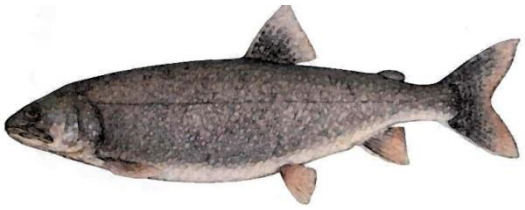
Technical Fisheries Committee Administrative Report 2017: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron, and Michigan, with Recommended Yield and Effort Levels for 2017



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

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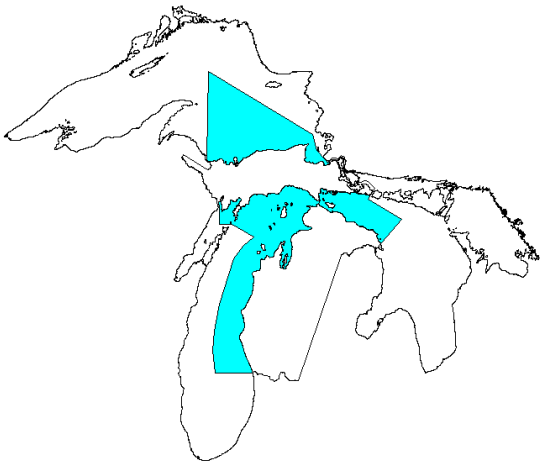
Editors



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EXECUTIVE SUMMARY

Prepared by Stephen J. Lenart and David C. Caroffino

This document outlines the status of Lake Trout and Lake Whitefish stocks in the 1836 Treaty (hereafter "Treaty") waters of the Great Lakes as assessed by the 2000 Consent Decree's (Decree) Modeling Subcommittee (MSC). The primary purposes of this report are 1) to describe the status of each managed stock in the context of establishing harvest limits according to the terms of the Decree; and 2) to document important technical changes in the stock assessment process. For more in-depth technical detail on stock-assessment structure, see the 2011 version of this report available at https://www.michigan.gov/documents/dnr/2011-status-report_371584_7.pdf

Except in a few cases, statistical catch-at-age (SCAA) models have been developed for each management unit where the provisions of the Decree apply. Estimates from the SCAA models are utilized in projection models that incorporate the mortality target and allocation rules of the Decree to calculate model-recommended yield limits for these units. Annual mortality rate targets for Lake Trout are either 40 or 45%, depending on the area, and 65% for Lake Whitefish, though a complementary rule for Lake Whitefish reduces mortality below the target rate if spawning potential ratio (SPR) falls below 0.2. Model-derived yield limits, along with the actual yield and effort limits for 2017, are provided in Table 1.

Table 1. 2017 yield and effort limits

Species	Lake	Management unit	Model-generated yield limit (lb)	Actual yield limit (lb)	Gill net limit (ft)
Lake trout	Superior	MI-5	169,456	169,456	NA
		MI-6	179,010	179,010	3,243,000
		MI-7	100,366	100,366	6,125,000
	Huron	MH-1	643,519	TBD	TBD
		MH-2	487,479	TBD	NA
	Michigan	MM-123	403,661	630,000	11,755,000
		MM-4	114,600	201,492	1,132,000
		MM-5	76,955	98,000	271,000
		MM-67	97,970	270,843	NA
Lake whitefish	Superior	WFS-04	91,000	91,000	NA
		WFS-05	312,300	312,300	NA
		WFS-06	NA	210,000	NA
		WFS-07	227,400	480,000	NA
		WFS-08	223,100	223,100	NA
	Huron	Northern Huron	479,100	379,900	NA
		WFH-05	886,600	394,000	NA
	Michigan	WFM-01	1,103,700	TBD	NA
		WFM-02	362,300	362,300	NA
		WFM-03	887,100	887,100	NA
		WFM-04	543,900	543,900	NA
		WFM-05	518,600	425,000	NA
		WFM-06	133,100	125,000	NA
		WFM-07	NA	350,000	NA
		WFM-08	277,300	500,000	NA

In instances where actual yield limits for Lake Trout units or shared-allocation Lake Whitefish units (WFS-04, WFS-05, WFM-01, WFM-06 and WFM-08) differ from model-generated yield limits, a brief explanation is provided below. For non-shared whitefish units, where the tribes have exclusive commercial fishing opportunities, harvest regulation guidelines (HRGs), as established by the Chippewa-Ottawa Resource Authority (CORA), serve as final yield limits - these may differ from the model-generated limits. SCAA models for Lake Whitefish are on a one-year lag, so estimates reported here are derived from data through 2015. For Lake Trout unit MI-7, the last full stock assessment was conducted in 2015 and the 2017 yield limit was derived by projecting the population forward an additional year. It is worth noting that a new hooking mortality rate (41%) was incorporated into the SCAA models for Lake Trout during the 2017 assessments, and recreational yield values provided below incorporate this new estimate of hooking deaths.

Lake Trout

In Lake Superior, lean Lake Trout are self-sustaining, and the SCAA models and target mortality rates apply to these wild fish in three management areas (MI-5, MI-6, and MI-7). There has been no effort to construct an assessment model for Lake Trout in unit MI-8 due to its status as a deferred area.

Modest increases in recruitment in western Treaty waters appear to have stabilized population levels in MI-5 and MI-6, where peak abundance occurred in the late 1990s to early 2000s. Estimated total biomass has been steady or increasing in MI-5 and MI-6 since 2009. In MI-7, where population levels peaked in the late 1980s, total biomass has been markedly stable since the early 1990s (based on estimates through 2014). Aside from natural mortality, sea lamprey-induced mortality (SLIM) has been the largest individual source of mortality in all modeled Superior units throughout the duration of the 2000 Consent Decree. Average SLIM rates remain lower in unit MI-5 (0.04 y^{-1}) than in units MI-6 and MI-7 (0.12 y^{-1}), a potential explanation for the slight downward trajectory of spawning biomass in MI-6 despite increased recruitment.

Commercial fishing mortality remains low (<0.05 y^{-1}) throughout the Treaty waters of Lake Superior. Commercial harvest of Lake Trout from unit MI-5 occurs exclusively in 1842 Treaty waters, though data from the most recent year (2016) were unavailable for this fishery - yield and effort were thus assumed to be equivalent to 2015 levels for stock assessment purposes. Recreational fishing mortality is low (<0.03 y^{-1}) and recreational yield has been fairly stable (40-60K lb) across Lake Superior since the mid-2000s. Total fishery yield of lean Lake Trout has only rarely eclipsed 50K lb in any modeled unit since the inception of the Decree and mortality of lean Lake Trout remains below the maximum target rate of 45% throughout Lake Superior Treaty waters.

Wild Lake Trout represent a substantial portion of the adult lake trout population in Lake Huron and wild fish continue to recruit to the fishable stock. In 2016, 50% of the Lake Trout sampled in Lake Huron Treaty-water monitoring efforts were of wild origin. Estimating recruitment of wild fish remains a challenge, a condition that has resulted in high levels of uncertainty in the scaling of the Huron populations. To address this as well as other technical issues in the Huron Lake Trout assessments, the MSC restructured the models in an attempt to better reflect the current status of the Lake Trout population in northern Lake Huron. As part of the restructuring, fishery and monitoring data from both Huron Treaty units (MH-1, MH-2), as well adjacent Ontario waters, have been combined into a single model. For this reason, individual model-based estimates for MH-1 and MH-2 are no longer available. More detail on the structure of the new combined assessment model, referred to here as "North-Central Lake Huron (NCLH)" is provided in the *Technical Changes* section that follows.

A change in the methodology used to estimate SLIM in Lake Huron has resulted in a reduced scale for this mortality component and current estimates suggest SLIM has remained below 0.06 yr^{-1} in NCLH since 2001. The most recent iteration of the Huron model estimates that natural mortality (0.09 yr^{-1}) has remained the single largest source of mortality in NCLH since the early 2000s. Yield of Lake Trout from commercial fisheries in NCLH has ranged

between 300 to 427K lb since 2004 and was virtually unchanged from 2015 to 2016 at roughly 370K lb. The majority (70-80% since 2006) of the commercial yield is associated with CORA fisheries operating in statistical district MH-1, with the remainder coming from Ontario waters. Estimated commercial fishing mortality rates associated with these yield levels are below 0.1 yr^{-1}. During 2006 to 2013, yield from recreational fisheries in the US waters of NCLH was fairly consistent (range 36-52K lb per year); recreational yields have since increased, nearly doubling from 2015 (84K) to 2016 (159K). Landings from the recreational fisheries were split nearly equally between statistical districts MH-1 and MH-2. Total annual mortality is estimated to be stable, and quite low, in NCLH – the current assessment suggests that annual mortality has remained below 23% since 2001, rates that seem highly questionable given the level of yield produced (465K average during 2012-2016). Spawning biomass is estimated to have increased annually by 30%, on average, during 2001-2010. Spawning biomass has since levelled off in NCLH, but progress toward establishing self-sustaining Lake Trout populations continues in Lake Huron. Further evaluation of the assessment structure and population scaling will continue given concerns that the harvest limit produced by the model is unrealistic, or, at a minimum, unsustainable. As of this writing, 2017 harvest limits for MH-1 and MH-2 have not been established as the Parties deliberate on how to interpret a model-based harvest limit that is more than 2-fold higher than the prior year's limit.

The Lake Michigan Lake Trout SCAA models apply only to stocked fish. Although wild fish are becoming more abundant in discrete areas of the lake, as a whole, Lake Trout recovery in Lake Michigan is well behind that of the other lakes. The Lake Michigan models underwent significant restructuring over the past two years and all units are now structurally aligned. Substantive changes are detailed in the *Technical Changes* section that follows.

In unit MM-123 total mortality was estimated to be at the target rate for the first time since the late 1980s, a product of increased stocking as well as reduced SLIM. SLIM declined for the fifth consecutive year in MM-123 and the most recent estimate (0.04 yr^{-1}) is the lowest since the mid-1990s. Commercial fishing is the largest source of mortality in MM-123, with yield eclipsing 500K lb in three of the last four years. Yield from the recreational fishery declined substantially from the level observed in 2015, yet the 48K lb harvested in 2016 was the second highest in the time series. Lower mortality rates (A=40% in 2016) have allowed stocks to build and spawning biomass is now estimated to be the highest since 1985. Nonetheless the population is still dominated by fish younger than age eight and continued population expansion will be linked to adequate survival of stocked fish – though not substantiated, recent information suggests survival may be in decline across northern Lake Michigan. The Parties adopted a harvest limit of 630K lb for Lake Trout in MM-123 for 2017, which exceeded both the model limit and the previous stipulated limit of 605K lb.

In unit MM-4, fisheries have harvested between 150-200K lb of Lake Trout annually since 2009 and during this period annual mortality has been above the 45% target. Commercial fishing is the largest source of mortality in MM-4, though recreational fishing mortality is higher than in most areas (five-year average 0.18 y^{-1}). Mortality from sea lamprey was estimated to be negligible (0.02 yr^{-1}) in MM-4 during 2015, the fourth consecutive year that SLIM was below 0.1 yr^{-1}. The most recent assessment suggests spawning biomass has been stable since 2007, but as is the case with MM-123, the survival of recently stocked cohorts is of concern. A 2009 stipulation to the Consent Decree sets base harvest limits in this unit, and it includes a transfer provision that increases CORA's harvest limit by the amount that the state remained below its harvest limit the prior year.

Mortality rates in units MM-5 and MM-67 are below target and natural mortality is the largest individual source of mortality in these units. Between 80-100K lb of Lake Trout was harvest annually from MM-5 during 2013-2016, the majority by recreational anglers (average mortality 0.09 y^{-1}). The most recent assessment indicates that abundance and biomass have been declining in MM-5 since the late 2000s, but further investigation of the assessment seems warranted since certain indices are at odds with this pattern. Mortality from sea lamprey

predation in MM-5 was barely measurable (<0.01) in 2015 and has been below the 1998 threshold for five consecutive years; thus, consensus was reached by the TFC that the conditions of the 2009 Stipulation have been met, but the Parties agreed to a continuance of the previously stipulated harvest limits for 2017. Commercial fishery yield is nearly non-existent in unit MM-67 and recreational fishery yield had not eclipsed 70K lb during 2009-2015. Recreational yield increased to nearly 120K lb in 2016, the highest since 2002. Rescaling of the population in the most recent MM-67 model resulted in a lower stock size, and slightly higher mortality estimates, than previous assessments. Biomass patterns since 2000 largely mirror those in MM-5 and as is the case with MM-5, further evaluation of the MM-67 assessment is warranted. SLIM in MM-67 followed the same pattern observed throughout Lake Michigan and mortality from sea lamprey predation was the lowest estimated for the time series (<0.02 yr^{-1}) during 2015. Due to the large reduction in the model-derived harvest limit for 2017, the Decree's 15% rule was implemented, limiting the decline in the harvest limit to a level 15% below the 2016 limit.

Lake Whitefish

Lake Whitefish populations in western Lake Superior (WFS-04 and WFS-05) are among the most stable in 1836 Treaty waters, primarily as a result of consistent recruitment and lower fishing mortality relative to eastern Lake Superior. Fishery yield during 2015 was greater in WFS-04, where most of the fishing activity occurs in 1842 Treaty waters, than WFS-05 (107K vs 71K lb) for the first time since 2007 and mortality on the most vulnerable age class was higher (0.46 vs 0.32 yr^{-1}). An upward abundance trajectory in WFS-05 is being driven by recent recruitment events, a pattern not evident in adjacent WFS-04 and one that may require additional observations to confirm. Total annual mortality in these units is well below the 65% annual target.

In unit WFS-06, where there has been no attempt to fit a stock assessment model since 2006, fishery effort is quite sporadic, as are fishery monitoring data. Annual yield had not exceeded 50,000 lb since the inception of the Decree until 2014, when 68,000 lb of Lake Whitefish were harvested. Recent yields remain variable, although the unit has attracted increased effort, perhaps offering a future opportunity for model development if biological sampling is sufficient. In the easternmost units (WFS-07 and WFS-08) fisheries are more consistent, and intense. Since 2009 commercial fishery yields from WFS-07 have ranged between 350K-500K lb and mortality rates are among the highest in Treaty waters - the target rate of 65% was exceeded during 2015, largely as a result of a gill-net fishery that exhibited a nearly three-fold increase in effort since 2013. Despite fairly consistent recruitment during the past two decades, spawning biomass continues its long, slow decline, with the most recent estimate the lowest since the early 1980s. Yields have also been consistent since the late 2000s in neighboring WFS-08, but here the trap-net fishery dominates. Trap-net effort was the highest in the time series in 2015, when more than 700 lifts were reported. Mortality rates have been markedly consistent (at roughly 50%) for over a decade and biomass levels appear to be steadier here than in WFS-07.

In northern Lake Huron Treaty waters (WFH-01 thru WFH-04), dramatic declines in recruitment that began in the early 2000s and substantial sea lamprey mortality have combined to drive Lake Whitefish stocks down to their lowest levels since the late 1970s. This area produced an average of 1.71M lb of yield during the 1990s, and as recently as 2006, yield exceeded 1M lb. Less than 230K lb of whitefish were harvested from northern Lake Huron in 2015 and catch rates are roughly 10-20% of those observed during the peak of the fishery. Estimated annual mortality of the most vulnerable age class exceeded 60% for the sixth consecutive year and spawning biomass remains near the time-series low. Similar patterns in recruitment and sea lamprey mortality are evident in adjacent unit WFH-05, though the impacts are somewhat muted when compared to the north. Nonetheless, fishery yield has declined in WFH-05 for nine consecutive years (130K lb in 2015), fishery catch rates are the lowest in the time series, and spawning biomass has declined to a level not observed since the early 1990s. Less than eleven hundred trap-net lifts were reported in the Treaty waters of Lake Huron during 2015,

the fewest dating back to at least the mid-1970s. Despite preliminary evidence for a slight recovery in recruitment, the near-term outlook for Lake Huron whitefish stocks, and fisheries, remains bleak.

