

# Monterey Bay Aquarium Seafood Watch®

White sturgeon, Shovelnose sturgeon, American Paddlefish

*Acipenser transmontanus, Scaphirhynchus platorhynchus, Polyodon spathula*



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**U.S.**  
Drift gillnet

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## **About Seafood Watch®**

The Monterey Bay Aquarium Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the North American marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's mission is to engage and empower consumers and businesses to purchase environmentally responsible seafood fished or farmed in ways that minimize their impact on the environment or are in a credible improvement project with the same goal.

Each sustainability recommendation is supported by a seafood report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's sustainability criteria to arrive at a recommendation of "Best Choice," "Good Alternative," or "Avoid." In producing the seafood reports, Seafood Watch utilizes 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 with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying seafood reports will be updated to reflect these changes. Both the detailed evaluation methodology and the scientific reports, are available on [seafoodwatch.org](http://seafoodwatch.org).

For more information about Seafood Watch and seafood reports, please contact the Seafood Watch program at Monterey Bay Aquarium by calling 1-877-229-9990 or visit online at [seafoodwatch.org](http://seafoodwatch.org).

### Disclaimer

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

## 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 capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species under assessment
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and score
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rating** for that criterion

Once a score and rating has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

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

**Best Choice/Green:** Are well managed and caught or farmed 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 or farmed.

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

## Summary

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 only in the Northern Hemisphere. These are among the oldest living species of fishes living today and share common biological characteristics that increase their susceptibility to forces acting on the population such as harvesting and habitat alteration. Sturgeon and paddlefish reproduce in freshwater but each species may spend some of their life cycle in brackish or salt water depending on the species and potentially due to habitat alteration. Damming rivers presents an obstruction to movement and can also change the flow rate and temperature of the water. These critical conditions in addition to harvesting pressure are essential to consider in the management of the species.

Caviar from sturgeon and paddlefish has been of significant commercial value internationally since the 1800s and the demand for caviar has maintained heavy pressure on the species to present day. The United States was one of the largest producers of caviar in the 19th century until a drastic crash at the end of the century due to population decline and a lack of management regulations. Throughout the 20th century, Russia became the largest global producer and far exceeded any annual US production. Domestic stocks started to slowly rebuild as a result of decreased harvest pressure and the initiation of management regulations but simultaneously, sturgeon caviar from the Caspian Sea began to plummet as well. Sturgeon and paddlefish catch is sustained at its lowest in recent decades and is cause for concern for the future of these species and the associated caviar and roe production.

White sturgeon live along the US west coast and primarily use the Sacramento and Lower Columbia Rivers for reproduction. California manages the population that inhabits the Sacramento River and associated waters. This population at the southern end of the spawning areas is less resilient and thus recruitment is less than the populations in Oregon or Washington. Management of the sturgeon in California was started decades after Oregon and Washington and therefore the population has not yet recovered as well. The harvest in California is limited to the sport fishery. Oregon and Washington share management responsibility for white sturgeon in the Lower Columbia River where a clearly defined conservation plan is being used to guide the recovery of the population. Management strategies strictly limit fish length, are designed to exclude mature females and thus are 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 increased pinniped predation increasingly seen. These strategies attempt to allow the population to recover from past heavy

harvest pressure. The southern distinct population segment of green sturgeon was ESA listed as threatened in 2006. The northern population segment was in turn listed as a species of concern to offer greater protection. White sturgeon fisheries are designed to exclude green sturgeon as bycatch as much as possible in their respective operations.

Shovelnose sturgeon are found in the Mississippi and Missouri Rivers and their tributaries. Historically, they were found through 24 states where population abundances, habitat conditions, and management varied in each. Today, populations continue to fluctuate and commercial fisheries exist in only a handful of states. Pallid sturgeon, listed as endangered in 1990, overlap ranges with shovelnose sturgeon and are difficult to tell apart. Shovelnose were thus listed as threatened because of a similarity of appearance with pallid sturgeon as a means of offering more protection to the endangered species. Paddlefish similarly inhabited much of the Mississippi River to the Great Lakes but are now more restricted in the river basin because of local extirpations. River modification and overfishing have contributed to these declines and the recovery of the population will not be a quick process.

Studies on the population size and structure for both shovelnose sturgeon and paddlefish are limited and as a result, uniform management is not built on a constructive understanding of the species status. The Mississippi Interstate Cooperative Resource Association (MICRA) Sturgeon and Paddlefish Committee was created to address the concerns of a species spanning multiple jurisdictions facing similar threats. Though it is not a regulatory body, MICRA was designed to share information between each state management body and increase effective conservation for the species as a whole. Species wide stock status, monitoring, and consistent management goals have not been established though the information exchange allows each representative state to understand the effects and trends across the range.

The pressure continues to increase for sturgeon and paddlefish because of their highly valued caviar and roe. These relict species are also faced with habitat alterations that impact survival and ultimately resilience to recover from low population sizes. Dams blocking waterways, altered flow regimes, and changes in water temperature impact sturgeon and paddlefish. Additionally, harvest pressure and potential poaching are increased concerns, especially for a high market value product. Caviar aquaculture has become an increasingly viable option and is a better alternative compared to caviar and roe from wild-caught fishes.

Due to these concerns, shovelnose sturgeon and American paddlefish are a Seafood Watch **Avoid**. White sturgeon is a Seafood Watch **Good Alternative**.

## Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
White sturgeon United States Lower Columbia River - Gillnet, Drift	Yellow (3.05)	Red (1.82)	Yellow (3.00)	Yellow (3.12)	<b>Good Alternative (2.686)</b>
Paddlefish United States Mississippi River Basin - Gillnet, Drift	Red (1.41)	Red (1.20)	Red (1.73)	Yellow (3.12)	<b>Avoid (1.741)</b>
Shovelnose sturgeon United States Mississippi River Basin - Gillnet, Drift	Red (1.41)	Red (1.20)	Red (1.73)	Yellow (3.12)	<b>Avoid (1.741)</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, **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, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern **Error! Bookmark not defined.**, **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).

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# **Introduction**

## **Scope of the analysis and ensuing recommendation**

The following is an analysis of sturgeon caviar from U.S. domestic commercial fisheries. Three primary species for wild-caught sturgeon caviar production 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 and Missouri River Basins. The Mississippi River is also home to the American Paddlefish. Sturgeon are caught commercially with drift gillnets where the mesh size can be increased and regulated to allow for smaller fish to pass through without being trapped.

