Monterey Bay Aquarium Seafood Watch®

Lake trout, Lake whitefish, Walleye and Yellow perch

Salvelinus namaycush, Coregonus clupeaformis, Sander vitreus, Perca flavescens

©New York State Dept. of Environmental Conservation

Michigan and Wisconsin (Lake Michigan)

Set gillnets, Barriers, fences, weirs, corrals, etc.

February 2, 2015

Jeremiah Johnson, Whitney Conard, Bailey Keeler, Joseph Krieger, Ellen Spooner

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF2

Table of Contents

About Seafood Watch 3
Guiding Principles 4
Summary 5
Final Seafood Recommendations 9
Introduction 12
Assessment 17
Criterion 1: Impacts on the species under assessment 17
Criterion 2: Impacts on other species 33
Criterion 3: Management Effectiveness 38
Criterion 4: Impacts on the habitat and ecosystem 47
Acknowledgements 52
References 53

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wildcatch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

The following Seafood Watch report provides recommendations for lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*) and rainbow smelt (*Osmerus mordax*) caught throughout the Great Lakes of North America by U.S, Canadian, and tribal fisheries. Since commercial fishing began in the Great Lakes in the 1800s, the profile of commercially targeted and caught species has undergone dramatic changes in response to a suite of anthropogenic pressures over time. Particularly substantial declines in target species biomass occurred during the first half of the 20th century due to a combination of overfishing, habitat loss, chemical contamination, and the proliferation of invasive species that followed urban, agricultural, and industrial expansion throughout the Great Lakes region. In response to these dramatic declines, new management and assessment regimes were put into place in the mid-twentieth century, which have continued to evolve and expand. Because of these efforts, the current Great Lakes fishery more closely resembles the fishery of the early 1900s than it has in the past 75 years. Today's commercial fisheries are a mixture of recovered native species that have long been mainstays of the Great Lakes (e.g., lake trout, yellow perch, walleye, and lake whitefish) and non-native forage species (e.g., rainbow smelt).

1. Lake trout (*Salvelinus namaycush*): This long-lived species was once the dominant top predator in all of the Great Lakes, and a main target of the commercial fishery. Although it is moderately resilient to fishing pressure, the combined stress of overfishing and high levels of predation by the exotic sea lamprey served to drive lake trout populations into steep decline during the middle of the 20th century. By 1960, lake trout were nearly extirpated in all lakes except Lake Superior. At present, only Lake Superior has self-sustaining populations able to support a targeted commercial fishery for wild-caught lake trout. Restoration of lake trout populations remains a major management goal throughout the Great Lakes.

In Lake Erie, Lake Trout are not allowed to be harvested by commercial fishermen and any lake trout that show up at a market are not allowed to be sold. Furthermore, commercial fisheries that do accidentally catch lake trout are required to return them to the lake alive and this number is unreported.

In Lake Huron, stock status is considered poor, but rehabilitation efforts are in place and ongoing. Spawning and recruitment have been somewhat successful, and the abundance of spawning adults is increasing. Lake trout from Lake Huron are considered a '**Good Alternative**'.

Lake trout in Michigan waters of Lake Superior are a "**Good Alternative**" because populations are in recovery. Lake trout in Wisconsin waters of Lake Superior are "**Avoid**" primarily due to lack of available data. Lake trout in Minnesota waters of Lake Superior are "**Best Choice**" because of stable populations and well managed harvest. Lake trout in Canadian waters of Lake Superior are "**Good Alternative**" because of unlicensed fishing in a portion of those waters.

Lake trout populations in Lake Ontario hit a low point in 2005 after a significant decline in the 1990s. Mainly due to hatchery stocking program problems, lake trout populations have seen some increases in recent years. There is no commercial fishery for lake trout in Lake Ontario.

Lake trout in Lake Michigan waters are considered a "**Good Alternative**". Lake trout populations throughout the lake are still heavily maintained through stocking with little natural reproduction being evident.

2. Walleye (*Sander vitreus*): This dominant near-shore predator has been a target of Great Lakes commercial fisheries since the late 19th century. It is resilient to fishing pressure and tolerant of a wide variety

of environmental conditions. This has allowed walleye populations to recover quickly from environmental degradation, and the species has remained dominant in the commercial fishery.

The walleye recommendation for Lake Superior in canada and Michigan is "**Good Alternative**" because populations are in recovery. In Wisconsin it is "**Avoid**" primarily due to lack of data.

The recommendation for Lake Huron is "**Good Alternative**". Commercial harvest of walleye is restricted throughout much of the lake in an effort to aid in stock recovery.

Today, walleye harvested by commercial fisheries are caught only in Canadian waters using gillnets. Walleye populations began to recover in Lake Erie as soon as nutrient abatement programs went into effect in the 1970s; however, after a period of recovery from 1970s to 1990s walleye populations underwent a second period of decline in the 1990s due to highly variable recruitment. At present, populations are still recovering and a better understanding is needed of what species-specific and environmental characteristics affect year class strength. Primarily due to this poor recruitment, walleye is recommended as a "**Good Alternative**."

There is a small gillnet and trap net fishery for walleye in Canadian waters of Lake Ontario. This comprised 8% of the total commercial catch in 2012, and both are given "**Good Alternative**" recommendations because impacts of the fishery on the target stock is very low, effective management is in place, and impacts on other species is moderate to low.

The walleye recommendation for Lake Michigan is "**Good Alternative**". Walleye in Lake Michigan are still in recovery following a dramatic decline during the 1990's.

3. **Yellow perch (*Perca flavescens*):** This near-shore species has an intermediate position in the aquatic food web and is often found in the same environments as walleye. It is broadly distributed in the Great Lakes and resilient to fishing pressure. Yellow perch abundance has been highly variable since the middle of the 20th century, due to the effects of habitat loss, interactions with invasive species, and overfishing, but has recovered quickly when stresses have been removed. The 1980s were a period of record productivity for the yellow perch fisheries throughout the Great Lakes, including Lake Michigan's Green Bay, but yellow perch entered a new period of decline in the 1990s. Currently, yellow perch population status is widely uncertain and variable, and populations are not at levels seen before their decline.

Lake Erie has the largest fishery for yellow perch for all the Great Lakes. In recent years, yellow perch commercial harvest has been showing a generally increasing trend. Overall, increasing populations (as evidenced by increased catch per unit effort throughout most of Lake Erie), an effective management regime, and inherently resilient life history characteristics make yellow perch caught in Lake Erie a "**Best Choice**" if caught in trapnets within Pennsylvania or New York waters and "**Good Alternativ**e" if caught in trapnets within Ohio waters or gillnets within Ontario waters.

In Lake Superior Canadian waters, yellow perch were over harvested and the fishery was closed in 2004. They are currently in recovery but have the recommendation of "**Good Alternative**" because of restrictions to harvest which allow for recovery. Lake Superior Michigan waters are "**good alternative**" because of stable populations and low harvest.

Yellow perch have a "**Good Alternative**" recommendation for Lake Huron. Yellow perch populations are still in a state of recovery following lake-wide declines in the 1980's to 1990's. Additionally, several years of poor year-class strength and recruitment have resulted in uncertain population status for yellow perch in US waters.

In Canadian waters of Lake Ontario, yellow perch is one of the two main targeted species along with lake

whitefish. Yellow perch in Canadian waters for both Gillnet and Trapnet fisheries receive a "**Good Alternative**" because the fishery impacts on stocks, impacts on other species, and effects on habitats and ecosystems are all moderate to low. Furthermore, effective management is in place.

In New York waters of Lake Ontario Yellow Perch is the main target species with a catch of 27.21 tonnes. In New York waters yellow perch received a "**Best Choice**" ranking because it is a small fishery and Yellow Perch have comprised >95% of the fishery since 2004, so its impacts on other species is minimal. In addition, effective management is in place, and the fisheries impacts on habitat, the target stock, and other species is low to moderate.

In Lake Michigan, the Yellow Perch recommendation is "**Good Alternative**", as stocks are still in a period of recovery following dramatic declines in harvest yield.

4. Lake whitefish *(Coregonnus clupeaformis)*: Lake whitefish have been a longtime target of the Great Lakes commercial fishery. As an epibenthic fish, this species occupies deep, cold waters rather than near-shore environments. Lake whitefish are a schooling fish caught primarily from Lake Michigan and Lake Huron, and the patchy distribution of its intermingling stocks complicates stock assessment and management. Like other deepwater fish, lake whitefish underwent substantial population declines in the middle of the 19th century, but was able to recover quickly after nutrient abatement and sea lamprey control measures were put in place in the 1970s. Stocks in Lake Huron, and Lake Superior are deemed moderate or low concern. Lake whitefish is currently the dominant deepwater benthic fish in the Great Lakes, as other native fish, such as the cisco, have not recovered as successfully. Their condition, growth, and catch rates became highly variable in the 1990s when their preferred prey, the amphipod Diporeia, disappeared in many lake areas in an apparent response to the proliferation of exotic zebra mussels. Lake whitefish have adjusted to these food web changes, first by changing their distribution to areas where Diporeia persisted, and more recently by changing their diets and utilizing alternate prey, including zebra mussels. In spite of decreased condition and changing catch rates, populations remain large, management is effective, and impacts of bycatch are low due to effort, placement, and size restrictions on gear.

In Lake Erie, there is no evidence of year-of-young or yearling whitefish in 2012 lake-wide surveys and assessments. Recruitment appears to be sparse which is thought to lead to continuing population declines. The recommendation lake whitefish from Lake Erie are "**Good Alternative**".

Lake Ontario lake whitefish are a "**Good Alternative**". Lake whitefish are only targeted in Canadian waters of Lake Ontario where they are a main target species. Impacts on other species, mainly lake trout, are the main concern.

Lake Whitefish in Lake Huron are also given a "**Good Alternative**" recommendation. Lake whitefish represent the largest and most valuable fishery in Lake Huron but concerns in regards to bycatch (mainly lake trout and potentially lake sturgeon) result in the score awarded.

The lake whitefish recommendation is "**Good alternative**" for Lake Superior Michigan waters because of historically stable populations. Lake Whitefish in Lake Superior Wisconsin waters are **"Avoid**" primarily due to a lack of available data. Lake Whitefish in Canadian waters in Lake Superior are "**Good Alternative**" because of unlicensed fishing in portions of their waters.

With the exception of individuals harvest with trapnets from Wisconsin waters, the Lake Whitefish recommendations for Lake Michigan are "**Good Alternative**". Those taken with trapents from Wisconsin waters are considered a '**Best Choice**'.

5. Rainbow smelt (*Osmerus mordax*): This non-native forage species first arrived in the Great Lakes in the 1930s, and was seen as a nuisance as they had no commercial value, clogged nets, and competed with native species. In the mid-1960s, salmonine stocking programs were instituted with a number of motivations: to control non-native species like Rainbow Smelt and Alewife; to support increased recreational fishing; and to aid in the recovery of lake trout populations. The first two of these goals were met successfully, but resulted in complications for rainbow smelt management: introduced predators were now successfully controlling forage fish populations, but this forage was essential in feeding the predator community that now support highly lucrative recreational fisheries. Smelt had also become a favored prey of recovering native predators such as lake trout. At the same time, Smelt began to support a substantial commercial fishery. In the latter part of the 20th century, Rainbow Smelt stocks entered a period of highly variable recruitment, possibly as a response to excessive predation pressure and reduction of food availability in the water column associated with proliferation of zebra and quagga mussels. However, rainbow smelt is an invasive species that has negative impacts on native forage fish by competing for food and preying on juvenile fish.

Currently, the outlook for rainbow smelt stocks is unclear though management recognizes the inherent difficulty and complicated nature of managing rainbow smelt populations. This results in high uncertainty about stock status and fishery impacts. Overall, management recognizes that restoring the native predator-prey balance to the Great Lakes is important, but the recreational fisheries made possible in part by rainbow smelt presence in the Great Lakes are also highly valued.

In Lake Erie, rainbow smelt has become an important forage species and in recent years surveys are performed to determine their abundance. Rainbow smelt abundances reached their historic highs in 2012. In Lake Erie, the only fishery that targets rainbow smelt is a trawling fishery located in Ontario waters. The recommendation rainbow smelt in Lake Erie is "**Best Choice**".

Rainbow smelt are "**Good alternative**" in Michigan waters of Lake Superior because they are an invasive species. In Lake Superior Wisconsin waters they are "**Good Alternative**" because of a lack of available data. In Canadian waters of Lake Superior they are considered a "**Good Alternative**" because of unlicensed fishing in a portion of their waters. They are **"best choice"** in Minnesota because they are invasive and have minimal impacts on other species.

Rainbow smelt in Lake Huron is deemed a **"Good Alternative"**, primarily due to concerns with bycatch. However, rainbow smelt is not a targeted species and has little commercial value.

There are no rainbow smelt commercial fisheries in Lake Ontario or Lake Michigan.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Lake trout Michigan Lake Michigan, Set gillnets, United States of America	Yellow (2.709)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.937)**
Lake trout Michigan Lake Michigan, Barriers, fences, weirs, corrals, etc., United States of America	Yellow (2.709)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.937)**
Lake whitefish Michigan Lake Michigan, Set gillnets, United States of America	Green (3.318)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (3.090)**
Lake whitefish Wisconsin Lake Michigan, Set gillnets, United States of America	Yellow (2.644)	Green (3.318)	Yellow (3.000)	Green (3.464)	**Good Alternative (3.090)**
Lake whitefish Michigan Lake Michigan, Barriers, fences, weirs, corrals, etc., United States of America	Green (3.318)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (3.090)**
Lake whitefish Wisconsin Lake Michigan, Barriers, fences, weirs, corrals, etc., United States of America	Yellow (2.644)	Green (5.000)	Yellow (3.000)	Green (3.464)	**Best Choice (3.423)**
Walleye Michigan Lake Michigan, Set gillnets, United States of America	Yellow (2.644)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.919)**
Walleye Michigan Lake Michigan, Barriers, fences, weirs, corrals, etc., United States of America	Yellow (2.644)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.919)**
Yellow perch Michigan Lake Michigan, Set gillnets, United States of America	Yellow (2.644)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.919)**

Yellow perch Wisconsin Lake Michigan, Set gillnets, United States of America	Green (3.318)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (3.090)**
Yellow perch Michigan Lake Michigan, Barriers, fences, weirs, corrals, etc., United States of America	Yellow (2.644)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	**Good Alternative (2.919)**

Summary

Walleye and yellow perch taken from Lake Michigan are considered a GOOD ALTERNATIVE, due in part their impact on other species, most notably lake trout, a species of special concern. Concerns with the stock status of yellow perch and walleye also contribute to their score.
Lake trout and lake whitefish harvested from Michigan waters of Lake Michigan as well as lakewhitefish harvested with gillnets in Wisconsin waters are considered a GOOD ALTERNATIVE due to concerns in the stock status of the species and future sustainability of the fishery.