Lake Whitefish recruitment patterns in northern Lake Michigan (WFM-01 thru WFM-04) are synchronous and similar to those in Lake Huron, with similarly predictable consequences: declining abundance, fishery yields and catch rates. Less than 1.2 M lb of whitefish were harvested in these four northern units combined during 2015, the lowest yield since the late 1970s. Trap-net effort has not declined across the board as it has in Lake Huron and gill-net effort remained consistent at roughly 10 M feet for the third consecutive year in units WFM-02-WFM-04 combined. Annual mortality rates are below target in these northern units (range 33-48%). Whitefish growth has increased throughout northern Lake Michigan in response to declining abundance, somewhat muting reductions in biomass. As in Lake Huron, there are signs that recruitment may be rebounding, but this has yet to be substantiated. As of this writing, a harvest limit has yet to be adopted for unit WFM-01 for the 2017 fishing season.

In central Lake Michigan Treaty units (WFM-05 and WFM-06), recruitment patterns are similar to those in the north, but fisheries are less intense and/or more sporadic and mortality rates are lower (~30%). Commercial yield increased slightly in WFM-05 during 2015 due to the reemergence of the trap-net fishery, yet remained below 60K lb for the fifth consecutive year. Low mortality and increased growth have combined to keep biomass levels more stable in WFM-05 despite declining recruitment. In WFM-06, yield declined for the fourth consecutive year to just under 25K lb during 2015, a consequence of both declining effort and catch rates. After years of holding harvest limits constant at 250K lb, the TFC agreed to recommend a harvest limit of 125K lb for WFM-06 in 2017; a harvest level thought to be more reflective of the productivity of the stock given the current ecology of the lake.

In unit WFM-07 the commercial fishery has ceased to operate. The fishery operated from 2001 through 2013, with peak yield observed in 2007. The lack of long-term monitoring data has precluded development of a SCAA model for this unit. Population dynamics in WFM-08, the southernmost Lake Michigan Treaty unit, largely mirror those in the north, with sharp declines in recruitment, biomass and fishery yields. Yield rebounded slightly in 2015 to 123K lb after two consecutive years when yield was less than 100K lb. Natural mortality is the largest source of mortality in this unit and fishing mortality on the most vulnerable age class was estimated to be 0.19 yr^{-1} in 2015. Biomass has declined from the 2008 peak and estimates suggest stock size is at the lowest level in the time series. The assessment for unit WFM-08 has generated highly variable estimates of stock size over the years, though model-generated limits have been below 300K lb the past two cycles. After reviewing the constant catch policy for WFM-08, and factoring in dynamics observed throughout Lake Michigan (and Huron), the MSC recommended, and the TFC adopted, a reduction in the harvest limit to 500K lb, a level thought to be more appropriate for this stock given current recruitment dynamics. The MSC will continue to conduct the stock assessment and evaluate a suite of stock parameters when making future recommendations to the TFC.

Technical Changes

Lake Huron Lake Trout stock assessment and stock apportionment

The Lake Huron Lake Trout models underwent a complete structural review over the past two cycles. This review resulted in a number of impactful changes to the assessment, the most significant of which are listed below.

- The two existing Huron assessments were merged into a single stock assessment, largely as a result of recent research into movement patterns of Lake Trout in Lake Huron. The model now includes data from MH-1, MH-2 and Ontario Quota Management Areas 4-1, 4-2 and 4-3. The MSC is evaluating the inclusion of fishery data from the western North Channel (NC-1). These data may be included in future iterations;
- The model now estimates total recruitment (wild plus hatchery) at age-3, without the use of stocking data;

- Based on previous studies on the susceptibility of Seneca-strain Lake Trout to sea lamprey predation, and given the dominance of this strain in the population, sea lamprey-induced mortality was reduced by 57% from the base estimates, with the reduction phased-in during 1997 through 2001 to reflect the shift in strain composition in the lake;
- Natural mortality is held constant by age and year, using a prior value of 0.10 based on previous studies on Seneca strain Lake Trout;
- Three separate base variance parameters were estimated during model-fitting- one for recruitment, the second for fishery observations, and a third for time-varying processes. For the latter two, pre-assigned ratios were then used to estimate a standard deviation for each component (as a proportion of the base variance) within the category.

These changes were implemented to address 1) long-standing, systematic retrospective patterns in stock size in MH-1 (larger stock sizes predicted with the addition of successive years of data, suggesting a lower mortality regime); 2) the inadequacy of previous methods for predicting wild recruitment (which directly linked wild recruitment to the recruitment of stocked fish after fitting to the observed proportions of stocked and wild fish); and 3) general instability around model convergence. The assumptions underlying these changes, the sensitivity of the assessment to these assumptions, and the overall technical performance of the assessment are still being evaluated by the MSC. The assessment was assigned a low rating pending further vetting.

Differing mortality-rate targets and allocation schemes for management units MH-1 and MH-2 necessitated formulation of a method to apportion the abundance estimates from the model into the discrete management areas included in the assessment (MH-1, MH-2, and OH-1). This was accomplished by deriving estimates of habitat (area of surface waters <80m) for each area using a GIS-based spatial analysis, the results of which follow.

Unit	ha<80m	Proportion
MH-1	308,015	0.406
MH-2	254,946	0.336
OH-1	196,346	0.259

The estimated abundance for each age class was then apportioned to the Treaty-area units according to these habitat proportions, followed by implementation of the usual projection model procedures for fitting to the management targets to derive the unit-specific harvest limits.

Lake Michigan Lake Trout assessments

A variety of structural refinements were incorporated into all four Lake Michigan Lake Trout assessments, including the following most substantive alterations

- Institute separate surveys for time periods corresponding to pre- and post-implementation of the Lake Michigan Lakewide Assessment Plan (1998);
- For the post-LWAP survey period, include month as a fixed factor in mixed-model estimates of survey cpe; this was implemented to account for inclusion of Fishery-Independent Lake Whitefish survey effort (beginning in 2001), which primarily occurs in the summer months;
- Replace the four-parameter double logistic functions (often with fixed parameters) with freely estimated two-parameter lognormal functions to estimate fishery and survey selectivities;
- Expand age compositions to age-15+ for all data sources;
- Implement model-based estimates of lengths- and weights-at-age.

The modeled time series for units MM-123 and MM-67 now begin in 1985 versus 1981. This change is expected to be implemented for units MM-4 and MM-5 during the next assessment cycle. Furthermore, modelers are evaluating the maximum effective sample size (ESS) for fishery and survey age compositions- in most units the ESS assigned to the fishery components has been down-weighted relative to past assignments. This evaluation will continue.

Hooking mortality estimates for Lake Trout

The results of a recently completed research project conducted in lakes Superior and Huron revealed that the existing estimate of hooking mortality utilized in the Lake Trout assessments (15%) is an underrepresentation of this mortality component. Based on the results of the study, the MSC has incorporated a hooking mortality rate of 41% across all Treaty units, beginning with the assessments utilized to derive 2017 model-generated harvest limits.

Lake Whitefish assessments

A number of modest structural or data-related changes have been instituted in many of the Lake Whitefish assessments over the past few cycles. Though not universally adopted, the following items represent a general approach:

- Use of model-based estimates of lengths- and weights-at-age;
- Constant, size-based selectivity and increased use of gamma or lognormal functions to estimate gill-net fishery selectivity (versus a double logistic function);
- Expansion of the plus group in fishery age compositions;
- Trend toward down-weighting of the effective sample size for age composition data.

Regarding the latter, the MSC is exploring the use of an iterative fitting approach to estimate multinomial effective sample size. Such an approach would utilize year-specific assignments of effective sample size in place of the single pre-assigned integer currently in use. Such an approach would logically apply to the Lake Trout assessments as well.

Finally, in all but the eastern Lake Superior units, otoliths have become the standard structure for estimating the age structure of Lake Whitefish populations in Treaty waters.

MANAGEMENT UNIT DESCRIPTIONS

The Great Lakes are divided into spatially explicit management units, which differ for Lake Trout and Lake Whitefish. The provisions of the 2000 Consent Decree apply to each of the individual management units either partially or wholly contained within the 1836 Treaty-ceded (Treaty) waters of the Great Lakes. What follows are descriptions of the nine Lake Trout management units (Figure 1) and 15 Lake Whitefish management units (Figure 2) that are assessed by the Modeling Subcommittee.

Lake Trout Management Units

MI-5: Lake trout management unit MI-5 extends from Pine River Point (west of Big Bay) to Laughing Fish Point (east of Marquette) covering 374,000 ha. This management unit includes Stannard Rock, an offshore shoal about 72 km north of Marquette, and is in both the 1836 (250,000 ha) and 1842 Treaty waters (124,000 ha). The 1836 Treaty area extends east from the north-south line established by the western boundaries of grids 1130, 1230, 1330, 1430, and 1530. This unit has a wide bathymetric range with depths beyond 235 m, and with 117,000 ha shallower than 80 m.

MI-6: Lake trout management unit MI-6 extends from Laughing Fish Point (east of Marquette) to Au Sable Point (east of Munising), encompassing 728,000 ha. This management unit includes Big Reef, an offshore reef complex about 32 km northeast of Munising. This management unit contains the deepest waters of Lake Superior with soundings deeper than 400 m, and only 105,000 ha of the total area is shallower than 80 m.

MI-7: Lake trout management unit MI-7 extends from Au Sable Point (west of Grand Marais) to Little Lake Harbor (east of Grand Marais), encompassing 457,000 ha. This management unit has complex bathymetry with many lacustrine ridges, trenches, and slopes. There is approximately158,000 ha of lean Lake Trout habitat (depth less than 80 m).

MH-1: Lake trout management unit MH-1 is located in northern Lake Huron and extends from the Mackinac Bridge south to the border between grids 607 and 608. For stock assessment purposes, biological data from adjacent Ontario waters and unit MH-2 are included. The management unit has a wide bathymetric range with areas in grids 407 and 408 as deep as 130 m. The Michigan portion of this unit lies completely within 1836 Treaty waters, covering 437,000 ha, of which approximately 308,000 ha are less than 80 m in depth. The Ontario portion, which lies outside 1836 Treaty waters, covers approximately 124,000 ha, of which approximately 69,000 ha is less than 80 m in depth. On the Michigan shore this unit encompasses the ports of Saint Ignace, Mackinaw City, Cheboygan, Hammond Bay, and Rogers City. The St. Marys River, connecting Lakes Superior and Huron, flows into Lake Huron in grid 306. The 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 72,000 ha of 1836 Treaty waters. Retention of Lake Trout in the refuge is prohibited. For Lake Trout assessment purposes, this unit is presently combined with MH-2.

MH-2: Lake trout management unit MH-2 is in north-central Lake Huron. For assessment purposes, data from this unit are combined with adjacent Canadian waters and MH-1. This unit contains the boundary of the 1836 Treaty (304,000 ha within and 336,000 ha outside), a line running north-east from the mouth of the Thunder Bay River (or the tip of North Point) to the international border. The Michigan ports of Presque Isle and Alpena are contained in this unit. The management unit has a wide bathymetric range with areas in grids 714 and 814 deeper than 210 m, and a total of approximately 255,000 ha of the Michigan portion has bottom depths less than 80 m. A similar area (257,000 ha) in the Ontario portion contains waters less than 80 m. 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, a large offshore reef complex that bisects districts MH-2 and MH-3. A portion of the Six

Fathom Bank Refuge is contained in unit MH-2, covering the eastern half of grid 913 grid 914 and Michigan waters of grid 915. Retention of Lake Trout is prohibited in the refuge. Canadian waters adjacent to the refuge are a commercially protected area where commercial fishers are prohibited from fishing in waters shallower than 40 fathoms.

MM-123: 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, covering 1.29 million ha. Water depths in the northern portion of the unit are generally less than 45 m, and approximately 911,000 ha are less than 80 m. In southern portions of the unit, depths can be greater than 170 m. Most of the historically important Lake Trout spawning reefs in Lake Michigan are located in MM-123. The unit contains many islands including the Beaver Island complex (Beaver, Hat, Garden, Whiskey, Trout, High and Squaw Islands), North and South Fox Islands, and Gull Island in Lake Michigan. Another series of islands form a line separating Green Bay from Lake Michigan; these include Little Gull, Gravely, St. Martins, Big and Little Summer and Poverty Islands. Except for the southern one-half of MM-1 in Green Bay, this management unit is entirely in 1836 Treaty waters, and contains a Lake Trout refuge. The "northern refuge" is nearly 233,000 ha and occupies the southern ½ of grids 313 and 314, grids 413, 414, 513-516, the northwest quarter of grid 517, grid 613, and the northern ½ of grid 614. Retention of lake trout by sport or commercial fisheries is prohibited in the refuge. Both commercial and subsistence gill-net fishing are prohibited in the refuge, while commercial trap-net operations are permitted to harvest Lake Whitefish.

MM-4: Lake trout management unit MM-4 encompasses the Grand Traverse Bay region of Lake Michigan. There are two islands in this management unit, Bellow and Marion Island. A large peninsula bisects the southern half of the bay. For the most part water depths in the bay range up to 85 m. However, waters on either side of the peninsula are much deeper, ranging to 134 m in the west arm and 195 m in the east arm. This management unit is entirely in 1836 Treaty waters. There are no refuge areas allocated, however commercial fishing is prohibited in the southern most portion of the bay (grids 915 and 916). The total area of the unit is 66,000 ha of which 50,000 ha are less than 80 m 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.

MM-5: 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 546,000 ha 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 250 m and for the most part are greater than 120 m. Only 125,000 ha (23%) of the unit are at depths less than 80 m. 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.

MM-67: Lake trout management unit MM-67 is located in eastern central Lake Michigan, comprising 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 1,157,000 ha, of which 241,000 ha are less than 80 m in depth. The northern section of the region (MM-6) is deeper, with depths up to 275 m, and is characterized by greater slope than the southern section (MM-7). For the most part, water depths in MM-7 are less than 122 m. There are no islands or structures in southern treaty waters, and there is little Lake Trout spawning habitat, with the exception of offshore deep-water spawning reefs located within the mid-lake refuge. 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 179,000 ha

in the unit are outside treaty waters. A line running parallel to the northern side of the Grand River (located approximately ¾ of the way through grids in the 1900 series) out to the state line in the middle of the lake delineates the southern boundary of treaty territories in the unit. Management unit MM-67 contains a portion of the mid-lake Lake Trout refuge, which comprises 850 square miles of the unit (grids 1606, 1607, 1706, 1707, 1806, 1807, 1906 and 1907). It is illegal for recreational, commercial and subsistence fishers to retain Lake Trout when fishing in the refuge area. Gill-net fishing (both commercial and subsistence) is prohibited in the refuge, State- and Tribal-licensed commercial trap-net operations are permitted to fish in the refuge; however, the retention of Lake Trout is prohibited.

Lake Whitefish Management Units

WFS-04: Lake whitefish unit WFS-04 (486,000 ha) is located in Lake Superior near Marquette, roughly between Big Bay and Laughing Fish Point. Near shoreline features of this zone include many points, bays, islands, and in-flowing rivers. Habitat suitable for Lake Whitefish growth and reproduction is associated with many of these features. This unit holds waters both within and outside the 1836 Treaty area. Based partly on the number of statistical grids on either side of the 1836 treaty line and partly on established protocol for a similar situation with Lake Trout, 70% of WFS-04 is considered to be in 1836 waters.

WFS-05: The WFS-05 Lake Whitefish management unit extends approximately from Laughing Point to Au Sable Point in Michigan waters of Lake Superior. Surface area of the unit is 747,000 ha. Several bays (Shelter Bay, Au Train Bay, South Bay, and Trout Bay) and islands (Au Train Island, Wood Island, Williams Island, and Grand Island) are prominent in this area, providing substrate and depth contours suitable for Lake Whitefish habitat and spawning. Different whitefish stocks exist within this unit, including a smaller, slower-growing stock identified in Munising (South) Bay.

