

# Management Plan for the Green Sturgeon (*Acipenser medirostris*) in Canada

## Green Sturgeon



2016

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## PREFACE

Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years. The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada.

The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for the Green Sturgeon and have prepared this Management Plan as per section 65 of SARA. It has been prepared in cooperation with the British Columbia Ministry of Forests, Lands and Natural Resource Operations as per section 66(1) of SARA.

Success in the management of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this Plan and will not be achieved by Fisheries and Oceans Canada, Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this Management Plan for the benefit of the Green Sturgeon and Canadian society as a whole.

Implementation of this Management Plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

## **ACKNOWLEDGMENTS**

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## EXECUTIVE SUMMARY

The Green Sturgeon (*Acipenser medirostris*) is an anadromous fish that was originally assessed in November 2004 as 'special concern' by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC), and recently reassessed under the same status in November 2013. Green Sturgeon was listed as a species of Special Concern under the *Species at Risk Act* (SARA) in September 2006 and is currently listed as such.

Green Sturgeon are thought to represent an early evolutionary offshoot from primitive bony fish, dating back about 200 million years. These large fish can reach a maximum size of 2.3 metres and 159 kg (Scott and Crossman 1973). The ventral surface is white with a dark olive stripe extending down the middle of the belly, often terminating anterior to the pectoral fins (Scott and Crossman 1973). Green Sturgeon are found in the shallower waters of the continental shelf (*i.e.*, less than 110 metres) along the western coast of North America, from Mexico to southeastern Alaska. This range overlaps with that of White Sturgeon (*Acipenser transmontanus*), thus it is important to distinguish between the two species as they are generally similar in appearance.

There is limited historical information on the species population – the number of individuals in Canadian waters is unknown, but is likely not large (COSEWIC 2004). This species is globally at risk and is of concern in the United States and Canada due to habitat loss from damming of rivers and exploitation, respectively. Although Green Sturgeon were historically targeted in fisheries in Canada and the United States, there is currently no directed commercial or recreational fishery for this species in either country and they have no legal commercial value (EPIC 2001).

The management objective for the Green Sturgeon is to maintain their distribution and abundance at existing levels or higher in Canadian waters by limiting threats to the species within Canadian waters.

The Management Plan recommends an approach to conservation that assumes Green Sturgeon populations have the potential to recover. Although it is generally recognized that the primary threat to the species is the destruction of spawning habitat which is found outside of Canada, the threat of mortality through incidental fisheries catch in Canadian waters has the potential to compromise the management objective. Broad strategies and conservation measures have been identified in this Plan to support the management objective. Table 5 summarizes conservation measures that are recommended to support the broad management strategies and associated objective. Implementation of this Management Plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

## TABLE OF CONTENTS

<b>Preface</b> .....	<b>i</b>
<b>Acknowledgments</b> .....	<b>ii</b>
<b>Executive Summary</b> .....	<b>iii</b>
<b>Table of Contents</b> .....	<b>iv</b>
<b>List of Tables</b> .....	<b>v</b>
<b>List of Figures</b> .....	<b>v</b>
<b>1. COSEWIC Species Assessment Information</b> .....	<b>1</b>
<b>2. Species Status Information</b> .....	<b>1</b>
<b>3. Species Information</b> .....	<b>2</b>
3.1. Species Description .....	2
3.2. Population and Distribution .....	3
3.2.1 Global .....	3
3.2.2 Canada (Pacific).....	4
3.3. Needs of the Green Sturgeon .....	5
3.3.1 Habitat and Biological Needs.....	5
3.3.2 Ecological Role.....	6
3.3.3 Limiting Factors .....	6
3.4. Knowledge Gaps.....	6
3.4.1 Population Monitoring.....	6
3.4.2 Habitat Use.....	6
3.4.3 Dietary Requirements.....	7
3.4.4 Food, social, ceremonial harvests .....	7
3.4.5 Post-release mortality .....	7
<b>4. Threats</b> .....	<b>7</b>
4.1. Threat Assessment .....	8
4.2. Description of Threats .....	10
4.2.1 Fisheries Bycatch .....	10
4.2.2 Freshwater Habitat Loss.....	15
4.2.3 Marine Habitat Loss.....	16
4.2.4 Environmental Contaminants – Persistent Bioaccumulative Toxins .....	17
<b>5. Management Objective</b> .....	<b>18</b>
<b>6. Broad Strategies and Conservation Measures</b> .....	<b>18</b>
6.1. Actions Already Completed or Currently Underway .....	18
6.1.1 Bycatch Mitigation .....	18
6.1.2 Habitat Impact Mitigation .....	19

6.1.3 Other.....	20
6.2. Broad Strategies .....	20
6.2.1 Management.....	20
6.2.2 Research and Monitoring.....	21
6.2.3 Outreach and Communication .....	22
6.3. Conservation Measures .....	23
<b>7. Measuring Progress.....</b>	<b>25</b>
<b>References.....</b>	<b>27</b>
<b>Appendix A: Threat Attributes Terminology .....</b>	<b>31</b>
<b>Appendix B: Effects on the Environment and Other Species .....</b>	<b>32</b>
<b>Appendix C: Record of Cooperation and Consultation .....</b>	<b>33</b>
<b>Appendix D: Green Sturgeon Bycatch Data .....</b>	<b>34</b>

## LIST OF TABLES

Table 1: Visible differences between Green Sturgeon ( <i>Acipenser medirostris</i> ) and White Sturgeon ( <i>Acipenser transmontanus</i> ). .....	2
Table 2: Classification of threats to Green Sturgeon in Canadian Pacific waters. ....	9
Table 3: Commercial groundfish trawl catch (kg) of Green Sturgeon in British Columbia waters from 1996 to 2013 by Groundfish Management Area (DFO fisheries databases). .....	13
Table 4: Commercial groundfish trawl catch (kg) of sturgeon in British Columbia waters from 1996 to 2013 by Groundfish Management Area (sturgeon not identified by species; DFO fisheries databases). .....	14
Table 5: Conservation measures and implementation schedule. ....	23
Table 6: Performance measures for Green Sturgeon conservation in Canadian Pacific waters.....	26

## LIST OF FIGURES

Figure 1 Range map for Green Sturgeon (EPIC 2001; Moyle 2002). ....	3
Figure 2 Pacific Groundfish Fisheries Management Areas (DFO 2014).....	12
Figure 3 Western Canadian continental shelf area closed to the Commercial Groundfish Bottom Trawl Fishery (DFO 2013).....	17

## 1. COSEWIC SPECIES ASSESSMENT INFORMATION

**Date of Assessment:** November 2013

**Common Name (population):** Green Sturgeon

**Scientific Name:** *Acipenser medirostris*

**COSEWIC<sup>1</sup> Status:** Special Concern

**Reason for Designation:** This is a large-bodied fish species that is slow to grow and mature. The number of individuals in Canadian waters is unknown, but is undoubtedly not large. This species is globally at risk, and known threats are fisheries by-catch in both Canada and the United States, and habitat loss and degradation owing to water extraction, industrial and recreational development, and construction of dams in the United States where all known spawning locations are found.

**Canadian Occurrence:** BC, Pacific Ocean

**COSEWIC Status History:** Designated Special Concern in April 1987. Status re-examined and confirmed in November 2004 and November 2013.

## 2. SPECIES STATUS INFORMATION

In Canada, Green Sturgeon was legally listed as Special Concern under the *Species at Risk Act* (SARA) in September 2006. This designation characterizes the species as one that may become Threatened or Endangered due to biological characteristics and identified threats.

In 2006, the United States National Marine Fisheries Service (NMFS) listed the Southern Distinct Population Segment of North American Green Sturgeon as a Threatened species and the Northern Distinct Population Segment of North American Green Sturgeon as Special Concern under the United States *Endangered Species Act*. Distinct Population Segments utilized by NMFS are similar to COSEWIC's definition of Designatable Units – discrete and evolutionary significant units of the taxonomic species that are important for the evolutionary legacy of the species as a whole.

