channel from January through mid March in years when ice forms in North Channel areas. The trap-net fishery takes place along the south shore of Drummond Island nearly year-round because ice seldom forms along the islands southshore.

The annual commercial yield of whitefish from WFH-03 averaged 53,000 during 1976-2000, and but the harvest was 222,000 lb in 1999 and 295,000 lb in 2000. The annual gill-net yield ranged from 0 to 13,300 lb during 1976-2000, while the trap-net yield ranged from 0 to 290,000 lb during 1976-2000.

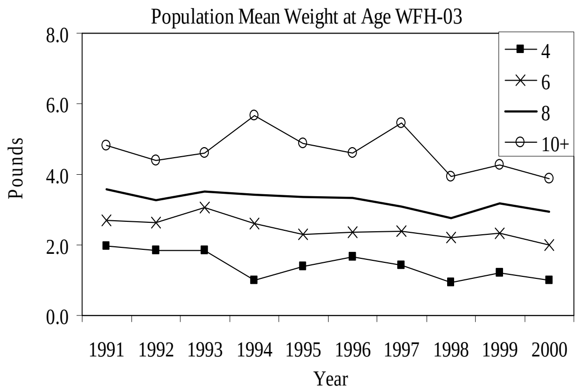




The huge increase in trap-net harvest in 1999 and 2000 from that experienced in previous years was due to an increase in trap-net effort from 392 lifts in 1998 to 806 lifts in 2000. Gill-net effort averaged only about 34,000 ft annually from 1976-2000 and showed little trend through time.

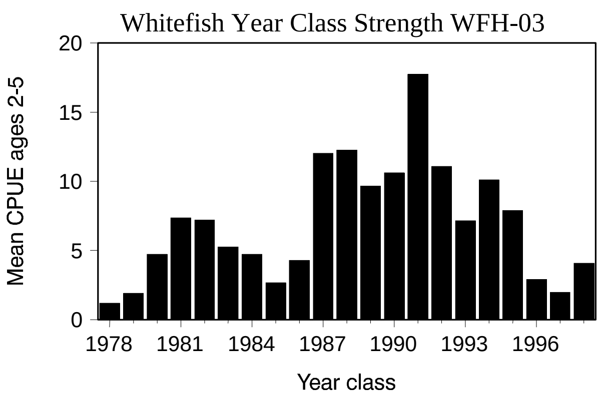
Whitefish caught in the fishery of WFH-03 are moderate sized. During 1987-2000 68% of the whitefish harvested were No. 1 fish, 24% were mediums (3-4 lb), and 8% were jumbos (>4 lb). Mean weight of whitefish in the trap-net fishery ranged from 2.0 to 2.8 lb and averaged 2.5 lb during 1991-2000. Whitefish harvested by the gill-net fishery were substantially larger than in the trap-net fishery. Mean weight in the gill-net fishery ranged from 2.3 to 3.0 lb and averaged 2.9 lb during 1991-2000.

Growth of whitefish in WFH-03 has been more stable than growth in the more western management units of Lake Huron. Mean weight at ages 4, 6, 8, and 10+ did decline through time during 1991-2000 in WFH-03 based on catches made during CORA graded-mesh gill-net surveys and monitoring of



commercial trap-net catches. The decline in growth was most severe for age-4 whitefish.

Relative abundance of the 1987-1995 year classes of whitefish in WFH-03 was relatively consistent and good, but the 1996 and 1997 year classes appear to be very small in comparison based on CORA graded-mesh gill-net surveys. The 1998 year class is more



abundant than the 1996 or 1997 year class even though the 1998 year-class was assessed only as age-2 and age-3 fish. The 1991-1995 year classes were abundant and have made up the bulk of the harvest from the unit during the 1990s.

Sexual maturity of female whitefish from WFH-03 has declined concurrently with growth rate. Age-specific maturity of female whitefish declined for ages 4-8 from the 1991-1995-time period to the 1996-2000-time period as illustrated below:

Age Class	1991-1995	1996-2000
4	32%	14%
5	53%	35%
6	70%	35%
7	86%	74%
8	92%	88%

Reliable estimates of mortality and abundance could not be produced with the stock assessment model for WFH-03. Input data for the stock assessment model spanned 1991-2000 and no independent survey data were input to the model to assist with estimating mortality and abundance. Even when convergence criteria were met, estimated fishable stock biomass varied 2-5 fold after small changes were made to the stock assessment model or input data.

The harvest regulating guideline in WFH-03 for 2002 is **293,000 lb** and represents the yield reported by the fishery in 2000 since there was no estimated harvest limit projected from the stock assessment model. The harvest regulating guideline was 220,000 to 250,000 lb in WFH-03 in 2001.

WFH-04 (Hammond Bay Stock)

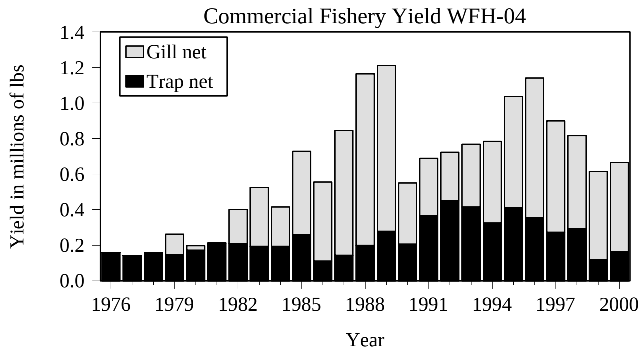
Prepared by Mark P. Ebener

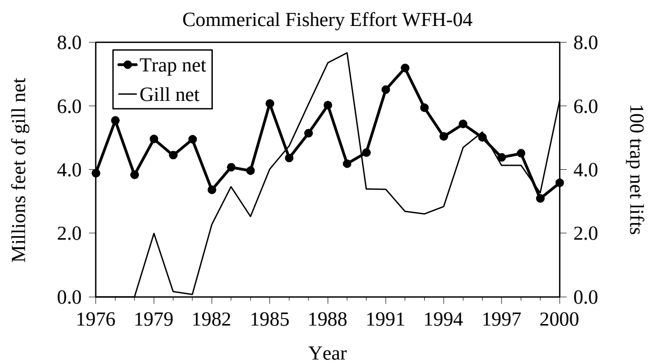
WFH-04 is the largest whitefish unit in the 1836 treaty-ceded waters of Lake Huron. The unit contains 377,567 surface acres of water <240 ft deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found near Cheboygan and Hammond Bay.

In August 2000 WFH-04 became an exclusive CORA commercial fishing zone. During 2000, the waters north of 40 Mile Point were an exclusive fishing zone for CORA fishers, while waters south of 40 Mile Point were an exclusive fishing area for a state-licensed trap-net fishery. In August 2000 WFH-04 waters from the Hammond Bay Refuge Harbor to 40 Mile Point was closed to large-mesh gill-net fishing except by Bay Mills members during October through December. During the fall season large-mesh gill-net effort is limited to no more than ten small-boat fishers fishing a maximum of 6,000 ft of gill net per boat. South of 40 Mile Point only two CORA trap-net operations are permitted to fish with 12 nets per operation. North of Hammond Bay has been open to large-mesh gill nets and trap nets since 1982 and that regulation continued in 2000. The CORA fishery is permitted to harvest only whitefish of 17 inches and larger, whereas the state fishery could harvest only 19-inch and larger whitefish.

The CORA large-mesh gill-net fishery has taken the majority of the whitefish from WFH-04. The annual yield of whitefish averaged 626,000 lb from WFH-04 during 1976-2000 and the gill-net fishery accounted for 62% of that yield. The peak yield of whitefish from WFH-04 was 1.2 million lb in 1989 and the gill-net fishery accounted for 77% of that yield. The annual trap-net harvest averaged 238,000 lb and ranged from a low of 111,000 lb in 1986 to 450,000 lb in 1992.

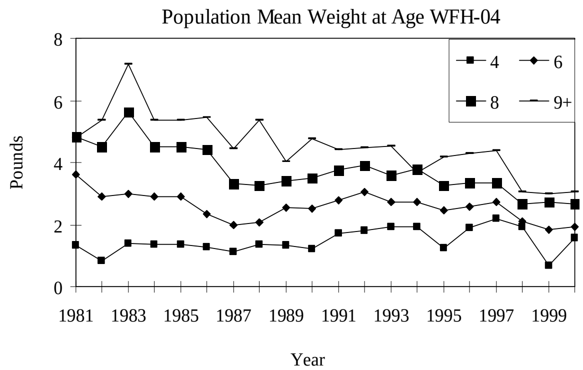
Both large-mesh gill-net and trap-net effort increased from 1999 to 2000. Large-mesh gill-net effort peaked at 7.7 million feet in 1989, then declined to 2.6 million ft in 1993, and has been increasing thereafter. Annual trap-net effort was variable yet stable from 1976-1991, increased to a peak of 719 lifts in 1992, and declined nearly thereafter until 2000. Fishing effort in 2000 was made up of 6.2 million feet of large-mesh gill net and 358 trap-net lifts.





Whitefish from WFH-04 are of moderate size. Annual mean weight of whitefish in the gill-net fishery ranged 2.6 to 3.0 lb during 1982-2000, while mean weight in the trap-net fishery ranged from 2.5 to 3.6 lb and averaged 2.7 lb. Whitefish caught in the trap-net fishery are larger than those caught in the gill-net fishery because the minimum size limit was 19 and 18 inches for the state-licensed fishery and CORA trap-net fisheries, respectively, prior to 2000.

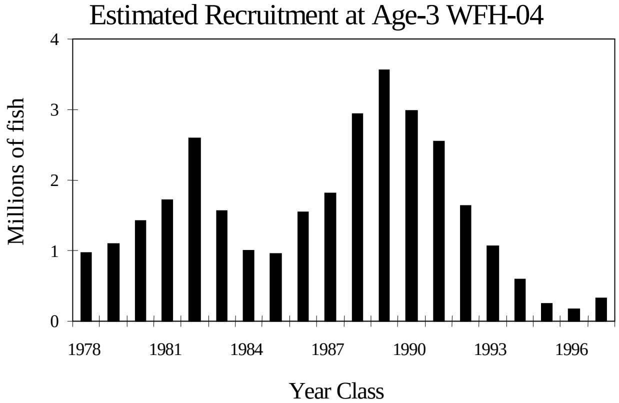
Growth rate of whitefish from WFH-04 has declined substantially through the years. Mean weight of age 9+ fish declined from about 5.5 lb in the early 1980s to only 3.0 lb in 1999.



Mean weight of age-6 whitefish declined from 2.9 lb in the early 1980s to 1.8 lb in 1999. Mean weight-at-age did increase somewhat for all ages from 1999 to 2000.

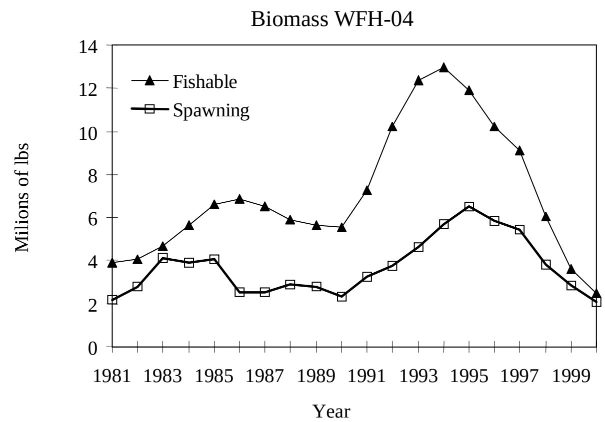
Sexual maturity of female whitefish in WFH-04 is similar to that in WFH-01 and WFH-03. Less than 5% of female whitefish in WFH-04 first become sexually mature at about 15 inches long and three years old, but 50% of female whitefish are not sexually mature until about 18 inches long and five years old. Because of the declines in growth no age-class of whitefish achieved 100% sexual maturity in WFH-04 after 1995.

The stock assessment model indicated that recruitment to the fishery population declined substantially after 1992. Average recruitment of age-3 whitefish to the fishable population was 1.6 million fish during 1991-2000.
A series of good year classes were produced in 1988-1991 and have supported the fishery in WFH-04 since the mid 1990s. The most abundant year class estimated by the model was the 1989 at 3.4 million age-3 fish, and the 1996 year class was smallest at 167,000 fish.

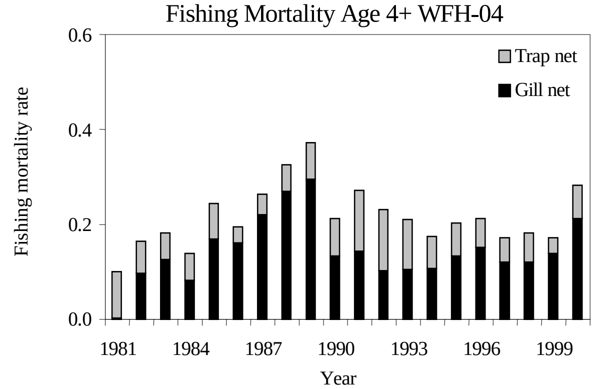


Biomass of the whitefish ≥ age 3 at the beginning of each year averaged 7.1 million lb during 1981-2000 and 8.6 million lb during 1991-2000. Peak fishable stock biomass was estimated to be 13.0 million lb in 1994 and the minimum biomass was 2.5 million lb in 2000. Estimated fishable biomass was lower in 1999 and 2000 than any other time since 1981.