WFS-06: The Grand Marais stock of Lake Whitefish is probably one of the smallest in the 1836 ceded waters, certainly the smallest in terms of harvest levels in Lake Superior waters. There are typically only small aggregations of spawning Lake Whitefish in WFS-06, based on anecdotal information from commercial fishers that have regularly fished WFS-06 throughout the year.

WFS-07: WFS-07 is located in the Whitefish Bay area of Lake Superior and contains 150,000 ha of water less than 80-m deep. There is a substantial commercial fishery in adjacent Canadian management unit 33. WFS-07 contains a single, large stock of whitefish that spawns in the southwest portion of Whitefish Bay.

WFS-08: WFS-08 is located in the southeast portion of Whitefish Bay, Lake Superior. WFS-08 is spatially the smallest of the management units in the 1836 ceded waters of Lake Superior, and it contains 65,000 ha of water less than 80-m deep. A substantial commercial fishery targeting whitefish also exists in adjacent Canadian management units 33 and 34. It is thought that four reproductively isolated stocks of whitefish contribute to the commercial fishery in WFS-08. There are two spawning areas in WFS-08, a probable contributing spawning population in Canadian waters of management unit 34, as well as contributions from spawning fish in WFS-07 directly west of WFS-08.

Northern Huron (WFH-01 thru WFH-04): Management unit WFH-01 is located in the northwest portion of the main basin of Lake Huron. It is relatively shallow and contains 94,000 ha of water less than 80 m. Management unit WFH-02 is located along the northern shore of the main basin of Lake Huron. Much of WFH-02 is deeper than 45 m and maximum depth is slightly more than 90 m. WFH-02 is a small unit made up of only three statistical grids and contains 50,000 ha of water less than 80-m deep. The unit has an irregular shoreline with many small, rocky points, small bays, and scattered boulders. Management unit WFH-03 is small and encompasses only the area around Drummond Island. A Lake Trout refuge is located along the south shore of Drummond Island where large-mesh gill-net fishing is prohibited and retention of Lake Trout by trap-net fisheries is prohibited. The south side of WFH-03 is deep. with much of the water exceeding 45 m in depth, whereas the north and west sides of Drummond Island are relatively shallow. WFH-03 contains six statistical grids and less than 40,000 ha of water less than 80-m deep. WFH-04 is the largest

whitefish management unit in the 1836 Treaty waters of Lake Huron. The unit contains 153,000 ha of water less than 80-m deep. Spawning concentrations of whitefish are scattered throughout the unit with concentrations being found from Cheboygan to Hammond Bay.

WFH-05: WFH-05 extends from Presque Isle south to the southern end of grids 809-815 in US waters and includes some waters of Lake Huron that lie outside the 1836 Treaty waters. There are an estimated 85,000 ha of water less than 80-m deep in WFH-05. WFH-05 contains multiple spawning aggregates, most of which are likely associated with the numerous islands (Crooked, Gull, Middle, Sugar and Thunder Bay) or small embayments that are found in the southern part of the unit.

WFM-01: Lake whitefish management unit WFM-01 is located in the 1836 Treaty waters of northern Green Bay. Prominent features of this area include two large bays (Big and Little Bay de Noc), numerous small embayments, several islands (including St. Martins Island, Poverty Island, Summer Island, Little Summer Island, Round Island, Snake Island, and St. Vital Island), as well as various shoal areas (Gravelly Island Shoals, Drisco Shoal, North Drisco Shoal, Minneapolis Shoal, Corona Shoal, Eleven Foot Shoal, Peninsula Point Shoal, Big Bay de Noc Shoal, Ripley Shoal, and shoals associated with many of the islands listed above). Little Bay de Noc is the embayment delineated by statistical grid 306, and its surface area is 16,000 ha. Shallow waters characterize the northern end and nearshore areas, but there is a 12- to 30-m deep channel that runs the length of the bay. Rivers that flow into Little Bay de Noc include the Whitefish, Rapid, Tacoosh, Days, Escanaba, and Ford. Big Bay de Noc is a larger embayment of 38,000 ha delineated by statistical grids 308 and 309. Big Bay de Noc is relatively shallow with over half the area less than 10-m deep and a maximum depth of 21 m. Rivers that empty into Big Bay de Noc include the Big, Little, Ogontz, Sturgeon, Fishdam, and Little Fishdam. Only grids 308, 309, 407 and 408 are entirely within 1836 Treaty waters

WFM-02: WFM-02 is located in the northwest portion of Lake Michigan. There are 157,000 ha of water less than 80-m deep in the unit. The only known spawning population of whitefish in the management unit is located in Portage Bay; this population is not as abundant as other stocks in Lake Michigan. Many of the whitefish inhabiting WFM-02 move into the unit from adjacent units.

WFM-03: 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 a complex of shoals and islands surrounding it. Nearly the entire unit is shallow water less than 27 m deep. There are 195,000 ha of water less than 80-m deep.

WFM-04: WFM-04 is located in central northern Lake Michigan and contains a very diverse range of habitat. The Beaver Island archipelago, which consists of eight named islands, is the dominant feature of the unit. These islands, located mainly along the northern edge of the unit, are associated with a large, rocky reef complex that extends about 15 miles west from Waugoshance Point near the northwestern tip of Michigan's Lower Peninsula. This northern reef complex is shallow, ranging from 2- to 9-m deep. Many smaller submerged reefs extend from the northern reef complex to the south, running along the east and west sides of Beaver Island, a 14,245 ha landmass that bisects the unit. These latter reefs are surrounded by deep water. WFM-04 contains 234,000 ha of water less than 80-m deep.

WFM-05: 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 greater than 80-m deep, including both the east and west arms of Grand Traverse Bay. The deepest parts of WFM-05 exceed 183 m, both in the offshore waters west of the Leelanau Peninsula, as well as within the east arm of Grand Traverse Bay. Several small shallow reef areas are located in the offshore waters, and there is an extensive shallow water area associated with the Fox Islands. Seventeen statistical grids make up WFM-05, but only 197,000 ha, or 46% of the water in these grids, is less than 80-m deep. Much of the offshore waters of WFM-05 are part of the northern Lake Michigan Lake Trout refuge.

WFM-06: Lake whitefish management unit WFM-06 is located in 1836 Treaty waters west of the Leelanau Peninsula from about Cathead Point

south to Arcadia. Surface area for this unit is 382,000 ha (including part or all of grids 709-714, 808-814, 908-912, and 1008-1011). These waters of Lake Michigan include Good Harbor Bay, Sleeping Bear Bay, and Platte Bay. Two large islands, North Manitou and South Manitou, are contained in this management zone, as are three large shoal areas including North Manitou Shoal, Pyramid Point Shoal, and Sleeping Bear Shoal. Major rivers flowing into WFM-06 include the Platte and the Betsie. Betsie Lake is a drowned river mouth formed where the Betsie River flows into Lake Michigan. Except for areas near shore or around the islands, most of the waters in WFM-06 are deep (greater than 60 m). Bays, islands, and shoal areas offer the best habitat for Lake Whitefish spawning in this management area.

WFM-07: 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 Michigan/Wisconsin 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 521,000 ha, of which 111,000 ha have bottom depths of 80 m or less, with maximum depths up to 275 m. There are several inflows from the Big Manistee, Little Manistee, Big Sable, Pere Marquette, and Pentwater Rivers, and drowned river mouths at Manistee Lake, Pere Marquette Lake, and Pentwater Lake.

WFM-08: Management unit WFM-08 is the Lake Michigan whitefish zone that extends from Montague south past Port Sheldon. WFM-08 has a surface area of 610,000 ha in Michigan grids 1706-1710, 1806-1810, 1906-1911, and 2006-2011; only those waters north of the Grand River lie within 1836 Treaty waters. Apart from the shoreline, and inflows from the White, Muskegon, and Grand Rivers, and drowned river mouths at White Lake, Muskegon Lake, Mona Lake, and Pigeon Lake, this area has few other distinguishing features relevant to Lake Whitefish biology. Depth gradients west from shore are relatively gradual, but most of the waters in WFM-08 are 61-m deep or deeper.

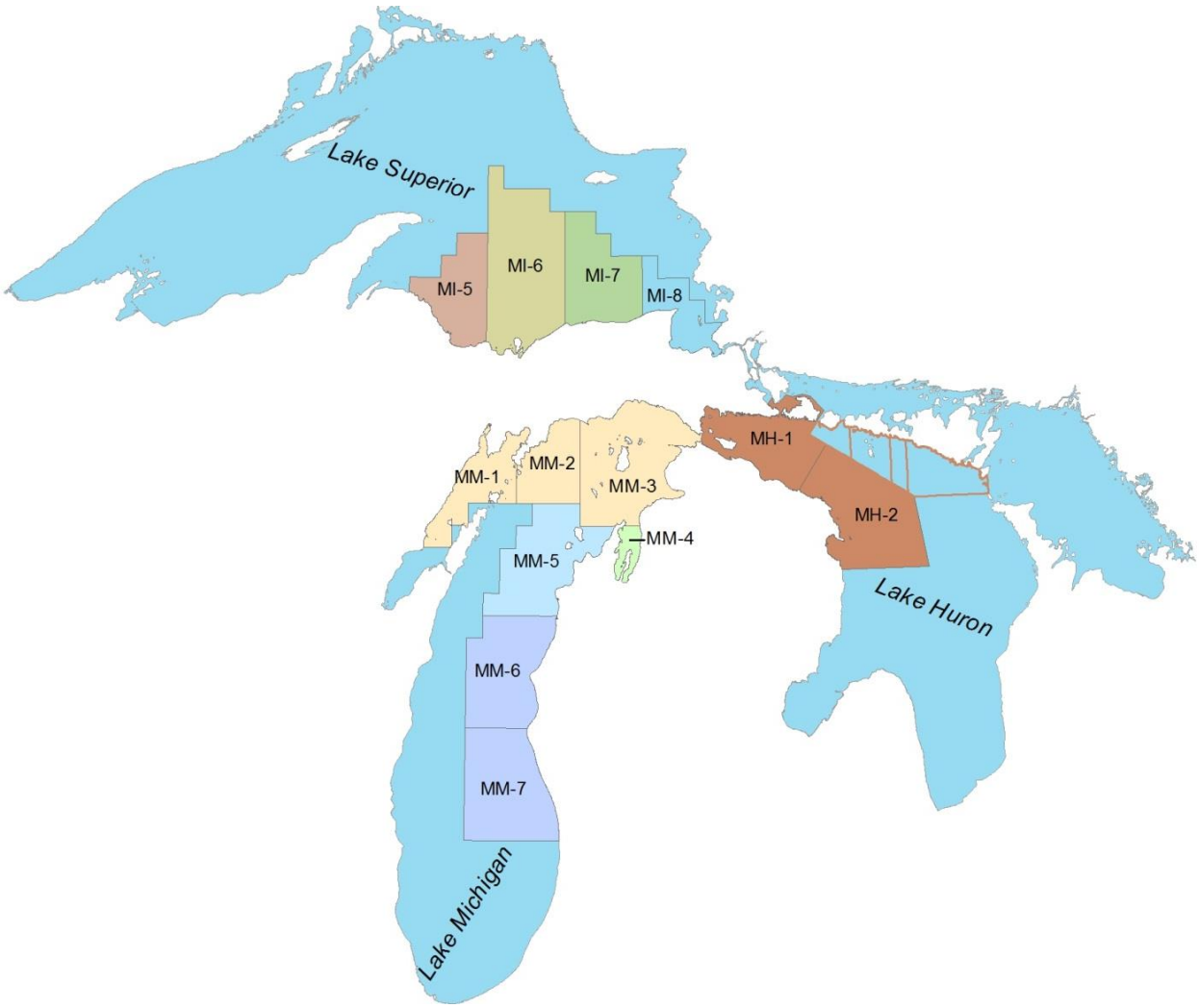


Figure 1. Lake Trout Management Units. Shaded areas denote units subject to provisions of the 2000 Consent Decree. Like shading indicates where statistical districts have been combined into a single management unit for stock assessment purposes. In the case of Lake Huron, outlined areas adjacent to statistical districts MH-1 and MH-2 denote where fishery data from Ontario waters are included in the stock assessment for Lake Huron. No stock assessment has been developed for Lake Superior unit MI-8.

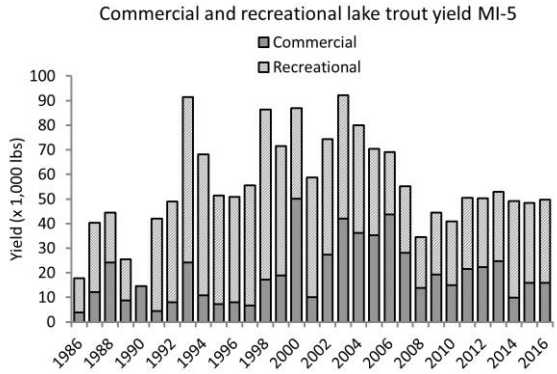
Figure 2. Lake Whitefish Management Units. Shaded areas denote units subject to provisions of the 2000 Consent Decree. Like shading indicates where units have been combined into a single management area for stock assessment purposes. No stock assessment model has been developed for Lake Michigan unit WFM-07 and the stock assessment model for Lake Superior unit WFS-06 has not been populated since 2006 due to a paucity of available data.

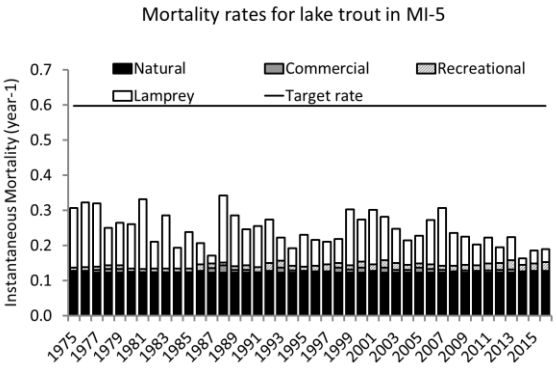
STATUS OF LAKE TROUT POPULATIONS

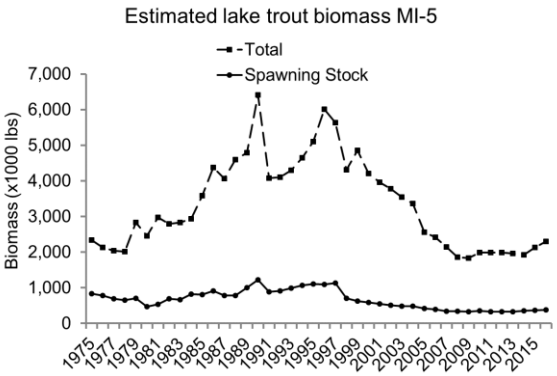
Lake Superior

MI-5 (Marquette)

Shawn Sitar

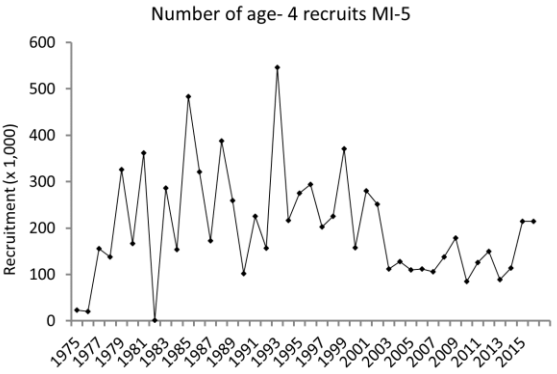






Parameter[(1)]	Value
Base SSBR	3.91 lb
Current SSBR	1.73 lb
Target SSBR	0.188 lb
Current SPR	0.44
M	0.12 y^{-1}
F, Commercial (2014-2016)	0.005 y^{-1}
F, Recreational (2014-2016)	0.02 y^{-1}
Sea Lamprey Mort (2013-2015)	0.04 y^{-1}
Z (2016)	0.19 y^{-1}
Recommended TAC	169,456 lb
Actual TAC	169,456 lb
Model Rating	Medium

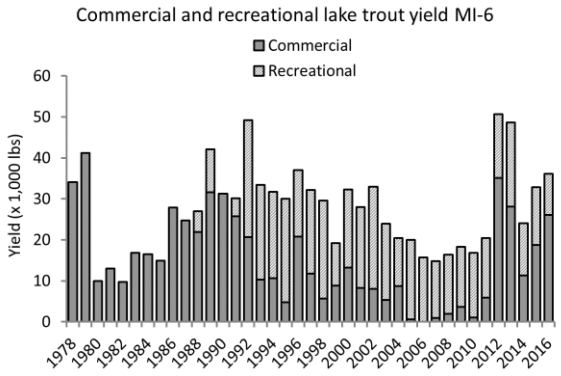
(1) For this table and all subsequent tables in this section, mortality rates represent averages for Lake Trout ages 6-11.