## **Overview of the species and management bodies**

The peak of the sturgeon and paddlefish harvest was around the end of the 19th century when the fisheries were not regulated. At the turn of the century, there was a drastic decline in abundance and thus production as a result of the severe fishing pressure as well as habitat losses from the construction of dams and watershed development and alteration. Harvest efforts shifted to other species when regulations were being set out of necessity and to rebuild and properly manage sturgeon and paddlefish. Acipenseriformes are generally long lived species that travel great distances throughout their range, increasing the complexity of effective management. White sturgeon are divided by the National Marine Fisheries Service into a northern and southern distinct population segment. California manages the southern distinct population segment that reproduces in the Sacramento River Basin and Oregon and Washington both manage the northern distinct population segment that reproduces in the Columbia River Basin.

Similarly, sturgeon and paddlefish travel throughout most the Mississippi River Basin but many more states border these waters. Therefore, the number of state management bodies is much greater in this region. The Mississippi Interstate Cooperative Resource Association (MICRA) created a Sturgeon and Paddlefish Committee in 1992 "address the needs of paddlefish and sturgeon species inhabiting the Mississippi River Basin, and to provide guidance for their future management". While there is no regulatory authority of MICRA, each state is represented in the group in order to try to provide cooperative management strategies across political boundaries.

## **Production Statistics**

In the 19th century, the United States was the top caviar producer, exporting black caviar from the US waters (primarily from the Atlantic sturgeon *A. oxyrinchus oxyrinchus*) to Europe. The production plummeted in the early 1900s due to lack of effective management and by the end of the 20th century, Russia became the world leader as a caviar trading nation. Sturgeon and paddlefish fisheries catch has remained at its lowest in last few decades while aquaculture production has surpassed wild caught production {Pikitch et al. 2005}. In 2010 and 2011, white sturgeon commercial landings averaged 115 metric tons where in the prior ten years, the average was closer to 173 metric tons {NMFS 2013}.

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

During the 19th century, the United States led the world in caviar production, supplying 90% of the global caviar trade (Hoover 1998) but a drastic crash in population lead to a corresponding crash in production and export. Throughout the 20th century, Russia became a much larger producer and exporter of caviar than the United States ever was. Due to the massive pressure on sturgeon and paddlefish caviar and restrictions on trade through CITES, the domestic market has increased. Since 2000, the total sturgeon caviar export has varied drastically between almost \$5,000 (in 2005) and almost \$750,000 (in 2011) {NOAA OST 2013}.

## **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 pasteurised to obtain longer term storage.

## Assessment

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

### Criterion 1: Impacts on the Species under Assessment

*This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:*

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

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

#### Criterion 1 Summary

PADDLEFISH				
Region / Method	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
United States Mississippi River Basin Gillnet, Drift	1.00:High	2.00:High Concern	1.00:High Concern	<b>Red (1.414)</b>

SHOVELNOSE STURGEON				
Region / Method	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
United States Mississippi River Basin Gillnet, Drift	1.00:High	2.00:High Concern	1.00:High Concern	<b>Red (1.414)</b>

WHITE STURGEON				
Region / Method	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
United States Lower Columbia River Gillnet, Drift	1.00:High	4.00:Low Concern	2.33:Moderate Concern	<b>Yellow (3.053)</b>

Acipenseriformes, including sturgeon and paddlefish, are an order of 27 fish species that reproduce in freshwater systems in the Northern Hemisphere. Some species will live entirely in

freshwater while others will migrate to brackish or seawater for a growth period. Sturgeon and paddlefish are some of the oldest ray-finned fishes alive today. Similar biological characteristics shared among the species are the large body size, a long life span and maturation that is late in life. These characteristics hinder effective recovery from stressors such as habitat alteration and harvesting acting on a population.

## **Criterion 1 Assessment**

### **Factor 1.1 — Inherent Vulnerability**

#### *Scoring guidelines*

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (<5 years), short lived (< 10 years), small maximum size, and low on food chain).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*

*High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).*

*Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

### **Factor 1.2 — Abundance**

#### *Scoring guidelines*

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

### **Factor 1.3 - Fishing Mortality**

#### *Scoring guidelines*

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

## PADDLEFISH

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### 1.1 - Inherent Vulnerability

#### United States Mississippi River Basin, Gillnet, Drift

**1.00**     **High**

The FishBase vulnerability score assigned to paddlefish is 85 of 100, indicating very high vulnerability to pressure on the population. The vulnerability is due to life-history characteristics, which are similar to sturgeon, that prohibit quick recovery. Paddlefish are long-lived, have a late onset to maturity, only reproduce periodically and also have specific habitat requirements {Pikitch et al. 2005}. All of these characteristics decrease the likelihood of low population sizes from increasing.

### 1.2 -Abundance

#### United States Mississippi River Basin, Gillnet, Drift

**2.00**     **High Concern**

A comprehensive, quantitative analysis of the paddlefish stock throughout its range is lacking, and the health of the stock in relation to biological reference points is unknown.

**Rationale:**

Paddlefish move long distances through the Mississippi River Basin and historically through 26 state jurisdictions. A range wide, coordinated management effort is not in place and so in order to classify the stock status of paddlefish, state specific surveys have been conducted to track trends. State agency representative biologists completed questionnaires in 1983, 1994 and 2006 {Bettoli et al. 2009b}{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, 16 states 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. 2009b}. This comprehensive assessment of the paddlefish stock status throughout its range does not include quantified population estimates or reference points but rather relative changes in size by state, indicating a population that fluctuates both spatially and temporally.

**1.3 - Fishing Mortality****United States Mississippi River Basin, Gillnet, Drift****1.00****High Concern**

Paddlefish densities, demographic rates, management strategies and thus fishing pressure vary by state and is often site-specific. Fishing mortality of paddlefish across the entire range is therefore unknown with respect to reference points that help maintain a sustainable population. The lack of range-wide fisheries-independent data prohibits quantifying the threat of commercial harvest on paddlefish {Quinn 2009}. Without understanding the effect of the fisheries, effective management cannot be established.