Estimated spawning stock biomass averaged 3.7 million lb during 1981-2000 and 4.4 million lb during 1991-2000. Peak spawning stock biomass was 6.5 million lb in 1995 and the smallest spawning stock biomass during 1981-2000 was 2.1 million lb in 2000.



Total annual mortality of whitefish ≥ age 4 averaged 0.58 y^{-1} during 1998-2000. Total mortality of age-4 and older whitefish was 0.55 y^{-1} in 1998, 0.54 y^{-1} in 1999, and 0.65 y^{-1} in 2000. Mortality induced by the gill-net fishery was the largest single source of fishing mortality during 1981-2000. Gill net-induced mortality on whitefish ≥ age 4 averaged 0.16 y^{-1} during 1998-2000 compared to 0.06 y^{-1} for



trap net-induced mortality.

Total annual mortality rate on whitefish ≥ age 4 was less than the target rate during 1998-2000. The SPR value was 0.37 during 1998-2000, therefore, the projection model indicted that fishing mortality could be increased 1.87 times from the 1998-2001 level. The recommended yield limit projected with the spreadsheet model was 320,000 lb and was substantially less than the average fishery yield during 1998-2000. Consequently, the harvest regulating guideline was set at **634,000 lb** in WFH-04 for 2002. The harvest regulating guideline was 787,000 lb in WFH-04 in 2001.

Summary Status WFH-04	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 y
Size at 50% maturity	18 in
Age at 50% maturity	5 y
Spawning stock biomass per recruit	
Base SSBR	1.25 lb
Current SSBR	0.46 lb
SSBR at target mortality	0.32 lb
Spawning potential reduction	
At target mortality	0.25
Average yield per recruit	0.42 lb
Natural mortality (M)	0.32 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1998-00	0.05 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	7 y
fully selected age to trap nets	8 y
average gill net ages 4+	0.16 y^{-1}
average trap net ages 4+	0.06 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.58 y^{-1}
average 4+ 2000	0.65 y^{-1}
average 4+ 2002	0.77 y^{-1}
Average recruitment age-3 1991-2000	1,600,000 fish
Average biomass age 3+ 1991-2000	8,630,000 lb
Average spawning biomass 1991-2000	4,400,000 lb
Harvest Regulating Guideline 2002	634,000 lb

WFH-05 (Alpena Stock)

Prepared by Mark P. Ebener

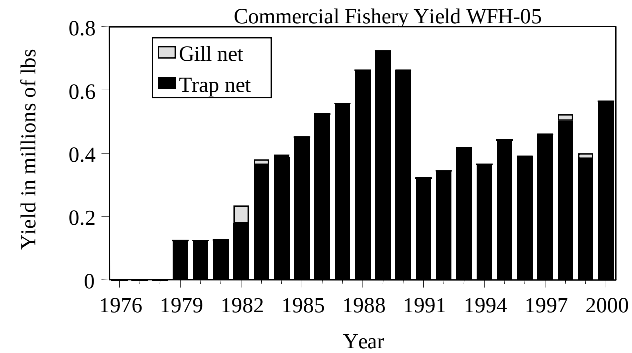
WFH-05 runs from Presque Isle south to North Point and includes some waters that lie outside the 1836 treaty-ceded waters. There are an estimated 209,000 surface acres of water <240 ft deep in WFH-05. WFH-05 contains a single, very large spawning stock of whitefish that spawns in the area from Middle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

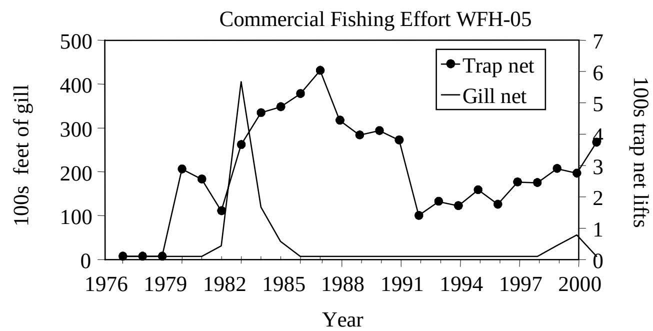
WFH-05 was an exclusive zone for two state-licensed trap-net fisheries from 1985 through July of 2000. The fishery operated primarily in October and fished waters <40 ft deep. A fishery did take place from April-June in WFH-05 but was restricted to waters <90 ft deep. The minimum length limit on whitefish was 19 inches total length. Only a few CORA small-boat gill-net fisheries ventured into WFH-05 prior to 1985, and a gill-net assessment fishery operated briefly here in 1998 and 1999.

The 2000 Consent Decree converted WFH-05 to an exclusive CORA trap net 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 nets. The CORA fishery has a minimum length limit on whitefish of 17 inches total length, and there is no limit on the depth of water in which trap nets can be fished.

Annual commercial trap-net yields have ranged from 124,000 lb in 1980 to 724,000 lb in 1989 and averaged 368,000 lb during 1976-2000. Changes in the fishery yield appear to be directly related to changes in fishery effort. As trap-net effort increased from 130 lifts in 1991 to 364 lifts in 2000 the yield increased from 322,000 lb in 1991 to 564,000 lb in 2000.

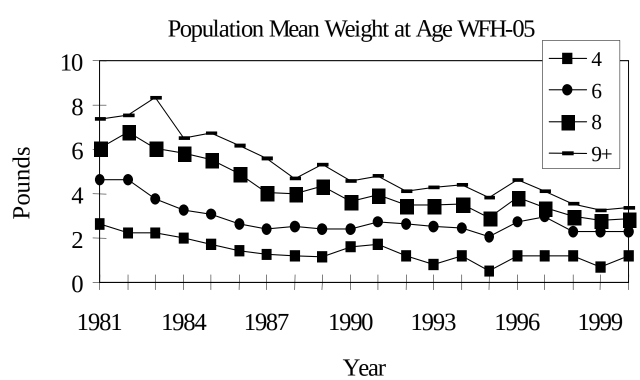
Because of the 19 minimum size limit and the limited fishery, whitefish from WFH-05 tend to be larger than whitefish from other stocks in the 1836 treaty-ceded waters. The commercial harvest is made up of roughly 50% No. 1 whitefish, 35% mediums, and 15% jumbos by weight.



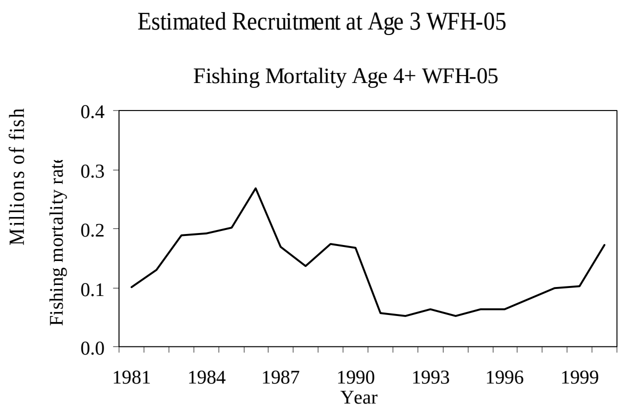


Growth rate of whitefish in WFH-05 appears to have stabilized over the last few years after continually declining since 1981. Mean weight-at-age declined almost annually for nearly all age classes, but increased or remained the same for all ages from 1999 to 2000. Whitefish of ages 4, 5, 8, and 9+ all weighed more in 1999 than in 2000.

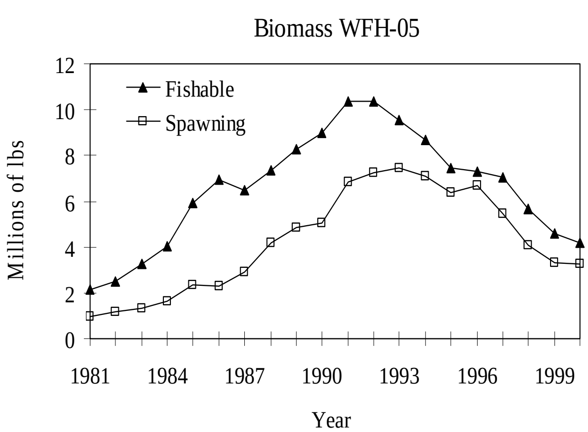
The stock assessment model estimated that recruitment of the 1993-1997 year classes was substantially less than for year classes prior to



1993. Very large year classes were produced in WFH-05 during 1982-1988 that ranged from 1.8 to 2.8 million fish at age 3. In comparison, the stock assessment model estimated that the 1993-1996 year classes contained only 920,000 to 1.1 million fish. Recruitment at age 3 averaged 1.5 million fish during 1981-2000 and 1.3 million fish during 1991-2000.



The predicted fishable and spawning stock biomass in WFH-05 has been declining since the early 1990s based on the stock assessment model. Biomass of whitefish ≥ age 3 peaked at 10.4 million lb in 1992 then declined to 4.2 in 2000. Spawning stock biomass peaked at 7.5 million lb in 1993 then declined to 3.3 million lb in 2000. Biomass of age-3 and older whitefish averaged 7.6 million lb during 1991-2000 and biomass of the spawning stock



averaged 5.8 million lb during 1991-2000.

Fishing mortality on whitefish ≥ age 4 peaked at 0.27 y^{-1} in WFH-05 in 1986, but has been substantially less since then. Fishing mortality averaged only 0.13 y^{-1} during 1998-2000 and trap nets accounted for >99% of that mortality. Age-8 whitefish are the most vulnerable to the fishery in WFH-05 and fishing mortality on these fish was estimated to be 0.34 y^{-1} in 2000. Average fishing mortality rate on age-4+ whitefish did increase from 0.10 y^{-1} in 1999 to 0.17 y^{-1} in 2000.

Total annual mortality was only 42% on whitefish ≥ age 4 in WFH-05 in 2000, thus the projection model indicated that fishing mortality could be increased 2.6 times over the 1998-2001 level. The recommended yield limit at this increased rate of fishing was estimated to be **670,000 lb** in WFH-05 for 2002. The harvest regulating guideline was 461,000 lb in WFH-05 in 2001.

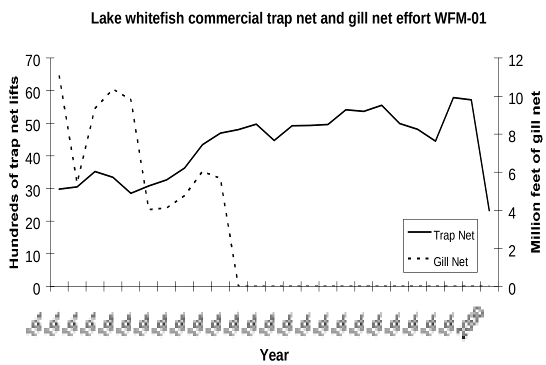
Summary Status WFH-05	
Female maturity	
Size at first spawning	17 in
Age at first spawning	4 yr
Size at 50% maturity	19 in
Age at 50% maturity	5-6 yr
Spawning stock biomass per recruit	
Base SSBR	1.70 lb
Current SSBR	0.91 lb
SSBR at target mortality	0.68 lb
Spawning potential reduction	
At target mortality	0.39
Average yield per recruit	0.34 lb
Natural mortality (M)	0.32 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0.05 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	7
fully selected age to trap nets	9
average gill net ages 4+	0.00 y^{-1}
average trap net ages 4+	0.13 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.50 y^{-1}
average 4+ 2000	0.54 y^{-1}
average 4+ 2002	0.69 y^{-1}
Average recruitment age-3 1991-2000	1,275,000 fish
Average biomass age 3+ 1991-2000	7,520,000 lb
Average spawning biomass 1991-2000	5,796,000 lb
Recommended yield limit in 2002	670,000 lb

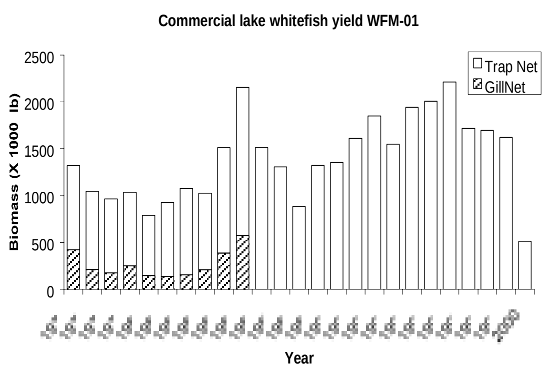
Lake Michigan

WFM-01 (Bays de Noc)

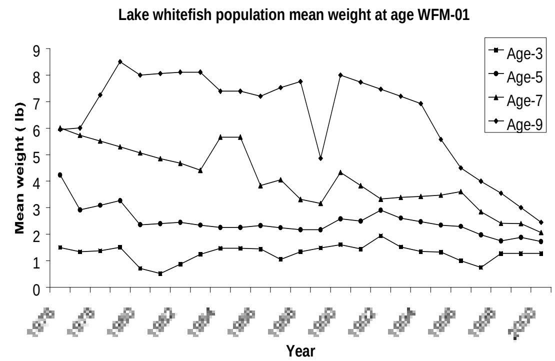
Prepared by Philip J. Schneeberger

Lake whitefish yield in WFM-01 was 511 thousand lb in 2000, all taken using trap nets. Commercial gill netting ceased in the bays de Noc after 1985. Total yield in 2000 was 70% lower than the 1997-99 average and 61% lower than the 1976-99 average. Lower yield was largely attributable to reduced fishing effort, which totaled 2,232 trap-net lifts during 2000, a sharp drop from 5,719 lifts in 1999 and down 56% from the 1997-99 average.