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<sup>1</sup> Committee on the Status of Endangered Wildlife in Canada

### 3. SPECIES INFORMATION

#### 3.1. Species Description

Members of the sturgeon family (Acipenseridae) are thought to represent an early evolutionary offshoot from primitive bony fish, dating back about 200 million years. Sturgeon differ from other bony fish in that they have a cartilaginous skeleton instead of bone, and large bony plates (scutes) instead of scales. These and other features such as their heterocercal tail, jaw structures, and spiracles are more characteristic of sharks and rays than bony fish. Sturgeon are highly adapted for preying on demersal animals, which they detect with a row of extremely sensitive barbels on the underside of their snouts and then suck up using their long and flexible 'lips' (Moyle 2002).

In North America, the range of Green Sturgeon overlaps with that of White Sturgeon (*Acipenser transmontanus*) and it is important to distinguish between the two species, which are generally similar in appearance (Table 1).

**Table 1: Visible differences between Green Sturgeon (*Acipenser medirostris*) and White Sturgeon (*Acipenser transmontanus*).**

Feature	Green Sturgeon	White Sturgeon
<b>Maximum Length</b>	2.1 metres	6.1 metres
<b>Maximum Weight</b>	159 kg	816 kg
<b>Dorsal Surface</b>	dark olive-green with longitudinal olive-green stripes between their lateral and ventrolateral rows of scutes	grey, pale olive, or grey-brown with no stripes
<b>Ventral Surface</b>	white, with a dark olive stripe extending down the middle of the belly, often terminating anterior to the pectoral fins	clean white, lacks longitudinal and ventral stripes
<b>Barbels</b>	located close to the mouth	located close to tip of snout
<b>Scutes</b>	8 to 11 scutes anterior to dorsal fin 23 to 30 lateral scutes	11 to 14 scutes anterior to dorsal fin 38 to 48 lateral scutes
	1 large scute posterior to the dorsal fin	No scutes posterior to dorsal fin
	2 rows of 4 to 8 post-vent scutes	1 row of 1 to 4 scutes extending from the pelvic fins to the anal fin
<b>Anal Vent</b>	located directly between the posterior insertions of the pelvic fins	located behind the pelvic fins

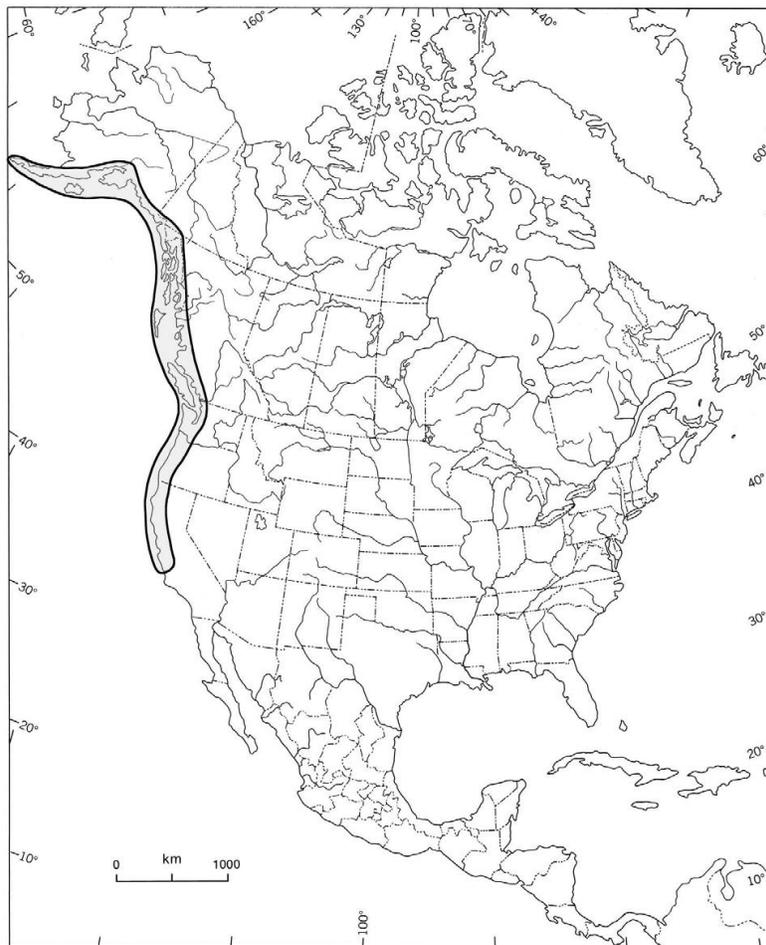
Green Sturgeon are anadromous, but spend the majority of their time in the marine environment (Adams *et al.* 2002). Green Sturgeon have been recorded to reach an age of 42 years, but it is possible that they reach ages of 60-70 years (Moyle 2002). They reach maturity at 14 to 20 years, and reproduce every two to five years (Tracy 1990,

Moyle 2002). Females produce 60,000 to 140,000 large eggs, reaching maximum fecundity at 24 years (Moyle 2002, Beamesderfer *et al.* 2007).

### 3.2. Population and Distribution

#### 3.2.1 Global

Green Sturgeon are found in the shallower waters of the continental shelf (*i.e.*, less than 110 metres, and usually at depths of 40 to 70 metres during the winter and spring months (Erickson and Hightower 2007)) along the western coast of North America, from Mexico to southeastern Alaska (Figure 1).



**Figure 1** Range map for Green Sturgeon (EPIC 2001; Moyle 2002).

Note: Green Sturgeon have been noted as far south as Mexico in 2009 (D. Woodbury, NMFS, pers. comm., 2013).

Two Distinct Population Segments (DPSs) of Green Sturgeon are currently recognized by the United States NMFS. The Southern Distinct Population Segment is comprised of

the spawning population in the Sacramento River (NMFS 2006), and the Northern Distinct Population Segment is comprised of the spawning population in the Rogue, Klamath, and Umpqua Rivers (NMFS 2007). The Northern and Southern DPSs match the three rivers in which the Green Sturgeon primarily spawn in North America, all of which are within the United States: the Rogue River in Oregon, and the Klamath and Sacramento River systems in California (EPIC 2001, Adams *et al.* 2002, Moyle *et al.* 1994). Evidence of spawning has also been recorded for the Umpqua River in Oregon (Adams *et al.* 2007) and more recently in the Feather River in California (Seesholtz *et al.* 2012). Historically, spawning may also have occurred in the San Joaquin, Eel, and South Fork Trinity Rivers (EPIC 2001).

Juveniles from the Southern DPS rear in the Sacramento River, the Sacramento-San Joaquin Delta, and the San Francisco Bay Estuary. Northern DPS juveniles also rear in their natal rivers and estuaries. Adults and subadults of both populations co-mingle in non-natal estuaries, with regular summer aggregations occurring in the major estuary basins of the west coast of North America (*e.g.*, Winchester Bay, Columbia River, Willapa Bay, Grays Harbour; Lindley *et al.* 2011). This distribution generally reflects the northward movement of both populations during the ocean migration phase of their life history.

In the ocean, Green Sturgeon are highly migratory, ranging in coastal waters from Mexico to the Bering Sea (Moyle 2002). They are rarely found south of 30° North Latitude and their greatest abundance is between 40° and 60° North Latitude (Moyle 2002). Distribution also varies seasonally as Green Sturgeon make non-spawning movements into coastal lagoons and bays in the late summer to fall (NMFS 2013). In general, ocean migrations trend northwards from their natal rivers (Adams *et al.* 2007).