Lake whitefish harvested with trapnets from Wisconsin waters of Lake Michigan are considered BEST CHOICE.

Eco-Certification Information

No elements of the fisheries considered here are eco-certified or part of fisheries improvemetnt projects (FIPs).

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report evaluated the commercial harvest of lake whitefish (*Coregonus clupeaformis*), lake trout (*Salvelinus namaycush*), yellow perch (*Perca flavescens*), walleye (*Sander vitreus*), and rainbow smelt (*Osmerus mordax*) in the Laurentian Great Lakes.
In addition, impacts of the commercial fishery on the non-target, state and provincially listed threatened species lake sturgeon (Acipenser fulvescens) is also evaluated.

Fishing gears examined in this region include gillnets and trapnets utilized by commercially licensed fisherman from Michigan, Wisconsin, Minnesota, Illinois, Indiana, Ohio, Pennsylvania, New York, the Canadian Province of Ontario, and Tribal fisherman.

Species Overview

Lake trout are found in the northern parts of North America, principally in Canada, throughout Alaska, and in the Laurentian Great Lakes, preferring cool water temperatures of 45-55 °F (Froese & Pauly 2012). During the spring and fall, lake trout may be found at depths of 10 to 15 ft but move to depths of 100-200 ft waters during the summer and winter. Lake trout are the largest of the charr (a sub-grouping within Salmonidae), reaching lengths of up to 50 inches, and typically weighing 15 to 40 lbs (Froese & Pauly 2012). Once in the dominant predator in Lake Huron, introduction of sea lamprey, habitat alterations, and overfishing have resulted in dramatic declines of this once economically valuable fish.
Lake whitefish (member of the family Salmonidae) are found inland lakes throughout Canada, Alaska, and the northern part of the United States. Lake whitefish are schooling fish, which prefer cool waters at depths of up to 200 ft. Lake whitefish typically achieve lengths of 20-30 inches and weigh upwards of 20 lbs. Lake whitefish represent the highest commercial yield of any fishery in the Great Lakes (Froese & Pauly 2012).

Yellow perch are found throughout freshwater lakes in North America. Yellow perch are utilized as both a food fish and a game fish making them a source of great value. Yellow perch prefer water temperatures of 66-70°F and are generally taken at depths of > 45 ft (Froese & Pauly 2012). They average 4-10 inches in length and achieve weights of 4-10 oz (Froese & Pauly 2012).

Walleye (the largest member of the perch family) are also utilized as both a food fish and a game fish. They are found throughout most of Canada and the Northern United States. Walleye are veracious near shore predators, reaching lengths of 20-30 inches and weighing up to 20 lbs. They prefer temperatures of 55-68°F and are seldom found at depths of >50 ft (Froese & Pauly 2012).

Rainbow smelt are native to the Atlantic Coast and throughout the Northern portions of the Atlantic Ocean and Arctic Ocean. They were introduced into inland lakes, escaped, and made their way into the Great Lakes in the early 1900's. The rainbow smelt is slender and cylindrical, achieving lengths of 7 to 9 inches and weighs of ~3 oz. The commercial fishery for rainbow smelt has greatly declined in Lake Huron where they are now currently caught only as bycatch with other, more valuable species (Froese & Pauly 2012).

The commercial fishery in Lake Michigan has been in operation since at least 1843, when the major target was lake whitefish. By 1860, once abundant near-shore whitefish stocks had been mostly depleted, but production remained steady as both efficiency of gear and fishing effort continued to increase and new fishing grounds were sought. Effort soon also included lake trout, lake sturgeon, and lake herring, particularly as lake whitefish catches began to drop. Increased catches of lake herring allowed production to increase dramatically at the turn of the century, but it declined soon after and fluctuated from 1911 to 1970, with a high of US $9.7 million in 1952 and a low of only US $40,000 in 1970. These changes have been influenced by both market value and

changes in abundance, as well as interactions with non-indigenous rainbow smelt beginning in the 1930s. Increasing catches of other secondary targets such as cisco, perch, sucker, and some walleye also allowed production to remain high. Non-native species were added to the commercial fishery early on, with carp being sought as early as 1893 and substantial production (1.5 million lbs) occurring by the 1930s. Rainbow smelt, which in the Great Lakes originated from a planting in the Lake Michigan watershed, was present throughout Lake Michigan by 1936, and commercial production had risen to 4.8 million pounds by 1941. This was followed by an abrupt drop in production in 1943 and fluctuations thereafter between less than one million pounds and as high as 9.1 million pounds. These fluctuations resulted from a combination of disease (reduction in stock) and changes in market value (changes in effort). Lake trout, which became the most valuable species in the fishery after the early decline of whitefish, began to decline in the middle of the 20th century and was essentially eliminated from the lake by 1950, primarily as a result of sea lamprey predation. Lake whitefish production remained between one and 2.6 million pounds between 1911 and 1950, after its precipitous decline from a high in the late 19th century of 5.5 million pounds. After 1950 it again decreased, primarily due to overfishing as deepwater trap nets progressively fished down local populations. The lake trout decline also caused an increase of lamprey predation on whitefish, but the whitefish population recovered somewhat from this by the1960s, when lamprey control methods began to take effect. The lake whitefish population then underwent a substantial if erratic increase to 1.7 million pounds by 1970. As lake whitefish, lake sturgeon, and walleye became rare in the late 19th century, commercial production of yellow perch increased. Beginning in 1889, yellow perch became an important part of both the commercial and recreational fishery in Lake Michigan, with catches increasing to 6.3 million pounds by 1896 and remaining high at nearly 5 million pounds until the 1960s. Since then production trends have appeared to be tied to alewife abundance, with declines following the proliferation of alewife north to south due to competition between juvenile alewife and perch, and predation by adult alewife on juvenile perch. Walleye and round whitefish have both been of only minor importance in the fishery, with spikes in production corresponding to declines in other target species. Walleye abundance peaked in the middle of the 20th century and then underwent declines dramatic enough that it became rare throughout Lake Michigan by the 1970s.

The fisheries targeting the species mentioned above are managed by the Great Lakes Fishery Commission (GLFC) under the Joint Strategic Plan for Management of Great Lakes Fisheries, which was originally enacted in 1981. It was reviewed in 1986 and amended in 1997 in an effort to adopt practices to better coordinate fishery and environmental management issues. During this time tribal fisherman (CORA and GLIFWC) and USGS representatives were offered seats on the Council of Lake Committees (GLFC 2007).

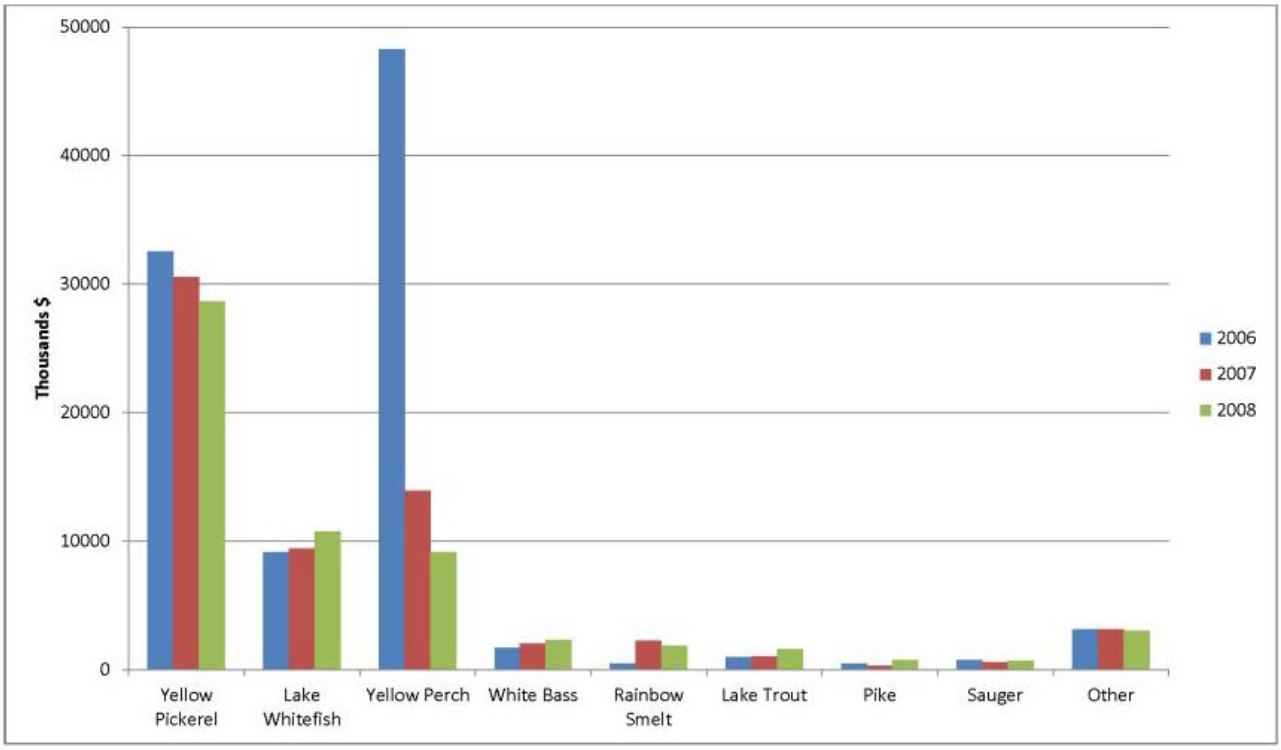
Production Statistics

None of the species evaluated in this report are considered important on a global scale. Most of the harvest remains on the continent and is insignificant compared to global landings of other fish in other fisheries. Lake whitefish yields are the largest with an estimated 9, 494 tonnes reported as harvested globally (FAO 2014). In Lake Michigan, total landings of lake trout have generally increased over the past 7 years with stocking programs currently facilitating the fishery. Natural reproduction of lake trout in Lake Michigan is believed to be extremely low and not significant regarding contributions to the fishery. Harvest of lake whitefish has remained relatively stable over the past 10 years, however harvest is considerably down when compared to historical catch data. Yellow perch and walleye landings have also been generally stable, but with overall historical declines.

Importance to the US/North American market.

Commercial fisheries for lake trout in the Great Lakes are generally small and restricted for the most part to Lake Superior, Lake Huron, and Lake Michigan. Although some lake trout are caught in Canadian waters of Lake Superior, this species is not a primary freshwater export for Canada.

The majority of walleye sold in the US comes from Canadian sources, primarily from Lake Erie. Walleye is one of Canada's largest freshwater fish exports, together with yellow perch and lake whitefish, and is the recently most valuable in terms of price per pound.



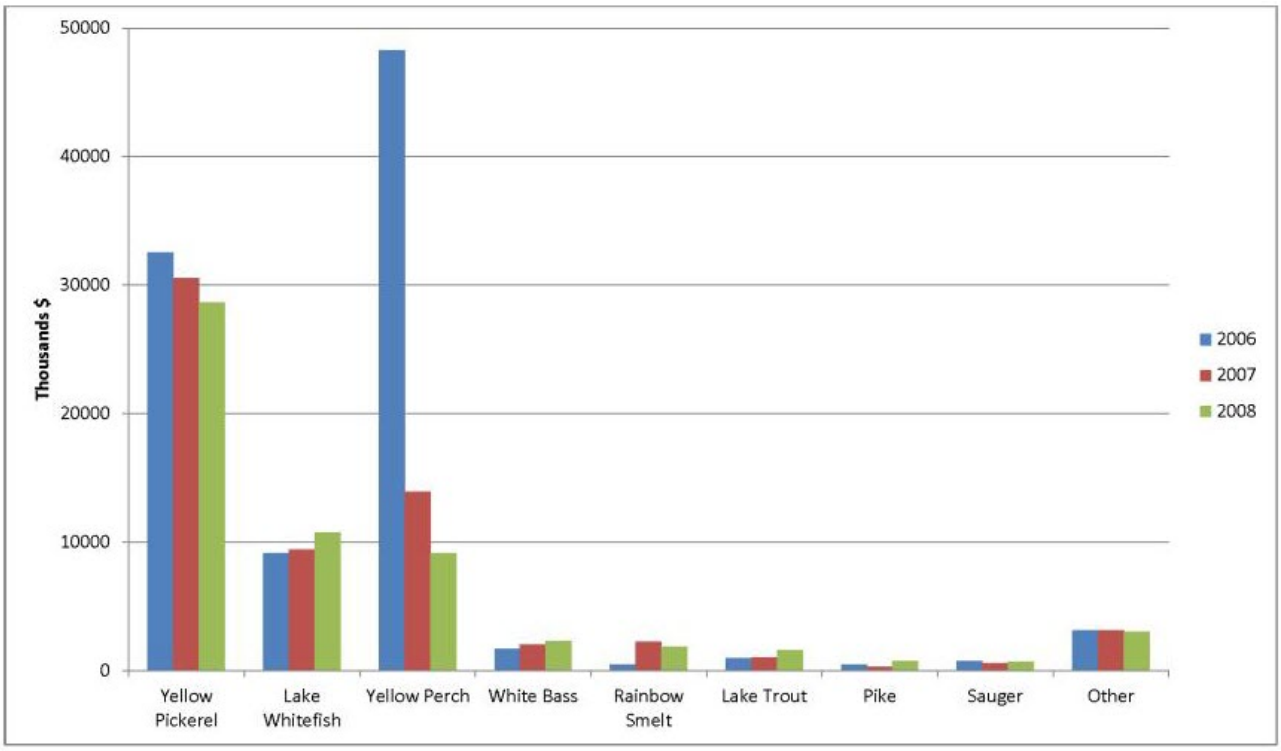
Commercial landing values of Canadian Freshwater Fisheries.

The US imports about 6.6 million pounds of fresh and frozen walleye annually from Canada, primarily as frozen fillets, but also as fresh whole fish, fresh fillets, and frozen block (DFO 2011). Approximately 90% is from Great Lakes sources, with about 87% coming from Lake Erie and about 3% from Lake Huron.

The largest market for yellow perch in the United States is in the Great Lakes region, where fresh perch fillets can attain the highest price per pound. US demand for yellow perch makes it one of Canada's largest and most valuable freshwater fishery exports, together with walleye and lake whitefish.

The demand for yellow perch in the Great Lakes region has been estimated to reach about 50-100 million pounds annually (Hinshaw 2006). Currently, close to two million pounds are commercially harvested within the US, primarily from Ohio waters of Lake Erie. Nearly twice that, just under four million pounds, is imported, nearly all of it from Canadian commercial Great Lakes fisheries operating in Ontario ((Hinshaw 2006),(Baldwin et al. 2009),(DFO 2011)).