**Rationale:**

Fishing mortality or exploitation is not estimated across the entire range of paddlefish in the Mississippi River Basin. Each state of the paddlefish range has specific survey methods and reporting techniques to evaluate the population and fishery (if existing). Arkansas, Kentucky and Tennessee have the largest number of total paddlefish harvested, paddlefish flesh and processed roe, of the six commercial fisheries {Quinn 2009}. Harvest rates are rarely estimated from annual surveys that compare the harvest to population density estimates for relative density changes. Fishery independent assessments are not applied to the paddlefish fisheries contributing to the lack of accurate estimates of fishing mortality rates and established biological references points. Management to avoid potential overfishing has to this point focused on maintaining spawning potential ratios and therefore is not well developed across the paddlefish range.

## SHOVELNOSE STURGEON

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### 1.1 - Inherent Vulnerability

#### United States Mississippi River Basin, Gillnet, Drift

**1.00**     **High**

The life history characteristics of shovenose sturgeon leave the species highly vulnerable to fishing pressure. Shovelnose are smaller than many other sturgeon, they live up to 30 years, grow slowly and mature late in life, and do not spawn annually {Keenlyne 1997}. Fish Base ranks shovelnose sturgeon vulnerability as 60 out of 100.

### 1.2 -Abundance

#### United States Mississippi River Basin, Gillnet, Drift

**2.00**     **High Concern**

Shovelnose sturgeon travel throughout the Mississippi River Basin and across multiple state jurisdictions. Comprehensive assessments of the population status in each of 26 states where shovelnose sturgeon were historically distributed were conducted in 1983, 1994 and 2006 {Keenlyne 1997}. Koch & Quist {2010} reevaluated the stock status in each state by surveying the biologist with shovelnose sturgeon authority in each of the 24 states though an online questionnaire. Of those states, 9 reported that the population was stable, in 2 states the population increased and decreased in one. The remaining states' population status was unknown. Roughly half of the states where shovelnose sturgeon exist monitor the population regularly {Koch & Quist 2010} thus there are not range wide quantified population abundance estimates.

### 1.3 - Fishing Mortality

#### United States Mississippi River Basin, Gillnet, Drift

**1.00**     **High Concern**

Colombo et al {2007} estimated annual percent mortality of shovelnose sturgeon in the Upper Mississippi by quantifying the rate of decline in annual cohorts with annual samples that were independently derived. 3 year averaged estimates of the fishery mortality (37%) were quite higher than previously determined (20%) in the lower Mississippi and prior to increased harvest pressure {Colombo et al. 2007}.

Of a 2010 survey to the eight states that allowed commercial harvest of shovelnose sturgeon (AR, IA, IL,

IN, KY, MO, TN, WI) six reported an increase in the harvest amount for the 10 years prior. The other two states did not have good estimates of whether the harvest had increased or decreased in the same period. Commercial fishery regulations vary in each state and reflect local efforts to conserve shovelnose sturgeon. Some regulations have been established to limit yield, change size limits, number of permits, or area closures, resulting in reduced harvest numbers. These subsequent changes though, may be due to anglers shifting their practices to areas with fewer restrictions {Koch et. al. 2009}. As of 2013, only 6 states allow the commercial harvest of shovelnose sturgeon.

Maximum sustainable yield has not established for shovelnose sturgeon in order to maintain harvest regulations that would sustain the population and thus fishery. It has been suggested that management efforts focus on spawning potential ratio where a 40% ratio would be the minimum to prevent recruitment overfishing {Koch et al. 2009} but each state independently managed the stock.

## WHITE STURGEON

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### 1.1 - Inherent Vulnerability

#### United States Lower Columbia River, Gillnet, Drift

1.00 High

White sturgeon inherent vulnerability is very high (87 out of 100) as ranked by Fish Base primarily because they are a long-lived, slow growing species which spawns infrequently.

#### Rationale:

The maximum age recorded is about 100 years and males do not mature for 12 years while females mature between 16 and 35 years. Spawning periodicities in the Lower Columbia River range from 1-4 years {Webb & Kappenman 2012} triggered by water temperatures. Sturgeon will need long recovery periods from natural or anthropogenic population level impacts due to their life history characteristics.

### 1.2 - Abundance

#### United States Lower Columbia River, Gillnet, Drift

4.00 Low Concern

The white sturgeon population in the Lower Columbia River is considered healthy and not at risk but does not reach the desired target status established through the Lower Columbia River and Oregon Coast White Sturgeon Conservation Plan {ODFW 2011}.

#### Rationale:

Due to the long generation time of sturgeon, both short and long-term abundance goals were established in order to enhance and rebuild the population on an appropriate timescale. Current estimates of sub-legal white sturgeon (89,000) is below the target reference point, a desired abundance of 257,000 though it does exceed the threshold limit of 31,000 for which the population would be considered at risk of extinction. Current adult fish abundance estimates (11,000) exceed the short-term limit of 9,250 but do not exceed the long-term, 500 year target abundance {ODFW 2011}.

### 1.3 - Fishing Mortality

#### United States Lower Columbia River, Gillnet, Drift

2.33

#### Moderate Concern

In the Columbia River Basin, the harvest target of white sturgeon for 2011-2013 has been the lower of either 17,000 fish or 22.5% of the estimated legal size abundance. Recently, the exploitation of the population has slightly exceeded this target (~26%). It is believed that the current and recent exploitation rates have been at a sustainable rate based on population viability analyses {ODFW 2011}. The commercial gillnet fishery is allotted 20% while the recreational hook and line fishery is allotted 80% of the total fishing mortality the Lower Columbia River Conservation Plan (2012). Commercial regulations are updated often in order to best manage the impact on populations by specifying gear, size, and catch limits {ODFW 2013}.

