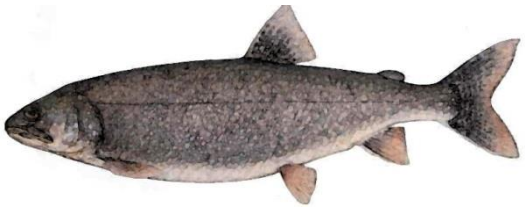
Technical Fisheries Committee Administrative Report 2016: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron, and Michigan, with Recommended Yield and Effort Levels for 2016



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

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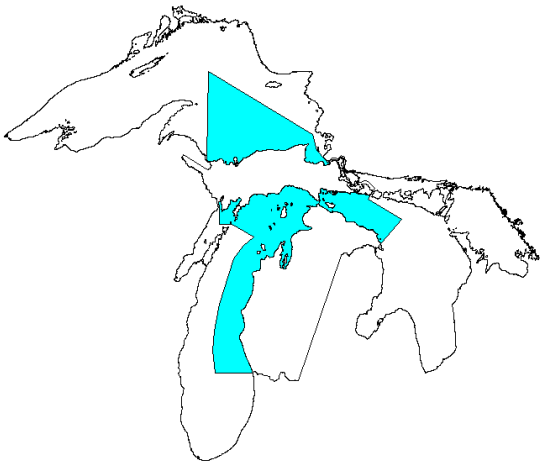

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EXECUTIVE SUMMARY

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. We retain here the revised report format first instituted in 2013. The objective of the revised format is to provide a more succinct, consistent summary while maintaining focus on the primary purposes of the report, which are 1) to describe the status of each 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.

Model-generated yield limits and actual yield and effort limits for 2016 are provided in Table 1. In instances where actual yield limits for lake trout units or shared-allocation 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. Population models for Lake Whitefish are on a one-year lag, so estimates reported here are derived from data through 2014.

Table 1. 2016 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	148,787	148,787	NA
		MI-6	213,842	213,842	3,848,000
		MI-7	111,366	111,366	4,583,000
	Huron	MH-1	No model estimate	420,931	10,791,000
		MH-2	No model estimate	125,000	NA
	Michigan	MM-123	148,219	TBD	TBD
		MM-4	90,982	192,661	955,000
		MM-5	68,610	98,000	205,000
		MM-67	215,962	318,639	NA
Lake whitefish	Superior	WFS-04	136,000	136,000	NA
		WFS-05	336,100	336,100	NA
		WFS-06	No model estimate	210,000	NA
		WFS-07	599,800	599,800	NA
		WFS-08	178,800	178,800	NA
	Huron	Northern Huron	561,600	379,900	NA
		WFH-05	394,000	394,000	NA
	Michigan	WFM-01	1,466,300	1,466,300	NA
		WFM-02	367,400	367,400	NA
		WFM-03	797,700	797,700	NA
		WFM-04	601,800	601,800	NA
		WFM-05	425,000	425,000	NA
		WFM-06	153,000	250,000	NA
		WFM-07	No model estimate	350,000	NA
		WFM-08	217,300	1,400,000	NA

Lake Trout

In Lake Superior, lean Lake Trout are self-sustaining, and the statistical catch-at-age (SCAA) models and target mortality rates apply to these wild fish in three management areas (MI-5, MI-6, and MI-7). In 2016, full assessments were completed for MI-5 and MI-6, and MI-7 was in rotation.

Declines in population abundance and biomass have occurred since the late 1990s, a product of a long-term decline in recruitment. Recent estimates, however, suggest that this downward trend has been somewhat ameliorated. Estimated total biomass has now been stable or increasing in MI-5 and MI-6 since 2009. In MI-7, where biomass declines were not as pronounced, total biomass has increased modestly since the middle 2000s. Aside from natural mortality, sea lamprey-induced mortality (SLIM) has represented the greatest individual source of mortality in all modeled Superior units throughout the duration of the 2000 Consent Decree. SLIM rates declined sharply in MI-5 in 2014 to 0.04 y^{-1}. Mechanical problems aboard the Michigan DNR research vessel prevented surveys from occurring in MI-6 and MI-7 in 2015, resulting in not enough LAT captured to directly estimate SLIM. The little raw wounding data examined from commercial monitoring suggested SLIM rates were declining in the eastern end of the lake, similar to the western side. Overall, the news is positive news related to reductions in SLIM in Lake Superior.

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 (2015) were unavailable for this fishery - yield and effort were thus assumed to be equivalent to 2014 levels for stock assessment purposes. The future of the fishery in 1842 waters of MI-5 is uncertain as the longstanding local fisher passed away in 2015. Commercial yield in MI-6 increased by 70% compared to 2014, but it still below the peak years of 2012 and 2013. Commercial yield in MI-7 declined from 2014 and nearly equaled the long term average. Recreational fishing mortality is low (<0.03 y^{-1}) and harvest is stable across Lake Superior.

Mortality of lean Lake Trout remains below the maximum target rate throughout Lake Superior Treaty waters, thus projections suggest yield could be increased in all modeled management units. 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.

Wild fish comprise an increasing proportion of the Lake Trout population in Lake Huron and recruitment of wild Lake Trout to the adult population continues to be evident. In 2015, unclipped fish represented more than 50% of the samples collected. While the spawning biomass still includes a majority of hatchery fish, wild fish are making up a larger proportion each year. 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 assessments, a subgroup within the MSC began a comprehensive review of the Lake Huron model structure in 2015, and that review continues in 2016. Based on movement data collected from other work, the focus of the subgroup is building a single assessment model for all of Lake Huron's 1836 Treaty Waters. To provide adequate time for the review, the Parties established constant harvest limits for the Huron units for 2015-2016. A more detailed analysis of stock structure is expected in the 2017 version of this report, once the updated assessment model is completed.

Average SLIM declined by more than 50% in MH-1 from 2013 to 2014. In MH-2 SLIM also declined, but by a lesser amount. In both units, average SLIM is approximately 0.06 y^{-1}. Commercial fishing is the largest source of mortality in MH-1, and it increased by 17% in 2015. Favorable weather and increased catch rates pushed yield for the state recreational fishery to its all-time peak of nearly 44,000 lb in MH-1. Recreational yield in MH-2 remained stable.

The Lake Michigan Lake Trout assessment models apply only to stocked fish. While the number of wild fish is beginning to increase in select areas of the lake, as a whole, Lake Trout recovery in Lake Michigan is well behind that of the other lakes. In unit MM-123 total mortality is well above target, a product of excessive

commercial fishing and sea lamprey-induced mortality, though SLIM has steadily declined since 2010 and is now 0.07 y^{-1}. Commercial fishing mortality remains excessively high (0.66 y^{-1} average for fish ages 6-11, this alone exceeds the mortality target), despite the fact that the fishery was closed in late October of 2015. Recreational fishery yield increased for the fourth consecutive year and was nearly double the 2014 value. Biomass of young fish continues to increase due to increased stocking, yet few fish survive beyond age 7 and adult stocks remain depressed. A Decree Amendment dated 4 April 2007 set the harvest limit in MM-123 at 453,000 lb for CORA and 50,000 lb for the State. These limits were imposed because the elevated sea lamprey mortality would have prevented any harvest under the original terms of the Consent Decree. Despite this stipulation, the parties have not reached consensus on a 2016 harvest limit for MM-123 as the amount of penalty due to the State from CORA's overharvests in 2013 and 2014 is being debated. The entire fishing season passed in 2015 with no formally adopted harvest limit, and at the time of this writing, half of the 2016 fishing season has passed under the same situation.

The MM-4 assessment model scaled downward in 2015 after some data errors were corrected from prior years. The current version is more in line with past assessments, although it provides slightly different estimates of mortality. Natural mortality is no longer the largest source, rather commercial fishing kills more Lake Trout than any other source. Average SLIM values have been on a long-term, cyclical decline and were 0.07 y^{-1} last year. In total, mortality sources combined to exceed the target in 2015. Total yield of Lake Trout from MM-4 remained near the average since 2009. Recruitment is enhanced by the substantial increase in stocking in adjacent MM-123, a mitigating factor for the relatively intense harvest that occurs in the unit. 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 the harvest limit the prior year.

Mortality rates in units MM-5 and MM-67 remain below target and natural mortality is the largest individual source of mortality in these units. Recreational fishery yield from MM-5 in 2015 (65,666 lb) was the highest observed during the current Consent Decree and exceeded the stipulated value, but not by enough to trigger a penalty. MM-5 is the only Treaty unit where recreational fishing mortality (0.09 y^{-1}) exceeds both commercial fishing mortality (0.06 y^{-1}) and SLIM (0.07 y^{-1}). SLIM has been quite variable in MM-5 and the 2014 average rate was the highest in Lake Michigan Treaty Waters during. Commercial fishery yield is non-existent in unit MM-67 and recreational fishery harvest is modest (average mortality <0.05 y^{-1}) relative to the size of the population. Although spawning biomass in MM-5 has declined slightly since 2009, current biomass levels remain near or slightly above the long-term average for the unit. Biomass in unit MM-67 is higher than any other modeled Lake Trout unit, despite technical changes to the model that caused a downward rescaling of this population in the current assessment. This shift resulted in implementation of Decree's 15% rule, thus limiting the decline in the harvest limit to a level 15% below the 2015 limit. There is a Decree stipulation for MM-5 that establishes the 2016 harvest limit at 98,000 lb.

Lake Whitefish

In the western 1836 Treaty waters of Lake Superior (WFS-04 and WFS-05), Lake Whitefish populations are characterized by stable recruitment, leading to stable biomass and low levels of fishing, leading to low mortality. Recent increases in yield in these units compared to the previous decade are due to increases in effort, although overall effort remains low. Estimated maximum mortality rates during 2014 were approximately 30% in each unit. Fishing mortality does exceed natural mortality in both units.

In unit WFS-06, where there has been no attempt to fit a stock assessment model since 2006, fishery effort is quite sporadic, as is 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 eastern units (WFS-07 and WFS-08) fisheries are more stable. Both gill-net and trap-net fisheries are active in WFS-07 and yields have been roughly equivalent for the two gears for a number of years. The trap-net fishery has dominated in WFS-08 since 1999, and, although trap-net effort remains quite variable from year to year, total yield has been fairly consistent since 2009 (range 90-115K lb). Estimated mortality rates on the most vulnerable age classes (44-52%) were below target in both units in 2014; however, mortality in these units is higher than in the western units, due to the more developed fisheries. Estimated recruitment is roughly twofold higher and more stable in unit WFS-07 than unit WFS-08. Biomass patterns have mirrored recruitment, but the long-term declining trend which began during the late 1980s in WFS-07 remains evident.

In northern Lake Huron Treaty waters (WFH-01-WFH-04), dramatic declines in recruitment that began in the early 2000s and substantial increases sea lamprey mortality have combined to drive Lake Whitefish stocks down to their lowest levels since the late 1970s. Fishery yields have predictably declined and 2014 yield was the lowest in a time series that begins in 1976. Lake Huron is the only lake where independent estimates of SLIM are calculated for Lake Whitefish. Average SLIM on whitefish in northern Lake Huron still exceeds 0.17 y^{-1} for ages 6-11 and is triple the mortality rate experienced by Lake Trout. Total mortality nearly reaches the target rate for the oldest fish in the population (1.02 y^{-1}) and spawning stock biomass continued to decline for the tenth consecutive year to a new time series low. Similar patterns in recruitment and SLIM are evident in unit WFH-05, though the impacts are somewhat muted when compared to the north. Average SLIM in WFH-05 was 0.16 y^{-1} in 2014 and maximum total mortality was 0.75 y^{-1}. Yield (trap-net only) continues to decline, and catch rates are near the time-series low. However, they remain higher (>540 lb) than in most other treaty units. Nonetheless, fisheries in Lake Huron continue to be supported by strong year classes from the 1990s. Spawning biomass has declined annually since 2005 in WFH-05 though the decrease, while substantial, is not as pronounced as in the northern unit. Recent observations from surveys suggest some increase in abundance of pre-recruits, though additional observations will be necessary for confirmation. The near-term outlook for Lake Huron whitefish stocks remains negative.

Lake Whitefish recruitment patterns in northern Lake Michigan (WFM01-04) are synchronous and now appear similar to those in Lake Huron. With the exception of WFM-01, the relative decline from peak recruitment in the late 1990s appears less severe than in Lake Huron. Mortality from sea lamprey is substantially lower on whitefish here than in adjacent northern Lake Huron, thus it is simply acknowledged as a component of natural mortality. Commercial effort and yield increased in most northern Lake Michigan units during the latter 2000s but declining catch rates have since contributed to decreased yields in recent years - some have speculated that the decline in catch rates is not entirely explained by decreases in abundance. Commercial fishing mortality rates have increased and estimated maximum mortality rates range between 33% (WFM-04) and 56% (WFM-03). Spawning biomass has declined by varying degrees in all northern Lake Michigan units since the middle 2000s. As in Lake Huron, there are early signs that recruitment may have rebounded, but this has yet to be substantiated.

In central Lake Michigan Treaty units (WFM-05 and WFM-06), fisheries are less intense and/or more sporadic than in the north. Commercial yield has not exceeded 50,000 lb in WFM-05 since 2009, a product of a nearly non-existent trap-net fishery. Conversely, during 2010-2012, annual trap-net yields in WFM-06 were among the highest in the time series. Catch rates and total yield have declined in each of the past two years in WFM-06. Estimated maximum mortality rates (28-43%) remain below target in these units. Recruitment patterns in WFM-05 mirror those in the north, but due to low mortality and increased growth, spawning biomass has increased modestly since 2010. The sporadic nature of the fishery in WFM-06 results in somewhat ambiguous estimates and temporal trends have a higher level of uncertainty than in other areas. Although model performance has improved in recent years, the TFC has continued

to recommend a harvest limit of 250,000 lb for this unit until such time that model performance is satisfactory.

