Sturgeon & Paddlefish (US)

White sturgeon (*Acipenser transmontanus*)
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)
Paddlefish (*Polyodon spathula*)

United States/Columbia River, Mississippi River Basin, Alabama River

Drift gillnets (driftnets)

Report ID 27933
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Seafood Watch Standard used in this assessment: Fisheries Standard v3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental 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. 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.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

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.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.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, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

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

Avoid/Red: Take a pass on these for now; they're caught or farmed 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 covers gillnet fisheries for white and shovelnose sturgeon and wild paddlefish in the United States. White sturgeon (*Acipenser transmontanus*), shovelnose sturgeon (*Scaphirhynchus platorhyncus*), and American paddlefish (*Polyodon spathula*) represent 3 of 27 species in 2 families in the order Acipensiformes that live exclusively in the Northern Hemisphere (25 sturgeon species and 1 paddlefish species; Chinese paddlefish was recently declared extinct {Qiwei 2022}). Although these species are a source of meat, they are most valued for their caviar: demand for black caviar has been responsible for heavy fishing pressure on Acipensiformes species for more than a century and into the present. Aquaculture surpassed wild fisheries in 2000 as the leading source of black caviar, and now accounts for >99% of the global supply. Although most black caviar sold in the past in the U.S. was produced domestically (with presumably a small contribution from U.S. fisheries and a larger proportion from farmed California sturgeon), recent trade data show a significant increase in U.S. imports of caviar/caviar substitute in 2020 and 2021, likely because of COVID-19 pandemic restrictions and increasing demand.

White sturgeon lives along the U.S. West Coast and primarily uses the Sacramento and Lower Columbia Rivers for reproduction. Harvest in California is limited to the sport fishery. Meanwhile, Oregon and Washington share management responsibility for fishing and conservation of white sturgeon in the Lower Columbia River (below Bonneville Dam), where a clearly defined conservation plan guides the recovery of the population and management of the commercial and sport fisheries. A commercial driftnet fishery occurs below the Bonneville Dam in the mainstem and off-channel sloughs and bays. There is also a tribal-treaty set gillnet fishery occurring above the Bonneville Dam (it is not covered in the scope of this assessment).

Fisheries are managed with strict size limits that are designed to exclude mature females, so the fisheries are not directed for caviar (following a nontreaty fisheries rule that prohibits the sale of sturgeon eggs) {OAR 2021}. When abundance is sufficient to allow consumption fisheries, 80% of the limited fishery is allotted to sport fishing and 20% to commercial harvest. In addition to harvest pressure, management addresses the impact of the dams along the river as well as the controversial problem of pinniped predation. Management focuses on allowing the population to recover from past heavy harvest pressure. Another emphasis is on excluding the green sturgeon (*Acipenser medirostris*), which is listed as "Threatened" under the Endangered Species Act (ESA), from bycatch as much as possible.

Shovelnose sturgeon is found in the Mississippi and Missouri Rivers and their tributaries. Although shovelnose sturgeon's range has constricted, the remaining populations are stable. Pallid sturgeon (*Scaphirhynchus albus*), which was listed as "Endangered" in 1990, has an overlapping range with shovelnose sturgeon, and the two species are difficult to tell apart. In addition, the two species can hybridize, which adds to the difficulties in differentiation and has been identified in the recovery plan as a potential threat {USFWS 2014}. Consequently, shovelnose sturgeon was listed as "Threatened" in 2010 to protect pallid sturgeon. As a result, commercial fisheries exist only in a handful of states where the species' ranges do not overlap.

Similarly, paddlefish once inhabited much of the Mississippi River basin, but its habitat is now more restricted—primarily along the fringes of its former range. River modification and overfishing have contributed to these declines. Paddlefish was also commercially fished in the Alabama River until a permanent closure was declared in 2018.

"Shovelnose sturgeon are typically fished for using smaller mesh nets that are not floated or trot lines (both of these gears are set so that they are right on the bottom of the river), whereas paddlefish are caught in larger mesh nets that are floated so that they set just under the surface of the water and target the upper portion of the water column. There may be a little bycatch of either species in these fisheries, but it is likely that the bycatch of either species while fishing for the other is minimal" (pers. comm., Sara Tripp, April 2023).

Studies on the population size and structure for both shovelnose sturgeon and paddlefish are limited; as a result, there is no uniform management approach built upon a shared and comprehensive understanding of species status. The Mississippi Interstate Cooperative Resource Association (MICRA) Sturgeon and Paddlefish Committee was created in 1992 to address the concerns of a species spanning multiple jurisdictions and facing similar threats. But, it is not a regulatory body, and only quite recently has MICRA been able to persuade all individual states to adopt some basin-wide rules and regulations {MICRA 2023}. There is a recommendation for the creation of a Mississippi River Basin Interstate Fishery Commission {Hupfeld et al. 2016}. "The majority of states are actively involved in MICRA and meet at minimum annually to discuss the management of paddlefish and shovelnose sturgeon and are continuing to develop more complementary regulations and management strategies every year. Additionally, a recent MICRA project, conducted by the commercial harvest states for paddlefish, suggests there could be differences in paddlefish population demographics based on location" (pers. comm., R. Hupfeld, Iowa Department of Natural Resources, 2022) {MICRA 2023}.

White sturgeon, shovelnose sturgeon, and paddlefish caught within the U.S. commercial gillnet fisheries are rated a Good Alternative.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Paddlefish | Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States	1.732	2.644	3.000	3.000	**Good Alternative (2.534)**	Unknown
Shovelnose sturgeon | Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States	1.732	2.644	3.000	3.000	**Good Alternative (2.534)**	Unknown
White sturgeon | Columbia River | America, North - Inland Waters | Drift gillnets | United States	3.413	1.732	3.000	3.000	**Good Alternative (2.701)**	Unknown

Summary

White sturgeon, shovelnose sturgeon, and paddlefish caught within the U.S. commercial gillnet fisheries are rated a Good Alternative. The assessed fisheries represent about 0.28% of the total U.S. production of these species in 2020 (the remainder of U.S. production is farmed).

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 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 analyzes U.S. domestic commercial fisheries that target sturgeon and paddlefish. Three fishery units are assessed: the Lower Columbia River drift gillnet fishery for white sturgeon (nontreaty commercial driftnets below Bonneville Dam), the Mississippi River basin set gillnet fishery for paddlefish, and the Mississippi River basin drift/pelagic gillnet fishery for shovelnose sturgeon. The previous version of this report included the Alabama River set gillnet fishery for paddlefish, but this fishery has been closed permanently for commercial harvest after the 2018 season, because of a lack of reliable fishery-dependent data from recent fishing seasons. Sport fishing for these species also occurs at these and other locations, including California (white sturgeon), Oklahoma (paddlefish), Montana (paddlefish), Nebraska (paddlefish), Iowa (shovelnose sturgeon and paddlefish), and South Dakota (paddlefish). This report assesses the commercial fisheries, but also accounts for the recreational fisheries in rating each of these three fishery units.

Species Overview

The three primary wild-caught sturgeon and paddlefish species in the United States are white sturgeon (*Acipenser transmontanus*), shovelnose sturgeon (*Scaphirhynchus platorhyncus*), and American paddlefish (*Polyodon spathula*), which is also referred to as spoonbill catfish. Each species belongs to the order Acipenseriformes, lives exclusively in the Northern Hemisphere, and reproduces in freshwater. White sturgeon is found from northern Baja California (Mexico) to the Gulf of Alaska (Love 1996), (Miller and Lea 1972) *apud* {Rosales-Casian and Ruz-Cruz 2005}. Shovelnose sturgeon inhabits parts of the Mississippi, Missouri, and Ohio River basins. The Mississippi, Missouri, and Ohio River basins and adjacent large tributaries are also home to the American paddlefish, as is the Alabama River.

Production Statistics

In the 19th century, the United States was the world's top caviar producer and exported black caviar—primarily from the Atlantic sturgeon (*A. oxyrinchus oxyrinchus*)—to Europe. Black caviar production in the United States plummeted in the early 1900s from a lack of effective management, and by the end of the 20th century, Russia had become the world's leading caviar trader. But, Russian stocks began to decline due to overharvest in the early 1900s and because of dams built on the Volga River and other sturgeon spawning streams in the 1960s (Pikitch et al. 2005).

In 2000, aquaculture surpassed wild fisheries as the leading source of black caviar, and aquaculture now accounts for >99% of the global black caviar supply. In 2020, China produced 57% of the world's sturgeon (all farmed), whereas product harvested in the United States accounted for 0.02% of the global sturgeon harvest (Table 1). Recent production values may have been affected by the COVID-19 pandemic, so pre-pandemic values (from 2019) are also displayed. Canada is the leading producer of wild sturgeon (92% of all wild production in 2019 and 37% in 2020), but the current abundance of sturgeon there is likely depleted in comparison to historic abundance (e.g., (McAdam et al. 2005)).

Table 1. 2019 and 2020 aquaculture and wild sturgeon production by the top 15 producing countries, plus all other countries combined (in metric tons) (FAO 2022); U.S. wild production available from NOAA Fisheries (NOAA Fisheries 2022c).

	2019				2020		
Country	**Aquaculture**	**Wild**	**Total**		**Aquaculture**	**Wild**	**Total**
China	102,042	—	102,042	China	104,280	—	104,280
France	28,868	—	28,868	United States	11,662	33	11,695
Lithuania	16,561	1	16,562	Italy	10,506	—	10,506
Kazakhstan	14,135	—	14,135	Lithuania	8,539	—	8,539
United States	11,662	31	11,693	Ukraine	7,919	—	7,919
Ukraine	9,709	—	9,709	Hungary	6,749	—	6,749
Romania	9,443	—	9,443	Estonia	5,026	—	5,026
Hungary	8,739	—	8,739	Russian Fed.	4,836	—	4,836
Bulgaria	4,511	—	4,511	Bulgaria	4,202	—	4,202
Russian Fed.	4,021	—	4,021	Armenia	4,200	—	4,200
Armenia	4,000	—	4,000	Latvia	3,844	—	3,844
Iran	2,516	13	2,529	Iran	2,640	20	2,660
Latvia	2,239	—	2,239	Vietnam	2,410	—	2,410
Vietnam	1,716	—	1,716	Greece	1,241	—	1,241
Canada	—	12,393	12,393	Canada	—	124	124
Others	6,073	1,021	7,094	Others	4,366	158	4,524
Total	**226,235**	**13,459**	**239,694**		**182,420**	**335**	**182,755**

As for the fisheries assessed in this report, the Columbia River commercial harvest of white sturgeon was at its lowest in 2015 since harvest records were first kept in the late 1800s, at less than one ton. This reflects both the persistent low abundance of Columbia River white sturgeon and strict harvest regulations that were put into place in 1989 (Jones and Mallette 2011). Also, in 2014, no commercial harvest or sport retention of white sturgeon below the Bonneville Dam was allowed, which has significantly curtailed the harvest in order to stimulate recovery (ODFW 2017a). Limited commercial retention of white sturgeon was reinstated in 2017 downstream of the Bonneville Dam, so landings have increased in the most recent years.

