

# Monterey Bay Aquarium Seafood Watch®

## Sturgeon & Paddlefish (US)

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



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

## Drift gillnets (driftnets)

11/5/18

*Seafood Watch Consulting Researcher*

### Disclaimer

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

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## **About Seafood Watch**

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

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

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

## **Guiding Principles**

Seafood Watch defines sustainable seafood as originating from sources, whether fished<sup>1</sup> 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, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

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

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

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

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<sup>1</sup> "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

## **Summary**

This report covers gillnet fisheries for wild paddlefish and white and shovelnose sturgeon in the US. White sturgeon (*Acipenser transmontanus*), shovelnose sturgeon (*Scaphirhynchus platorhynchus*), and American paddlefish (*Polyodon spathula*) represent three of twenty-seven species of two families in the order Acipensiformes that live exclusively in the Northern Hemisphere (twenty-five sturgeon species, two paddlefish species). While also a source of meat, these species are most valued for their caviar: demand for black caviar has been responsible for heavy fishing pressure on Acipensiformes species for over 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 global supply. Most (82%) of the black caviar sold in the US is also produced in the US. There is no estimate available on the proportion of US black caviar production by US fisheries, but it is presumed to be small (0 to 3%), with farmed California sturgeon accounting for most production.

White sturgeon live along the US West Coast and primarily use 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 commercial and sport fisheries. A commercial driftnet fishery that 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).

Management strictly limits fish length and excludes mature females, which are thus not directed for caviar. Eighty percent of the limited fishery is allotted to sport fishing and the remaining twenty percent 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 exclusion, as much as possible, of the highly vulnerable green sturgeon from bycatch.

Shovelnose sturgeon are found in the Mississippi and Missouri Rivers and their tributaries. Although shovelnose sturgeon range has constricted, remaining populations are stable. Pallid sturgeon (*Scaphirhynchus albus*), listed as endangered in 1990, has an overlapping range with shovelnose sturgeon, and the two species are difficult to tell apart. Consequently, shovelnose sturgeon were listed as threatened in 2010 to protect pallid sturgeon. Because of this a commercial fishery only exists in a handful of states.

Similarly, Paddlefish historically inhabited much of the Mississippi River basin, but their range is now more restricted because of local extirpations over the years. River modification and overfishing have contributed to these declines. Besides the Mississippi basin, paddlefish are also commercially fished on a limited basis in the Alabama River.

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 facing similar threats. However, it is not a regulatory body, and MICRA has not been able to persuade all individual states to adopt basin-wide rules and regulations. A recent article reviewing the status of paddlefish recommended the creation of a Mississippi River Basin Interstate Fishery Commission (Hupfield 2016).

Despite some issues with bycatch of endangered fish species, the Mississippi River paddlefish and shovelnose sturgeon fisheries, the Alabama River paddlefish fishery, and the Columbia River white sturgeon fishery are rated by Seafood Watch as a "Good Alternative."

## Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Paddlefish United States of America Alabama River, Set gillnets, United States of America	Yellow (2.640)	Yellow (2.640)	Yellow (3.000)	Yellow (3.000)	<b>Good Alternative (2.814)</b>
White sturgeon United States of America Columbia River, Drift gillnets, United States of America	Green (3.410)	Red (1.730)	Yellow (3.000)	Yellow (3.000)	<b>Good Alternative (2.699)</b>
Paddlefish United States of America Mississippi River Basin, Set gillnets, United States of America, Paddlefish fishery	Red (1.530)	Yellow (2.640)	Yellow (3.000)	Yellow (3.000)	<b>Good Alternative (2.455)</b>
Shovelnose sturgeon United States of America Mississippi River Basin, Set gillnets, United States of America, Shovelnose sturgeon fishery	Yellow (2.640)	Red (1.730)	Yellow (3.000)	Yellow (3.000)	<b>Good Alternative (2.532)</b>

### Scoring Guide

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

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

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern<sup>2</sup>, 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.

<sup>2</sup> 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**

The following is an analysis of US domestic commercial fisheries that target sturgeon and paddlefish. Four fishery units are broken out for assessment in this report: 1) Lower Columbia River drift gillnet fishery for white sturgeon (non-treaty commercial driftnets below Bonneville Dam), 2) Mississippi River basin set gillnet fishery for paddlefish, 3) Alabama River set gillnet fishery for paddlefish, and 4) Mississippi River basin set gillnet fishery for shovelnose sturgeon. Sport fishing for these species also occurs at these and other locations, including California (white sturgeon), Oklahoma (paddlefish), Montana (paddlefish), Nebraska (paddlefish), and South Dakota (paddlefish). This report assesses the commercial fisheries, but also accounts for the recreational fisheries in rating each of these four 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 platorhynchus*), and American paddlefish (*Polyodon spathula*), also referred to as spoonbill catfish. Each of these species are Acipenseriformes (from the order Acipenseriform) that live exclusively in the Northern Hemisphere and reproduce in fresh water. White sturgeon are found along the US West Coast from northern California to British Columbia. Shovelnose sturgeon inhabit 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 top caviar producer, exporting black caviar (primarily from the Atlantic sturgeon *A. oxyrinchus oxyrinchus*) to Europe. US black caviar production plummeted in the early 1900s due to lack of effective management and by the end of the 20<sup>th</sup> century, Russia had become the world's leading caviar trader. However, Russian stocks began to decline due to overharvest in the early 1900s and 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. As of 2014, China produced 85% of the world's sturgeon (all farmed), and wild US-harvested product accounted for only 0.03% of global sturgeon harvest (Table 1). Canada is the leading producer of wild sturgeon, but current abundance of sturgeon in that country is likewise depleted in comparison with historic abundance.

<b>COUNTRY</b>	<b>AQUACULTURE</b>	<b>WILD</b>	<b>TOTAL</b>
China	75,920	-	75,920
Russia	3,560	44	3,604
Armenia	2,931	-	2,931
Vietnam	1,300	-	1,300
US	947	28	975
Italy	850	-	850
Iran	650	41	691

Poland	472	-	472
France	350	13	363
Germany	257	-	257
Bulgaria	243	-	243
Uruguay	180	-	180
Ukraine	164	-	164
Canada	-	120	120
Others	762	27	789
<b>TOTAL</b>	<b>88,586</b>	<b>273</b>	<b>88,859</b>

Table 1: 2014 aquaculture and wild sturgeon production of the top 14 producing countries plus all other countries combined (in metric tons) (FAO 2016).

As for the particular fisheries assessed in this report, Columbia River commercial harvest of white sturgeon is at its lowest since harvest records were first kept in the late 1800s, with a harvest of less than one ton in 2015 (Figure 1). This reflects both persistent low abundance of Columbia River white sturgeon and strict harvest regulations that were first put into place in 1989 (Jones and Mallette 2011). Also, since 2014, there has been no commercial harvest or sport retention of white sturgeon below the Bonneville dam, which has significantly curtailed harvest to stimulate recovery (ODFW 2017a). Limited commercial retention of white sturgeon was allowed in 2017 downstream of the Bonneville dam.

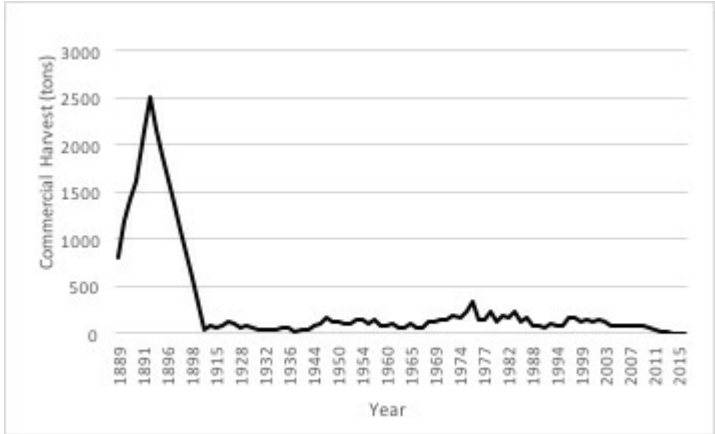


Figure 1 Commercial harvest of Columbia River white sturgeon, 1889–2015, in metric tons (ODFW 2017b).