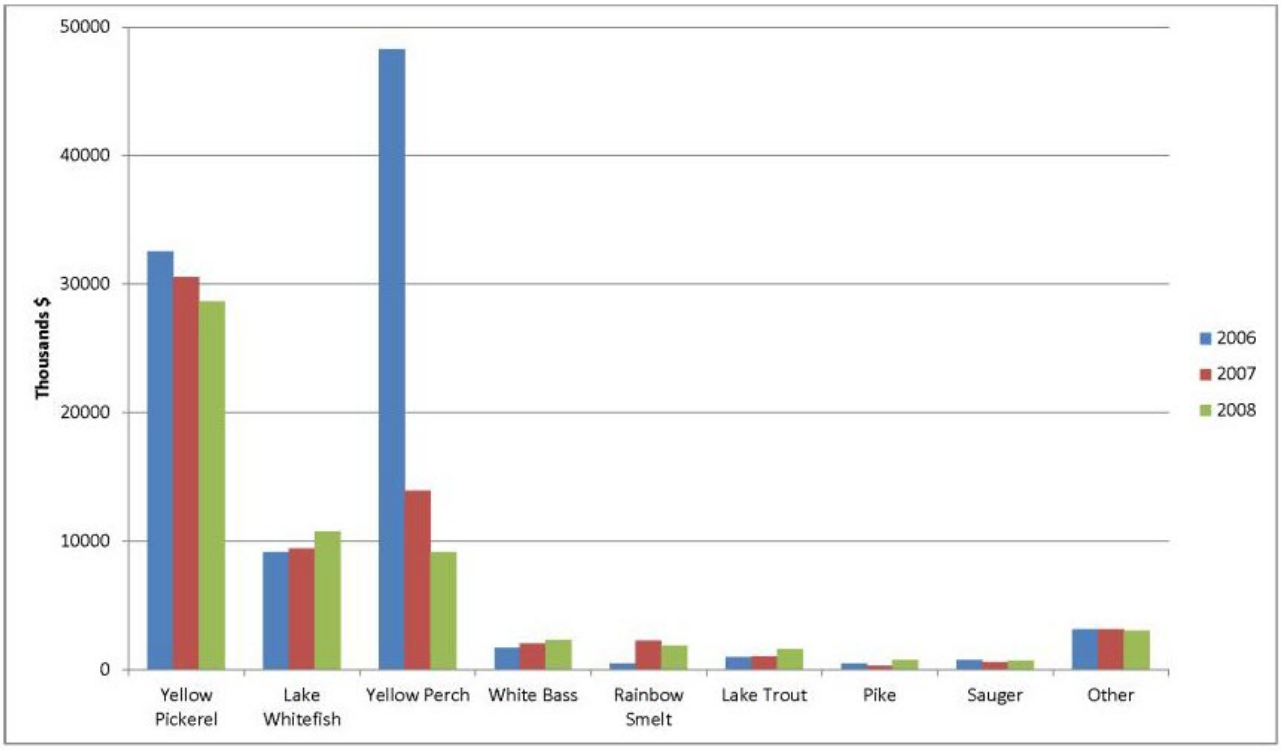
The largest exports of whitefish from Canada are from the Northwest Territories, Manitoba, Saskatchewan, and Alberta. Great Lakes catches traditionally focused on domestic wholesale markets but competition from Canadian wholesalers from northwest regions of Canada are influencing prices and increasing competition with Great Lakes fish. Partly as a result of this competition and also because of declining quota and the need to get greater return from less available product, the lake whitefish market is currently exploring better branding and value-added products. Lake whitefish is one of the three largest freshwater exports, by both weight and value, from Canada.



Commercial landing values of Canadian Freshwater Fisheries.

These fish are primarily sold in US markets.

Great Lakes rainbow smelt are the fifth largest Canadian freshwater fish export by value.



Commercial landing values of Canadian Freshwater Fisheries.

The majority of Canadian-caught freshwater smelt are exported frozen to Japan, with some going to the US. A portion of the Lake Erie catch is also exported fresh to the US.

Common and market names.

Lake trout, *Salvelinus namaycush*, is also known as Great Lakes trout, laker, namaycush, togue, grey trout, mountain trout, mackinaw, lake char/charr, touladi, and salmon trout.
Walleye, *Sander vitreus*, is also known as yellow pickerel, pickerel (Canada), yellow pike, yellow walleye, and dore (France, Canada).

Yellow perch, *Perca flavescens*, is also known as lake perch, ringed perch, raccoon perch, Ned, yellow Ned, redfin, and redfin perch.

Lake whitefish is also known as common whitefish, Sault whitefish, whitefish, eastern whitefish, Great Lakes whitefish, inland whitefish, gizzard fish, grande coregone (French), and Attikumaig(Chippewa).

Rainbow smelt is also known as American smelt, leefish, freshwater smelt, and frost fish.

Primary product forms

Lake trout may be marketed fresh, frozen, or smoked. Though "smoked lake trout" is typically siscowet, or oily lake trout, a substantial portion of the larger lean lake trout sold is also smoked. Smaller fish are primarily marketed fresh or frozen, as whole dressed fish.
Walleye is available fresh as whole fish (head on or off, dressed) or fillets (skin on or off), and frozen as fillets or fingers (7-12 cm strips).

Yellow perch can be found fresh or frozen, sold primarily as scaled, skin-on fillets.

Whitefish is available fresh or frozen as whole dressed fish or fillets. New value-added products growing in market share include frozen vacuum-packed fillets and prepared foods such as spreads. Lake whitefish roe is also successfully marketed as "golden caviar." Canadian whitefish catches from outside the Great Lakes are marketed by the Freshwater Fish Marketing Corporation (FFMC), which produces three main whitefish products: minced block, whole fresh, and whole frozen whitefish.

Rainbow smelt can be found on the US market as fresh or frozen whole fish.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown.

The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical

Criterion 1 Summary

LAKE TROUT				
Region | Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Michigan/Lake Michigan Set gillnets | United States of America	1.00: High	2.00: High Concern	3.67: Low Concern	Yellow (2.71)
Michigan/Lake Michigan Barriers, fences, weirs, corrals, etc. | United States of America	1.00: High	2.00: High Concern	3.67: Low Concern	Yellow (2.71)

LAKE WHITEFISH				
Region | Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Michigan/Lake Michigan Set gillnets | United States of America	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.32)
Wisconsin/Lake Michigan Set gillnets | United States of America	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)
Michigan/Lake Michigan Barriers, fences, weirs, corrals, etc. | United States of America	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.32)

Wisconsin/Lake Michigan Barriers, fences, weirs, corrals, etc. | United States of America	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)

WALLEYE				
Region | Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Michigan/Lake Michigan Set gillnets | United States of America	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)
Michigan/Lake Michigan Barriers, fences, weirs, corrals, etc. | United States of America	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)

YELLOW PERCH				
Region | Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Michigan/Lake Michigan Set gillnets | United States of America	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)
Wisconsin/Lake Michigan Set gillnets | United States of America	3.00: Low	3.00: Moderate Concern	3.67: Low Concern	Green (3.32)
Michigan/Lake Michigan Barriers, fences, weirs, corrals, etc. | United States of America	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)

Lake trout, lake whitefish, walleye, and yellow perch are the main species commercially fished in Michigan and Wisconsin waters of Lake Michigan. These are also the 4 key species outlined in the scope of this Lake Michigan assessment.
Fish are harvested using both bottom gillnets and trapnets.
Inherent vulnerability scores are derived from the "vulnerability" score provided on fishbase, which is based on several inherent biological characteristics of the species (e.g., age at maturity, maximum age, fecundity, etc.). The FishBase vulnerability score is derived from Cheung et al. (2005) and is found at www.fishbase.org on the species' page. This score is used to determine a risk-based score for Factor 1.2 (abundance of the stock) only in cases where the abundance is otherwise unknown. Attributes that affect susceptibility of the species to the fishery, e.g. its attraction to fishing gear and spatial overlap with the fishery, are germane to the degree of fishing mortality experienced by the species and therefore are considered under Factor 1.3 (fishing mortality) in cases where fishing mortality is unknown and a risk-based score is needed.

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Inherent Vulnerability

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Factor 1.2 - Abundance

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Factor 1.3 - Fishing Mortality

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

LAKE TROUT

Factor 1.1 - Inherent Vulnerability

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

High

The Fishbase Inherent Vulnerability Score for lake trout is 72 (Forse & Pauley 2012)

The lake trout is the largest trout native to the Great lakes and other Michigan lake waters, where they are considered the top native predator. They have relatively long lives (>25 years) and become sexually mature at 6 or 7 years of age. Like many members of Salmonidae, lake trout are broadcast spawners, preferring cobble and gravel substrate on which to spawn.

Factor 1.2 - Abundance

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

High Concern

Lake trout stocks throughout Lake Michigan are scored as “high concern” given that natural reproduction is only occuring minimally, and is likely that recruitment from wild fish are unable to sustain the population.

Justification:

Lake trout harvest in the Michigan waters of Lake Michigan is taken by tribal fisheries operating in tribal waters. The tribal fishery is managed by CORA (Chippewa Ottawa Resource Authority), which is a member of the Council of Lake Committees. Commercial fishing operations issued a license from the state of Michigan are prohibited from taking lake trout in Lake Michigan.

Factor 1.3 - Fishing Mortality

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Fishing mortality for lake trout harvested in the Michigan waters of Lake Michigan is scored as "low concern" given that percent mortality attributed to fishing is relatively minimal, and catch rates are typically below established TAC (total allowable catch) restrictions, which are set at a level that has been found to allow the population to sustain itself. TAC’s are established annually by estimating population abundance-at-age at the start of the year and then adjusting fishing mortality either to meet mortality targets or to follow guidelines established in the Consent Decree for phasing in the targets. The resulting projection of yield or effort associated with the fishing mortality then form the basis for the TAC recommendation (Caroffino & Lenart 2012).

Additionally, TAC's are determined annually based on modeled projections of total fish mortality. A total annual mortality of 45% has been determined as necessary to allow for sustained population growth (Caroffino & Lenart 2012). When determining allowable commercial fishing mortalities (i.e. TACs), mortality due to natural causes and sea lamprey predation are combined to determine total mortality. TAC limits are then adjusted based on the increase or decrease in mortality from other sources.

Justification:

Commercial fishing mortality for lake trout harvested in the Michigan waters of Lake Michigan was estimated at 28%. Sea lamprey predation continues to account for the largest percentage of lake trout mortality in Lake Michigan (Caroffino & Lenart 2012).
In 2012, 229 tonnes of lake trout were harvested from the Michigan waters of Lake Michigan, representing 41% of actual TAC with gill net harvest accounting for 39% of actual TAC (Caroffino & Lenart 2012).

Spawning stock biomass is estimated at 608.2 tonnes. Lake trout stock biomass is maintained almost entirely through stocking, averaging 1,754,557 yearlings annually over the past 10 years. (Caroffino & Lenart 2012)

Until an increase in natural reproduction becomes evident in Lake Michigan, lake trout populations will continue to rely on annual stockings to sustain the fishery.

LAKE WHITEFISH

Factor 1.1 - Inherent Vulnerability

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Medium

The Fishbase inherent vulnerability score for lake whitefish is 48 (Forse & Pauley 2012)

The lake whitefish, a member of the family Salmonidae, has long comprised the mainstay of the commercial catch in the Great Lakes. This schooling, planktivorous fish can live >25 years, and reaches sexual maturity at ~ 3-6 years of age. Lake whitefish are characteristic broadcast spawners.

Factor 1.2 - Abundance

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Lake whitefish biomass (age 3+) in the Michigan waters of Lake Michigan was estimated at 22,038.7 tonnes, which indicates a generally modest increase in biomass over the past 10 - 15 years (Caroffino & Lenart 2012).

Biomass in relation to biological reference points is unknown, resulting in a score of "moderate concern".

Justification:

Lake whitefish harvest by gill net in the Michigan waters of Lake Michigan are taken only by tribal fisheries operating in tribal waters. The tribal fishery is managed by CORA (Chippewa Ottawa Resource Authority), which is a member of the Council of Lake Committees.

WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

This stock is given a 'Moderate Concern' recommendation because the quantitative stock assessment is lacking and mean lengths and weights at age have been showing a decline since 1995. Catch per unit effort (CPUE) is used to assess stocks and there has been no major technology changes over time, but there is uncertainty concerning whether the fishery is depleting the proportion of large individuals along with its overall effects on the stock.

Justification:

Since 1995, mean lengths and weights-at-age measured in spring sampling have been showing a general decline. (see images). In 2012, weight-at-age levels were at or below historic lows for most age classes. ((Hansen 2013), 55). Recent studies have shown mixing of stocks in Green Bay, which likely compromised the consistency in measuring growth over time. See images below for mean length and weight-at-age for lake whitefish over time in Wisconsin waters of Lake Michigan.

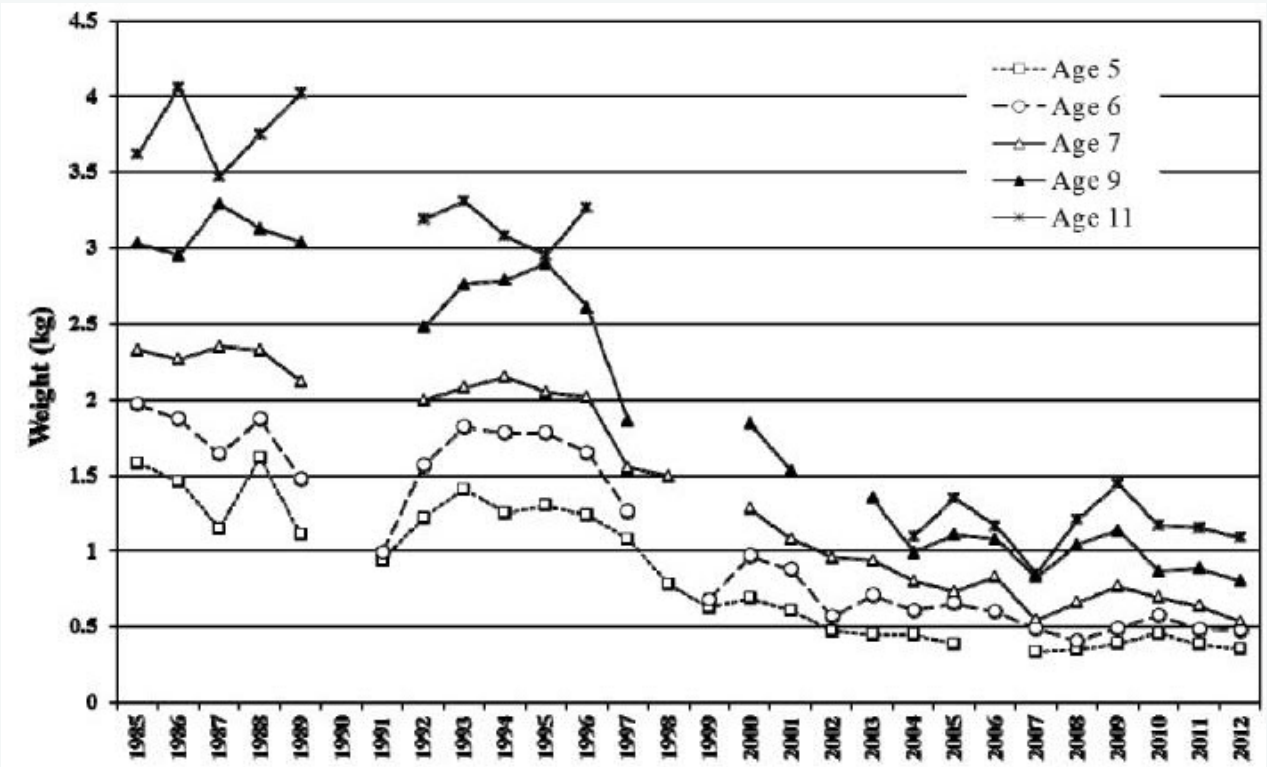


Figure 5. Mean weight at age of spring sampled lake whitefish from 1985 thru 2012.