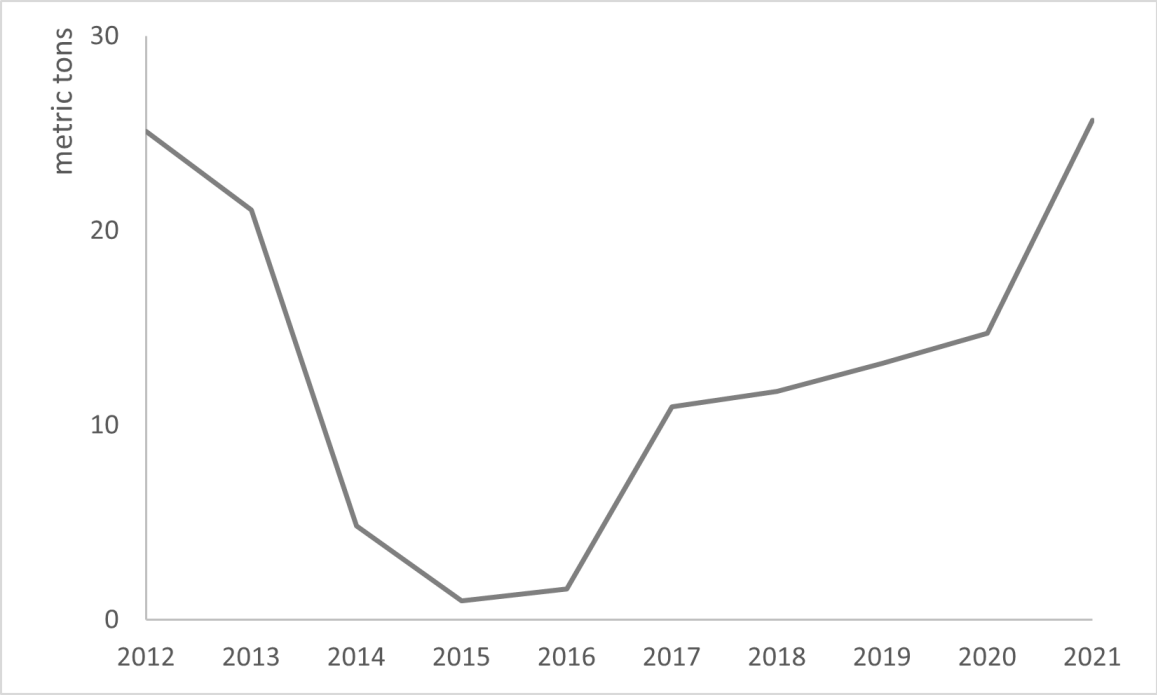

Figure 1: Commercial harvest of Columbia River white sturgeon, 2012–21, in metric tons (ODFW 2022).

There are five states with commercial harvest of Mississippi River basin shovelnose sturgeon and six states that commercially harvest paddlefish (the Alabama River paddlefish commercial fishery was permanently closed after the 2018 season, and harvest in the Mississippi River in the state of Minnesota was closed in 2022) (see Table 2). The Upper Mississippi River Conservation Committee (UMRCC) has compiled commercial harvest data for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri for both shovelnose sturgeon and paddlefish (the latter with data until 2012, so it is not displayed here). Historical data for shovelnose sturgeon (Figure 2; from 1985 to 2014) indicate wide annual fluctuations and no long-term linear trend, with the variations accounted for by trends in the price and market for caviar rather than stock size (UMRCC 2020). The most recent production for paddlefish has been oscillating between 10,000 and 20,000 individuals per fishing season (Figure 3) (MICRA 2023).

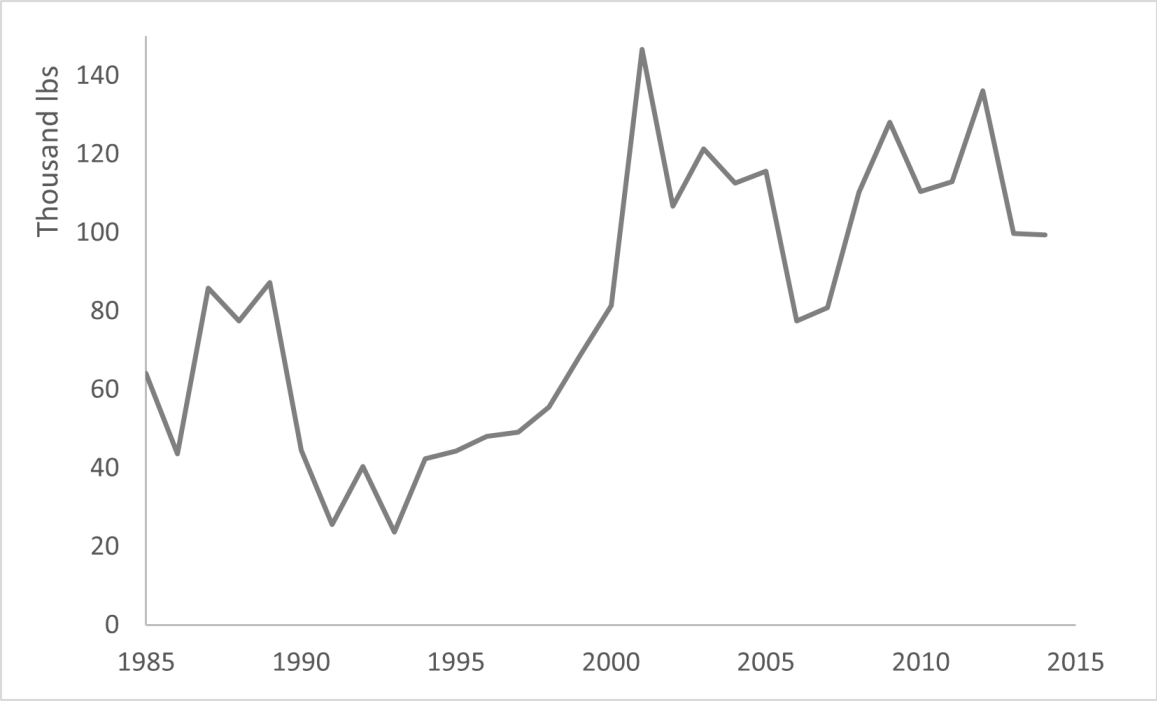

Figure 2: Reported shovelnose sturgeon commercial fishery statistics from the Upper Mississippi River (Minnesota, Wisconsin, Iowa, Illinois, and Missouri) 2004–14 (UMRCC 2020).

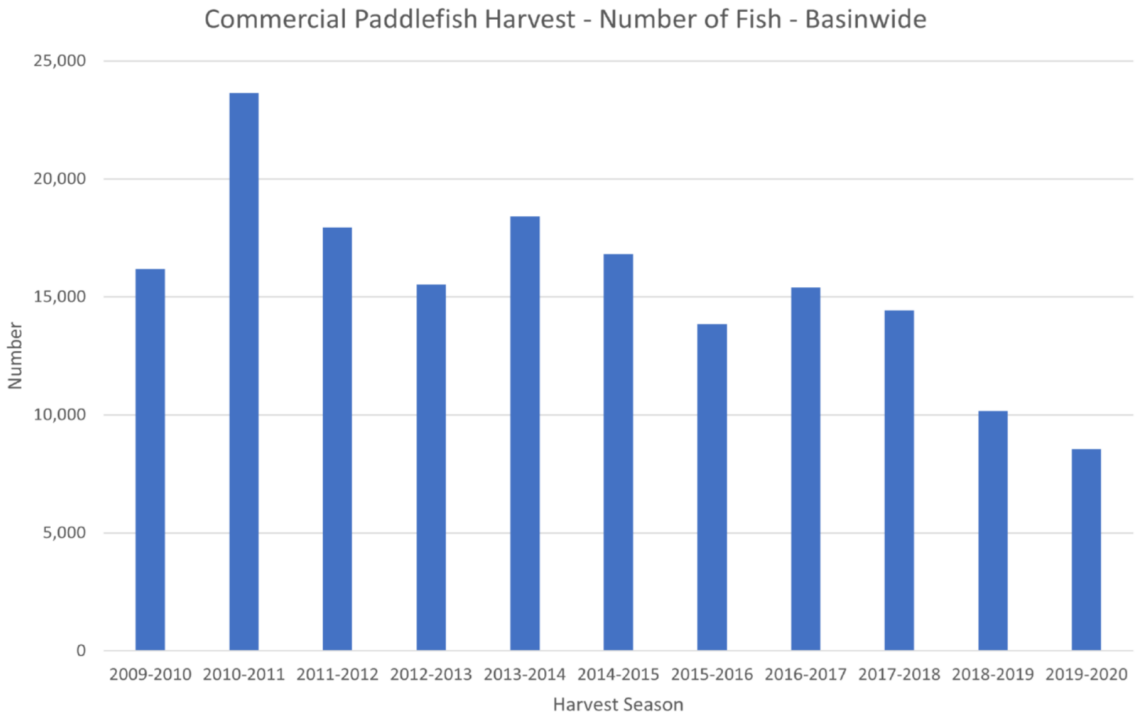

Figure 3: Number of paddlefish commercially harvested from all states and waterbodies from 2009–10 to 2019–20 harvest seasons (MICRA 2023).

Table 2: States operating commercial fisheries for shovelnose sturgeon and paddlefish as of January 2023 (indicated with an X).

State	Shovelnose sturgeon	Paddlefish
Alabama	—	— (ADCNR 2018)
Arkansas	—	X
Illinois	X; only upstream of the Mel Price Lock and Dam in Alton, IL (excluding the area from lock and dam 19 to the State Highway 9 bridge in Niota) (IDNR 2021)	X; only below lock and dam 19 (IDNR 2021)
Indiana	—	X; Ohio River only (MICRA 2023)
Iowa	X	—
Kentucky	X; Ohio River only	X
Louisiana	—	—
Minnesota	—	—
Mississippi	—	— (MDWFP 2022)
Missouri	X; only above Lock and Dam 26 at Alton, IL	X
Tennessee	—	X
Wisconsin	X	—

Importance to the US/North American market.

Because of black caviar's status as one of the world's most valuable food commodities and the endangered nature of 85% of the sturgeon populations that produce it, the global caviar trade is shrouded in secrecy. The proportion of this supply that is consumed in the U.S. is difficult to determine: data on caviar trade in and out of the U.S. are readily available, but information on American caviar and sturgeon meat production is not, resulting in a lack of clarity regarding the overall American demand for sturgeon products, particularly caviar. U.S. trade data are available, and the past seven years have shown a significant increase in U.S. exports of sturgeon caviar/roe (Table 3). Since 1998, international trade in all species of sturgeon has been regulated under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), to prevent the overexploitation of stocks. All sturgeon and its derivatives that enter international trade require accompanying CITES permits. The CITES database indicates greater American exports of black caviar (over 293 tons of shovelnose sturgeon, paddlefish, and white sturgeon caviar in 2020) than the exports reported by NOAA (CITES 2022), although the values within the CITES database are discriminated by whether the product is farmed or wild (the 293 tons reported for 2020 are split between 254 tons of farmed sturgeon and 39 tons of wild paddlefish). Since 2013, less than 1,000 lbs of paddlefish egg/caviar have been exported, and no exports were registered during 2021 and 2022 (MICRA 2023).

Table 3. Annual U.S. trade of sturgeon and caviar/caviar substitute, 2009–21 (in metric tons) (NOAA Fisheries 2022c).

		Sturgeon		Caviar/caviar substitute	
Year	**Product class**	**Exports (mt)**	**Imports (mt)**	**Exports (mt)**	**Imports (mt)**

2009	Caviar/roe	1	0	481	739
2010	Caviar/roe	2	0	931	667
2011	Caviar/roe	98	3	751	782
2012	Caviar/roe	1	0	655	819
2013	Caviar/roe	6	0	759	1,049
2014	Caviar/roe	1	12	1,225	970
2015	Caviar/roe	46	7	1,351	1,189
2016	Caviar/roe	223	1	1,265	1,373
2017	Caviar/roe	830	0	1,355	1,388
2018	Caviar/roe	384	0	1,441	1,733
2019	Caviar/roe	211	0	1,208	1,845
2020	Caviar/roe	173	0	653	1,153
2021	Caviar/roe	367	—	516	2,055

Common and market names.

The species evaluated in this report can be found on the market as either simply "sturgeon" or "paddlefish." In addition, vernacular names for white sturgeon can be recognized as Columbia sturgeon, Sacramento sturgeon, Oregon sturgeon, California sturgeon, or Pacific sturgeon. Shovelnose sturgeon can be referred to as sand sturgeon, hackleback, switchtail, or flathead sturgeon. Paddlefish is sometimes referred to as Mississippi paddlefish, American paddlefish, spoonbill, spoonbill cat, shovelbill cat, duckbill cat, shovelnose cat, spoonbill sturgeon, spadefish, boneless cat, freshwater sturgeon, Chattanooga beluga, American sturgeon, or freshwater whale.

Primary product forms

Caviar is prepared by removing the egg masses from the freshly caught fish, and salt is added to preserve the eggs. Caviar is then packed in cans, glass, or porcelain. In some cases, it is pasteurized to obtain longer-term storage.

Sturgeon meat is also sold, generally as fresh and frozen fillets. Efforts are ongoing to successfully market sturgeon meat to American consumers.

Paddlefish meat is also typically sold fresh or smoked.

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.