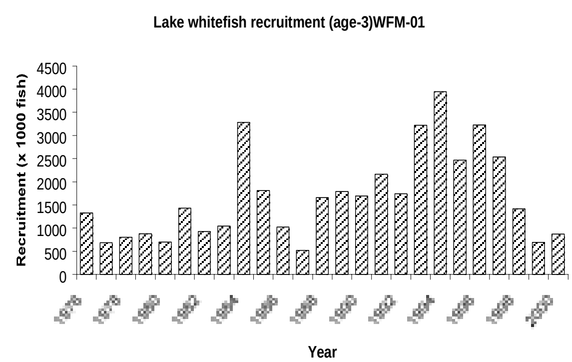




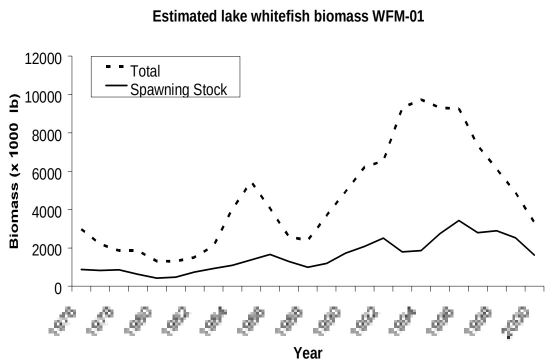
Weight-at-age for WFM-01 lake whitefish continued to decline, especially for fish age 5 and older. This decline in weight-at-age has continued a trend that began during the early 1990s for most whitefish of ages recruited to the fishery, and even earlier for older fish. Weight-at-age values (ages 4-9+) in 2000 were down between 8 and 30% compared to 1997-99 averages, and down 30-63% from 1976-99 averages.



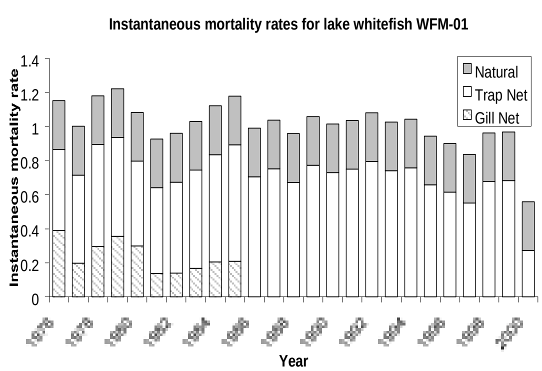
The 2000 estimate of 869,000 age-3 lake whitefish (recruitment) was lower by 44 and 49% from short-term and long-term averages. Higher than normal recruitment occurred during 9 straight years between 1989 and 1997, followed by 3 years of below average values from 1998 to 2000.



Fishable biomass was estimated at 3.3 million lb in 2000 and of this total, spawning stock biomass (1.6 million lb) represented 49%. The fishable biomass estimate for 2000 was 28% lower than the 1976-99 average and 46% lower than the 1997-99 average. Somewhat less dramatically, the 2000 spawning stock biomass estimate was 3% lower than the 14-yr average (1976-99) and 41% lower than the 3-yr average (1997-99).



Lower yield and effort during 2000 resulted in relatively low mortality rates for the WFM-01 lake whitefish population as well. Total instantaneous mortality rate (Z) was 0.56 y^{-1} in 2000, split nearly evenly between instantaneous fishing mortality rate (F = 0.27 y^{-1}) and instantaneous natural mortality rate (M = 0.28 y^{-1}). The 2000 Z and F values represent 39% and 57% decreases compared to averages during 1997-99 and are the lowest values estimated over the entire 1976-2000 data set. Model outputs indicate that total mortality rates have been below target maximums nine out of ten years between 1991 and 2000.



The projected 2002 yield limit for WFM-01 is 703 thousand lb. This decrease of 12% from the 2001 yield limit of 796 thousand lb is attributable to the combined effects of declining weight-at-age, recruitment, and estimated biomass. However, because the most recent yield statistic for the year 2000 was below the projected yield limit for 2001, the projection model indicates that fishing effort can increase by a factor of 3.4 to achieve the 2002 yield limit. The state harvest limit is 70,000 lb and the tribal harvest limit is 633,000 lb.

Summary Status – WFM-01	
Female maturity	
Size at first spawning	1.52 lb
Age at First Spawning	4 y
Size at 50% maturity	1.78 lb
Age at 50% maturity	5 y
Spawning biomass per recruit	
Base SSBR	0.991 lb (SE 0.002)
Current SSBR	0.23 lb (SE 0.01)
SSBR at target mortality	0.229 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.233 (SE 0.010)
Average yield per recruit	0.543 lb (SE 0.008)
Natural Mortality (M)	0.381 y^{-1}
Fishing mortality rate 1998-2000	
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+	0.623 y^{-1} (SE 0.034)
Sea lamprey mortality (ML) (average ages 4+,1998-2000)	N/A
Total mortality (Z)	
Average ages 4+,1998-2000	1.004 y^{-1} (SE 0.034)
Recruitment (age-3) (1991-2000 average)	2,227,700 fish (SE 82,237)
Biomass (age 3+) (1991-2000 average)	7,198,800 lb (SE 218,450)
Spawning biomass (1991-2000 average)	2,423,400 lb (SE 93,696)
Recommended yield limit in 2002	703,000 lb

WFM-02 (Manistique Stock)

Prepared by Mark P. Ebener

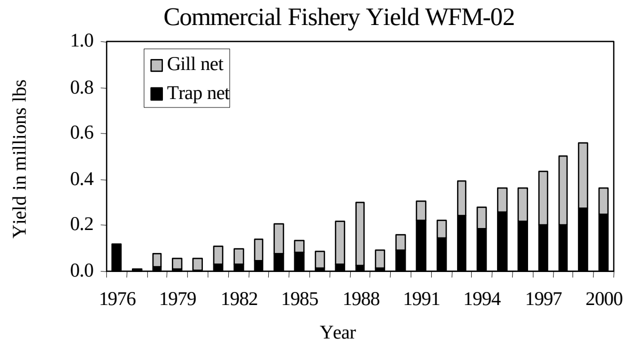
WFM-02 is located in the northwest portion of Lake Michigan. There are 387,000 surface acres of water <240 ft deep in the unit. The entire shoreline of WFM-02 lies within the Niagara Escarpment and is composed of dolomite limestone on the surface. The only known spawning population of whitefish in WFM-02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

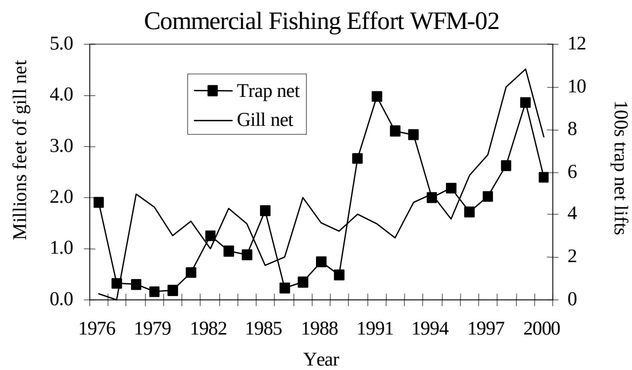
WFM-02 has been an exclusive CORA fishing zone since 1985. One trap-net operation and up to four large gill-net boats have regularly fished WFM-02. Very little small-boat gill-net effort occurs in this unit. Besides whitefish, the large-boat gill-net fishery routinely targets bloater chubs in offshore waters. The unit is known for being a "dirty" place to fish with gill nets because logs, dead algae and dead periphyton, zebra mussels, and burbot routinely foul the gear.

The average commercial yield from WFM-02 was 226,000 lb from 1976-2000. The peak yield was 559,000 lb in 1999 and the lowest yield was 11,000 lb in 1977. During 1991-2000 the average yield was 378,000 lb. The long-term harvest has been equally split between trap nets and gill nets.

The increase in yield from WFM-02 has been due to substantial increases in fishing effort. Large-mesh gill-net effort peaked at 4.5 million ft in 1999 then declined to 3.2 million ft in 2000, but still continues to be greater than most years during 1976-2000. Trap-net effort declined from 926 lifts in 1999 to 574 lifts in 2000.

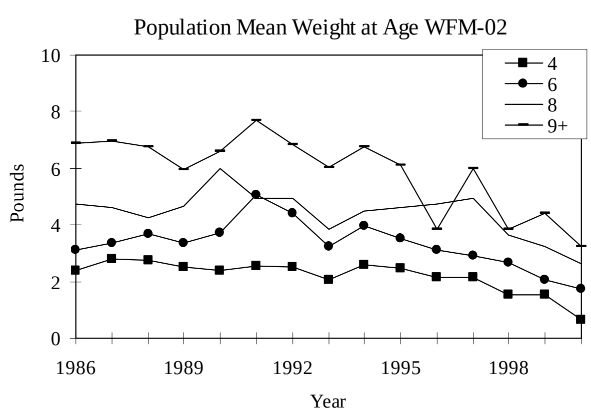
Whitefish in WFM-02 are of moderate size. The harvest by weight was made up of 56% No. 1 whitefish, 28% mediums, and 16% jumbos during 1986-2000. Mean weight in the harvest ranged from 2.2 to 3.3 lb in the trap-net fishery and 2.5 to 3.8 lb in the gill-net fishery during 1986-2000.





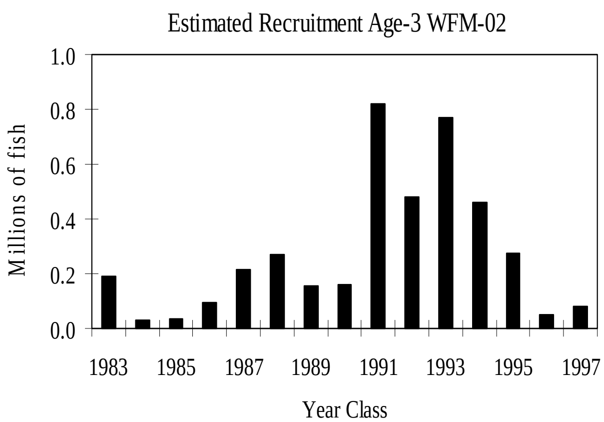
Mean weight of nearly all age classes of whitefish ≥ age 4 has declined continually since 1986. Whitefish of ages 4-9+ weighed less in 2000 than all other years. The decline in mean weight of age-8 and older fish has been occurring longer than the decline in mean weight of ages 4-6. Mean weight of ages 4-6 whitefish began declining in 1994.

The decline in growth rates has had a profound effect on sexual maturity of female



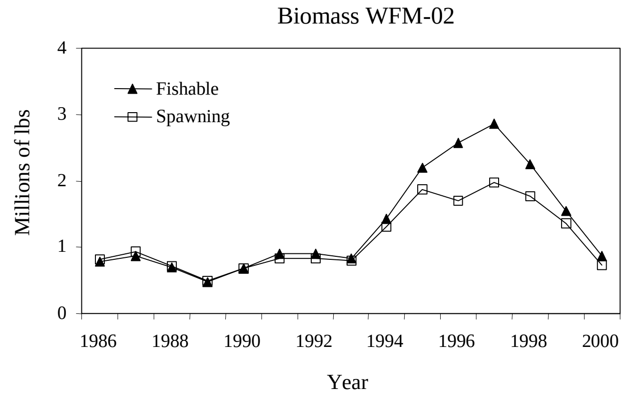
whitefish in WFM-02. In the mid 1980s slightly more than 50% of age-3 and >90% of age-5 and older female whitefish were sexually mature in WFM-02. By 2000 only 25% of age-3, 54% of age-4, and 74% of age-5 female whitefish were sexually mature.

Predicted recruitment of age-3 whitefish to the fishable population in WFM-02 varied 29-fold during 1986-2000. The stock assessment model estimated that the 1991-year class contained 821,000 fish at age 3, compared to only 28,000 fish for the 1984-year class at age 3. Recruitment of age-3 whitefish to the fishable population averaged 272,000 fish during 1986-2000 and 383,000 fish during 1990-2000. The 1996 and 1997 year classes were the least abundant year classes produced in WFM-02 since the 1984 and 1985 year classes.