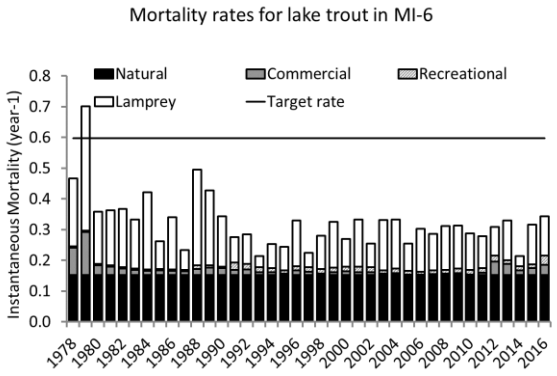


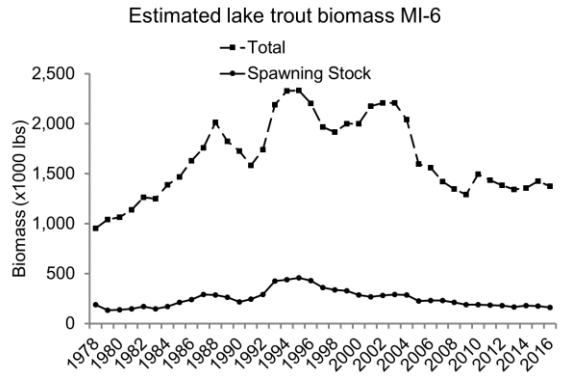
<u>Notable Stock Dynamics and Model Changes:</u>

Lake trout biomass has been stable for the past decade and the population in this unit experiences low mortality rates. No changes were made to the model for 2017; however, commercial data were not provided and 2015 information was carried forward for 2016 as a placeholder. The harvest limit for 2017 increased 14% from 2016 due to a small increase in stock size.

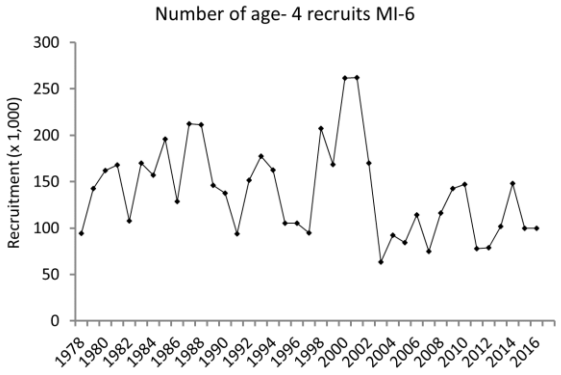
MI-6 (Munising) Shawn Sitar







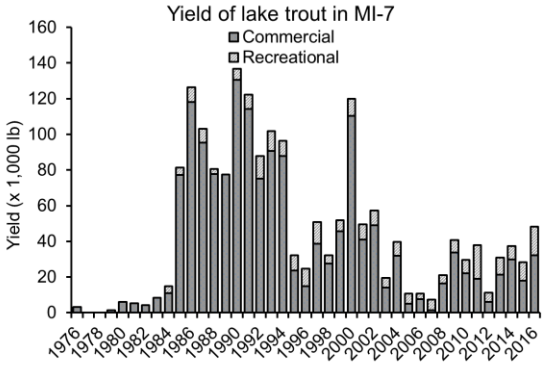
Parameter	Value
Base SSBR	2.45 lb
Current SSBR	0.69 lb
Target SSBR	0.27 lb
Current SPR	0.28
M	0.15 y^{-1}
F, Commercial (2014-2016)	0.02 y^{-1}
F, Recreational (2014-2016)	0.02 y^{-1}
Sea Lamprey Mort (2013-2015)	0.10 y^{-1}
Z (2016)	0.34 y^{-1}
Recommended TAC	179,010 lb
Actual TAC	179,010 lb
Model Rating	Medium



<u>Notable Stock Dynamics and Model Changes:</u>

Biomass has generally been stable in MI-6 since 2010 and the stock experiences low mortality, similar to MI-5. No changes were made to the model structure for 2017. Of note, sea lamprey mortality increased substantially from the prior value, although the previous value was not directly estimated from data, due to the lack of a spring survey in MI-6. The increase in lamprey mortality caused the harvest limit to decline; however, it is more in line with limits estimated in recent years.

MI-7 (Grand Marais) Shawn Sitar

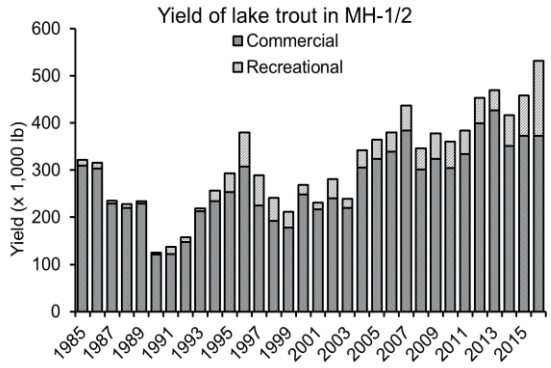


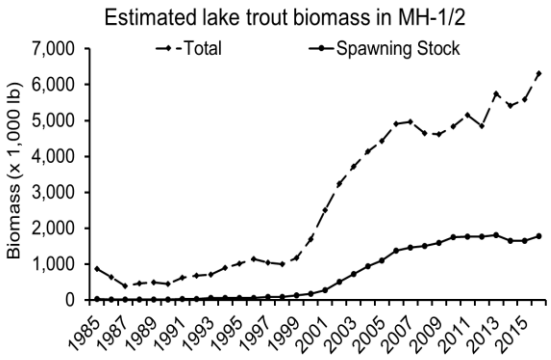
Parameter	Value
Sea Lamprey Mort (2013-2015)	0.103 y^{-1}
Recommended TAC	100,366 lb
Actual TAC	100,366 lb

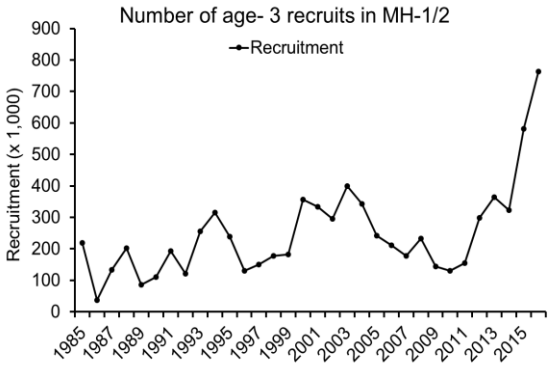
Notable Stock Dynamics and Model Changes:

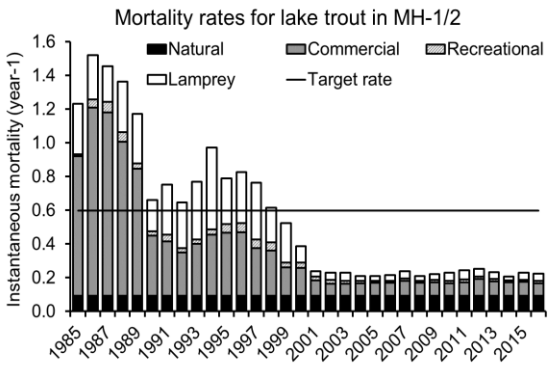
This model was in rotation status for 2017 and the harvest limit was projected based on 2015 model estimates of abundance and recruitment with updated fishing and sea lamprey mortality rates. Commercial yield has been consistently higher than recreational harvest since 2003, averaging 26,900 lb in the last three years. The 2017 harvest limit for MI-7 was 10% less than 2016 due to higher levels of sea lamprey mortality, similar to MI-6.

Lake Huron
MH-1 and MH-2 (Northern and North-central Lake Huron) Ji He







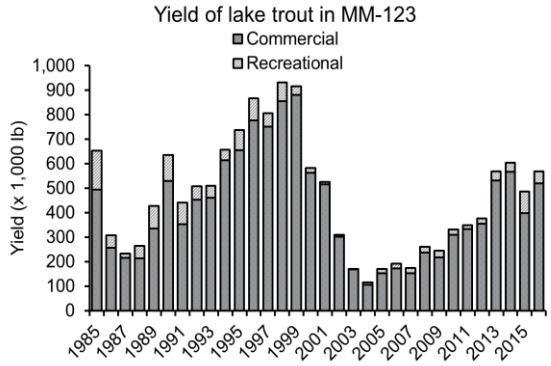


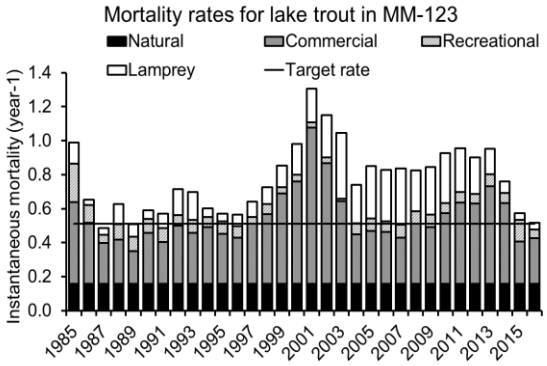
Parameter	Value
Base SSBR	13.25 lb
Current SSBR	3.84 lb
Target SSBR	0.68 lb
Current SPR	0.29
M	0.09 y^{-1}
F, Commercial (2014-2016)	0.08 y^{-1}
F, Recreational (2014-2016)	0.01 y^{-1}
Sea Lamprey Mort (2013-2015)	0.04 y^{-1}
Z (2016)	0.22 y^{-1}
Recommended TAC	1,130,998 lb
Actual TAC	TBD
Model Rating	Low

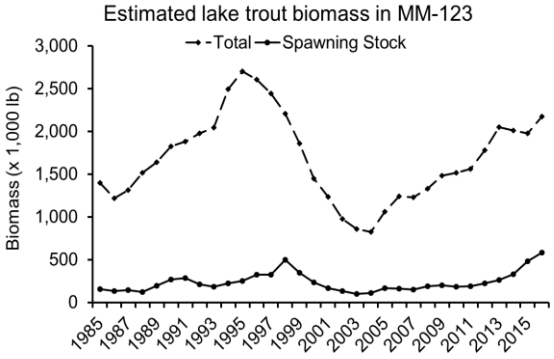
Notable Stock Dynamics and Model Changes:

The Lake Huron stock assessment models have been under development for the past two years. The changes made due to the MSC review, led by Ji He, are detailed in the *Technical Changes* section of the *Executive Summary*. Estimated recruitment during the last two years was not constrained by any available survey or fishery data and should be considered unreliable. As such, the harvest limit projection was calculated by using 10-yr average abundance for age-3 and age-4 fish. Estimated female spawning stock biomass was relatively stable in recent years, mostly because of low average mortality and continued gradual increases in wild recruitment. Total yield by all fisheries exceeded 400K lb for the fifth consecutive year and the 2016 yield (531K lb) was the highest in the time series. Model-generated limits were 643,519 lb for MH-1 and 487,479 lb for MH-2. The model received a low rating due to the large uncertainty associated with wild recruitment, an ongoing need to evaluate model convergence and diagnostics, and concerns that actual mortality is higher than the model is presently predicting.

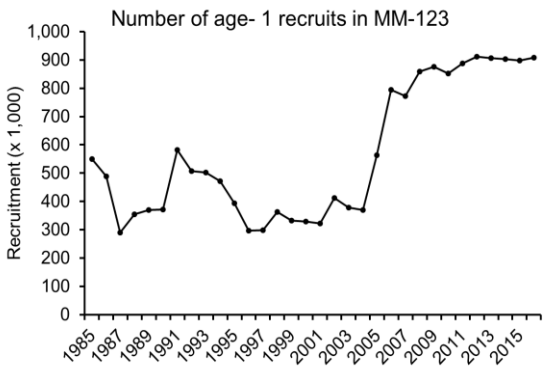
Lake Michigan
MM-123 (Northern Treaty Waters) Ted Treska







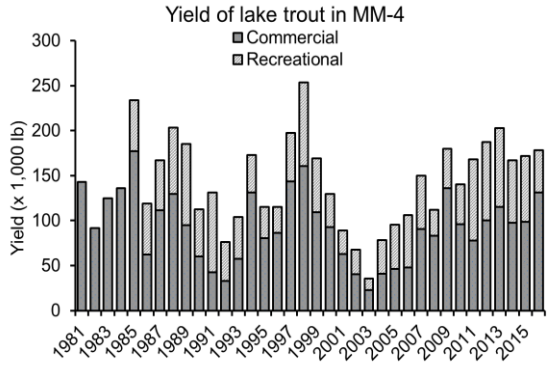
Parameter	Value
Base SSBR	1.45 lb
Current SSBR	0.29 lb
Target SSBR	0.37 lb
Current SPR	0.20
M	0.16 y^{-1}
F, Commercial (2014-2016)	0.33 y^{-1}
F, Recreational (2014-2016)	0.08 y^{-1}
Sea Lamprey Mort (2013-2015)	0.09 y^{-1}
Z (2016)	0.52 y^{-1}
Recommended TAC	403,661 lb
Actual TAC	630,000 lb
Model Rating	Medium

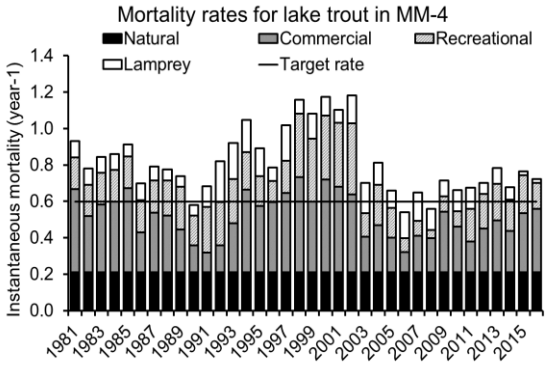


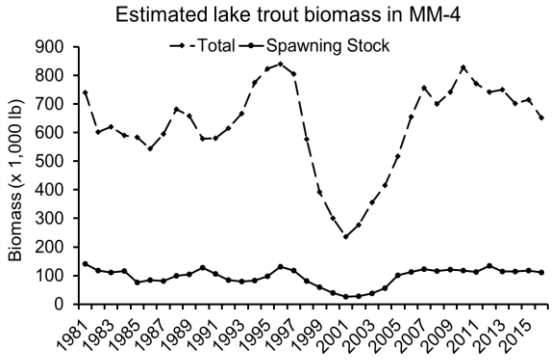
Notable Stock Dynamics and Model Changes:

The model for this unit has undergone changes related to the fishery independent survey, age compositions, weight-at-age, time series modeled, and replacement of outdated recreational harvest biodata. Sea lamprey mortality in this unit has also continued its dramatic decline. These changes improved overall model performance and resulted in a harvest limit of 403,661 lb. However, the number of age 3 and 4 lake trout in the population appears to be low, possibly signaling reduced survival of stocked fish.