The five states with commercial harvest of Mississippi River basin shovelnose sturgeon and the seven states that commercially harvest paddlefish, including Alabama River paddlefish (Table 2), do not appear to report their harvest statistics to NOAA’s national commercial landings repository. Louisiana’s 1986 harvest of paddlefish is the last record of harvest of that species, and no state harvests of shovelnose have been recorded in the NOAA repository (NOAA 2017). The Upper Mississippi River Conservation Committee (UMRCC) has compiled commercial harvest data for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Data from 1947



through through 2000 indicate wide annual fluctuations and no long-term, linear trend, with variations accounted for by trends in price and market for caviar rather than stock size (Figure 2).

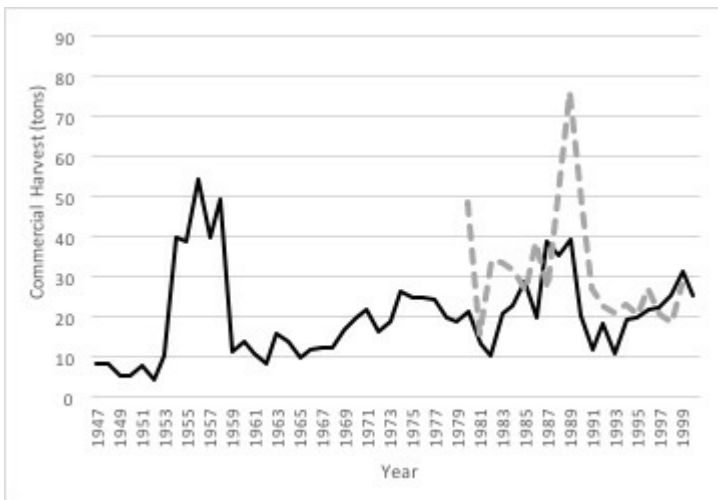


Figure 2 Upper Mississippi River commercial harvest of shovelnose sturgeon (black, solid line) and paddlefish (dotted, gray line), 1947–2000, in metric tons (UMRCC 2004).

STATE	SHOVELNOSE STURGEON	PADDLEFISH
Alabama	-	X
Arkansas	-	X
Illinois	X - only above Lock and Dam 26 at Alton, IL	X
Iowa	X	-
Kentucky	X - Ohio River only	X
Louisiana	-	-
Minnesota	-	-
Mississippi	-	X
Missouri	X - only above Lock and Dam 26 at Alton, IL	X
Tennessee		X
Wisconsin	X	-

Table 2: States operating commercial fisheries for shovelnose sturgeon and paddlefish as of summer 2017 (indicated with Xs).

### Importance to the US/North American market.

Due to 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. Reliable global production estimates are hard to come by, although a recent report pegged annual global supply at 250

tons and rising, with the possibility of doubling by 2020 (Reuters 2016). The proportion of this supply that is consumed in the US is difficult to determine: data on caviar trade in and out of the US is readily available, but information on American caviar and sturgeon meat production is not, resulting in lack of clarity regarding overall American demand for sturgeon products and caviar in particular. American caviar production can be estimated using yield coefficients. The proportion of sturgeon body weight accounted for by eggs varies by species (e.g., 6 to 9% for white sturgeon, and up to 25% for shovelnose sturgeon) (LeBreton et al. 2005). Using the low number (6%) as the coefficient results in an estimate of 58.5 tons of caviar production in the US in 2014. The 6% coefficient yields a low estimate, appropriate as a proportion of the farmed and wild-harvest production volume is male and non-egg-bearing.

According to NOAA (NOAA 2014), in 2013 to 2014 the US exported 1 ton of sturgeon caviar and imported 12 tons, with the imports contributing to filling a total US demand of 70 MT (metric tons) of black caviar, accounting for 28% of the global market. It is unclear whether or not caviar from paddlefish is counted as sturgeon caviar in NOAA's reports, or rather grouped with caviar from other unspecified fish in the much larger trade volumes listed as "unclassified." Since 1998, international trade in all species of sturgeons has been regulated under CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) to prevent overexploitation of stocks. All sturgeon and derivatives that enter international trade require accompanying CITES permits. The CITES database indicates larger American exports of black caviar (over 8 tons of shovelnose, paddlefish, and white sturgeon caviar in 2014) than those reported by NOAA (CITES 2017).

### **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* are 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 to successfully market sturgeon meat to American consumers are ongoing.

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](http://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
United States of America/Alabama River   Set gillnets   United States of America	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.640)
United States of America/Mississippi River Basin   Set gillnets   United States of America   Paddlefish fishery	2.33: Moderate Concern	1.00: High Concern	Red (1.530)

SHOVELNOSE STURGEON			
Region   Method	Abundance	Fishing Mortality	Score
United States of America/Mississippi River Basin   Set gillnets   United States of America   Shovelnose sturgeon fishery	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.640)

WHITE STURGEON			
Region   Method	Abundance	Fishing Mortality	Score
United States of America/Columbia River   Drift gillnets   United States of America	2.33: Moderate Concern	5.00: Low Concern	Green (3.410)

## Criterion 1 Assessment

### SCORING GUIDELINES

#### Factor 1.1 - Abundance

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

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

#### Factor 1.2 - Fishing Mortality

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

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

## PADDLEFISH

#### Factor 1.1 - Abundance

UNITED STATES OF AMERICA/ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA
<p><b>Moderate Concern</b></p> <p>Paddlefish sturgeon abundance in the Alabama River is not well-understood at this time. However, because they are not deemed a highly vulnerable species (see Productivity Susceptibility Analysis below) a rating of "moderate" concern is awarded.</p> <p><b>Justification:</b></p> <p>In 2013, the Alabama River paddlefish fishery was reopened, reversing a fishery closure initiated in 1988. The fishery was reopened based on model simulations of population size and age structure (Rider et al. 2012).</p>

Detailed studies on abundance have not been published, neither as rationale for reopening the fishery nor in the years that have followed.

Productivity-Susceptibility Analysis (data from (Sharov et al. 2014) and (Fishbase 2004)):

*Scoring Guidelines*

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows:

$$SS = [(S1 * S2 * S3 * S4) - 1/40] + 1 .$$

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula:  $V = \sqrt{(P^2 + S)}$

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Avg age at maturity	7	2
Avg max age	17	2
Avg max size	110 cm	2
Avg size at maturity (Lm)	79.8 cm	2
Fecundity	74,000 eggs/year	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.4	3
SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Aerial overlap (considers all fisheries)	>30% fished	3
Vertical overlap (considers all fisheries)	High overlap	3
Selectivity of fishery (specific to fishery under assessment)	Moderate selectivity	2
Post-capture mortality (specific to fishery under assessment)	Majority survive post-capture, but poachers may keep undersize individuals.	3
<b>PSA SCORE:</b>		<b>2.98, Medium</b>

## Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

### Moderate Concern

Fishing mortality relative to a sustainable level is uncertain for Alabama River paddlefish, resulting in a rating of "moderate" concern. No stock assessments have been published since the fishery reopened in 2013.

Note that in August 2018, Alabama Department of Conservation and Natural Resources (ADCNR) announced that commercial paddlefish harvest is suspended indefinitely. A review by ADCNR of the biological information and outcomes of the 2017 and 2018 commercial paddlefish seasons indicated that any future commercial paddlefish harvest seasons could lead to overfishing and jeopardize the long-term sustainability of paddlefish in the Alabama River (Courier Journal 2018).

### Justification:

Paddlefish are susceptible to overharvest and consistent overharvest runs a risk of complete extirpation (Hupfield et al. 2016). The fishery was closed in 1988 due to overharvest in the early 1980s spurred by increases in roe prices (DeVries et al. 2009). Although overharvest is a distinct possibility following reopening of the fishery in 2013, no fishing mortality estimates have been published.

## PADDLEFISH

### Factor 1.1 - Abundance

UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

### Moderate Concern

Paddlefish sturgeon abundance in the Mississippi River is not well-understood at this time. However, because they are not deemed a highly vulnerable species (see Productivity Susceptibility Analysis below) a rating of "moderate" concern is awarded.

### 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 understanding of paddlefish migratory behavior has improved over time, providing a basis upon which coordinated management could be organized (Pracheil et al. 2012). State agency biologists completed questionnaires in 1983, 1994, and 2006 (Bettoli et al. 2009) (Keenlyne 1997). In each of the surveys, the population status was qualitatively documented as extirpated, stable, increasing, decreasing, or unknown. In the most recent survey (2006), which is over 10 years old, 16 biologists reported the status of the population in their states as stable, stable/increasing, or increasing, while three states reported the status as stable/decreasing or decreasing (Bettoli et al. 2009). This comprehensive assessment of the paddlefish stock status throughout its range did not include quantitative population estimates or reference points, but rather examined relative changes in size by state, indicating a population that fluctuates both spatially and temporally.

