

Monterey Bay Aquarium Seafood Watch®

Common Carp Roe

Cyprinus carpio



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United States of America: Great Lakes

Seine nets, Barriers, fences, weirs, corrals, etc.

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Seafood Watch Consulting Researcher

Disclaimer

Seafood Watch and The Safina Center strive to ensure that all our Seafood Reports and recommendations contained therein are accurate and reflect the most up-to-date evidence available at the time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or of The Safina Center or their recommendations on the part of the reviewing scientists. Seafood Watch and The Safina Center are solely responsible for the conclusions reached in this report. We always welcome additional or updated data that can be used for the next revision. Seafood Watch and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation and other funders.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

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About The Safina Center

The Safina Center (formerly Blue Ocean Institute) translates scientific information into language people can understand and serves as a unique voice of hope, guidance, and encouragement. The Safina Center (TSC) works through science, art, and literature to inspire solutions and a deeper connection with nature, especially the sea. Our mission is to inspire more people to actively engage as well-informed and highly motivated constituents for conservation.

Led by conservation pioneer and MacArthur fellow, Dr. Carl Safina, we show how nature, community, the economy and prospects for peace are all intertwined. Through Safina's books, essays, public speaking, PBS television series, our Fellows program and Sustainable Seafood program, we seek to inspire people to make better choices.

The Safina Center was founded in 2003 by Dr. Carl Safina and was built on three decades of research, writing and policy work by Dr. Safina.

The Safina Center's Sustainable Seafood Program

The Center's founders created the first seafood guide in 1998. Our online seafood guide now encompasses over 160-wild-caught species. All peer-reviewed seafood reports are transparent, authoritative, easy to understand and use. Seafood ratings and full reports are available on our website under Seafood choices. tsc's sustainable seafood program helps consumers, retailers, chefs and health professionals discover the connection between human health, a healthy ocean, fishing and sustainable seafood.

- Our online guide to sustainable seafood is based on scientific ratings for more than 160 wild-caught seafood species and provides simple guidelines. Through our expanded partnership with the Monterey Bay Aquarium, our guide now includes seafood ratings from both The Safina Center and the Seafood Watch[®] program.
- We partner with Whole Foods Market (WFM) to help educate their seafood suppliers and staff, and provide our scientific seafood ratings for WFM stores in the US and UK.
- Through our partnership with Chefs Collaborative, we created Green Chefs/Blue Ocean, a free, interactive, online sustainable seafood course for chefs and culinary professionals.
- Our website features tutorials, videos, blogs, links and discussions of the key issues such as mercury in seafood, bycatch, overfishing, etc.

Check out our Fellows Program, learn more about our Sustainable Seafood Program and Carl Safina's current work at www.safinacenter.org .

The Safina Center is a 501 (c) (3) nonprofit organization based in the School of Marine & Atmospheric Sciences at Stony Brook University, Long Island, NY. www.safinacenter.org admin@safinacenter.org | 631.632.3763

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 Watch Assessment. Each assessment 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." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, 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 assessments 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 Watch assessments in any way they find useful.

Guiding Principles

The Safina Center and Seafood Watch define sustainable seafood as originating from sources, whether fished¹ 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 and the Safina Center have developed four sustainability **criteria** for evaluating wild-catch 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 the Safina Center's 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

This report is for common carp (*Cyprinus carpio*), which is captured in the Great Lakes (primarily Lake Erie) with trap nets and seines, primarily for its roe. This report focuses primarily on the US side of Lake Erie, which lands 92% of all Great Lakes common carp.

Common carp are introduced to the Great Lakes, and because they are non-native, concern over abundance and fishing mortality are rated as "very low" and "low" concern, respectively.

The trap net and seine fisheries are multi-species fisheries. The trap net fishery also lands channel catfish, white bass, and freshwater drum, for which limited data exist on abundance and fishing mortality. Yellow and white perch are also landed by traps with common carp, but abundance is above, and fishing mortality is below benchmarks. The seine net fishery lands some of the same species, but gizzard shad (young-of-the-year), an important forage species does not have appropriate management reference points in place. No endangered or threatened species are routinely encountered in these fisheries.

Total allowable catches (TACs) are allocated for some, but not all, of the species in this fishery. Key reference points for species in this fishery still need to be developed, harvest is the primary means by which non-native species abundance is kept in check, and it's unlikely that the fishery is having serious negative impacts on retained native species. Additionally, there are limited measures in place to control the population of invasive common carp.

Seine and trap nets have some contact with the bottom, but this is low to moderate. The seine net fishery receives a reduction in ecosystem impacts due to limited data on forage fish species caught within the fishery.

The trap net fishery in Lake Erie scores "green" or "Best Choice," and the seine net fishery scores "yellow" or "Good Alternative."

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
Common carp United States of America Great Lakes, Barriers, fences, weirs, corrals, etc., United States of America	Green (5.000)	Yellow (2.644)	Yellow (3.000)	Green (3.464)	Best Choice (3.423)
Common carp United States of America Great Lakes, Seine nets (unspecified), United States of America	Green (5.000)	Red (1.526)	Yellow (3.000)	Green (3.464)	Good Alternative (2.984)

Summary

Common carp (Cyprinus carpio) has a worldwide distribution due to purposeful introduction, but it is native to Europe and Asia. This assessment covers the fisheries in the Great Lakes for carp roe; the majority of landings come from Lake Erie. This report covers two kinds of fishing gear; trap nets and seine nets, which are used in shallow marsh and beach habitats, respectively. The fishery catches small species, including forage fish, as bycatch, but undersized and undesired species are generally released alive.