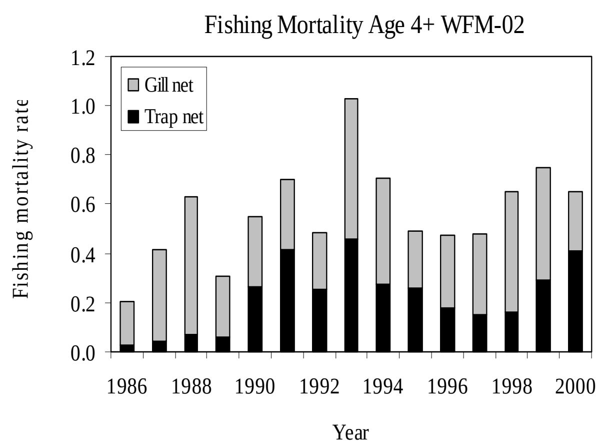


Estimated biomass of whitefish in WFM-02 increased from 1986 through 1997, and then declined substantially. The stock assessment model estimated that fishable stock biomass increased from an average of 769,000 lb during 1986-1993 to 2.9 million lb in 1997, then declined to an estimated 870,000 lb in 2000.

Sexually mature whitefish made up a substantial proportion of the total biomass in WFM-02. Spawning stock biomass ranged from 495,000 lb in 1989 to 1.97 million lb in 1997 and averaged 1.1 million lb during 1986-2000.



Fishing mortality on whitefish ≥ age 4 peaked at 1.03 y^{-1} in 1993 in WFM-02 and gill-net effort accounted for 55% of that mortality. The maximum trap-net mortality rate was 0.46 y^{-1} in 1993. Fishing mortality of age-4+ whitefish was 0.69 y^{-1} during 1998-2000.



Total annual mortality of whitefish ≥ age 4 was slightly less than the target mortality rate of 1.05 during 1998-2000; however, total annual mortality on fully vulnerable age-classes exceeded the maximum total mortality rate. Consequently, the projection model indicted that fishing effort in 2002 should be decreased to 65% of that experienced during 1998-2001. The projected harvest level at the target mortality rate was estimated to be 100,000 lb, which was substantially less than annual harvest during the previous years. The harvest regulating guideline adopted for WFM-02 in 2002 was **186,000 lb**. The 2001 harvest regulating guideline was 357,000 lb.

Summary Status WFM-02	
Female maturity	
Size at first spawning	16 in
Age at first spawning	3 y
Size at 50% maturity	18 in
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	2.70 lb
Current SSBR	0.58 lb
SSBR at target mortality	0.74 lb
Spawning potential reduction	
At target mortality	0.27
Average yield per recruit	0.74 lb
Natural mortality (M)	0.25 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	8 y
fully selected age to trap nets	7 y
average gill net ages 4+	0.40 y^{-1}
average trap net ages 4+	0.29 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.94 y^{-1}
average 4+ 2000	0.90 y^{-1}
average 4+ 2002	0.69 y^{-1}
Average recruitment age-3 1991-2000	383,000 fish
Average biomass age 3+ 1991-2000	1,637,000 lb
Average spawning biomass 1991-2000	1,150,000 lb
Harvest Regulating Guideline 2002	186,000 lb

WFM-03 (Naubinway Stock)

Prepared by Mark P. Ebener

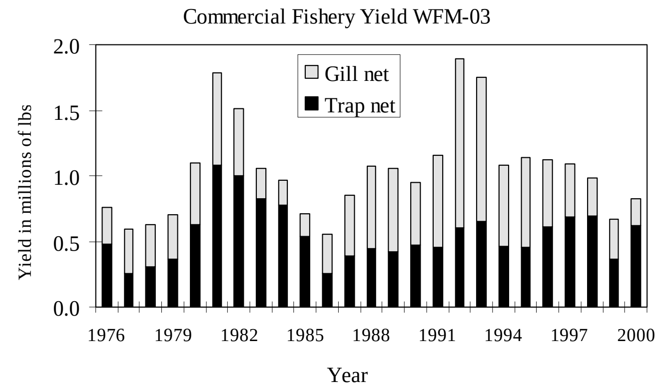
WFM-03 is located in northern Lake Michigan. The unit extends from the Straits of Mackinac west to Seul Choix Point and is bounded on the south by Beaver Island and the complex of shoals and islands than surround the island. Nearly the entire unit is shallow water <90 ft deep. There are 483,000 surface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

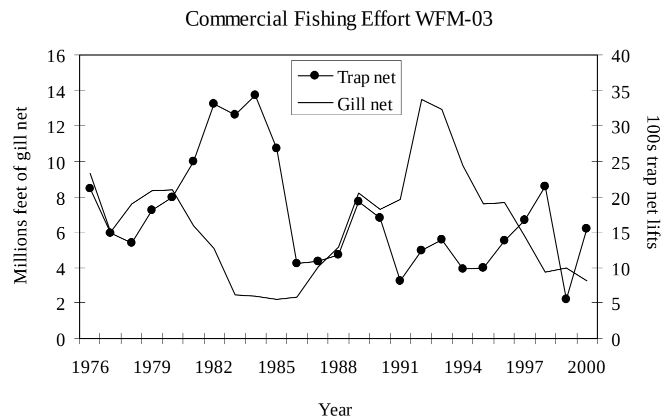
This unit contains several very large spawning aggregations of whitefish. The entire northern shoreline of WFM-03 is part of the Niagara Escarpment; consequently, much of the whitefish spawning occurs throughout the northern shoreline. Large spawning aggregations are associated with the area between Epoufette and Naubinway, and in the Straits of Mackinac along the upper and lower Peninsula.

WFM-03 has been an exclusive fishing zone for the CORA fishery since 1985, and has been an important commercial fishing area for whitefish for most of the twentieth century. A large state-licensed trap-net fishery operated in WFM-03 prior to 1985.

The commercial fishery yield from WFM-03 averaged 1.04 million lb during 1976-2000. During this time period, the trap-net yield averaged 553,000 lb and the gill-net fishery 487,000 lb. The trap-net yield ranged from 254,000 lb in 1977 to 1.08 million lb in 1981. The gill-net harvest ranged from 176,000 lb in 1985 to 1.3 million lb in 1992. The trap-net yield was 617,000 lb in 2000 while the gill-net yield was only 208,000 lb in 2000. The gill-net yield has declined substantially since the late 1980s. Gill-net effort has declined nearly annually since 1991 and was only 3.3 million ft 2000. Conversely, the trap-net yield has increased continually since the mid 1980s. Trap-net effort has been variable but stable around 1,300 lifts annual since 1986.

Whitefish in WFM-03 are of small size with 84% of the harvest by weight being composed of No. 1 fish during 1996-2000. Medium whitefish made up 13% and jumbos only 3% by weight of the commercial harvest from WFM-03 during 1986-2000. Annual mean weight of whitefish in the trap-net harvest was 2.3 lb and ranged from 2.1 to 2.6 lb during 1986-2000. Annual mean weight of whitefish in the gill-net harvest was 2.5 lb and ranged from 2.4 to 3.6 lb during 1986-2000.

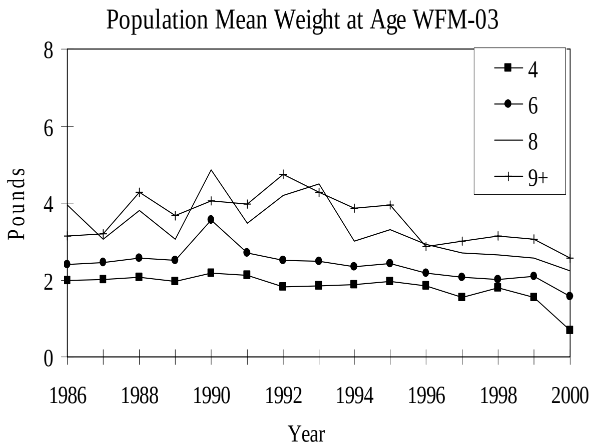




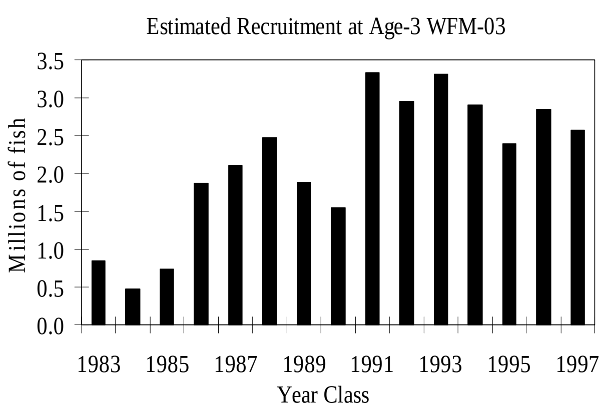
As in most many other management units, growth of whitefish in WFM-03 has declined through time and the decline is most pronounced for age-5 and older fish. All age classes of whitefish weighed less in 2000 than any other time during 1986-2000. The declines in growth began in about 1993.

The decline in growth has had an influence on sexual maturity of whitefish in WFM-03. Prior to 1991, 88% of age-3 and 96% of age-4 whitefish were sexually mature. After 1995 only 11% of age-3 and 56% of age-4 whitefish were sexually mature. Meanwhile, over 85%

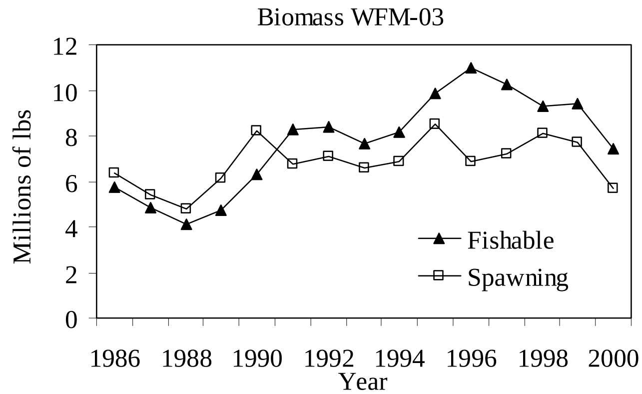
of age-5 whitefish have been sexually mature in WFM-03 during 1986-2000.



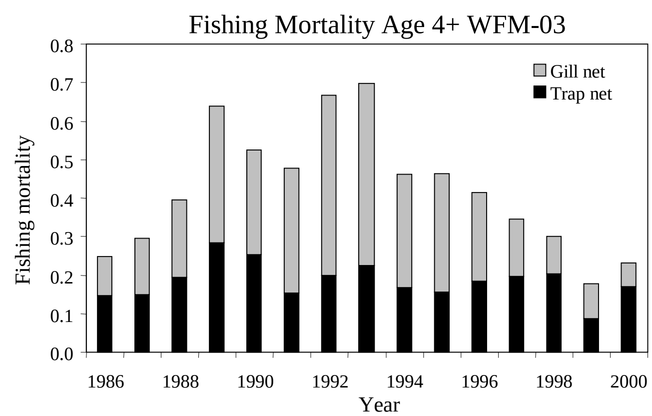
The estimates of recruitment from the stock assessment model were fairly constant. Recruitment of age-3 whitefish in WFM-03 averaged 2.1 million fish from 1986-2000 and 2.6 million fish from 1991-2000. The 1991 and 1993 year-classes were the most abundant in WFM-03 during 1986-2000.



Estimated fishable biomass of whitefish ≥ age 3 at the beginning of each year averaged 7.7 million lb during 1986-2000. Annual biomass ranged from a low of 4.1 million lb in 1988 to 10.9 million lb in 1996. Biomass of whitefish ≥ age 3 was estimated to be 7.4 million lb in 2000. Spawning stock biomass averaged 6.8 million lb during 1986-2000. The lowest spawning stock biomass occurred in 1988, but spawning stock biomass in 2000 was 5.7 million lb; the lowest since 1988.



Estimated fishing mortality of age-4+ whitefish ranged from 0.18 to 0.70 y^{-1} during 1986-2000. Fishing mortality was lowest in 1999 and highest in 1993. Trap net-induced fishing mortality has exceeded gill-net fishing mortality since 1997. Total fishing mortality has declined from 0.70 y^{-1} in 1993 to 0.23 y^{-1} in 2000.



Total annual mortality on age-4+ whitefish was less than the target rate during 1998-2000. The SPR value at the target fishing mortality rate was 0.43, well above the minimum level of 0.20. The projection model estimated that fishing mortality could be increased 1.7 times from the 1998-2001 levels and still keep total mortality to ≥ 65% on the most fully vulnerable age class. A recommended yield limit of **1,313,000 million lb** was projected for WFM-03 in 2002. The recommended yield limit was 953,000 lb in 2001.