Guiding principles

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

Criterion 1 Summary

PADDLEFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

SHOVELNOSE STURGEON			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

WHITE STURGEON			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Columbia River | America, North - Inland Waters | Drift gillnets | United States	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

Criterion 1 Assessments

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.*

Paddlefish

Factor 1.1 - Abundance

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

High Concern

Paddlefish abundance in the Mississippi River is not well understood at this time. The International Union for the Conservation of Nature (IUCN) lists the species' status as "Vulnerable" because of river modifications in the Mississippi River basin that reduced suitable habitats, particularly spawning grounds, over the years (Moore and Rider 2022). Because the species is red-listed by the IUCN, this factor receives a score of high concern.

Justification:

Abundance of paddlefish in the Mississippi River basin is not tracked consistently against a biomass target or limit reference point. Paddlefish move long distances through the basin and historically through 26 state jurisdictions. A range-wide, coordinated management effort is not in place, but state-specific surveys have been conducted to track trends, and the understanding of paddlefish migratory behavior has improved over time, providing a basis upon which coordinated management could be organized (Pracheil et al. 2012). It is known that paddlefish stocks in general have a greatly decreased recruitment as the result of habitat changes, such as sedimentation and river backwater (Scarnecchia et al. 2019). Recently, a 5-year tagging study (Devine et al. 2020) provided a baseline estimate of average annual abundance for paddlefish moving through the sampling area between 2015 and 2019 of 60,004 (SE = 24,098; 95% CI: 28,152–128,062).

Factor 1.2 - Fishing Mortality

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderate Concern

A 5-year (2015–19) tagging study was completed to estimate exploitation rates for paddlefish in the Mississippi River basin (Devine et al. 2020), where mark and recapture techniques were used with telemetry to evaluate annual survival and the contribution of both natural and fishing mortality factors. An average annual exploitation rate was estimated at 2.5% (SE = 0.6) for the study area, and the instantaneous fishing mortality estimate was 0.03 (SE = 0.12) (Devine et al. 2020). Although the exploitation rate is much lower than what has been reported in previous years (see Justification), there are still concerns regarding the lack of data in other regions of the Mississippi River basin, including studies on population dynamics and movement data. Because of uncertainties in legal-size regulations that directly affect fishing mortality estimates, this factor is scored a moderate concern.

Justification:

Paddlefish is susceptible to overharvest, and consistent overharvest runs a risk of complete extirpation (Hupfeld et al. 2016). A 2016 study found annual mortality rates in different portions of the Mississippi River basin to range from 26% to 34%, with exploitation rates of 15% to 20% (Hupfeld et al. 2016). Concerns have been voiced that these exploitation rates are resulting in

growth and recruitment overfishing: in particular, Sharov et al. opined that fishing mortality rates exceeding $F_{40\%}$ in most systems point to the possibility of overfishing throughout the Mississippi River basin (Sharov et al. 2014). In the past, several authors have called into question the existing minimum length limits and whether or not they prevent recruitment overfishing (Tripp et al. 2012) (Scholten and Bettoli 2005).

Previous studies showed a lack of information that fishers throughout the Mississippi River basin are voluntarily complying with length limits that ensure that females spawn at least once before capture (Hupfeld et al. 2016) (Sharov et al. 2014), which suggested that paddlefish fishing mortality could be above sustainable levels. Since the 2017–18 season, for every harvest zone in the Mississippi River zone, the minimum length limit was set at 37 in (940 mm), with the intention of protecting around 30% of paddlefish spawning stock from being harvested (Rider et al. 2019).

Shovelnose sturgeon

Factor 1.1 - Abundance

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

High Concern

The shovelnose sturgeon is unique among sturgeons in that it seems to be relatively stable within its historic habitat range, despite facing the same threats that have severely depleted other sturgeon species. The smaller size and earlier maturation of shovelnose sturgeon may account for a greater resilience to habitat and fishing impacts (Phelps et al. 2016). The species is listed as "Vulnerable" by the IUCN (criteria A2bce) (Phelps and Webb 2022). Because of this "Vulnerable" status, a rating of high concern is awarded.

Justification:

Shovelnose sturgeon migrates throughout the Mississippi River and its tributaries, crossing multiple state jurisdictions. Phelps et al. (2016) review the findings of questionnaire-based studies, along with place-based studies examining trends in size structure and CPUE, and paint a picture of stable stock status in the upper Missouri and upper Mississippi Rivers, with concerns about how habitat fragmentation affects stock status in the middle and lower Missouri River and middle and lower Mississippi River, as well as about the absence of data in some areas of the Ohio River (Indiana, Ohio, and Kentucky) (Phelps et al. 2016). More recently, a study on natural oscillations between low- and high-water periods and different flow conditions concluded that abundances of shovelnose sturgeon were greater during high-water conditions (Hammen et al. 2018). This information is key in the face of climate-driven changes, existing anthropogenic impacts that alter river flow regimes/connectivity within river basins, and how species such as shovelnose sturgeon are going to adapt to such changes (Hammen et al. 2018).

Factor 1.2 - Fishing Mortality

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderate Concern

Fishing mortality relative to a sustainable level is uncertain for shovelnose sturgeon in the Mississippi River basin, resulting in a rating of moderate concern.

White sturgeon

Factor 1.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Moderate Concern

Abundance of the adult and sub-adult white sturgeon population in the Lower Columbia River (LCR) is tracked annually against two "conservation thresholds," or proxies for limit reference points, that are established in the Lower Columbia River and Oregon Coast White Sturgeon Conservation Plan {ODFW 2011}. In 2016, for the first time since the goals' establishment, the adult abundance estimate of 5,950 fish (determined through mark and recapture surveys) exceeded the adult conservation threshold. But an alternate estimate, using a regression analysis that correlated past research fishery catch per unit effort (CPUE) with adult-size abundance in that same year, generated a lower abundance of 4,140 fish, which is below the threshold. Meanwhile, two estimates for sub-adult abundance were likewise generated using the two methods, and both estimates exceeded the threshold (ODFW 2017a). Since 2019, the 3-year average adult abundance of white sturgeon ≥167 cm fork length (FL) has been above the desired status (n ≥ 9,250 fish) (ODFW and WDFW 2022). Annual abundance has been increasing since 2016, which indicates that restrictive measures (e.g., the closure of LCR sturgeon retention fisheries in 2014–17, a more restrictive slot size, and a harvest guideline upon reopening fisheries in 2017) have helped the escape of spawning-size individuals {ODFW and WDFD 2022}. Because confidence intervals for the abundance estimates overlap between recent years, the actual difference between years may look unclear. Recent legal-size abundance estimates have been increasing since 2018; however, issues stemming from the COVID-19 pandemic have reduced tag recovery efforts, so abundance estimates are less precise (ODFW and WDFW 2022). The 2021 estimate of 122,400 fish may indicate a decline in the overall population abundance, which might also be related to the low survival and recruitment of juvenile sturgeon over the past decade (ODFW and WDFW 2022). "This may suggest lower recruitment (compared to information gathered prior to 2010), which seems to be contributing to reduced sub-legal numbers and an increasing proportion of adults in the population" (pers. comm., T. Jones 2022).

There are uncertainties in the absolute change in abundance year-to-year as a result of the confidence intervals, and the decrease since 2020 might be a direct result of reduced reporting tags; however, adult abundance has been above the limit reference point since 2017 and above the target reference point since 2019. The species is listed as "Vulnerable" by an IUCN assessment from 2020 (Crossman and Hildebrand 2022). But, the population is monitored annually and values are above the limit reference point, so the IUCN status is overruled. Because of the statistical uncertainty about the population being above the target reference point, this factor is scored a moderate concern.

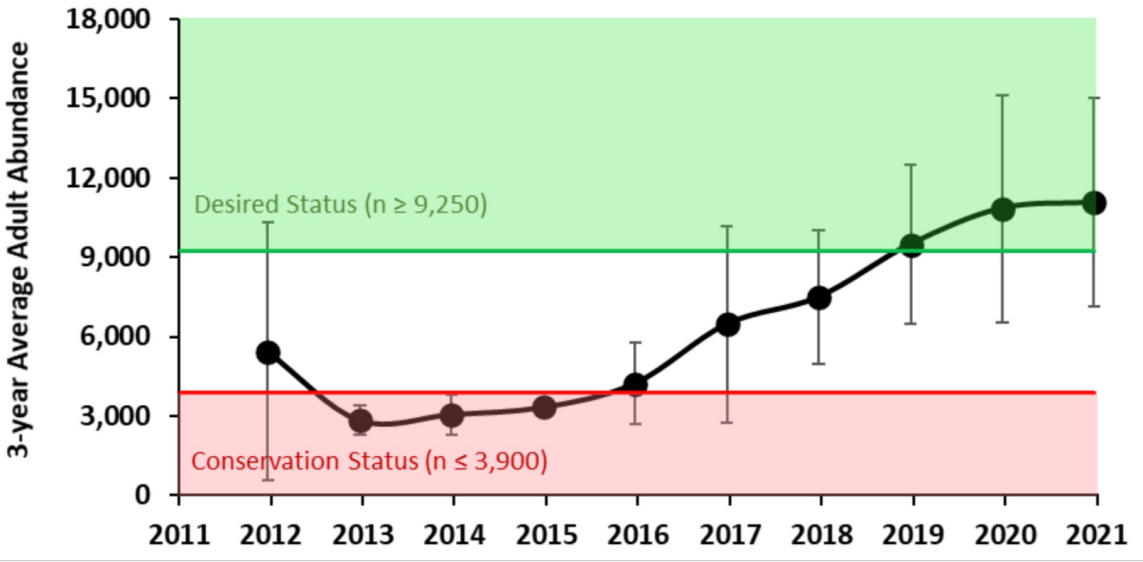

Figure 4: The 3-year average estimated abundance for white sturgeon ≥167 cm FL from the Lower Columbia River, 2012–21. Less than 3 years of data were available before 2012, so earlier averages are unavailable. Errors bars = standard deviation (ODFW and WDFW 2022) .

		Setline (S)			Estimation Method (H/S) and Number (%) by size class	
Year	Historic (H)	Actual	Projected [1]		42-48 in. TL; 38-43 in. FL	48-60 in. TL; 43-54 in. FL
1987	104,000			H	75,900 (73%)	28,100 (29%)
1988	68,100			H	34,400 (51%)	33,700 (49%)
1989	48,700			H	31,900 (66%)	16,800 (34%)
1990	37,800			H	25,800 (68%)	12,000 (32%)
1991	44,200			H	32,500 (74%)	11,700 (26%)
1992	79,100			H	70,400 (89%)	8,700 (11%)
1993	129,700			H	115,500 (89%)	14,200 (11%)
1994 [2]	N/A			H	N/A	N/A
1995	202,200			H	143,200 (71%)	59,000 (29%)
1996	170,600			H	137,100 (80%)	33,500 (20%)
1997	174,300			H	146,600 (84%)	27,700 (16%)
1998	140,700			H	116,800 (83%)	23,900 (17%)
1999	134,500			H	116,800 (87%)	17,700 (13%)
2000	134,700			H	117,300 (87%)	17,400 (13%)
2001	127,500			H	102,200 (80%)	25,300 (20%)
2002	121,600			H	87,400 (72%)	34,200 (28%)
2003	131,200			H	85,000 (65%)	46,200 (35%)
2004 [2]	N/A			H	N/A	N/A
2005	136,900			H	106,900 (78%)	30,000 (22%)
2006	123,400			H	88,100 (71%)	35,300 (29%)
2007	131,700			H	101,800 (77%)	29,900 (23%)
2008	101,200			H	69,800 (69%)	31,400 (31%)
2009	95,000			H	65,000 (68%)	30,000 (32%)
2010	65,300	100,300		H	39,100 (60%)	26,200 (40%)
2011	72,800	80,600	77,000	H	46,300 (64%)	26,500 (36%)
2012	83,400	72,700	65,000	H	52,600 (63%)	30,800 (37%)
2013 [3]	N/A	113,900	74,300	-	N/A	N/A
2014	N/A	131,000	131,700	S	76,200 (55%)	54,800 (45%)
2015	N/A	143,900	138,200	S	74,100 (51%)	69,700 (49%)
2016	N/A	224,000	147,100	S	104,100 (46%)	119,900 (54%)
2017	N/A	199,800	237,900	S	86,300 (43%)	113,500 (57%)
2018	N/A	162,200	198,300	S	70,300 (43%)	91,900 (57%)
2019	N/A	168,200	164,100	S	76,900 (46%)	91,300 (54%)
2020 [4]	N/A	199,500	148,800	S	97,200 (49%)	102,300 (51%)
2021 [5]	N/A	122,400	206,100	S	62,700 (51%)	59,700 (49%)
2022 [5]			114,400	S		

[1] *Projected abundance is based on the previous year's setline estimate. Projections do not include harvest.*

[2] *Abundance estimates were not developed in 1994 and in 2004.*

[3] *Since 2013, abundance estimates have been developed using the setline method rather than the historic approach.*

[4] *Partial sampling season due to COVID-19 restrictions*

[5] *Preliminary estimte*

Figure 5: Estimated and projected abundance for white sturgeon 42–60 in total length (38–54 in FL) in the Lower Columbia River, 1987–2022 (ODFW and WDFW 2022) .