Productivity-Susceptibility Analysis (data from (Sharov et al. 2014) and (Fishbase 2004)):

*Scoring Guidelines*

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows:  

$$S = [(s1 * s2 * s3 * s4) - 1/40] + 1$$

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula:  $V = \sqrt{(P^2 + S)}$

Productivity-Susceptibility Analysis for American paddlefish:

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Avg age at maturity	11	2
Avg max age	20	2
Avg max size	110 cm	2
Avg size at maturity (Lm)	98.7 cm	2
Fecundity	74,000 eggs/year	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.4	3
SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK 2 = MEDIUM RISK, 3 = HIGH RISK)
Aerial overlap (considers all fisheries)	>30% fished	3
Vertical overlap (considers all fisheries)	High overlap	3
Selectivity of fishery (specific to fishery under assessment)	Moderate selectivity	2
Post-capture mortality (specific to fishery under assessment)	Majority survive post-capture, but poachers may keep undersize individuals	3
<b>PSA SCORE:</b>		<b>2.98, Medium Risk</b>

## Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

### High Concern

Fishing mortality rates exceeding  $F_{40\%}$  in most systems indicate that there may be overfishing throughout the Mississippi basin, yielding a "high" concern rating (Sharov et al. 2014).

### Justification:

Paddlefish are susceptible to overharvest and consistent overharvest runs a risk of complete extirpation (Hupfield et al. 2016). A recent study found annual mortality rates in different portions of the Mississippi Basin to range from 26 to 34%, with exploitation rates of 15 to 20% (Hupfield et al. 2016). Concerns have been voiced that these exploitation rates are resulting in growth and recruitment overfishing: particularly, Sharov et al. opined that fishing mortality rates exceeding  $F_{40\%}$  in most systems points to the possibility of overfishing throughout the Mississippi Basin (Sharov et al. 2014). Furthermore, several authors have called into question existing minimum length limits and whether or not they prevent recruitment overfishing (Tripp et al. 2012) (Scholten and Bettoli 2005). However, most fishermen in Missouri voluntarily exercise a minimum length limit of 30 to 32 in (several inches beyond the actual legal minimum length of 24 in), a length at which most females have reached maturity and have spawned at least once (pers. comm., Anonymous September 2017).

In the absence of information indicating that fishermen throughout the Mississippi basin are voluntarily complying with length limits that ensure females spawn at least once before capture, a rating of "high" concern is awarded on the basis of (Hupfield et al. 2016) and (Sharov et al. 2014), which indicate that paddlefish fishing mortality could be above sustainable levels.

## SHOVELNOSE STURGEON

### Factor 1.1 - Abundance

UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

### Moderate Concern

The shovelnose sturgeon is unique among sturgeons in that the species seems to be relatively stable within its historic habitat range despite facing the same threats that have severely depleted other sturgeon species. Smaller size and earlier maturation of shovelnose may account for greater resilience to habitat and fishing impacts (Phelps et al. 2016). Because Mississippi River basin shovelnose sturgeon abundance is not well-understood at this time, and because the species is of medium vulnerability (see Productivity Susceptibility Analysis below), a rating of "moderate" concern is awarded.

### Justification:

Shovelnose sturgeon migrate throughout the Mississippi River and its tributaries, crossing multiple state jurisdictions. As with paddlefish, assessments of the population status in each of 26 states where shovelnose sturgeon were historically distributed were conducted using questionnaires in 1983, 1994, and 2006. Koch and Quist (2010) reevaluated the stock status in each state by surveying the biologist with shovelnose sturgeon authority in each of the 24 states through an online questionnaire. Of those states, nine reported that the population was stable; in two states the population had increased, and in one it had decreased. The population status in the remaining states was unknown. Roughly half of the states overlapping with shovelnose sturgeon monitor the population regularly (Koch and Quist 2010), but there are no range-wide, quantified population abundance estimates. Phelps et al. (2016) review the findings of these questionnaire-based studies, as well as place-based studies examining trends in size structure and CPUE at particular locations



within the Mississippi basin, all conducted prior to 2010. Phelps et al. paint a picture of stable stock status in the upper Missouri and upper Mississippi Rivers, concerns about how habitat fragmentation impacts stock status in the middle and lower Missouri River and middle and lower Mississippi River, and absence of data in some areas of the Ohio River (Indiana, Ohio, and Kentucky) (Phelps et al. 2016).

States will be reevaluating the population in the near future to determine the effects of partial fishery closure due to the species' similarity of appearance (SOA) listing under the Endangered Species Act, intended to prevent bycatch of the endangered pallid sturgeon (pers. comm., Anonymous 2017).

Productivity-Susceptibility Analysis: data from (Koch and Quist 2010) and (Phelps et al. 2016)

*Scoring Guidelines*

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows:  

$$S = \left[ \frac{(s1 * s2 * s3 * s4) - 1}{40} \right] + 1$$

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula:  $V = \sqrt{(P^2 + S)}$

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Avg age at maturity	6	2
Avg max age	43	3
Avg max size	108 cm	2
Avg size at maturity (Lm)	54.7 cm	2
Fecundity	25,000 eggs / year (but varies with size)	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.5	3
SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Aerial overlap (considers all fisheries)	>30% fished	3
Vertical overlap (considers all fisheries)	High overlap	3
Selectivity of fishery (specific to fishery under assessment)	Moderate selectivity	2
Post-capture mortality (specific to fishery under assessment)	Majority survive post-capture, but poachers may keep undersize individuals	3

<b>PSA Score:</b>		3.07, yellow
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## Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

### Moderate Concern

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

## WHITE STURGEON

### Factor 1.1 - Abundance

UNITED STATES OF AMERICA/COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

### Moderate Concern

The rating of "moderate" concern for Columbia River white sturgeon reflects promising increases in sub-adult and adult abundance noted in 2016. This is tempered by continuing concerns about sub-legal fish not comprising as much of the population as desirable (currently 65%, desirable 90%), and uncertainty regarding whether or not the adult conservation threshold has been met (ODFW 2017a).

### Justification:

Abundance of the adult and sub-adult white sturgeon population in the Lower Columbia River is tracked annually against two "conservation thresholds," or proxies for limit reference points, 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-recapture surveys, exceeded the adult conservation threshold. However, an alternative estimate using a regression analysis that correlated past research fishery CPUE with adult-size abundance in that same year generated a lower estimate of 4,140 fish that is below the threshold. Meanwhile, two estimates for sub-adult abundance were likewise generated using the two methods, and they both exceeded the threshold (ODFW 2017a).

## Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

### Low Concern

Because harvests have consistently been very low in 2014 due to precautionary management, the Columbia River fishery is rated as "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 sufficient numbers of juvenile white sturgeon survive fisheries so that the rate of recruitment to the broodstock population exceeds the rate of mortality for the broodstock population (Jones and Mallette 2011).

From 2011 onward, commercial harvest of white sturgeon in the Columbia 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 was prohibited from 2014 to 2016. The only commercial fisheries for white sturgeon that took place in this time period were Native American fisheries. In response to a rebound in the number of adults, however, a limited commercial harvest was allowed in fall 2017 (Oregon Live 2017), with 1,245 total fish harvested and retained in the commercial fishery over the year (WDFW 2018).

Summer openings at particular locations in the Lower Columbia basin have also been inserted into the fishery administrative rules on a temporary basis (ODFW 2017d).

## Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

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

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

### Guiding Principles

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

### Criterion 2 Summary

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

PADDLEFISH - UNITED STATES OF AMERICA/ALABAMA RIVER - SET GILLNETS - UNITED STATES OF AMERICA					
Subscore:	2.640	Discard Rate:	1.00	C2 Rate:	2.640
Species	Abundance	Fishing Mortality	Subscore		
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		
Benthic inverts	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		

PADDLEFISH - UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN - SET GILLNETS - UNITED STATES OF AMERICA - PADDLEFISH FISHERY					
Subscore:	2.640	Discard Rate:	1.00	C2 Rate:	2.640
Species	Abundance	Fishing Mortality	Subscore		
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		
Benthic inverts	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		
Shovelnose sturgeon	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		

**SHOVELNOSE STURGEON - UNITED STATES OF AMERICA/MISSISSIPPI RIVER BASIN - SET GILLNETS - UNITED STATES OF AMERICA - SHOVELNOSE STURGEON FISHERY**

<b>Subscore:</b>	<b>1.730</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.730</b>
Species	Abundance	Fishing Mortality	Subscore		
Pallid sturgeon	1.00:High Concern	3.00:Moderate Concern	Red (1.730)		
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		
Benthic inverts	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		
Paddlefish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.640)		

**WHITE STURGEON - UNITED STATES OF AMERICA/COLUMBIA RIVER - DRIFT GILLNETS - UNITED STATES OF AMERICA**

<b>Subscore:</b>	<b>1.730</b>	<b>Discard Rate:</b>	<b>1.00</b>	<b>C2 Rate:</b>	<b>1.730</b>
Species	Abundance	Fishing Mortality	Subscore		
Green sturgeon	1.00:High Concern	3.00:Moderate Concern	Red (1.730)		
Chinook salmon	1.00:High Concern	3.00:Moderate Concern	Red (1.730)		
Steelhead	1.00:High Concern	3.00:Moderate Concern	Red (1.730)		
Coho salmon	1.00:High Concern	5.00:Low Concern	Yellow (2.240)		
American shad	3.67:Low Concern	5.00:Low Concern	Green (4.280)		

The habitat range of two ESA-listed sturgeon species overlaps with that of species targeted by fisheries covered in this report: namely, green sturgeon intermingle with white sturgeon in the Columbia River (NMFS 2015) (NMFS 2014), and pallid sturgeon inhabit particular portions of the Mississippi River basin where shovelnose sturgeon are found. In both cases, red ratings for bycatch were awarded. Shovelnose and pallid sturgeons can be mistaken for one another, and results of monitoring the effectiveness of the 2010 shovelnose sturgeon ESA listing (enacted to protect pallid sturgeon) have yet to be published (USFWS 2014). Meanwhile, misidentification rates of green sturgeon are thought to be low and the vast majority are returned to the water after harvest in the white sturgeon fishery, but 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 salmon, and shad (the fishery is multi-species in nature, targeting salmon, sturgeon, and shad) (ODFW 2017d). Red bycatch ratings were attributed for Chinook salmon and steelhead salmon due to their ESA listing and, in the case of Chinook salmon, an existing NOAA "overfishing" designation. As for steelhead salmon, preliminary information on post-release mortality indicates that it is high in gillnet gear (ODFW 2017e).

No non-fish species (e.g., diving birds, otters, sea lions, beavers, etc.) were included as main species in this report, since there is no published, recent evidence of significant bycatch of these species in the fisheries. However, "unknown finfish" and "unknown benthic invertebrates" were included for the paddlefish and shovelnose sturgeon fisheries due to absence of published catch composition data for these fisheries and the unselective nature of gillnets.

## 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)

### GREEN STURGEON

#### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **High Concern**

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

##### **Justification:**

As with white sturgeon, North American green sturgeon (*Acipenser medirostris*) habitat ranges from California to Alaska along the North American west coast. While 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 (those that spawn in the Sacramento River) was listed as a threatened species under ESA on 7 April 2006 (FR 2006). The northern distinct population segment (NDPS) (spawners from the Klamath and Rogue Rivers) was reviewed by the National Marine Fisheries Service as a result of the SDPS listing. Full ESA listing was deemed unnecessary, but NMFS recognized concern over the population status and therefore the NDPS was listed as a "species of concern" (NMFS 2007). The species is threatened 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 northern and southern DPSs migrate through the Columbia River and, in recent history, more fish from the southern rather than the northern population have been sampled there. According to the latest status reports (5-year NMFS review reports for each DPS published in 2014 and 2015), information on abundance is incomplete, but on the basis of existing information, NMFS decided to maintain the "threatened" status of the SDPS and the "species of concern" status of the NDPS (NMFS 2015) (NMFS 2014).

#### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **Moderate Concern**

There is bycatch of green sturgeon in the Columbia River white sturgeon fishery. Although very little misidentification and retention occurs, post-release mortality is not known, resulting in a rating of "moderate" concern (ODFW and WDFW 2012).

##### **Justification:**

Due to the ESA listing, the sale and retention of the 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 at the beginning of 2007. Bycatch of green sturgeon in the Columbia River white sturgeon fishery is thought to be minimal. Washington State officials observed the commercial fisheries in 2011 and 2012 in the lower Columbia River and elsewhere in the state to detect rates of encounters with green sturgeon. Encounters occurred mostly in the summer/fall period. During 2012, it was estimated that 129 green sturgeon were released from white sturgeon catch and five were kept as a result of misidentification (ODFW and WDFW 2012). An earlier estimate determined that 271 SDPS green sturgeon are annually encountered in lower Columbia fisheries, with only a small number (<10) retained due to misidentification (NMFS 2008). Although a limited number of green sturgeon are encountered in Columbia River white sturgeon fisheries, and most are immediately released, post-capture mortality is unknown.

**Factor 2.3 - Modifying Factor: Discards and Bait Use**

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

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

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

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**< 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 three-day period from drift gillnet catch and release of 32 white sturgeon (LGL 2006). Furthermore, in the several years leading up to 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 with the exception of all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

CHINOOK SALMON

**Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**High Concern**

Lower Columbia River (LCR) Chinook salmon have been classified as "threatened" under the Endangered Species Act since 2005, and this designation was maintained in 2014 following status review (FR 2014). LCR fall Chinook salmon are harvested in mainstem gillnet fisheries below Bonneville dam (PFMC 2017b). The ESA listing results in a score of "high" concern.

**Justification:**

The Lower Columbia 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 2017 total Columbia River fall Chinook salmon run (582,800 returnees) is near the 30-year average following very strong returns in 2013 to 2015 (WDFW 2017). Escapements and harvest rates are monitored for indicator stocks for the two larger stock groupings that migrate upriver in summer and fall (overlapping with the 2017 white sturgeon fishery) to spawn: Columbia River summers and falls. Escapement goals for all indicator stocks were met in 2010 to 2016 (PSC CTC 2017a).

## Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

### Moderate Concern

All escapement goals for all indicator stocks have been met over the last 7 years, and no Maximum Exploitation Rate threshold was exceeded in the most recent year for which data is available (2014). However, NOAA has an overfishing designation in place for Columbia River summer Chinook salmon. A score of "moderate" concern is awarded because the conflicting information results in unknown status.

### Justification:

Exploitation rates on Columbia River Chinook salmon indicator stocks are estimated annually, both for terminal and for offshore troll fisheries. In the most recent year for which data is available (2014), exploitation rates for Columbia River summer and fall Chinook salmon ranged from 53% (Columbia fall Upriver Brights) to 75% (mid-Columbia summers) (PSC CTC 2017b). These exploitation rates do not exceed Maximum Fishing Mortality Thresholds of 75% for mid-Columbia summers and 86% for Upriver Brights (PFMC 2017). However, as of 2016 NOAA has an overfishing designation in place for Columbia River summers. 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).

## Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

### < 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 three-day period from drift gillnet catch and release of 32 white sturgeon (LGL 2006). Furthermore, in the several years leading up to 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 with the exception of all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

## STEELHEAD

### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **High Concern**

Lower Columbia River steelhead salmon have been classified as "threatened" under the Endangered Species Act since 2006, and the latest 5-year status report recommends that this designation be maintained (NMFS 2016). The ESA listing results in a score of "high" concern.

#### **Justification:**

Lower Columbia drift gillnetting in the summer and fall overlaps with runs of Columbia River steelhead salmon (*Oncorhynchus mykiss*). 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. Population status fluctuates from year to year. The Upper Columbia run for 2017 is forecast to be the lowest in over 30 years due to poor ocean conditions, with only 130,700 projected returnees to Bonneville Dam compared to 182,736 returning in 2016 (WDFW 2017).

### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **Moderate Concern**

Gillnetters on the Lower Columbia target white sturgeon and salmon concurrently, although steelhead salmon are not targeted due to their ESA listing status. Information regarding harvest rates in the gillnet fishery is not available, but preliminary studies on post-release mortality indicate cause for concern, with much higher mortality in gillnets compared with seine gears (ODFW 2017e). In the absence of more definitive information, a rating of "moderate" concern is given.