Summary Status WFM-03	
Female maturity	
Size at first spawning	14 in
Age at first spawning	3 y
Size at 50% maturity	16 in
Age at 50% maturity	4 y
Spawning stock biomass per recruit	
Base SSBR	1.26 lb
Current SSBR	0.69 lb
SSBR at target mortality	0.54 lb
Spawning potential reduction	
At target mortality	0.43
Average yield per recruit	0.36 lb
Natural mortality (M)	0.35 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	8 y
fully selected age to trap nets	8 y
average gill net ages 4+	0.08 y^{-1}
average trap net ages 4+	0.15 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.58 y^{-1}
average 4+ 2000	0.58 y^{-1}
average 4+ 2002	0.76 y^{-1}
Average recruitment age-3 1991-2000	2,619,000 fish
Average biomass age 3+ 1991-2000	8,969,000 lb
Average spawning biomass 1991-2000	7,156,000 lb
Recommended Yield Limit 2002	1,313,000 lb

WFM-04 (Beaver Island Stock)

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 are also located many smaller submerged reefs located on the east and west sides of Beaver Island. These later reefs are surrounded by deep water. Twelve statistical grids make up WFM-04 and the unit contains 577,000 surface acres of water <240 ft deep.

There are at least several reproductively isolated stocks of lake 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. There are probably several other spawning stocks located in WFM-04 associated with Beaver Island and some of the other islands.

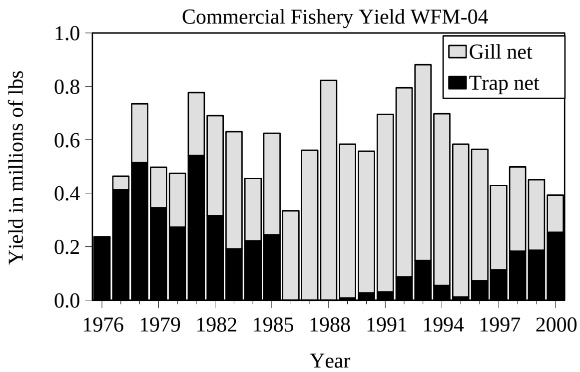
WFM-04 has been an exclusive fishing zone for the CORA fishery since 1985, but much of the unit is designated as a lake trout refuge. Prior to the 2000 Consent Decree the area around Beaver Island was designated as a primary lake trout rehabilitation zone, while the areas south and west of Beaver Island make up the refuge. Retention of lake trout by sport or commercial fisheries is prohibited in the refuge. Grids to the east of Beaver Island were designated as deferred rehabilitation zones where no limits were placed on the harvest of lake trout by the commercial fishery. The 2000 Consent Decree kept the refuge intact, but eliminated the primary and deferred designations.

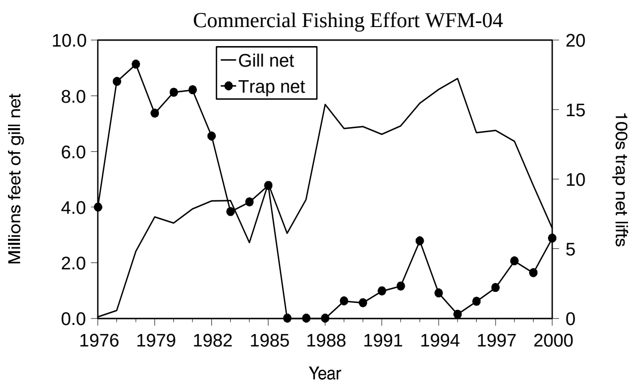
The eastern portion of WFM-04 along the lower peninsula of Michigan is a favorite fishing area for CORA small-boat fisheries, while the more offshore waters of WFM-04 around Beaver Island are exclusive fishing grounds for CORA large-boat gill-net and trap-net fisheries. Only trap-net fisheries harvest whitefish from within the refuge.

Commercial harvest of whitefish from WFM-04 has ranged from a low of 335,000 lb in 1986 to 881,000 lb in 1992 and averaged 577,000 lb during 1976-2000. The commercial harvest was 393,000 lb in 2000; 255,000 lb in the trap-net fishery and 139,000 lb in the gill-net fishery. Since the 1985 Consent Decree, the large-mesh gill-net fishery has accounted for the majority of the harvest in WFM-04, but the lowest gill-net harvest occurred in 2000.

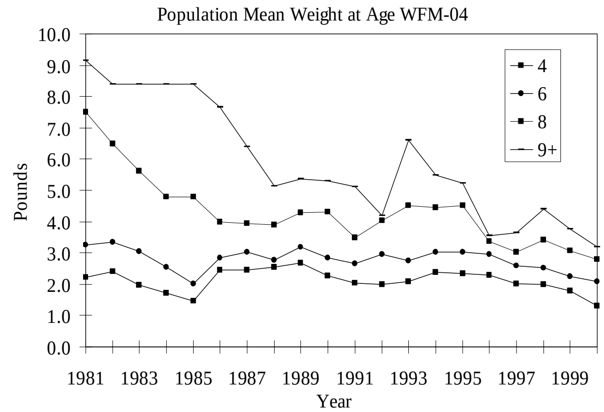
Trap-net effort has been increasing and gill-net effort declining in WFM-04 since 1995. Trap-net effort increased from 28 lifts in 1995 to 575 lifts in 2000. Gill-net effort declined from a peak of 8.6 million ft in 1995 to 3.2 million ft in 2000.

Whitefish living in WFM-04 are of moderate size. During 1985-2000 No. 1 whitefish made up 57% of the harvest, followed by mediums at 25%, and jumbos at 17%. Annual mean weight of whitefish in the harvest ranged from 2.1 to 3.3 lb in the trap-net fishery and 2.6 to 3.5 lb in the gill-net fishery during 1985-2000. Mean weight of whitefish has averaged 2.4 lb in the trap-net fishery and 2.9 lb in the gill-net fishery during 1985-2000.





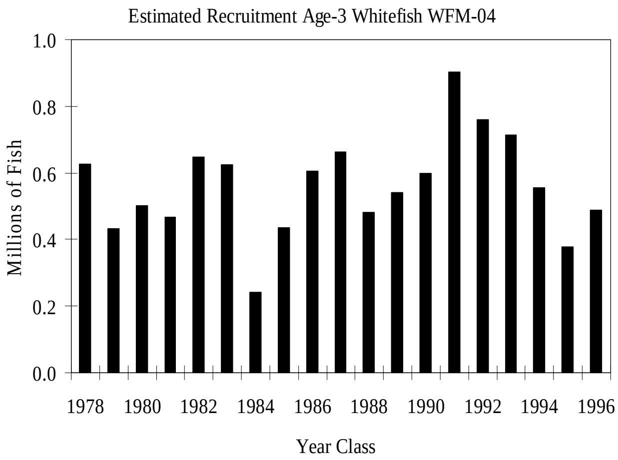
As in most other areas of Lake Michigan growth of whitefish in WFM-04 has declined substantially over the years, and the decline in growth has been most pronounced on older whitefish. Mean weight of an age-8 whitefish declined from 7.0 lb in the early 1980s to 2.8 lb in 2000. Mean weight of age-4 and age-6 whitefish has been more stable than for other fish, yet both these age-classes weighed less in 2000 than all other years during 1981-2000.



These declines in growth have also reduced the rate of sexual maturity of whitefish in WFM-04. All female whitefish >age 6 were sexually mature prior to 1985, but since then no age class has achieved complete maturity. During 1981-1995 31-69% of age-3 female whitefish were sexually mature, but during 1996-2000 only 4% of age-3 female whitefish have been sexually mature. The proportion of sexually mature age-4 female whitefish declined from an average of 84% prior to 1996 to 50% after 1996.

Estimated recruitment of age-3 whitefish to the population in WFM-04 has been more stable than most of stocks of whitefish in the 1836 ceded waters. The stock assessment model estimated that an average of 560,000 age-3 whitefish recruited to the population during 1981-2000. Recruitment varied from 243,000 for the 1984 year class to 904,000 for the 1991 year class. Most other year classes varied between 450,000 and 700,000 fish during 1981-2000. The 1997 year class was estimated at 524,000 fish when it recruited to the population of WFM-04 in 2000.

Estimated biomass of whitefish in WFM-04 was also remarkably stable during 1981-2000 compared to other management units. The stock



assessment model estimated that biomass of whitefish ≥ age 3 at the beginning of each year ranged from 2.0 million lb in 1984 to 4.1 million lb in 1996, and averaged 2.9 million lb during 1981-2000. The fishable stock biomass declined annually from 1995 to 2000 and was estimated to be 2.4 million lb in 2000. Spawning stock biomass averaged 2.8 million lb during 1981-2000 and

peaked at 4.0 million lb in 1995. The spawning stock biomass was estimated to be 2.0 million lb in 2000.

The large-mesh gill-net fishery accounted for the majority of fishing mortality in WFM-04 during 1981-2000, but overall fishing mortality has declined through time. Fishing mortality on age-4+ whitefish was 0.86 y^{-1} in 1981 and declined to 0.24 y^{-1} in 2000. Fishing mortality induced by the large-mesh gill-net fishery averaged 0.16 y^{-1} during 1998-2000 compared to 0.11 y^{-1} for the trap-net fishery. Fishing mortality was lower in 2000 than all other years but 1986.

Total annual mortality on the fishable stock of whitefish in WFM-04 was substantially less than the target rate during 1998-2000. Total annual mortality of age-4+ whitefish averaged 0.50 y^{-1} during 1998-2000. The SPR-value was 0.38 during 1998-2000 indicating that fishing mortality in 2002 could be increased. The projection model indicated that fishing mortality could be increased by 1.98 times in 2002 from the 1998-2001 levels. The projected yield limit for 2002 at the increased fishing rate was estimated to be **639,000 lb**. The recommended yield limit was 590,000 lb in 2001.

Summary Status WFM-04	
Female maturity	
Size at first spawning	15 in
Age at first spawning	3 yr
Size at 50% maturity	17 in
Age at 50% maturity	4 yr
Spawning stock biomass per recruit	
Base SSBR	3.11 lb
Current SSBR	1.19 lb
SSBR at target mortality	0.80 lb
Spawning potential reduction	
At target mortality	0.26
Average yield per recruit	0.84 lb
Natural mortality (M)	0.23 y^{-1}
Sea lamprey mortality (M_L)	
age 4+ 1997-99	0 y^{-1}
Fishing Mortality Rate (F) 1998-2000	
fully selected age to gill nets	8
fully selected age to trap nets	8
average gill net ages 4+	0.16 y^{-1}
average trap net ages 4+	0.11 y^{-1}
Total Mortality Rate (Z)	
average 4+ 1998-2000	0.50 y^{-1}
average 4+ 2000	0.47 y^{-1}
average 4+ 2002	0.76 y^{-1}
Average recruitment age-3 1991-2000	594,000 fish
Average biomass age 3+ 1991-2000	3,199,900 lb
Average spawning biomass 1991-2000	2,897,000 lb
Recommended Yield Limit 2002	639,000 lb

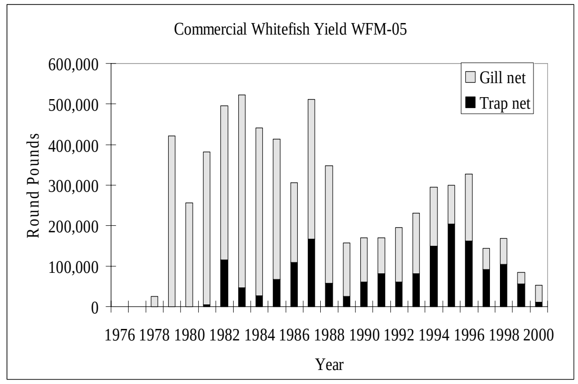
WFM-05 (Grand Traverse Bay Stock)

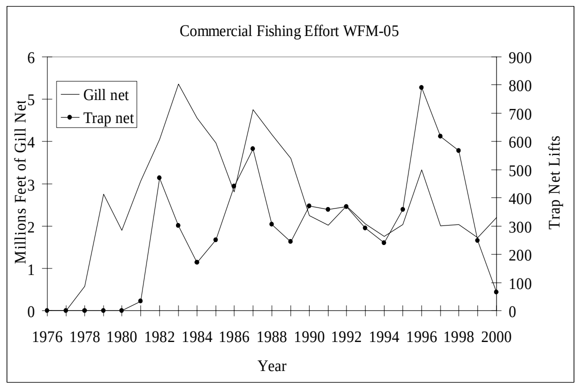
Prepared by Mark P. Ebener and Erik J. Olsen

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. in the offshore waters west of the Leelanau Peninsula, although several small shallow reef areas are located in these offshore waters and there is also 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. Based on mark-recapture studied conducted by Michigan State University researchers, 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. There probably is another spawning stock of whitefish associated with the Fox Islands based on size and age structure of fish caught at the islands. Another, but smaller, spawning stock is likely found in Little Traverse Bay.