## Criterion 2: Impacts on Other Species

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

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

- Subscore >3.2=Green or Low Concern
- Subscore >2.2 and <=3.2=Yellow or Moderate Concern
- Subscore <=2.2=Red or High Concern

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

### 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 B.

Paddlefish: United States Mississippi River Basin, Gillnet, Drift						
Subscore::		<b>1.414</b>	Discard Rate:	<b>0.85</b>	C2 Rate:	<b>1.202</b>
Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore		
PADDLEFISH	1.00: High	2.00: High Concern	1.00: High Concern	<b>1.414</b>		
SHOVELNOSE STURGEON	1.00: High	2.00: High Concern	1.00: High Concern	<b>1.414</b>		
PALLID STURGEON	1.00: High	1.00: Very High Concern	2.33: Moderate Concern	<b>1.526</b>		

**Shovelnose sturgeon: United States Mississippi River Basin, Gillnet, Drift**Subscore:: **1.414** Discard Rate: **0.85** C2 Rate: **1.202**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
PADDLEFISH	1.00: High	2.00: High Concern	1.00: High Concern	<b>1.414</b>
SHOVELNOSE STURGEON	1.00: High	2.00: High Concern	1.00: High Concern	<b>1.414</b>
PALLID STURGEON	1.00: High	1.00: Very High Concern	2.33: Moderate Concern	<b>1.526</b>

**White sturgeon: United States Lower Columbia River, Gillnet, Drift**Subscore:: **1.916** Discard Rate: **0.95** C2 Rate: **1.820**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
GREEN STURGEON	1.00: High	1.00: Very High Concern	3.67: Low Concern	<b>1.916</b>
WHITE STURGEON	1.00: High	4.00: Low Concern	2.33: Moderate Concern	<b>3.053</b>

**Criterion 2 Assessment****GREEN STURGEON****2.1 - Inherent Vulnerability****United States Lower Columbia River, Gillnet, Drift****1.00 High**

Green Sturgeon (*Acipenser medirostris*) like other Acipensiforms, are long-lived, slow growing fish. They reproduce in freshwater but are the most marine oriented of North American sturgeon. Green sturgeon weigh up to 350 pounds and can reach 7 feet in length. The average lifespan is 60-70 years but they do not reach maturity for at least 15 years {Moyle 2002}. These life history characteristics make a population vulnerable to stressors and recovery from those stressors difficult. The vulnerability of green sturgeon is very high (80) according to Fish Base.

## 2.2 - Abundance

### United States Lower Columbia River, Gillnet, Drift

1.00

**Very High Concern**

The southern distinct population segment (SDPS) of Green sturgeon (those that spawn in the Sacramento River) was listed as a threatened species on April 7, 2006 {71 FR 17757 2006}. Green sturgeon in the northern distinct population segment (NDPS) (spawners from the Klamath and Rogue Rivers) were reviewed by the National Marine Fisheries Service as a result to petition the species. ESA listing was not warranted but NMFS recognized the concerns over the population status and therefore the northern DPS remained as a species of concern {NMFS 2007}. The species is threatened in part by a reduction in spawning area, insufficient flow rates in spawning areas, contaminants, bycatch in other fisheries, and poaching {NMFS 2010}.

## 2.3 - Fishing Mortality

### United States Lower Columbia River, Gillnet, Drift

3.67

**Low Concern**

Since the SDPS of green sturgeon in California was ESA-listed and the NDPS was recognized as a species of concern in Oregon and Washington, the sale and retention of the green sturgeon from commercial and recreational fisheries across the range was prohibited. The impact of fishing mortality on green sturgeon is thus very minimal. 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/WDFW 2012}.

## 2.4 - Discard Rate

### United States Lower Columbia River, Gillnet, Drift

0.95

**20-40%**

The commercial white sturgeon fishery uses drift gillnets that are directed for fish of a minimum size in order to reduce the impact to smaller, non-harvestable white sturgeon or other species. Gillnets are pulled up frequently which reduces the threat to any non-target species and their potential to survive after being released. A handful of green sturgeon are accidentally retained due to misidentification and the small portion that are caught are released immediately {ODFW/WDFW 2013}. Oregon Department of Fish and Wildlife's (ODFW) recent targeted gillnet tagging effort 1.3% were adult white sturgeon above the legal-size limit 47.2% were juveniles below the legal-size limit and limited mortality results from the release of sub-legal sturgeon {ODFW 2011}.

## PALLID STURGEON

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### 2.1 - Inherent Vulnerability

#### United States Mississippi River Basin, Gillnet, Drift

**1.00**      **High**

Pallid sturgeon have high to very high inherent vulnerability (67 out of 100) as described by FishBase due to their late age at maturity (15 years), less than annual spawning (every 2-3 years) and maximum age (40 years) {Billard & Lecointre 2001}. The time required for a population to recover from reduced abundances will be long because of this life history strategy.

### 2.2 - Abundance

#### United States Mississippi River Basin, Gillnet, Drift

**1.00**      **Very High Concern**

Pallid sturgeon were Federally listed as an endangered species in 1990 primarily because of habitat alterations but fishing practices also contributed to their decline.

### 2.3 - Fishing Mortality

#### United States Mississippi River Basin, Gillnet, Drift

**2.33**      **Moderate Concern**

Pallid sturgeon are not targeted in fisheries due to their Federal listing but they can be caught as bycatch where there is range overlap with shovelnose sturgeon. Quantifying pallid sturgeon mortality as by-catch is difficult because of the similarity of appearance with shovelnose sturgeon {FR 2010}. Most evidence of pallid sturgeon caught as by-catch is through annual angler surveys but due to the similarity of appearance, the information cannot be verified with confidence {MICRA survey 2013}.

### 2.4 - Discard Rate

#### United States Mississippi River Basin, Gillnet, Drift

**0.85**      **60-80%**

In commercial gillnet fisheries in the Mississippi and Missouri River basins, bycatch rates of

predominantly sub-legal paddlefish and sturgeon as well as other species is a major concern. This gear type allows for harvesting without using bait as fish swim through the net and are trapped. Even though bait is not used in when harvesting with gillnets, it can be more difficult to ensure that the catch is of the species, sex and size that is being targeted. Bycatch rates of sub-legal fish can make up 60% of the commercial catch. In the shovelnose fishery waters, there is around a 2% encounter rate with the endangered pallid sturgeon {Bettoli et al. 2009}.

## Criterion 3: Management Effectiveness

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

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

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

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

### Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
United States Lower Columbia River Gillnet, Drift	3.000	3.000	Yellow(3.000)
United States Mississippi River Basin Gillnet, Drift	1.000	3.000	Red(1.732)

#### 3.1.0 - Critical?

##### United States Lower Columbia River, Gillnet, Drift

0.00

No

Management of the commercial drift gillnet white sturgeon fishery has been modified on a very regular basis to help ensure that the population in the Lower Columbia River maintains a healthy state. In this region, the commercial fishery is allocated 20% of the total fishery and the recreational fishery comprises 80%, a rule established since 1997 {ODFW/WDFW 2012}. The Lower Columbia River and Oregon Coast White Sturgeon Conservation plan (2011) regulations include also size and catch limits as well as gear restrictions. Through this strategy, management has been modified as necessary. Lower than expected abundance estimates have reduced annual the harvest accordingly {ODFW/WDFW 2012}.