### 3.2.2 Canada (Pacific)

The Canadian distribution of Green Sturgeon includes the entire coast of British Columbia (BC), as it is part of the northward oceanic migration pattern for the species along the Pacific coast of North America. Although little is known of these migrations, recent research has identified large concentrations of Green Sturgeon near Brooks Peninsula on northwest Vancouver Island during May through June and October through November, suggesting that important overwintering habitat might exist north of Vancouver Island and south of Cape Spencer, Alaska (Lindley *et al.* 2008). Additionally, the species is sighted every few years during the spring months off of rivers in the San Juan, Sooke, and Gold River areas on the West Coast of Vancouver Island; this observation is consistent with its northward oceanic migration pattern (T. Michalski, BC MFLNRO, pers. comm., 2014). Data collected by Erickson and Hightower (2007) suggest that Green Sturgeon are more abundant in the coastal waters off northwestern Vancouver Island than in other areas off the BC coast. Overall, there is limited historical information on the species population and the number of individuals in Canadian waters is unknown, but is likely not large (COSEWIC 2004).

Green Sturgeon are rarely encountered in fresh water in Canada (McPhail and Carveth 1993). Observations in fresh water are generally limited to irregular reports from the Albion Test Fishery at kilometer 58 on the Fraser River (three confirmed records since 2005; P. Logan, DFO, pers. comm., 2013), and sport fishers and researchers conducting the White Sturgeon tagging program (three likely and three possible since 2000; T. Nelson, unpublished data from the Fraser River Sturgeon Conservation Society). Green Sturgeon have been caught in the Nass, Stikine, Skeena, and Taku Rivers, but these reports are rare (FISS 2013). Scott and Crossman (1973) reported potential spawning in the Fraser River, but Moyle (2002) concluded that there was no evidence of Green Sturgeon spawning in Canada or Alaska.

### **3.3. Needs of the Green Sturgeon**

#### **3.3.1 Habitat and Biological Needs**

Mature adults in breeding condition migrate up rivers to spawn from March to July, when water temperatures are within the preferred temperature range for spawning (8 to 14 °C; Moyle 2002). The preferred spawning substrate is likely large cobble, but can range from clean sand to bedrock. Eggs are broadcast and externally fertilized in relatively fast water and in depths greater than three metres. The importance of water quality is unknown, but a small amount of silt is known to prevent the eggs from adhering to each other, thus increasing survival (Moyle 2002).

Green Sturgeon juveniles migrate downstream as they grow, and move into estuaries within the first year and a half of life where they reside for one to two years. Migration to marine waters occurs between 2.5 to 3.5 years of age (Allen *et al.* 2009). Males spend three to nine years and females three to thirteen years at sea before returning to freshwater to spawn (Moyle 2002).

Huff *et al.* (2011) found that in the ocean environment Green Sturgeon spent relatively more time in areas with high seafloor complexity than in areas with less complexity. These preferred habitats had large boulders, were found between 20 to 60 metres depth, and ranged from 9.5 to 16.0 °C. The authors hypothesize that this type of environment may support the appropriate benthic prey items while providing refuge from potential predators.

Adult and subadult Green Sturgeon aggregate in non-natal estuaries and coastal embayments for periods of up to several months during the marine phase of their life history (Adams *et al.* 2007, Lindley *et al.* 2011). The reason for this aggregation behavior is not clear, but it has been suggested that feeding does not occur during this time as Green Sturgeon captured in these areas have empty stomachs (Adams *et al.* 2007). It is possible that aggregation is related to physiological requirements with respect to temperature (Beamesderfer *et al.* 2007) or for osmoregulation (Sulak and Randall 2002).

### **3.3.2 Ecological Role**

Green Sturgeon are primarily bottom feeders that are highly adapted for preying on benthic animals (Moyle 2002). The diet of Green Sturgeon is known to include shrimp, crab, worms, amphipods, and isopods (EPIC 2001). Stomach contents of Green Sturgeon captured in estuaries included opossum shrimp, amphipods, sand lances, callianassid shrimp, anchovies and clams (Moyle 2002, Dumbauld *et al.* 2008).

Larval and juvenile Green Sturgeon are likely eaten by other species present in freshwater spawning areas. Adult Green Sturgeon have few known predators, although some observations suggest predation by some shark species and marine mammals may occur (Fitch and Lavenburg 1971, Emmett *et al.* 1991, Huff *et al.* 2011). The decline in large pelagic sharks and the subsequent increase in the abundance of pinnipeds and smaller demersal sharks in the marine environment could have negative effects on Green Sturgeon populations and their associated food webs (Huff *et al.* 2011).

### **3.3.3 Limiting Factors**

Green Sturgeon are a long lived species with estimates of a maximum age of roughly 60-70 years (Moyle 2002). They reach maturity at a late age (14 to 20 years) with maximum fecundity for females occurring at 24 years (Moyle 2002, Beamesderfer *et al.* 2007). Green Sturgeon also have relatively low reproductive potential, despite the ability to produce 60,000 to 140,000 large eggs at a time, as they only reproduce every few years (Tracy 1990, Moyle 2002). These combined life history traits of late maturation and long breeding intervals make Green Sturgeon particularly vulnerable to changes in mortality or reproductive rates, which often result from anthropogenic impacts (Gessner *et al.* 2007).

## **3.4. Knowledge Gaps**

### **3.4.1 Population Monitoring**

The vast majority of information regarding the population status and trends of Green Sturgeon comes from the United States, where all currently known spawning populations are located. Estimates of Green Sturgeon abundance in Canadian waters have not been made.

### **3.4.2 Habitat Use**

Little is known about Green Sturgeon habitat and how it is used during migration and overwintering in Canadian waters.

### **3.4.3 Dietary Requirements**

Very little information is available on the food and nutritional requirements of the different life stages of Green Sturgeon. As areas in Canadian Pacific waters have been indicated as important overwintering and foraging areas for Green Sturgeon, it would be valuable to be able to identify the key prey items utilized by the species so that this information can be considered in the protection and management of the species.

### **3.4.4 Food, social, ceremonial harvests**

Further information is needed on the frequency and extent of the use of Green Sturgeon by First Nations for food, social and ceremonial purposes.

### **3.4.5 Post-release mortality**

Post-release mortality rates for Green Sturgeon are unknown, and are necessary to provide an accurate estimate of the population mortality rate. The question is most relevant to the groundfish trawl fishery.

## **4. THREATS**

Anthropogenic threats to Green Sturgeon have been identified by a number of authors (e.g., Adams *et al.* 2007, Huff *et al.* 2012). The nature of these threats is widely divergent, originates from a number of sources, and occurs across a diversity of habitats throughout the species' range. The threats addressed in this Management Plan fall into three categories (Table 2):

1. Accidental mortality (through fishing),
2. Habitat loss or degradation, and
3. Pollution.

These threats may affect behaviour, physiology, fecundity, immune response, habitat use, and result in direct or indirect mortality. Individual and population level impacts to the species may arise from the effect of any combination of the above threats, in conjunction with limiting factors (Section 3.3.3). The consequence of these interactions may be more serious than those of a single threat acting upon the population in isolation.

As this Management Plan applies to actions that may be undertaken in Canadian Pacific waters, the scope of the threats assessment has been limited accordingly. As such, threats to spawning habitat – although of high overall concern for the species (Adams *et al.* 2007) – are not addressed in this Plan as Green Sturgeon spawning habitats occur exclusively in waters within the United States (US). Also outside the

scope of this Management Plan are other threats which are restricted to US waters. For example, invasive fish species impacting juvenile Green Sturgeon (NMFS 2010) and disease transfer from hatchery-raised White Sturgeon (COSEWIC 2004) have not been included as these threats target a life history stage or habitat that does not occur in Canada. As well, the potential disruption of migratory behaviour from electromagnetic fields associated with subsea power transmission cables (NMFS 2010) has not been addressed here due to the high prevalence of the threat in US waters as compared to Canadian Pacific waters; there are relatively few subsea power transmission cables in Green Sturgeon migratory habitat in Canada.