WFM-05 has been an important tribal fishing area since the 1970s. Much of the tribal fishing activity that occurred prior to and immediately after re-affirmation of treaty-reserved fishing





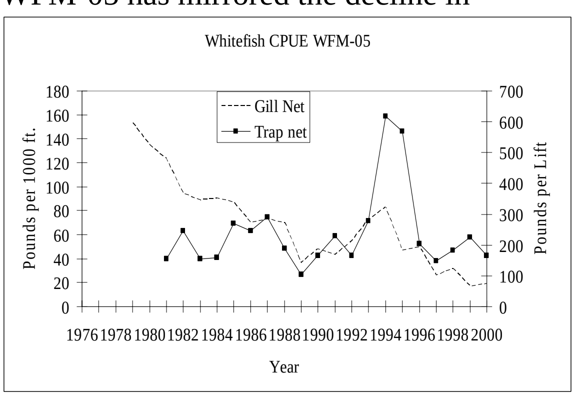
rights took place in Grand Traverse Bay. CORA small-boat fishers relied on Grand Traverse Bay as an important fishing ground because the Bay contains deep water located close to shore, and because it offers small-boat fishers protection from wind and waves. WFM-05 has been an exclusive tribal commercial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

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

Commercial yields of lake whitefish were substantially less during the decade of the 1990s than during the 1980s. The commercial yield averaged 384,000 lb during 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 1996 to 1999.

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 5.4 million ft. in 1983 to only 1.7 million ft. in 2000. Trap-net effort has varied annually between 200 and 800 lifts during 1982-1999. Trap-net effort has declined from 790 lifts in 1996, to a low of 66 in 2000.

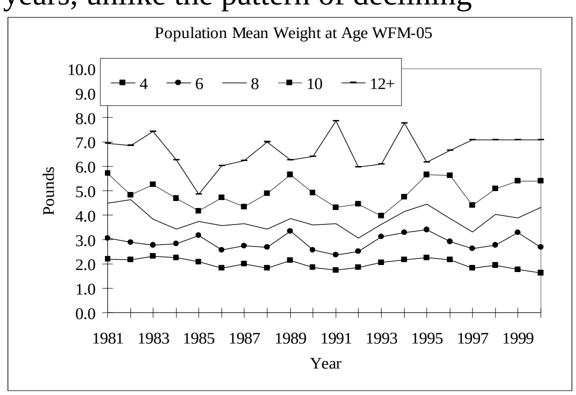
The decline in yield of whitefish in WFM-05 has mirrored the decline in gill-net effort because of an apparent decline in catchability of whitefish to the large-mesh gill-net fishery. CPUE of whitefish in the large-mesh gill-net fishery declined from 153 lb per 1,000 ft. of gill net in 1979 to17 lb per 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 fishers in WFM-05 claim the decline in catchability is because the gill nets commonly become coated with a 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 CPUE WFM-05

Whitefish from WFM-05 are of moderate to large size. The proportion of the yield made up of the three sizes of whitefish was 55% No. 1 (<3 lb), 26% medium (3-4 lb), and 19% jumbo during 1979-2000. As illustrated earlier, size structure of whitefish in the yield from WFM-05 has changed over time, as the proportion of jumbos declined and the proportion of No. 1 whitefish increased. Annual mean weight of whitefish sampled from trap-net harvest ranged from 2.0 to 3.6 lb and averaged 2.7 lb during 1981-2000. Annual mean weight of whitefish in the gill-net harvest ranged from 2.4 to 3.5 lb and averaged 2.9 lb during 1981-2000.

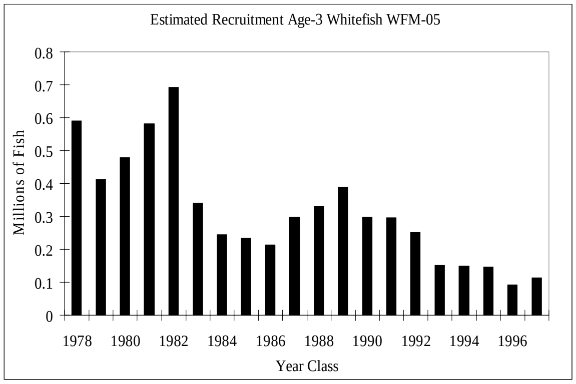
Growth of whitefish from WFM-05 has remained very stable through the years, unlike the pattern of declining growth seen in other areas of Lakes



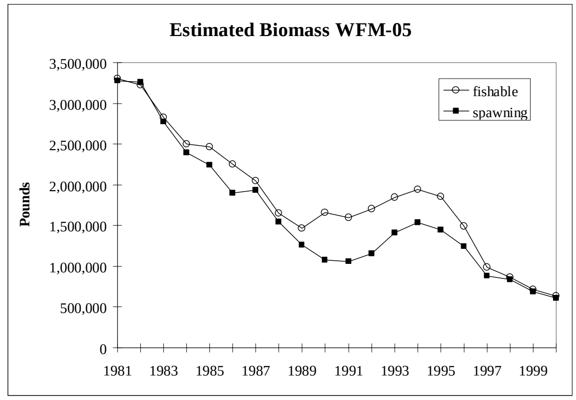
Population Mean Weight at Age WFM-05

Michigan and Huron, including substantial declines in areas adjacent to this management unit. Mean weight of ages 4-12+ whitefish showed no trends through time in WFM-05 from 1981 to 2000, although some age classes did weigh slightly less in 2000 than in 1981.

Recruitment of age-3 whitefish to the population in WFM-05 was highly variable and has declined lately based on estimates from the stock assessment model. The number of age-3 whitefish entering the population each year was estimated to average 421,000 during 1981-1989, but only 222,000 during 1990-1999. The 1978-1983 year classes were estimated to range from 340,000 to 591,000 fish, while more recently the 1993-1997 year classes averaged only 131,000 fish. It is difficult to assess whether the decline in recruitment is real, or an artifact of changing catchability in the gill-net fishery.



Biomass of whitefish estimated with the stock assessment model declined in response to declines in recruitment. Annual biomass of whitefish ≥ age 3 calculated at the beginning of each year peaked at the beginning of the 1981-2000 timeframe with 3.3 million lb.



This steadily declined to 1.5 million lb in 1989, rebounded to 1.9 million lb in 1994 and has declined to only 640,000 lb in 2000. Spawning stock biomass also followed the same trend peaking at 3.3 million lb in 1981 and declining to 614,000 lb in 2000.

Fishing mortality (F) in WFM-05 was split about equally between the gill- and trap-net fisheries in recent years. Average fishing-induced mortality on whitefish ≥ age 4 averaged 0.11 for the large-mesh gill-net fishery and 0.09 for the trap-net fishery during 1998-2000. 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.

Total annual mortality on the fishable stock in WFM-05 during 1999-2000 was substantially less than the target rate of 65%. Total annual mortality was estimated to be 54% during 1998-2000 and the spawning potential reduction value was 0.21. Consequently, the projection model estimated that fishing mortality could be increased 3.26 times in WFM-05 in 2002 from the average value during 1998-2000. The projected yield associated with this level of fishing was 244,000 lb, and was accepted as the recommended maximum yield in 2002.

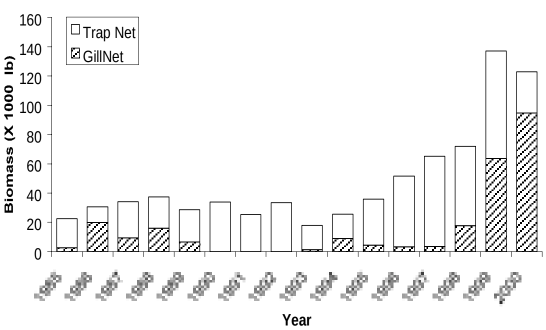
Summary Status WFM-05	
Female maturity	
Size at first spawning	NA
Age at First Spawning	3 y
Size at 50% maturity	NA
Age at 50% maturity	4 y
Spawning biomass per recruit	
Base SSBR	2.84 lb
Current SSBR	1.38 lb
SSBR at target mortality	0.60 lb
Spawning potential reduction	
At target mortality	0.21
Average yield per recruit	
Natural Mortality (M)	0.33 y^{-1}
Fishing mortality rate 1998-2000	
Fully selected age to Gill Nets	6 y
Fully selected age to trap nets	6 y
Average gill net F, ages 4+	0.11 y^{-1}
Average trap net F, ages 4+	0.09 y^{-1}
Sea lamprey mortality (ML)	
(average ages 4+,1997-1999)	0.00 y^{-1}
Total mortality (Z)	
Average ages 4+,1998-2000	0.53 y^{-1}
Recruitment (age-3)	
(1991-2000 average)	222,000 fish
Biomass (age 3+)	
(1991-2000 average)	1,366,700 lb
Spawning biomass	
(1991-2000 average)	1,089,300 lb
Recommended yield limit in 2002	244,000 lb

WFM-06 (Leland and Frankfort)

Prepared by Philip J. Schneeberger

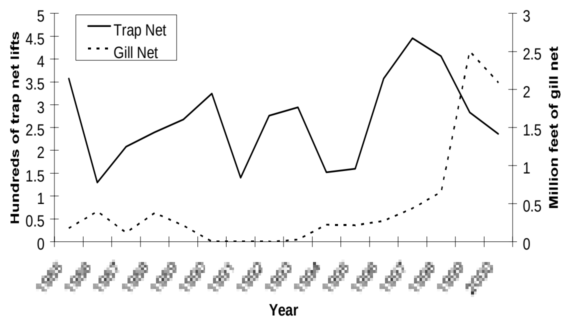
Yield during 2000 was 123,000 lb in WFM-06, 10% lower than in 1999, but 180% higher than the 1985-99 average. Of the total in 2000, gill-net yield was 95,000 lb (77%) and trap-net yield was 28,000 lb (23%). These proportions of yield by gear type contrast markedly from the period from 1985 through 1999 when gill-net yield averaged 25% and trap-net yield averaged 75% of the total. Gill-net yield was higher in 2000 than for any prior year during 1985-99 and trap-net yield was lower than any year since 1994.

Commercial lake whitefish yield WFM-06



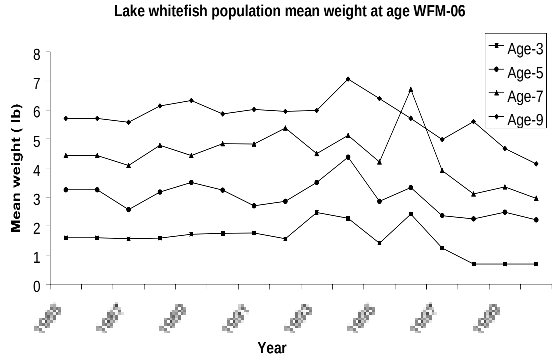
Gill-net effort rose from 27 thousand ft in 1993 to 653 thousand ft in 1998, jumped sharply higher to 2.5 million ft in 1999, then dropped slightly lower to 2.1 million ft in 2000. Trap-net effort fluctuated during 1985-2000, but the recent trend has been a sharp decline, from a peak of 446 lifts in 1997 down to 236 lifts in 2000.

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

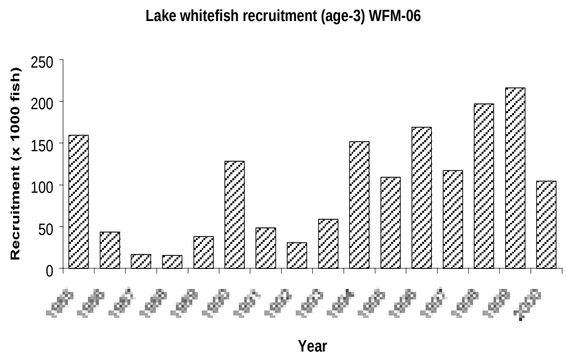


In general, lake whitefish weight-at-age in 2000 was consistent with the previous 2 years. Values have leveled off following declines that occurred from the early to mid 1990s through 1998. Weight-at-age values in 2000 for age-3-12+ fish were 20-57% lower than 1985-99 averages.

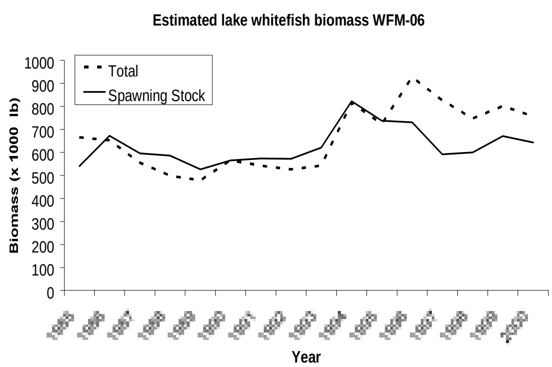
Lake whitefish population mean weight at age WFM-06



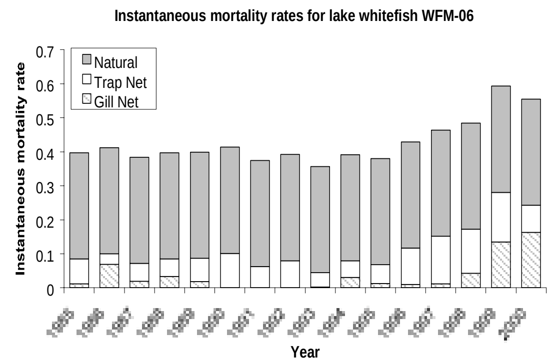
Year-class strength, based on estimated numbers of age-3 fish, has been relatively strong through the 1990s. Year classes produced in 1995 and 1996 (showing up as age 3 in 1998 and 1999) were especially strong. The 1997 year class, estimated as 104,000 age-3 fish in 2000, was moderate and was comparable to 1992 and 1994 year classes.