Mean weight at age of lake whitefish from Wisconsin waters of Lake Michigan over time. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

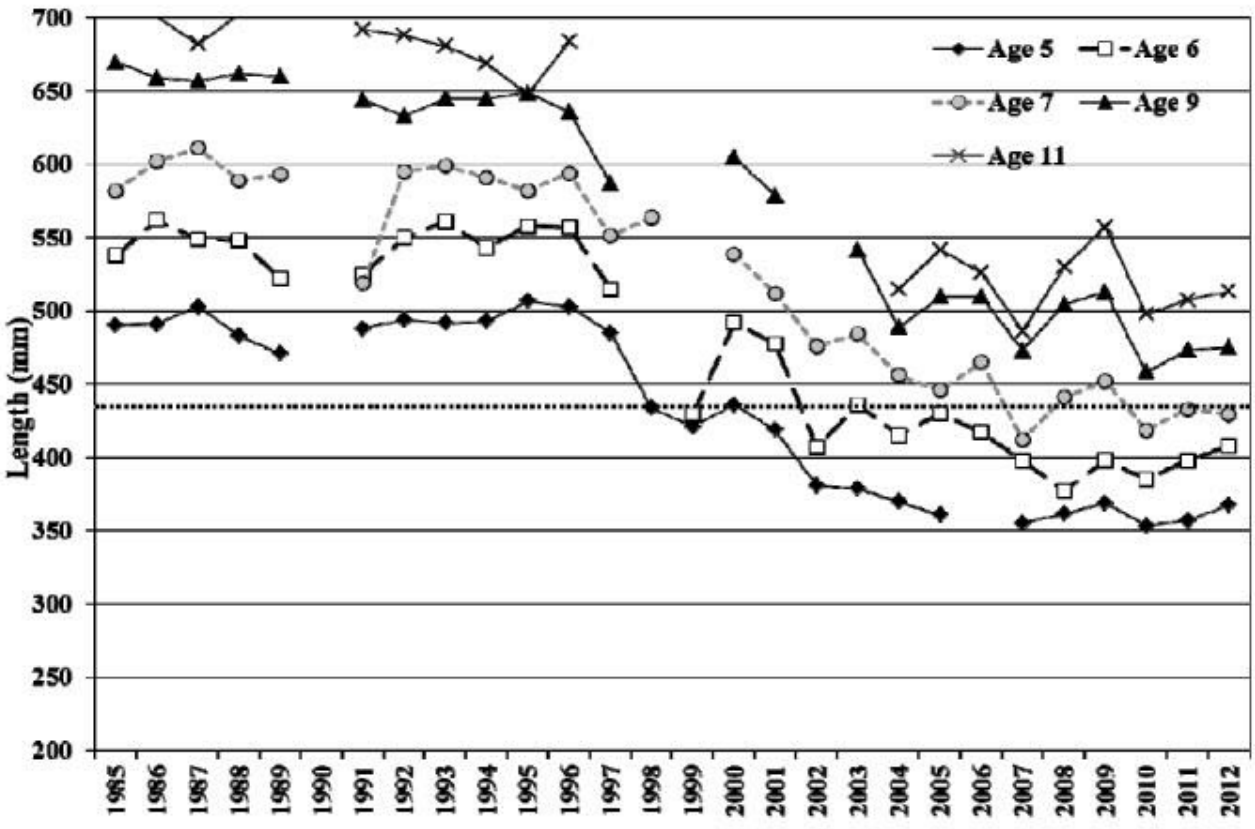


Figure 4. Mean length at age of spring sampled lake whitefish from 1985 thru 2012.

Mena length at age for lake whitefish from Wisconsin waters of Lake Michigan over time. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

Factor 1.3 - Fishing Mortality

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Low Concern

Fishing mortality for lake whitefish harvested in the Michigan waters of Lake Michigan is scored as "low concern" given that catch rates are typically at or below established TAC (total allowable catch) restrictions for each lake whitefish management zone (Caroffino & Lenart 2012), and TACs are set at a level that has been found to be sustainable. TAC's are established annually by estimating population abundance-at-age at the start of the year and then adjusting fishing mortality either to meet mortality targets or to follow guidelines established in the Consent Decree for phasing in the targets. The resulting projection of yield or effort associated with the fishing mortality then form the basis for the TAC recommendation (Caroffino & Lenart 2012).

Additonally, TAC's are determined annually based on modeled projections of total fish mortality. A total annual mortality of 45% has been determined as necessary to allow for sustained population growth (Caroffino & Lenart 2012). When determining allowable commercial fishing mortalities (i.e. TACs), mortality due to natural causes and sea lamprey predation are combined to determine total mortality. TAC limits are then adjusted based on the increase or decrease in mortality from other sources.

Given that catch rates are generally within established TAC restrictions, fishing mortality is likely to have minimal impact on lake whitefish stocks. Additionally, TAC's are adjusted to achieve target mortality rates and account for current population abundance estimates, resulting in flexible TAC levels reflective of current population status.

Justification:

Fishing mortality of lake whitefish (age 4+) in the Michigan waters of Lake Michigan for gill net fisheries was estimated at 0.078, comprising 16% of total mortality. Although gill net fisheries only account for 16% of total mortality, they account for roughly half of estimated commercial harvest mortality (Caroffino & Lenart 2012).

WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderate Concern

This fishery is given a 'Moderate Concern' recommendation because F is unknown and this fisheries impact on the stock is uncertain but not negligible. Harvests have been below set quota levels, but whether or not these quota levels are determined and adjusted based on population status is unknown.

Justification:

Lake Whitefish harvests as a percentage of total harvest (all species) in Wisconsin waters of Lake Michigan have been increasing since the mid 2000s. (See image of Commercial fishing harvest from Wisconsin waters of Lake Michigan taken from the 2013 LMFT-DNR report). Lake Whitefish now constitute the majority of Wisconsin commercial catch (~80%).

While the population biomass is believed to be increasing, lake whitefish growth rates have declined markedly through the middle part of the decade (Bunnell, D. B. 2012). This decrease is attributed to the increase importance of dreissenid of mussels and the declining importance of Diporeia in the lake whitefishes' diet. As a consequence of declining growth, the mean age in the commercial harvest has steadily increased from ages 5-6 to at least age 8 (Bunnell, D. B. 2012). These trends have led to concerns about the ability of lake whitefish stocks to retain their current levels of biomass.

1,523,861lbs were harvested in 2012 total, which is an increase from previous years and the highest catch since 2001. The quota was increased in both the 2009-2010 quota rear to 2.88 million pounds. This is up from the 1998-1999 quota year of 1.15 million pounds. Gillnet use has decreased over time and now only constitutes a small portion (~20%) of total commercial harvest effort. (See images of lake whitefish by gear type over time taken from the LMFT-DNR 2013 report).

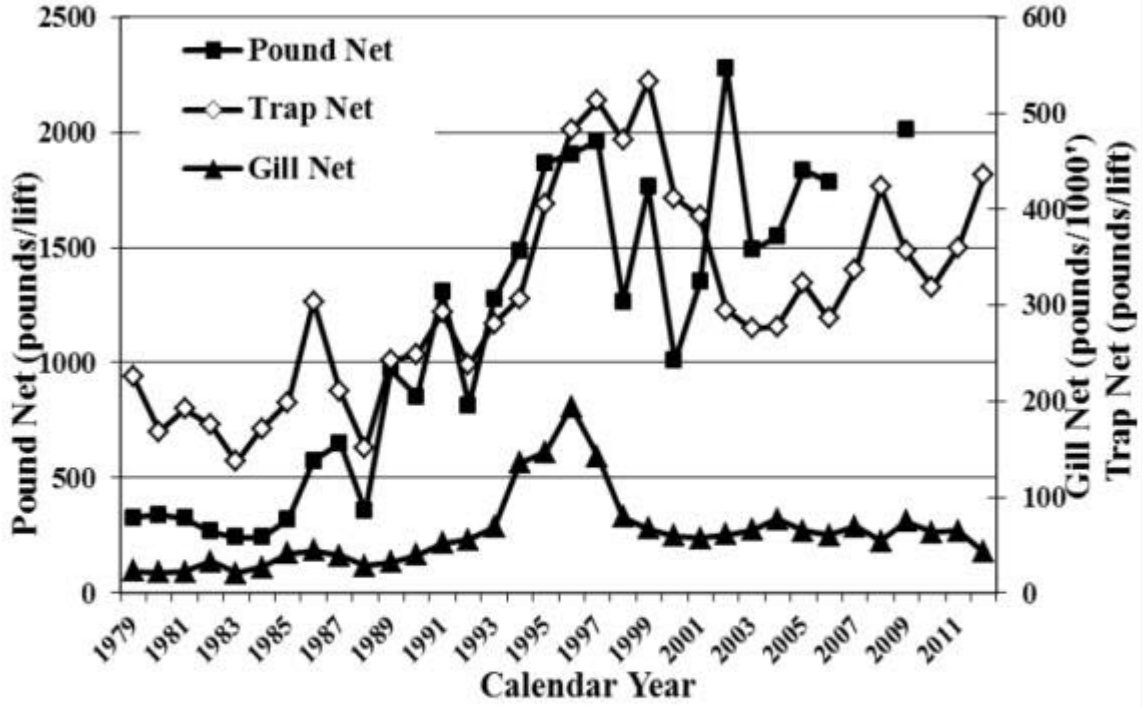


Figure 3. Trends in gill net, trap net, and pound net catch per unit of effort (CPE) in the Wisconsin waters of Lake Michigan including Green Bay, 1979 – 2012. Gill net CPE is pounds of whitefish harvested per 1,000 feet lifted; trap and pound net CPE is pounds of whitefish harvested per pot lifted.

Trends in CPE by gear type over time for lake whitefish in Wisconsin waters of Lake Michigan. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

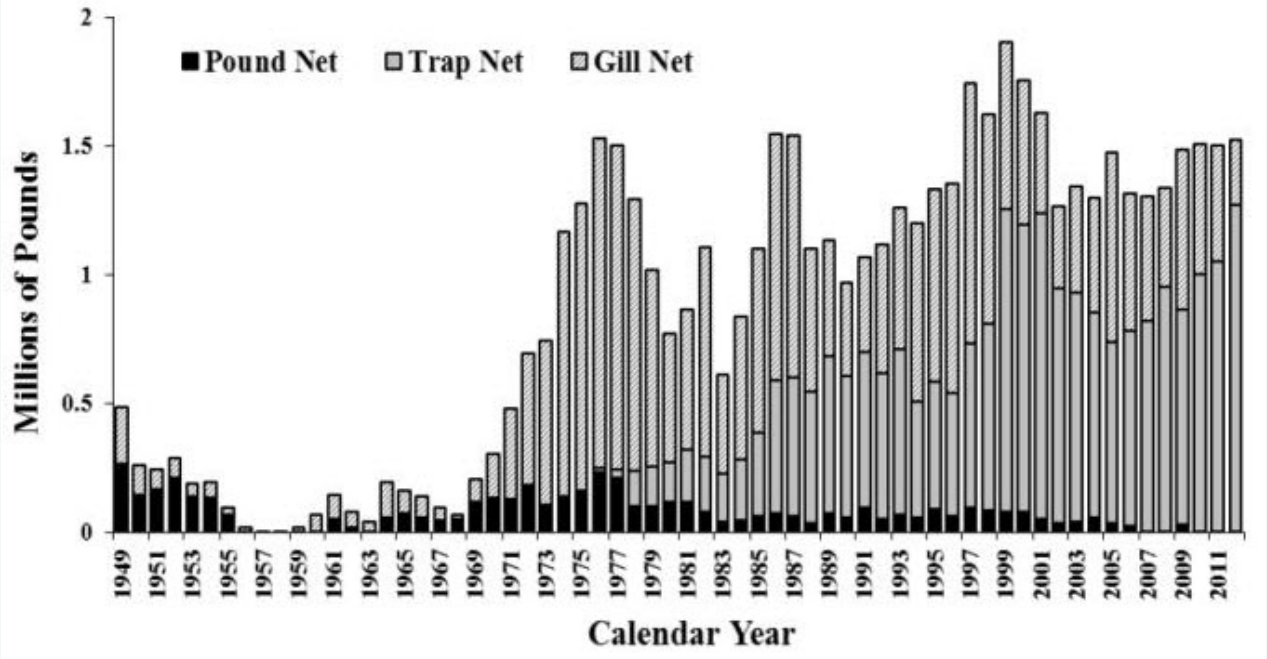
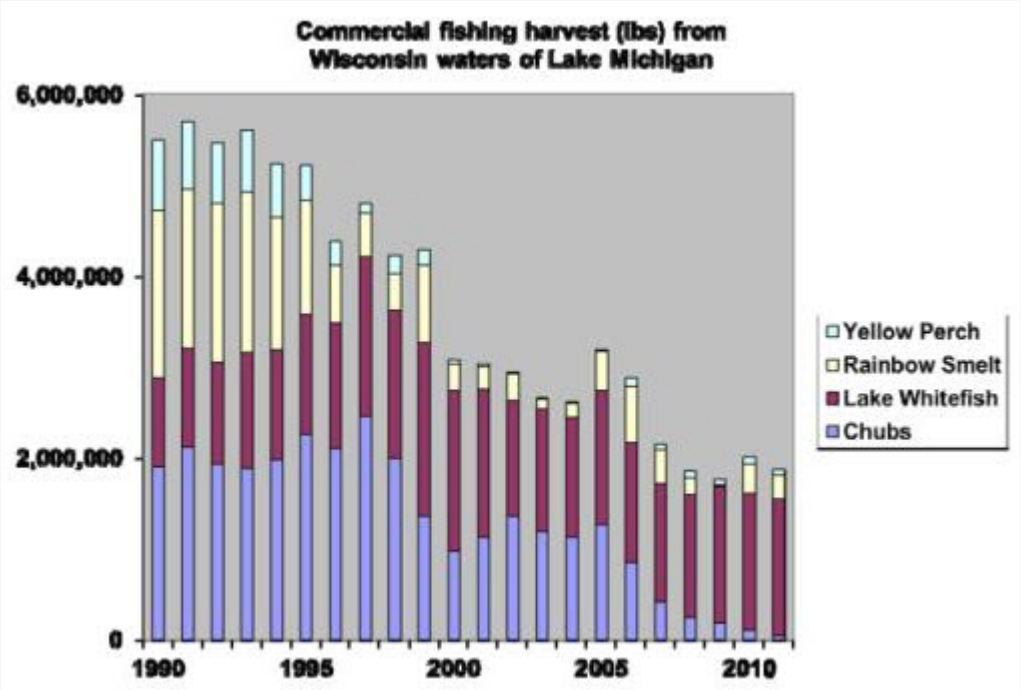


Figure 1. Lake whitefish calendar year commercial harvest reported by gear type in pounds (dressed weight) from Wisconsin waters of Lake Michigan including Green Bay from 1949 through 2012.