Threats from climate change are outside the scope of this assessment, although the widespread ecosystem impairment from climate change would be expected to impact the feeding, growth, and survival of higher trophic level fish foraging on benthic invertebrates and fish. As the general threat of climate change has broad implications to all species, it is more appropriate to consider climate change in a forum beyond the present species-specific Management Plan.

#### **4.1. Threat Assessment**

Assessment of threats to the population allows for the prioritization of recommended management and other actions to prevent the Green Sturgeon from becoming Threatened or Endangered in Canada. Table 2 summarizes the major threats that are present within Canadian waters, ranked by level of concern, with the greatest threat to the conservation of the species appearing at the top of the table. In assigning value to the threat attributes (*i.e.*, Level of Concern, Extent, Occurrence, Frequency, Severity, Causal Certainty) each threat is evaluated as it pertains to Green Sturgeon in Canadian waters; however, because the fish are migratory in nature, threats that occur in Canadian Pacific waters may have population level effects. Details of each threat and consideration of key attributes are described in Section 4.2. Further details for the attribute values may be found in Appendix A.

Overall, the threats of destruction of habitat and pollution to Green Sturgeon are of low concern in Canada because they have limited impact on Green Sturgeon in Canadian waters or are not found to have a strong causal link to reduced population viability of the species (*i.e.*, low causal certainty). The threat of bycatch from commercial marine fisheries (salmon and groundfish) and the freshwater White Sturgeon recreational fishery is of high concern because of the potential for accidental mortality and the widespread extent in which these fishing activities occur. This threat is presented as the highest priority for management action in Canadian waters.

**Table 2: Classification of threats to Green Sturgeon in Canadian Pacific waters.**

1. Fisheries Bycatch		Threat Information	
<b>Threat Category</b>	Accidental Mortality	<b>Extent</b>	Widespread
<b>General Threat</b>	Fishing	<b>Occurrence</b>	Current
		<b>Frequency</b>	Seasonal
<b>Specific Threat</b>	Bycatch during non-targeted commercial and recreational fisheries	<b>Causal Certainty</b>	Medium
		<b>Severity</b>	Unknown
<b>Stress</b>	Mortality, loss of reproductive potential	<b>Level of Concern</b>	High
2. Freshwater Habitat Loss		Threat Information	
<b>Threat Category</b>	Habitat Loss or Degradation	<b>Extent</b>	Localized
<b>General Threat</b>	Channel, Streambank and Foreshore Habitat Alteration	<b>Occurrence</b>	Current
		<b>Frequency</b>	Seasonal
<b>Specific Threat</b>	Elimination of floodplain, riparian and backwater habitat in rivers and estuaries	<b>Causal Certainty</b>	Medium
		<b>Severity</b>	Unknown
<b>Stress</b>	Physiological stress, interruption of life processes	<b>Level of Concern</b>	Low
3. Marine Habitat Loss		Threat Information	
<b>Threat Category</b>	Habitat Loss or Degradation	<b>Extent</b>	Widespread
<b>General Threat</b>	Fisheries	<b>Occurrence</b>	Current
		<b>Frequency</b>	Continuous
<b>Specific Threat</b>	Alteration of marine benthic habitat by trawl gear	<b>Causal Certainty</b>	Low
		<b>Severity</b>	Unknown
<b>Stress</b>	Reduced foraging success, increased stress from predator avoidance, mortality	<b>Level of Concern</b>	Low

4. Environmental Contaminants – Persistent Bioaccumulative Toxins		Threat Information	
<b>Threat Category</b>	Pollution	<b>Extent</b>	Localized
<b>General Threat</b>	Deposition of industrial and agricultural chemicals in aquatic food webs	<b>Occurrence</b>	Current
		<b>Frequency</b>	Continuous
<b>Specific Threat</b>	Chronic and acute effects of bioaccumulation	<b>Causal Certainty</b>	Low
		<b>Severity</b>	Unknown
<b>Stress</b>	Reduced reproductive success, reproductive impairment, reduced immune competence, mortality	<b>Level of Concern</b>	Low

## 4.2. Description of Threats

### 4.2.1 Fisheries Bycatch

Although Green Sturgeon were historically targeted in fisheries in Canada and the United States, there is currently no directed commercial or recreational fishery for Green Sturgeon in either country, and they have no legal commercial value (EPIC 2001). Bycatch is reported in commercial groundfish trawl fisheries, sport fisheries, and commercial and First Nations salmon gillnet and beach seine fisheries (Adams *et al.* 2007). Because current regulations in Canadian commercial and recreational fisheries prohibit the retention of Green Sturgeon in marine or freshwater areas in Canada, all bycatch is currently released at sea. However, post-release mortality estimates in these fisheries are presently unknown, and given the widespread occurrence of fishing activity throughout the range of Green Sturgeon, it is certain that some fishing-related mortality occurs on an annual basis.

Post-release mortality of Green Sturgeon in all fisheries has not been quantified; however inferences may be made from other sturgeon species. Beardsall *et al.* (2013) found generally high post-release survival rates (94%) for Atlantic Sturgeon in otter trawls. Post-release mortality estimates in the trawl fishery have been estimated at approximately 5% (Doukakis, NOAA, pers. comm. 2013), suggesting that only a small number of Green Sturgeon are harmed or directly killed by trawl fishing in Canada each year. The survival of White Sturgeon released from the recreational hook and line fishery in the Fraser River is reported to be high (Nelson *et al.* 2013). Other post-release mortality studies have estimated the post-release survival rate of White Sturgeon from hook and line capture at 97.3%, 53.1% from set gillnet, and 100% from drift gillnet.

The Green Sturgeon's life history traits of long life and late age of maturity also contribute to their vulnerability to fishing mortality. Green Sturgeon populations exhibit strong sensitivity to small changes in mortality levels of adult and subadults, which

result in abrupt declines in numbers, reproductive potential, growth rate, and the potential yield of the population (Beamesderfer *et al.* 2007, Heppell 2007). The tendency for Green Sturgeon to aggregate in freshwater, marine, and estuarine areas throughout their geographic range makes Green Sturgeon vulnerable to episodic incidents of high interception by fishing. A single high interception event combined with poor post release survival could result in population level impacts despite the localized nature of the event (Moser and Lindley 2007).

### *Commercial Groundfish Trawl Fishery*

Monitoring data collected by the commercial groundfish trawl fishery in British Columbia indicates that a total of 16.4 tonnes of Green Sturgeon was reported as bycatch between 1996 and 2013, although the number of individual sturgeon is unknown as the bycatch is recorded by weight, not by piece. Approximately 87% of the commercial trawl bycatch identified as Green Sturgeon during this time period occurred off the northwest coast of Vancouver Island (Figure 2), with the remainder recorded off the west coast of Vancouver Island (about 9%), and in Hecate Strait and Queen Charlotte Sound (4%; Table 3).