Common carp caught with trap nets is considered Green/"Best Choice" due to limited bycatch and little to no impacts on the environment. Common carp caught with seine nets are considered Yellow/"Good Alternative" due to potential co-landings/bycatch of important forage fish species for which management could be improved.

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 either Criterion 1 or Criterion 3 (or both) is Green, 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 Concern2, 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 assesses the sustainability of the Great Lakes fisheries for common carp (*Cyprinus carpio*), which may be harvested for its roe. The majority of commercial catches come from western Lake Erie, with small landings from Lake Huron (Michigan) and the Ontario portion of Lake Erie. This assessment covers common carp caught with trap nets and seines.

Species Overview

Common carp, *Cyprinus carpio*, is a benthic fish in the family Cyprinidae (carps and minnows) (Froese and Pauly 2018). It was introduced to the United States in the mid-1800s and then spread rapidly; generally, it is considered a nuisance species (Nico et al. 2018). It is found in every state with the exception of Alaska and can live in moderate- to heavily-polluted bodies of water. Its native range spans across Europe and Asia, but has been spread extensively across the globe to Australia, Africa, and Central and South America. It inhabits shallow, warm freshwater and prefers muddy and vegetated habitat for spawning and feeding. Adults mature at 1 to 4 years and 25 to 36 cm (Froese and Pauly 2018). Females spawn by laying eggs on vegetation and more than one million eggs can be produced in a year (Nico et al. 2018) (Froese and Pauly 2018). They are considered problematic in some habitats where they have been introduced because they uproot vegetation during feeding and increase the turbidity of the environment; this affects native fish, invertebrates, and plant species (Kowalski et al. 2014) (LEHTG 2017).

The Great Lakes Fishery Commission oversees fisheries in the Great Lakes and includes partners from each neighboring state and the province of Ontario, Canada (GLFC 2018). The Lake Erie Committee is composed of members of Michigan, New York, Ohio, Pennsylvania, and Ontario. In the US, where most carp is landed, commercial fishing is actively managed by each state through respective departments of natural resources (e.g., Ohio Department of Natural Resources).



Figure 1 Management structure for fisheries in the Great Lakes. Available at: http://www.glfc.org/joint-strategic-plan-committees.php

Production Statistics

The majority of common carp caught in the Great Lakes originate from US landings in Lake Erie; approximately 5% of the US landings come from Lake Huron, specifically Saginaw Bay (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). Only 3% of all carp from the Great Lakes are landed in the Canadian portion of Lake Erie (Ontario Province). Seine nets represent about 56% of landings in Lake Erie, and trap nets represent 44% (ODW 2018). Great Lakes harvest averaged 514,000 lb between 2007 and 2016 at a value averaging USD 122,000 (NOAA 2018).

Importance to the US/North American market.

Most common carp from the Great Lakes are sold to processors or distributors in New York City; a majority are sold live and others are processed for their roe (pers. comm., T. Goniea 2018). Carp exports form the US averaged up to 1.82 million lb between 2012 and 2017 (NOAA 2018); this data is not species specific and also includes packaged fish like tilapia, catfish, eels, and snakehead, so the actual exports of common carp are difficult to discern. The US imports of the above aggregated products totaled 8.26 million lb in 2017 (NOAA 2018).

Common and market names.

Other names include German, European, mirror, and leather carp, or koi (Nico et al. 2018).

Primary product forms

Common carp roe is commonly sold preserved and salted in jars as "tarama." It is most frequently used to make a dip in Greek cuisine called "taramasalata" (or taramosalata).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the Species Under Assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. 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

COMMON CARP			
Region Method	Abundance	Fishing Mortality	Score
United States of America/Great Lakes Barriers, fences, weirs, corrals, etc. United States of America	5.00: Very Low Concern	5.00: Low Concern	Green (5.000)
United States of America/Great Lakes Seine nets (unspecified) United States of America	5.00: Very Low Concern	5.00: Low Concern	Green (5.000)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- 5 (Very Low Concern) Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.
- 3.67 (Low Concern) Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.
- 2.33 (Moderate Concern) Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.
- 1 (High Concern) Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- 5 (Low Concern) Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.
- 3 (Moderate Concern) Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.
- 1 (High Concern) Probable that fishing mortality from all source is above a sustainable level.

COMMON CARP

Factor 1.1 - Abundance

UNITED STATES OF AMERICA/GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA/GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Very Low Concern

Common carp, *Cyprinus carpio*, are native to Eurasia, and were likely introduced to the United States in the mid 1800s (Nico et al. 2018). Because they are non-native, we have awarded a score of "very low" concern.

Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

UNITED STATES OF AMERICA/GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Low Concern

Because carp have been introduced to the Great Lakes, fishing mortality is automatically rated "low" concern.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. 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. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait 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 is Critical if Factor 2.3 (Fishing Mortality) is Critical

Guiding Principles

- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable level.
- Minimize bycatch.

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.