**United States Mississippi River Basin, Gillnet, Drift**

**0.00**      **No**

Management strategies have been established and are being refined for Shovelnose sturgeon in the Mississippi River basin.

**Factor 3.1: Harvest Strategy**

*Scoring Guidelines*

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

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

**Factor 3.1 Summary**

<b>Factor 3.1: Management of fishing impacts on retained species</b>							
<b>Region / Method</b>	<b>Strategy</b>	<b>Recovery</b>	<b>Research</b>	<b>Advice</b>	<b>Enforce</b>	<b>Track</b>	<b>Inclusion</b>
<b>United States Lower Columbia River Gillnet, Drift</b>	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Highly Effective
<b>United States Mississippi River Basin Gillnet, Drift</b>	Moderately Effective	Ineffective	Moderately Effective				

### Subfactor 3.1.1 - Management Strategy and Implementation

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

#### United States Lower Columbia River, Gillnet, Drift

2.00

**Moderately Effective**

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 were also developed to indicate and bring attention to a population in lower biological health. Population levels are managed to avoid conservation thresholds and are compared to similar reference points for other long-lived marine species to ensure sustainability {ODFW 2011}.

#### **Rationale:**

Sturgeon exhibit little resilience in recovering from forces acting on the population due in part to their long generation time. In order to meet population abundance goals for sturgeon recovery, it may take hundreds of years for a population level response.

#### United States Mississippi River Basin, Gillnet, Drift

2.00

**Moderately Effective**

Paddlefish and shovelnose sturgeon are affected by varying harvest strategies as well as habitat conditions throughout their distribution. Given that the species are managed by individual states even though they move through multiple jurisdictions, the extent of these stressors must be addressed in order to promote population persistence and ensure long-term productivity. Additionally, it remains important to focus on and build effective regional management plans to further support these efforts.

#### **Rationale:**

Effectively managing a species that can move through multiple state jurisdictions presents a number of challenges. Both sport and commercial fisheries exist in a number of these states though specific regulations and closure of some of the fisheries have changed in the last few decades. States manage their populations based on estimates of population density, fishing mortality and spawning dynamics and adjust the respective regulations accordingly. Paddlefish and shovelnose migrate through differently managed areas and experience a variety of habitat conditions through the areas. In order to provide more of an overarching, integrated approach to management of the species through such areas, the

MICRA (Mississippi Interstate Cooperative Resource Association) Paddlefish and Sturgeon Committee was established.

MICRA was established in 1992 and is recognized as the key coordinating body for fisheries in the Mississippi River Basin. The goals of the Committee are to create a system by which paddlefish and sturgeon are protected population wide. To meet this goal, multiple states must communicate and coordinate multiple efforts including surveys, research, habitat protection and management.

The National Paddlefish Stock Assessment Database was established in 1995 through the US Fish and Wildlife Service and MICRA. The database contains records from state agencies that stock, tag, collect and recapture paddlefish in order to quantify and better understand paddlefish population status, habitat requirements, and movement patterns {USFWS 2004}.

In 2008, a cooperative management plan for the lower Mississippi River commercial paddlefish fisheries was proposed between 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. The plan was ultimately not approved but provided insight into how these states felt the paddlefish resources of the Mississippi River should be shared {AGFC 2012}.

### **Subfactor 3.1.2 - Recovery of Species of Concern**

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

#### **United States Lower Columbia River, Gillnet, Drift**

**2.00**

**Moderately Effective**

Oregon and Washington work together in joint management efforts 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 {ODFW 2011}. 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 {ODFW 2011}.

## United States Mississippi River Basin, Gillnet, Drift

1.00

### Ineffective

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 these 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}. An analysis of monitoring shovelnose in the Middle Mississippi River suggests population declines because of increased mortality, declining recruitment, and declining growth rates {Tripp et al. 2009}. Without thorough assessments, goals and plans, there is little potential for population recovery.

#### **Rationale:**

Management of the shovelnose sturgeon population is working toward increasing the stock to a healthy abundance that can sustain harvesting pressures. Of the states where shovelnose are found, some have maintained commercial fisheries, some have maintained recreational fisheries and few have maintained both. Populations are being monitored to varying degrees in each state and have fluctuated so that most other states do not allow any take of shovelnose. This has contributed to the recovery of the population though due to the life history characteristics of the species, the degree to which these management efforts are effective is unknown.

Throughout the range distribution of paddlefish, the species is listed in a number of states as threatened or as a species of special concern but is still open to sport and commercial harvesting in others. Over the past few decades, population status has been reported as stable, increasing, decreasing or unknown relative to each state and in those states where populations were declining or special concerns were raised, commercial fisheries were closed. Seven states still allow the commercial harvest of paddlefish but with various rules and regulations: Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee. To protect and rebuild the paddlefish population 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 & Zigler 2009}. As the water temperature increases, paddlefish

spawning is aggregated and increases the potential for higher fishing mortality. Some state regulations have thus been shortened to end before temperatures increase to protect the stock {Bettoli & Scholten 2006}.

### **Subfactor 3.1.3 - Scientific Research and Monitoring**

*Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species. To receive a highly effective score, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.*

#### **United States Lower Columbia River, Gillnet, Drift**

**2.00**      **Moderately Effective**

Both fishery dependent and independent data is collected on the white sturgeon stock in the Columbia River {ODFW 2011; ODFW/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. Both fishery dependent and independent information is continually being collected to be able to update and better estimate natural mortality by 2015 {ODFW 2011}. Oregon Department of Fish and Wildlife also constructed age-based population models for white sturgeon in order to evaluate impacts to the population and how effective various management strategies would be to determine where to focus efforts {ODFW 2011}. 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 mainstem lower Columbia River, by-catch in all fisheries, and recommended management changes {FWC 2011}.

#### **United States Mississippi River Basin, Gillnet, Drift**

**2.00**      **Moderately Effective**

As each state manages shovelnose and paddlefish populations individually, any research and monitoring is typically at a similar spatial scale in order 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 does not yet exist.

#### **Rationale:**

Nearly half of the states with shovelnose populations regularly monitor the species and the focus of that work is primarily 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 et al. 2010}.