Factor 1.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

Because harvests have consistently been quite low since 2014 as a result of precautionary management, the Columbia River fishery is rated a low concern for fishing mortality.

Justification:

In the Columbia River basin, harvest management to meet an optimum sustained yield (OSY) goal has been in place since 1989, although information on performance against this goal does not appear to have been published in the recent past. For the lower Columbia River, OSY is defined as the harvest level that ensures that sufficient numbers of juvenile white sturgeon survive fisheries so the rate of recruitment to the broodstock population exceeds the rate of mortality for the broodstock population (Jones and Mallette 2011).

From 2011 on, commercial harvest of white sturgeon in the Columbia River has been particularly restricted in response to steady declines in adult abundance from 2006 to 2012. Both commercial and recreational retention of white sturgeon below the Bonneville Dam were prohibited from 2014 to 2016. The only commercial fisheries for white sturgeon that occurred during this period were Native American fisheries. Summer openings at particular locations in the Lower Columbia River basin have also been inserted into the fishery administrative rules on a temporary basis (ODFW 2017d). But in response to a rebound in the number of adults, a limited commercial harvest has been allowed since 2017, with about 1,200 total fish harvested and retained in the commercial fishery in 2021 (ODFW and WDFW 2022).

	White Sturgeon				
	Recreational [1]		Commercial [2]		Total
Year	Catch	%	Catch	%	Catch
1977-79 Ave	29.2	70	13.3	30	42.5
1980-84 Ave	31.5	70	13.2	30	44.7
1985-89 Ave	44.9	84	8.3	16	53.2
1990-94 Ave	30.3	83	6.0	17	36.3
1995-99 Ave	41.5	80	10.2	20	51.7
2000	40.5	79	10.9	21	51.4
2001	41.2	82	9.3	18	50.5
2002	38.3	80	9.6	20	47.9
2003	31.9	80	8.0	20	39.9
2004	28.4	78	7.9	22	36.3
2000-04 Ave	36.0	80	9.1	20	45.1
2005	30.9	79	8.2	21	39.1
2006	26.4	76	8.3	24	34.7
2007	35.1	82	7.8	18	42.9
2008	29.5	79	7.9	21	37.4
2009	23.8	76	7.7	21	31.5
2005-09 Ave	29.1	78	8.0	22	37.1
2010	14.1	76	4.4	24	18.5
2011	11.2	77	3.4	23	14.6
2012	7.3	79	1.9	21	9.2
2013	7.4	79	2.0	21	9.4
2014 [3]	0.0	0	0.0	0	0.0
2010-14 Ave	8.0	78	2.9	22	10.9
2015 [3]	0.0	0	0.0	0	0.0
2016 [3]	0.0	0	0.0	0	0.0
2017	3.7	75	1.2	25	4.9
2018	3.5	81	0.8	19	4.3
2019 [4]	3.5	74	1.2	26	4.7
2015-19 Ave	2.1	77	6.5	23	8.6
2020 [4]	1.0	48	1.1	52	2.1
2021 [4 5]	3.5	74	1.2	26	4.7

Figure 6: Recreational and commercial white sturgeon catch (in thousands) and sharing percentages in the lower Columbia River, 1977–2021 (ODFW and WDFW 2022).

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 Crtitical

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

PADDLEFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States	2.644	1.000: < 100%	Yellow (2.644)

SHOVELNOSE STURGEON			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States	2.644	1.000: < 100%	Yellow (2.644)

WHITE STURGEON			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Columbia River | America, North - Inland Waters | Drift gillnets | United States	1.732	1.000: < 100%	Red (1.732)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

COLUMBIA RIVER | AMERICA, NORTH - INLAND WATERS | DRIFT GILLNETS | UNITED STATES			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Rainbow trout	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Chinook salmon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Coho salmon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Green sturgeon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
White sturgeon	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
American shad	3.670: Low Concern	5.000: Low Concern	Green (4.284)

MISSISSIPPI RIVER BASIN | AMERICA, NORTH - INLAND WATERS | DRIFT GILLNETS | UNITED STATES			
SUB SCORE: 2.644	DISCARD RATE: 1.000	**SCORE: 2.644**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Shovelnose sturgeon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

MISSISSIPPI RIVER BASIN | AMERICA, NORTH - INLAND WATERS | SET GILLNETS | UNITED STATES			
SUB SCORE: 2.644	DISCARD RATE: 1.000	**SCORE: 2.644**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Paddlefish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

White sturgeon gillnet fishery

One ESA-listed sturgeon (green sturgeon) intermingles with white sturgeon in the Columbia River (NMFS 2015)(NMFS 2014). Although misidentification rates of green sturgeon are thought to be low and the majority are returned to the water after capture in the white sturgeon fishery, there is no post-release mortality information available (ODFW and WDFW 2012). In addition to green sturgeon, the Columbia River gillnet fishery also catches several ESA-listed species of Pacific salmon: Chinook salmon, coho salmon, steelhead, and shad (the fishery is multispecies in nature, targeting salmon, sturgeon, and shad) (ODFW 2017d). The Red rating is attributed to steelhead's ESA listing and to preliminary data on post-release mortality rates, which indicate that steelhead mortality is high in gillnet gear (ODFW 2017e).

Paddlefish gillnet fishery

An "unknown finfish" category was included for the paddlefish fishery because of the absence of published catch composition data and the unselective nature of gillnets.

Shovelnose sturgeon gillnet fishery

One ESA-listed sturgeon (pallid sturgeon) inhabits particular portions of the Mississippi River basin where shovelnose sturgeon are found. Shovelnose sturgeon and pallid sturgeon can be mistaken for one another; therefore, shovelnose sturgeon fisheries in the Mississippi River basin have been closed where there is overlap of these species. Now, shovelnose sturgeon can be harvested only in the Ohio River, the Wabash River, and the Upper Mississippi River above Lock and Dam 26 (USFWS 2014)(Thornton 2018). Although uncertainties, the risk of species misidentification, and likely inaccurate estimates on catches exist, hybridization is more evident where both species overlap (i.e., where the fishery is currently closed). The previous report included pallid sturgeon as a Criterion 2 species; however, the fishery is now allowed only where pallid sturgeon does not occur, so we removed it in this updated assessment. In addition, we included an "unknown finfish" category to consider possible catches of other species, because information on catch composition for this fishery is not available.

No nonfish species (e.g., benthic invertebrates, diving birds, otter, sea lion, or beaver) were included as main species in this report, because there is no published, recent evidence of significant bycatch of these species in these fisheries.

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)

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

American shad

Factor 2.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

American shad is native to the East Coast and was introduced to the West Coast in 1871 (ODFW 2022b). Because it has been established for over 150 years, it is considered native for the purposes of this assessment. The 2020 minimum shad run size of nearly 6 million fish was the fourth largest on record since 1980 and followed a record high return of 7.7 million the previous year (ODFW and WDFW 2021). A rating of low concern is awarded because recent run sizes are within the ranges considered healthy.

Factor 2.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

After the shad fishery was restricted to area 2S in the Columbia River, no commercial catch was reported in 2020. The nontreaty (lower Columbia and lower Willamette Rivers) recreational combined catch was 168,700 fish (2.8% of the total run), which was below the recent 5-year average of 179,500 fish (commercial and recreational combined) (ODFW and WDFW 2021). A rating of low concern is awarded because the fishery's contribution to mortality is considered low enough to not adversely affect the population.

Chinook salmon

Factor 2.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

High Concern

Lower Columbia River (LCR) Chinook salmon has been classified as "Threatened" under the Endangered Species Act (ESA) since 2005, and this designation has been kept following status review (FR 2014). In 2019, an ongoing 5-year review plan started for salmon species, including chinook (NOAA Fisheries 2019). LCR fall Chinook salmon are harvested in mainstem gillnet fisheries below the Bonneville Dam (PFMC 2017b). The ESA listing results in a score of high concern.

Justification:

The Lower Columbia River drift gillnet fishery is a mixed-stock fishery, targeting not only white sturgeon but also Chinook salmon (*Oncorhynchus tshawytscha*). Many Columbia River Chinook salmon population segments are included in the 2005 ESA "Threatened" listing. Population status fluctuates among population segments and from year to year: the forecast for the 2021 total Columbia River fall Chinook salmon run totaled 576,200, which equaled 100% of the 2020 actual

return and 80% of the average return for the previous decade (ODFW and WDFW 2021b). Escapements and harvest rates are monitored for indicator stocks for the two larger stock groupings that migrate upriver in summer and fall to spawn: Columbia River summers and falls. Escapement goals for all indicator stocks were met in the past 3 years (Figure 7) (PSC CTC 2022).

Stock group	Run	Escapement Indicator	Management Objective[1]	2019	2020	2021	3 Yrs < 85%?
Columbia River							
Columbia River Summers	Sum	CAN Okanagan[7]	TBD	NA	NA	NA	
		Mid-Col Summers	12,143	41,090	70,654	52,076	No
Columbia River Falls	Fall	Upriver Brights	40,000	94,939	125,097	117,435	No
		Lewis	5,700	14,307	26,792	12,430	No
		Coweeman	TBD	374	807	669	

Figure 7: Escapement indicator stocks and escapement performance, 2019–21. All escapements (shown in green) in the Columbia River are above the goal or lower bound escapement range (PSC CTC 2022).

Factor 2.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

All escapement goals for all indicator stocks have been met over the last years, and no maximum exploitation rate threshold has been exceeded since 2013 (ODFW and WDFW 2021). The upper Columbia River summer Chinook salmon stock is currently not experiencing overfishing (PFMC 2022). A score of low concern is awarded, because exploitation has been below the threshold for nearly 10 years and the species is currently not experiencing overfishing.

Justification:

Exploitation rates on Columbia River Chinook salmon indicator stocks are estimated annually, both for terminal and for offshore troll fisheries. In 2020, exploitation rates for Columbia River summer and fall Chinook salmon ranged from 40% to 60% (PSC CTC 2022). These exploitation rates do not exceed maximum fishing mortality thresholds (Figure 9). For some years, NOAA had an overfishing designation in place for Columbia River summers (upper Columbia River) (NOAA Fisheries 2019b), but the overfishing status was removed in 2019 (PFMC 2022). The last time the exploitation rate limit for this stock was exceeded was in 2012, when an all-fisheries exploitation rate of 83% was observed (PSC CTC 2017b).

Ocean escapement of LRW fall Chinook salmon in 2021 was forecast at 20,000 adults, or about 103% of the recent 10-year average return of 19,400. The forecast equals about 56% of the 2020 actual return of 35,400 (PFMC 2021).

Stock Region[1]	Escapement Indicator	Management Objective[2]	S_{MSY}[3]	85% of S_{MSY}[3]	U_{MSY}[3]	Exploitation Rate Indicator[3]	Exp. Rate Type[4]
Columbia	Upriver Brights	40,000	40,000	34,000	0.56	URB	CMRE
						HAN	
Columbia	Lewis River Fall	5,700	5,791	4,922	0.79	LRW	CMRE
Columbia	Upriver Brights	40,000	40,000	34,000	0.56	URB	CMRE
Columbia	Lewis River Fall	5,700	5,791	4,922	0.79	LRW	CMRE
Columbia	Coweeman	TBD	TBD	TBD	TBD	CWF	CMRE
Columbia	Mid-Columbia Summers	12,143	12,143	10,322	0.75	SUM	CMRE

Figure 8: Summary of information available for synoptic stock evaluations (shaded row indicates stock that cannot be evaluated due to data gaps). S_{MSY}: escapement producing maximum sustainable yield; U_{MSY}: exploitation rate at maximum sustainable yield; CMRE: cumulative mature-run equivalent (PSC CTC 2022).