COMMON CARP - UNITED STATES OF AMERICA/GREAT LAKES - BARRIERS, FENCES, WEIRS, CORRALS, ETC UNITED STATES OF AMERICA								
Subscore:	2.644		Discard Rate:		1.00	C2 Ra	te:	2.644
Species		Abu	Indance	Fishing	g Mortality		Subscore	
Channel Catfish		2.33	3:Moderate Concern	3.00:N	loderate Co	ncern	Yellow (2.6	44)
White bass		2.33: Moderate Concern		3.00: Moderate Concern			Yellow (2.6	44)
Freshwater drum		2.33	3:Moderate Concern	3.00:N	Ioderate Co	ncern	Yellow (2.6	44)
Yellow perch		3.67	7:Low Concern	5.00:L	ow Concern		Green (4.28	34)
White perch		5.00):Very Low Concern	5.00:L	ow Concern		Green (5.00)))

Common Carp - UNI Of America	TED STAT	TES C	OF AMERICA/GREAT LA	AKES - S	SEINE NETS	(UNSPE	CIFIED) - UN	NITED STATES
Subscore:	1.526		Discard Rate:		1.00	C2 Ra	te:	1.526
Species		Abu	Indance	Fishing	g Mortality		Subscore	
Gizzard shad		2.33	3:Moderate Concern	1.00:+	ligh Concerr	า	Red (1.526)

Channel Catfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)
Freshwater drum	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)
Bigmouth buffalo	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

Species included in Criterion 2 were included based on commercial landing data of species caught with carp. Because this is a multi-species fishery that most often targets species other than common carp, any species that contributes 5% or more of landings for a given gear were included. Specifically, we used landings data from Lake Erie because 95% of the common carp landed come from Lake Erie (5% from Lake Huron; (pers. comm., T. Goniea 2018). Also, only 3% of total Great Lakes common carp landings come from Canada, so bycatch was based solely on Lake Erie, US landings. No threatened or endangered species are routinely encountered in the seine or trap net fisheries.

Data on commercial landings for each gear type were provided by Brian Schmidt, Ohio Dept. of Natural Resources (3/29/18). Additional discussions with Tom Goniea, MI DNR were used to determine potential bycatch species by gear and whether species like endangered or threatened sturgeon should be included; sturgeon were excluded because interactions with these gear are very limited in fisheries surveys with similar gear and survival would be expected to be very high (pers. comm., T. Goniea 2018). Potential bycatch species were also discussed with Eric Weimer, Ohio Dept. of Natural Resources (pers. comm., E. Weimer 2018) and Ronald Kinnunen of MI SeaGrant (pers. comm., R. Kinnunen 2018). When assessing abundance and fishing mortality of other species, the focus was placed on Ohio DNR abundance surveys for western Lake Erie, since this is where the majority of the carp harvest comes from in Lake Erie (pers. comm., T. Goniea 2018). More detailed estimates of abundance can be found in New York waters of Lake Erie, but minimal carp landings are reported from the eastern portion of Lake Erie (ODW 2017).

The trap net fishery score for Criterion 2 is determined by channel catfish, freshwater drum, and white bass, which all had an equally moderate score due to minimal information available on their abundance and fishing mortality.

Gizzard shad is the limiting score in the seine net fishery due to its role as a forage fish in Lake Erie. Even though other species of forage fish (as defined by the Lake Erie Forage Task Group) are caught in the trap and seine fishery, only gizzard shad closely meets most of the criteria for forage fish from the Lenfest Forage Fish Task Force report (listed below from (Pikitch et al. 2012)), which is used in our assessments. This forage species is considered the "cornerstone for piscavore production in western Lake Erie" (Hartman 1998), whereas white bass, yellow perch, and freshwater drum are only a pathway for energy during their juvenile stage. Additional available information on LEFTG forage species as they relate to the Lenfest definition is listed in the table below; cells are left blank when information is unavailable.

1) Forage fish provide the main pathway for energy to flow from very low trophic levels—plankton—to higher trophic levels—predatory fish, birds, and mammals. They transfer a large proportion of energy in the ecosystem and support or regulate a variety of ecosystem services.

2) Few species are in this trophic role in marine food webs, but they are the largest vertebrate component of each system by number and weight.

3) Forage fish retain their unique role in the food web from egg to adult.

4) Forage fish can experience rapid population expansion because of their relatively small body size, fast growth, early maturity, and relatively high fecundity. However, their short life span can also lead to sudden population collapse when adult mortality rates are high.

5) Forage fish population size is usually strongly environmentally driven and may exhibit large annual, interannual, or decadal-scale fluctuations

6) Forage species usually form dense schools, making them highly accessible to fishing.

			Lenfest Forage Species Criteria (from above)					
Forage fish according to LEFTG	Comments (trophic level from fishbase.org)	1	2	3	4	5	6	Reference(s)
Gizzard shad	Feeds on plankton and detritus throughout life (2.4)	~	х	1	1	1	~	(Michaletz 2012) (Porath 2006) (LEFTG 2018)
White bass	Adults piscivorous (4.0). Population size at least partially driven by white perch abundance	x	x	x	x	~	~	(Hamilton and Nelson 1984) (Madenjian et al. 2000) (Ahrens et al. 2010)
Yellow perch	Adults piscivorous (3.7)	х	х	х	1	х	~	(Santucci et al. 2014) (LEFTG 2018)
Freshwater drum	Adults omnivorous (3.4)		х	х			~	(Sluss 2006)
White perch	Non-native	-	-	-	-	-	-	

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

CHANNEL CATFISH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderate Concern

Channel catfish, *Ictalurus punctatus*, has been assessed by the IUCN as "Least Concern" (NatureServe 2013). There are no quantitative stock assessments for channel catfish in the Great Lakes. In Lake Erie, abundance for channel catfish is collected in a smallmouth bass gillnet survey by the Ohio DNR, but these methods are too limited to make quantitative conclusions about population trends (pers. comm., E. Weimer, ODNR 2018). Because data on abundance is limited, but the species is listed as "Least Concern," we have awarded a score of "moderate" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderate Concern