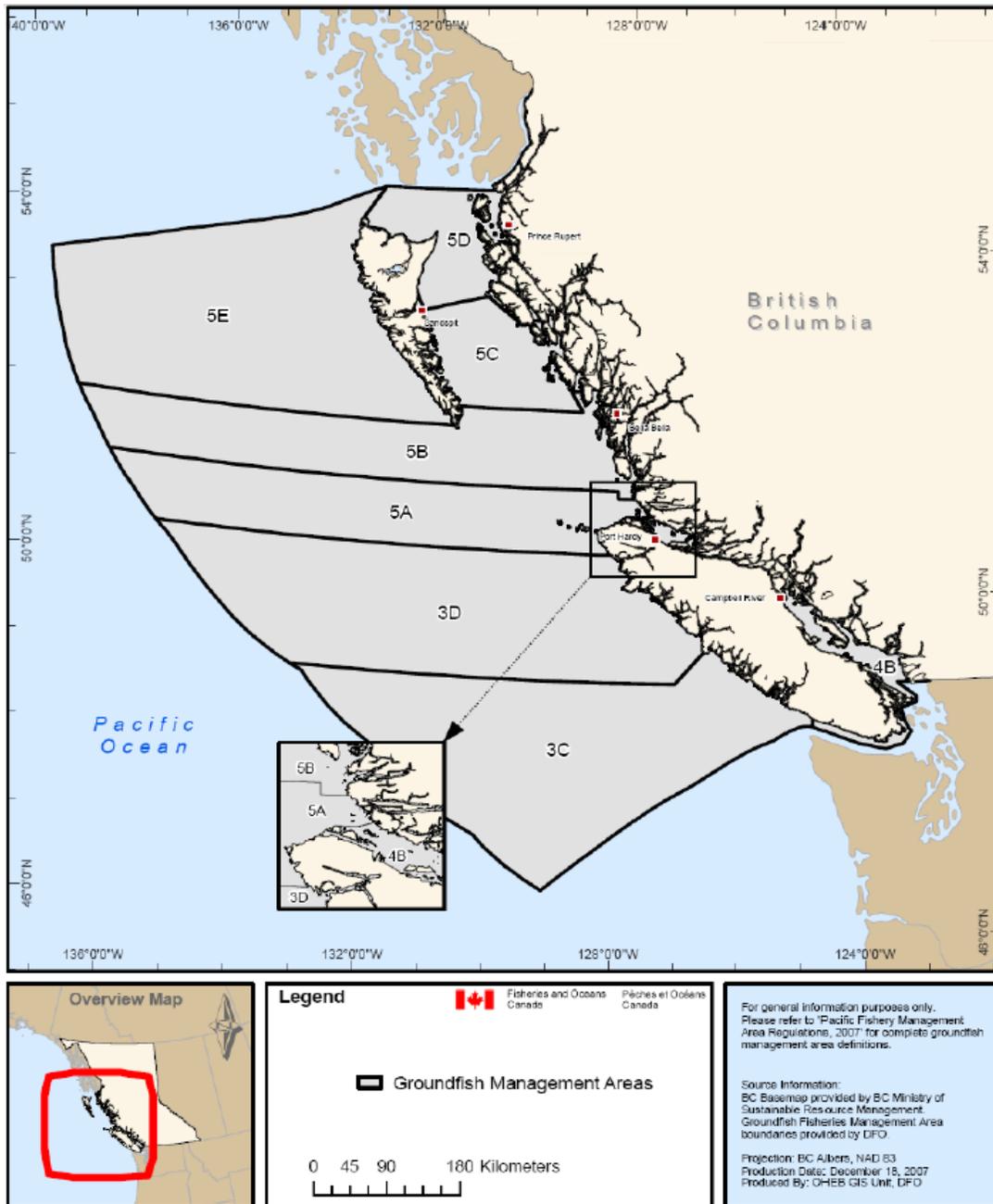
A major source of uncertainty with the Green Sturgeon bycatch data from the commercial groundfish trawl fishery at-sea observer program stems from the large number of records that are recorded as sturgeon, but which are not identified to the species level. These records may refer to Green Sturgeon, White Sturgeon, or Sturgeon Poachers (*Podothecus accipenserinus*), but it is not known what proportion of the bycatch is represented by each species (Table 4).

### *Commercial Salmon Fishery*

Incidental catch also occurs in the salmon gillnet and seine fisheries in the Fraser River and its estuary, and at the mouths of other rivers along the southern coast of BC (Anonymous 1954; Slack and Stace-Smith 1996; Houston 1988; Echols 1995). Records of Green Sturgeon catch from commercial salmon gillnet fisheries in DFO's Fishery Operations System (FOS) database are limited to two call-in records totaling six fish from Area 29 in 2002, single records from the Albion Gillnet Test Fishery in 2007 and 2009, and a single record from a seine test fishery in area 13 (*i.e.*, Discovery Passage area north of Georgia Strait) in 2011.

### *Commercial Hook and Line Fisheries*

DFO catch monitoring data includes only three records of Green Sturgeon caught by commercial hook and line gear (single records in 1999, 2003, and 2005).



**Figure 2** Pacific Groundfish Fisheries Management Areas (DFO 2014).

**Table 3: Commercial groundfish trawl catch (kg) of Green Sturgeon in British Columbia waters from 1996 to 2013 by Groundfish Management Area (DFO fisheries databases<sup>2</sup>).**

Year	Area <sup>3</sup> and Catch (kg)								Total Released (kg)
	3C	3D	4B	5A	5B	5C	5D	5E	
1996		145		144					289
1997	21			36		17			98
1998	27	163		326	18		11		546
1999	24	177				11	42		254
2000	156			2,463	27				2,646
2001	64			2,703		9			2,775
2002	36			2,940	7	1	5		2,989
2003	40	20		602	54	9			726
2004				1,326			32		1,358
2005	11			249	34		27		322
2006	25			1,326	90	23			1,465
2007	54	27		175	45				301
2008				639					639
2009				88	23				111
2010	27			811	34		9		882
2011	108			23					131
2012	97			405					503
2013	273			29		34	84		420
<b>Total</b>	967	533	0	14,292	334	103	210	0	16,439
<b>Average / yr</b>	54	30	0	794	18	6	12	0	913

<sup>2</sup> From PacHarvTrawl and GFFOS fisheries databases. All data obtained from the commercial groundfish trawl fishery's 100% at-sea monitoring (observer and electronic video) program.

<sup>3</sup> 3C= southwest Vancouver Island; 3D= northwest Vancouver Island; 4B= Strait of Georgia; 5A= Queen Charlotte Sound south; 5B= Queen Charlotte Sound north; 5C=southern Hecate Strait; 5D= northern Hecate Strait; 5E= west coast of Haida Gwaii.

**Table 4: Commercial groundfish trawl catch (kg) of sturgeon in British Columbia waters from 1996 to 2013 by Groundfish Management Area (sturgeon not identified by species; DFO fisheries databases<sup>4</sup>).**

Year	Area and Catch (kg)								Total Released (kg)
	3C	3D	4B	5A	5B	5C	5D	5E	
1996		20		1,099		<1			790
1997		135		1,649			23		36
1998	45			37					83
1999		<1		166			<1		167
2000	54			64					118
2001				37	<1	20			58
2002				1,221					1,221
2003	53	18		2,835	32	<1	<1		2,939
2004	16	64		828	9		55		970
2005	10	41		284			32		367
2006	27			1,349	34				1,411
2007	86			207		54	45		393
2008				191			36		227
2009	27	8		395	7		41		477
2010	44			755			14		812
2011	230			136	102		45		513
2012	84	18		587			9		699
2013	333			11					344
<b>Total</b>	1,008	304		11,851	184	76	302		11,624
<b>Average / yr</b>	56	17		658	10	4	17		646

*Recreational White Sturgeon Fishery*

Incidental capture of Green Sturgeon has also been confirmed in the recreational White Sturgeon catch and release fishery on the lower Fraser River, though few confirmed

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<sup>4</sup> From PacHarvTrawl and GFFOS fisheries databases. All data obtained from the commercial groundfish trawl fishery's 100% at-sea monitoring (observer and electronic video) program.

records of capture exist (three likely and three possible since 2000, T. Nelson, unpublished data from the Fraser River Sturgeon Conservation Society). There is considerable uncertainty with catch records in the recreational fishery due to varying ability among anglers to differentiate between White and Green Sturgeon.