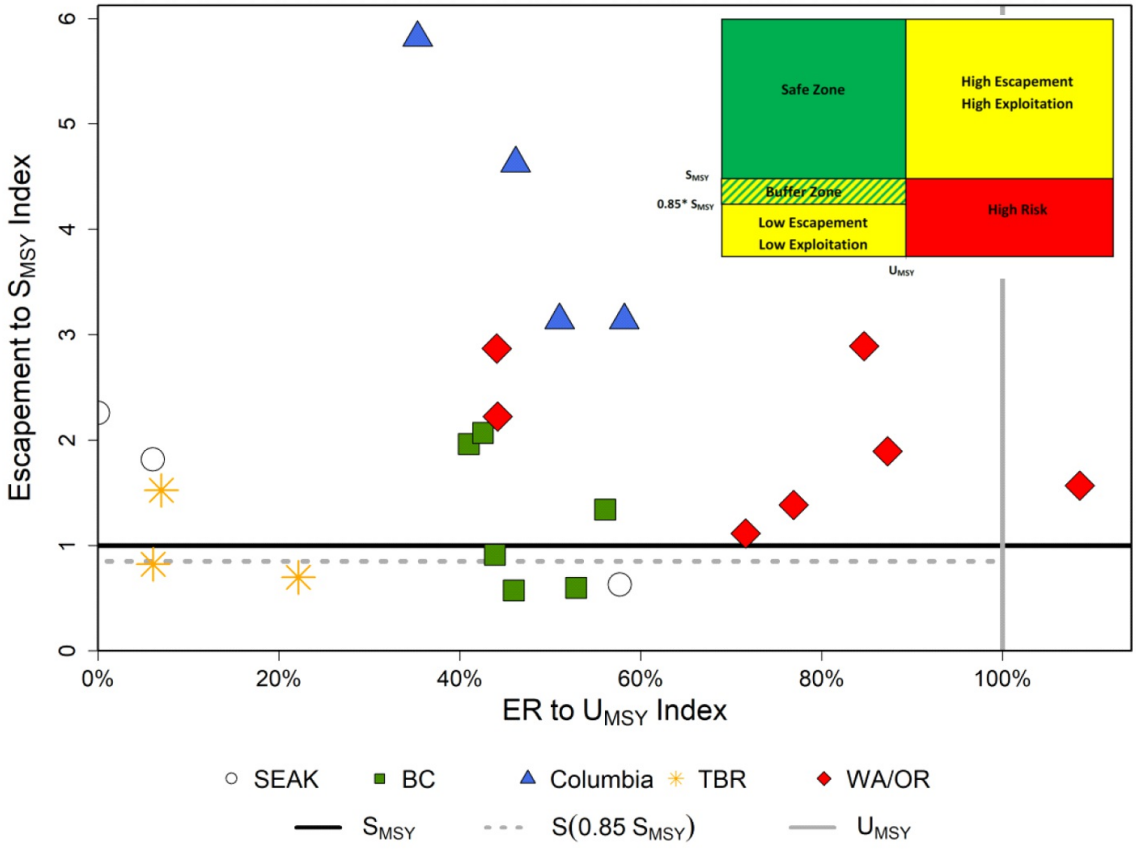

Figure 9: A synoptic summary by region of stock status for stocks with escapement and exploitation rate data in 2020 (PSC CTC 2022). S_{MSY}: escapement producing maximum sustainable yield; ER: exploitation rate; U_{MSY}: exploitation rate at maximum sustainable yield.

Coho salmon

Factor 2.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

High Concern

Lower Columbia River coho salmon has been classified as "Threatened" under the ESA since 2005, and in 2019, an ongoing 5-year review plan started for salmon species, including coho (NOAA Fisheries 2019). The ESA listing results in a score of high concern.

Justification:

The Lower Columbia River drift gillnet fishery is a mixed-stock fishery, targeting not only white sturgeon but also Pacific salmon, including coho salmon (*Oncorhynchus kisutch*). In some years, such as 2014, coho salmon can be the dominant species in the Lower Columbia River catch (ODFW 2017b). Columbia River coho salmon spawning migrations occur in the late summer through fall, overlapping with the summer and fall openings for white sturgeon.

Columbia River coho salmon stocks are part of the Oregon Production Index (OPI) for which spawning, abundance, and exploitation rates are estimated annually. The OPI includes all Washington, Oregon, and California wild and hatchery stocks from streams south of Leadbetter Point, Washington. Within the OPI, coho returns to the Columbia River have been generally stable over the past decade. The predicted adult return in 2021 was 1,343,200 fish (with the preliminary return at around 50% of forecast), whereas for 2020 it expected the sixth-highest return since 1977 (ODFW and WDFW 2022c). For the Lower Columbia River Natural (LCN), the 2021 preseason abundance prediction of 39,200 LCN coho was 56% of the preliminary postseason estimate of 70,500 coho, and the 2022 prediction for LCN coho was 65,700 (NOAA Fisheries 2022b). An exploitation rate goal is in place for Lower Columbia River coho salmon, and tributary abundance targets are also included in the Lower Columbia River salmon recovery plan (NMFS 2016).

Table 4. Preliminary preseason and postseason coho stock abundance estimates for the Lower Columbia River Natural (LCN) in thousands of fish (NOAA Fisheries 2022b).

Year of Average	Preseason	Postseason[a]	Preseason/Postseason[a]
2007	21.5	20.5	1.0
2008	13.4	28.7	0.5
2009	32.7	37.6	0.9
2010	15.1	53.2	0.3
2011	22.7	29.5	0.8
2012	30.1	12.9	2.3
2013	46.5	36.8	1.3
2014	33.4	108.7	0.3
2015	35.9	20.9	1.7
2016	40.0	25.1	1.6
2017	30.1	31.2	1.0
2018	21.9	29.7	0.7

2019	36.9	34.1	1.1
2020	24.8	55.4	0.4
2021	39.2	70.5	0.6
2022	65.7	-	-

[a] Postseason estimates based on preliminary data.

Factor 2.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

The cumulative exploitation rate for Lower Columbia River Natural (LCN) coho salmon in 2021 was 10.1% and the forecast for 2022 was 13.5%, which are both below the 2022 FMP Conservation Objective of <23% (NOAA Fisheries 2022b).

Justification:

ESA standards have restricted the exploitation rate on LCN coho salmon to thresholds of 15% to 23% since 2004. These thresholds have generally been adhered to in all but two years: 2005 and 2007 (PFMC 2017b).

Finfish

Factor 2.1 - Abundance

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderate Concern

There is a lack of information on the bycatch composition in the paddlefish and shovelnose sturgeon fisheries, but because set gillnets are unselective, we have included unknown finfish in the assessment. Gillnet bycatch in freshwater has been recorded in previous studies, and further research is needed to identify other potential affected species (Raby et al. 2011)(Bettoli and Scholten 2006)(Bettoli et al. 2007)(Bettoli et al. 2009b). The Seafood Watch Standard for Fisheries scores abundance of finfish that are not from highly vulnerable taxa a moderate concern.

Factor 2.2 - Fishing Mortality

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderate Concern

There is a lack of information on the bycatch composition of paddlefish and shovelnose sturgeon fisheries (there are few available studies on freshwater fisheries bycatch) (Raby et al. 2011), so fishing mortality is considered unknown for this group. This results in a moderate concern score. Also, there is some information that could benefit eventual bycatch:

- The Mississippi River fisheries typically occur during the cold months of the year (thus increasing good survival of released fish) (MICRA 2023)(UMRCC 2020).
- Large-mesh nets are used in the fisheries (MICRA 2023), potentially reducing the number of nontarget species captured.
- Invasive Asian carps occur in the Upper Mississippi River and are known to interact with paddlefish (fishing mortality is desirable in order to remove them from the river) (Freedman et al. 2012)(Szott et al. 2023).

Green sturgeon

Factor 2.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

High Concern
Because of green sturgeon's ESA status ("Threatened" for the southern population segment, and "Species of concern" for the northern population segment), the species receives a rating of high concern for abundance.

Justification:
As with white sturgeon, the habitat of North American green sturgeon (*Acipenser medirostris*) ranges from California to Alaska along the North American West Coast. Although the Columbia River is not a main spawning system for green sturgeon, the species concentrates in coastal estuaries, including the Columbia River estuary during the late summer and early fall. There, it interacts with the sturgeon drift gillnet fishery.

The southern distinct population segment (SDPS) of green sturgeon (which spawns in the Sacramento River) was listed as "Threatened" under the ESA on April 7, 2006 (FR 2006). The northern distinct population segment (NDPS) (spawners from the Klamath and Rogue Rivers) was reviewed by the National Marine Fisheries Service (NMFS) as a result of the SDPS listing. A full ESA listing was deemed unnecessary, but NMFS recognized concern over the population status, so the NDPS was deemed a "Species of Concern" (NMFS 2007). The species is imperilled by a reduction in spawning area, insufficient flow rates in spawning areas, contaminants, bycatch in other fisheries, and poaching (NMFS 2010).

Fish from both the NDPS and SDPS migrate through the Columbia River and, in recent history, more fish from the southern rather than the northern population have been sampled there. From the most recent 5-year review of the SDPS, there are no past survey data or abundance estimates that can be used as a reference point, which means that existing data do not provide a basis for changing the status of the SDPS. In addition, such data suggest that the spawning population of the SDPS is smaller than that of the NDPS, which is consistent with the fact that the SDPS is listed under the ESA whereas the NDPS is not (NMFS 2021).

Factor 2.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Low Concern

Bycatch of green sturgeon in the Columbia River white sturgeon fishery is thought to be minimal. In 2021, 16 green sturgeon were released by anglers (i.e., recreational fishery) in the white sturgeon season; however, post-release mortality is not known (ODFW and WDFW 2022). No retention of the species has been reported since 2015 (ODFW and WDFW 2022). On the West Coast, an estimated 288–664 green sturgeon were encountered in only one fishery in California during 2015–19 (Richerson et al. 2022). Because the Columbia River white sturgeon fishery is not a substantial contributor to the mortality of green sturgeon, this factor is scored a low concern.

Justification:

Because of the ESA listing, the sale and retention of green sturgeon from commercial and recreational fisheries across the range has been prohibited. Furthermore, retention of green sturgeon in the Columbia River recreational fisheries was prohibited beginning in 2007. Although a limited number of green sturgeon were encountered in Columbia River white sturgeon fisheries and immediately released, post-capture mortality is unknown.

Rainbow trout

Factor 2.1 - Abundance

Columbia River | America, North - Inland Waters | Drift gillnets | United States

High Concern

Lower Columbia River steelhead salmon has been classified as "Threatened" under the ESA since 2006, and in 2019, an ongoing 5-year review plan started for salmon species, including steelhead (NOAA Fisheries 2019). The ESA listing results in a score of "high" concern.

Justification:

Lower Columbia River drift gillnetting in the fall overlaps with runs of Columbia River steelhead salmon (*Oncorhynchus mykiss*). Summer gillnet seasons have been limited to the off-channel terminal fishery area since 2017 (WFWC 2017)(WFWC 2020). Most Columbia River steelhead population segments are included in the ESA "Threatened" listing, and there has been no commercial fishery for the species since the 1970s. The population status fluctuates from year to year. The 2021–22 forecast was for 13,400 wild winter steelhead returning to the Columbia River mouth. For upriver summer steelhead, in 2021 the total return to the Bonneville Dam was 69,669 fish, which was 69% of the preseason forecast (101,400 fish) and the lowest on record (ODFW AND WDFW 2022b).

Factor 2.2 - Fishing Mortality

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Moderate Concern

Gillnetters on the Lower Columbia River target white sturgeon and salmon concurrently, although steelhead salmon is not targeted because of its ESA listing. Information regarding harvest rates specific to the gillnet fishery is not available, but there is an indication that the post-release mortality rate from gillnets ranges from 38.3% (mesh size 9–9.75 in) to 44.8% (mesh size 8–8.75 in) (ODFW AND WDFW 2022b). In the absence of more definitive information, a rating of moderate concern is given.

Justification:

Columbia River steelhead salmon population segments are listed under the ESA; therefore, commercial retention of steelhead in nontreaty fisheries has been prohibited since 1975, and upon capture, it "must be released immediately with care and the least possible injury to the fish to the river without violence or into an operating recovery box" (ODFW 2017d). Retention of wild steelhead salmon is particularly undesirable, and is mark-selective in the recreational fishery (ODFW and WDFW 2021b): wild and hatchery steelhead salmon are distinguishable by the presence or absence of the adipose fin (the seven artificial propagation programs that contribute hatchery steelhead to the Lower Columbia River steelhead salmon distinct population segment all remove the adipose fin from steelhead before release into the wild).