Channel catfish fishing mortality is unknown for Lake Erie. Harvest rates have been consistent or have increased in western Lake Erie, where the majority of common carp are harvested, over the past decade (2007 to 2016), but to what extent this contributes to mortality to the population is not quantified (ODW 2017) (Thomas et al. 2016). Because fishing mortality is unknown, we have awarded a score of "moderate" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 100%

The majority of trap net bycatch studies focus on commercially valuable cold to warm-water trap net fisheries that exist in deeper water for species like walleye and lake trout, so little information is available for fisheries that target shallow and warm environments where carp are found. These studies focusing on deep water trap netting indicate that bycatch and mortality rates are substantially lower than gill netting and mortality rates are well below 100% (Johnson et al. 2004)(MacMillan and Roth 2012) (Raby et al. 2011).

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

< 100%

Seine and trap nets must have a relatively large (3.5 in or larger) mesh size in Lake Erie, so larger adult fish are targeted. Undesired species are often released alive, and post-release survival may be generally high (ODNR 2017) (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). Studies in other systems have demonstrated generally low discard mortality in seine net fisheries (<<100%; (Gray and Kennelly 2003) (Uzer et al. 2017)). There is potential interaction with species like endangered or threatened sturgeon, but these interactions are rare and there is no indication that sturgeon are released moribund or dead (pers. comm., T. Goniea 2018). It is highly likely that discard rate/landings do not exceed 100%.

FRESHWATER DRUM

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Freshwater drum, *Aplodinotus grunniens*, (also known as sheepshead or sheephead) is considered by the IUCN to be a species of "Least Concern" (NatureServe 2013c). No quantitative stock assessments have been performed and its abundance is variable in surveys (ODW 2017).

In Lake Erie, freshwater drum at age-0 is considered a forage fish species, and is often grouped in with other spiny-rayed species like white perch and bass. Spiny-rayed forage species in western Lake Erie have been increasing in biomass between 1995 and 2017, with generally consistent abundance (LEFTG 2018), but freshwater drum have seen a decline in abundance between 2013 and 2016 in western Lake Erie; the decline was observed across assemblages (predators, forage fishes, and large benthic species) (USGS 2018). However, because abundance of freshwater drum has not been quantified relative to target reference points, we have awarded a score of "moderate" concern.

Justification:



Figure 2 Lake Erie forage fish time series. Note, due to their small size and contribution to the diet of piscivorous fish, age-0 spiny-rayed fishes are presented here. From: LEFTG 2018.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

Freshwater drum fishing mortality is unknown for Lake Erie. Commercial harvest rates have increased in Lake Erie in the last decade, but there are no obvious signs of decline in some data-limited surveys of abundance (ODW 2017) over the past decade (2007 to 2016). However, because fishing mortality has not been quantified, we have awarded a score of "moderate" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

< 100%

Seine and trap nets must have a relatively large (3.5 in or larger) mesh size in Lake Erie, so larger adult fish are targeted. Undesired species are often released alive, and post-release survival may be generally high (ODNR 2017) (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). Studies in other systems have demonstrated generally low discard mortality in seine net fisheries (<<100%; (Gray and Kennelly 2003) (Uzer et al. 2017)). There is potential interaction with species like endangered or threatened sturgeon, but these interactions are rare and there is no indication that sturgeon are released moribund or dead (pers. comm., T. Goniea 2018). It is highly likely that discard rate/landings do not exceed 100%.

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 100%

The majority of trap net bycatch studies focus on commercially valuable cold to warm-water trap net fisheries that exist in deeper water for species like walleye and lake trout, so little information is available for fisheries that target shallow and warm environments where carp are found. These studies focusing on deep water trap netting indicate that bycatch and mortality rates are substantially lower than gill netting and mortality rates are well below 100% (Johnson et al. 2004)(MacMillan and Roth 2012) (Raby et al. 2011).

WHITE BASS

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

White bass, *Morone chrysops*, is considered by the IUCN to be a species of "Least Concern" (NatureServe 2013d). No quantitative stock assessments have been performed. It experienced a sharp decline in recruitment in the 1980s, likely due to the establishment of a competitor, white perch (Madenjian et al. 2000). In 2017, it experienced a large increase in abundance relative to past years, as evidenced by survey data (ODW 2017).

In Lake Erie, it is considered a forage fish species, and is often grouped in with other spiny-rayed species like perch and drum. Spiny-rayed forage species in western Lake Erie have been increasing in biomass between 1995 and 2017, with generally consistent abundance, although white bass generally make up a small proportion of the spiny-rayed abundance in this survey (LEFTG 2018). However, because abundance of white bass has not been quantified relative to target reference points, we have awarded a score of "moderate" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Moderate Concern

White bass fishing mortality is unknown for Lake Erie. Commercial harvest rates have been relatively consistent in Lake Erie in the last decade, and there are no obvious signs of decline in some data-limited surveys of abundance over the past decade (2007 to 2016, (ODW 2017)). Because fishing mortality has not been quantified, we have awarded a score of "moderate" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 100%

The majority of trap net bycatch studies focus on commercially valuable cold to warm-water trap net fisheries that exist in deeper water for species like walleye and lake trout, so little information is available for fisheries that target shallow and warm environments where carp are found. These studies focusing on deep water trap netting indicate that bycatch and mortality rates are substantially lower than gill netting and mortality rates are well below 100% (Johnson et al. 2004)(MacMillan and Roth 2012) (Raby et al. 2011).