#### **Justification:**

The Lower Columbia River summer/fall drift gillnet commercial fishery targets not only sturgeon, but concurrently Pacific salmon. Because most Columbia river steelhead salmon population segments are listed under ESA, this species cannot be retained by gillnetters, and upon capture "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: 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 steelhead salmon distinct population segment all remove adipose fins from steelhead fry prior to release into the wild).

As part of the Columbia River Fisheries Reform process initiated in 2012 under then-Oregon governor John

Kitzhaber, studies are underway to determine post-release mortality of ESA-listed species in various gear types. Results have yet to be comprehensively published, but preliminary information indicates much higher mortality of steelhead salmon in gillnets than in seines (ODFW 2017e).

**Factor 2.3 - Modifying Factor: Discards and Bait Use**

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

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

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

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**< 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 three-day period from drift gillnet catch and release of 32 white sturgeon (LGL 2006). Furthermore, in the several years leading up to 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 with the exception of all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

**PALLID STURGEON**

**Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

**High Concern**

Pallid sturgeon were listed under the US Endangered Species Act (ESA) as "endangered" in 1990 primarily because of habitat alterations, but fishing practices also contributed to their decline (FR 2010). Because their status remains "endangered" in 2017 (27 years after their initial listing), a rating of "high" concern for abundance is awarded.

## Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

### Moderate Concern

In order to limit fishery mortality of pallid sturgeon due to misidentification, several shovelnose sturgeon fisheries in the Mississippi River have been closed where shovelnose and pallid sturgeon habitats overlap. Now shovelnose can only be harvested in the Ohio River, Wabash River, and Upper Mississippi River above Lock and Dam 26. However, the effectiveness of these measures needs to be assessed. Therefore, fishing mortality of pallid sturgeon is rated as "moderate" concern.

### Justification:

Pallid sturgeon are not targeted in Mississippi River fisheries due to their ESA listing but they can be caught as bycatch because their range overlaps with shovelnose sturgeon (Bettoli et al. 2009b). Quantifying pallid sturgeon mortality as bycatch is difficult because of the similarity of appearance with shovelnose sturgeon. In 2010, shovelnose sturgeon were listed as "threatened" under ESA, not because of their status, but rather because they are difficult to distinguish from pallid sturgeon (a Similarity of Appearance listing, or SOA) (FR 2010). This resulted in the closure of the commercial shovelnose fisheries in four states where shovelnose and pallid sturgeon habitat overlaps (with commercial fisheries remaining in five states today). The latest recovery plan for pallid sturgeon refers to these regulations as sufficient, but also cites the need for continued monitoring to indicate their effectiveness (USFWS 2014). This post-SOA monitoring is intended to occur soon, particularly in Missouri (pers. comm., Tripp 2017). However, in the absence of publication of such monitoring, a rating of "moderate" concern is awarded to the shovelnose fishery.

## Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

### < 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

## FINFISH

### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

#### **Moderate Concern**

There is a lack of information on the bycatch composition of paddlefish and shovelnose sturgeon fisheries, but because set gillnets are unselective, we have included unknown finfish in the assessment. The Seafood Watch Standard for Fisheries scores abundance of finfish that are not from highly vulnerable taxa as "moderate" concern.

### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

#### **Moderate Concern**

There is a lack of information on the bycatch composition of paddlefish and shovelnose fisheries, but because set gillnets are unselective, this factor is scored using the Seafood Watch Unknown Bycatch Matrix (UBM). Finfish have a high susceptibility to capture in set gillnets. Therefore, the UBM would score bycatch of finfish as "high" concern. However, the score is overridden to "moderate" concern based on the following stakeholder feedback:

- the Mississippi River fisheries typically take place in the cold months of the year (good survival of released fish),
- the Alabama River fishery takes place exclusively in February (colder water = good survival of released fish),
- large-mesh nets are used in the fisheries, reducing the number of non-target species captured, and
- among the most-commonly harvested finfish in paddlefish fisheries are invasive Asian carp (fishing mortality is desirable in order to remove them from the river) and catfish (stocks are considered to be in healthy condition and fish are legal for commercial sale in many states) (pers. comm., Anonymous 2018).

### **Factor 2.3 - Modifying Factor: Discards and Bait Use**

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

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

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

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

**< 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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). Other tagging surveys in the region suggest that this post-release mortality estimate should be considered conservative (pers. comm., Anonymous September 2017).

Another aspect of bycatch mortality is the high mortality rates (60% sub-legal bycatch, 71% of which were dead in the nets when water temperature exceeded 17°C) 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 eight days.

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

**< 100%**

In the absence of information, bycatch rates of sub-legal and juvenile fish are thought to represent substantial portions of the catch in Alabama River paddlefish fisheries as they do in Mississippi River fisheries. For example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

**< 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

## BENTHIC INVERTS

### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA  
UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

#### **Moderate Concern**

There is a lack of information on the bycatch composition of paddfish and shovelnose fisheries, but because set gillnets are unselective, we have included invertebrates in the assessment. The Seafood Watch Standard for Fisheries scores abundance of invertebrates that are not from highly vulnerable taxa as "moderate" concern.

### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA  
UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

#### **Moderate Concern**

There is a lack of information on the bycatch composition of paddfish and shovelnose fisheries, but because set gillnets are unselective, this factor is scored using the Seafood Watch Unknown Bycatch Matrix (UBM). Invertebrates have a moderate susceptibility to capture in set gillnets. Therefore, the UBM scored bycatch of invertebrates as "moderate" concern.

### **Factor 2.3 - Modifying Factor: Discards and Bait Use**

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

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

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
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<100%	1
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>=100	0.75
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UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

#### **< 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch

(Kerns et al. 2009). A tagging survey there at that time 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). Other tagging surveys in the region suggest that this post-release mortality estimate should be considered conservative (pers. comm., Anonymous September 2017).

Another aspect of bycatch mortality is the high mortality rates (60% sub-legal bycatch, 71% of which were dead in the nets when water temperature exceeded 17°C) 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 eight days.

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

< 100%

In the absence of information, bycatch rates of sub-legal and juvenile fish are thought to represent substantial portions of the catch in Alabama River paddlefish fisheries as they do in Mississippi River fisheries. For example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

< 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

SHOVELNOSE STURGEON

**Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

**Moderate Concern**

The shovelnose sturgeon is unique among sturgeons in that the species seems to be relatively stable within its historic habitat range despite facing the same threats that have severely depleted other sturgeon species. Smaller size and earlier maturation of shovelnose may account for greater resilience to habitat and fishing impacts (Phelps et al. 2016). Because Mississippi River basin shovelnose sturgeon abundance is not well-understood at this time, and because the species is of medium vulnerability (see Productivity Susceptibility Analysis below), a rating of "moderate" concern is awarded.

**Justification:**

Shovelnose sturgeon migrate throughout the Mississippi River and its tributaries, crossing multiple state

jurisdictions. As with paddlefish, assessments of the population status in each of 26 states where shovelnose sturgeon were historically distributed were conducted using questionnaires in 1983, 1994, and 2006. Koch and Quist (2010) reevaluated the stock status in each state by surveying the biologist with shovelnose sturgeon authority in each of the 24 states through an online questionnaire. Of those states, nine reported that the population was stable; in two states the population had increased, and in one it had decreased. The population status in the remaining states was unknown. Roughly half of the states overlapping with shovelnose sturgeon monitor the population regularly (Koch and Quist 2010), but there are no range-wide, quantified population abundance estimates. Phelps et al. (2016) review the findings of these questionnaire-based studies, as well as place-based studies examining trends in size structure and CPUE at particular locations within the Mississippi basin, all conducted prior to 2010. Phelps et al. paint a picture of stable stock status in the upper Missouri and upper Mississippi Rivers, concerns about how habitat fragmentation impacts stock status in the middle and lower Missouri River and middle and lower Mississippi River, and absence of data in some areas of the Ohio River (Indiana, Ohio, and Kentucky) (Phelps et al. 2016).

States will be reevaluating the population in the near future to determine the effects of partial fishery closure due to the species' similarity of appearance (SOA) listing under the Endangered Species Act, intended to prevent bycatch of the endangered pallid sturgeon (pers. comm., Anonymous 2017).