The following release mortality rates are applied to commercial fishing gears: tangle net (≤3.75" mesh; Coho, steelhead, chum = 23.6%); gillnet (8–8.75" mesh: steelhead, chum = 44.8%); gillnet (9–9.75" mesh: steelhead = 38.3%) (ODFW and WDFW 2021).

Factor 2.3 - Discard Rate/Landings

Columbia River | America, North - Inland Waters | Drift gillnets | United States

< 100%

The Columbia River gillnet fishery has minimum size limits, and undersized juveniles and sub-legal adults must be returned live to the water. Post-release mortality of white sturgeon is presumed low: a study on the nearby Fraser River found no mortality over a 3-day period from drift gillnet catch-and-release of 32 white sturgeon {LGL 2006}. Furthermore, in the several years leading up to the closure of the fishery below the Bonneville Dam in 2014, legal fish predominated over sub-legal fish harvested in the Lower Columbia River (ODFW 2017a). Pacific salmon that meet size limits are retained by the gillnet fishery, except for all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

< 100%

Bycatch rates of sub-legal and juvenile fish that are to be returned to the water alive can represent substantial portions of the catch in the Mississippi River shovelnose sturgeon and paddlefish fisheries. For example, a tagging survey there found a 4% post-release mortality rate; this was low, but potentially a meaningful source of mortality in light of the high rate of sub-legal catch (Bettoli et al. 2007). "State management agencies are adjusting season dates based on water temperature to reduce any mortality of sub-legal fish that may occur" (pers. comm., R. Hupfeld, Iowa Department of Natural Resources 2022).

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

< 100%

Bycatch rates of sub-legal and juvenile fish that are to be returned to the water alive can represent substantial portions of the catch in the Mississippi River shovelnose sturgeon and paddlefish fisheries. For example, a tagging survey there found a 4% post-release mortality rate; this was low, but potentially a meaningful source of mortality in light of the high rate of sub-legal catch (Bettoli et al. 2007).

Another aspect of bycatch mortality is the high mortality rate (60% sub-legal bycatch, 71% of which were dead in the nets when water temperatures exceeded 17 °C/63 °F) that Bettoli and Scholten (Bettoli and Scholten 2006) found when nets were fished in the warm waters characteristic of the beginning and end of each fishing season. On the basis of their research, the commercial fishing season in Tennessee was shortened by 8 days.

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.

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:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Columbia River | America, North - Inland Waters | Drift gillnets | United States	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

Criterion 3 Assessment

SCORING GUIDELINES

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.

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.

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.

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.

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.

Factor 3.1 - Management Strategy And Implementation

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

White Sturgeon

Oregon and Washington have established short-term targets specific to various age classes. Even though natural variability will cause the population to fluctuate, goals are set for periods ranging from a couple of years to hundreds of years. Population viability analyses are conducted to quantify the effects of management strategies so that targets could be reached in specific time frames and annual harvest rates can be established. Conservation status criteria also have been developed to indicate if the population requires rebuilding. Population levels are managed to avoid conservation thresholds and are compared to similar reference points for other long-lived marine species, to ensure sustainability (Jones and Mallette 2011). Because of a failure to meet conservation thresholds, the entire sturgeon commercial fishery was completely closed from 2014 to 2016 except for the Native American component (ODFW 2017a). Signs of population recovery set the stage for a limited commercial season in 2017, with harvest occurring in select areas during the summer and in both select areas and the mainstem during the fall (WDFW 2018)(Oregon Live 2017). Current Commission guidance on white sturgeon management includes: assign 80% of the white sturgeon available for non-Treaty harvest to recreational fisheries and 20% to commercial fisheries (ODFW and WDFW 2022d).

Salmon

The gillnet fishery is a multispecies fishery, in that it targets Pacific salmon and shad in addition to white sturgeon. The harvest of Pacific salmon is of particular concern: threatened populations of steelhead, Chinook, and coho salmon may be harvested along with their hatchery-reared counterparts (the fisheries are intended to target hatchery fish and abundant wild stocks).

There are a variety of conservation measures in place to protect threatened Pacific salmon species. All steelhead salmon must be returned to the water live upon capture, as must be with coho fisheries and for mainstem spring Chinook tangle net fisheries; steelhead is identifiable by the presence of an adipose fin. Much of the fishery has also been moved out of the mainstem and into designated sloughs and bays that overlap with hatchery releases, to increase the likelihood of harvest of hatchery fish rather than wild fish. Mainstem Columbia River fall Chinook are full-retention fisheries and are managed carefully to remain within federally approved impact limits (ODFW and WDFW 2022f).

Shad

Because the timing of the annual American shad run overlaps with those of Columbia upriver Chinook, sockeye, and steelhead, shad is harvested concurrently in gillnet fisheries with salmon and sturgeon. But, salmon conservation efforts, as well as a lack of market demand for shad (likely the main limiter (ISAB 2021)), limit the amount of shad harvested; for example, only 6% of the shad run was harvested in 2017 (ODFW and WDFW 2018). Work is ongoing to explore the feasibility of using alternative gear types (e.g., pound net, fish traps) to increase opportunities to harvest the abundant American Shad runs while minimizing the impacts to salmonids (ISAB 2021).

Overall, the fishery employs a precautionary management approach and is working actively toward recovery of white sturgeon. The score of moderately effective reflects this success, balanced by discord between the two management bodies (the states of Oregon and Washington) over whether gillnetting should be allowed in the mainstem during the fall season and nonconcurrent rules between the two states (see Justification).

Justification:

White Sturgeon

Oregon and Washington work together to ensure the protection of white sturgeon from population declines. The stock, harvest pressure, and additional ecosystem interactions are evaluated each year to determine necessary management changes. The fisheries have been managed for optimum sustainable yield since 1989. To meet these goals, harvest numbers have been reduced or length size has been increased when necessary. These efforts protect the population, but recovery for the species will not be quick—primarily because of the biological life-history characteristics of sturgeon and the response time of management. Marine mammal predation on sturgeon in the Columbia River has increased because of dams that restrict upstream movement, contributing to the difficulty in population recovery (Jones and Mallette 2011).

Fine-tuning of mesh restrictions since the 1980s has been focused on maximizing the harvest of legal fish while limiting the harvest of smaller and larger fish. In recent years of the fishery, there has been more harvest of legal fish than catch-and-release of sub-legal fish. While this parameter attests to fishery selectivity, it also indicates sub-legal abundance, which is lately a problem for the fishery (ODFW 2017a).

Salmon

The two main management entities for this fishery, the states of Oregon and Washington, have been at odds during the past several years about whether or not this fishery should continue to operate. In early 2013, both the Oregon and Washington Fish and Wildlife Commissions approved a 4-year transition plan to phase out mainstem commercial gillnetting for salmon and sturgeon in the Columbia River. The gillnet fleet was to be transitioned into bay and slough areas, where larger releases of hatchery salmon would compensate for the loss of catches of spring and summer Chinook salmon in the mainstem. Conversion of part of the gillnet fleet to purse and beach seine gear was also foreseen.

Oregon used the adaptive management provisions in the reform policy and implemented those in 2017 (ODFW 2016). Washington largely managed concurrently with Oregon while the former reviewed its policy, but then actually backed it further away from the reforms beginning in 2020 (CBB 2020)(OFWC 2017). Allocations and allowed gears remain nonconcurrent in all seasons, with Washington allocating more impacts to commercial fisheries than Oregon and allowing gillnets in all areas during all seasons (though fisheries are still managed concurrently to the most restricting state's policy) (WFWC 2020).

Proponents of the transition plan believe that gillnetting is insufficiently selective and contributes to the continuing threatened status of Columbia River populations of steelhead, Chinook, and coho salmon. But, studies of mortality rates for seine gears have generated conflicting results and inserted uncertainty into the assertion that seine gear would be more selective and less detrimental to

threatened salmon stocks than gillnets (ODFW 2015).

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

Shovelnose sturgeon in the Mississippi River basin are managed individually by multiple states where fishing is still allowed (i.e., the Ohio River, Wabash River, and Upper Mississippi River above Lock and Dam 26 (USFWS 2014)(Thornton 2018)). Season, length, and mesh restrictions are among the commonly used mechanisms for regulating state shovelnose sturgeon fisheries. Although management can be effective at each state level, harvest and habitat management is insufficiently coordinated across states. Effective regional management plans are needed to promote population persistence and ensure long-term productivity. To provide this integrated approach to management of the species, the MICRA (Mississippi Interstate Cooperative Resource Association) Paddlefish and Sturgeon Committee was established in 1992. Despite concerted efforts over the past decades that have improved the state of knowledge about Mississippi River paddlefish, MICRA has not been able to persuade all individual states to adopt basin-wide rules and regulation. The last Upper Mississippi River Conservation Committee (UMRCC) Fisheries Compendium has listed several efforts that should be the focus for management and restoration of the species: "(1) implementation of structural habitat features, (2) alterations of flow variability necessary to maintain and enhance both natural and manmade habitats, (3) monitor and adapt harvest regulations based on assessment, and (4) continued monitoring of populations to ensure shifts in harvest after the Similarity of Appearance ruling are sustainable" (UMRCC 2020). The rating of moderately effective balances the presence of state management approaches with the general absence of regional, range-wide approaches.

Justification:

Table 5. State regulations for shovelnose sturgeon commercial fishing in the Upper Mississippi River (UMRCC 2020).

State	Commercial water	Length limit	Season
WI	Mississippi River	WI/MN border: minimum of 25 in (trot line only) WI/IA border: harvest slot of 27–34 in	All year
IA	Mississippi River	IA/WI border: harvest slot of 27–34 in IA/IL border: minimum of 27 in	Oct. 15–May 15
IL	Mississippi River (above L&D 26 at Alton, IL)	Harvest slot of 24–32 in	Oct. 1–May 31
MO	Mississippi River (above L&D 26 at Alton, IL)	Harvest slot of 24–32 in	Oct. 15–May 15

The multistate management of sturgeon and paddlefish limits effective recovery of the populations, partly because of the limited communication and action among researchers, managers, and public stakeholders over appropriate geographic and disciplinary boundaries (Garvey et al. 2010). Recovery of the species group has been deemed ineffective in the past because range-wide management plans

and population estimates are lacking and biological timeframes and targets are not defined (Pikitch et al. 2005).

On the other hand, considering the status of sturgeon species globally, shovelnose sturgeon may be in the best condition of all (Phelps et al. 2016). This probably results from its life-history characteristics (earlier average age at maturity, smaller size, and shorter lifespan). Of the states where shovelnose sturgeon is found, some have maintained commercial fisheries and some have maintained recreational fisheries, but few have maintained both: populations are being monitored to varying degrees in each state, and instability/fluctuations as well as the ESA "Threatened" listing of 2010 (due to the similarity of appearance of pallid sturgeon (FR 2010)) have led to the closure of several fisheries. Although there was concern that fishing closures could potentially shift pressure to areas where harvest still occurs and lead to overharvest of shovelnose sturgeon populations in areas outside the range of pallid sturgeon, the justification given was that shovelnose sturgeon that occupy waters outside the areas regulated by this rule are subject to individual state commercial fishing regulations (Table 5), and those states indicated that their existing regulations are adequate to allow the sustainable harvest of the species (UMRCC 2020).

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderately Effective

Paddlefish in the Mississippi River are managed by each state along its range. Currently, six states have commercial fisheries for the species: Arkansas, Illinois, Indiana, Kentucky, Missouri, and Tennessee (MICRA 2023). The states of Alabama and Mississippi each closed their commercial fishery indefinitely in 2018 and 2019, respectively (MICRA 2023). Season, length, reporting requirements, and mesh restrictions are among the commonly used mechanisms for regulating state paddlefish fisheries (see Table 6 in the Justification). More recently, based on studies focusing on water temperature data and paddlefish mortality, standardized season dates were agreed to among the states, based on a 58 °F water temperature to reduce paddlefish mortality; however, changes in regulations and season length in most states are still needed (MICRA 2023).