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 harvesting, 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 & 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}.

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. While there is some effort to collect the necessary information, there is a need for much more research to have a more complete understanding.

### **Subfactor 3.1.4 - Management Record of Following Scientific Advice**

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

#### **United States Lower Columbia River, Gillnet, Drift**

**3.00**

**Highly Effective**

A detailed conservation plan identifies necessary research, actions, and targets to maintain a white sturgeon population in the Lower Columbia River that is sustainable {ODFW 2011}. Research and evaluations are frequent enough to be able to modify management from year to year. Over the past decade, rules and regulations concerning landing limits, open harvest periods and spatial closures have been modified both seasonally and annually based on scientific assessments to reflect current status of the stock {ODFW/WDFW 2012}.

#### **United States Mississippi River Basin, Gillnet, Drift**

**2.00**

**Moderately Effective**

Scientific research is being conducted in order to get a better understanding of the population structure of shovelnose sturgeon as well as the effects of harvesting and habitat alteration. While there is still a substantial information gap with respect to these, any new information is not always incorporated into management. The impacts of harvesting and habitat quality has sometimes followed scientific advice in management decisions in order to maintain a sustainable population, primarily with respect to changes in harvest length limits.

**Rationale:**

Size restrictions have been implemented to allow for recovery of the population but research suggests that the limits are not sufficient {Colombo et al., 2007}. It has been recommended since the formation of the MICRA Paddlefish/Sturgeon Committee that management cross the political boundaries and each state work together toward the same conservation goal but obstacles in doing and sharing research and adjusting strategies for effective conservation have not been overcome {Garvey et al. 2010}. The MICRA Paddlefish and Sturgeon Committee was established to share information and data across political boundaries and a database exists to coordinate efforts region wide {Paukert & Scholten 2009; Scholten 2009}. Raising the length limit is frequently advised and thus changed to protect spawning potential, shortening the season to avoid bycatch mortality due to warm temperature, changes to gear to decrease bycatch mortality, avoiding take from some spawning areas and habitat restoration {Paukert & Scholten 2009; Scholten 2009; Bettoli et al. 2011}. Many of these suggested changes need frequent evaluation for which management is only sometimes adapted.

**Subfactor 3.1.5 - Enforcement of Management Regulations**

*Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations. To achieve a highly effective rating, there must be regular enforcement of regulations and verification of compliance.*

**United States Lower Columbia River, Gillnet, Drift**

**2.00 Moderately Effective**

The Oregon State Police Fish and Wildlife Division enforce regulations to protect white sturgeon in the Columbia River. In 2008 and 2009, the number of reported illegally harvested sturgeon totaled 25 and 48 respectively {ODFW 2011}. Staffing limitations prohibit more extensive enforcement of regulations.

**United States Mississippi River Basin, Gillnet, Drift**

**2.00 Moderately Effective**

Due to the increased pressure on paddlefish from a decline in worldwide sturgeon and high demand for

caviar, poaching can present a major concern to the paddlefish population but increased enforcement has been effective in reducing illegal poaching. Federal and state enforcement agencies have arrested, cited, and charged a large association with poaching activities to support the caviar market, both domestically and internationally {Morris 2013}. There is increased pressure on this fishery because of the demand to support an economically valuable market and will need to be maintained to protect the population. Annual surveys of the population are conducted to help ensure that the population abundance and harvesting pressure are maintained at a level that allows for a sustainable harvest and if concerns arise, changes in management are put in place to counter any population declines.

**Rationale:**

Of the states that do allow legal harvest, some do not have regular enforcement activities, others are limited to responding to complaints, and others conduct regular, routine checks of angler's harvest while on the water. To enforce bans set to protect sturgeon populations, states that prohibit harvest have conducted standard patrols by increasing enforcement in areas of high sturgeon density and during snag fishery season while some states use random checks or depend on undercover enforcement operations {MICRA Survey 2001}.

**Subfactor 3.1.6 – Management Track Record**

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

**United States Lower Columbia River, Gillnet, Drift**

**2.00 Moderately Effective**

The white sturgeon population in the Lower Columbia River peaked toward the end of the 19th century with a harvest approximately 5.5 million pounds {ODFW 2011}. At the turn of the century with harvest regulations just coming in to place, the population collapsed and less than 75,000 pounds were harvested. In the last century, the population, and thus harvest, has remained significantly lower than the peak yield while management strategies have focused on rebuilding the population {ODFW/WDFW 2013}. Sturgeon unfortunately exhibit a slow reaction to measures of protection due to life history characteristics. It does appear that the population may be responding positively to additional protection from management but certainty in this response will take time.

**United States Mississippi River Basin, Gillnet, Drift**

**2.00 Moderately Effective**

Recognition of paddlefish and shovelnose sturgeon population declines has become increasingly important because of the effects of harvesting and habitat alteration especially on economically important species. These long-lived and slow growing species that are highly vulnerable to stressors will not recover quickly but management actions and the need for more effective management has increased. State agency staff and researchers are beginning to work together more effectively to proactively monitor and regulate the species at appropriate scales but the actions have not been in place long enough to measure or modify effective change {Paukert & Scholten 2009; Koch & Quist 2010}.

**Rationale:**

Paddlefish are a long lived species, maturing late in life and will not respond quickly to changes in management. Efforts are in place to protect the species in the long term but the biological characteristics prohibit determining with confidence whether the population is responding as expected to management. Changes in harvest pressure whether via sport or commercial fisheries and habitat alteration or restoration affect the population over long time scales increasing the difficulty of assessing long-term maintenance.

Shovelnose sturgeon have a large geographic distribution and throughout that distribution, they have faced a variety of natural and anthropogenic stressors. Significant harvest pressure resulted in a drastically suppressed population for which the recovery has been difficult. The commercial roe harvest has increased in some states while it has decreased in others. The inconsistency in harvest has been attributed to changes in regulations such as fish length and area closures but it has also been suggested that these new regulations may have caused a shift in harvest efforts to locations without regulations {Koch et al. 2009}. The life history of sturgeon also prohibits a quick recovery from stressors but harvest management has not yet proven to be effective.