Productivity-Susceptibility Analysis: data from (Koch and Quist 2010) and (Phelps et al. 2016)

#### Scoring Guidelines

1.) Productivity score ( $P$ ) = average of the productivity attribute scores ( $p_1, p_2, p_3, p_4$  (finfish only),  $p_5$  (finfish only),  $p_6, p_7$ , and  $p_8$  (invertebrates only))

2.) Susceptibility score ( $S$ ) = product of the susceptibility attribute scores ( $s_1, s_2, s_3, s_4$ ), rescaled as follows:  

$$SS = [((s_1 * s_2 * s_3 * s_4) - 1/40) + 1]$$

3.) Vulnerability score ( $V$ ) = the Euclidean distance of  $P$  and  $S$  using the following formula:  $V = \sqrt{(P^2 + S)}$

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Avg age at maturity	6	2
Avg max age	43	3
Avg max size	108 cm	2
Avg size at maturity (Lm)	54.7 cm	2
Fecundity	25,000 eggs / year (but varies with size)	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.5	3
SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Aerial overlap (considers all fisheries)	>30% fished	3



Vertical overlap (considers all fisheries)	High overlap	3
Selectivity of fishery (specific to fishery under assessment)	Moderate selectivity	2
Post-capture mortality (specific to fishery under assessment)	Majority survive post-capture, but poachers may keep undersize individuals	3
<b>PSA Score:</b>		3.07, yellow

### Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY  
 UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

#### Moderate Concern

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

### Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

#### < 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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). Other tagging surveys in the region suggest that this post-release mortality estimate should be considered conservative (pers. comm., Anonymous September 2017).

Another aspect of bycatch mortality is the high mortality rates (60% sub-legal bycatch, 71% of which were dead in the nets when water temperature exceeded 17°C) 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 eight 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.

### **Criterion 3 Summary**

<b>Fishery</b>	<b>Management Strategy</b>	<b>Bycatch Strategy</b>	<b>Research and Monitoring</b>	<b>Enforcement</b>	<b>Stakeholder Inclusion</b>	<b>Score</b>
Fishery 1: United States of America / Alabama River   Set gillnets   United States of America	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Moderately Effective	Yellow (3.000)
Fishery 2: United States of America / Columbia River   Drift gillnets   United States of America	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)
Fishery 3: United States of America / Mississippi River Basin   Set gillnets   United States of America   Paddlefish fishery	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Yellow (3.000)

Fishery 4: United States of America / Mississippi River Basin   Set gillnets   United States of America   Shovelnose sturgeon fishery	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Yellow (3.000)
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**Criterion 3 Assessment**

**Factor 3.1 - Management Strategy and Implementation**

*Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do managers 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.*

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

**Moderately Effective**

The State of Alabama has various measures in place to limit fishing effort and harvest, including the following:

- Temporal restrictions: the winter-only season runs for only one month (February) with fishing restricted to weekdays,
- Spatial restrictions: only three reaches of one system (the Alabama River) are open to fishing,
- Limiting daily effort: fishing with gill nets is allowed only between dawn and 4:00 PM; no overnight fishing is allowed,
- Limited entry: only 12 permits are awarded annually (Alabama Department of Conservation and Natural Resources 2017); (Alabama Department of Conservation and Natural Resources 2017b).

Model simulations of population size and age structure were conducted to inform the decision to reopen the fishery in 2012 (Rider et al. 2012). The science-based approach, along with the regulatory measures listed above, are indicative of a precautionary approach and earn the fishery a score of "moderately effective" (published evidence of conservation targets and evidence that they are being implemented successfully would earn the fishery a score of "highly effective").

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**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 that 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). Due to failure to meet conservation thresholds, the entire sturgeon commercial fishery was completely closed in 2014 to 2016 with the exception of the Native American component (ODFW 2017a). Signs of population recovery set the stage for a limited commercial season in 2017, with harvest taking place in select areas in the summer and in both select areas and the mainstem in the fall (WDFW 2018) (Oregon Live 2017).

### Salmon

The gillnet fishery is a multi-species 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 fishery is intended to harvest hatchery salmon, but not wild salmon).

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 wild Chinook and coho salmon: they are 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 in order to increase the likelihood of harvest of hatchery rather than wild fish.

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 recent discord between the two management bodies (the states of Oregon and Washington) over whether or not gillnetting should be allowed in the mainstem in the fall season (see "Justification" below for more on this).

### Shad

Since the timing of the annual American shad run overlaps with Columbia upriver Chinook, sockeye, and steelhead runs, shad are harvested concurrently in gillnet fisheries with salmon and sturgeon. However, salmon conservation efforts, as well as lack of market demand for shad, 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. purse seine and beach seine) to increase opportunities to harvest the abundant American Shad runs while minimizing impacts to salmonids.

### **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 due to 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 upon maximizing harvest of legal fish while limiting 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 is indicative of sub-legal abundance, a problem for the fishery of late (ODFW 2017a).

### Salmon

The two main management entities for this fishery, the states of Oregon and Washington, have been at odds with one another over 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 four year transition plan to phase out main stem 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 main stem. Conversion of part of the gillnet fleet to purse and beach seine gear was also foreseen.

However, in late 2016, the Oregon Fish and Wildlife Commission voted unanimously to delay implementing gillnet reforms for a year (ODFW 2016). Washington, meanwhile, signified its intention to go forward with the original plan. The divergence between the two states threatened to result in quite non-concurrent regulations among the two states, who have managed Columbia River fisheries mostly in close coordination for over 100 years. However, in March 2017 the Oregon Fish and Wildlife Commission "backed off of its standoff" with Washington, halting spring and summer gillnetting in the mainstem, leaving fall gillnetting the mainstem of continued discordance with Washington (Oregon Live 2017b). In 2017, among 1,245 commercially-harvested white sturgeon, 845 were taken in the main stem and 400 in the "select area" (designated off-channel areas such as Youngs Bay, Tongue Point, and Blind and Knappa Sloughs) (WDFW 2018).

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. However, 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). Ghost fishing is another concern about gillnetting, because abandoned gillnets have been documented to result in white sturgeon mortality on the Columbia (Kappenman and Parker 2007).

#### UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

##### **Moderately Effective**

Paddlefish in the Mississippi River are managed individually by multiple states. Season, length, and mesh restrictions are among the commonly-used mechanisms for regulating state paddlefish fisheries. While management can be effective at individual state levels, 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. Initiatives of MICRA include the National Paddlefish Stock Assessment Database, created in 1995 in partnership with the US 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. Despite concerted efforts over the past 25 years 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 regulations.

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 minimize bycatch losses. Unfortunately, the plan was subsequently not approved (AGFC 2012). However, since then, the Lower Mississippi River states have begun work on a basin-wide management plan and are currently collecting supporting data, including fishing mortality estimates (pers. comm., Anonymous 2017).

The rating of "moderately effective" balances the presence of state management approaches with the absence of a regional, range-wide management regime.

**Justification:**

The multi-state management of sturgeon and paddlefish limits effective recovery of the populations, in part due to the limited communication and action among researchers, managers, and public stakeholders over appropriate geographic and disciplinary boundaries (Garvey et al. 2010). The spatial and temporal variability of paddlefish is not understood at a broad scale, but 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. Recovery of the species is currently ineffective because range-wide management plans and population estimates are lacking and biological timeframes and targets are not defined (Pikitch et al. 2005).

Paddlefish are listed in a number of states as threatened or as a species of special concern, but are fished commercially and recreationally in others. Over the past few decades, population status has been reported as stable, increasing, decreasing or unknown in each state, and in those states where populations were declining or special concerns were raised, commercial fisheries were closed. The following eight states still allow the commercial harvest of paddlefish, but with various rules and regulations: Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee. To protect and rebuild paddlefish populations to maintain the commercial and sport fisheries, many states use spawning potential ratios in efforts to prevent recruitment overfishing (Scholten 2009) (Quinn 2009). Protecting sexually immature females is also necessary to allow successful recruitment into the fishery for sustainability. Minimum length requirements for females increase the spawning potential, and changes to the length requirements have been used to adapt management when necessary for additional protection. Water temperature has a direct impact on paddlefish gametes and also triggers spawning (Jennings and Zigler 2009). As the water temperature increases, paddlefish spawning is aggregated and increases the potential for higher fishing mortality. Very high bycatch rates for sub-legal paddlefish when water is warmer at the beginning and end of the fishing season (according to one survey, 60% bycatch, 71% of which was dead in the nets when water was above 17°C) have been noted, and some state fishing seasons have thus been shortened to end before temperatures increase in order to protect the stock (Bettoli and Scholten 2006).