GIZZARD SHAD

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderate Concern

Gizzard shad, *Dorosoma cepedianum*, is considered by the IUCN to be a species of "Least Concern." No quantitative stock assessments have been performed; its abundance is variable in surveys, but there is no obvious recent decline (ODW 2017).

In Lake Erie, it is considered a forage fish species that is important in the diet (>50%) of predator game fish like walleye (LEFTG 2018). For survey purposes, it is grouped in with other clupeids like alewife. Clupeid forage species in western Lake Erie have demonstrated relatively steady biomass between 1995 and 2017, with generally consistent abundance (LEFTG 2018) (Figure 3). Gizzard shad (age-0) abundance in surveys has been variable, with no indication of major decline (LEFTG 2018). However, due to the IUCN rating of "Least Concern," and because abundance of gizzard shad has not been quantified relative to target reference points, particularly since it is such an important forage species in Lake Erie, we have awarded a score of "moderate" concern.



Justification:

Figure 3 Gizzard shad (age-0) density in western Lake Erie. From: LEFTG 2018.



Figure 4 Lake Erie forage fish time series. Note, due to their small size and contribution to the diet of piscivorous fish, age-0 spiny-rayed fishes are presented here. From: LEFTG 2018.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

High Concern

Gizzard shad is an important forage species in the Great Lakes for predators like walleye and cormorants (LEFTG 2018). The only regulations for shad include mesh size requirements, but otherwise gizzard shad of all sizes may be taken (ODNR 2017). Gizzard shad populations are strongly impacted by winter temperatures, and die-offs are common (LEFTG 2018). Gizzard shad are also used as bait by recreational and commercial fishermen, but this has not been quantified.

No reference points for gizzard shad fishing mortality have been set in Lake Erie. Because of its importance as a forage fish and because it meets the qualifications for an "intermediate" level of information known about this species, its ecology and functioning in the system (Lenfest Forage Fish Task Force guidelines (Pikitch et al. 2012)), we have awarded a score of "high" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

< 100%

Seine and trap nets must have a relatively large (3.5 in or larger) mesh size in Lake Erie, so larger adult fish are targeted. Undesired species are often released alive, and post-release survival may be generally high (ODNR 2017) (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). Studies in other systems have demonstrated generally low discard mortality in seine net fisheries (<<100%; (Gray and Kennelly 2003) (Uzer et al. 2017)). There is potential interaction with species like endangered or threatened sturgeon, but these interactions are rare and there is no indication that sturgeon are released moribund or dead (pers. comm., T. Goniea 2018). It is highly likely that discard rate/landings do not exceed 100%.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- 5 (Very Low Concern) Meets the standards of 'highly effective' for all five factors considered.
- 4 (Low Concern) Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.
- 3 (Moderate Concern) Meets the standards for at least 'moderately effective' for all five factors.
- 2 (High Concern) At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'
- 1 (Very High Concern) Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'
- 0 (Critical) Management Strategy and Implementation is 'critical'.

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 = Red or High Concern

Rating is Critical if Management Strategy and Implementation is Critical.

GUIDING PRINCIPLE

The fishery is managed to sustain the long-term productivity of all impacted species.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: United States of America / Great Lakes Barriers, fences, weirs, corrals, etc. United States of America	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 2: United States of America / Great Lakes Seine nets (unspecified) United States of America	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)

Criterion 3 Assessment

Factor 3.1 - 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? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are

based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species. 23

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderately Effective

Great Lakes Fisheries Management

The Great Lakes Fishery Commission (GLFC) oversees fisheries in the Great Lakes and includes partners from each neighboring state and the province of Ontario, Canada (GLFC 2018). The GLFC provides a platform to coordinate research, quotas, and other management issues. Committees within GLFC help guide management as well. For instance, the Lake Erie Committee is responsible for recommending total allowable catch (TAC) of some species, while the state agencies allocate their share of the TAC. On-the-ground management is the responsibility of the Departments of Natural Resources for each state, and the Ontario Ministry of Natural Resources. Here, we consider management in Michigan and Ohio since they are the only states reporting landings of common carp (NOAA 2018). Michigan and Ohio Department of Natural Resources (MI DNR and ODNR) issue commercial fishing licenses, establish seasonal closures, set gear-specific regulations (e.g., minimum mesh sizes and maximum net lengths), and allocate TACs for certain species (ODNR 2017) (MI DNR 2018a). In both Ohio and Michigan, the commercial fishery is limited entry, and only fishers holding a license in the previous season or holders of a transferred license are eligible for a license (ODNR 2018b) (MI DNR 2018b). Fishers in the trap fishery are required to submit weight of all quota species immediately after each net is lifted, and weights of non-quota species must be entered before fishermen enter a different area (ODNR 2017) (MI DNR 2018b).

Species Specific Management

Carp are landed with other species in a multi-species fishery using trap nets and seines; licenses specify the type of gear used (MI DNR 2018a). The only species in this report with defined reference points is yellow perch, which is closely managed throughout Lake Erie (Markham and Knight 2017). There are several native species that are commonly caught with carp that are in need of abundance and/or fishing mortality reference points (such as B_{MSY} or F_{MSY}).