In unit WFM-07 the commercial fishery has ceased to operate. The commercial fishery operated from 2001 through 2013 and peaked in 2007. The lack of long-term monitoring data has precluded development of a SCAA model and the HRG for this unit, which had remained constant at 500,000 lb since 2004, was to 350,000 lb to reflect reductions in Lake Whitefish populations in other areas of Lake Michigan. In WFM-08, the southernmost Lake Michigan Treaty unit, trap-net fishery yield had been quite stable, ranging from 205,000 to 341,000 lb during 2003-2011. Since then, yield declined to the lowest level of the time series in 2014 when only 86,000 lb of Lake Whitefish were harvested. Declining catch rates contributed to the reduction in yield. Natural mortality is the largest source of mortality in this unit and although the assessment model rescaled with structural changes in the current run, it is still believed that the fishery yield is small relative to stock size. Fishing mortality was estimated to be 0.10 yr^{-1} and total mortality was well below target in 2014. Recruitment patterns suggest that a relatively strong year class was produced in 2006, something not observed in northern units (but does appears evident in WFM-06). Biomass has declined from the 2008 peak and estimates suggest stock size is similar to those from 1980s and 1990s. The assessment for unit WFM-08 has generated highly variable estimates of stock size over the years, a situation that has lead the TFC to recommend a constant harvest limit of 1.4 million lb. The MSC will continue to conduct the stock assessment and evaluate a suite of stock parameters when making a recommendation to the TFC for continuance of the constant catch policy.

Technical Changes

As previously discussed, the Lake Huron Lake Trout models are undergoing structural review. A description of the new model structure will be provided upon completion of the review, likely in the 2017 version of this report. There were no structural changes to the Lake Superior Lake Trout models in 2016, though estimates of SLIM for units MI-6 and MI-7 had to be interpolated from last year's values due to the lack of available biological samples – the proportional reduction in SLIM observed in MI-5 was applied to last year's estimates for MI-6 and MI-7 to derive the most recent estimate for these units. For the Lake Michigan Lake Trout assessments, lead responsibility was shifted within the MSC to a new group of modelers. The group coordinated their review of structural changes across the assessments, from which two primary changes were adopted for this year: 1) replacement of hard-coded double logistic functions that had become commonplace in the Lake Michigan models with lognormal functions; and 2) for units where a substantial gap existed in available survey data during the 1990s (all but unit MM-4), the separation of the survey time series into two time periods. The MSC recommended that additional structural changes be reviewed prior to 2017; those adopted will be detailed in a future version of this document.

There were minimal changes to Lake Whitefish models for the 2016 assessments. Some modelers continued to evaluate changes related to selectivity functions (eg lognormal or gamma rather than double logistic). Also, for many units, weight-at-age data were based on modeled estimates rather than raw data. The whitefish models are nearing a state of equilibrium, in that they are not substantively changed from year to year - a positive step for the MSC.

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 waters in adjacent Ontario management area 4-1 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.

MH-2: Lake trout management unit MH-2 is located in north-central Lake Huron. It includes statistical district MH-2 (approximately 640,000 ha) as well as adjacent Canadian waters (areas 4-2, 4-3, and 4-7 for a total of approximately 546,000 ha). Michigan waters of the MH-2 unit include both 1836 Treaty waters (304,000 ha) and non-treaty waters (336,000 ha), 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 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: The catch-at-age model for Lake Whitefish in Northern Lake Huron was created in 2009 after mark-recapture data showed fluid movement of adult fish between management units WFH-01, WFH-02, WFH-03, and WFH-04. The consolidated stock assessment model was an attempt by the Modeling Subcommittee to estimate population parameters for a mixed-stock fishery exploited by only one agency (CORA). 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.

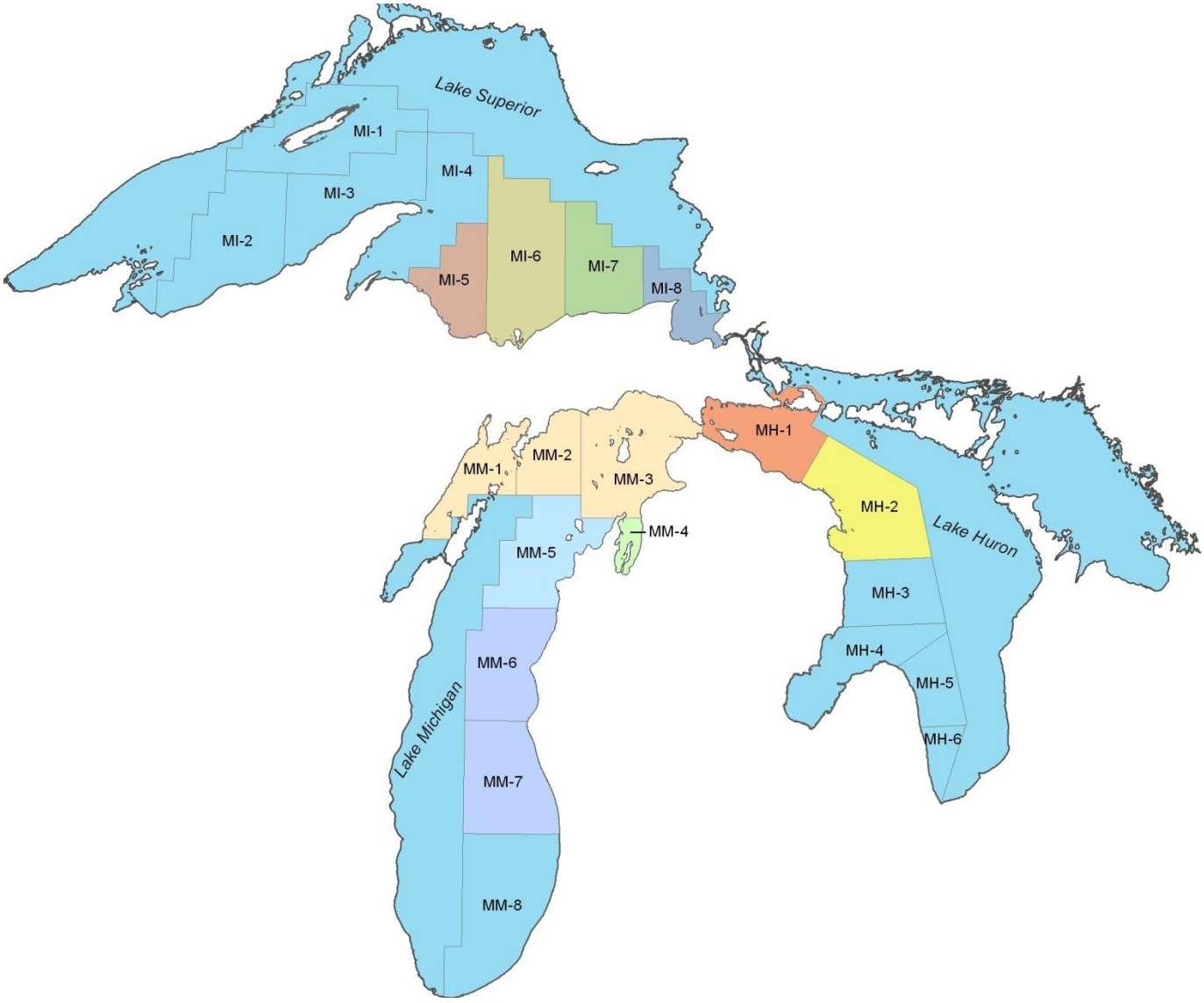


Figure 1. Lake Trout Management Units. Shaded areas denote units subject to provisions of the 2000 Consent Decree. Like shading indicates where statistical districts have been combined into a single management unit for stock assessment purposes. No stock assessment has been developed for Lake Superior unit MI-8.

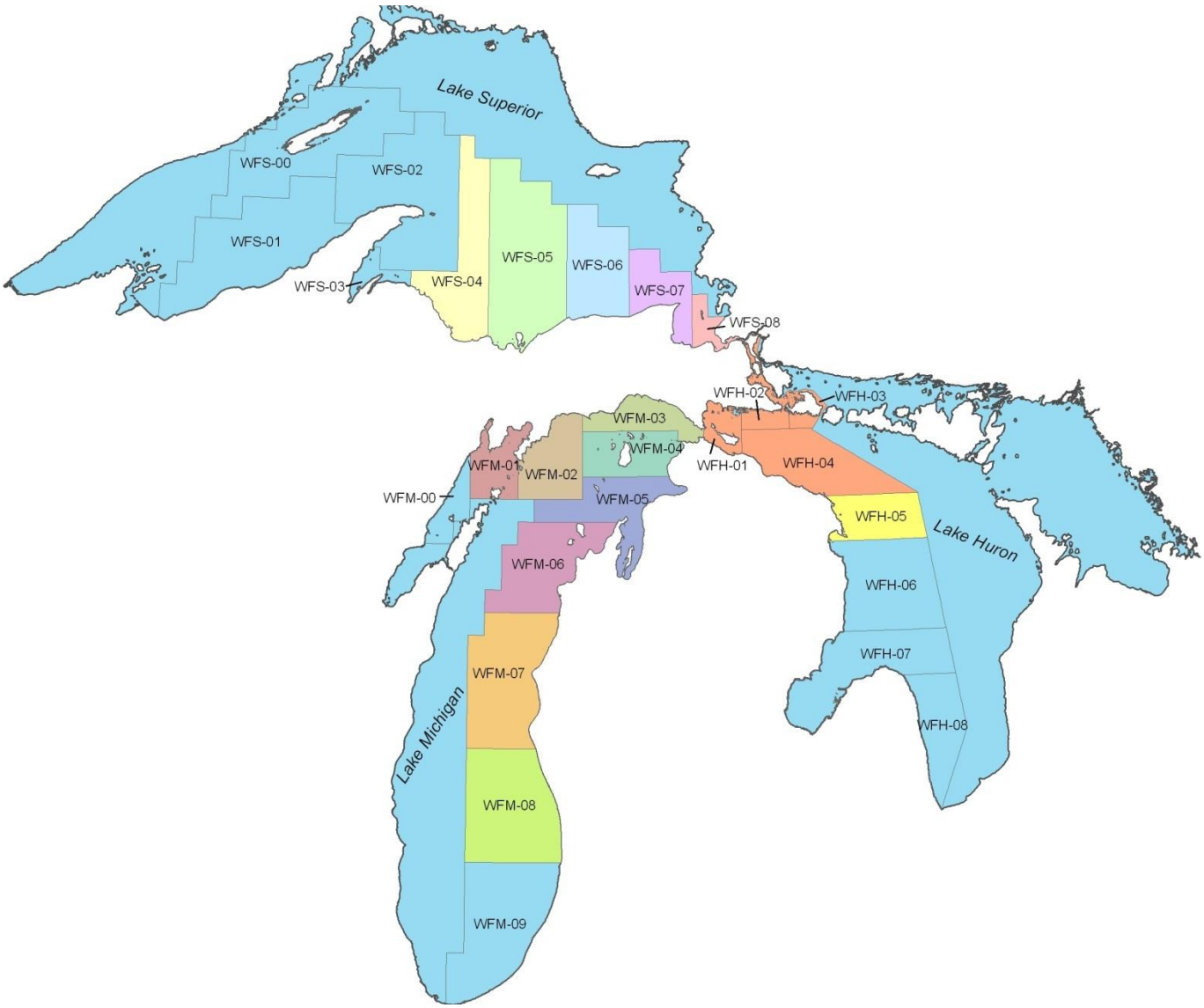


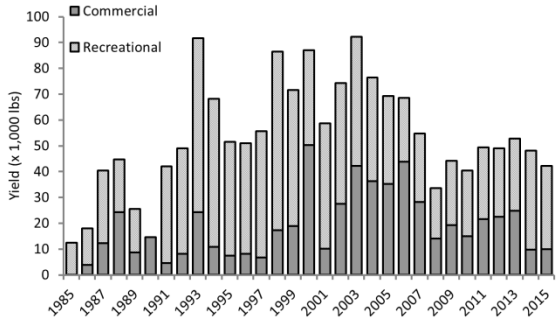
Figure 2. Lake Whitefish Management Units. Shaded areas denote units subject to provisions of the 2000 Consent Decree. Like shading indicates where units have been combined into a single management area for stock assessment purposes. No stock assessment model has been developed for Lake Michigan unit 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

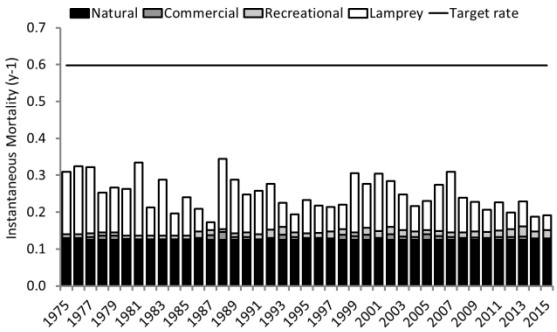
Lake Superior

MI-5 (Marquette) **Shawn Sitar**

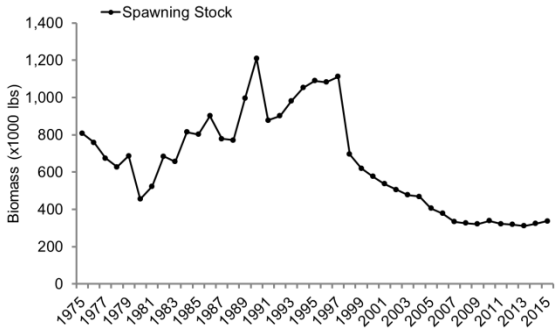
Commercial and recreational fishery lake trout yield MI-5



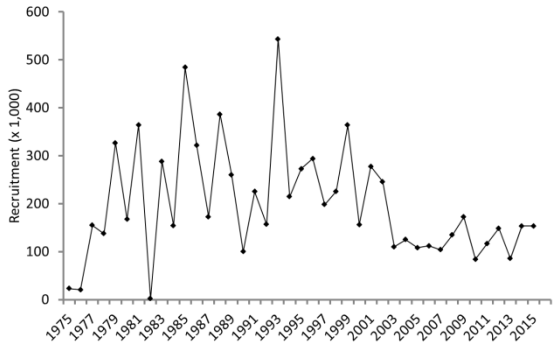
Average instantaneous mortality rates for lake trout in MI-5