Estimates of fishable biomass and spawning stock biomass have been relatively stable since 1997. Values estimated for 2000 were 757 thousand lb for fishable biomass, up 15% from the 1985-99 average, and 643 thousand lb for spawning stock biomass, up 3% over the 1985-99 average. The ratio of spawning stock biomass to fishable biomass was 0.85 in 2000.



Total instantaneous mortality rate (Z) in 2000 represented a 33% increase over the 1985-99 average, due almost entirely to higher values for the gill-net fishery. Instantaneous fishing mortality rate (F) was 0.16 y^{-1} for gill nets in 2000, twice the 0.08 y^{-1} estimate for trap nets. These values were 515% (gill net) and 1% (trap net) higher than average estimates for F from 1985 through 1999. Instantaneous natural mortality rate, estimated at 0.31 y^{-1} remains the largest source of lake whitefish mortality in WFM-06.



The 2002 yield limit is 222 thousand lb, a 46% increase from the yield limit for 2001. The increase was not driven by population characteristics, but may have resulted from historical and recent yields being considerably lower than projected limits. To achieve the 2002 yield while meeting the prescribed state-tribal allocation requirements, the projection model indicates that effort should increase by a factor of 1.7 for trap nets and 3.8 for gill nets. Effort by state fishers is entirely with trap nets, and assuming all tribal effort is with gill nets, the increased effort would result in yields of 65,000 lb for the state and 157,000 lb for the tribe.

Summary Status – WFM-06	
Female maturity	
Size at first spawning	0.46 lb
Age at First Spawning	3 y
Size at 50% maturity	1.40 lb
Age at 50% maturity	4 y
Spawning biomass per recruit	
Base SSBR	2.82 lb (SE 0.005)
Current SSBR	1.3 lb (SE 0.09)
SSBR at target mortality	0.367 lb (SE 0.000)
Spawning potential reduction	
At target mortality	0.461 (SE 0.034)
Average yield per recruit	0.682 lb (SE 0.038)
Natural Mortality (M)	0.312 y^{-1}
Fishing mortality rate 1998-2000	
Fully selected age to Gill Nets	6
Fully selected age to trap nets	7
Average gill net F, ages 4+	0.103 y^{-1} (SE 0.014)
Average trap net F, ages 4+	0.109 y^{-1} (SE 0.016)
Sea lamprey mortality (ML)	
(average ages 4+,1998-2000)	N/A
Total mortality (Z)	
Average ages 4+,1998-2000	0.524 y^{-1} (SE 0.029)
Recruitment (age-3)	
(1991-2000 average)	120,170 fish (SE 14,950)
Biomass (age 3+)	
(1991-2000 average)	720,890 lb (SE 89,168)
Spawning biomass	
(1991-2000 average)	656,310 lb (SE 84,527)
Recommended yield limit in 2002	222,000

WFM-07 (Ludington)

Prepared by Archie W. Martell and Randall Claramunt

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 shared commercial fishing zone, part of the Little River zone with tribal fishing regulated under the permitting control of the Little River Band of Ottawa Indians. 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 the use large-mesh trap nets for commercial whitefish exploitation. In 2001 the Little River Band 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.

Modeling / Harvest Limits

There has not been any effort to model 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. No harvest limits have been set for this unit at this time. Pursuant to the 2000 Consent Decree, the tribes have three years of allowing commercial fishing without harvest limits before implementing 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.

Commercial Harvest and Effort

The commercial fishing harvest within WFM-07 for 1981-2001 is represented in Figure 1. Commercial harvest reached a peak of 124,735 pounds in 1984 represented mostly by large-mesh gill-net effort of 684,700 feet in Figure 2. All large-mesh gill-net effort for commercial fishing was eliminated in this unit by 1986.

Tribal commercial fishing activities in 2001 were limited and the effort was only distributed in October and November. The total harvest from 2001 was 6,361 round pounds representing 5 trap-net lifts.

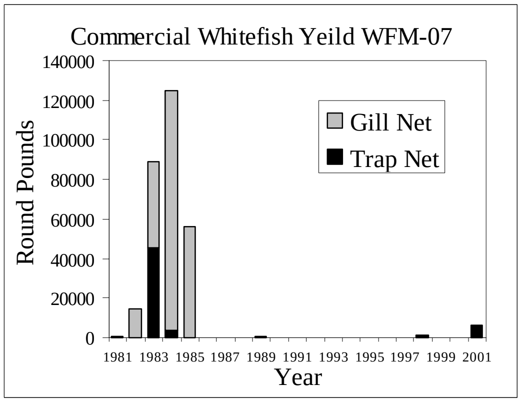


Figure 1. Reported commercial yield of lake whitefish (pounds) in WFM-07, 1981-2001.

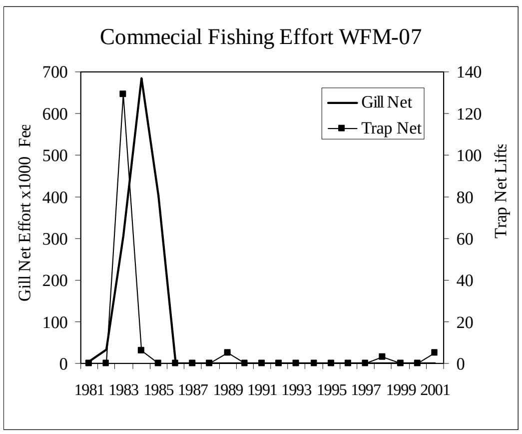


Figure 2. Commercial fishing effort in WFM-07, 1981-2001.

Historical and Current Abundance

Current abundance of lake whitefish in WFM-07 appears to be increasing as compared to compared to historical levels (Figure 3). Historical graded-mesh gill-net CPUE of 4.3/1,000 feet of for lake whitefish from spring surveys is represented by the average for 1978-1989. Between 1999 and 2002, graded-mesh gill-net survey CPUE of lake whitefish in spring assessments ranged from 1.4 to 6.5/1,000 feet respectively.

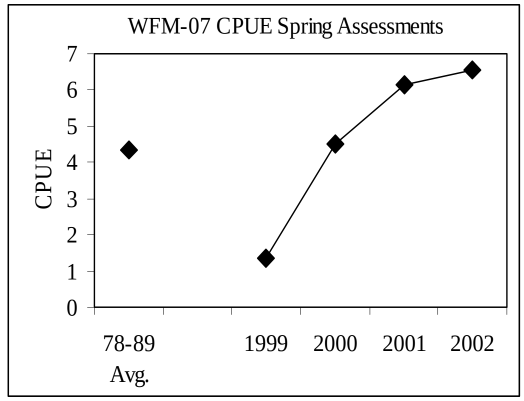


Figure 3. Spring lake whitefish graded-mesh gill-net survey CPUE, compared to 1978-1989 average CPUE.

Age, Length, Weight, Characteristics

The current mean age, mean weight, and mean total length of lake whitefish sampled in spring graded-mesh gill-net surveys has declined from the 1978-1989 average as seen in Table 1. The mean weight-at-age of lake whitefish from the 2001 graded-mesh gill-net survey compared to 1978-1989 average weight-at-age indicates a reduction for older age classes (Figure 4). There was a shift in age-class composition from higher numbers of young age fish in the 1978-1989 average to predominantly older age fish in 2001 (Figure 5).

The mean age, mean length and mean weight of commercially-harvested lake whitefish have declined from 1983 to 2001 (Table 1). The age-classes represented in the commercial harvest indicate a shift to older lake whitefish in 2001 as compared to 1983.

Table 1. WFM-07 mean age, weight, total length, and age classes from spring graded-mesh gill-net surveys (GMGN) and commercial fishing (CF) harvest.

Year	Gear	Mean Age	Mean Wt (g)	Mean TL (mm)	Age Classes
2001	GMGN	9.9	1073.3	481.6	4-16
2000	GMGN	--	1006.6	472.6	--
1978-1989 Avg.	GMGN	4.8	3101.7	593.3	2-15
2001	CF	10.9	1254.1	505.2	7-16
1983	CF	7.3	2510.2	592.3	3-17

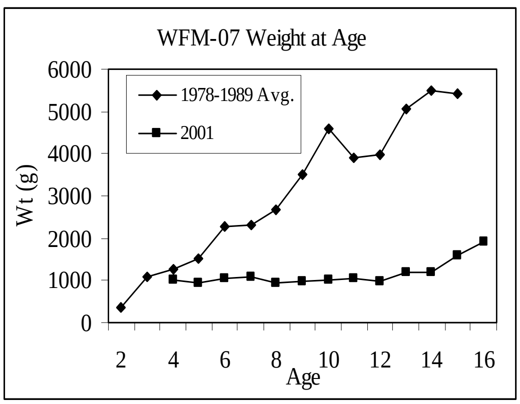


Figure 4. Spring lake whitefish graded-mesh survey mean weight-at-age.

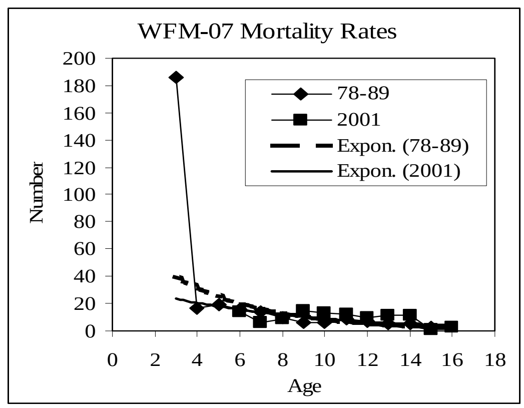


Figure 5. WFM-07 catch curves with exponential curves for total annual mortality rates.

Mortality of Lake Whitefish

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

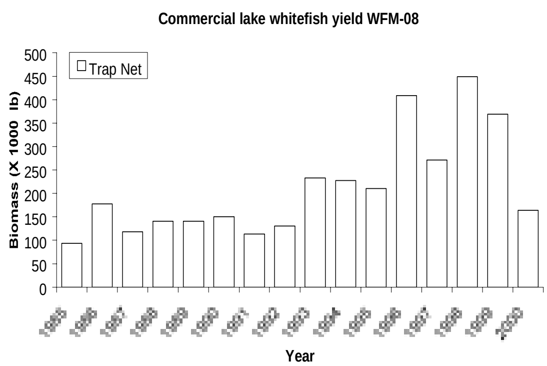
Summary for WFM-07

The lake whitefish stocks within WFM-07 are relatively unexploited as compared to other management zones in 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.

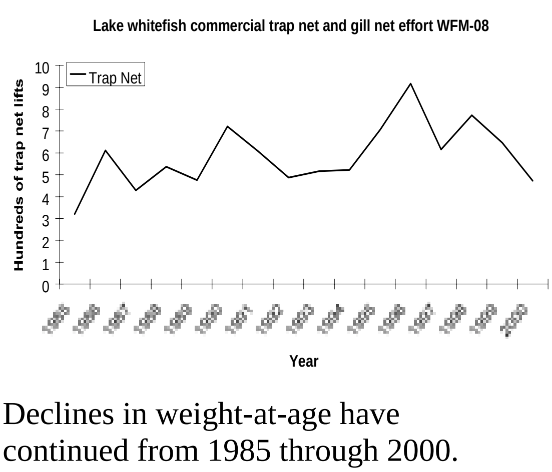
WFM-08 (Muskegon)

Prepared by Philip J. Schneeberger

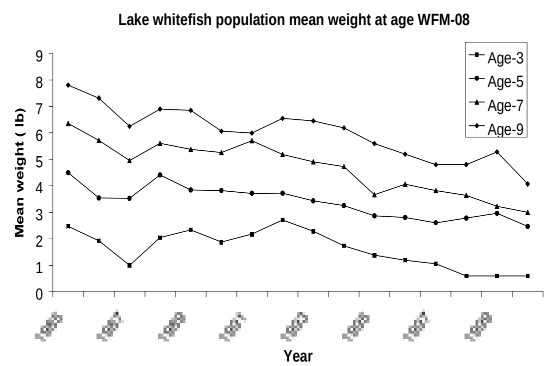
Lake whitefish yield from WFM-08 in 2000 was the lowest of any year since 1992. Trap nets are the sole commercial gear in this area and 2000 trap-net yield was 164,000 lb. This yield was 24% lower than the 1985-99 average, and 55% lower than the average from the most recent 3 years (1997-99).