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

**Moderately Effective**

Shovelnose sturgeon in the Mississippi River are managed individually by multiple states. Season, length, and mesh restrictions are among the commonly-used mechanisms for regulating state shovelnose sturgeon fisheries. While management can be effective at individual state levels, 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 25 years 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 rating of "moderately effective" balances the presence of state management approaches with the general absence of regional, range-wide approaches.

**Justification:**

The multi-state management of sturgeon and paddlefish limits effective recovery of the populations, in part due to 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 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, when one looks at the status of sturgeon species globally, shovelnose may be in the best condition of all (Phelps et al. 2016). This probably results from their life history characteristics (earlier average age at maturity, smaller size, shorter life-span compared with other sturgeons). Of the states where shovelnose are 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 have led to the closure of several fisheries. This has likely contributed to the recovery of the population.

### **Factor 3.2 - Bycatch Strategy**

*Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.*

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

#### **Highly Effective**

Minimal finfish bycatch occurs in the Alabama River paddlefish fishery—for example, of channel catfish. Regulations in place in the fishery to reduce bycatch mortality include:

- Ban on overnight fishing,
- Gear restrictions: monofilament gillnets are prohibited and nets cannot exceed 200 ft in length, and
- Nets must be checked every two hours to reduce bycatch mortality (Alabama Department of Conservation and Natural Resources 2017).

The rating of "highly effective" reflects that the fishery has a highly effective and precautionary strategy designed to minimize the impacts of the fishery on bycatch species and mitigate any likelihood of ghost fishing.

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **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 are to be reported and released immediately (Jones and Mallette 2011). Very few (<10) green sturgeon are retained annually by fishers due to 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 fishermen 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 retention of threatened species is



minimized.

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

**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 per 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, 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.

Because each state has its own regulations, there is no cohesive bycatch strategy for the entire Mississippi basin. The rating of "moderately effective" balances some proactive state approaches with the lack of cohesive regulations across the entire fishery.

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

**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 were listed as "threatened" under the ESA because of their Similarity of Appearance (SOA). This resulted in the closure of shovelnose fisheries in areas of the Mississippi where shovelnose and pallid sturgeon overlap.

Some additional measures have been taken by individual states regulating 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 per 24 hours in another part of the season to prevent ghostfishing (Illinois DNR 2012) .

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 lack of cohesive regulations across the entire fishery, as well as the absence of monitoring that indicates the SOA listing has effectively prevented pallid sturgeon bycatch.

**Factor 3.3 - Scientific Research and Monitoring**

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

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

**Moderately Effective**

The Alabama fishery is known in the paddlefish researcher community for "keeping the closest tabs on the resource" among the various state fisheries (pers. comm., Anonymous June 2018). Monitoring highlights include:

- Model simulations of population size and age structure were conducted to inform the decision to reopen the fishery in 2012 (Rider et al. 2012),
- Size and age data collection from harvested fish upon delivery to processors,
- Annual stock status monitoring in three rivers (Tennessee Tombigbee, and Alabama), with commercial roe harvest presently only allowed at the Alabama River.

The rating of "moderately effective" reflects that data is collected for the purpose of stock status monitoring and precautionary management.

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**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-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 being collected to update and better estimate natural mortality (Jones and Mallette 2011). Oregon Department of Fish and Wildlife also has constructed age-based population models for white sturgeon to evaluate 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, accounting of fish left unharvested, 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 retention of salmon species must be reported and statistics are maintained. However, 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 nor 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 vs. the less substantive research on bycatch species.

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

**Moderately Effective**

As each state manages paddlefish populations individually, any research and monitoring is typically at a limited spatial scale to better inform local management decisions. Some, but not all states 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. However, because some data related to paddlefish stock abundance and health are collected and analyzed, we rate this as "moderately" effective.

**Justification:**

In the Mississippi River, each state maintains a program to monitor the abundance of paddlefish in their own respective waters. Since 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 variability of paddlefish is not understood at a broad scale. Within particular river drainages, the variability of population characteristics should be quantified to create more effective management plans 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 meaningful genetic distinctions among populations residing in these areas (Alabama Department of Conservation and Natural Resources 2017).

Major threats to paddlefish have been recognized. Understanding the degree to which each of these threats contribute 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.

It is noted that publicly-available research on occurrence of bycatch species in the paddlefish fishery and species composition and volumes in the fishery are also lacking.

#### UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

##### **Moderately Effective**

Nearly half of 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 in order 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 furthermore 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 species composition and volumes in the fishery.

### **Factor 3.4 - Enforcement of Management Regulations**

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

#### UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

##### **Highly Effective**

Alabama has fairly detailed enforceable regulations in place for paddlefish in order to deter illegal fishing. For

example, it is illegal to willfully waste paddlefish meat and take only caviar from a harvested individual. Fishing for paddlefish without a license is punishable by a minimum \$1,500 fine for the first violation and fines of \$2,000 to \$10,000 for subsequent violations. Commercial fishers and roe buyers must submit daily harvest and buying records each week. Furthermore, to enable law enforcement effectiveness, fishers can only use certain ramps to launch their boats, and fish and their roe cannot be processed on water.

During the 2018 season, reports of illegal fishing methods used by some permitted paddlefish harvesters led to Alabama Department of Conservation and Natural Resources law enforcement officers initiating an intensive investigation. This investigation resulted in 135 convictions for paddlefish fishing violations (Courier Journal 2018).

As regulations of demonstrated effectiveness are in place, a rating of "highly effective" is applied.

#### UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **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 don't 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). However, 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, not far from Portland in the Columbia River, were closed after sturgeon poaching operations were detected (ODFW 2017c). The score of "highly effective" is rewarded for this evidence of effective anti-poaching efforts.

#### UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

#### UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

##### **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 than in 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 rather a recreational fishery for paddlefish (therefore outside the scope of these recommendations, yet providing a relevant example of a progressive state management approach). This fishery operates an innovative program in which fishermen turn in their sturgeon catch to the Paddlefish Research Center, where the meat is cleaned and packed for free and returned to the fisherman, while the eggs are extracted and made into caviar products that are predominantly sold 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 anti-poaching 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

*Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.*

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA

#### **Moderately Effective**

There are examples of the Alabama authorities including and working with stakeholders on fishery management. For example, sport fishers under the umbrella of B.A.S.S Nation (an eNGO) have lobbied for safe boating laws, which have lowered boating fatalities as part of a partnership with the Alabama Department of Conservation and Natural Resources (Alabama B.A.S.S. Nation 2017).

A score of "moderately effective" is awarded for a management process that includes stakeholder input from various sources.

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **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 composed of at-large members of the public—these are both 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, 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.

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

#### **Moderately Effective**

There have been some targeted efforts to include stakeholder input in 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. However, information is not often made easily and publicly available in order to foster this stakeholder inclusion. Therefore, we have rated this factor as "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**

<b>Region / Method</b>	<b>Gear Type and Substrate</b>	<b>Mitigation of Gear Impacts</b>	<b>EBFM</b>	<b>Score</b>
United States of America / Alabama River / Set gillnets / United States of America	3	0	Moderate Concern	Yellow (3.000)
United States of America / Columbia River / Drift gillnets / United States of America	3	0	Moderate Concern	Yellow (3.000)
United States of America / Mississippi River Basin / Set gillnets / United States of America / Paddlefish fishery	3	0	Moderate Concern	Yellow (3.000)
United States of America / Mississippi River Basin / Set gillnets / United States of America / Shovelnose sturgeon fishery	3	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 - Physical Impact of Fishing Gear on the Habitat/Substrate**

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA  
 UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA,  
 PADDLEFISH FISHERY  
 UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA,  
 SHOVELNOSE STURGEON FISHERY

**3**

Paddlefish and shovelnose sturgeon use a variety of habitats in different seasons and at different stages in their life cycle. For example, paddlefish spawn in faster-moving waters with gravel substrates, while they often feed and rear in off-channel and backwater river sections with slower and deeper waters. Shovelnose sturgeon meanwhile are 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 do damage to the substrate (Montana Fish Wildlife and Parks 2014).

**Justification:**

Set gillnets will not often come in contact with the river bottom and thus 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 which can potentially scrape or damage the river bottom.