### *Illegal Trade*

The illegal take and selling of White Sturgeon is known to occur in the Fraser River. This illegal trade may also include the illegal take and sale of Green Sturgeon; however, as the relative abundance of the species is low in the Fraser River, this threat is potentially insignificant.

### **4.2.2 Freshwater Habitat Loss**

Land development practices and dyking for flood protection on the Fraser River have resulted in the permanent elimination of floodplains, tidal marshes, riparian and backwater areas (Environment and Climate Change Canada 1992). In addition to the direct loss of these habitats through infill and obstruction, the natural nutrient and organic matter exchange processes between the outer channel or estuary and areas behind the dyke are also interrupted, leading to reduced estuarine production (Van Dyke and Wassen 2005). The hydraulic impacts of channel confinement and bank armoring can also alter flow velocity, which causes scouring in upstream areas, and sedimentation, loss of deep pool habitat, and degradation in lower gradient areas and downstream estuaries (Van Dyke and Wassen 2005). Estuaries in BC are also often used for log dumps or log storage in forestry operations, which can result in debris accumulation and physical disruption of benthic habitats (Conlan and Ellis 1979).

Navigational dredging in the Fraser River disrupts benthic habitat, impacting organisms that potentially provide food for Green Sturgeon, although the feeding habits of Green Sturgeon in the Fraser River are not known. Dredging also affects tidal flow patterns and salinity levels, and interrupts natural sediment transport processes, which can lead to the degradation of adjacent foreshore areas and offshore banks (Schoof 1980). The risk of mortality through entrainment of individuals by the cutter head dredge is not likely a threat in Canada, as the threat would be greatest for juveniles (Hoover *et al.* 2011), which are not present in Canadian waters.

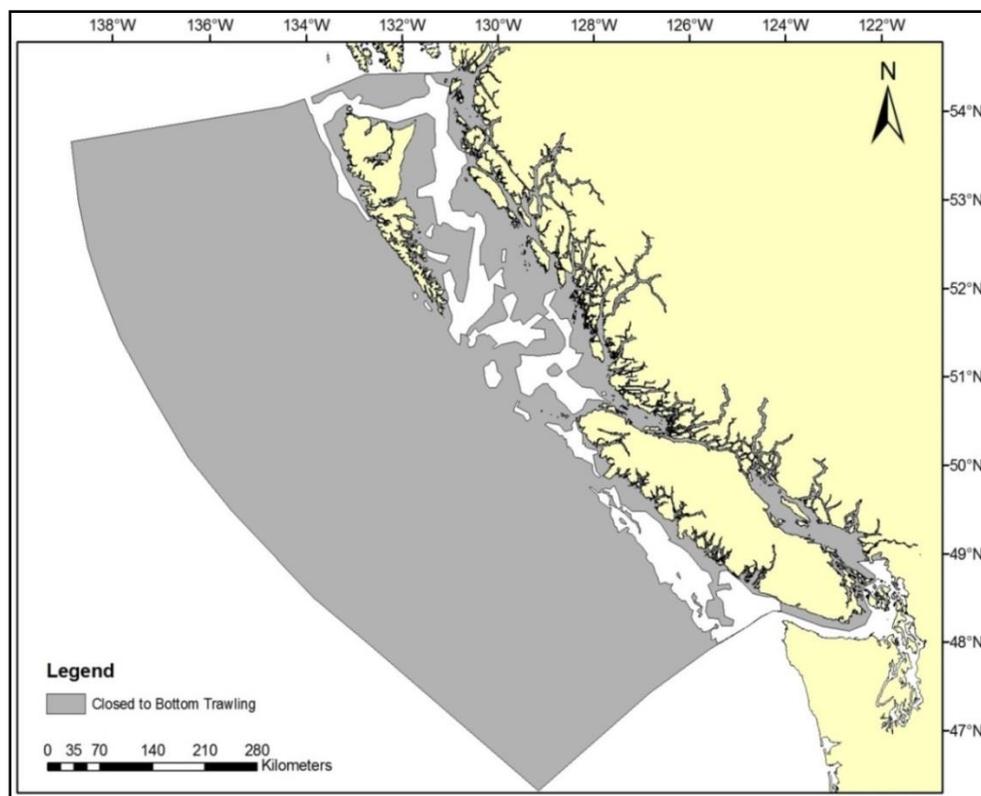
Given the seasonal concentrations of Green Sturgeon in estuaries on the northwest coast of North America (Lindley *et al.* 2011), impacts to estuarine habitat and the lower reaches of Canadian rivers (*e.g.*, Fraser River, Skeena River) may influence Green Sturgeon survival in these habitats. However, although channel, streambank, and foreshore alteration can have locally severe impacts on fish habitat, the severity of the impact on Green Sturgeon populations is unknown. The freshwater and estuarine habitat preferences of Green Sturgeon, such as deeper pools in large mainstem channels (WDFW and ODFW 2012) may make them less susceptible to channel and streambank alterations than would otherwise be the case if they preferred the shallow

margin areas. Overall, the threat of channel, streambank and foreshore alteration in Canada is considered to be of low concern to the species.

#### **4.2.3 Marine Habitat Loss**

Although much of the area across the continental shelf of western Canada is closed to the groundfish trawl fishery (Figure 3), the fishery is still open in certain areas that overlap with the known marine distribution of Green Sturgeon, particularly west of Vancouver Island, and in Queen Charlotte Sound and Hecate Strait. Impacts to benthic habitat from deployment of bottom trawl fishing gear have been well documented, and include the reduction of structural biota and habitat complexity, changes in species abundance and complexity of benthic communities, reduction in species ranges, and other sub-lethal effects (DFO 2006).

Huff *et al.* (2011) showed that Green Sturgeon may select complex benthic areas as feeding and refuge habitat, which suggests they may be vulnerable to this threat. Although impacts to Green Sturgeon production have not directly been demonstrated, a general reduction of habitat complexity from bottom fishing activity is a plausible threat based on available information and could reduce foraging efficiency or expose Green Sturgeon to higher predation rates. Although the severity of this impact is unknown, its causal certainty is low. This threat is thus considered to be of low overall concern to the species. Further research is required to better assess the impact of marine habitat loss on the species.



**Figure 3** Western Canadian continental shelf area closed to the Commercial Groundfish Bottom Trawl Fishery (DFO 2013).

#### 4.2.4 Environmental Contaminants – Persistent Bioaccumulative Toxins

Green Sturgeon are at risk of exposure to Persistent Bioaccumulative Toxins (PBTs) during their freshwater and estuarine residency as juveniles or during seasonal use of estuaries in their marine migratory phase.

The long life span and late age of maturity of these fish increases their vulnerability to chronic and acute effects of bioaccumulation (COSEWIC 2004). Although contaminant levels have not been directly measured in Green Sturgeon, White Sturgeon have been shown to carry high contaminant loads (USEPA 1999).

In Canadian waters, Green Sturgeon would be exposed to PBTs in the Fraser River estuary, and potentially elsewhere, at locations of point source contaminant discharge (e.g., pulp mills) or disposal-at-sea sites, or from non-point source run-off. High contaminant loads in individual fish could cause a continuous impairment of their behaviour and physiological processes throughout their range, affecting feeding, growth and reproductive success. However, the limited residency of Green Sturgeon in freshwater/estuarine habitats likely reduces their exposure to contaminants, and their contaminant load is likely much less than White Sturgeon. The overall concern of the threat is currently considered to be low.

## **5. MANAGEMENT OBJECTIVE**

The management objective for Green Sturgeon is to maintain their distribution and abundance at existing levels or higher in Canadian waters by limiting threats to the species within Canadian waters.

The Management Plan recommends an approach to conservation that assumes that Green Sturgeon populations have the potential to recover. Although it is generally recognized that the primary threat to the species occurs in spawning habitat outside of Canada, the threat of mortality through non-targeted fisheries in Canadian waters has the potential to compromise the management objective.