Estimated lake trout biomass MI-5



Number of age- 4 recruits MI-5



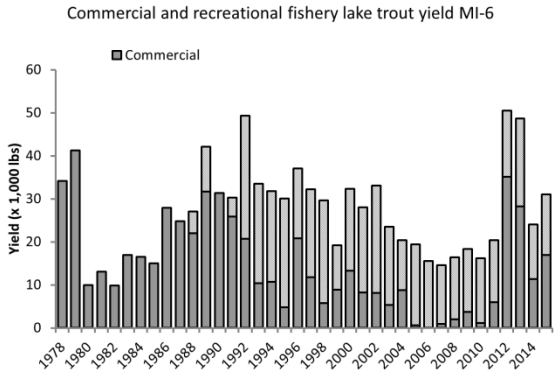
Parameter[(1)]	Value
Base SSBR	8.43 lb
Current SSBR	2.91 lb
Target SSBR	0.41 lb
Current SPR	0.35
M	0.12 y^{-1}
F, Commercial (2013-2015)	0.01 y^{-1}
F, Recreational (2013-2015)	0.02 y^{-1}
Sea Lamprey Mort (2012-2015)	0.05 y^{-1}
Z (2015)	0.19 y^{-1}
Recommended TAC	148,787 lb
Actual TAC	148,787 lb
Model Rating	Medium

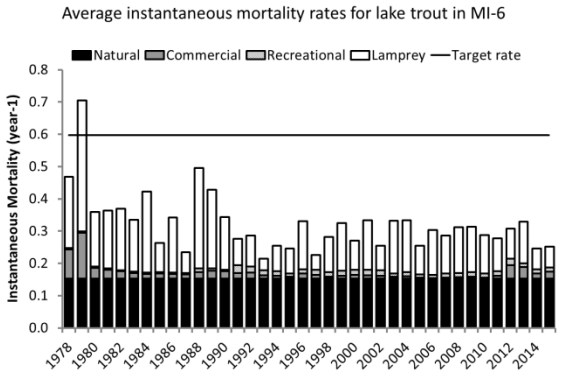
(1) For this and all subsequent tables in this section, mortality rates represent averages for Lake Trout ages 6-11.

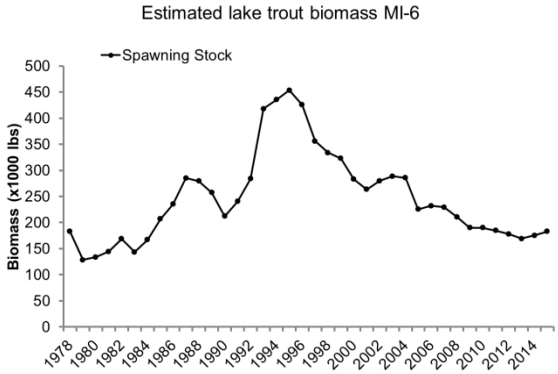
Notable Stock Dynamics and Model Changes:

Lake trout biomass has progressively declined since the 1990s and is driven by reduced recruitment and growth. Sea lamprey-induced mortality has declined since 2007 and is low compared to the mid-1990s. Recreational harvest has been stable. Commercial yield declined by 50% between 2013 and 2014. The 2016 model does not have actual 2015 commercial yield, effort, and age composition data, as it was not provided; all values were assumed to be constant from 2014. The lake trout TAC in 2016 increased 4% from 2015 due to a slight increase in stock size.

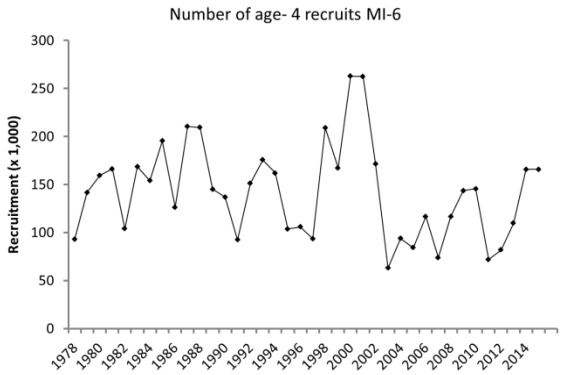
MI-6 (Munising) Shawn Sitar







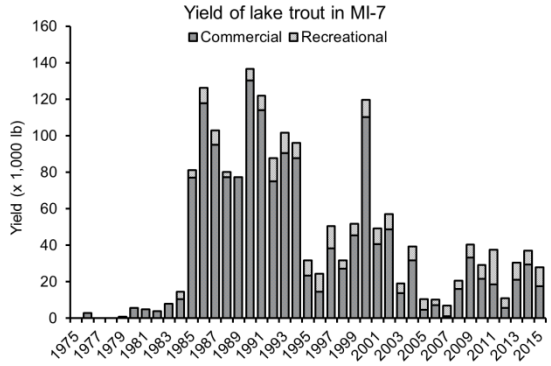
Parameter	Value
Base SSBR	5.41 lb
Current SSBR	1.81 lb
Target SSBR	0.59 lb
Current SPR	0.33
M	0.15 y^{-1}
F, Commercial (2013-2015)	0.02 y^{-1}
F, Recreational (2013-2015)	0.01 y^{-1}
Sea Lamprey Mort (2012-2014)	0.10 y^{-1}
Z (2015)	0.27 y^{-1}
Recommended TAC	213,842 lb
Actual TAC	213,842 lb
Model Rating	Medium



Notable Stock Dynamics and Model Changes:

Abundance of lake trout has increased in the last three years due to recent increases in recruitment and slightly lower mortality rates. With the exception of 2014 and 2015, total mortality has not varied much in the last 10 years and is mostly driven by sea lamprey predation. Recent commercial landings have been low; however in 2012 and 2013 they increased by five-fold to the highest levels observed since 1980. Commercial yields have since declined from those levels. The 2016 TAC for MI-6 increased by 28% from last year due to a 50% decline in sea lamprey-induced mortality and recent increase in abundance.

MI-7 (Grand Marais) Shawn Sitar

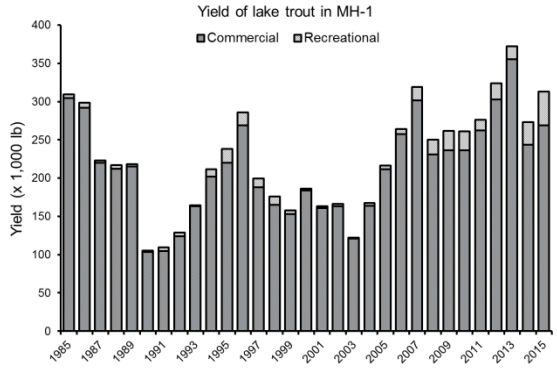


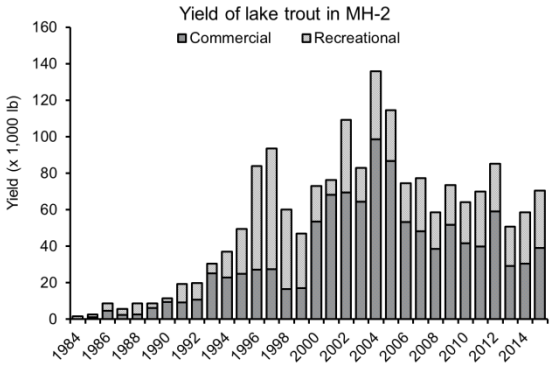
Parameter	Value
Sea Lamprey Mort (2012-2014)	0.10 y^{-1}
Recommended TAC	111,366 lb
Actual TAC	111,366 lb

Notable Stock Dynamics and Model Changes:

This model was in rotation status for 2016; therefore the TAC was projected from 2015 model estimates of abundance and recruitment, with updated fishing and sea lamprey mortality rates. Total lake trout abundance has been steady since 2004 and recruitment has been variable. Total mortality is low and averaged 28% in the last three years. Sea lampreys persist as the highest mortality source since 2001. Commercial yield has been consistently higher than recreational harvest since 2003 and declined 40% between 2014 and 2015. The 2016 TAC for MI-7 was essentially the same as the model estimate in 2015.

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

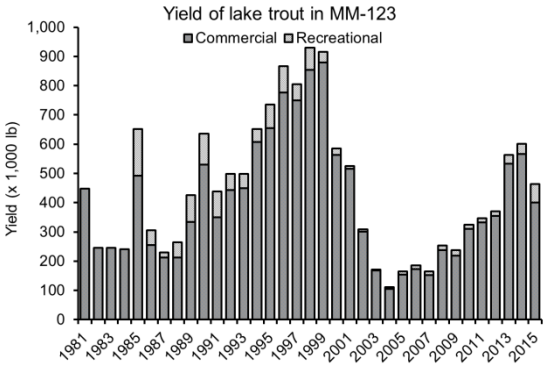


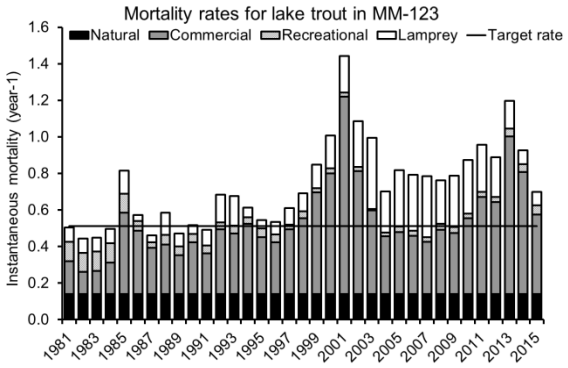


Notable Stock Dynamics and Model Changes:
Continued evidence for strong retrospective patterns in the MH-1 assessment, coupled with widely varying population scaling, led the MSC to assemble a sub-group to review and reconstruct the Lake Huron assessments with the hope of overcoming their most persistent problems. This process began in 2015 and continued in 2016. During this review period, the MSC recommended and the TFC and Consent Decree parties approved a 2-year (2015-2016) constant harvest limit for the Lake Huron units based upon a rough average of model-based limits over the most recent five-year period.

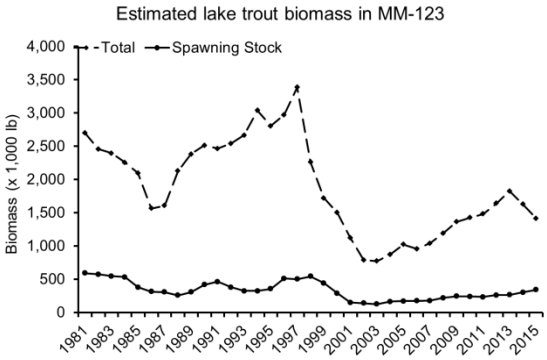
Despite the persistent performance issues in the assessments for Lake Huron, the overall status of the population remains positive. Wild fish continue to recruit to fisheries and surveys and now compose more than 50% of the biological samples collected in US waters. Nearly 90% of the fish sampled in the Ontario waters of north-central Lake Huron, where no stocking occurs, were of wild origin. Commercial and recreational yield increased in MH-1 in 2015. Sea lamprey mortality declined to 0.06 in 2015, the lowest level since 1990.

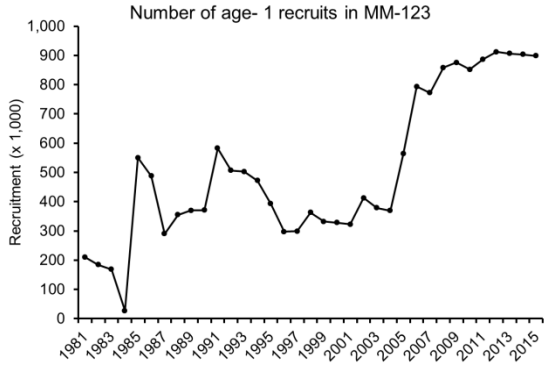
Lake Michigan
MM-123 (Northern Treaty Waters) Ted Treska





Parameter	Value
Base SSBR	1.06 lb
Current SSBR	0.06 lb
Target SSBR	0.22 lb
Current SPR	0.06
M	0.14 y^{-1}
F, Commercial (2013-2015)	0.66 y^{-1}
F, Recreational (2012-2014)	0.05 y^{-1}
Sea Lamprey Mort (2012-2014)	0.15 y^{-1}
Z (2015)	0.94 y^{-1}
Recommended TAC	148,769 lb
Actual TAC	N/A
Model Rating	Low



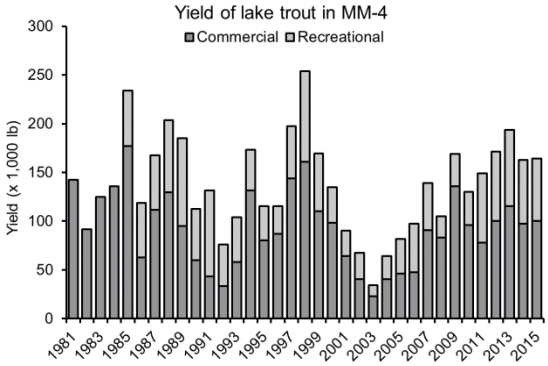


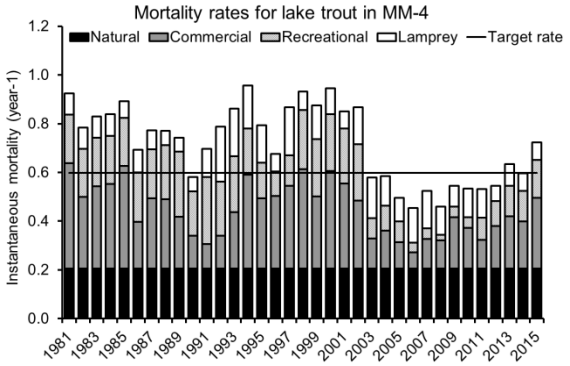
<u>Notable Stock Dynamics and Model Changes:</u>

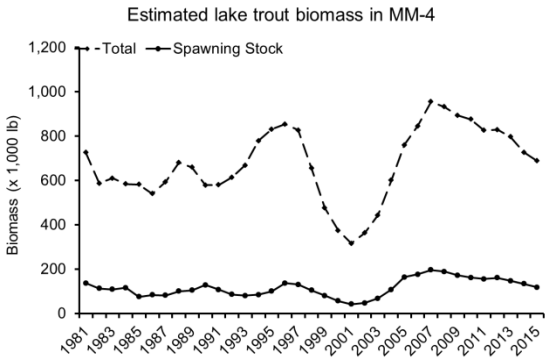
Harvest has been increasing in both the commercial and recreational fishery over the last decade. An emergency closure of the commercial fishery occurred late in 2015 in an effort keep yield within management targets. This year's model incorporates estimated discard poundage that resulted from implementation of a bag limit in the commercial gill-net fishery in 2015. Numerous changes were made to the structure of this model in this year's assessment, mostly related to the handling of selectivity of the different gears and treatment of survey data (see *Technical Changes* section). The 2016 model-recommended harvest limit is 148,769 lb, up from the 2015 estimate of 44,790, primarily due to reductions in projected sea lamprey

mortality. The model was assigned a low rating to reflect the outstanding need to evaluate a suite of potential structural/data-related changes for next year's harvest limit cycle.