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

**3**

The entirety of the Columbia River below 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. However, damming and channelization has impacted river geomorphology markedly, 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 and thus 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 which can potentially scrape or damage the river bottom.



## Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA  
UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA  
UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA,  
PADDLEFISH FISHERY  
UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA,  
SHOVELNOSE STURGEON FISHERY

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. However, 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

UNITED STATES OF AMERICA / ALABAMA RIVER, SET GILLNETS, UNITED STATES OF AMERICA  
UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA,  
PADDLEFISH FISHERY

### Moderate Concern

Paddlefish influence plankton community structure but do not contribute disproportionately to ecosystem function and services as exceptional species. These Acipenseriformes, whose history goes back over 100 million years, face serious threats with anthropogenic habitat disturbances. They 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 are sometimes stocked to enhance the population. It is necessary to understand the impacts of these practices on 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 capture species' ecological role, but detrimental food web impacts are not likely. Thus, we rate ecosystem-based fisheries management as "moderate" concern.

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

### Moderate Concern

White sturgeon do not fill the role of an exceptional species that play a disproportionately important role relative to their biomass, although their interactions as both predator and prey do contribute to healthy ecosystem functioning. These interactions have increased pinniped predator abundances (California and Stellar Sea Lion 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 capture species' ecological role, but detrimental food web impacts are not likely. Therefore, we rate this as "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 is ongoing.

**Moderate Concern**

Shovelnose sturgeon help structure benthic communities but do not contribute disproportionately to ecosystem function and services as exceptional species. These Acipenseriformes, whose history goes back over 100 million years, face serious threats with anthropogenic habitat disturbances. The species is 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). The fishery lacks spatial management or other policies to protect ecosystem functioning and account for capture species' ecological role, but detrimental food web impacts are not likely. Thus, we rate ecosystem-based fisheries management as "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: Extra By Catch Species**

### COHO SALMON

#### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **High Concern**

Lower Columbia River coho salmon have been classified as "threatened" under the Endangered Species Act since 2005, and this designation was maintained in 2014 following status review (FR 2014). The ESA listing results in a score of "high" concern.

##### **Justification:**

The Lower Columbia 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, for example, in 2014, coho salmon can be the dominant species in the Lower Columbia River catch (ODFW 2017b). Columbia River coho salmon spawning migrations occur in late summer through fall, overlapping with 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, with a fair amount of variance between year classes: e.g., a peak of 280,000 returnees to the Bonneville dam in 2014 vs. 37,400 in 2015 (PFMC 2017b). An exploitation rate goal is in place for Lower Columbia River coho salmon, and tributary abundance targets are also included in the Lower Columbia salmon recovery plan (NMFS 2016).

#### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **Low Concern**

The cumulative exploitation rate for Lower Columbia River (LCN) coho salmon in 2016 was 7.6%, well below the management threshold of 17% (PFMC 2017b).

##### **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).

#### **Factor 2.3 - Discard Rate**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

##### **< 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 three-day period from drift gillnet catch and release of 32 white sturgeon (LGL 2006). Furthermore, in the several years leading up to 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 with the exception of all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

## AMERICAN SHAD

### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **Low Concern**

The 2017 run of American shad in the Columbia River of 3.3 million fish was the largest since a nearly 4-million-fish run in 2013, and was well above the recent 5-year average of 2.5 million (ODFW and WDFW 2018). A rating of "low" concern is awarded because recent run sizes are within ranges considered healthy.

### **Factor 2.2 - Fishing Mortality**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **Low Concern**

In 2017, the commercial and recreational Columbia River fisheries accounted for a combined 6% of American shad mortality (ODFW and WDFW 2018). A rating of "low" concern is awarded because the fishery's contribution to mortality is considered low enough to not adversely affect the population.

### **Factor 2.3 - Discard Rate**

UNITED STATES OF AMERICA / COLUMBIA RIVER, DRIFT GILLNETS, UNITED STATES OF AMERICA

#### **< 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 three-day period from drift gillnet catch and release of 32 white sturgeon (LGL 2006). Furthermore, in the several years leading up to 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 with the exception of all steelhead salmon and non-adipose clipped Chinook and coho salmon (ODFW 2017d).

## PADDLEFISH

### **Factor 2.1 - Abundance**

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

#### **Moderate Concern**

The shovelnose sturgeon is unique among sturgeons in that the species seems to be relatively stable within its historic habitat range despite facing the same threats that have severely depleted other sturgeon species. Smaller size and earlier maturation of shovelnose may account for greater resilience to habitat and fishing impacts (Phelps et al. 2016). Because Mississippi River basin shovelnose sturgeon abundance is not well-understood at this time, and because the species is of medium vulnerability (see Productivity Susceptibility Analysis below), a rating of "moderate" concern is awarded.

**Justification:**

Shovelnose sturgeon migrate throughout the Mississippi River and its tributaries, crossing multiple state jurisdictions. As with paddlefish, assessments of the population status in each of 26 states where shovelnose sturgeon were historically distributed were conducted using questionnaires in 1983, 1994, and 2006. Koch and Quist (2010) reevaluated the stock status in each state by surveying the biologist with shovelnose sturgeon authority in each of the 24 states through an online questionnaire. Of those states, nine reported that the population was stable; in two states the population had increased, and in one it had decreased. The population status in the remaining states was unknown. Roughly half of the states overlapping with shovelnose sturgeon monitor the population regularly (Koch and Quist 2010), but there are no range-wide, quantified population abundance estimates. Phelps et al. (2016) review the findings of these questionnaire-based studies, as well as place-based studies examining trends in size structure and CPUE at particular locations within the Mississippi basin, all conducted prior to 2010. Phelps et al. paint a picture of stable stock status in the upper Missouri and upper Mississippi Rivers, concerns about how habitat fragmentation impacts stock status in the middle and lower Missouri River and middle and lower Mississippi River, and absence of data in some areas of the Ohio River (Indiana, Ohio, and Kentucky) (Phelps et al. 2016).

States will be reevaluating the population in the near future to determine the effects of partial fishery closure due to the species' similarity of appearance (SOA) listing under the Endangered Species Act, intended to prevent bycatch of the endangered pallid sturgeon (pers. comm., Anonymous 2017).

Productivity-Susceptibility Analysis: data from (Koch and Quist 2010) and (Phelps et al. 2016)

*Scoring Guidelines*

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows:  

$$SS = [(P1 * P2 * P3 * P4) - 1/40] + 1.$$

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula:  $V = \sqrt{P^2 + S}$

PRODUCTIVITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Avg age at maturity	6	2
Avg max age	43	3
Avg max size	108 cm	2
Avg size at maturity (Lm)	54.7 cm	2
Fecundity	25,000 eggs / year (but varies with size)	1

Reproductive strategy	Broadcast spawner	1
Trophic level	3.5	3
SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFORMATION	SCORE (1 = LOW RISK, 2 = MEDIUM RISK, 3 = HIGH RISK)
Aereal overlap (considers all fisheries)	>30% fished	3
Vertical overlap (considers all fisheries)	High overlap	3
Selectivity of fishery (specific to fishery under assessment)	Moderate selectivity	2
Post-capture mortality (specific to fishery under assessment)	Majority survive post-capture, but poachers may keep undersize individuals	3
<b>PSA Score:</b>		3.07, yellow

## Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, PADDLEFISH FISHERY

### Moderate Concern

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

## Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / MISSISSIPPI RIVER BASIN, SET GILLNETS, UNITED STATES OF AMERICA, SHOVELNOSE STURGEON FISHERY

### < 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 Mississippi River shovelnose sturgeon and paddlefish fisheries; for example, in the Kentucky Lake fishery in 2004 to 2006, sub-legal paddlefish accounted for 75% of the catch (Kerns et al. 2009). A tagging survey there at that time 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).

## **Appendix B: Summary of Changes**

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

- 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 closure of the fishery below the Bonneville Dam.
- White sturgeon Criterion 2 rating changed from red to yellow. No discard modifier was applied due to sufficient evidence of high post-release survival.

## **Appendix C: Review Schedule**

An annual review of Lower Columbia River white sturgeon population status and management occurs in January. A briefing summarizing review results and public input is published subsequently. Contact person: Tucker A. Jones, Oregon Department of Fish and Wildlife, [tucker.a.jones@state.or.us](mailto:tucker.a.jones@state.or.us)