## **6. BROAD STRATEGIES AND CONSERVATION MEASURES**

### **6.1. Actions Already Completed or Currently Underway**

The following management actions are already completed or underway in Canadian Pacific waters.

#### **6.1.1 Bycatch Mitigation**

##### *Commercial Fisheries*

##### **Required Release:**

No commercial fishery in Canadian Pacific waters is permitted to retain Green Sturgeon; all fisheries are required to release bycatch at sea with the least possible harm.

##### **At Sea Monitoring:**

Since 1996, the groundfish bottom trawl fishery has been monitored intensively (100% observer coverage on all trips); since 2006, all commercial hook and line/trap groundfish fisheries have 100% at-sea monitoring in the form of observers or electronic monitoring. This monitoring, in addition to fishing logbooks, enables more accurate accounting of sturgeon bycatch in these fisheries than obtained prior to 1996.

##### **Dockside Monitoring:**

Dockside monitoring of catch has been in place since 1990 for Sablefish and Halibut, 1994 for Groundfish Trawl, 1995 for Rockfish (hook and line), and 1996 for Lingcod and Dogfish. Any Green Sturgeon which are landed in these fisheries will be documented through this program.

### *Recreational Fisheries*

#### No Retention:

It is illegal to retain Green Sturgeon while sport fishing in marine or freshwater areas in Canada. The recreational harvest limit for Green Sturgeon is zero (*British Columbia Sport Fishing Regulation*, s. 5, 1996).

### **6.1.2 Habitat Impact Mitigation**

#### *Commercial Fisheries*

##### Groundfish Trawl Closures:

On April 2, 2012 the Canadian Groundfish Research and Conservation Society, on behalf of the groundfish trawl industry and the Pacific Marine Conservation Caucus, agreed to “freeze the bottom trawl footprint” to areas previously trawled between 1996-2011 (DFO 2013). The primary objective was to reduce and manage coral and sponge bycatch and damage off the west coast of BC. Although these closures effect a significant reduction in marine habitat disturbance, it is uncertain how much Green Sturgeon habitat is directly protected by these closure areas.

##### Rockfish Conservation Areas:

A conservation strategy developed for British Columbia’s inshore rockfish led to the creation of Rockfish Conservation Areas, covering 30% of the protected waters east of Vancouver Island (inside area) and 20% of the remaining open-coast waters (outside area; Yamanaka and Logan 2010). The physical habitat characteristics of Rockfish Conservation Areas on the northwest coast of Vancouver Island at Scott Islands, Topknot, Brooks Bay, Checkleset Bay, West of Bajo Reef, and Estevan Point generally match the Green Sturgeon’s 20-60 metre depth range and habitat complexity preference described by Huff *et al.* (2011), and therefore may provide incidental protection for this species.

#### *Near-Shore and In-River Activities*

##### Fraser River Estuary Management Plan:

The Fraser River Estuary Management Program (FREMP) operated from 1985 to 2013, with one of its goals to protect and improve environmental quality in and around the Fraser River Estuary. FREMP produced The Fraser River Estuary Management Plan (FREMP 2003), which defines actions to address issues relating to water and sediment quality, fish and wildlife habitat, dredging and navigation, log management, and industrial and urban development in the Fraser River estuary. Although the program has ended, recommendations of the Management Plan have been incorporated into the

standard practices of industries and regulatory agencies with authority in the Fraser River (e.g., navigational dredge management).

### 6.1.3 Other

#### *Access to Data*

Catch Record Queries and Summaries:

In order to retrieve a consistent summary of Green Sturgeon bycatch in Canadian Fisheries, the contact information and specific queries to provide to Fisheries and Oceans Canada is provided in Appendix D.

## 6.2. Broad Strategies

The following three broad strategies support the management objective outlined in Section 5. Many of the conservation measures that fall under these broad strategies are currently underway (Section 6.1). Broad strategies and conservation measures are summarized and prioritized in Table 5 (Section 6.3).

### 6.2.1 Management

Given the restriction of key Green Sturgeon life history stages to habitats located in areas outside of Canadian jurisdiction, the primary management effort of this Plan will focus on fisheries management measures to ensure that bycatch levels in Canadian fisheries do not pose a threat to the recovery of the species. However, as a general management approach, the *Fisheries Act*, *Aboriginal Communal Fishing Licences Regulations*, *Oceans Act*, *Canada National Parks Act*, *National Marine Conservation Areas Act*, and British Columbia provincial *Wildlife Act* will be applied in order to support continued assessment and reduction of Green Sturgeon bycatch and to protect Green Sturgeon habitat in BC waters.

#### *Commercial Fisheries*

Fisheries and Oceans Canada uses integrated fisheries management plans (IFMPs) to guide the conservation and sustainable use of marine resources. The licence conditions for each fishery further outline prohibited species and requirements for reporting bycatch. For commercial fisheries, Green Sturgeon conservation measures should include, but are not limited to the following:

- Continue to implement licence restrictions on Green Sturgeon retention or bycatch in commercial fisheries.

- Continue to implement fisheries management measures regarding fishing bycatch and habitat alteration in areas where interactions with Green Sturgeon are identified, including:
  - All commercial groundfish vessels must have 100% at-sea monitoring.
    - Hook and line and trap vessels must include either electronic monitoring or a third-party-at-sea observer;
    - For Option A trawl vessels (fishing outside of the Strait of Georgia), this includes a third-party at-sea observer; and
    - For Option B (fishing in the Strait of Georgia) and mid-water directed Pacific hake trawl vessels, this includes electronic monitoring.
- Continue to prohibit the retention of Green Sturgeon in Canadian Pacific waters.
- All fisheries are required to release Green Sturgeon with the least possible harm.

### *Recreational Fisheries*

Recreational fishing is managed under the finfish recreational fisheries, and includes the following conservation measures for Green Sturgeon:

- Continue to implement the following licence restrictions on Green Sturgeon retention or bycatch in recreational fisheries:
  - A prohibition against fishing for or retaining Green Sturgeon in freshwater; and
  - A zero retention limit in tidal waters.

### *Food, Social and Ceremonial Fisheries*

Retention of Green Sturgeon in First Nations food, social, and ceremonial (FSC) fisheries is not specifically restricted in Canadian waters.

## **6.2.2 Research and Monitoring**

### *Address Knowledge Gaps*

To protect Green Sturgeon in Canadian Pacific waters from threats to their conservation, research is needed to clarify the significance of threats and factors that may limit their distribution and abundance. Collaboration with other government

agencies, First Nations, academia, and environmental non-government organizations (ENGOS) is beneficial to the species. Research activities may include:

- Determine the range, areas of aggregation, and seasonal occurrence;
- Expand receiver arrays to better track tagged fish in Canadian waters;
- Include tissue sampling in observer program for genetic analysis of population structure;
- Investigate habitat and diet requirements;
- Improve estimation of all sources and magnitude of human-induced mortality; and
- Conduct scientific research on post-release mortality in the groundfish trawl fishery.

#### *Data Retrieval and Interpretation*

Canadian catch monitoring data varies across fisheries with respect to detail and format due to different catch monitoring requirements. A DFO project to standardize catch monitoring requirements and catch data across aboriginal, recreational, and commercial fisheries through a risk-based approach is currently underway (DFO 2012). The ability to retrieve and consistently interpret data is essential to Green Sturgeon research and recovery initiatives. The following actions should assist researchers in the consistent collection and accurate interpretation of information:

- Identify data required to increase understanding of Green Sturgeon abundance and distribution in order to inform the development of consistent and informative Green Sturgeon bycatch monitoring and reporting processes;
- Document potential Green Sturgeon fisheries bycatch data sources; develop and update descriptive metadata to aid in interpretation (provided in this Plan, see Appendix D).