To provide this integrated approach to management of the species, the MICRA (Mississippi Interstate Cooperative Resource Association) Paddlefish and Sturgeon Committee was established in 1992. Initiatives of MICRA include the National Paddlefish Stock Assessment Database, which was created in 1995 in partnership with the U.S. Fish and Wildlife Service (USFWS). The database contains records from state agencies that stock, tag, collect, and recapture paddlefish to quantify and better understand paddlefish population status, habitat requirements, and movement patterns. Concerted efforts over the past decades have improved the state of knowledge about Mississippi River paddlefish, but it was only quite recently that MICRA was able to persuade all individual states to adopt some basin-wide rules and regulations (MICRA 2023).

In 2008, a cooperative management plan for the lower Mississippi River commercial paddlefish fisheries was proposed between the Arkansas Game and Fish Commission, Tennessee Wildlife Resources Association, and Mississippi Department of Wildlife, Fisheries, and Parks. The objectives of the management plan were to prevent recruitment overfishing and to minimize bycatch losses. Unfortunately, the plan was subsequently not approved (AGFC 2012). Despite past and more recent efforts to promote the integration of management measures among states, many studies over the

years have highlighted the need for a framework encompassing the life history of the species, including a series of reference points (e.g., (Pikitch et al. 2005)(Scarnecchia et al. 2019b)), because available studies most commonly concern pieces of a stock and are insufficient as part of a recovery strategy (Scarnecchia et al. 2019b). Finally, with a combination of fishing areas, seasons, harvest restrictions, and licensing, each state conducts its fishing regulations according to its political and biological situation (Rider et al. 2019).

The rating of moderately effective balances the presence of state management approaches and a recent improvement in integrative measures with the absence of a consistent life history framework of the species (including reference points) in the river basin, which is imperative for an effective recovery strategy.

Justification:

Table 6. State regulations where a commercial paddlefish fishery is active (as of January 2023). The regulations presented are restricted to the Mississippi River, if there are multiple regulations within rivers/state. The state of Indiana currently has an active paddlefish commercial fishery in the Ohio River only. Adapted from (MICRA 2023).

Regulation	Arkansas	Illinois	Indiana	Kentucky	Missouri	Tennessee
Minimum length limit (eye to fork)	35″	28″	32″	32″	32″	34″

Gear restrictions	Statewide: Gill and trammel nets must be no less than 3.5″ bar mesh. Nets must be marked with gear tags.	Except during ice cover conditions, hoop net and baskets must be attended at least once every 72 hours. Trammel and gill nets must be attended from 10 a.m. to 4 p.m. when taking or possessing roe-bearing species.	All permitted commercial gear, but primarily gill and trammel nets are used. Minimum bar mesh for gill or trammel nets is 4″.	Statewide: Hoop nets: minimum 1″ bar mesh in Ohio, Mississippi, lower Tennessee, and lower Cumberland Rivers. Minimum of 3″ bar mesh everywhere else. Maximum of 60′ leads. Commercial gear tag must be attached on first hoop of each net. Gill and trammel nets: only permitted in the Ohio and Mississippi Rivers and can be fished weighted or as flag nets. Minimum bar mesh is 3″ in the Mississippi River. Commercial gear tag is required at every 100′ of net. Trotlines: not allowed for use in the Ohio or Mississippi Rivers for paddlefish harvest.	Trammel and gill nets must be always attended by the permittee's immediate presence where nets are set. Gill and trammel nets having a mesh smaller than 2″ bar measure, measured when wet, may not be used.	A commercial fisher (type 100, 101, and 103) that has purchased a commercial roe fish permit (supplemental) (type 108 or 110) is limited to fishing twelve (12) gill nets during paddlefish season on the Mississippi River. The only legal gear for the taking of paddlefish is five (5) inch bar mesh or greater from the Mississippi River.
Season length	Nov. 20–April 10 (142 days)	Oct. 1–May 31 (243 days)	Nov. 1–April 30 (181 days)	Nov. 1–April 30 (181 days)	Nov. 1–April 15 (166 days)	Nov. 1–April 15 (166 days)

License sales limit	None	Maximum of 50 permits in the North/South Mississippi River Zones, 10 for the Ohio River/ Mississippi South Zone.	Ohio River Roe Harvester licenses are annually capped at 15 total (resident or nonresident, in aggregate).	Statewide roe harvester permit: 101 residents, 18 nonresidents.	None	Maximum of 40 permits for roe fish species.
Reporting requirements	Commercial fishers must submit monthly reports of daily fishing activities. Roe buyers/exporters must report roe buying transactions monthly.	List all helpers before commercial season.	Maintain daily fishing records. Monthly report required. Same for roe harvesters. Roe dealers must submit a monthly dealers report.	Monthly report required of all commercial fishers. Daily transaction report required for roe harvesters. Monthly report required for roe-bearing fish buyers.	Monthly report with daily details required for commercial fishers and roe fish dealers.	Commercial fishers must submit a Daily Commercial Roe Fish Harvest Report during commercial paddlefish season. Wholesale fish dealers must submit Monthly Wholesale Fish Dealer Reports from all purchases of roe fish.
Other requirements	Commercial Fishing Permit Resident Roe Taker/Seller Permit Resident Roe Taker/Helper Permit Resident Roe Buyer/Exporter Permit Nonresident Roe Buyer Permit	Commercial sport and fishing licenses. Commercial roe harvest permit. Commercial roe dealer permit. Commercial watercraft device tag.	All nets must be marked with one gear tag for every 100' of net. All gill and trammel nets must be checked at least every 24 hours, at which time all fish captured must be removed.	Harvester permits may only be issued to nonresidents if that state will also sell a nonresident harvester permit to a Kentucky resident. Roe harvesters may only sell, ship, barter, or provide harvested roe from roe-bearing fish to a Kentucky permitted buyer, and must possess a valid bill of landing if transporting unprocessed roe.	Commercial fishing permit. Roe Fish Commercial Harvest Permit. Roe Fish Dealer Permit.	Supplemental permit required for paddlefish harvest. See TWRA website for additional regulations.

The most recent MICRA workgroup meeting listed several actions as a guideline toward cooperative interagency paddlefish management for all basin states with a current commercial fishery (MICRA 2023):

1. Cooperatively manage for $F_{30\%}$ for interjurisdictional, commercial paddlefish fisheries throughout the Mississippi River basin. Consider regulation changes (e.g., season length/dates, permit quotas, gear restrictions, and minimum length limits) as needed to achieve/maintain $F_{30\%}$.
2. All states managing commercial or recreational paddlefish fisheries participate in the development of the basin-wide framework for paddlefish management throughout the basin.
3. Update/develop sub-basin- or waterbody-specific paddlefish management plans as needed.
4. Each state managing a commercial paddlefish fishery aligns their season dates with those recommended in this report to limit harvest within a 58 °F water temperature threshold to minimize bycatch and sub-legal fish mortality.
   a. Regularly evaluate water temperatures and adjust commercial paddlefish harvest seasons as necessary to limit harvest to times when water temperatures are less than 58 °F.
5. Regularly engage law enforcement personnel in interjurisdictional paddlefish management discussions with agency biologists, including coordination meetings with neighboring states (as needed) and the MICRA Paddlefish and Sturgeon Committee.
6. Identify paddlefish harvest information needs (e.g., biologic- and law-enforcement-oriented) and standardize methods for documenting and reporting commercial paddlefish harvest data.
   a. Standardize commercial paddlefish harvest reporting to ensure comparable/meaningful metrics are collected by state management agencies.
   b. Annually submit paddlefish harvest data to MICRA with agency reports.
7. Collaboratively address priority research needs identified in this report.
8. Annually request a summary report from CITES that includes all information provided by state agencies.

Factor 3.2 - Bycatch Strategy

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Highly effective

Green sturgeon can potentially be caught as bycatch in the white sturgeon fishery. The Southern Distinct Population of green sturgeon in California is a federally listed species; as a consequence, there is no directed green sturgeon fishery in Oregon or Washington. Any green sturgeon caught in the white sturgeon fishery is to be reported and released immediately (Jones and Mallette 2011). Very few (<10) green sturgeon are retained annually by fishers as a result of misidentification.

Mesh size restrictions are in place to limit the harvest of diving birds, otters, beavers, and other wildlife that can potentially be snagged in gillnets. It is also mandatory for commercial fishers to report lost nets to the Washington State Department of Fish and Wildlife within 24 hours of loss.

A rating of highly effective is awarded; measures are in place and the retention of threatened species is minimized.

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

Pallid sturgeon is the main species of bycatch concern for Mississippi River gillnet fisheries. To reduce shovelnose sturgeon fishery impacts to pallid sturgeon, shovelnose sturgeon was listed as "Threatened" under the ESA because of their similarity of appearance (SOA). This resulted in the closure of shovelnose sturgeon fisheries in areas of the Mississippi River where shovelnose and pallid sturgeons overlap.

Some additional measures have been taken by individual states that regulate Mississippi River gillnet fisheries in their waters. For example, monofilament nets have been determined to be more lethal than multifilament nets (Bettoli and Scholten 2006) and have been banned by the state of Mississippi. Missouri and Illinois have mesh size and net length restrictions, as well as regulations stipulating that nets must be constantly attended to by operators in part of the season and at a minimum of once every 24 hours in another part of the season, to prevent ghostfishing (Illinois DNR 2012). "State management agencies are adjusting season dates to align with cooler water temperatures, which will reduce bycatch mortality" (pers. comm., R. Hupfeld, Iowa Department of Natural Resources 2022).

Because of the multiplicity of states involved in regulating the fishery, there is no cohesive bycatch strategy. The rating of moderately effective balances the proactive ESA listing approach to pallid sturgeon with the still incipient amount of cohesive regulations across the entire fishery.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderately Effective

Measures have been taken by individual states to regulate bycatch in gillnet fisheries in their waters, with alignment between some adjacent states and differences among others. For example, mesh size and net length restrictions, as well as regulations stipulating that nets must be constantly attended to by operators in part of the season and at a minimum once every 24 hours in another part of the season, are in place in Illinois to prevent ghostfishing (Illinois DNR 2012). Similar regulations are in place in the state of Missouri. Meanwhile, a discrepancy between the adjacent states of Kentucky and Tennessee in their regulations to limit bycatch has been noted, with Tennessee allowing smaller mesh sizes to be used in a longer fishing season (Hoffnagle and Timmons 1989).

Furthermore, monofilament nets have been determined to be more lethal than multifilament nets (Bettoli and Scholten 2006) and have been banned by the state of Mississippi. State management agencies are adjusting season dates to align with cooler water temperatures (threshold at 58 °F), which will reduce bycatch mortality below 15% (MICRA 2023).

Because each state has its own regulations, there are few cohesive bycatch strategies for the entire Mississippi River basin. The rating of moderately effective balances some proactive state approaches with the still minimal amount of cohesive regulations across the entire fishery.

Factor 3.3 - Scientific Research And Monitoring

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

Both fishery-dependent and -independent data are collected on the white sturgeon stock in the Columbia River (Jones and Mallette 2011) {ODFW and WDFW 2013}. Mark and recovery estimates through fishery sampling and set-line sampling, as well as harvest per angler trip in recreational fisheries, have been employed to estimate the stock status. Information is continually collected to update and better estimate natural mortality (Jones and Mallette 2011). The Oregon Department of Fish and Wildlife also has constructed age-based population models for white sturgeon, to evaluate the impacts to the population and the effectiveness of various management strategies. Annual reviews of the Columbia River white sturgeon population include stock status, predation rates, a review of in-season management actions, an accounting of fish left unharvested, a review of sturgeon harvest in areas outside the main stem lower Columbia River, bycatch in all fisheries, and recommended management changes (ODFW 2017a). Encounters with green sturgeon and the retention of salmon species must be reported, and statistics are maintained. But, research on bycatch is not as thorough as research on harvesting impacts to white sturgeon. There are no annual estimates of bycatch mortality of green sturgeon or of post-release mortality of sub-legal white sturgeon. Observer coverage in the fishery is limited. A rating of moderately effective balances the solid research with respect to the target species versus the less substantive research on bycatch species.

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

Nearly half the states with shovelnose sturgeon populations regularly monitor the species, and the focus of that work is primarily on population dynamics. States have started to partner with federal agencies, universities, and other organizations to help ensure the conservation of the species. More research is needed to adequately monitor and manage sturgeon populations (Koch and Quist 2010), but because data are used to monitor and maintain the shovelnose sturgeon stock, we rate scientific research and monitoring as moderately effective.