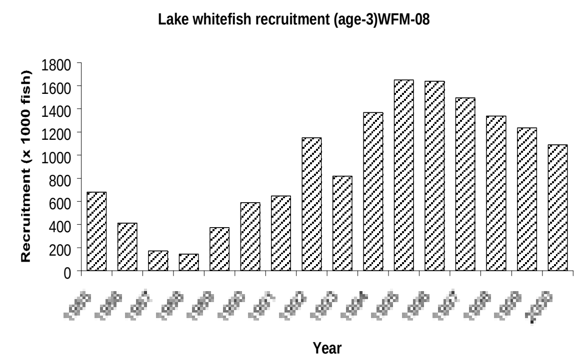
Lower yield was associated with lower effort. Trap-net effort declined for the second year in a row, falling to 473 lifts during 2000. The 1985-99 average (592 lifts) was 25% higher and the 1997-99 average (678) was 43% higher than effort in 2000.



Declines in weight-at-age have continued from 1985 through 2000. Depending on the age being considered, mean weight-at-age values in 2000 were 19-65% lower than averages for 1985-99. Despite these declines, lake whitefish weights-at-age remain among the highest in 1836 Treaty-ceded waters.

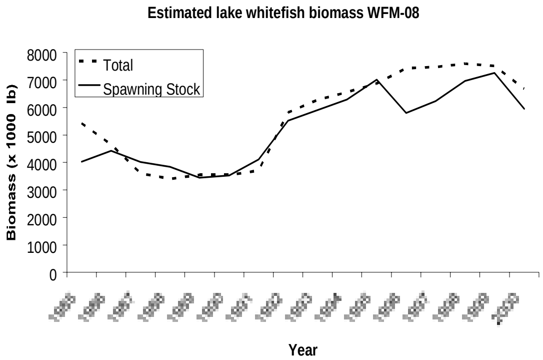


Recruitment, based on the estimated number of age-3 fish, was 1,090,000 in 2000. Estimates of recruitment have been declining gradually since 1995, but the 2000 estimate was still 19% higher than the average for 1985-99.

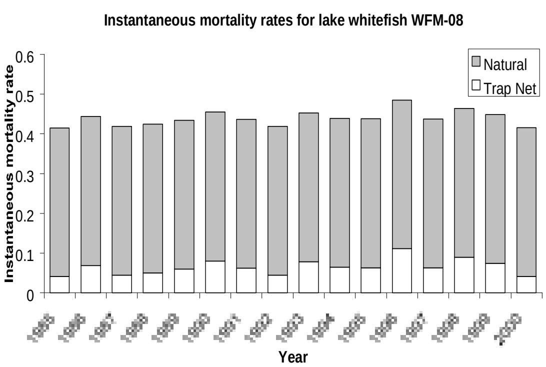


Estimates of fishable biomass and spawning stock biomass both showed upward trends from 1990 through 1999 before dipping lower in 2000. Fishable biomass was 6.7 million lb and spawning stock biomass was 6 million lb in 2000, values that were higher than 1985-99 averages by 20 and 14% respectively. The ratio of spawning stock biomass to fishable biomass was

0.89 in 2000, slightly lower than the 1985-99 average ratio of 0.94.

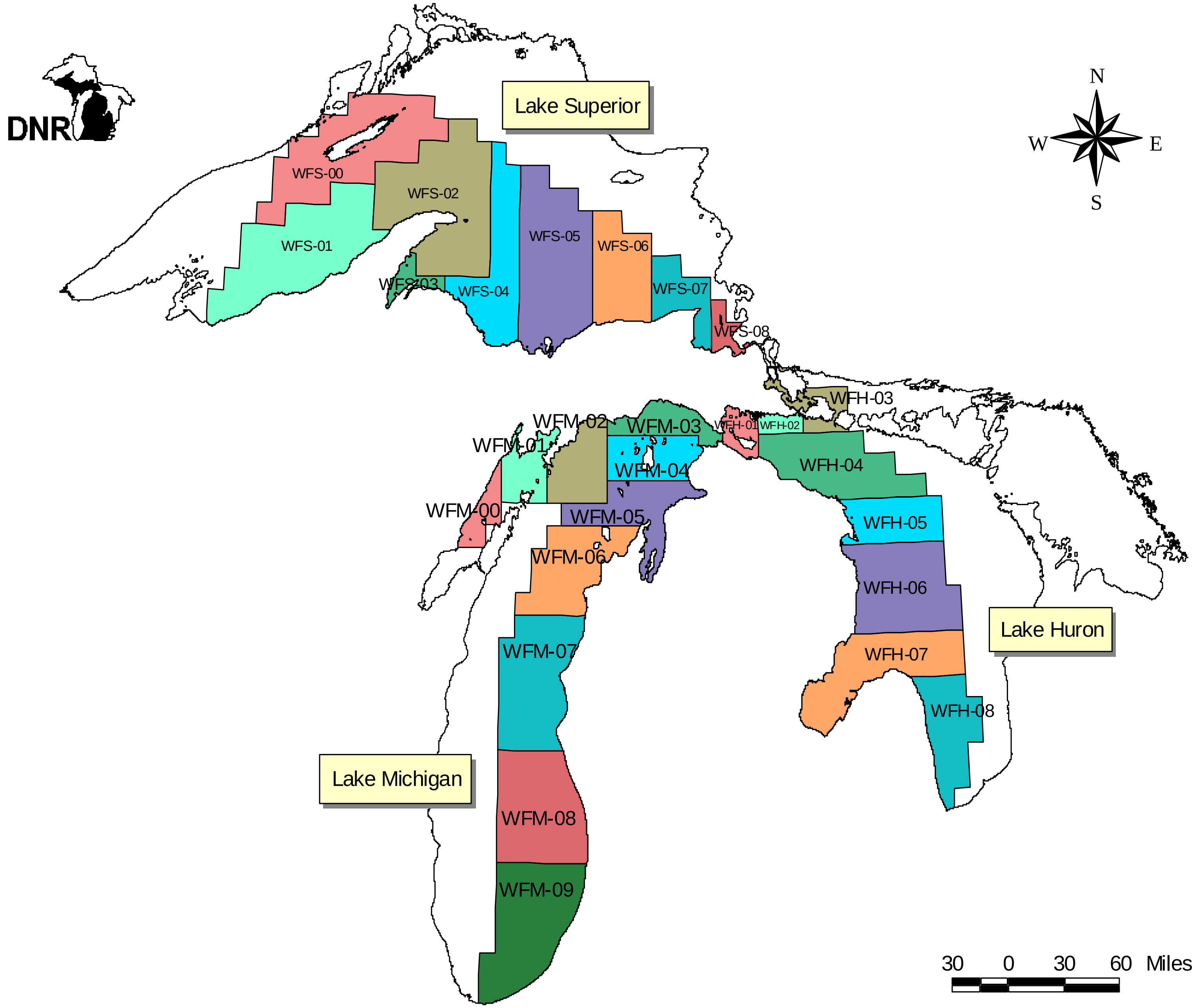


Relatively low yield and effort also translated into a relatively low (0.04 y^{-1}) estimated rate of instantaneous fishing mortality (F) for 2000. This was a 38% drop from the average estimate for 1985-99. Total instantaneous mortality rate (Z) was 0.42 y^{-1} in 2000, well below the target maximum. Estimates of mortality have been very consistent from 1985 through 2000 and F represents only 15% of Z, on average.

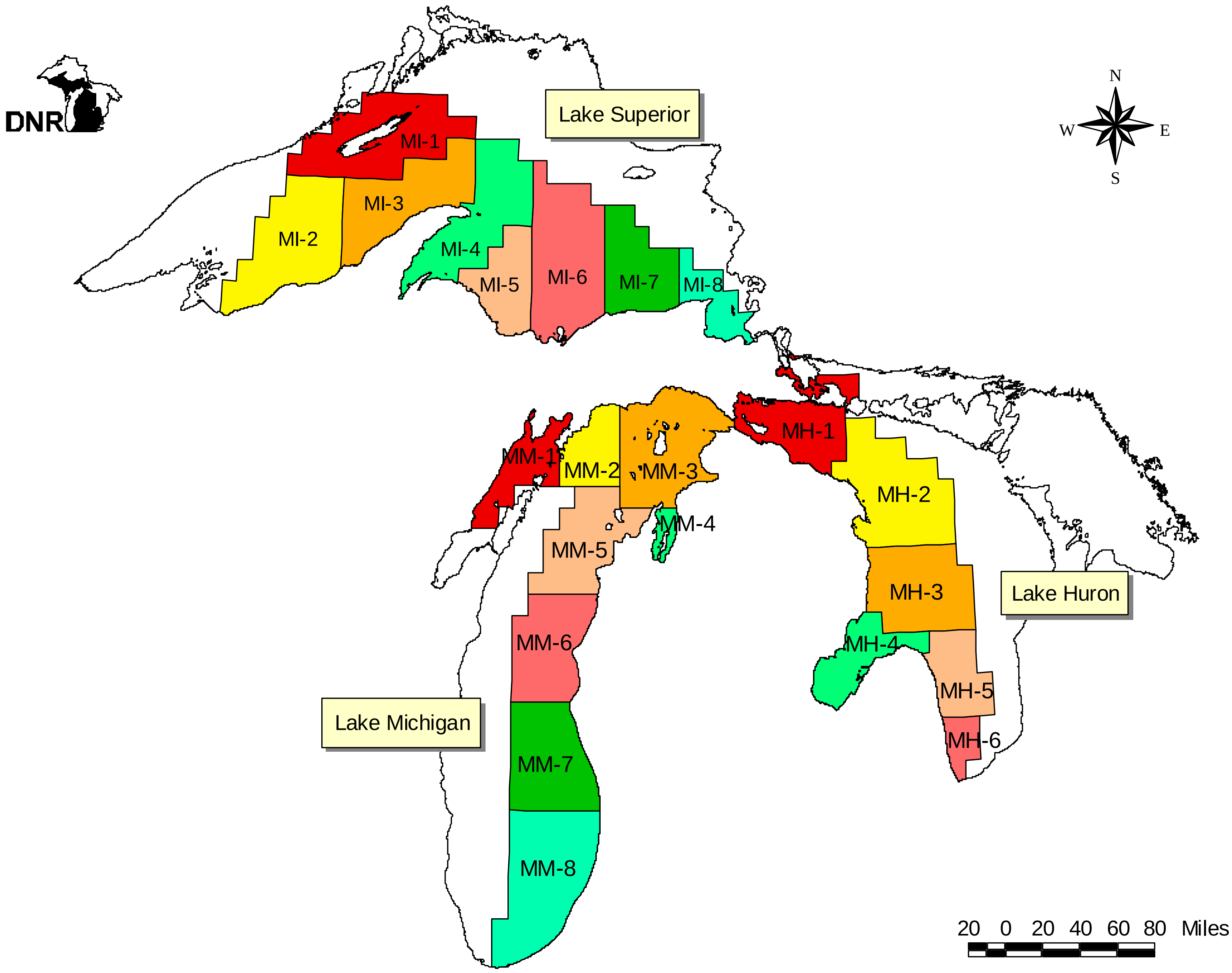


The projection model calculated a TAC of 1.861 million lb for 2002, a decrease of 44% from the 2001 TAC of 3.3 million lb. Lower values for weight-at-age, recruitment, and biomass influenced the 2002 yield limit. Trap-net effort would need to increase 8 fold to attain the 2002 TAC. The state harvest limit is 500,000 lb and the tribal harvest limit is 1,361,000 lb.

Summary Status – WFM-08	
Female maturity	
Size at first spawning	0.60 lb
Age at First Spawning	3 y
Size at 50% maturity	2.36 lb
Age at 50% maturity	4 y
Spawning biomass per recruit	
Base SSBR	2.045 lb
	(SE 0.004)
Current SSBR	1.65 lb
	(SE 0.1)
SSBR at target mortality	0.386 lb
	(SE 0.000)
Spawning potential reduction	
At target mortality	0.809
	(SE 0.047)
Average yield per recruit	0.244 lb
	(SE 0.058)
Natural Mortality (M)	0.374 y^{-1}
Fishing mortality rate 1998-2000	
Fully selected age to Gill Nets	
Fully selected age to trap nets	8
Average gill net F, ages 4+	0. y^{-1}
	(SE 0.)
Average trap net F, ages 4+	0.063 y^{-1}
	(SE 0.02)
Sea lamprey mortality (ML)	
(average ages 4+,1998-2000)	N/A
Total mortality (Z)	
Average ages 4+,1998-2000	0.438 y^{-1}
	(SE 0.02)
Recruitment (age-3)	
(1991-2000 average)	1,242,800 fish
	(SE 359,870)
Biomass (age 3+)	
(1991-2000 average)	6,591,500 lb
	(SE 1,833,100)
Spawning biomass	
(1991-2000 average)	6,105,400 lb
	(SE 1,694,900)
Recommended yield limit in 2002	1,861,000 lb



Appendix 1. Lake whitefish management units.



Appendix 2. Lake trout management units.