Lake whitefish commercial harvest by gear type over time. Taken from the 2013 Lake Michigan

Management Report section on Lake Whitefish by Scott Hensen.



Commercial fishing harvest (lbs) from Wisconsin waters of Lake Michigan over time. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Fishing mortality for lake whitefish harvested in the Michigan waters of Lake Michigan is scored as "low concern" given that catch rates are typically at or below established TAC (total allowable catch) restrictions for each lake whitefish management zone (Caroffino & Lenart 2012), and TACs are set at a level that has been found to be sustainable. TAC's are established annually by estimating population abundance-at-age at the start of the year and then adjusting fishing mortality either to meet mortality targets or to follow guidelines established in the Consent Decree for phasing in the targets. The resulting projection of yield or effort associated with the fishing mortality then form the basis for the TAC recommendation (Caroffino & Lenart 2012).

Additonally, TAC's are determined annually based on modeled projections of total fish mortality. A total annual mortality of 45% has been determined as necessary to allow for sustained population growth (Caroffino & Lenart 2012). When determining allowable commercial fishing mortalities (i.e. TACs), mortality due to natural causes and sea lamprey predation are combined to determine total mortality. TAC limits are then adjusted based on the increase or decrease in mortality from other sources.

Given that catch rates are generally within established TAC restrictions, fishing mortality is likely to have minimal impact on lake whitefish stocks. Additionally, TAC's are adjusted to achieve target mortality rates and account for current population abundance estimates, resulting in flexible TAC levels reflective of current population status.

Justification:

Fishing mortality of lake whitefish (age 4+) in the Michigan waters of Lake Michigan for trap net fisheries was

estimated at 0.084, comprising 17% of total mortality. Although trap net fisheries only account for 17% of total mortality, this represents roughly half of the estimated commercial harvest motality. (Caroffino & Lenart 2012)

WISCONSIN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

This fishery is given a 'Moderate Concern' recommendation because F is unknown and this fisheries impact on the stock is uncertain but not negligible. Harvests have been below set quota levels, but whether or not these quota levels are determined and adjusted based on population status is unknown. Trap net harvests as a proportion of total harvest has been increasing substantially over the past 10 years.

Justification:

Lake Whitefish harvests as a percentage of total harvest (all species) have been increasing since the mid 2000s. (See image of Commercial fishing harvest from Wisconsin waters of Lake Michigan taken from the 2013 LMFT-DNR report). Lake Whitefish now constitute the majority of Wisconsin commercial catch (~80%).

While the population biomass is believed to be increasing, lake whitefish growth rates have declined markedly through the middle part of the decade (Bunnell, D. B. 2012). This decrease is attributed to the increase importance of dreissenid of mussels and the declining importance of Diporeia in the lake whitefishes' diet. As a consequence of declining growth, the mean age in the commercial harvest has steadily increased from ages 5-6 to at least age 8 (Bunnell, D. B. 2012). These trends have led to concerns about the ability of lake whitefish stocks to retain their current levels of biomass.

1,523,861lbs were harvested in 2012 total, of which 84% was taken by trap nets (~1,280,043 lbs). Trap nets have been used to commercially catch Lake Trout in Wisconsin waters of Lake Michigan since 1976 and their use has been increasing over the past two decades. Trap nets have accounted for well over 50% of Lake Whitefish harvest over this time. Proportion taken by trap net in 2011 was 70%, and 84% in 2012. (See images of lake whitefish by gear type over time taken from the LMFT-DNR 2013 report).

The 2012 harvest was an increase in harvest from previous years. The quota was increased in both the 2009-2010 quota rear to 2.88 million pounds. This is up from the 1998-1999 quota year of 1.15 million pounds. The last 3 years of trap net effort has been stable, but there was a spike in effort in 2005 followed by a steady decline. The trap net CPE has improved for a second year and has increased between 2011-2012 (Hansen 2013).

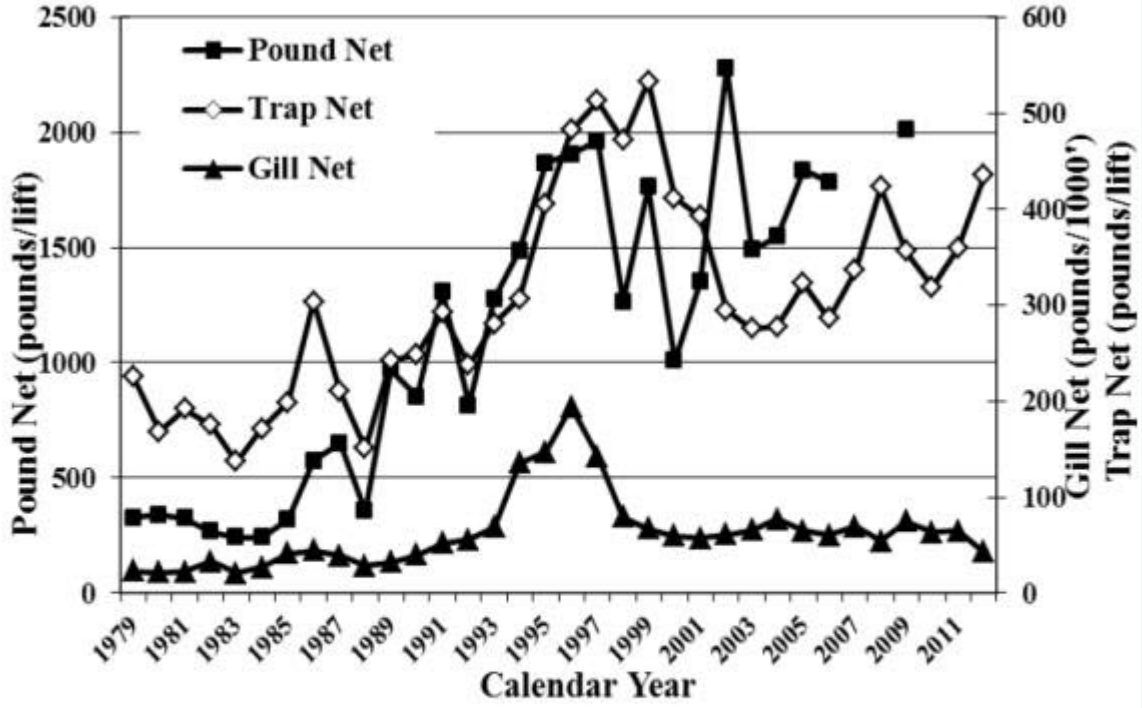


Figure 3. Trends in gill net, trap net, and pound net catch per unit of effort (CPE) in the Wisconsin waters of Lake Michigan including Green Bay, 1979 – 2012. Gill net CPE is pounds of whitefish harvested per 1,000 feet lifted; trap and pound net CPE is pounds of whitefish harvested per pot lifted.

Trends in CPE by gear type over time for lake whitefish in Wisconsin waters of Lake Michigan. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

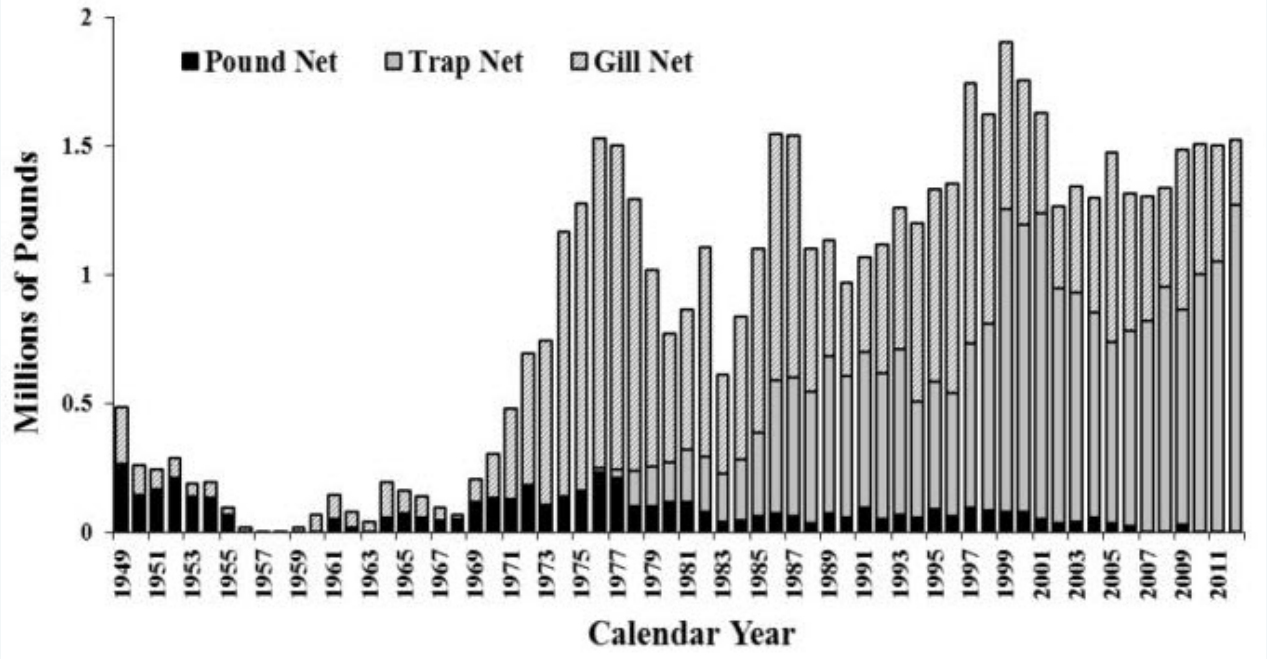
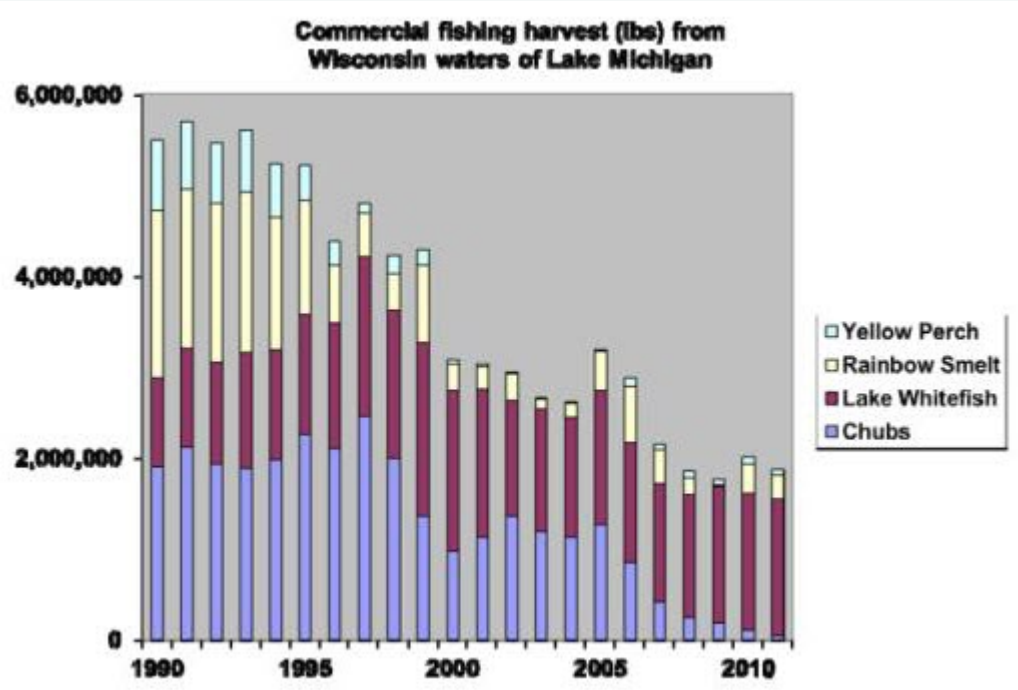


Figure 1. Lake whitefish calendar year commercial harvest reported by gear type in pounds (dressed weight) from Wisconsin waters of Lake Michigan including Green Bay from 1949 through 2012.

Lake whitefish commercial harvest by gear type over time. Taken from the 2013 Lake Michigan

Management Report section on Lake Whitefish by Scott Hensen.



Commercial fishing harvest (lbs) from Wisconsin waters of Lake Michigan over time. Taken from the 2013 Lake Michigan Management Report section on Lake Whitefish by Scott Hensen.

WALLEYE

Factor 1.1 - Inherent Vulnerability

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Medium

The Fishbase inherent vulnerability score for walleye is 40 (Forse & Pauley 2012)

The walleye is the largest member of the perch family, and are considered the dominate near shore predator. Walleye can live >25 years with males maturing at age 2-4 and females maturing at age 3-6. In the spring, walleye migrate to tributary streams to lay eggs over gravel and rock. They are also known to spawn over rocky shoals in the lake.

Factor 1.2 - Abundance

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderate Concern

This stock is given a 'moderate concern' because there is no evidence to suggest that stock is either above or below known reference points, as data on abundance is unavailable.

Justification:

A decline in total harvest has occurred when comparing 2007 - 2008 and 2009 - 2012 harvest levels of walleye in the 1836 Treaty Waters of Lake Michigan. In 2009, harvest levels fell below 20,000 pounds to 11,117 pounds, and subesquently declined to 9,148 pounds in 2012.

MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

This stock is given a 'moderate concern' because there is no evidence to suggest that stock is either above or below known reference points, as data on abundance is unavailable.