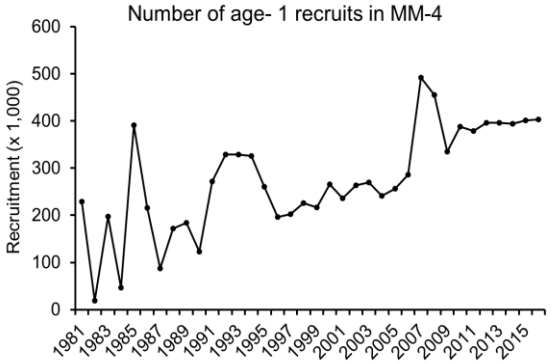
MM-4 (Grand Traverse Bay) Stephen Lenart







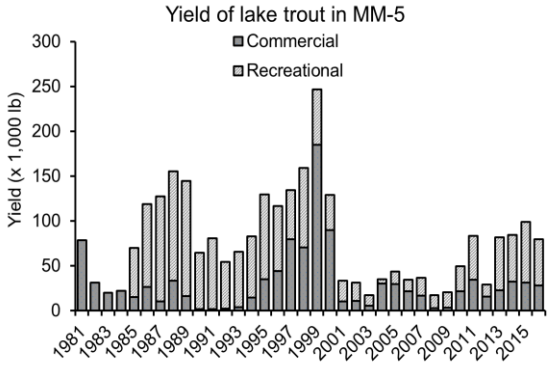
Parameter	Value
Base SSBR	0.36 lb
Current SSBR	0.05 lb
Target SSBR	0.07 lb
Current SPR	0.15
M	0.21 y^{-1}
F, Commercial (2014-2016)	0.30 y^{-1}
F, Recreational (2014-2016)	0.17 y^{-1}
Sea Lamprey Mort (2013-2015)	0.06 y^{-1}
Z (2016)	0.72 y^{-1}
Recommended TAC	114,600 lb
Actual TAC	201,492 lb
Model Rating	Medium

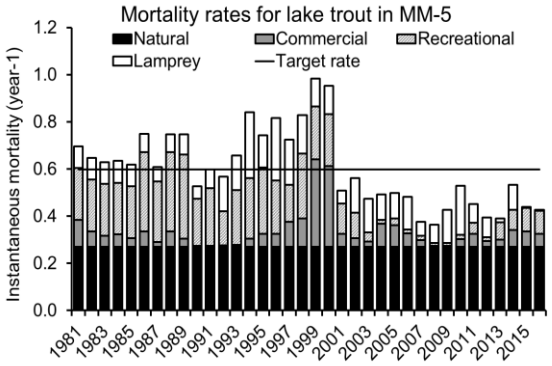


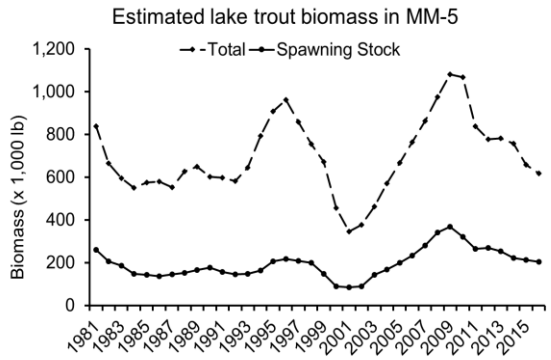
Notable Fishery Dynamics and Model Changes:

This unit incorporated model changes related to the survey, recreational age compositions, hooking mortality rate, and weight-at-age. The declining trend in abundance was driven by lower estimates of age 3- and age-4 fish. These trends are supported by the age composition data, which demonstrate lower contributions of these cohorts. Estimated sea lamprey mortality declined substantially and the 2017 model estimates that spawning biomass has been stable over the past decade, although total annual mortality for fish ages 6-11 is 51% and exceeds target.

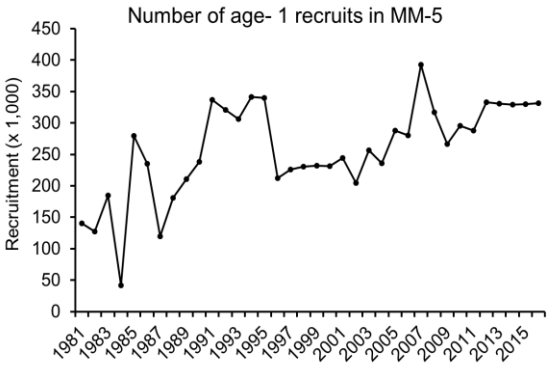
MM-5 (Leelanau Peninsula to Arcadia) Stephen Lenart







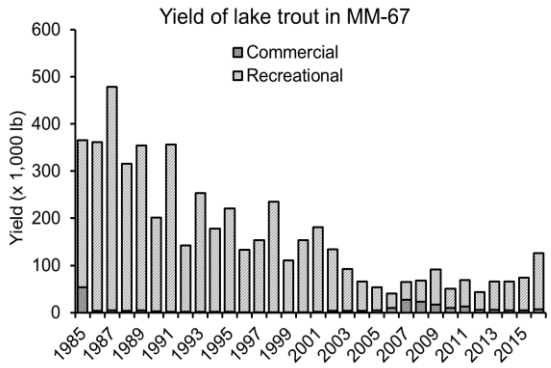
Parameter	Value
Base SSBR	0.34 lb
Current SSBR	0.15 lb
Target SSBR	0.15 lb
Current SPR	0.44
M	0.27 y^{-1}
F, Commercial (2014-2016)	0.06 y^{-1}
F, Recreational (2014-2016)	0.09 y^{-1}
Sea Lamprey Mort (2013-2015)	0.04 y^{-1}
Z (2016)	0.43 y^{-1}
Recommended TAC	76,955 lb
Actual TAC	98,000 lb
Model Rating	Low

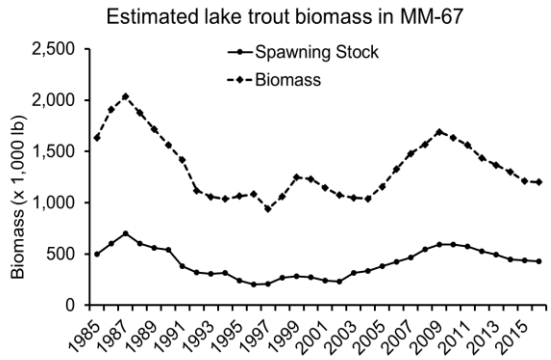


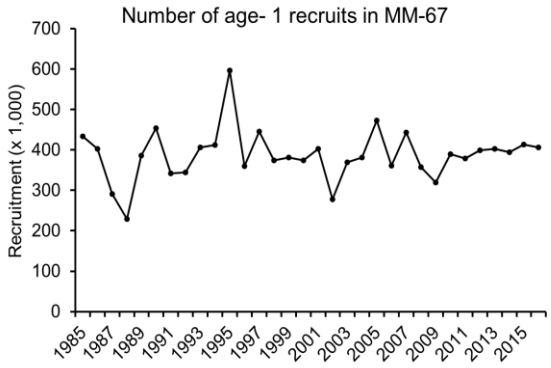
Notable Fishery Dynamics and Model Changes:

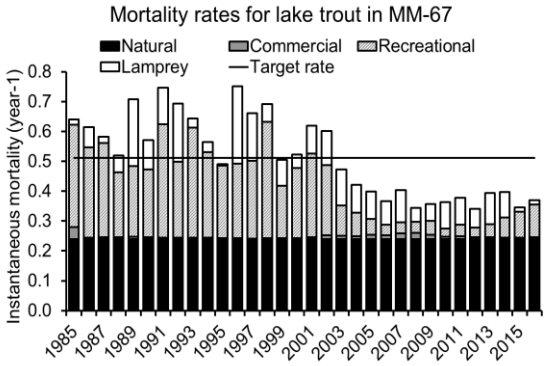
This unit incorporated model changes related to the survey, recreational age compositions, hooking mortality rate, weight-at-age, and reductions in the effective sample size for the fishery age compositions. The latter change, which results in less emphasis being placed on fitting these age compositions, helped reduce retrospective patterns; yet, the performance of the MM-5 model received a low rating due to apparent mismatches in observed and predicted population trends in the unit. As in nearby units, recent age-3 and age-4 cohorts appear to be weaker than previous years, and major reductions in sea lamprey mortality were observed.

MM-67 (Southern Treaty Waters) Mike Seider









Parameter	Value
Base SSBR	0.88 lb
Current SSBR	0.42 lb
Target SSBR	0.32 lb
Current SPR	0.48
M	0.24 y^{-1}
F, Commercial (2014-2016)	0.005 y^{-1}
F, Recreational (2014-2016)	0.09 y^{-1}
Sea Lamprey Mort (2013-2015)	0.07 y^{-1}
Z (2016)	0.37 y^{-1}
Recommended TAC	97,970 lb
Actual TAC	270,843 lb
Model Rating	Low

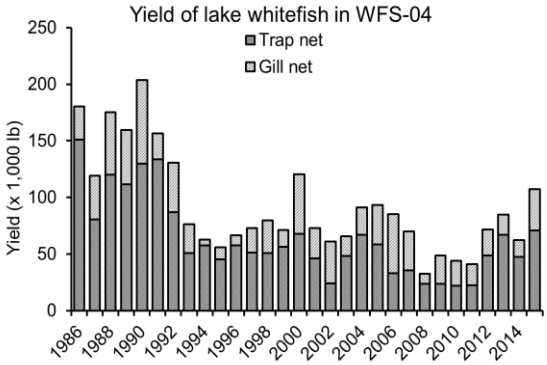
Notable Fishery Dynamics and Model Changes:

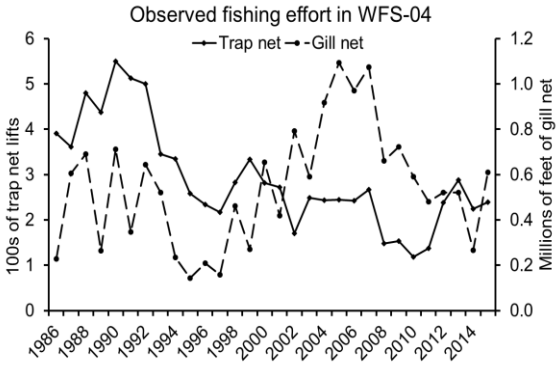
The model for MM-67 underwent similar structural changes to the rest of Lake Michigan, related to the time series of data modeled, survey, weight-at-age, recreational age compositions, and hooking mortality. Sea Lamprey mortality was over 75% lower than the five previous years. The present version of the model resulted in lower stock sizes than have been observed in the past, along with high estimates of age-1 mortality, resulting in a harvest limit 55% lower than 2016. Further work is necessary to ground truth the smaller population scale and higher age-1 mortality rates.

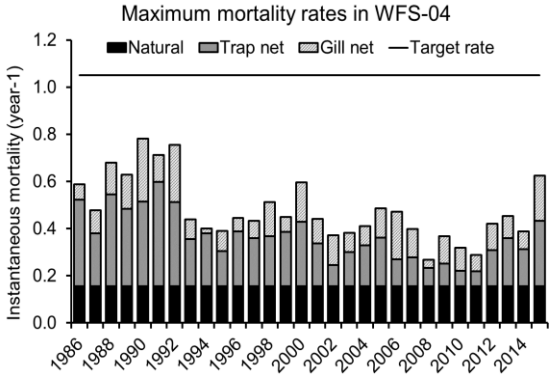
STATUS OF LAKE WHITEFISH POPULATIONS

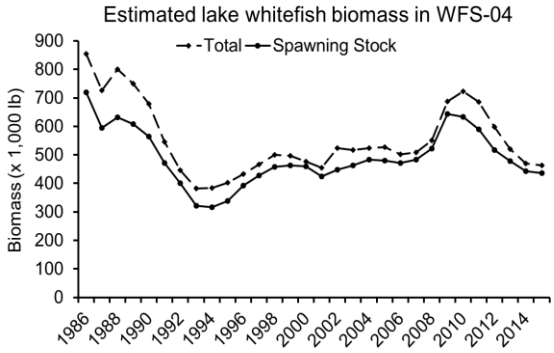
Lake Superior

WFS-04 (Marquette-Big Bay) — Mike Seider









Parameter[(2)]	Value
Base SSBR	9.67 lb
Current SSBR	1.93 lb
Target SSBR	1.49 lb
Current SPR	0.2
M	0.15 y^{-1}
F, trap net (2013-2015)	0.19 y^{-1}
F, gill net (2013-2015)	0.08 y^{-1}
Z (2015)	0.53 y^{-1}
Recommended TAC	91,000 lb
Actual TAC	91,000 lb
Model Rating	Medium

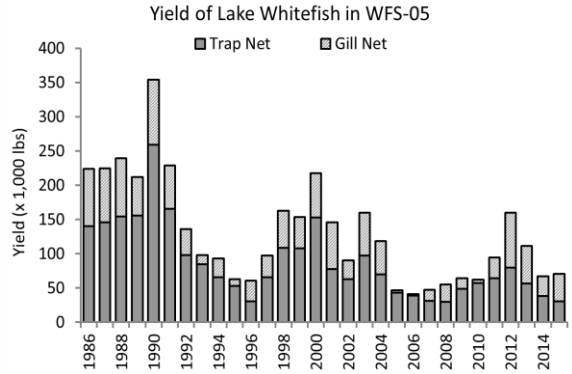
(2) For this table and all subsequent tables in this section, mortality rates represent averages for Lake Whitefish ages 6-11.

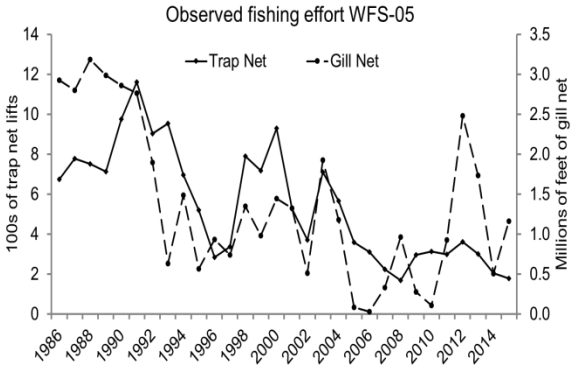
Notable Fishery Dynamics and Model Changes:

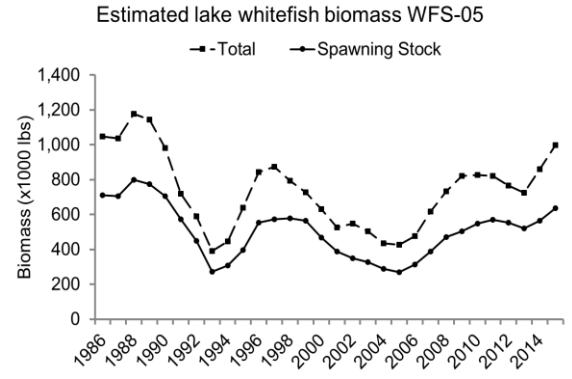
The population in WFS-04 remains relatively stable. Model changes for 2017 included a reduction in the effective sample size for the gill net fishery to down-weight its influence

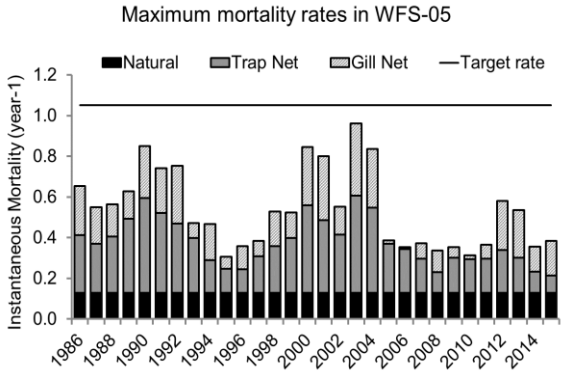
on the model. Informative biological data from the gill net fishery is lacking, thus selectivity was held constant for the entire time period. These changes modestly improved model diagnostics and slightly rescaled the estimated year class strength and mortality rates from the previous year's version. The age composition of the trap net catch continues to expand as evidenced by the increasing number of fish represented in the plus group (age 12). Thus the age composition for the trap net and gill net fisheries were incrementally expanded to age 18 and 16, respectively. Retrospective patterns and poor MCMC distributions occur due to lack of biological data from the gill net fishery.