As an invasive species, common carp harvest is the primary strategy in place to control population abundance. Several ongoing projects help to restore degraded shallow water systems that carp have helped to degrade, but generally the primary goal of these projects is not common carp exclusion, which would contribute to limiting their spawning habitat (LEHTG 2017) (pers. comm., E. Weimer 2018). White perch is also a non-native species and is an unlimited catch species (Alderstein et al. 2015).

Key reference points for species in this fishery still need to be developed, harvest is the primary means by which non-native species abundance is kept in check, and it's unlikely that the fishery is having serious negative impacts on retained native species. Therefore, we have awarded a score of "moderately effective."

Justification:

Ohio General Law (ODNR 2017)

-Season: 1 March to 10 December for all gears, except the seine season from March 1 to June 14 and the first Wednesday following Labor Day to 10 December each year.

Unlawful to set nets within 1/4 mile of an island or mainland from 15 June through 15 September

-Unlawful to set nets within 1/4 mile of a reef from 1 March through 10 May

- -Set fishing gear may not be left unattended for more than five days
- -Unlawful to set nets on a reef at any time

-All undersized fish and species that cannot be taken commercially must be released immediately

-Other commercial fish that may be sold and possessed of any size are: alewife, American eel, bowfin, carp, sheepshead, gar, gizzard shad, lamprey, quillback, smelt, goldfish, suckers, buffalo, burbot and white perch; white perch may not be sold alive for stocking in inland waters.

-Minimum sizes (whole) for species in this report: yellow perch = 8.5 inches (in); channel catfish = 14.5 in; white bass = 11 in;

-Commercial fishing gear is not permitted in the following limited fishing zones of Lake Erie: Camp Perry Firing Area in Ottawa County; Ruggles Reef Area in Erie County; Maumee Bay Area and West Sister Area in Lucas County; Bass Islands Area in Ottawa County; Kelleys Island Area in Erie County (See special zone charts); between 15 May and 15 October in that portion of Lake Erie beginning 1/2 mile north of the Lakeside Association dock to a point 1/2 mile northeast of the Marblehead light to a point extending 1/2 mile off the Sandusky Pier light; in an area extending one mile offshore from the water tower of the Ford Plant located west of Lorain and running east to the east bank of the Chagrin River; and within four nautical miles of navigational lights located near the mouths of the rivers in the ports of Huron, Vermilion, Lorain, Cleveland, Fairport Harbor, Ashtabula, and Conneaut from 15 May to 15 October of each year. If Buoy J is not placed in the southwest corner of the Camp Perry fishing zone, then the Davis-Besse cooling tower will form the southwest corner

Ohio Trap net specifications (ODNR 2017)

-The backs of trap nets must be 1/4 in to 4 in stretched mesh.

- -Names and license tags must be displayed on the buoy
- -Vessel monitoring system (VMS) required
- -Electronic catch reporting required
- -Weight of quota species must be entered into catch reporting system after each net is lifted
- -Weight of non-quota species must be entered into catch reporting system before entering a different grid

Ohio Seine net specifications (ODNR 2017)

- -Minimum mesh size of 4 in for wings of seines
- -Minimum mesh size of 4 in when fishing in the Inland Fishing District
- -Maximum small mesh cannot exceed 350 ft in length, of which 200 ft cannot be less than 3 in mesh in the Lake Erie Fishing District
- -Names and license tags must be placed on the seine
- -Non-minnow seining restricted to daylight hours unless permission granted by the Sandusky office

Michigan Regulations (MI DNR 2018c)

-Minimum sizes (whole) for species in this report: yellow perch = 8.5 in; channel catfish = 12 in

- -Mesh size (traps) must be 3.5 in for trap nets targeting any fish except whitefish and lake trout -Minimum mesh size (seines) 2.25 in
- -Seines must be labeled with a metal tag

-DNR may issue provisions such as the amount of fish to be taken by species; areas in which the licensee is permitted to fish; season and depth specifications; methods and gears allowed

-Licensed fishers may only fish within a radius of 50 mi of the port specified in the license

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts. UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Highly Effective

The fisheries that catch common carp are generally considered multi-species fisheries that target different species depending on the time of year and commercial demand (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). There is likely to be minimal interaction with endangered or threatened species like lake sturgeon in shallow waters where carp are found (i.e., trap net fisheries in deeper waters that target walleye and lake trout are more likely to encounter sturgeon (OMNR 2009) [pers. comm., T. Goniea 2018]). Any lake sturgeon that may be caught are released alive in both fisheries and that bycatch is minimal (OMNR 2009) (pers. comm., T. Goniea 2018). No formal bycatch observation program exists, although some data on incidental catch is collected by wildlife officials. Because there is likely to be minimal bycatch mortality, we have awarded a score of "highly effective."

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderately Effective

Research and monitoring are overseen, in part, by the Great Lakes Fishery Commission (GLFC 2018). Carp, and the species commonly caught in the fisheries with carp such as channel catfish and freshwater drum, are monitored for abundance in yearly surveys, and landings in commercial and recreational fisheries (ODW 2017), but reference abundance points such as B_{MSY} are not commonly calculated for management decisions for many of these species. Yellow perch is one exception because fishing mortality reference points are calculated and applied yearly (Adlerstein et al. 2017) (LEYPTG 2018). Of the species caught in this multispecies fishery, yellow perch is the most well assessed and researched species because of its importance to commercial and recreational fisheries.