Justification:

A decline in harvest has occurred when comparing 2007 - 2008 and 2009 - 2012 harvest levels of walleye in the 1836 Treaty Waters of Lake Michigan. In 2009, harvest levels fell below 20,000 pounds to 11,117 pounds, and subsequently declined to 9,148 pounds in 2012.

Factor 1.3 - Fishing Mortality

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Fishing mortality is given as 'moderate concern' because fishing mortality in regards to target reference point is either unknown or could not be found.

Justification:

Gill nets were responsible for 87% of the total harvest of walleye in the Michigan waters of Lake Michigan in 2012, for which the total catch was 9,148 pounds. Effect of gill nets on fishing mortality have been variable since 2007, but range over 90% in a given year as harvest levels have declined since 2009.

Trap nets were responsible for 13% of the total harvest of walleye in the Michigan waters of Lake Michigan in 2012, for which the total catch was 9,148 pounds. Effect of trap nets on fishing mortality have been variable since 2007, but may range over 20% in a given year as harvest levels have declined since 2009.

YELLOW PERCH

Factor 1.1 - Inherent Vulnerability

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low

The Fishbase inherent vulnerability score for yellow perch is 31 (Forse & Pauley 2012).

The yellow perch inhabits shallow, near shore areas where they dine primarily on immature insects, larger invertebrates (such as crayfish), and the eggs and young of other fish. Male perch reach sexual maturity ate 3 years of age while females mature at age 4. Yellow perch often live from 9-10 years. Yellow perch spawn in

the spring, laying eggs in gelatinous strings over dense vegetation, roots, and fallen trees.

Factor 1.2 - Abundance

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderate Concern

Stock status is given as 'moderate concern' since stock abundance relative to target reference point is either unknown or could not be found. Lake wide, yellow perch is intensively managed for the recreational fishery which has shown a relatively stable harvest rate over the last decade (250-300 tonnes). In comparison the commercial fishery has ranged from 12 to 45 tonnes and has also remained relatively stable over the past decade. Commercial harvest of yellow perch is prohibited in the Michigan Waters of Lake Michigan with the exception of tribal fisheries (Bunnell, D. B. 2012)

Justification:

Yellow perch harvest in Lake Michigan is often bycatch as the result of Tribal Fisheries targeting lake whitefish and walleye.

WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderate Concern

Stock status is given as 'moderate concern' since stock abundance relative to target reference point is either unknown or could not be found. Additionally, there is evidence that despite strong recruitment, there is poor survival occurring in age-0 classes, and current harvest levels are considerably below long-term historic harvest (pers. comm. WDNR).

Justification:

The gillnet fishery of Green Bay, Wisconsin for yellow perch represents 97% of the total commercial harvest of yellow perch from Lake Michigan in 2012. Although harvest has remained relatively stable since 2005, current harvest levels are particularly low despite an increase of total allowable catch from 60,000 pounds to 100,000 pounds in 2008. The 2012 harvest achieved 58% of the total allowable catch, and even though excellent recruitment has been detected in recent years, commercial harvest has not increased as expected. It is expected that despite strong recruitment there is poor survival occurring in age-0 classes, and impacts of double-crested cormorant predation may be a factor as well (WDNR, 2013).

MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Stock status is given as 'moderate concern' since stock abundance relative to target reference point is either unknown or could not be found. Lake wide, yellow perch abundance is significanly below historical trends, and commercial harvest of yellow perch is prohibited in the Michigan Waters of Lake Michigan with the exception of tribal fisheries. (Michigan Deparment of Natural Resources, 2014)

Justification:

In 2012, 150 pounds of yellow perch was harvested by Tribal Fishers from the 1836 Michigan Treaty Waters of Lake Michigan via trap net. This represents 9% of the total yellow perch catch in the Michigan waters of Lake Michigan for 2012. Trends in yellow perch harvest by trap net from 2007 - 2012 range from 0 to 150 pounds. Yellow perch harvest in Lake Michigan is usually bycatch as the result of Tribal Fisheries for lake whitefish and walleye. (Michigan Deparment of Natural Resources, 2014)

Factor 1.3 - Fishing Mortality

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderate Concern

Gill nets were responsible for 91% of the total harvest of yellow perch in the Michigan waters of Lake Michigan in 2012, for which the total catch was relatively small at 1,672 pounds. The contribution of Tribal harvest on fishing mortality does not likely have significant impact on yellow perch stocks. However, fishing mortality relative to target reference point could not be obtained, resulting in a score of 'moderate concern'.

WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Low Concern

Recent trends in harvest continue to be considerably below the established TAC despite an increase of TAC in 2008 (WDNR, 2013). This increase was the result of a new modeling tool developed to examine population health and viability (Bunnell, D. B. 2012) TAC's are established annually based on previous year's harvest, trends, scientific advice, and consumer demand. Based on this approach for calculating annual quotas, it is believe that they are an appropriate alternative to MSY. Given that catch rates are generally within established TAC restrictions, fishing mortality is likely to have minimal impact on yellow perch stocks.

MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Trap nets were responsible for 9% of the total harvest of yellow perch in the Michigan waters of Lake Michigan in 2012, for which the total catch was relatively small at 1,672 pounds. Data for 2007 - 2012 generally showed minor levels of harvest ranging from 0 - 9% of total harvest. The contribution of Tribal yellow perch harvest (which is a species targeted by tribal fisherman) on fishing mortality is likely negligible. However, fishing mortality relative to target reference point could not be obtained. Although the tribal fishery catches a small percent of the total harvest of this species, the tribal fishery is considered a substantial contributor to total mortality because it targets the species, resulting in a score of 'moderate concern' because fishing mortality relative to reference points is unknown.

Criterion 2: Impacts on other species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

LAKE TROUT - MICHIGAN/LAKE MICHIGAN - BARRIERS, FENCES, WEIRS, CORRALS, ETC. - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

LAKE TROUT - MICHIGAN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

LAKE WHITEFISH - MICHIGAN/LAKE MICHIGAN - BARRIERS, FENCES, WEIRS, CORRALS, ETC. - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)	

LAKE WHITEFISH - MICHIGAN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)	
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)	

LAKE WHITEFISH - WISCONSIN/LAKE MICHIGAN - BARRIERS, FENCES, WEIRS, CORRALS, ETC. - UNITED STATES OF AMERICA					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
No other main species caught					

LAKE WHITEFISH - WISCONSIN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**3.318**	**Discard Rate:**	**1.00**	**C2 Rate:**	**3.318**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Yellow perch	3.00:Low	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

WALLEYE - MICHIGAN/LAKE MICHIGAN - BARRIERS, FENCES, WEIRS, CORRALS, ETC. - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

WALLEYE - MICHIGAN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Yellow perch	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

YELLOW PERCH - MICHIGAN/LAKE MICHIGAN - BARRIERS, FENCES, WEIRS, CORRALS, ETC. - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

YELLOW PERCH - MICHIGAN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Walleye	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)
Lake trout	1.00:High	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Lake whitefish	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

YELLOW PERCH - WISCONSIN/LAKE MICHIGAN - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.644**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Lake whitefish	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)

Species included in Criteria 2 include all species composing 5% or more of the total catch by that fishery. Catch composition was determined from data provided in by the Wisconsin Department of Natural Resources (WDNR) and the Michigan Department of Natural Resources (MDNR). Lake whitefish is the main species reported in the Lake Michigan fishery. Gear types mentioned with catch data include gillnets, and trap nets.

There are no bycatch species in these fisheries that are discarded dead in significant amounts. Most species harvested have commercial value (even if they are not a targeted species) and are thus kept and sold portside. The only exceptions are lake sturgeon, which are listed as threatened or endangered throughout the region, and lake trout.
Lake trout harvesting is permitted by US tribal-fisherman. Lake trout are generally taken with gillnets, where they suffer the highest threat of gear-mortality. Lake trout harvested by tribal fisherman are not considered as bycatch. Otherwise, lake trout harvest is not permitted in Lake Michigan waters, and lake trout that are captured are released unharmed.

Lake sturgeon landings are prohibited throughout the Great Lakes, but they are occasionally incidentally captured in gillnets. However, there is a general concensus throughout the fishery community (scientists and fishermen) that gillnets most often do not harm lake sturgeon. Fishing methods utilized in Lake Michigan (gillnets and trapnets) are not believed to have significant impacts on lake sturgeon and most fish that are incidentally caught with such gears are returned to the water alive ((Threader and Broussaeu 1986),(Hayes and Caroffino 2012), Pers. comm. MDNR). The capture rates of lake sturgeon in both these fisheries are also extremely low. In Lake Michigan, no records of lake sturgeon bycatch in US waters have been identified. Therefore, the Great Lakes fisheries are deemed not to impact lake sturgeon populations, and lake sturgeon are not included in the assessment.

2.4 - Discards + Bait / Landings

MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

< 20%

Use of gillnets in Michigan waters of Lake Michigan is restricted to tribal fisheries. While detailed bycatch data from these fisheries could not be obtained, discard rates of lake trout and lake whitefish are believed to be minimal ({Caroffino & Lenart 2012}, (pers. comm. DNR)). Though many species harvested in the commercial fishery are retained as incidental catch, they still possess market value and are taken to port. Lake trout collected by Lake Michigan fisherman must be discarded.

MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 20%

Discard rates for trapnet fisheries could not be obtained but impact on fish stocks is considered minor. Trap nets collect live catches, and have been shown to have small incidence of bycatch compared to other gears (including gillnets), and relatively high survival rates of bycatch ({Bunnell et al 2013},{Siira et al. 2006}). Based on catch data from other fisheries throughout the Great Lakes Basin, discard rates of trapnets fisheries in Michigan waters of Lake Michigan are believed to be low, with less chance of mortality to any species caught incidentally.

WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN/LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

< 20%

While detailed bycatch data from these fisheries could not be obtained, discard rates of lake trout and lake whitefish are believed to be minimal ({Caroffino & Lenart 2012}, (pers. comm. DNR)). Though many species harvested in the commercial fishery are retained as incidental catch, they still possess market value and are taken to port. Lake trout collected by Lake Michigan fisherman must be discarded.

WISCONSIN/LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 20%

Discard rates for trapnet fisheries could not be obtained but impact on fish stocks is considered minor. Trap nets collect live catches, and have been shown to have small incidence of bycatch compared to other gears (including gillnets), and relatively high survival rates of bycatch ({Bunnell et al 2013},{Siira et al. 2006}). Based on catch data from other fisheries throughout the Great Lakes Basin, discard rates of trapnets fisheries in Wisconsin waters of Lake Michigan are believed to be low, with less chance of mortality to any species caught incidentally.

Criterion 3: Management Effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Harvest Strategy	Bycatch Strategy	Score
Michigan / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	3.000	0.000	Yellow (3.000)
Michigan / Lake Michigan / Set gillnets / United States of America	3.000	0.000	Yellow (3.000)
Wisconsin / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	3.000	0.000	Yellow (3.000)
Wisconsin / Lake Michigan / Set gillnets / United States of America	3.000	0.000	Yellow (3.000)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Harvest Strategy

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and*

unreported fishing occurring.

Factor 3.1 Summary

FACTOR 3.1 - MANAGEMENT OF FISHING IMPACTS ON RETAINED SPECIES							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Michigan / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Michigan / Lake Michigan / Set gillnets / United States of America	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Wisconsin / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Wisconsin / Lake Michigan / Set gillnets / United States of America	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderately Effective

The Great Lakes span jurisdictions in two countries, several states, one province, and a number of tribal lands. As such, management of the shared fishery resources is complex and dynamic. The main coordinating body of fishery management in the region is the Great Lakes Fishery Commission (GLFC), an inter-jurisdictional agency established in 1954 by the governments of the US and Canada (Beamish 2001). The Commission consists of four Canadian and four American commissioners, who are appointed by their respective governments and supported by a secretariat in Ann Arbor, Michigan.

Within the Great Lakes Fishery Commission, each lake has a Lake Committee that undertakes research and makes recommendations on sea lamprey control (the original motivation for the Commission), lake trout rehabilitation, stocking events, and other lake-specific management actions for each of the Great Lakes. Lake Committees are comprised of members of the actual management bodies for each lake. However, the GLFC and the Lake Committees do not manage the lakes, but rather serve as a platform to help bring together the multiple management agencies involved in the Great Lakes fisheries to better coordinate research, enforcement, stocking, quotas, and other management issues.

Tribal-licensed fisheries are managed by two agencies: the Chippewa-Ottawa Resource Authority (CORA) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). In 1976 the Michigan Supreme Court reaffirmed that treaties signed in 1836 and 1855 reserved some tribal fishing rights outside state regulation. This finding led to the 1985 Consent Order and the 2000 Consent Decree, now in effect. The Consent Decree establishes biological monitoring and law enforcement within CORA-managed tribal fisheries, with an Executive Council and Technical Fishery Committee comprising state, tribal, and federal biologists. Since the 2000 Consent Decree, these fisheries are managed on a species-specific rather than region-specific basis, with emphasis on restoring lake trout communities (CORA 2007)(GLIFWC 2007). Some fish stock surveys and water quality monitoring in the Great Lakes region is also undertaken by the US Geological Service's Great Lakes Science Center, NOAA's Great Lakes Environmental Research Laboratory (GLERL), and the US Environmental Protection Agency (EPA).

Stock assessments are conducted by the federal, state, and provincial agencies that make up the various Lake Technical Committees (LTCs). Daily catch reports, annual CPUE and harvest trends, and stock condition trends (length to weight ratios, size at maturity, and size at harvest) are all monitored and evaluated by the host agencies (DNR, OMNR, etc) and shared with LTC's. In addition, fisheries independent research conducted by local agencies and universities, which assess parameters of stock condition and the fishery as a whole, are also incorporated into stock assessments. The agencies use these stock assessments to propose and set changes to yearly quotas which are established for all species of commercial interest.

Gear types utilized in Lake Michigan waters are gillnets and trapnets. Gillnetting is prohibited in the US state-licensed fishery. Trawling is prohibited throughout the entire lake. Lake trout and walleye are not to be targeted or sold by US state-licensed fisherman but they may be sold as incidental catch by tribal fisherman. Size restrictions for lake whitefish are ~19" in length. This is set to allow lake whitefish at least one season in which to breed. Rainbow smelt is not a commercially important species in Lake Michigan and as such, it is generally unregulated..

Management Strategies and Implementation for fisheries in Lake Michigan receive a score of 'Moderately Effective'. Although strategies are in place to effectively manage the fishery, successful implementation has proven a challenge due to both ecological (invasive species introduction, lack of self sustaining lake trout populations) and anthropogenic (conflicting resource use interests) influences.

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderately Effective

Walleye, yellow perch, and lake trout are still in a recovery phase following the dramatic declines experienced after sea lamprey and alewife introductions in the mid 1900's. Effective lampricide treatments, reduced harvest attempts, and vigorous re-stocking attempts have resulted in the partial resurgence of the Lake Michigan commercial fishery (Bunnell, D. B. 2012).