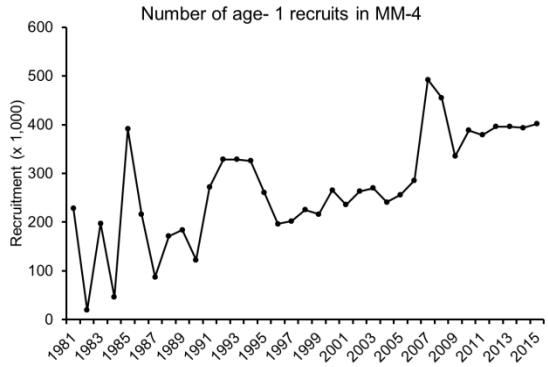
MM-4 (Grand Traverse Bay) Stephen Lenart





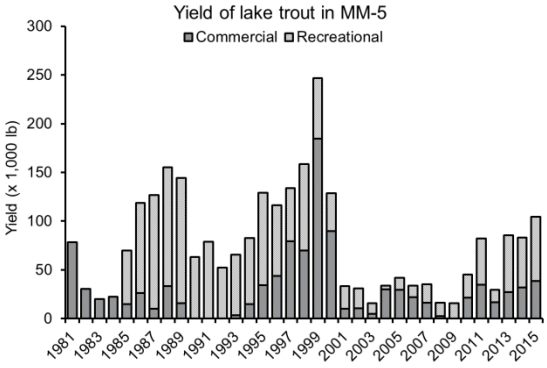


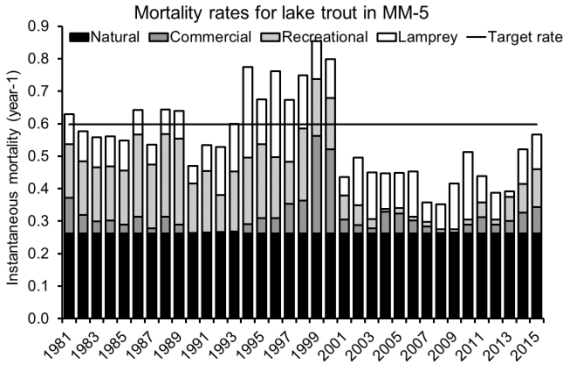
Parameter	Value
Base SSBR	1.32 lb
Current SSBR	0.18 lb
Target SSBR	0.25 lb
Current SPR	0.14
M	0.21 y^{-1}
F, Commercial (2013-2015)	0.23 y^{-1}
F, Recreational (2013-2015)	0.14 y^{-1}
Sea Lamprey Mort (2012-2014)	0.08 y^{-1}
Z (2015)	0.65 y^{-1}
Recommended TAC	90,982 lb
Actual TAC	192,661 lb
Model Rating	Low

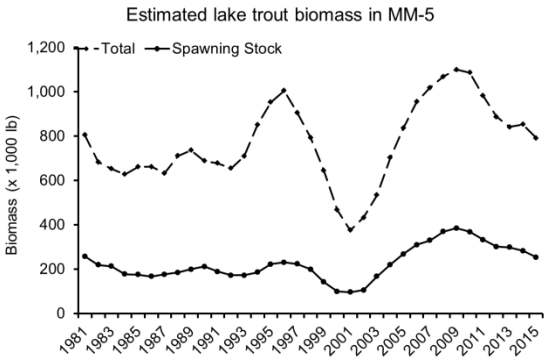


<u>Notable Fishery Dynamics and Model Changes:</u>
In addition to changes referenced in the Technical Changes section of this document, an update was made to the mean weight-at-age matrix and time-varying commercial selectivity was implemented. Both the 2016 base model and the updated version showed a marked decrease in estimates of stock size compared to the 2015 base model. The resulting TAC represented a 52% decline from last year; though it should be noted that the 2015 model TAC was inflated due to discrepancies in the 2015 data file. Total yield in 2015 was approximately 165,000 lb. The model was assigned a low rating to reflect the outstanding need to evaluate a suite of potential structural/data-related changes for next year's harvest limit cycle.

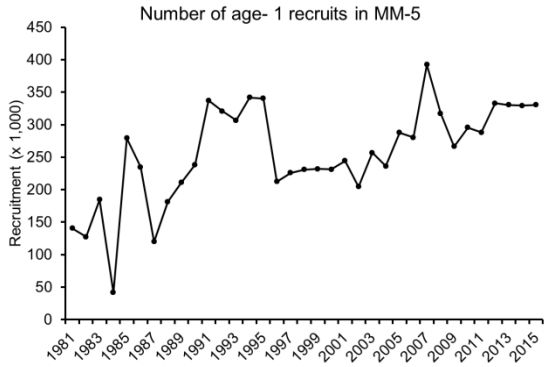
MM-5 (Leelanau Peninsula to Arcadia) Stephen Lenart







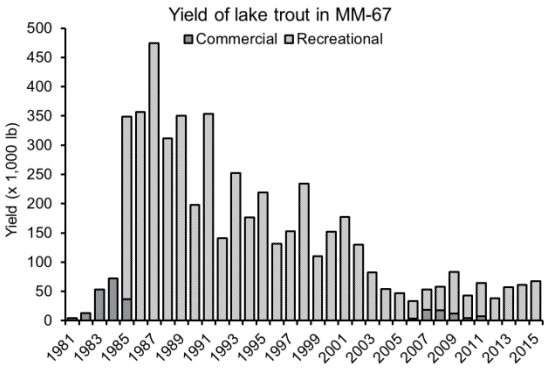
Parameter	Value
Base SSBR	1.47 lb
Current SSBR	0.57 lb
Target SSBR	0.57 lb
Current SPR	0.39
M	0.26 y^{-1}
F, Commercial (2013-2015)	0.06 y^{-1}
F, Recreational (2013-2015)	0.09 y^{-1}
Sea Lamprey Mort (2012-2014)	0.07 y^{-1}
Z (2015)	0.49 y^{-1}
Recommended TAC	68,610 lb
Actual TAC	98,000 lb
Model Rating	Low

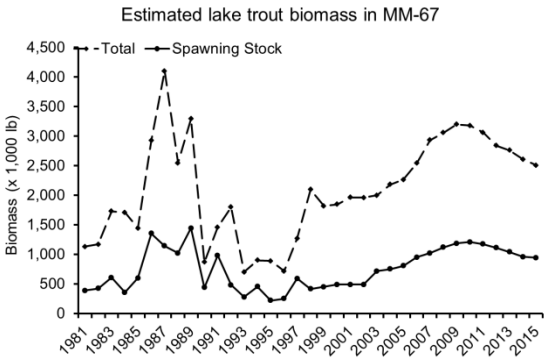


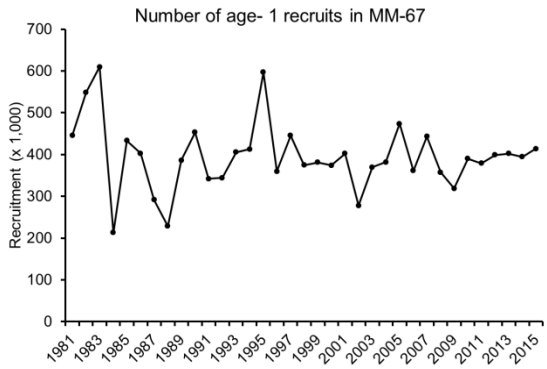
Notable Fishery Dynamics and Model Changes:

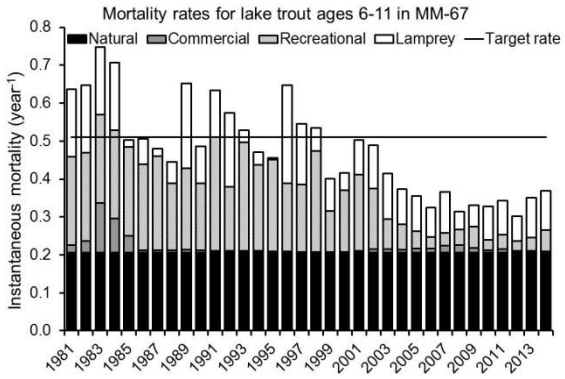
Model changes were similar to those described for other Lake Michigan units (selectivity, growth matrix, survey), though changes here also included a restructuring of the code for time-varying commercial fishery catchability during periods when no fishery was active. Stock size was down slightly compared to last year's base model and projected sea lamprey mortality was slightly higher, resulting in a 15% decline in the model-generated limit (68,610 lb) compared to 2015. Total yield eclipsed 100,000 lb for the first time since 2000, with each fishery exhibiting its highest yield since that year. The model was assigned a low rating to reflect the outstanding need to evaluate a suite of potential structural/data-related changes for next year's harvest limit cycle.

MM-67 (Southern Treaty Waters) Mike Seider









Parameter	Value
Base SSBR	3.00 lb
Current SSBR	1.62 lb
Target SSBR	1.06 lb
Current SPR	0.54
M	0.23 y^{-1}
F, Commercial (2013-2015)	<0.01 y^{-1}
F, Recreational (2013-2015)	0.03 y^{-1}
Sea Lamprey Mort (2011-2013)	0.08 y^{-1}
Z (2015)	0.35 y^{-1}
Recommended TAC	215,962 lb
Actual TAC	318,639 lb
Model Rating	Low

Notable Fishery Dynamics and Model Changes:

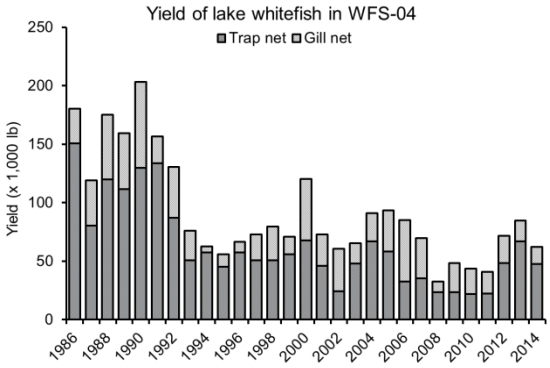
MM-67 currently only has recreational harvest, which has been relatively stable in recent years. Model changes mirrored those described for other Lake Michigan units (selectivity function and treatment of survey data). Other minor structural changes were also made to try to improve model stability. The structural changes made in 2016 reduced sensitivity to starting values and retrospective patterns compared to previous iterations of the model. The MCMC distributions were not improved with the changes made in 2016. The assessment received a low rating because further modifications to model input data and structure are still warranted.

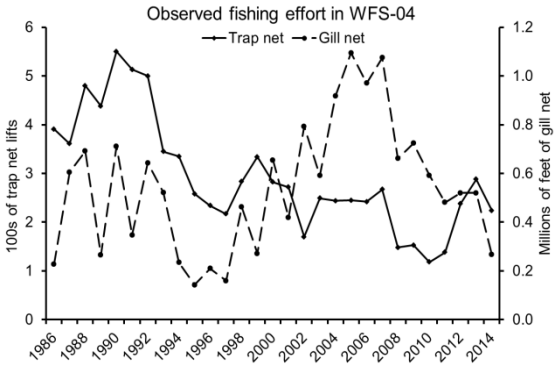
STATUS OF LAKE WHITEFISH POPULATIONS

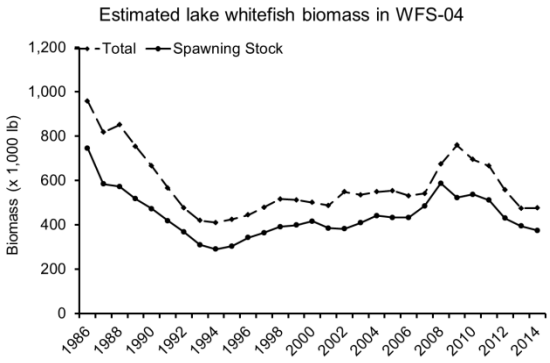
Lake Superior

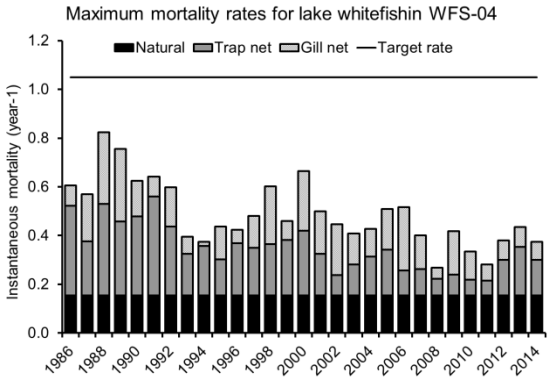
WFS-04 (Marquette-Big Bay)

Mike Seider









Parameter[(2)]	Value
Base SSBR	5.21 lb
Current SSBR	1.04 lb
Target SSBR	0.94 lb
Current SPR	0.20
M	0.16 y^{-1}
F, trap net (2012-2014)	0.15 y^{-1}
F, gill net (2012-2014)	0.05 y^{-1}
Z (2014)	0.34 y^{-1}
Recommended TAC	136,000 lb
Actual TAC	136,000 lb
Model Rating	Medium

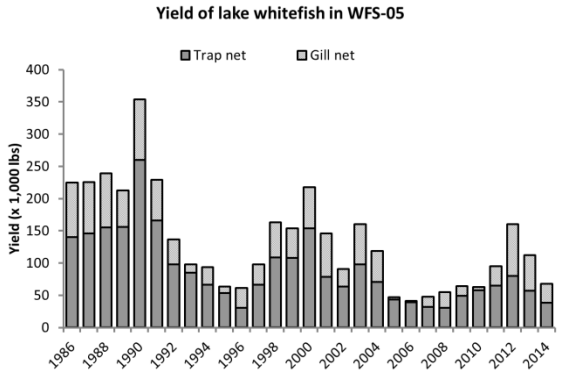
(2) For this and all subsequent tables in this section, mortality rates represent averages for whitefish ages 6-11.