Common carp populations are assessed in abundance surveys, and indirectly by using landings data. However, these are not explicitly geared toward understanding abundance trends of this species, since it is non-native and has been in Lake Erie since the mid-1800s. Bycatch in this fishery is not monitored by observers because these gears are expected to have extremely low mortality (pers. comm., T. Goniea 2018). Data on landings are collected from monthly reports by fishers (ODNR 2017), but no observer program exists for these fisheries.

Because several of the species in this multi-species fishery are lacking accurate, scientifically driven stock assessments, but monitoring for bycatch (for example) is not likely necessary, we have awarded a score of "moderately effective."

Factor 3.4 - 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.

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Highly Effective

In the Great Lakes, state wildlife officers work with the U.S. Fish and Wildlife Service to enforce management regulations. In Lake Erie, specifically, commercial fishers must have appropriate permits, and regulations such as mesh size and proper documentation must be in order (ODNR 2017). The Ohio Division of Wildlife reported between 84 and 222 commercial inspections per year between 2011 and 2015, and violators are occasionally caught and prosecuted (ODW 2015). Additionally, when catch limits are in place as they are for yellow perch, these are generally not exceeded (LEYPTG 2018), indicating a well-enforced fishery. Wildlife officials also contribute to surveillance and enforcement of invasive species spread (ODW 2015). Because of these enforcement measures, we have awarded a score of "highly effective."

Factor 3.5 - 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, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Highly Effective

Management decisions in the Great Lakes are transparent, progressive, and include input by all stakeholders. The Great Lakes Fishery Commission holds open meetings and requests public input, as well as that of commercial and recreational fishers and scientific experts (GLFC 2018). Particularly valuable fisheries, such as those for percids (including yellow perch in Lake Erie) are committed to both educating and including stakeholders in the process of managing the fishery (ODW 2017)(LEYPTG 2018). The GLFC runs public meetings under a code of conduct designed to treat all stakeholders fairly and to allow them to contribute to the management process (GLFC 2018). These factors result in a score of "highly effective" for stakeholder inclusion.

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 (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 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
United States of America / Great Lakes / Barriers, fences, weirs, corrals, etc. / United States of America	3	0	Low Concern	Green (3.464)
United States of America / Great Lakes / Seine nets (unspecified) / United States of America	3	0	Low Concern	Green (3.464)

Criterion 4 Assessment

SCORING GUIDELINES

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

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- 5 Fishing gear does not contact the bottom
- 4 Vertical line gear
- 3 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. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.
- 2 Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.
- 1 Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
- 0 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 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- +1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.
- +0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.
- 0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- 5 Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.
- 4 Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.
- 3 Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.
- 2 Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.
- 1 Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.

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

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Trap nets and seines are set on muddy or sandy bottoms that may or may not be vegetated, and recovery time for vegetation is likely to be quick. Trap nets are set in place, and only part of the net is removed to collect fish (CFS OSU 2018). Seines are limited to 350 ft in length, and are fished in Lake Erie from spring through early summer (ODNR 2017), ensuring substantial time for recovery of vegetation.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Impacts of trap and seine nets in Lake Erie have not been assessed. Therefore, no mitigation measures exist.

Factor 4.3 - Ecosystem-Based Fisheries Management

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Low Concern

Lake Erie, and populations of fish therein, is managed as four basins with unique biological and physical properties, so spatial management is in place for many of the fish stocks (ODW 2017). The importance of forage fish is taken into consideration, as these species are monitored and assessed by the Lake Erie Committee Forage Task Group (LEFTG 2018). However, it is unclear at this point whether management measures are precautionary enough to ensure ecosystem functioning, since management bodies in Lake Erie have not implemented Ecosystem Based Fisheries Management, per se. Because forage stocks are generally considered healthy, it is unlikely that fishing pressure in Lake Erie is leading to adverse food web effects (LEFTG 2018).

Managers do collect data and monitor changes in habitat quality, trophic structure, and role of invasive species in Lake Erie and these are collectively included in management decisions that affect fisheries (LEFTG 2018) (LEHTG 2017) (Ryan 2006)(Treibitz and Hoffman 2015). There is a strong, multi-state effort to reduce or limit the spread of invasive species (particularly Asian carp species) to reduce potential ecosystem impacts (ODW 2017). Additionally, numerous projects are underway to restore degraded, adjacent wetland habitat (LEHTG 2017) (Ryan 2006) (Treibitz and Hoffman 2015), and top predator populations are considered improving in Lake Erie (Ryan 2006).

Together, these efforts suggest minimal concern over negative impacts to ecosystem functioning, but studies detailing the potential ecological and/or genetic impacts due to these fisheries are minimal. This results in a score of "low" concern.

Acknowledgements

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

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Appendix A: Extra By Catch Species

WHITE PERCH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Very Low Concern

White perch, *Morone americana*, are native to the North and mid-Atlantic region, and invaded the Great Lakes, establishing in Lake Erie in the 1980's (Fuller et al. 2018). Because they are non-native, we have awarded a score of "very low" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Because white perch are not native to the Great Lakes, fishing mortality is automatically rated "low" concern (Fuller et al. 2018).

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 100%

The majority of trap net bycatch studies focus on commercially valuable cold to warm-water trap net fisheries that exist in deeper water for species like walleye and lake trout, so little information is available for fisheries that target shallow and warm environments where carp are found. These studies focusing on deep water trap netting indicate that bycatch and mortality rates are substantially lower than gill netting and mortality rates are well below 100% (Johnson et al. 2004)(MacMillan and Roth 2012) (Raby et al. 2011).