WFS-05 (Munising) Shawn Sitar





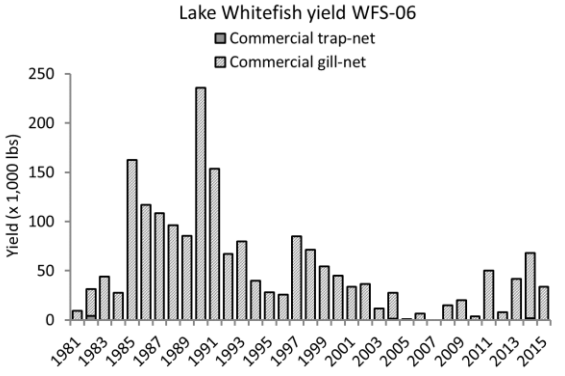


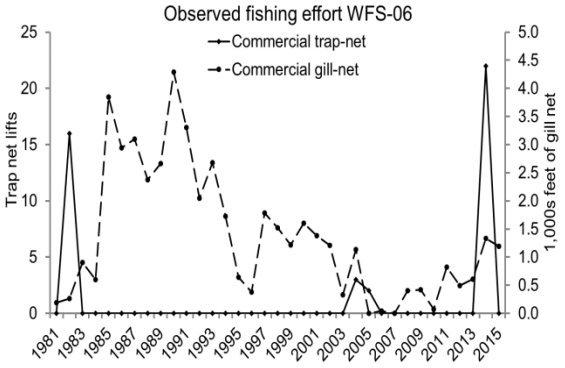


Parameter	Value
Base SSBR	4.37 lb
Current SSBR	1.40 lb
Target SSBR	1.13 lb
Current SPR	0.26
M	0.13 y^{-1}
F, trap net (2013-2015)	0.11 y^{-1}
F, gill net (2013-2015)	0.11 y^{-1}
Z (2015)	0.32 y^{-1}
Recommended TAC	312,300 lb
Actual TAC	312,300 lb
Model Rating	Medium

Notable Fishery Dynamics and Model Changes:
Estimates of recruitment were slightly lower in the 2017 version of this model, leading to a small reduction in harvest limit. Mortality remains low in this unit. No substantive changes were made to the model structure and performance has been consistent and has produced good diagnostics.

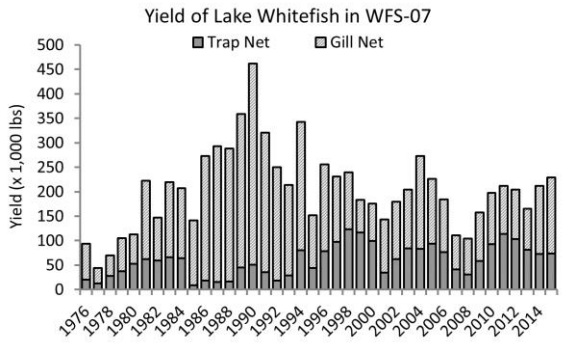
WFS-06 (Grand Marais)

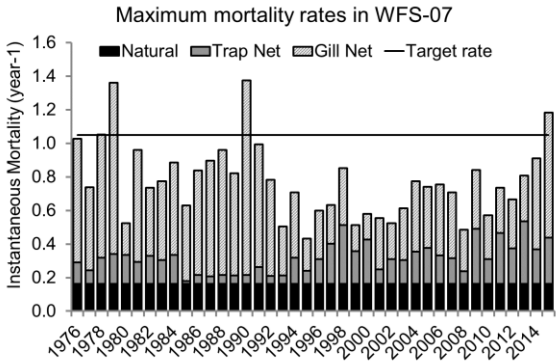


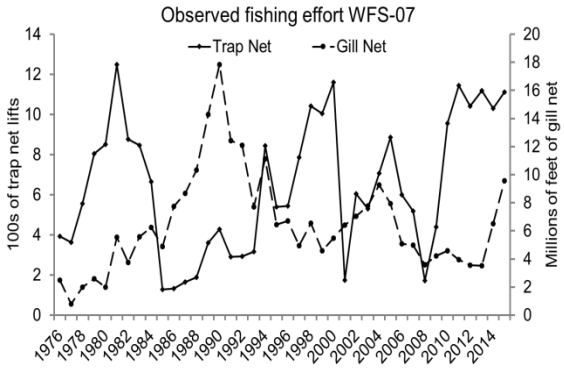


There is no current stock assessment model for WFS-06. Low levels of effort and harvest and a lack of fishery monitoring data since the early 2000s limit the ability to produce an assessment model for this unit. The HRG for this unit remains 210,000 lb.

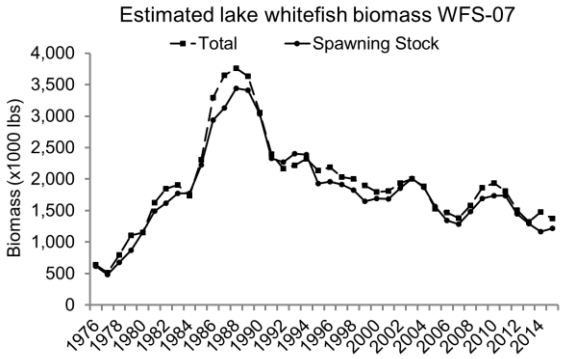
WFS-07 (Tahquamenon Bay) Mark Ebener







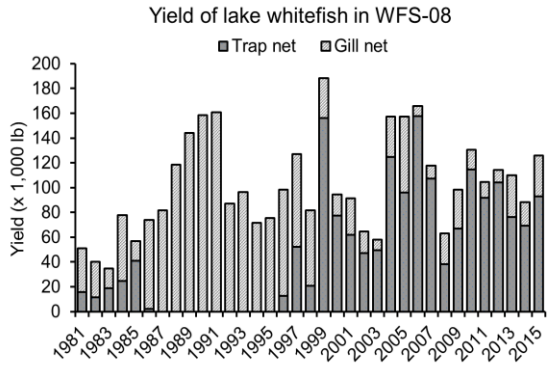
Parameter	Value
Base SSBR	3.13 lb
Current SSBR	0.88 lb
Target SSBR	0.81 lb
Current SPR	0.28
M	0.16 y^{-1}
F, trap net (2013-2015)	0.26 y^{-1}
F, gill net (2013-2015)	0.49 y^{-1}
Z (2015)	1.11 y^{-1}
Recommended TAC	227,400 lb
Actual TAC	480,000 lb
Model Rating	Medium

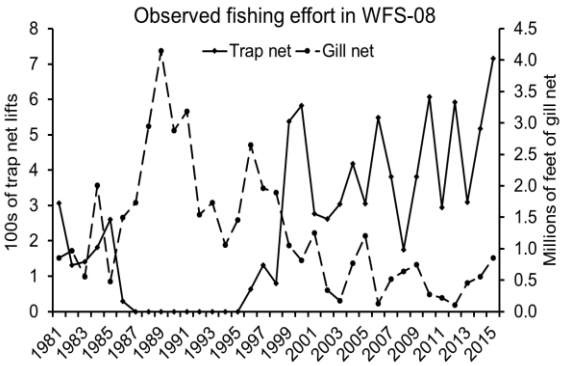


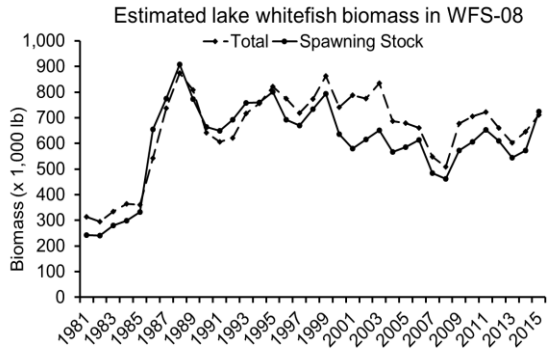
Notable Fishery Dynamics and Model Changes:

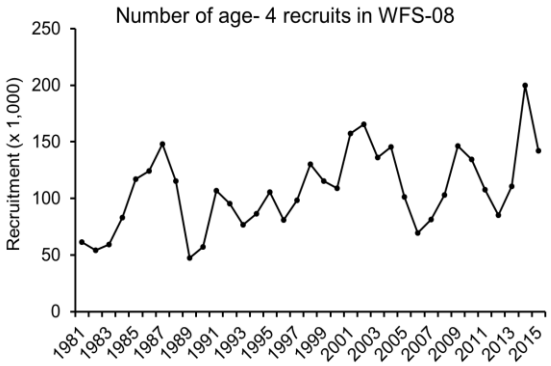
Biomass has been declining in this unit since the late 1980s. The current model estimated that total mortality on the most vulnerable ages exceeded the target value and has been increasing since the early 2000s. Recruitment has been stable, suggesting that fishing mortality is too high in this unit. The only notable change to the 2017 version of the assessment model was a change to the ratios used to estimating standard deviation within the model.

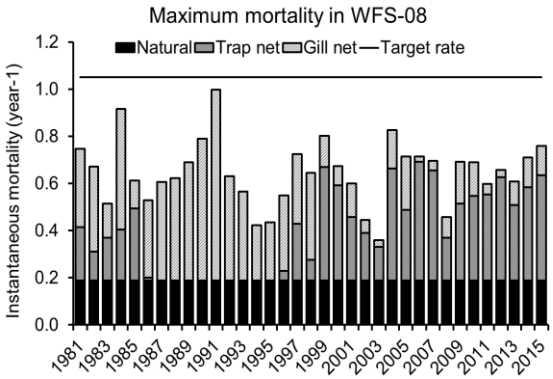
WFS-08 (Brimley) Paul Ripple









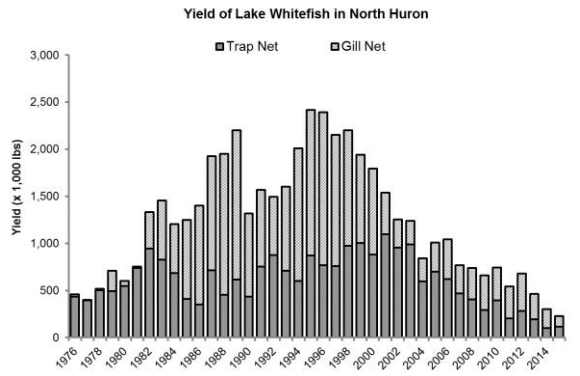


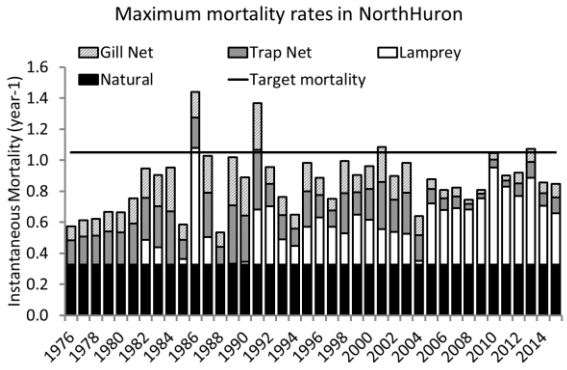
Parameter	Value
Base SSBR	2.89 lb
Current SSBR	0.84 lb
Target SSBR	0.41 lb
Current SPR	0.29
M	0.19 y^{-1}
F, trap net (2013-2015)	0.24 y^{-1}
F, gill net (2013-2015)	0.08 y^{-1}
Z (2015)	0.55 y^{-1}
Recommended TAC	223,100 lb
Actual TAC	223,100 lb
Model Rating	Medium

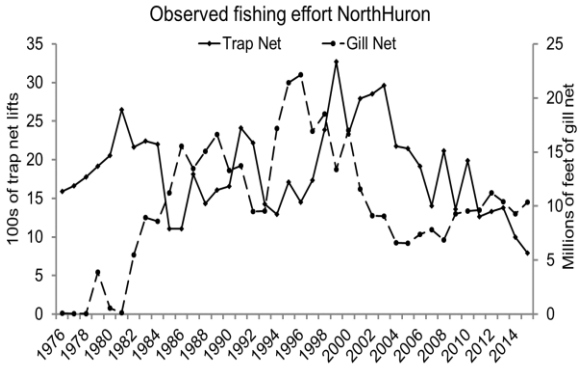
Notable Fishery Dynamics and Model Changes:

The current version of the model is unchanged from previous years and produced higher stock sizes with the addition of 2015 data. An unknown bug in the harvest limit projection program failed to account for the SPR trigger and produced a harvest limit higher than expected. This will be reexamined prior to the 2018 assessment cycle.

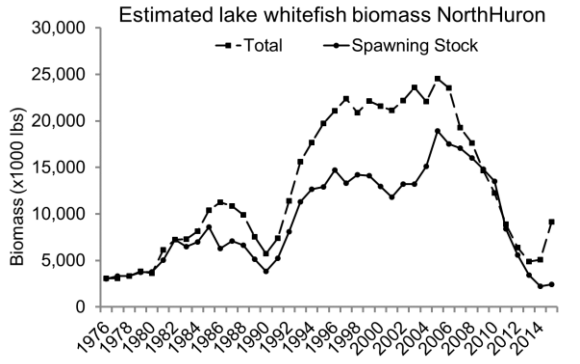
Lake Huron
Northern Huron (WFH-01 to WFH-04) Mark Ebener







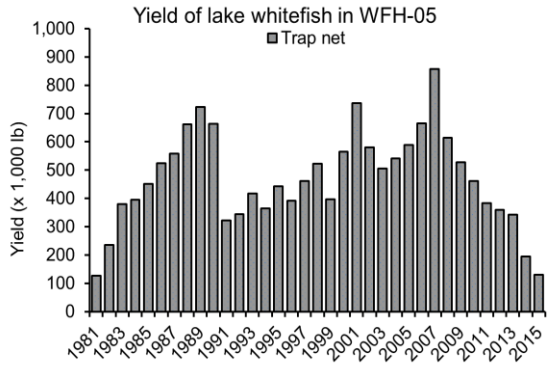
Parameter	Value
Base SSBR	1.28 lb
Current SSBR	0.51 lb
Target SSBR	0.57 lb
Current SPR	0.40
M	0.33 y^{-1}
F, trap net (2013-2015)	0.09 y^{-1}
F, gill net (2013-2015)	0.14 y^{-1}
Z (2015)	0.73 y^{-1}
Recommended TAC	479,100 lb
Actual TAC	379,900 lb
Model Rating	Medium

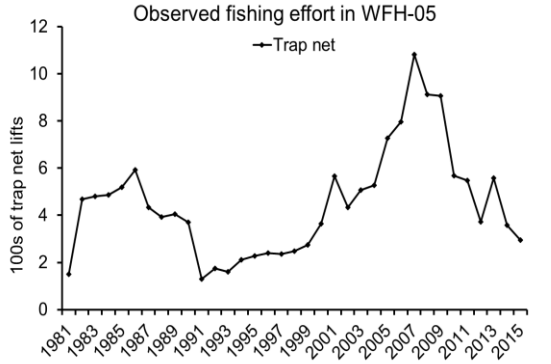


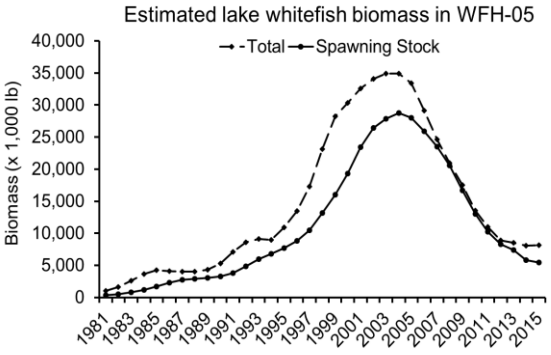
<u>Notable Fishery Dynamics and Model Changes:</u>

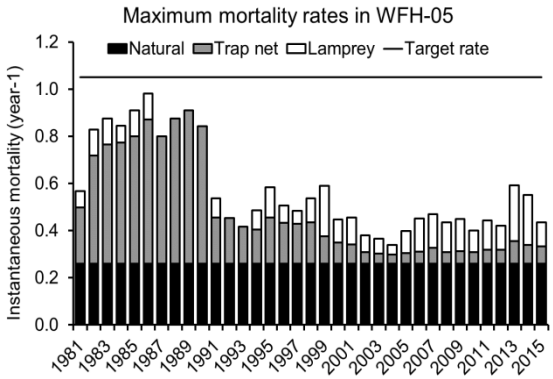
The most notable change to the 2017 version of this model was the expansion of the plus group from age 12+ to age 25+. Low recruitment and an aging stock have caused the proportion of fish captured in the plus group to increase substantially in the last five years. Sea Lamprey mortality remains high (0.23), but total mortality is not exceeding the target rate; however, when coupled with the lack of recruitment, biomass continues to be a small fraction of its peak.