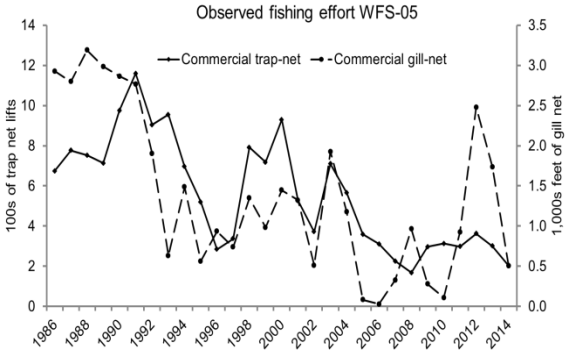
Notable Fishery Dynamics and Model Changes:

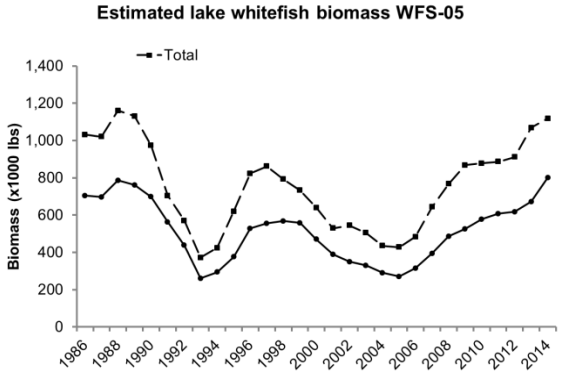
The lake whitefish population remains generally stable in WFS-04. Biomass has declined since the late-2000s, due to slight changes in abundance and weight at age. Gill-net CPUE and trap-net CPUE have gradually increased in recent years. Total mortality rates were well below the target maximum value throughout the time series. Annual mortality rate (A) for the most vulnerable age class was 31% in 2014. The only substantial change in 2015 was that modeled rather than raw mean weights-at-age were used. This change, along with another year of fishery data affected trends in biomass, estimated year class strength in

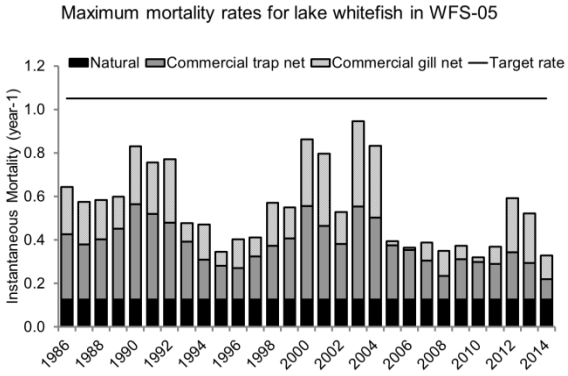
recent years, and inherently the calculation of the total allowable catch for 2016. Most diagnostics suggested this assessment model is performing reasonably well. Poor MCMC distributions were due to uncertainty in estimating selectivity parameters in the last two years. This was largely caused by no gill net age samples being collected in 2013 and 2014 to inform the model. The assessment received a medium rating because the model continues to provide consistent parameter estimates in spite of previous structural changes and poor MCMC distributions. The 2016 yield limit calculated for the entire WFS-04 management unit is 193,000, which is 27% higher than for 2015. After applying the prescribed reduction to reflect the proportion of this management unit that is outside the Consent Decree, the 2016 yield limit for lake whitefish in 1836 Treaty Waters is 136,000 lb.

WFS-05 (Munising) Shawn Sitar







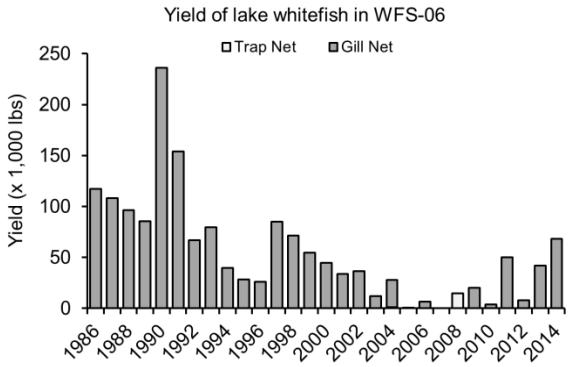


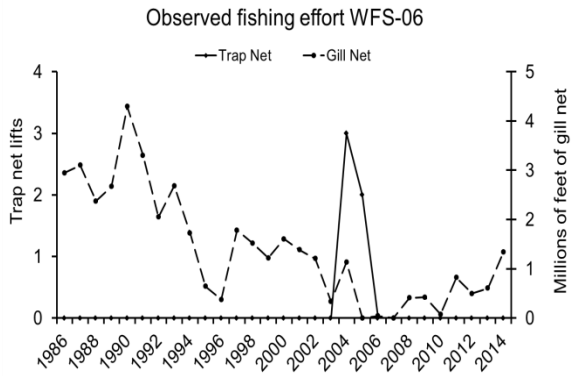
Parameter	Value
Base SSBR	4.65 lb
Current SSBR	1.67 lb
Target SSBR	1.42 lb
Current SPR	0.36
M	0.13 y^{-1}
F, trap net (2012-2014)	0.13 y^{-1}
F, gill net (2012-2014)	0.13 y^{-1}
Z (2014)	0.28 y^{-1}
Recommended TAC	336,100 lb
Actual TAC	336,100 lb
Model Rating	Medium

Notable Fishery Dynamics and Model Changes:

The 2016 lake whitefish TAC was 336,100 lb, a decrease of 18% from 2015. The decline in TAC was because of improvements made to the model structure that yielded more realistic estimates of stock structure and improved model fit to observed data. The primary change to the model from last year involved changing trap-net selectivity function from gamma to logistic. The annual mortality rate (A) experienced by the stock was 27%. Trap-net yield has increased since 2008 and gill-net yield has increased significantly since 2006; however, both sources of fishery yield declined in 2014. The model is rated medium because it has consistent performance with prior models, which have had good diagnostics.

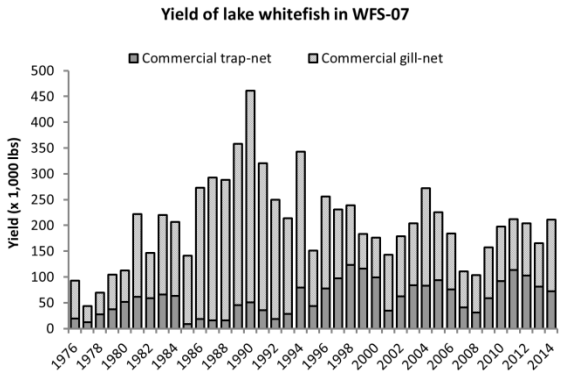
WFS-06 (Grand Marais)

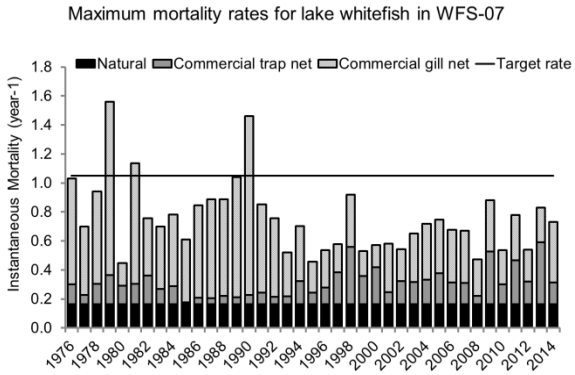


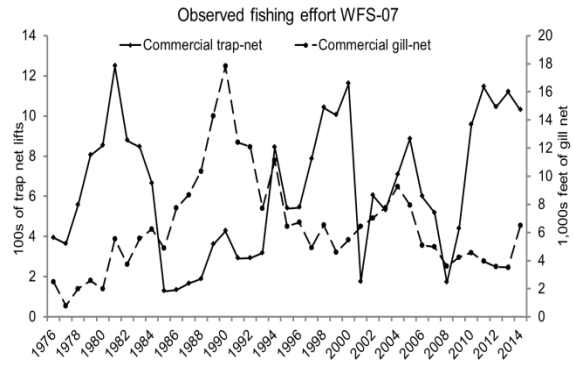


There is no current stock assessment model for WFS-06. Low levels of effort and harvest and a lack of fishery monitoring data since the early 2000s limit the ability to produce an assessment model for this unit.

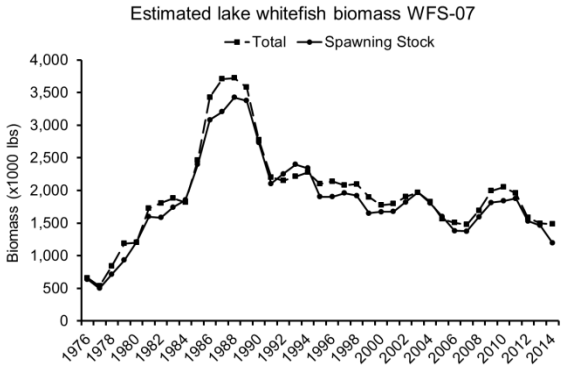
WFS-07 (Tahquamenon Bay) Mark Ebener







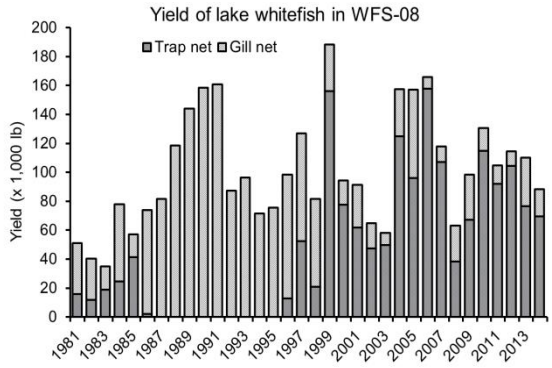
Parameter	Value
Base SSBR	3.44 lb
Current SSBR	0.75 lb
Target SSBR	0.72 lb
Current SPR	0.22
M	0.16 y^{-1}
F, trap net (2012-2014)	0.21 y^{-1}
F, gill net (2012-2014)	0.27 y^{-1}
Z (2014)	0.72 y^{-1}
Recommended TAC	599,800 lb
Actual TAC	599,800 lb
Model Rating	Medium

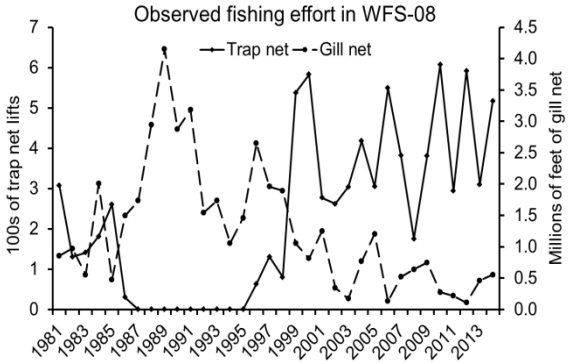


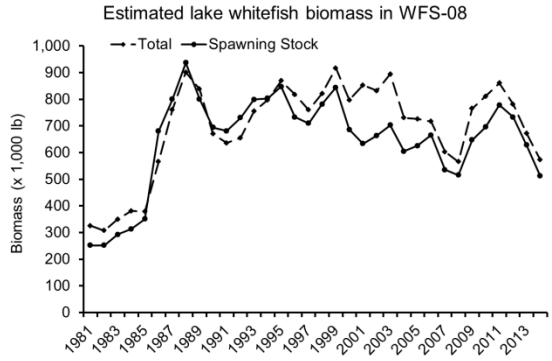
<u>Notable Fishery Dynamics and Model Changes:</u>

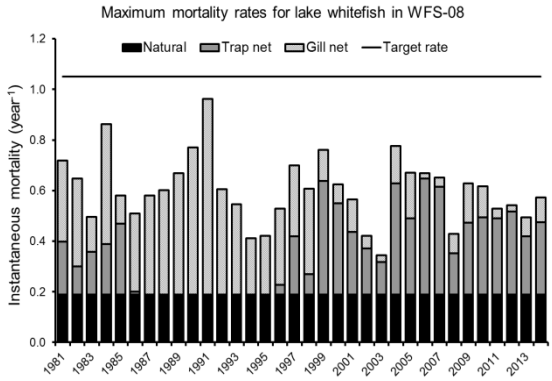
The 2016 stock assessment for WFS-07 had minor changes from 2015, including broadening the bounds for estimating sigma, estimating the descending limb of the double logistic for gill-net selectivity, and lowering the reference length for the trap-net fishery. Some retrospective patterns were present, though they were not severely biased and were improved from 2015. MCMCs were average, and model predictions of harvest were reasonable, but worse than most whitefish stock assessments. Annual mortality of the most vulnerable age class was estimated to be 52% in 2014. The resultant TAC was estimated to be 599,800 pounds for 2016 and the model was rated medium.