The Lake Michigan Committee has established Fish-Communities Objectives (FCO's) for all relevant fish stocks that are currently harvested as target or incidental catch in Lake Michigan (Eshenroder et al. 1995). These objectives define target yields and conditions for each species that are believed to represent restored stocks capable of sustaining desired annual harvest demands and/or allowing fish community structures to return to pre-collapse levels (Eshenroder et al. 1995).

Efforts to facilitate recovery of fish stocks have included: the prohibiting of gillnet use by US fisherman, changes in the mesh size and placement and effort of gillnets used by tribal fishermen, a gradual shift to less lethal trapnets, labeling of vulnerable stocks of walleye and yellow perch as incidental and not commercial harvest, reduced numbers of authorized fishing licenses, and increased restriction on the take of lake trout throughout the basin including the prohibited harvest of lake trout by US, state-licensed fishermen ((Bunnell, D. B. 2012),(Bronte et al. 2008),pers. comm.. DNR).

While these restrictions, along with the increased control of invasive sea lamprey predation and improved habitat management have resulted in yields that are nearing and in some cases exceeding historic averages, most FCO's are currently not being met, and some have shown a downward trend in relative progress (Bunnell, D. B. 2012). This has caused some discussion as to the ability of Lake Michigan to support the desired stock abundance in its current condition. FCO's of several species are currently under review because a new ecological paradigm exists in the lake and it may be difficult to ascertain exactly what "recovery" is or will be.

One species that is currently undergoing a vigorous recovery attempt in Lake Michigan is the lake trout. Lake trout stocks in Lake Michigan are the most actively managed and recovery and rehabilitation strategies have been developed and implemented in an effort to restore naturally reproducing stocks throughout the region (Bronte et al. 2008). While some evidence of increased natural reproduction has been identified in several stocks of Lake Michigan, the fishery is still reliant on annual stocking (Bronte et al. 2008).

Recovery of species of concern is considered moderately effective because while many stocks are not meeting the FCO's established by the Lake Michigan Committee, there is evidence of stock status improvement as shown by increased annual yields of target species. Recovery strategies such as gear and harvest restrictions are also believed to be having a positive influence on fish stock recovery.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Highly Effective

This criterion is receiving a 'Highly Effective' score. This ranking is based on the management process which uses an independent and up-to-date scientific stock assessment or analysis, or other appropriate method that seeks knowledge related to stock status, and this assessment is conducted regularly and is complete and

robust.

These assessments mainly use CPUE as an indicator of biomass or stock abundance, and target reference points are absent. However, these assessments are long term and robust and are coupled with species body-condition and age/weight assessments, and there is good probability they are good indicators of stock status and fish community health.

Recommendations for total annual harvest limits are adjusted based on best available information from the Department of Natural Resources (DNR). For some cases including lake whitefish and yellow perch, the DNR maintains a time series database and conducts biological surveys targeting commercially targeted species. For other species which may not have specific biological surveys, the DNR uses USGS surveys and commercial catch rates to estimate fish biomass (Bunnell et al 2013)(Caroffino & Lenart 2012) (Lake Michigan Fisheries Team 2004).

The US Geological Survey (USGS) has been conducting yearly lake-wide surveys of the fish community in Lake Michigan since 1976. These surveys collect data on relative abundance, size and age structure, and condition of individual fishes, which are used to create population parameters used by state and tribal agencies in managing Lake Michigan fish stocks (Bunnell et al 2013).

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Highly Effective

The Great Lakes Fishery Commission takes scientific advice into account when setting quotas and developing management strategies throughout the Great Lakes. With the enactment of the Joint Strategic Plan for Management of Great Lakes Fisheries, quotas and stock assessments are evaluated by representatives both state and provincial agencies and assessed based on proposed ecological impacts to the fishery and surrounding ecosystems (GLFC 2007). Additionally, scientific advice is elicited to help determine stock status on most of the species listed in this report. Serving on each lake technical committee and present at the lake committee technical hearings are representatives from the research divisions of DNR and OMNR agencies whose sole propose is to provide information on projected stock status, discuss potential adverse trends afflicting stocks of interest (including spread of VHS and lamprey control efforts), and to advice on future directions. The Great Lakes Fishery Commission is implementing scientific advice on a regular basis (pers. comm. DNR and OMNR officials). Independent research conducted by universities throughout the Great Lakes routinely finds its way to these meetings and significant results are discussed. Owing to the fragile nature of the Great Lakes fishery which appears to only recently be recovering from a period of low yield and decreased stock abundances, scientific advice is relied upon heavily to ensure the fishery continues to recover.

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Highly Effective

The GLFC created the International Great Lakes Fishery Law Enforcement Committee with the goal to "protect, enhance and promote the safe and wise use of the natural resources in the Great Lakes for present and future generations" (GLFC Website 2014). This committee is comprised of representatives from resource enforcement agencies (OMNR, DNR) from all states and provinces bordering the lakes, the United States Coast Guard, and tribal/ first nation authorities (CORA, GLIFWC). Specialists from the coast guard and both the Ontario Ministry of Natural Resources (OMNR) and the states Department of Natural Resources (DNR) routinely board commercial fishing vessels to inspect harvest and fishing gear to ensure that fisherman are following the required guidelines. Portside inspections are carried out by DNR and tribal authorities which enforce fisheries legislation including minimum landing sizes, retention of prohibited species, gear restriction, etc. Deployed gears are also randomly inspected by coastguard and conservation officers of the DNR to ensure that gears are properly marked, placed in authorized areas, and are utilizing legal mesh sizes (DNR Website 2005). Patrols and monitoring of illegal fishing are carried out by the U.S. coast guard, conservation officers of the DNR, and tribal authorities.

An agreement was reached between CORA and the US coast guard (the memorandums of agreement) which allows the coast guard to inspect and prosecute tribal fisherman in tribal waters of the Great Lakes (Pickering 2010). Additionally, the Tribal Fisheries Constent Decree of 2000 between the U.S. and CORA allows DNR officials to inspect portside take from tribal fisherman (DNR Website 2005).

Actions of the Law Enforcement Committee are guided by policies and recommendations enacted by the governing Council of Lake Committees. These include supporting investigations crossing jurisdiction lines, supporting development and dissemination of information on fisheries forensic sciences, and sharing of law enforcement intelligence information, and enforcing quota and harvest regulations (GLFC Website 2014).

MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Highly Effective

The Great Lakes Fishery Commission (GLFC) created the International Great Lakes Law Enforcement Committee with the goal to "protect, enhance and promote the safe and wise use of the natural resources in the Great Lakes for present and future generations" (GLFC Website 2014). This committee is comprised of representatives from the fishery management agencies representing all states and provinces bordering the Great Lakes. These management agencies include State Departments of Natural Resources (DNR), the Department of Environmental Conservation in New York (NYSDEC), the Pennsylvania Fish and Boat Commission, the Ontario Ministry of Natural Resources (OMNR), the United States Coast Guard, and the tribal/ first nation authorities Chippewa Ottawa Resource Authority (CORA) and the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) when applicable.

Specialists from the coast guard and both the OMNR and the states DNR routinely board commercial fishing vessels to inspect harvest and fishing gear to ensure that fisherman are following the required guidelines.

Portside inspections are carried out by DNR and tribal authorities which enforce fisheries legislation including

minimum landing sizes, retention of prohibited species, gear restriction, etc. Deployed gears are also randomly inspected by coastguard and conservation officers of the DNR to ensure that gears are properly marked, placed in authorized areas, and are utilizing legal mesh sizes (DNR Website 2005). Patrols and monitoring of illegal fishing are carried out by the U.S. coast guard, conservation officers of the DNR, and tribal authorities.

An agreement was reached between CORA and the US coast guard (the memorandums of agreement) which allows the coast guard to inspect and prosecute tribal fisherman in tribal waters of the Great Lakes (Pickering 2010). Additionally, the Tribal Fisheries Constent Decree of 2000 between the U.S. and CORA allows DNR officials to inspect portside take from tribal fisherman (DNR Website 2005).

Actions of the Great Lakes Law Enforcement Committee are guided by policies and recommendations enacted by the governing Council of Lake Committees. These include supporting investigations crossing jurisdiction lines, supporting development and dissemination of information on fisheries forensic sciences, and sharing of law enforcement intelligence information, and enforcing quota and harvest regulations (GLFC Website 2014).

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Moderately Effective

The fish stocks in the Great Lakes have been subject to fishing pressures for centuries. Historic overfishing, the introduction of non-native species (sea lamprey, alewifes, zebra mussels, etc), and habitat alteration and destruction have resulted in many of the fish stocks becoming greatly diminished or depleted. Comprehensive management of the Great Lakes began during the middle of the 20th century with the formation of the Great Lakes Fishery Commission (GLFC), after many of the commercially important stocks were already decimated. Implementation of legislation to promote improved conditions throughout the Great Lakes (Great Lake Water Quality Agreement 1972), as well as the development of more effective invasive control efforts, have resulted in the increased stock abundance of many target species. State (DNR), provincial (OMNR), and tribal (CORA) management agencies have made substantial progress in rehabilitation, restoration, and prevention efforts.

However, stocks of once commercially valuable lake trout and lake sturgeon are still far below historic levels (though improving) even after rigorous re-stocking and rehabilitation attempts over the last several decades. Additionally, systemic issues that occur between agencies (difference in regional priorities and interests, jurisdictional disputes, etc.) can impede or delay action and response to new threats or obstacles to the fishery. Such delays in action may interfere with current restoration attempts, as new threats such as invasive species and productivity changes continue to plague the fishery.

While current management strategies have proven effective in halting and in some cases reversing the downward trends in abundance of many stocks throughout the Great Lakes, it is too early to determine whether this management system will prevail in the face of mounting ecological pressures.

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Highly Effective

Agencies at the state, federal, and provincial level work with local stakeholders since they are the managing agencies with the delegated authority to invoke management actions (e.g. harvest restrictions, size limits, stocking, etc…). For example, Ontario has formed a provincial system of Fisheries Management Zone councils comprised almost entirely of mixed user groups. These groups meet regularly to hear from Ontario Ministry of Natural Resources (OMNR), research elements, and provide feedback for proposed management decisions. This ground level engagement is conducted by individual managing agencies, which include US state and federal agencies and Canadian provincial agencies.

Bringing together these managing agencies in Great Lakes region is The Great Lakes Fishery Commission (GLFC). The GLFC is comprised of representatives from all parties that have a stake in the commercial fishery including US state and federal agencies, Canadian agencies, and tribal/first nation representatives. The GLFC has a good track record of including stakeholders in the development of legislation, harvest restrictions, and enforcement regulations throughout the Great Lakes fisheries since there are representatives participating from managing agencies that reach out to their local stakeholders regularly. Furthermore, stakeholders representing recreational fishery interests are also present at local lake committee meetings. The U.S. fishery is largely managed for the benefit of the recreational fishing industry and as such their interests are acknowledge and incorporating in Great Lakes management ((DesJardine et al. 1995),(Riley 2013)).

Each lake committee is required to make regular reports to the Council of Lake Committees (CLC). These reports generate the development of new legislation which is made public and to local, state, provincial, and federal agencies who are invited to submit comments and suggestions. Findings, reports, and suggested management strategies are made public and opened to criticism which shows transparency of the process (GLFC 2007).

Factor 3.2 - Bycatch Strategy

SCORING GUIDELINES

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.' Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these rating are the same as in 3.1.

- *5 (Very Low Concern)—Rated as 'highly effective' for all four subfactors considered*
- *4 (Low Concern)—Management Strategy rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy but some other factors rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy rated 'ineffective.'*
- *0 (Critical)—No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substatntially impacted by the fishery*

FACTOR 3.2 - BYCATCH STRATEGY						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Michigan / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	Yes	All Species Retained				
Michigan / Lake Michigan / Set gillnets / United States of America	Yes	All Species Retained				
Wisconsin / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	Yes	All Species Retained				
Wisconsin / Lake Michigan / Set gillnets / United States of America	Yes	All Species Retained				

Subfactor 3.2.3 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery's impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met

Subfactor 3.2.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Subfactor 3.2.5 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Michigan / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	3.00: Low Concern	0.00: No Effective Mitigation	4.00: Low Concern	Green (3.464)
Michigan / Lake Michigan / Set gillnets / United States of America	3.00: Low Concern	0.00: No Effective Mitigation	4.00: Low Concern	Green (3.464)
Wisconsin / Lake Michigan / Barriers, fences, weirs, corrals, etc. / United States of America	3.00: Low Concern	0.00: No Effective Mitigation	4.00: Low Concern	Green (3.464)
Wisconsin / Lake Michigan / Set gillnets / United States of America	3.00: Low Concern	0.00: No Effective Mitigation	4.00: Low Concern	Green (3.464)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

- *5 (None) - Fishing gear does not contact the bottom*
- *4 (Very Low) - Vertical line gear*
- *3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble*

or boulder)
- *0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl) Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.*

Factor 4.2 - Mitigation of Gear Impacts

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats*

Factor 4.3 - Ecosystem-Based Fisheries Management

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators)*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

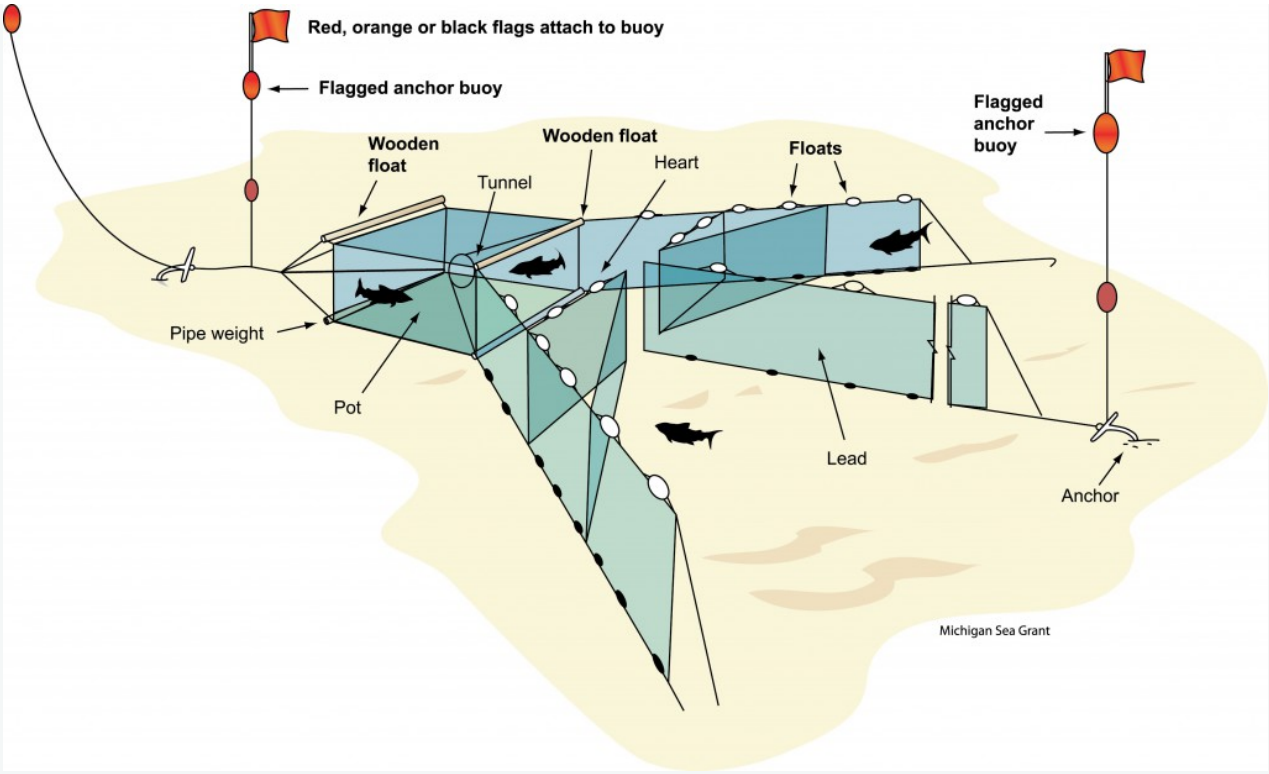
Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Trapnets are used lakewide in US and Tribal waters. Trapnet impacts on benthic substrate has not been assessed. However, their impacts are considered negligible in areas where they are utilized (pers. comm. OMNR). Substrates are most often comprised of sand, rocky and coarse materials, silt, muck, or *dreissenid* mussels.