**Subfactor 3.1.7 - Stakeholder Inclusion**

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

**United States Lower Columbia River, Gillnet, Drift**

**3.00**

**Highly Effective**

The Oregon Fish and Wildlife Commission holds public meetings approximately monthly where the public is encouraged to provide comment. The Commission organizes "state programs and policies concerning management and conservation of fish and wildlife resources and establishes seasons, methods and bag limits for recreational and commercial take" and considers the needs and opinions of all interested stakeholders.

## United States Mississippi River Basin, Gillnet, Drift

2.00

### Moderately Effective

The MICRA Paddlefish and Sturgeon Committee was formed to share information and provide guidance for future management in each state. Stakeholders are not included in decision making in each of these states and information is not easily, publicly available to include stakeholders nor describe the process and explanation behind the decisions. Paddlefish management has included stakeholder input in some state management.

#### Rationale:

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}. Missouri solicited input from the public to learn from fishermen expert knowledge in proposing regulation changes {MDC 2013}.

## Factor 3.2: Bycatch Management Strategy

### Scoring Guidelines

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

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

## Criterion 3.2 Summary

There are two distinct population segments of green sturgeon, one is ESA listed as endangered and the other as threatened. Both populations are caught as bycatch in the white sturgeon fishery where their ranges overlap as gillnets cannot target one species without the other. Regulations are set by the states

to limit as few green sturgeon takes as possible by checking nets frequently and reporting and green sturgeon in catch immediately to help monitor the population.

In the Mississippi River Basin, pallid sturgeon (another endangered sturgeon) also overlaps with shovelnose sturgeon range. Shovelnose have been ESA listed because of their similarity of appearance with pallid sturgeon in order to provide additional protection for the endangered fish. These efforts help to reduce the accidental take of a species that cannot afford any additional stressors.

<b>Factor 3.2: Management of fishing impacts on bycatch species</b>				
<b>Region / Method</b>	<b>Strategy</b>	<b>Research</b>	<b>Advice</b>	<b>Enforce</b>
<b>United States Lower Columbia River Gillnet, Drift</b>	No	Moderately Effective	Moderately Effective	Moderately Effective
<b>United States Mississippi River Basin Gillnet, Drift</b>	No	Moderately Effective	Moderately Effective	Moderately Effective

### 3.2.0 - All Species Retained?

#### United States Lower Columbia River, Gillnet, Drift

**0.00**    **No**

Salmon, steelhead, white sturgeon not within the legal size limit and green sturgeon caught in gillnets must be handled carefully to minimize injury and released immediately. Any encounters with green sturgeon, chinook and steelhead must also be reported immediately (WDFW 2012, 2013) in order to track the impact of the white sturgeon fishery on by-catch and inform management of the other populations.

#### United States Mississippi River Basin, Gillnet, Drift

**0.00**    **No**

Gillnets cannot select for specific species though they do limit the amount of bycatch as much as possible through the size of the mesh, limiting smaller fishes or other animals. While as many unintended species caught are released as quickly as possible for increased survival, many do not survive.

### 3.2.0 - Critical?

#### United States Lower Columbia River, Gillnet, Drift

0.00

No

Green sturgeon can potentially be caught as bycatch in the white sturgeon fishery. the Southern Distinct Population of Green sturgeon in California are a federally listed species and as a consequence of that, there is no directed green sturgeon fishery in Oregon or Washington. In the north, the population is not a listed species but is still provided similar measures of protection. Any green sturgeon caught in the white sturgeon fishery are to be reported and released {ODFW 2011, WDFW 2012}. Sublegal white sturgeon as bycatch are maintained at relatively small numbers because of gear restrictions.

#### United States Mississippi River Basin, Gillnet, Drift

0.00

No

### Criterion 3.2 Assessment

#### Subfactor 3.2.1 – Management Strategy and Implementation

*Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).*

#### United States Lower Columbia River, Gillnet, Drift

2.00

Moderately Effective

Green sturgeon can potentially be caught as bycatch in the white sturgeon fishery. The Southern Distinct Population of Green sturgeon in California are a federally listed species and as a consequence of that, there is no directed green sturgeon fishery in Oregon or Washington. In the north, the population is not a listed species but is still provided similar measures of protection. Any green sturgeon caught in the white sturgeon fishery are to be reported and released immediately {ODFW 2011, WDFW 2013}. The number of sublegal white sturgeon caught is limited due to gear restrictions in the white sturgeon fishery. In addition to sturgeon and other fish such as salmon caught as bycatch, diving birds, otters, beavers and other wildlife can also potentially be snagged in gillnets. Management actions to reduce impact of the gear type on non-targeted species is focused on increasing the size of the mesh so that smaller fish and other animals can pass through the net {ODFW 2011}.

## United States Mississippi River Basin, Gillnet, Drift

2.00

**Moderately Effective**

As additional research focuses on the effects of bycatch caught in gillnets, the actions necessary to reduce or prevent bycatch are being determined. Management strategies to protect the stock often focus on increasing the minimum harvest size but also reduce the sublegal bycatch which will in turn, benefit the stock. Fish held in warm waters can experience increased stress and mortality and so in order to avoid additional stressors, the open season has been shortened in some areas to protect paddlefish and shovelnose sturgeon in warmer waters {Bettoli et al. 2011}. Monofilament nets have been determined to be more lethal than multifilament nets {Bettoli & Scholten 2006} but there are no consistent regulations against them in the commercial harvest. While it is easiest to document initial mortality directly from the current practice, few studies have been done to determine delayed mortality after a fish has been released.

In order to reduce any impact to pallid sturgeon, an endangered species whose range overlaps with shovelnose sturgeon, shovelnose were listed as threatened because of their similarity of appearance. The harvest restriction of shovelnose in areas of range overlap will in turn offer increased protection for pallid sturgeon.

### **Rationale:**

A project in 2005-2006 to tag sublegal paddlefish found that delayed mortality was very low in Tennessee concluding that management should focus primarily on fishing gear and the timing of the season {Kerns et al 2009}.

### **Subfactor 3.2.2 - Scientific Research and Monitoring**

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

## United States Lower Columbia River, Gillnet, Drift

2.00

**Moderately Effective**

Washington requires any encounters with green sturgeon to be reported no more than the day following the landing {WDFW 2012}. Beginning in 2011, annual reports of bycatch in all fisheries would be presented to the Washington Fish and Wildlife Commission for evaluation of the impacts from the fishery {FWC 2011}. Observer coverage is limited along the Columbia River to ensure that bycatch is limited as much as possible.