It is further noted that there is also a lack of publicly available research on the occurrence of bycatch species besides pallid sturgeon in the shovelnose sturgeon fishery, and on species composition and volumes in the fishery.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderately Effective

Because each state separately manages paddlefish populations, any research and monitoring is typically at a limited spatial scale, to better inform local management decisions. Some states, but not all, regularly monitor the species, and even fewer estimate fishing mortality. The necessary research and monitoring efforts to support range-wide management do not yet exist, including bycatch research and monitoring. But, because some data related to paddlefish stock abundance and health

are collected and analyzed, we rate this factor as moderately effective.

Justification:
In the Mississippi River, each state maintains a program to monitor the abundance of paddlefish in that state's waters. Because the species' inherent resilience is low, it is well recognized that fishing pressure can have a major impact on the population. Most states aim to collect information that supports an evaluation of the impact of the fishery on the current stock (Scholten 2009). In addition to harvest, factors that need to be considered in the management of paddlefish are habitat quality, movement patterns, and variability in population characteristics. Additional information is needed to determine the effects of paddlefish habitat alteration and potential threats to key habitats on the population (Gerken and Paukert 2009). Large-scale movement patterns of paddlefish throughout the Mississippi River basin are just beginning to be understood (Pracheil et al. 2012). Understanding and describing such movement will be necessary to define effective jurisdictions at a scale for which paddlefish should be managed. The spatial and temporal variabilities of paddlefish are not understood at a broad scale. Within particular river drainages, the variability of population characteristics should be quantified to create more effective management plans that are grounded in more accurate representations of a population over a large geographic area (DeVries et al. 2009). An example of this is the recent splitting of the Alabama paddlefish fishery into three management areas, on the basis of research suggesting that there are meaningful genetic distinctions among populations in these areas (Alabama Department of Conservation and Natural Resources 2017).

Major threats to paddlefish have been recognized. Understanding the degree to which each threat contributes to the population at a local and regional scale will increase the effectiveness of strategies to protect the population. Although there is some effort to collect the necessary information, there is a need for much more research to have a more complete understanding. Furthermore, the research needs listed in the 2023 MICRA workshop report include: age validation (for better accuracy in dynamic rate functions estimates), spatially explicit population modeling (accounting for heterogeneity in population demography), sensitivity analysis (to better understand the effect of input values in stock assessment plus reference points), conservation and management: abiotic and biotic causes of fluctuating harvest rates and stocks (MICRA 2023). In addition, the work group recommended the development of a basin-wide paddlefish management framework, to foster consistent data collection, reporting, and analysis among states within the basin so that comparisons can be made and that all data can be used in any basin-wide analysis, if needed (MICRA 2023). It is noted that publicly available research on the occurrence of bycatch species in the paddlefish fishery, as well as the species composition and volumes in the fishery, are also lacking.

Factor 3.4 - Enforcement Of Management Regulations

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Highly effective
The Oregon State Police Fish and Wildlife Division and Washington Department of Fish and Wildlife Enforcement Division, as well as Columbia River Inter-Tribal Fisheries Enforcement, enforce regulations to protect white sturgeon in the Columbia River. Staffing limitations do not allow for the observer coverage needed to enable extensive enforcement of regulations, and in the last few years

there has been increased concern about sturgeon poaching operations on the Columbia River (SciTech 2015). But, fishery managers and law enforcement do use the tools at their disposal to attempt to limit poaching. For example, in spring 2017, all recreational fisheries in the Gilbert River on Sauvie Island, near Portland in the Columbia River, were closed after sturgeon poaching operations were detected (ODFW 2017c). In 2022, five sturgeon (including one sturgeon 7 feet long), were rescued from a poaching attempt in Oregon (BND 2022). ODFW also has a cash reward and hunter preference points program for turning in poachers, as an incentive to report any suspicious activity (ODFW 2022). The score of highly effective is awarded for this evidence of effective antipoaching efforts.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

Poaching enforcement for Mississippi River gillnet fisheries is conducted on a state-by-state basis, and is presumed to be stronger in some states than others, although information is not readily available to conduct a state-by-state comparison. In 2013, federal and Missouri state enforcement agencies arrested, cited, and charged a large number of people associated with poaching activities to support the caviar market, both domestically and internationally (Morris 2013). Oklahoma does not have a commercial fishery, but has a recreational fishery for paddlefish (therefore, it is outside the scope of these recommendations, yet provides a relevant example of a progressive state management approach). This fishery operates an innovative program in which fishers turn in their sturgeon catch to the Paddlefish Research Center, where the meat is cleaned and packed for free and returned to the fisher, while the eggs are extracted and made into caviar products that are sold predominantly to Japan, with all proceeds going to the Oklahoma Department of Wildlife Conservation. The program has been effective in generating money to support law enforcement and antipoaching capacity in Oklahoma (National Geographic 2016). The rating of moderately effective reflects the variability of enforcement depending on the state.

Factor 3.5 - Stakeholder Inclusion

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Highly effective

The opening and closing of commercial fisheries is handled through the Columbia River Compact. There is an opportunity for members of the public to provide input during the "public testimony" portion of these proceedings. The states of Oregon and Washington also have Recreational and Commercial Advisory Groups made up of at-large members of the public—both of these are additional opportunities for public input outside of Commission meetings. These bodies serve in an advisory role to the states, providing input on the shaping of fisheries. Furthermore, the Washington Department of Fish and Wildlife recently solicited public comments on the Lower Columbia River fisheries reform effort, offering stakeholders the options of testifying and of submitting comments by email {WDFW 2016}. Because the management process is transparent and includes stakeholder input, a rating of highly effective is awarded.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderately Effective

There have been some targeted efforts to include stakeholder input in the Mississippi River gillnet fishery management of particular states. For example, the Tennessee Wildlife Resources Agency consulted with representatives of the commercial fishing industry in setting fishing regulations in Kentucky Lake, to try and build the support of all stakeholders {Bettoli et al. 2011}. Furthermore, Missouri solicited input from the public in order to learn from fishers' expert knowledge before developing new regulations (MDC 2013). Other states have also solicited information from fishers in this way. But, information is not often made easily and publicly available in order to foster this stakeholder inclusion. Therefore, we have rated this factor moderately effective.

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***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Columbia River | America, North - Inland Waters | Drift gillnets | United States	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**

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 - Impact of Fishing Gear on the Habitat/Substrate

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Score: 3

The entirety of the Columbia River below the Bonneville Dam is affected by tidal waters and is estuarine in nature. The dominant historical landforms here are wetlands and tidal marsh, with high sediment loads and little boulder and bedrock habitat. But, damming and channelization have markedly affected river geomorphology, resulting in loss of marsh and wetland habitat {US Army Corps of Engineers 2013}. The score of 3 reflects the use of a gillnet with a riverbed substrate that has little boulder habitat.

Justification:

Drift gillnets will not often come in contact with the river bottom, so they do not cause considerable damage on the finer sediment substrates that dominate in the fishing zone. If gillnets are swept across the bottom while moving with the current, there is potential to cause some damage, but it would likely be minimal. Weights hang from the bottom of gillnets to maintain an open net, but any damage caused by the weights is a relatively small factor in the overall impact of the fishery. A few gillnets do become damaged, lost, or left during harvest operations, and can potentially scrape or damage the river bottom.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Score: 3

Paddlefish and shovelnose sturgeon use a variety of habitats in different seasons and at different stages in their life cycles. For example, paddlefish spawns in faster-moving waters with gravel substrates, while it often feeds and rears in off-channel and backwater river sections with slower and deeper waters. Shovelnose sturgeon is often found at the bottom of main channels and bays of large, turbid rivers, where currents are strong enough to keep the gravel substrate clear of silt (Georgia Aquarium 2017). A score of 3 is given because paddlefish and sholvenose sturgeon do not particularly congregate in boulder habitats where gillnets could damage the substrate {Montana Fish Wildlife and Parks 2014}.

Justification:

Set gillnets will not often come in contact with the river bottom, so they do not cause considerable damage on the finer sediment substrates that dominate in the fishing zone. A few gillnets do become damaged, lost, or left during harvest operations, and can potentially scrape or damage the river bottom.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States
Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States
Columbia River | America, North - Inland Waters | Drift gillnets | United States

Score: 0
Fishery zone closures do not appear to be in effect for the purpose of protecting substrates, resulting in no additional points for the fishery. But, the presumed minimal impact of gillnets on the river bottom does not necessitate action to mitigate any negative impacts.

Factor 4.3 - Ecosystem-based Fisheries Management

Columbia River | America, North - Inland Waters | Drift gillnets | United States

Moderate Concern
White sturgeon does not fill the role of an exceptional species that plays a disproportionately important role relative to its biomass, although its interactions as both predator and prey do contribute to healthy ecosystem functioning. These interactions have increased pinniped predator abundances (California and Steller sea lions, and harbor seal) near sturgeon spawning grounds (Stansell et al. 2014). Sea lion predation of white sturgeon is routinely monitored on the Columbia River (ODFW 2017a). The fishery lacks spatial management or other policies to protect ecosystem functioning and account for the capture species' ecological role, but detrimental food web impacts are not likely. Therefore, we rate this a moderate concern.

Justification:
There are also various hatchery programs that release approximately 48,000 hatchery sturgeon annually into the Columbia and Kootenai Rivers {CRITFC 2015}. The effects of these efforts on the population or within the ecosystem have not been extensively researched, although similar research on impacts of salmon hatcheries in the Columbia River is ongoing.

Mississippi River Basin | America, North - Inland Waters | Drift gillnets | United States

Moderate Concern
Shovelnose sturgeon helps to structure benthic communities but does not contribute disproportionately to ecosystem function and services as an exceptional species. Acipenseriformes, which have existed for over 100 million years, face serious threats from anthropogenic habitat disturbances. These species are dependent upon specific water temperatures and flow dynamics; a lack of genetic variation may decrease the ability to cope with such changes. Reintroduction of shovelnose sturgeon adults and hatchery-reared shovelnose sturgeon juveniles and larvae takes place in various locations throughout the range, but the effects of these efforts on the population or within the ecosystem are not yet well understood {Koch and Quist 2010}. In addition, hybridization between pallid and shovelnose sturgeons may potentially affect EBFM (in issues such as the accuracy of local demographic estimations for both stock and recruitment, and how those affect management actions) {Jordan et al. 2019}. The fishery lacks spatial management or other policies to protect ecosystem functioning and account for the capture species' ecological role, but detrimental food web impacts are not likely. Thus, we rate ecosystem-based fisheries management a moderate concern.

Mississippi River Basin | America, North - Inland Waters | Set gillnets | United States

Moderate Concern

Paddlefish influences plankton community structure but does not contribute disproportionately to ecosystem function and services as an exceptional species. Acipenseriformes, which have existed for over 100 million years, face serious threats from anthropogenic habitat disturbances. These species are dependent upon specific water temperatures and flow dynamics, and a lack of genetic variation may decrease the ability to cope with such changes. Paddlefish is sometimes stocked to enhance the population. It is necessary to understand the impacts of these practices on the conservation of genetic diversity. Research is being conducted and further developed to better understand spatial genetic structuring as well as variants that may be necessary for long-term sustainability {Slossvet al. 2009}. The fishery lacks spatial management or other policies to protect ecosystem functioning and account for the capture species' ecological role, but detrimental food web impacts are not likely. Thus, we rate ecosystem-based fisheries management a moderate concern.

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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.

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Appendix A: Review Schedule

Appendix B: Summary of updates

Summary of the main changes to the recommendations since the previous recommendation for this fishery was published (2013):

2018 update

- New fishery unit (Alabama River gillnet, drift—American paddlefish) added. This fishery has been operating since 2013.
- White sturgeon Criterion 1 rating changed from Yellow to Green. Fishing mortality has been quite low in 2014 to 2016 due to the closure of the fishery below the Bonneville Dam.
- White sturgeon Criterion 2 rating changed from Red to Yellow. No discard modifier was applied because of sufficient evidence of high post-release survival.

2023 update

- The fishery Alabama River gillnet, drift—American paddlefish, which was added in 2018, was removed in this assessment because of the permanent closure of the fishery.
- Shovelnose sturgeon Criterion 1 changed from Yellow to Red. The abundance score, which was previously based on a productivity-susceptibility analysis (PSA), is now based on the IUCN "Vulnerable" status.
- Pallid sturgeon was removed from Criterion 2 in the shovelnose sturgeon fishery because fishing is now prohibited wherever there is overlap between the species.
- The recommendations for white sturgeon, shovelnose sturgeon, and paddlefish remain as Good Alternative.