Justification:



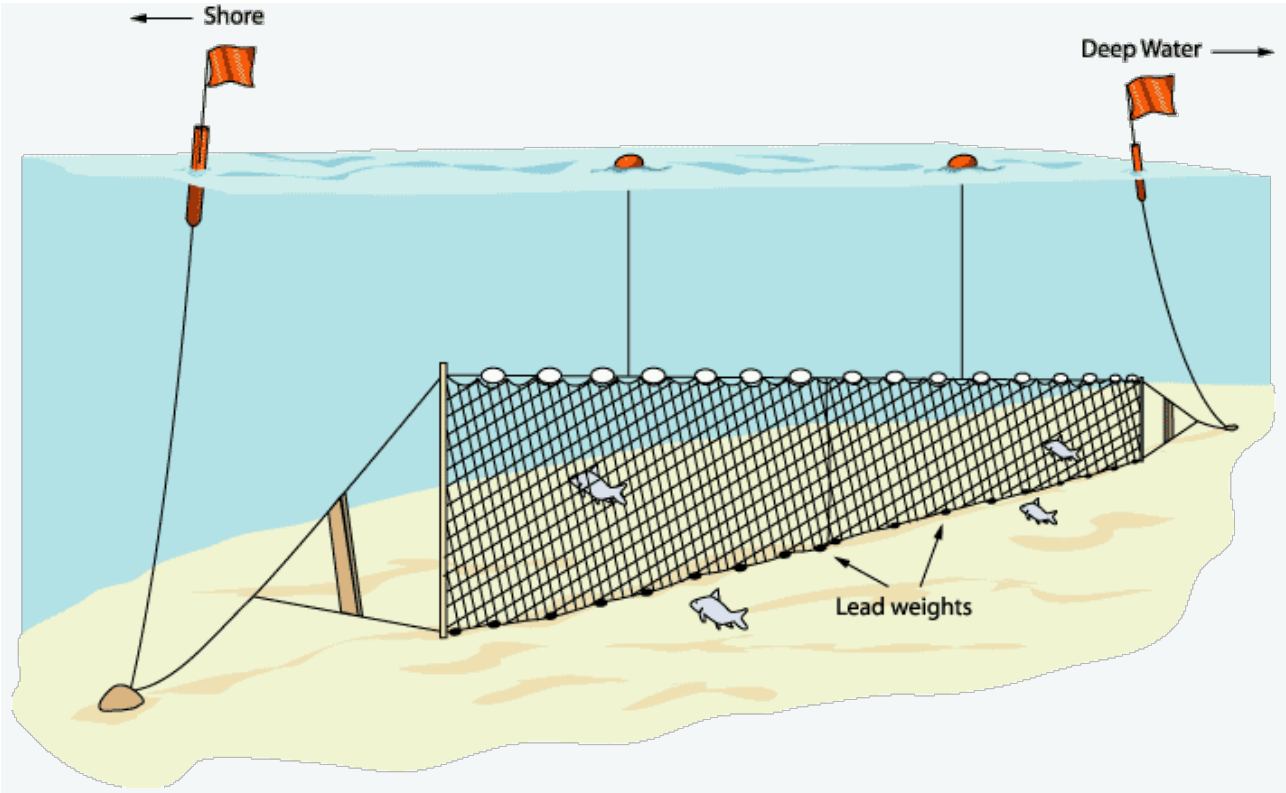
Depiction of trapnets as deployed throughout the Great Lakes. Image from Michigan Seagrant.

MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Low Concern

Gillnetting is restricted to tribal fisheries in Lake Michigan where it is the preferred fishing method. Gillnets are primarily utilized for lake whitefish, yellow perch and walleye fisheries. Lake trout are sometimes taken as incidental harvest. Impacts of gillnets on the lake bottom are expected to be limited to the impact of anchors on the substrate and minimal amounts of scouring during setting and hauling nets (fig. 1, pers. comm., DNR, OMNR). Substrates are most often comprised of sand, rocky and coarse materials, silt, muck, or *dreissenid* mussels.

Justification:



Depiction of typical gillnet deployment in Great Lakes. Image provided by Michigan Seagrant.

Factor 4.2 - Mitigation of Gear Impacts

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

No Effective Mitigation

Impacts of commercial fishing gear on benthic substrate has not been fully assessed in Lake Michigan. However, gears utilized in Lake Michigan are not believed to significantly impact benthic substrate and as such, mitigation strategies for negative impacts are non-existent. The benthic substrate of Lake Michigan is generally soft substrate, devoid of hard structure which may be damaged by gear placement. In areas deemed spawning or nursery areas (where such hard substrate may exist) fishing gear is rarely, if ever placed as such areas are recognized as vital to commercially valuable species such as lake whitefish (pers. comm. OMNR, DNR).

Factor 4.3 - Ecosystem-Based Fisheries Management

MICHIGAN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
MICHIGAN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA
WISCONSIN / LAKE MICHIGAN, SET GILLNETS, UNITED STATES OF AMERICA

Low Concern

This fishery is given a 'low' score for this category because scientific assessments and management efforts to account for ecological roles of targeted species are underway, policies are in place to protect 'exceptional species', hatchery supplementation practices are designed with the entire ecosystem in mind and to minimize

negative ecological or genetic impacts, and invasive/non-native species control and policies are in place. (Bunnell, D. B. 2012), (Dexter et al. 2011), (Ebner et al 2008), (GLFC 2007), (Lake Michigan Fisheries Team 2004). See details below.

The GLFC currently implements an Ecosystem Based Fisheries Management (EBFM) strategy (GLFC 2007). The Joint Strategic Plan for Management of the Great Lakes explicitly calls for an Ecosystem-Management Strategy as one of four agreed upon strategies recognized by the GLFC. The policy was adopted for 2 main reasons: 1) Fisheries managers realize that the Great Lakes are all intimately connected and if something negatively impacts ones there is a high likelihood that it will affect the others, 2) the Great Lakes commercial fishing industry is comprised of multi-species of interests with each currently existing in a different state of conservation concern and requiring different management efforts to recovery. As such, targeted fish stocks and status are continually monitored and recommendations on harvest restrictions are made to reflect current stock conditions.

Status of fish stocks and ecosystems, current management efforts, and future recommendations for Lake Michigan are detailed in the latest, "State of Lake Michigan Report" (2012), which was created to provide a progress report with supporting information to help meet fish-community objectives that were set and revised in the 1998 Joint Strategic Plan for the Management of Great Lakes Fisheries set by the GLFC and mentioned above ((Bunnell, D. B. 2012)). Furthermore, tailored specifically to Lake Michigan, is the, "Lake Michigan Integrated Fisheries Management Plan 2003-2013" (Lake Michigan Fisheries Team (LMFT), which is a guide for the management of recreational and commercial fisheries within Lake Michigan from 2003-2013 and states, "On the commercial fishing side, we have over the past 25 years moved toward a smaller and better regulated commercial fishery targeting five species – lake whitefish, yellow perch, round whitefish, rainbow smelt, and bloater chubs. Commercial fishing management is built on three principles – annual harvest limits, limited entry, and individual transferable quotas." (Lake Michigan Fisheries Team 2004).

Lake trout are considered an 'exceptional species'. Prior to their collapse, lake trout were the dominant, apex predator in the mid to deep water zones throughout the Great Lakes. Their collapse (which was facilitated by the spread of invasive sea lampreys, and anthropogenic influences such as over harvest and habitat alteration) laid open the Great Lakes to be infiltrated by a host of other invasives such as the alewife and rainbow smelt. The lake trouts role as a keystone species has generated strong support for their restoration ((He et al. 2012),(OMNR 2012)).

As an exceptional species, lake trout are closely monitored and the ecological interactions existing between Lake Trout and its surrounding ecosystem are a subject of great concern and consideration for managers throughout the Great Lakes. A basin-wide rehabilitation effort is currently underway which attempts to fully understand the lake trout ecological role in an effort to help restore the stocks. In Lake Michigan, there is no evidence for a self-sustaining Lake Trout population and Sea Lamprey predation is cited as a main cause of Lake Trout death and a major impediment to population growth. In response, a Great Lakes Sea Lamprey Control Plan was created. Furthermore, sea lamprey control via increases and improvements to lampricide control efforts has lead to a decrease in Sea Lamprey abundance and Lake Trout markings (Bunnell, D. B. 2012). Furthermore, there is, "A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan", which includes comprehensive stocking strategies, lamprey control, and harvest control. These strategies take into account genetics and stocking impacts on food web and ecosystem. (Dexter et al. 2011).

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

We would like to thank Lloyd Mohr, Jim Hoyle, David McLeish (Ontario Ministry of Natural Resources), and David Fielder (Michigan Department of Natural Resources) for graciously reviewing this paper for scientific accuracy. We would also like to thank Jeremiah Johnson (University of Michigan) for his contributions to the Lake Michigan report.

Seafood Watch would like to thank and six anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

Beamish, F. W. H., et al. 2001. Strategic Vision of the Great Lakes Fishery Commission for the First Decade of the New Millennium. Ann Arbor, MI, Great Lakes Fishery Commission.

Bronte, C. R., C. C. Krueger, M. E. Holey, M. L. Toneys, R. L. Eshenroder, and J. L. Jonas. 2008. A guide for the rehabilitation of lake trout in Lake Michigan. Great Lakes Fisheries Commission Miscellaneous Publication, (2008-01).

Bunnell, David B., Charles P. Madenjian, Timothy J. Desorcie, Melissa J. Kostich, Kelley R. Smith, and Jean V. Adams. Status and Trends of Prey Fish Populations in Lake Michigan, 2012. Rep. Ann Arbor: USGS, GLSC, 2013. Print. Lake Michigan Committee.

Bunnell, D.B. [ED.]. 2012. The state of Lake Michigan in 2011. Great Lakes Fish. Comm. Spec. Pub. 12-01.

Modeling Subcommittee, Technical Fisheries Committee. 2012. Technical Fisheries Committee Administrative Report 2012: 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 2012.

CORA. 2007. "Treaties and Court Decisions." Chippewa Ottawa Resources Authority, from http://www.1836cora.org/treaiescour.html.

Dexter, Jr., James L., Bradley T. Eggold, Thomas K. Gorenflo, William H. Horns, Steven R. Robillard, and Stuart T. Shipman. A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan. Rep. N.p.: Lake Michigan Committee, GLFC, 2011. Print.

DNR Website. 2005. Protecting the Great Lakes fishery through law enforcement. http://www.michigan.gov/dnr/0,4570,7-153-10366_46403_63473-122152--,00.html

Ebener, Mark P., Ronald E. Kinnunen, Philip J. Schneeberger, Lloyd C. Mohr, James A. Hoyle, and Paul Peeters. "International Governance of Fisheries Ecosystems Chapter 4 - Management of Commercial Fisheries for Lake Whitefish in the Laurentian Great Lakes of North America." American Fisheries Society (2008): 99-143. Web

Eshenroder, R. L., M. E. Holey, T. K. Gorenflo, and R. D. Clark. 1995. Fish community objectives for Lake Michigan. Great Lakes Fisheries Commission Special Publication, (95-3).

Froese, R., & Pauly, D. 2012. Editors. Fishbase. www.fishbase.org

GLFC. 2007. A joint strategic plan for management of Great Lakes fisheries (adopted in 1997 and supersedes 1981 original). Great Lakes Fish. Comm. Misc. Publ. 2007-01. Available at http://www.glfc.org/fishmgmt/jsp97.pdf

GLFC Website. 2014. Law Enforcement Committee. http://www.glfc.org/boardcomm/lawenforce/lawenf.php

GLIFWC. 2007. "The Great Lakes Indian Fish & Wildlife Commission." from http://www.glifwc.org/.

Goforth, R. R. 2000. Special Animal Abstract for Acipenser fulvescens (Lake Sturgeon). Michigan Natural Features Inventory. Lansing, MI. 4 pp.

Hansen, Scott. Lake Michigan Management Report -2013. Lake Whitefish. Rep. N.p.: Lake Michigan Fisheries Team, Wisconsin DNR, 2013. pg. 53-58.

Lake Michigan Fisheries Team. Lake Michigan Integrated Fisheries Management Plan 2003-2013. Rep. no. 56. N.p.: Bureau of Fisheries Management and Habitat Protection, Wisconsin Department of Natural Resources, 2004. Print.

Pickering, E. 2010. Great Lakes commercial fishing: Success through partnership. US Coast Guard Proceedings: Winter 2010-11. www.uscg.mil/proceedings.

Siira, A., P. Suuronon, E. Ikonen, and J. Erkinaro. 2006. Survival of Atlantic salmon captured in and released from a commercial trap-net: Potential for selective harvesting of stocked salmon. Fisheries Research, 80: 280-294.

Threader, R. W., and C. S. Broussaeu. 1986. Biology and management of the lake sturgeon in the Moose River, Ontario. North American Journal of Fisheries Management. 6: 383-390.

Wisconsin Department of Natural Resources. 2013. Lake Michigan management reports, Lake Michigan Fisheries Team: Wisconsin Department of Natural Resources.