## United States Mississippi River Basin, Gillnet, Drift

2.00

**Moderately Effective**

Each state is responsible for their own evaluation of the impact on bycatch from their respective fishery where some research and monitoring programs are further developed than others. The threat of lost nets can potentially have a serious impact on pallid and other sturgeon populations because of the life span of ghost nets which can remain up to 7 years. Sturgeon life history, such as poor eyesight, benthic orientation, and olfactory cues for prey make them susceptible to the unmaintained gear {Bettoli et al. 2009}.

### **Rationale:**

Arkansas wildlife officers maintain a visible presence in waterways especially focused where efforts are concentrated. The program includes angler monitoring and enforcing catch regulations through river and shore patrols, following up on anonymous tips and investigating suspected and reported chronic offenders {MICRA 2001}. Mail surveys are also conducted to determine if pallid sturgeon had been caught during the season though proper identification is not guaranteed. Arkansas Game and Fish conducts annually sampling to quantify bycatch by calculating the number of sublegal fish caught unlikely to survive divided by the total catch {2012 Arkansas sampling}.

### **Subfactor 3.2.3 - Management Record of Following Scientific Advice**

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

## United States Lower Columbia River, Gillnet, Drift

2.00

**Moderately Effective**

Gear type and net mesh size have been modified by management in order to reduce the impact to sublegal white sturgeon and other species. Research on bycatch is not as thorough as on harvesting impacts to white sturgeon and thus scientific advice is not as closely associated with changes in management.

NOAA initiated the 5 year review for the Southern Distinct Population (DPS) Segment of North American Green Sturgeon in 2012. Through the process, information is requested regarding the accuracy of the current listing classification. NOAA also simultaneously requested information on the Northern DPS in order to help ensure that the most current information for the entire species is addressed {77 FR 64959 2012}.

## United States Mississippi River Basin, Gillnet, Drift

2.00

**Moderately Effective**

A primary concern about harvesting using gillnets is unintentionally catching sublegal individuals of the target species. In addition, in the shovelnose sturgeon fishery, limiting bycatch of the endangered pallid sturgeon is essential. Current research has focused especially on quantifying both sublegal fishes caught and the ratio of pallid sturgeon to shovelnose sturgeon in the catch. Results of these studies further inform management and changes in regulations because a lack of these details cannot increase management effectiveness. Some changes in gillnet mesh size have been enforced due to the results of such studies.

### **Subfactor 3.2.4 - Enforcement of Management Regulations**

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

## United States Lower Columbia River, Gillnet, Drift

2.00

**Moderately Effective**

The Oregon State Police Fish and Wildlife Division enforce regulations to protect white sturgeon in the Columbia River. In 2008 and 2009, the number of reported illegally harvested sturgeon totaled 25 and 48 respectively {ODFW 2011}. Staffing limitations prohibit more extensive enforcement of regulations.

## United States Mississippi River Basin, Gillnet, Drift

2.00

**Moderately Effective**

Due to the increased pressure on paddlefish from a decline in worldwide sturgeon and high demand for caviar, poaching can present a major concern to the paddlefish population but increased enforcement has been effective in reducing illegal poaching. Federal and state enforcement agencies have arrested, cited, and charged a large number of people associated with poaching activities to support the caviar market, both domestically and internationally {Morris 2013}. There is increased pressure on this fishery because of the demand to support an economically valuable market and will need to be maintained to protect the population.

Annual surveys of the population are conducted to help ensure that the population abundance and harvesting pressure are maintained at a level that allows for a sustainable harvest and if concerns arise, changes in management are put in place to counter any population declines.

## Criterion 4: Impacts on the Habitat and Ecosystem

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

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

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

*Rating cannot be Critical for Criterion 4.*

### Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
United States Lower Columbia River Gillnet, Drift	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	<b>Yellow (3.123)</b>
United States Mississippi River Basin Gillnet, Drift	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	<b>Yellow (3.123)</b>

### Criterion 4 Assessment

#### Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

- 5 (None) = Fishing gear does not contact the bottom
- 4 (Very Low) = Vertical Line Gear
- 3 (Low) = Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom *occasionally* (<25% of the time) or purse seine known to commonly contact bottom
- 2 (Moderate) = Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand;
- 1 (High) = Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g. cobble or boulder).

- 0 (Very High) = Dredge or trawl fished on biogenic habitat, e.g. deep-sea corals, eelgrass and maerl.

*Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive plausible habitat type*

**United States Lower Columbia River, Gillnet, Drift**

**United States Mississippi River Basin, Gillnet, Drift**

**3.00      Low Concern**

Drift gillnets will not often come in contact with the seafloor and thus do not cause considerable damage. If gillnets are swept across the bottom while moving with the current, there is potential to cause some damage but likely would be minimal.

**Factor 4.2 - Mitigation of Gear Impacts**

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

**United States Lower Columbia River, Gillnet, Drift**

**United States Mississippi River Basin, Gillnet, Drift**

**0.25      Minimal Mitigation**

The minimal impact of drift gillnets on the seafloor does not necessitate action to mitigate any negative impacts. 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. Few gillnets do become

damaged, lost or left during harvest operations which can potentially scrape or damage the seafloor. Removing the derelict gear will reduce environmental impacts {Kappenman & Parker 2007} but these efforts are limited.

#### **Factor 4.3 – Ecosystem-Based Fisheries Management**

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

#### **United States Lower Columbia River, Gillnet, Drift**

**3.00**

#### **Moderate Concern**

White sturgeon do not fill the role of an exceptional species that play a disproportionately important role relative to their biomass though 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 Harbour Seal) near sturgeon spawning grounds. The reduced area of the spawning ground is likely due to river modifications and damming which concentrates sturgeon abundance {ODFW 2011}.

## United States Mississippi River Basin, Gillnet, Drift

3.00

### Moderate Concern

Shovelnose sturgeon help structure benthic communities and paddlefish influence plankton community structure but neither contribute disproportionately to ecosystem function and services as exceptional species. These Acipenseriformes, some of today's oldest freshwater fishes whose history goes back over 100 million years, face serious threats with anthropogenic habitat disturbances due to changes in the dynamics of their inhabited rivers and because of climate change. The species are linked and 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 but it is necessary to understand the impacts and 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 {Sloss et al. 2009}. 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 is not yet well understood {Koch & Quist 2010}.

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