WFH-05 (Alpena) Stephen Lenart







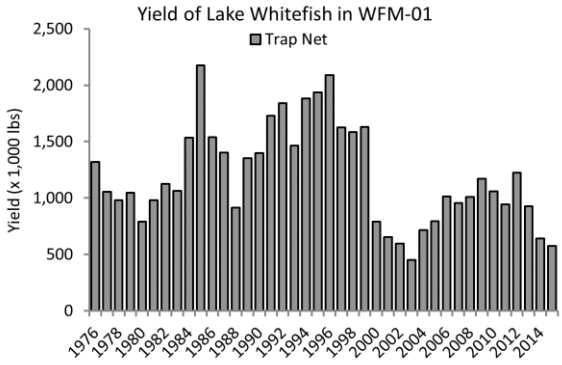


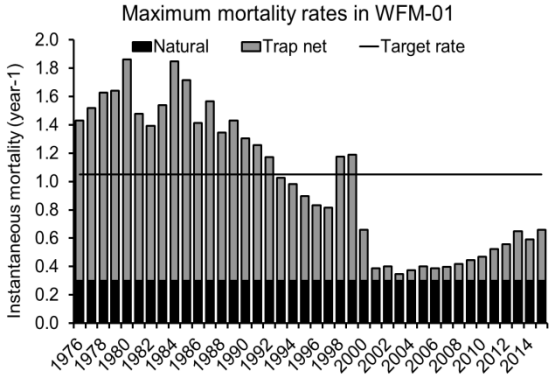
Parameter	Value
Base SSBR	2.14 lb
Current SSBR	0.93 lb
Target SSBR	0.92 lb
Current SPR	0.43
M	0.26 y^{-1}
F, trap net (2013-2015)	0.03 y^{-1}
Z (2015)	0.34 y^{-1}
Recommended TAC	886,600 lb
Actual TAC	394,000 lb
Model Rating	Low

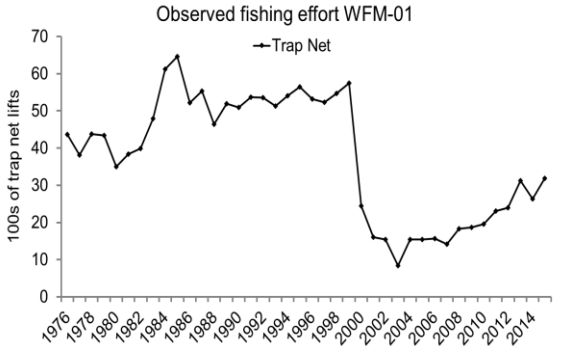
Notable Fishery Dynamics and Model Changes:

Spawning biomass continues to decline in this unit in response to declining recruitment. Average annual mortality remains below target, and sea lamprey mortality declined by 50% compared to the prior year, which caused an unrealistic increase in the estimated harvest limit. No substantive changes were made to the model structure. Strong retrospective patterns remain an issue for this assessment, though the issue has been primarily linked to age composition data.

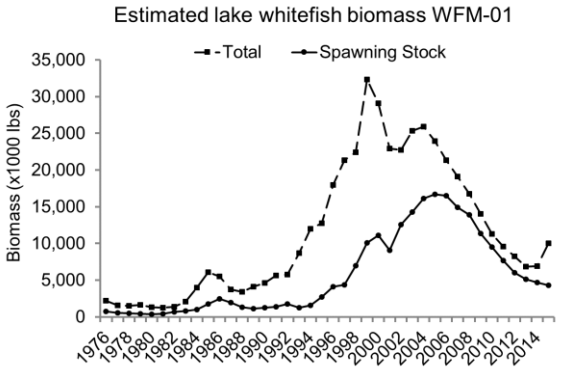
Lake Michigan
WFM-01 (Bays De Noc) Mark Ebener







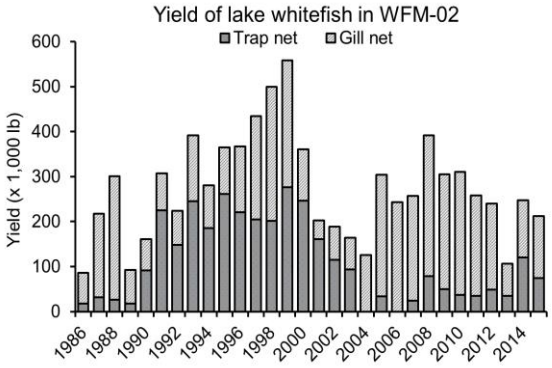
Parameter	Value
Base SSBR	1.76 lb
Current SSBR	0.67 lb
Target SSBR	0.67 lb
Current SPR	0.38
M	0.30 y^{-1}
F, trap net (2013-2015)	0.22 y^{-1}
Z (2015)	0.53 y^{-1}
Recommended TAC	1,103,700 lb
Actual TAC	TBD
Model Rating	Medium

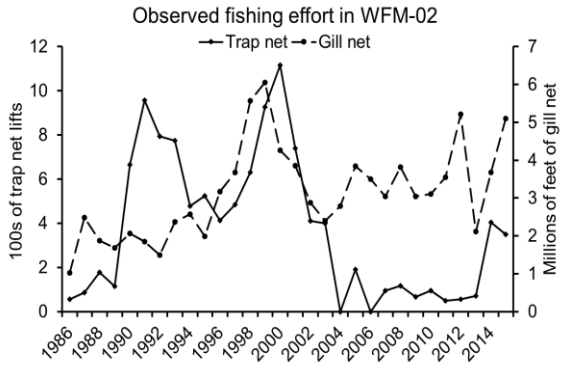


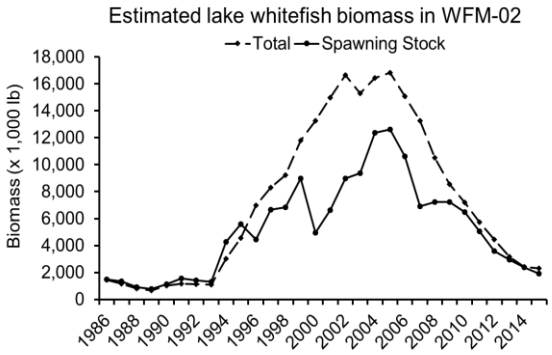
Notable Fishery Dynamics and Model Changes:

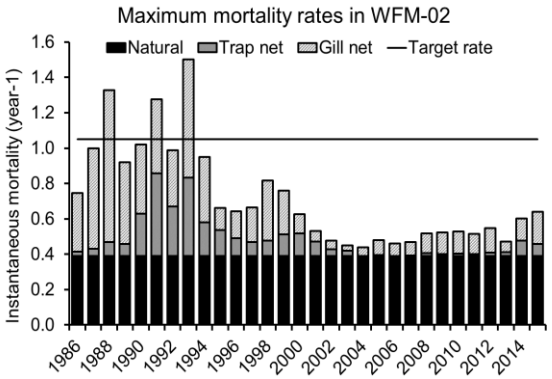
The 2017 stock assessment model for WFM-01 was unchanged from 2016. The patterns in the population were similar to previous years. Biomass has declined due to low recruitment. The most recent estimate of recruitment is higher, but suspect as few fish of that age were actually captured. It will likely be revised downward with an additional year of data. Total mortality remains well-below target and model performance was acceptable.

WFM-02 (Manistique) Ted Treska







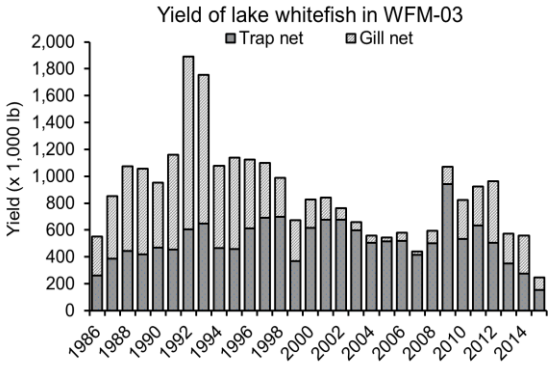


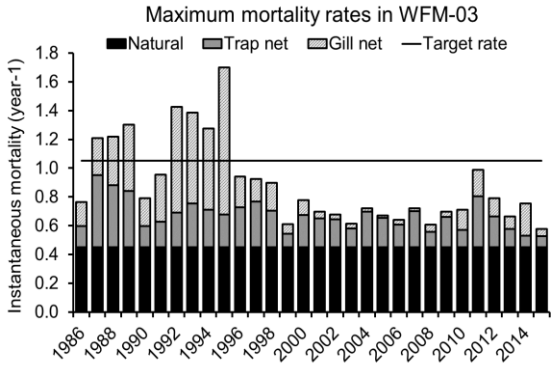
Parameter	Value
Base SSBR	1.26 lb
Current SSBR	0.72 lb
Target SSBR	0.73 lb
Current SPR	0.58
M	0.39 y^{-1}
F, trap net (2013-2015)	0.05 y^{-1}
F, gill net (2013-2015)	0.05 y^{-1}
Z (2015)	0.52 y^{-1}
Recommended TAC	362,300 lb
Actual TAC	362,300 lb
Model Rating	Medium

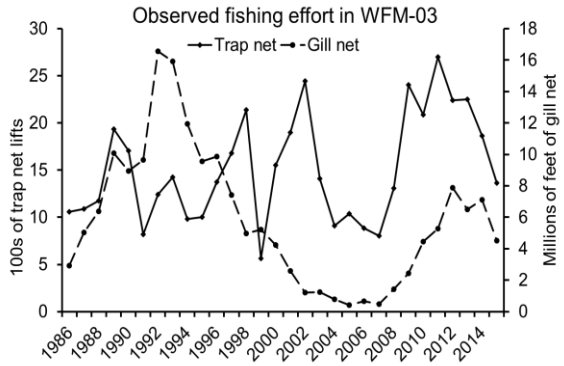
Notable Fishery Dynamics and Model Changes:

Changes to the model for 2017 were minor and included: an increase in the reference length for trap net (430 to 450 mm), an adjustment of the 1993 length and weight data which was very different from surrounding years and leading to very large mortality values, and constant selectivity parameters. The biomass trend looks similar to the last run, and now more closely mimics trends seen in neighboring units. The apparent increase in recruitment that was seen in the last run of the model has disappeared with the new data, with the decline seemingly continuing. Mortality remains below target and model performance was acceptable.

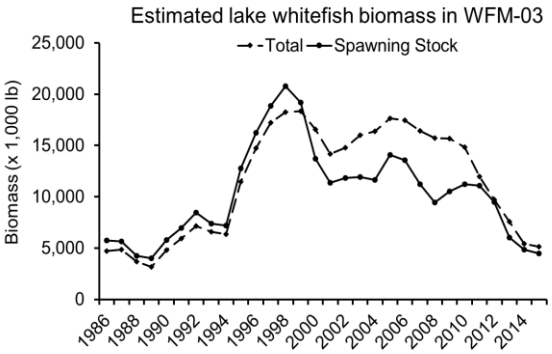
WFM-03 (Naubinway) Ted Treska

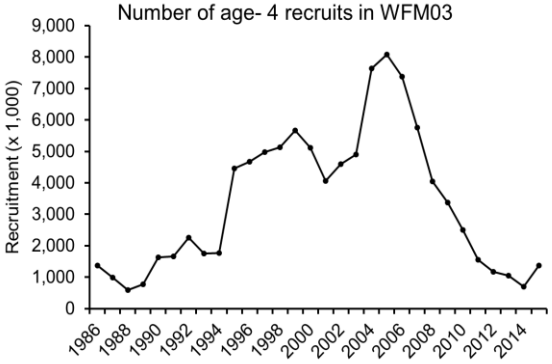






Parameter	Value
Base SSBR	1.25 lb
Current SSBR	0.75 lb
Target SSBR	0.74 lb
Current SPR	0.60
M	0.45 y^{-1}
F, trap net (2013-2015)	0.08 y^{-1}
F, gill net (2013-2015)	0.06 y^{-1}
Z (2015)	0.56 y^{-1}
Recommended TAC	887,100 lb
Actual TAC	887,100 lb
Model Rating	Medium

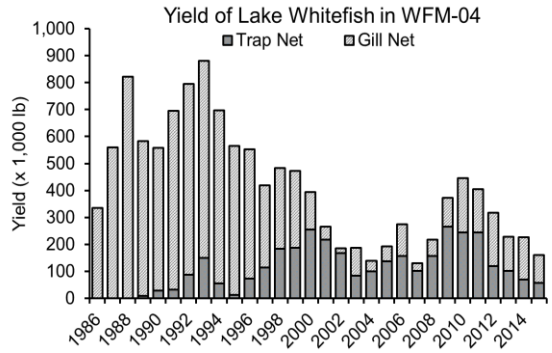


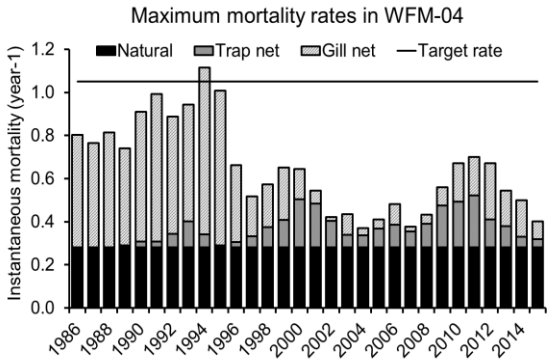


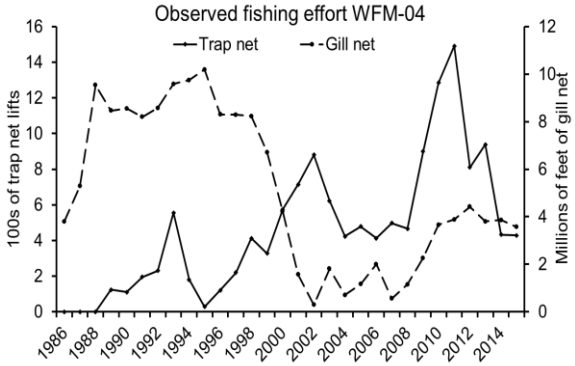
<u>Notable Fishery Dynamics and Model Changes:</u>

There were no major changes made to the assessment model for 2017. The trends in this unit still indicate a sharp decline in recruitment from a peak in 2005. Mortality rates remain below target, despite this unit having one of the highest estimates of natural mortality throughout the 1836 Treaty area. Yield in 2015 was less than half of 2014, likely due to an early fishery closure related to concerns over reaching the Lake Trout harvest limit in this area. Model diagnostics have improved over previous years.