YELLOW PERCH

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Yellow perch, *Perca flavescens*, is one of the most important commercial and recreational fisheries in the Great Lakes (LEFTG 2018). Yellow perch abundance is assessed under four separate management units in Lake Erie which correspond to semi-segregated basins with limited mixing of individual yellow perch among basins, and thus separate biological units (LEYPTG 2018). Biomass is stable or has increased, depending on the region, since the 1980s. An audit of the MSC-certified multi-species Lake Erie fishery, of which yellow perch is part, indicated that biomass for yellow perch remains above the biomass limit reference point (B_{LIM}) in at least three of the four MUs in recent years and that spawning stock biomass (SSB) is above

biomass limits (Adlerstein et al. 2017). Because abundance measurements are up-to-date and indicative of a healthy population in Lake Erie with the exception of uncertainty around one of the MUs, and the biomass of the western Lake Erie stock has been at least 75% of a potential TRP, we have awarded a score of "low" concern.

Justification:

An assessment of reference points between 2007 and 2012 indicated that spawning stock biomass at maximum sustainable yield (SSB_{MSY}) averaged 101% during this period in western Lake Erie (where most carp is landed) (Adlerstein et al. 2015). Yellow perch abundance has been generally high since then with the exception of equal to or lower than the 11 year mean (2007 to 2017) age-0 recruitment since 2013 in the western basin (LEFTG 2018). Biomass estimates in MU1 are fluctuating around the target biomass, indicating uncertainty for this MU (Adlerstein et al. 2017).



Figure 5 Yellow perch abundance estimates in Lake Erie for age 2 (dark bars) and ages 3+ (light bars) from the Yellow Perch Task Group (YPTG) model currently used to assess yellow perch for management purposes. Management Unit 1 covers western Lake Erie. Figure from YPTG 2018.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

Low Concern

Fishing mortality in Lake Erie for yellow perch is targeted at $1/2 F_{MSY}$ in each region and this target metric is designed to "support viable sport and commercial fisheries without inviting excessive biological risk" (LEYPTG

2018). Management in Lake Erie assesses abundance of Lake Erie perch, sets total allowable catches (TACs) based on the assessment, and TACs have not exceeded in the last decade, in part because quotas are lowered in response to years of poorer recruitment (Adlerstein et al. 2015) (Adlerstein et al. 2017) (LEYPTG 2018). Commercial fishing effort has generally decreased or has been stable over the past three decades, and the fishery is managed conservatively (LEYPTG 2018). Further analysis indicates that fishing pressure has not likely been strong enough to induce evolutionary changes to the population such as size or age at maturity (Gislason 2017). Together, these suggest that fishing pressure is below F_{MSY} and that fishing mortality is at or below a sustainable level. As a result, we have awarded a score of "low" concern.

Justification:



Figure 6 Lake Erie yellow perch population size estimates (1975 – 2013) in millions of fish (gray shading), harvest ratio (solid black line), instantaneous fishing mortality (F, year-1; solid gray line), exploitation ratio (black dashed line). From: Gislason 2017.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GREAT LAKES, BARRIERS, FENCES, WEIRS, CORRALS, ETC., UNITED STATES OF AMERICA

< 100%

The majority of trap net bycatch studies focus on commercially valuable cold to warm-water trap net fisheries that exist in deeper water for species like walleye and lake trout, so little information is available for fisheries that target shallow and warm environments where carp are found. These studies focusing on deep water trap netting indicate that bycatch and mortality rates are substantially lower than gill netting and mortality rates are well below 100% (Johnson et al. 2004)(MacMillan and Roth 2012) (Raby et al. 2011).

BIGMOUTH BUFFALO

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderate Concern

Bigmouth buffalo, *Ictiobus cyprinellus*, is listed by the International Union for the Conservation of Nature and National Resources (IUCN) as "Least Concern" (NatureServe 2013). The Ohio Department of Natural Resources (ODNR) and the New York State Department of Environmental Conservation (NYSDEC) perform annual abundance surveys of Lake Erie using trawl and gill nets (NYSDEC 2017) (ODW 2017), but these surveys do not measure absolute abundance and there is no stock assessment for this species. Because a stock assessment is lacking, but the IUCN considers this a species of "Least Concern," we have rated abundance as "moderate" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

Moderate Concern

Bighead buffalo fishing mortality has not been assessed. Landings have declined in recent years, reaching their lowest in 2016 (2007 to 2016); (ODNR 2017). Buffalo fish accounted for 10% of fish landed by commercial seine in Lake Erie in 2017 (ODNR 2018). Because fishing mortality is unknown, we have awarded a score of "moderate" concern.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GREAT LAKES, SEINE NETS (UNSPECIFIED), UNITED STATES OF AMERICA

< 100%

Seine and trap nets must have a relatively large (3.5 in or larger) mesh size in Lake Erie, so larger adult fish are targeted. Undesired species are often released alive, and post-release survival may be generally high (ODNR 2017) (pers. comm., E. Weimer 2018) (pers. comm., T. Goniea 2018). Studies in other systems have demonstrated generally low discard mortality in seine net fisheries (<<100%; (Gray and Kennelly 2003) (Uzer et al. 2017)). There is potential interaction with species like endangered or threatened sturgeon, but these interactions are rare and there is no indication that sturgeon are released moribund or dead (pers. comm., T. Goniea 2018). It is highly likely that discard rate/landings do not exceed 100%.