WFS-08 (Brimley) Paul Ripple







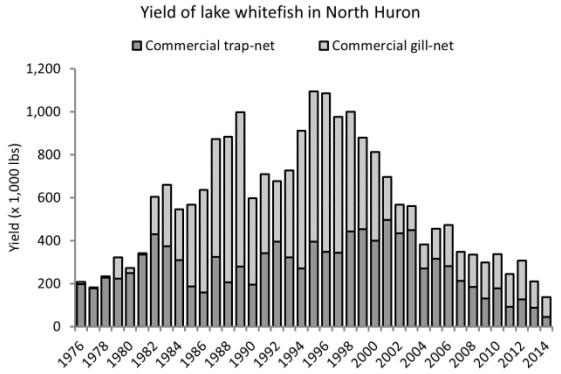


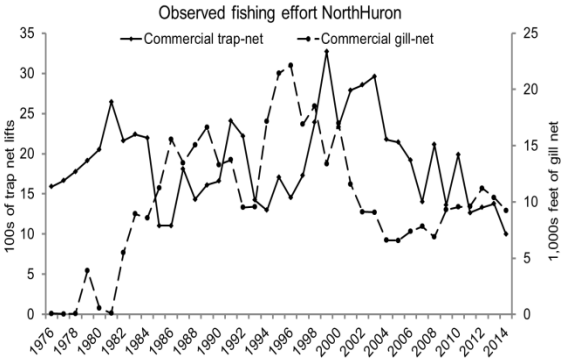
Parameter	Value
Base SSBR	2.27 lb
Current SSBR	0.51 lb
Target SSBR	0.19 lb
Current SPR	0.23
M	0.19 y^{-1}
F, trap net (2012-2014)	0.18 y^{-1}
F, gill net (2012-2014)	0.04 y^{-1}
Z (2014)	0.44 y^{-1}
Recommended TAC	178,800 lb
Actual TAC	178,800 lb
Model Rating	Medium

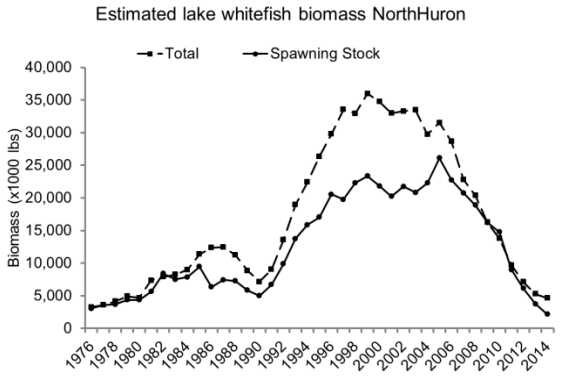
Notable Fishery Dynamics and Model Changes:

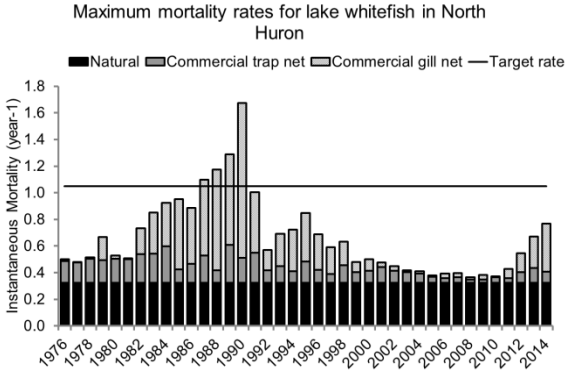
The model recommended TAC for 2016 in WFS-08 is 178,800 lb, up 11% from 2015. Spawning stock biomass in 2014 is 30% lower than the peak in 1988, but it remains well above the historical lows of the early 1980s. Gill-net effort peaked in 1989 and has steadily decreased since then until the last two years. Trap-net effort, while variable, has generally increased since 1995, from zero lifts to 517 lifts in 2014. Harvest has been dominated by trap nets since 1999. The CPUE for both gears has shown up and down variation over time. The current version of the model converged and was stable but many model diagnostics were marginal. The model rating for 2016 is medium.

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







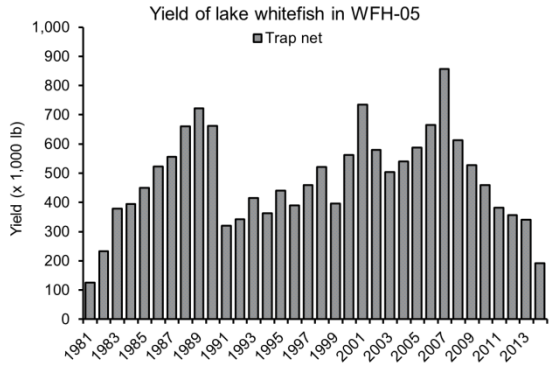


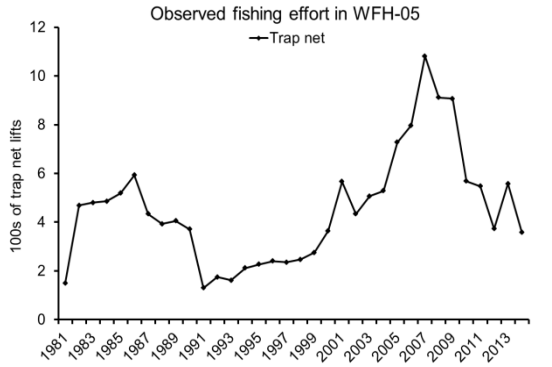
Parameter	Value
Base SSBR	1.07 lb
Current SSBR	0.40 lb
Target SSBR	0.46 lb
Current SPR	0.37
M	0.33 y^{-1}
F, trap net (2012-2014)	0.07 y^{-1}
F, gill net (2012-2014)	0.11 y^{-1}
Z (2014)	0.69 y^{-1}
Recommended TAC	561,600 lb
Actual TAC	379,900 lb
Model Rating	Medium

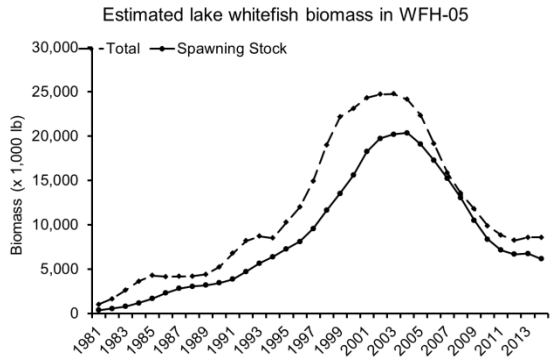
<u>Notable Fishery Dynamics and Model Changes:</u>

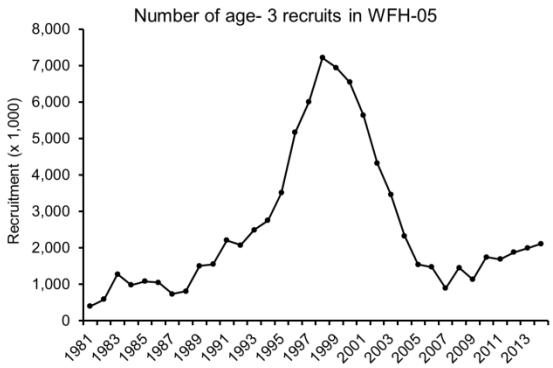
The Northern Lake Huron stock assessment model was unchanged for 2016. The model converged, was stable, had no patterns in residuals, and only minimal patterns in retrospective analyses. MCMCs were marginal but consistent with recent years. Fishable biomass of age-4 and older whitefish in 2014 was estimated to be only 4.6 million pounds and was the lowest value since 1978; only during 1976-1978 was biomass lower in northern Lake Huron than in 2014. The decline in biomass was due to huge declines in recruitment after 2004 and increased sea lamprey predation since that time. The TAC was estimated to be 561,600 lb, and the model was rated medium.

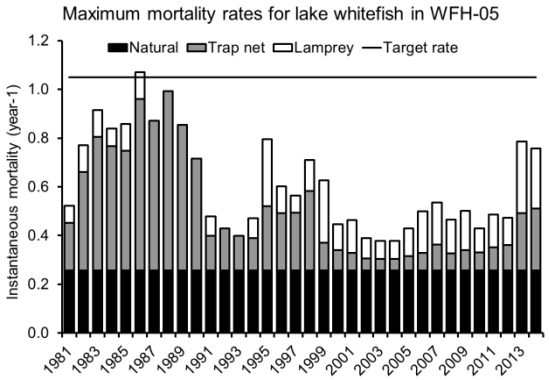
WFH-05 (Alpena) Stephen Lenart









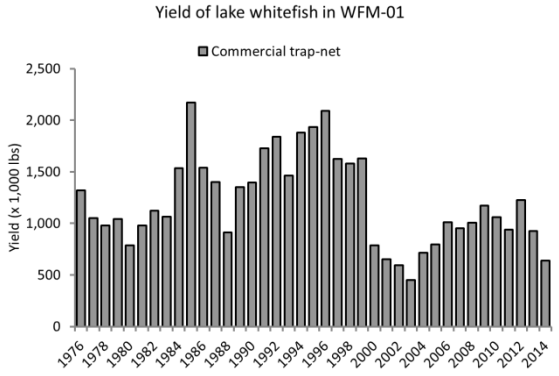


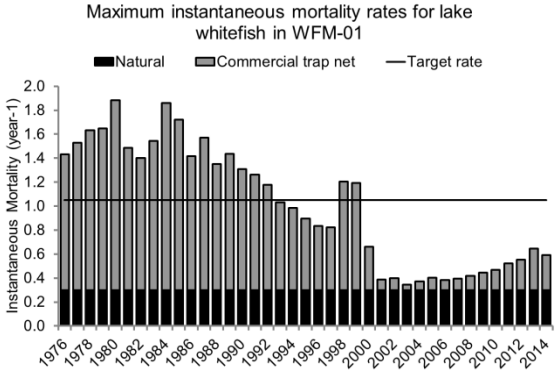
Parameter	Value
Base SSBR	2.24 lb
Current SSBR	0.95 lb
Target SSBR	0.93 lb
Current SPR	0.42
M	0.26 y^{-1}
F, trap net (2012-2014)	0.05 y^{-1}
Z (2014)	0.45 y^{-1}
Recommended TAC	394,000 lb
Actual TAC	394,000 lb
Model Rating	Low

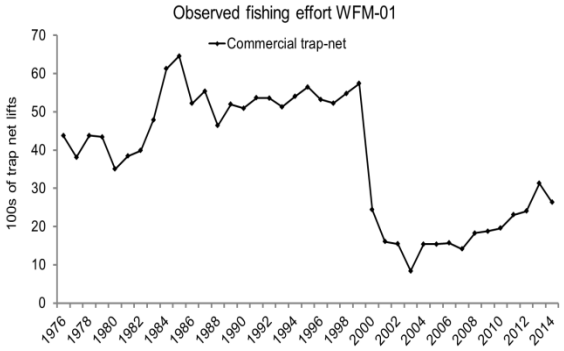
Notable Fishery Dynamics and Model Changes:

Spawning biomass continues to decline in WFH-05 in response to declining recruitment. The maximum annual mortality was 53%. Sea-lamprey induced mortality declined modestly during 2014 but was still high, averaging 18% for fish ages 6-15. The 2016 model-generated TAC declined 9%, primarily due to higher projections of both sea-lamprey and fishing mortality. No substantive changes were made to the model structure. Strong retrospective patterns remain an issue for this assessment, though the issue has been definitively linked to age composition data and not a structural element. Recent recruitment estimates suggest a slight increase from the lows observed during the previous decade, though additional observations will be necessary for confirmation.

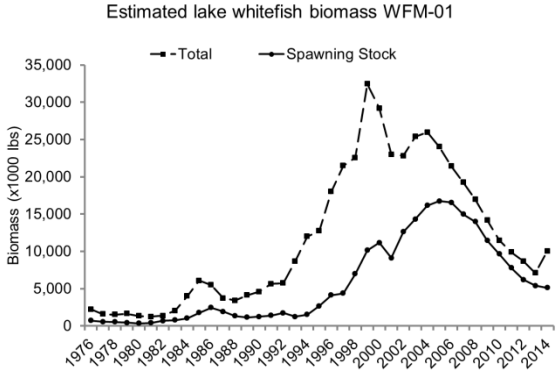
Lake Michigan
WFM-01 (Bays De Noc) — Mark Ebener







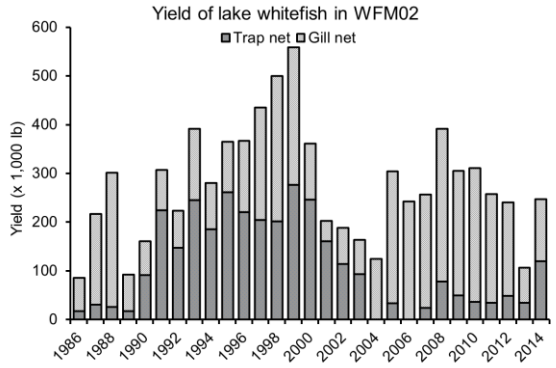
Parameter	Value
Base SSBR	1.84 lb
Current SSBR	0.65 lb
Target SSBR	0.65 lb
Current SPR	0.35
M	0.30 y^{-1}
F, trap net (2012-2014)	0.25 y^{-1}
Z (2014)	0.54 y^{-1}
Recommended TAC	1,466,300 lb
Actual TAC	1,466,300 lb
Model Rating	Medium