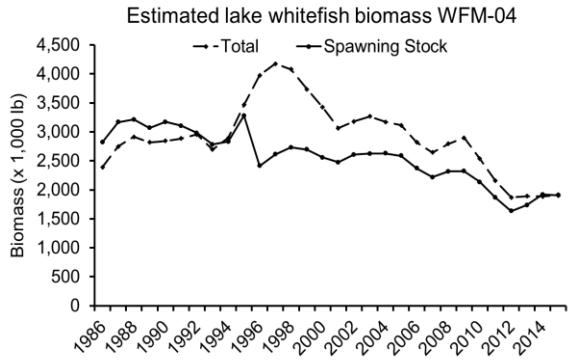
WFM-04 (Beaver Island) Kevin Donner







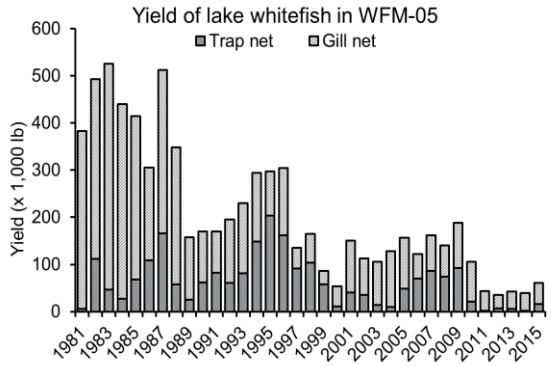
Parameter	Value
Base SSBR	2.93 lb
Current SSBR	0.99 lb
Target SSBR	0.92 lb
Current SPR	0.34
M	0.28 y^{-1}
F, trap net (2013-2015)	0.06 y^{-1}
F, gill net (2013-2015)	0.12 y^{-1}
Z (2015)	0.39 y^{-1}
Recommended TAC	543,900 lb
Actual TAC	543,900 lb
Model Rating	Medium

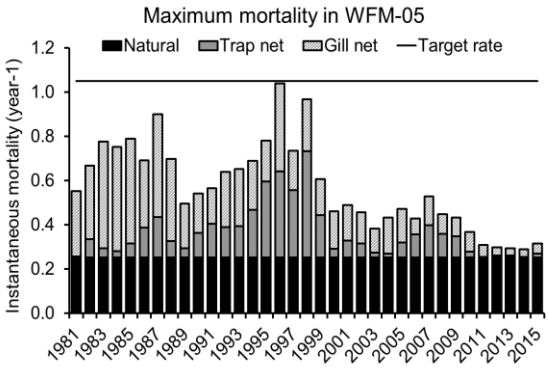


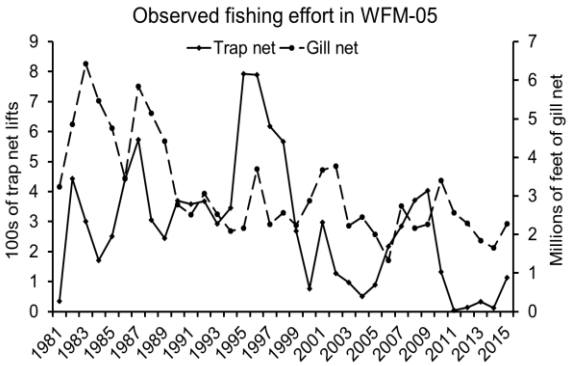
<u>Notable Fishery Dynamics and Model Changes:</u>

Gillnet selectivity is estimated using a lognormal function; however, selectivity is now fixed to address scaling issues that were estimating abundances beyond reasonable bounds. In addition, several years of data were removed from the beginning of the time series as they were consistently producing large harvest and effort residuals. Population trends (declining biomass, abundance. etc) estimated in past years and observed in adjacent management units are similar to those observed in the current model. Mortality remains below target and fishery yield declined from 2014 to 2015 likely due to a fishery closure late in the season due to concerns over lake trout harvest levels.

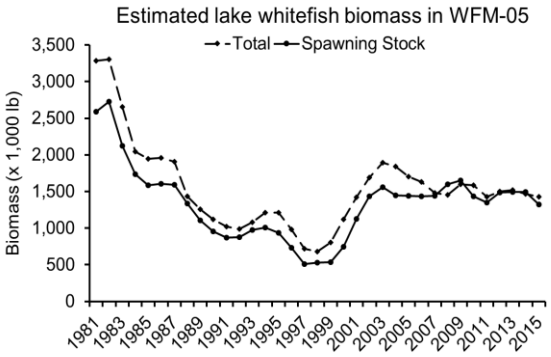
WFM-05 (Grand Traverse Bay) Stephen Lenart

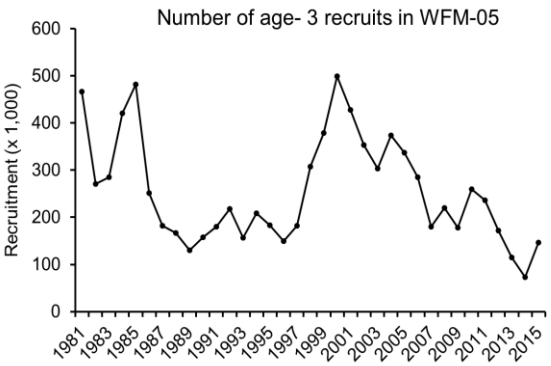






Parameter	Value
Base SSBR	2.82 lb
Current SSBR	0.69 lb
Target SSBR	0.62 lb
Current SPR	0.25
M	0.25 y^{-1}
F, trap net (2012-2014)	0.01 y^{-1}
F, gill net (2012-2014)	0.03 y^{-1}
Z (2014)	0.31 y^{-1}
Recommended TAC	518,600 lb
Actual TAC	425,000 lb
Model Rating	Medium

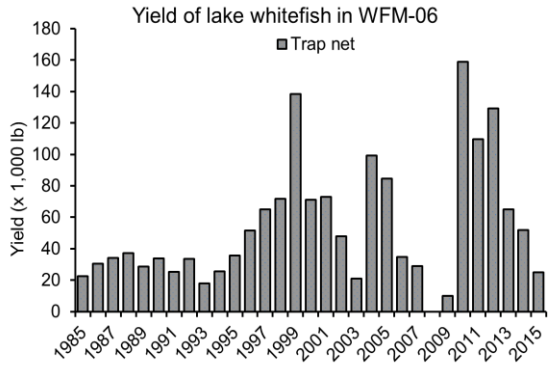


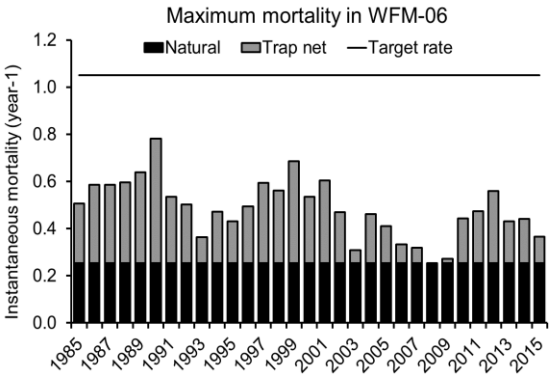


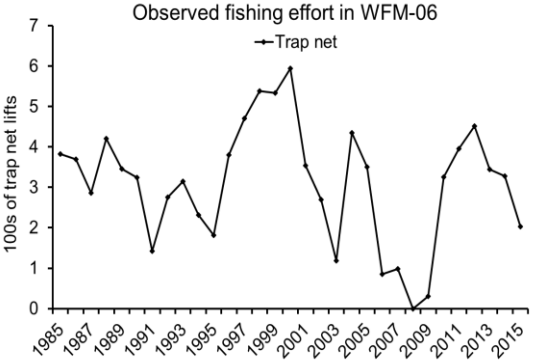
Notable Fishery Dynamics and Model Changes:

Recent increases in growth have offset slight declines in abundance to contribute to stable spawning biomass estimates during the past decade in WFM-05. Recruitment patterns show a similar, yet muted decline compared to northern Lake Michigan units. Mortality rates for this unit are the lowest in 1836 waters. Monitoring data are often sparse in this unit, leading to varied scaling in the last few years of the assessment. Selectivity parameters were held constant in this year's assessment, which resulted in increased model stability. The overall scaling of the assessment was somewhat higher under this scenario and is the primary reason for the 22% increase in the model-generated harvest limit.

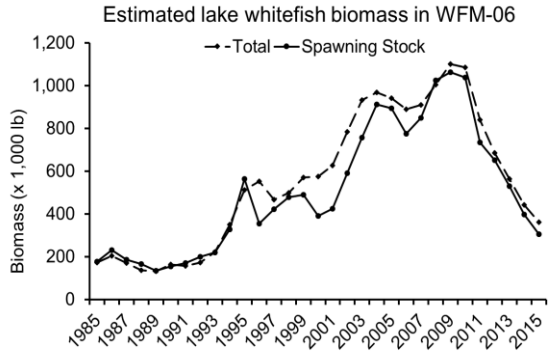
WFM-06 (Leland) Dave Caroffino

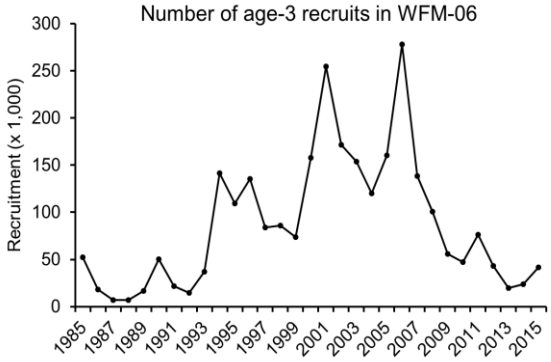






Parameter	Value
Base SSBR	3.44 lb
Current SSBR	0.69 lb
Target SSBR	0.69 lb
Current SPR	0.20
M	0.25 y^{-1}
F, trap net (2013-2015)	0.15 y^{-1}
Z (2015)	0.36 y^{-1}
Recommended TAC	133,100 lb
Actual TAC	125,000 lb
Model Rating	Low

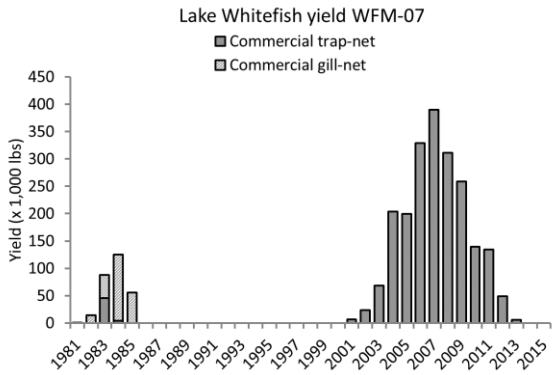


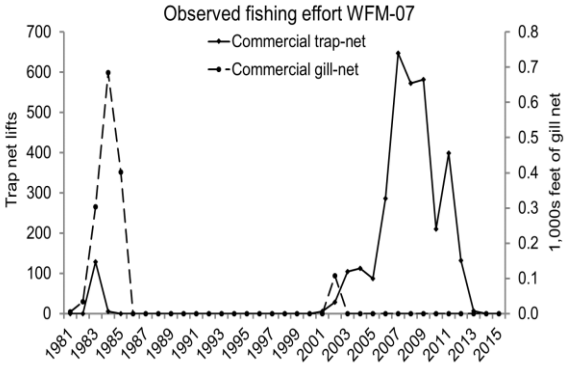


<u>Notable Fishery Dynamics and Model Changes:</u>

Substantial changes were made to the WFM-06 model. The paucity of gill-net data led to that gear being dropped as a separate, modeled fishery and the extractions rolled into trap-net harvest with adjustments to effort to maintain fishery catch rates. Otoliths were used for assigning age and the age compositions were expanded to age 20+. Selectivity continued to be modeled as a single logistic function of length, but the time-varying component was dropped. The effective sample size was reduced from 100 to 75. This unit has been managed under a Conditional Constant Catch Policy since 2011, set at 250,000 lb. However, given reductions in recruitment and stock size, this harvest limit is neither realistic nor sustainable. The MSC recommended that the Constant Catch Policy be halved to a value of 125,000 lb.

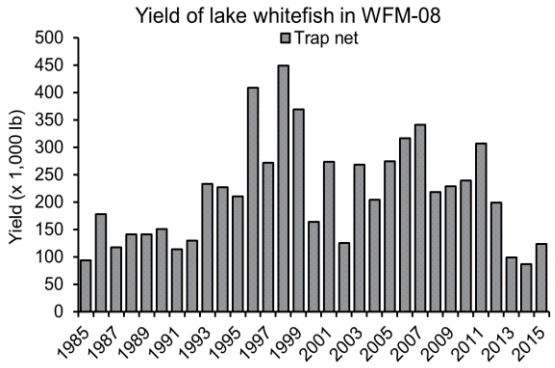
WFM-07 (Manistee to Pentwater)

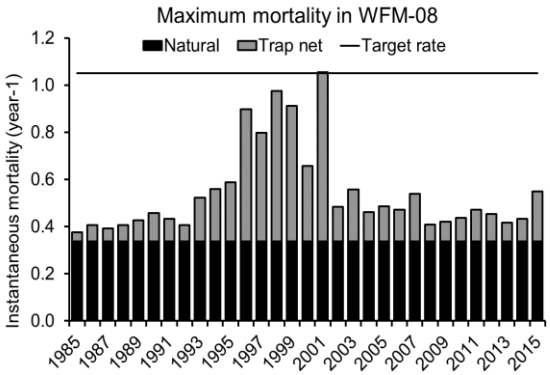


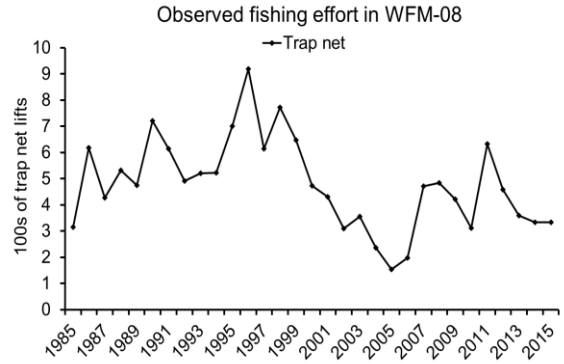


No stock assessment model has been developed for WFM-07. When the Consent Decree was initially signed, this unit lacked the necessary time series of data to populate a model. Fishing effort and yield in this unit peaked in 2007 and ceased in 2013. The HRG was reduced from 500,000 lb to 350,000 lb in 2016 and that reduced limit remains in place for 2017.

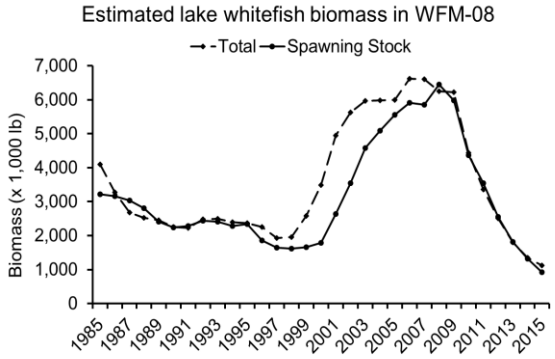
WFM-08 (Muskegon) Dave Caroffino

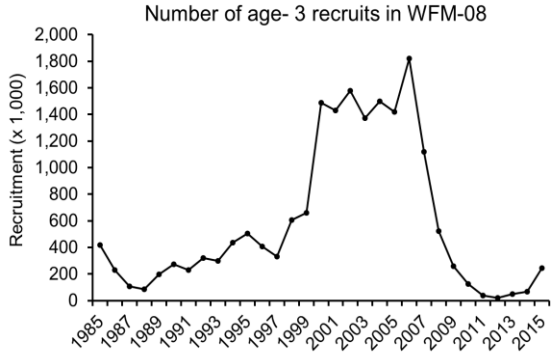






Parameter	Value
Base SSBR	2.12 lb
Current SSBR	0.85 lb
Target SSBR	0.85 lb
Current SPR	0.40
M	0.34 y^{-1}
F, trap net (2013-2015)	0.11 y^{-1}
Z (2015)	0.52 y^{-1}
Recommended TAC	500,000 lb
Actual TAC	500,000 lb
Model Rating	Low





<u>Notable Fishery Dynamics and Model Changes:</u>

The WFM-08 model has had problems scaling the whitefish population for several years. Changes to model structure included using otoliths as the structure for estimating ages, an expanded age composition (to age 20+), constant selectivity modeled as a function of length, and a reduced effective sample size. This unit has been managed under a constant harvest limit since 2012. Despite uncertainties surrounding total stock size, the MSC is confident that a harvest limit of 1,400,000 lb is not sustainable. Numerous iterations of the 2016 and 2017 models have estimated limits between 200,000 and 600,000 lb. The MSC recommended the constant catch level be reset to 500,000 lb, a 64% reduction from the previous level.