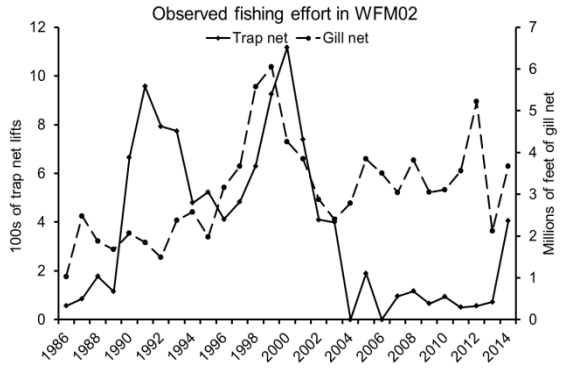


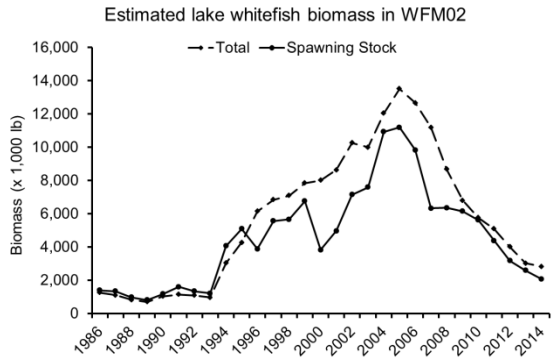
Notable Fishery Dynamics and Model Changes:

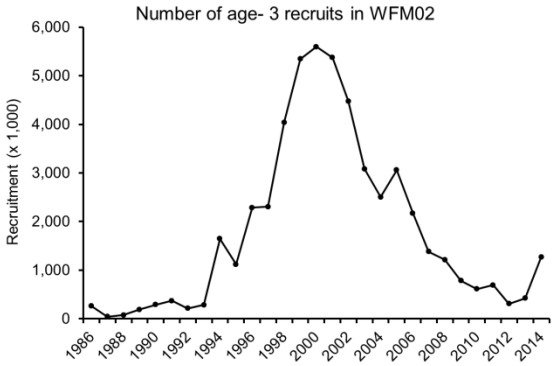
The 2016 stock assessment model for WFM-01 was unchanged from 2015. Retrospective and MCMC analyses were marginal. Biomass in WFM-01 in 2014 increased from the previous year for the first time since 2004. The declines in biomass observed since 2003 and the increased biomass in 2014 were directly related to the levels of recruitment in WFM-01. Annual mortality was estimated to peak at 45% in 2014. The TAC was estimated to be 1,466,300 pounds for 2016, and the model was rated as medium because MCMCs were not optimal and retrospective patterns were evident.

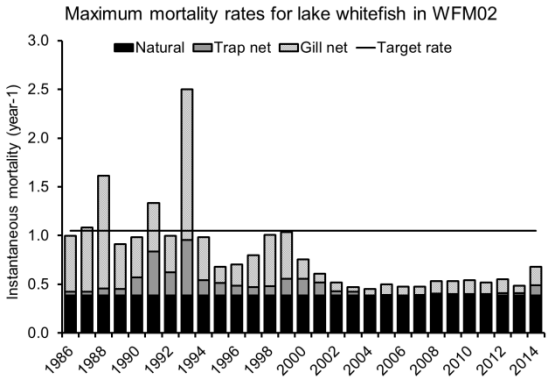
WFM-02 (Manistique) Ted Treska









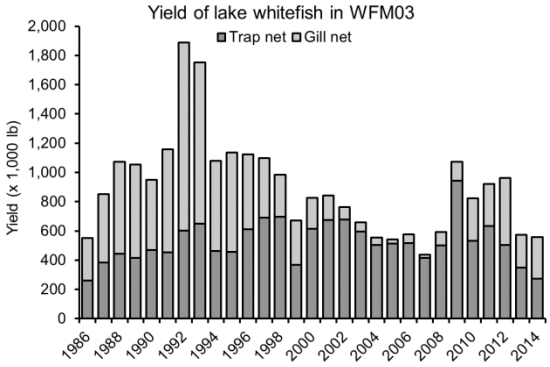


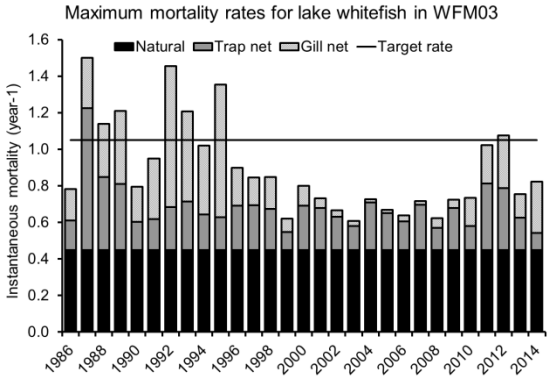
Parameter	Value
Base SSBR	0.89 lb
Current SSBR	0.56 lb
Target SSBR	0.58 lb
Current SPR	0.64
M	0.39 y^{-1}
F, trap net (2012-2014)	0.04 y^{-1}
F, gill net (2012-2014)	0.05 y^{-1}
Z (2014)	0.54 y^{-1}
Recommended TAC	367,400 lb
Actual TAC	367,400 lb
Model Rating	Medium

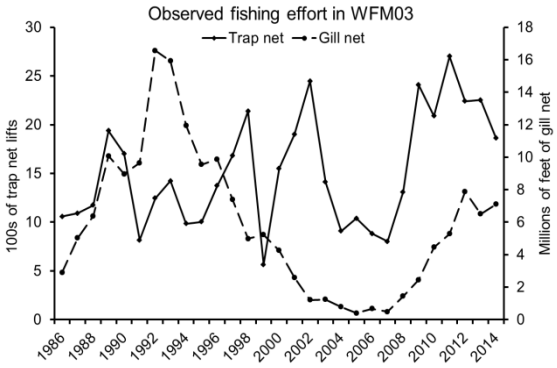
Notable Fishery Dynamics and Model Changes:

The 2016 model recommended harvest limit is 367,400 lb, down 21% from last year. Changes to the model for this year included removing the random walk for selectivity from both fisheries, a reduction in the reference length for the trap-net fishery (510 to 430 mm), and the change of the selectivity function for the gill-net fishery from a double logistic with fixed descending limb to a lognormal function. The biomass trend has changed dramatically from the last run, but now more closely mimics the trends seen in neighboring units. Harvest in 2014 rebounded to recent levels after a very low year in 2013. With the inclusion of the lognormal selectivity and removal of the random walk, this model is now rated medium as it exhibits better diagnostics, and trends similar to its neighboring units.

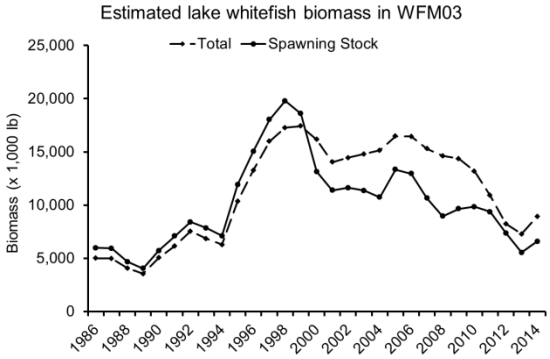
WFM-03 (Naubinway) Ted Treska





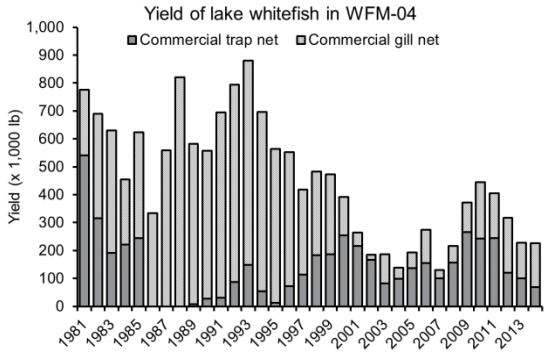


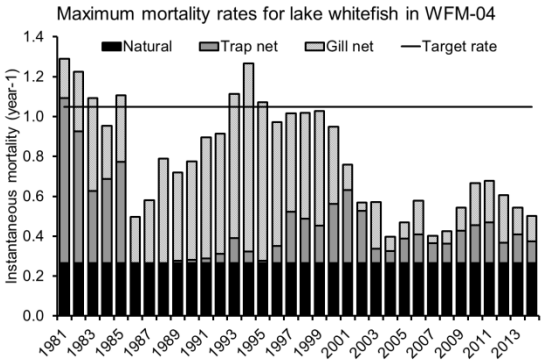
Parameter	Value
Base SSBR	0.99 lb
Current SSBR	0.70 lb
Target SSBR	0.70 lb
Current SPR	0.71
M	0.45 y^{-1}
F, trap net (2012-2014)	0.12 y^{-1}
F, gill net (2012-2014)	0.10 y^{-1}
Z (2014)	0.65 y^{-1}
Recommended TAC	797,700 lb
Actual TAC	797,700 lb
Model Rating	Medium

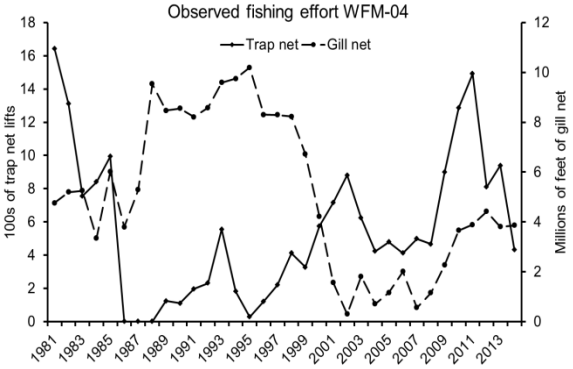


<u>Notable Fishery Dynamics and Model Changes:</u>
No major changes were made to the model. The 28% increase in the harvest limit is likely a result of recent increases in recruitment, which has been increasing since 2012. The average age of fish harvested in the gill-net fishery has increased from about 5 to nearly 9 over the time series, with a fairly consistent rise since the early 1990s, while the average age in the trap-net fishery has been declining for the past 4 years after a rise similar to the gill-net fishery until the mid-2000s. This model incorporates mean length-at-age to estimate selectivity, the variance-ratio approach, and a random walk structure for selectivity and catchability. Issues with covariance persist from the previous year, but could not be remedied. The model is rated medium due to improved diagnostics and performance.

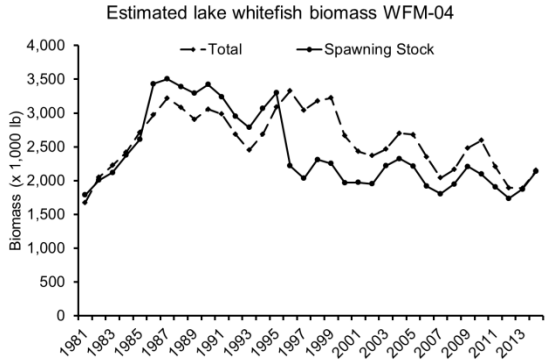
WFM-04 (Beaver Island) Kevin Donner

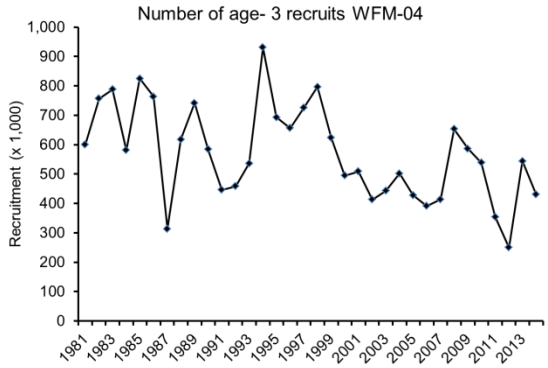






Parameter	Value
Base SSBR	2.81 lb
Current SSBR	1.05 lb
Target SSBR	0.98 lb
Current SPR	0.38
M	0.26 y^{-1}
F, trap net (2012-2014)	0.10 y^{-1}
F, gill net (2012-2014)	0.14 y^{-1}
Z (2014)	0.48 y^{-1}
Recommended TAC	601,800 lb
Actual TAC	601,800 lb
Model Rating	Medium

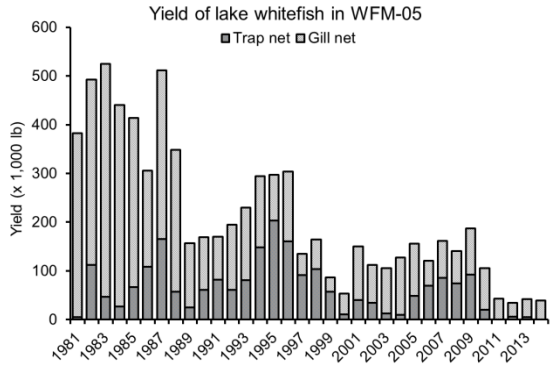


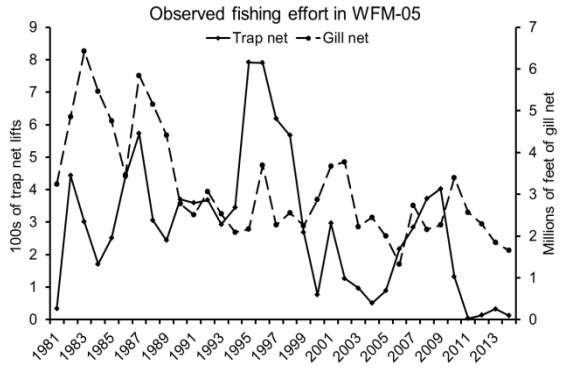


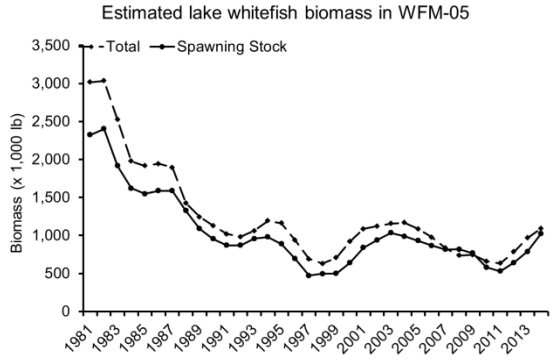
Notable Fishery Dynamics and Model Changes:

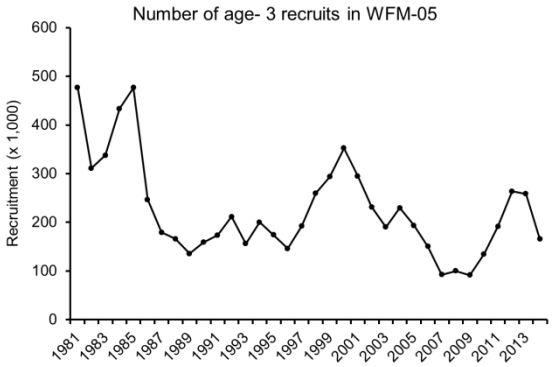
The 2016 model-generated harvest limit is 37% lower than the 2015 model limit, mostly attributable to changes to the model structure. Selectivity was changed to a lognormal function, rather than a double logistic. This resulted in a down-scaling of abundance and biomass. Still, population trends estimated in past years and observed in adjacent units are similar to those observed in the current model. Yield was unchanged between 2013 and 2014 and CPE increased modestly in both the gill-net and trap-net fisheries. Trap-net and gill-net commercial sampling revealed a relatively high proportion of age-3 fish, suggesting a potential increase in recruitment in the near future. The model was rated medium and exhibited good fit, no troubling retrospective patterns, and acceptable MCMC results.

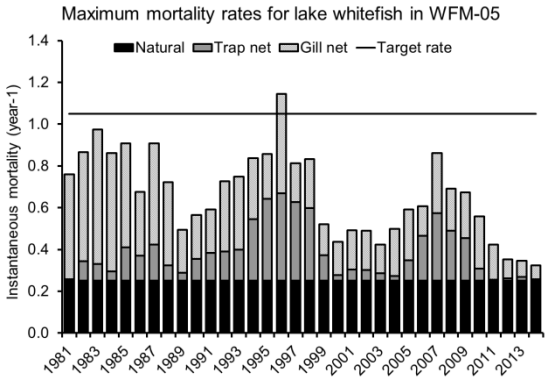
WFM-05 (Grand Traverse Bay) Stephen Lenart









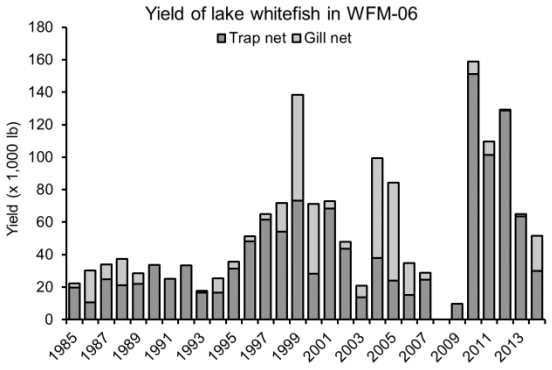


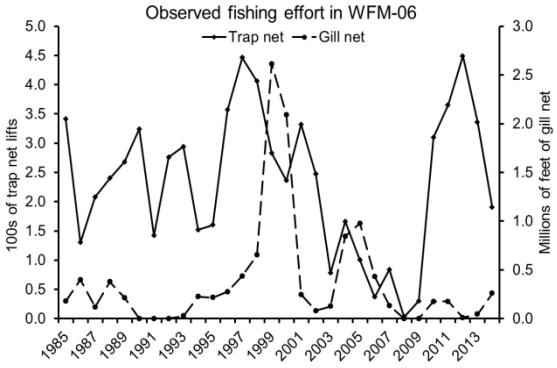
Parameter	Value
Base SSBR	3.18 lb
Current SSBR	0.83 lb
Target SSBR	0.77 lb
Current SPR	0.26
M	0.25 y^{-1}
F, trap net (2012-2014)	0.01 y^{-1}
F, gill net (2012-2014)	0.07 y^{-1}
Z (2014)	0.32 y^{-1}
Recommended TAC	425,000 lb
Actual TAC	425,000 lb
Model Rating	Medium

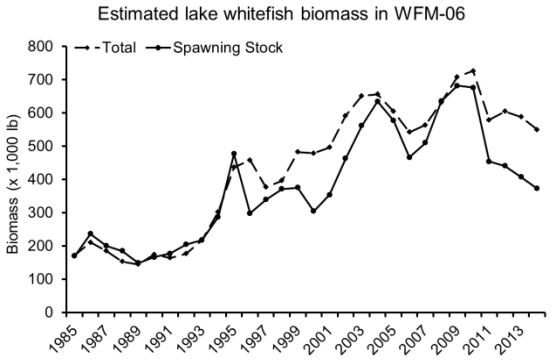
Notable Fishery Dynamics and Model Changes:

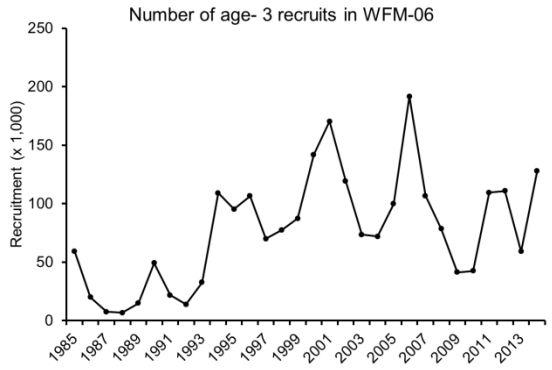
Recent increases in growth and abundance have contributed to an increasing trend in biomass in WFM-05 since 2010. Fishing effort remains low and the maximum annual mortality rate was 28% in 2014. Due to the limited nature of the fishery, monitoring data are sparse. Trap-net fishery samples from 2012 were biased and were thus ignored in the assessment – doing so resulted in greater stability. To alleviate the need to fix certain selectivity parameters, the lognormal replaced the double logistic function for gill-net selectivity. The overall scaling of the population was much lower with this updated version and more in line with expectations of stock productivity. The model-generated harvest limit was 425,000 lb, a less than 1% change from 2015.

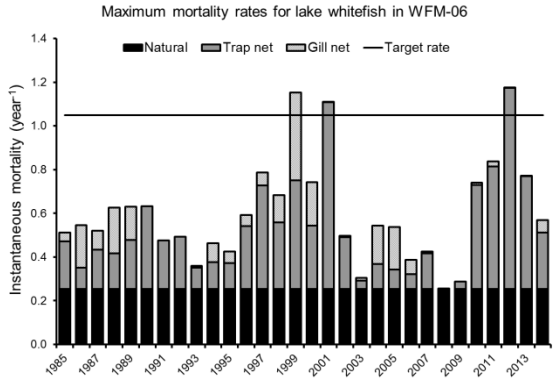
WFM-06 (Leland) Dave Caroffino









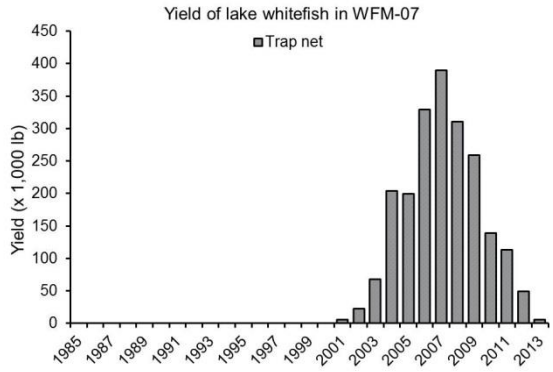


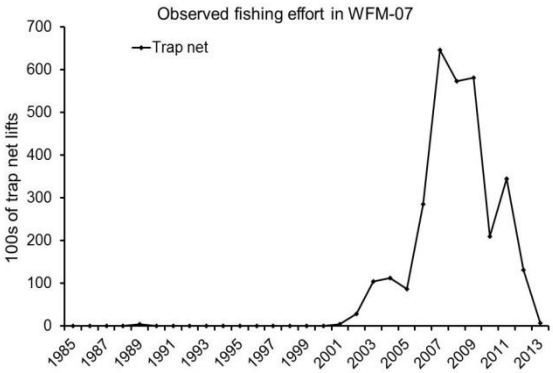
Parameter	Value
Base SSBR	2.90 lb
Current SSBR	0.97 lb
Target SSBR	1.30 lb
Current SPR	0.33
M	0.25 y^{-1}
F, trap net (2012-2014)	0.47 y^{-1}
F, gill net (2012-2014)	0.02 y^{-1}
Z (2014)	0.75 y^{-1}
Recommended TAC	250,000 lb
Actual TAC	250,000 lb
Model Rating	Low

Notable Fishery Dynamics and Model Changes:

The model-generated harvest limit for WFM-06 declined by 23% from 2015. Changes were made to the way that catchability was modeled, which caused the model to scale slightly downward. Biomass has declined 45% since 2010, and recent recruitment estimates are roughly 50% of their peak. The gill-net fishery yield in 2014 was the highest since 2005, but it was not sampled. This unit suffers from sporadic yield and biodata from the gill-net fishery is limited to only 7 years in the middle part of the time series. Diagnostics were worse than in recent versions of the model. The rescaling of the population suggested mortality may have exceeded target three years ago, but is now only about 45% and not limiting the fishery. The constant harvest limit of 250,000 lb can continue according to the decision criteria established in 2012.

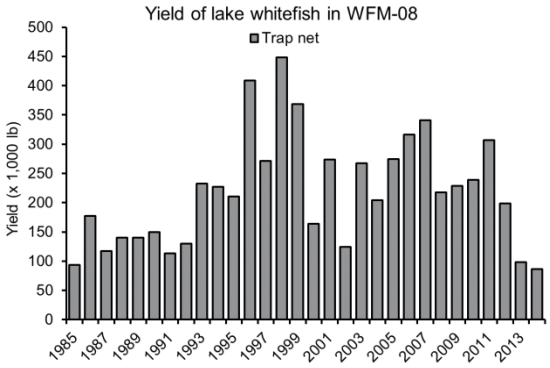
WFM-07 (Manistee to Pentwater)

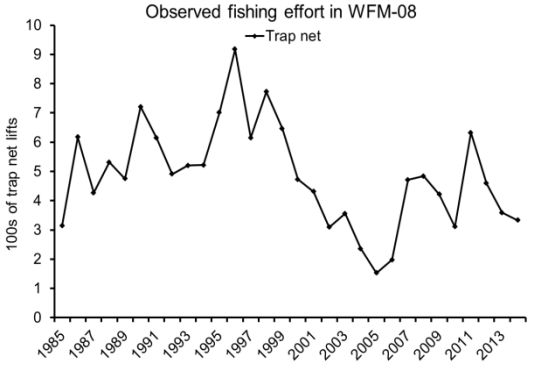


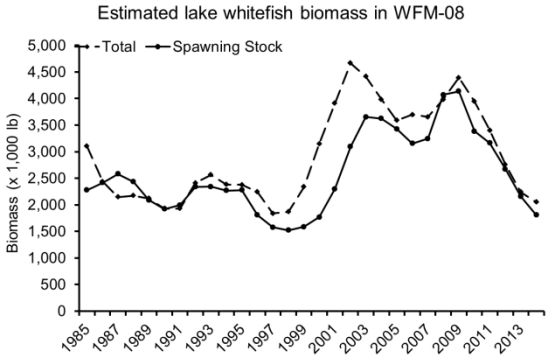


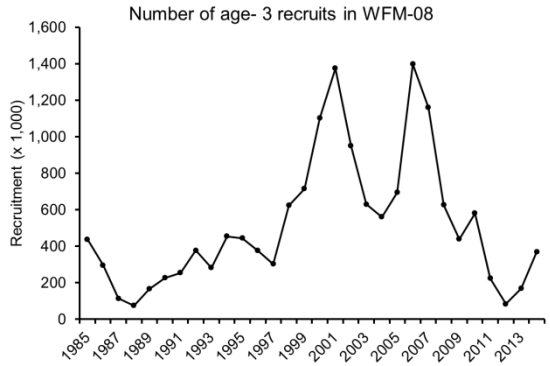
No stock assessment model has been developed for WFM-07. When the Consent Decree was initially signed, this unit lacked the necessary time series of data to populate a model. Fishing effort and yield have declined in this unit since peaking in 2007 and there was no commercial effort or yield in 2014.

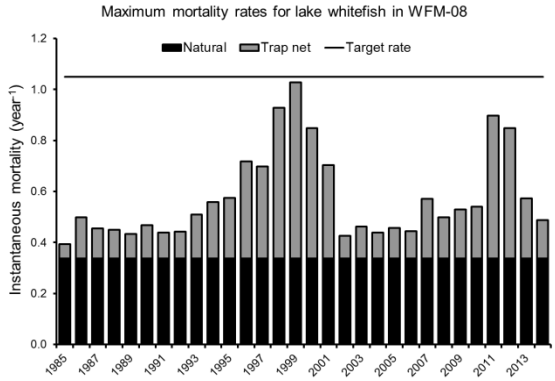
WFM-08 (Muskegon) Dave Caroffino











Parameter	Value
Base SSBR	2.20 lb
Current SSBR	1.70 lb
Target SSBR	1.49 lb
Current SPR	0.77
M	0.34 y^{-1}
F, trap net (2012-2014)	0.10 y^{-1}
Z (2014)	0.41 y^{-1}
Recommended TAC	1,400,000 lb
Actual TAC	1,400,000 lb
Model Rating	Low

Notable Fishery Dynamics and Model Changes:

The model estimated harvest limit declined by 73% for 2016. This model has been sensitive to changes in ratios used to estimate variance, but this year the decline was due to how catchability was modeled. Old code that placed a random walk on annual effort deviations was removed and now catchability is directly estimated each year. This caused the model to rescale sharply downward. Fishery trends in this unit are not positive. Both yield and CPUE are near the lowest of the time series. The model estimates that biomass has declined by 60% from its 2009 peak, and recruitment has declined by roughly 70%. However, mortality rates are below target and the fishery is not having a large impact on the population; according to the decision criteria established in 2012, the constant catch level of 1,400,000 lb can be maintained.