#### **6.2.3 Outreach and Communication**

Due to the rarity of encounters with Green Sturgeon, and that White Sturgeon may be misidentified as Green Sturgeon due to their similar appearances, reports of their occurrence in Canadian waters are often uncertain. Communication to agency staff, the public, and others is important to improve identification and protection of Green Sturgeon, and to better understand their distribution and habits in Canada. This approach should include but is not limited to the following:

- Develop an identification guide and accompanying outreach program to assist with distinguishing Green Sturgeon from White Sturgeon to provide to fishers, regulatory agencies, First Nations, and the public; and
- Include Green Sturgeon management measures in IFMPs and fishing licences.

### 6.3. Conservation Measures

Recommended conservation measures have been identified for each broad strategy (Table 5). The measures implemented by responsible jurisdictions will be subject to the availability of funding and resources. Where appropriate, partnerships with organizations and sectors will provide the necessary expertise and capacity to carry out the listed action.

Conservation measures have been recommended where implementation is deemed to be practical and feasible, and most likely to result in protection of the population in Canada. The conservation measures are prioritized, with respect to the degree of direct contribution each measure would have on the conservation of the Green Sturgeon in Canada. The assigned prioritization of each measure may change with time as new information emerges. Unless otherwise stated, these measures are specific to the Green Sturgeon in Canada.

**Table 5: Conservation measures and implementation schedule.**

Conservation Measure	Priority <sup>5</sup>	Threats or Concerns Addressed	Timeline
<b>Broad Strategy: Management</b>			
<b>Commercial Fisheries</b>			
Continue to prohibit retention of Green Sturgeon in Canadian Pacific waters	High	<ul style="list-style-type: none"> <li>• Fisheries bycatch</li> </ul>	Ongoing
Continue to require release of Green Sturgeon with the least possible harm	High	<ul style="list-style-type: none"> <li>• Fisheries bycatch</li> </ul>	Ongoing

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<sup>5</sup> “Priority” reflects the degree to which the action contributes directly to the conservation of the species or is an essential precursor to an action that contributes to the conservation of the species.

Conservation Measure	Priority <sup>5</sup>	Threats or Concerns Addressed	Timeline
Continue to implement fisheries management measures regarding fishing bycatch and habitat alteration in areas where interactions with Green Sturgeon are identified	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> <li>Marine habitat loss</li> </ul>	Ongoing
<b>Recreational Fisheries</b>			
Continue to implement a prohibition against fishing for or retaining Green Sturgeon in freshwater	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
Continue to implement a zero retention limit in tidal waters	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
Continue to require release of Green Sturgeon with the least possible harm	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
<b>Broad Strategy: Research and Monitoring</b>			
<b>Address Knowledge Gaps</b>			
Improve estimation of all sources and magnitude of human-induced mortality	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> <li>Freshwater habitat loss</li> <li>Marine habitat loss</li> <li>Environmental contaminants – persistent bioaccumulative toxins</li> </ul>	Ongoing
Conduct scientific research on post-release mortality in the groundfish trawl fishery	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	2019
Determine the species range, areas of aggregation, and seasonal occurrence	Medium	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
Include tissue sampling in observer program for genetic analysis of population structure	Medium	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
Investigate habitat and diet requirements	Medium	<ul style="list-style-type: none"> <li>Freshwater habitat loss</li> <li>Environmental contaminants – persistent bioaccumulative toxins</li> </ul>	Ongoing
Expand receiver arrays to better track tagged fish in Canadian waters	Medium	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> <li>Marine habitat loss</li> </ul>	Ongoing

Conservation Measure	Priority <sup>6</sup>	Threats or Concerns Addressed	Timeline
<b>Data Retrieval and Interpretation</b>			
Identify data required to increase understanding of Green Sturgeon abundance and distribution to inform the development of consistent and informative Green Sturgeon bycatch monitoring and reporting processes	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	2019
Document potential Green Sturgeon fisheries bycatch data sources; develop and update descriptive metadata to aid in interpretation	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	Ongoing
<b>Broad Strategy: Communication and Outreach</b>			
Develop an identification guide and accompanying outreach program to distinguish Green Sturgeon from White Sturgeon to provide to fishers, regulatory agencies, First Nations, and the public	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	2019
Include Green Sturgeon management measures in Integrated Fisheries Management Plans	High	<ul style="list-style-type: none"> <li>Fisheries bycatch</li> </ul>	2019

## 7. MEASURING PROGRESS

Pursuant to section 72 of SARA, progress on implementation of the Management Plan will be assessed within five years of the date of posting to the SARA Registry. The status of each of the broad strategies and conservation measures listed above will be reported upon at these five year intervals, until the Management Plan objective has been achieved. The performance measures that will be used to monitor progress toward the Management Plan objective are listed below in Table 6:

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<sup>6</sup> “Priority” reflects the degree to which the action contributes directly to the conservation of the species or is an essential precursor to an action that contributes to the conservation of the species.

**Table 6: Performance measures for Green Sturgeon conservation in Canadian Pacific waters.**

<b>Management Objective</b>	<ul style="list-style-type: none"> <li>No change or decreasing trend in Green Sturgeon bycatch estimates<sup>7</sup></li> </ul>
<b>Broad Strategy 1: Management</b>	<ul style="list-style-type: none"> <li>Maintain or enhance fisheries management measures to reduce bycatch mortality in Canadian Pacific waters as required by 2019</li> </ul>
<b>Broad Strategy 2: Research and Monitoring</b>	<ul style="list-style-type: none"> <li>Complete Green Sturgeon population monitoring to determine interception trends in commercial and recreational fisheries by 2019</li> <li>Complete scientific research on the biology, ecology, stock structure and threats to determine: the species range, areas of aggregation and seasonal occurrence, and population structure by including tissue sampling in observer program for genetic analysis by 2019</li> <li>Identify habitat and dietary requirements by 2019</li> <li>Expand receiver arrays to better track tagged fish in Canadian waters by 2019</li> </ul>
<b>Broad Strategy 3: Outreach and Communication</b>	<ul style="list-style-type: none"> <li>Complete identification guide and accompanying outreach program (to distinguish Green Sturgeon from White Sturgeon) to provide species specific information to fishers, regulatory agencies, First Nations, and the public by 2019</li> <li>Include Green Sturgeon management measures in Integrated Fisheries Management Plans and Licence Conditions by 2019</li> </ul>

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<sup>7</sup> Comparison of future bycatch estimates should take into account potential consequences of improvements in fisheries bycatch data, including species identification (*i.e.*, improving quality of bycatch estimates may increase quantity of bycatch estimates), as well as any increase in species abundance.

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## APPENDIX A: THREAT ATTRIBUTES TERMINOLOGY

Description of terms used for assessment of threats to the North American Green Sturgeon (Environment and Climate Change Canada 2008).

Attribute	Level of Effect	Description
<b>Extent</b>	Widespread	Across the species range
	Localized	Across a specific portion of the species range
	Unknown	Available information is insufficient to gauge the extent of the threat
<b>Occurrence</b>	Historical	Contributed to decline but no longer affecting the species
	Current	Affecting the species now
	Imminent	Is expected to affect the species very soon
	Anticipated	May affect the species in the future
	Unknown	Available information is insufficient to gauge the occurrence of the threat
<b>Frequency</b>	One-time	Occurring only once
	Seasonal	Due to migration or particular seasons
	Continuous	Ongoing
	Recurrent	Reoccurs from time to time, but not on annual/seasonal basis
	Unknown	Available information is insufficient to gauge the occurrence of the threat
<b>Severity</b>	High	Very large population-level effect
	Medium	Moderate population-level effect
	Low	Small population-level effect
	Unknown	Available information insufficient to gauge the degree to which the threat may affect population viability*
<b>Causal Certainty</b>	High	Evidence causally links the threat to stresses on population viability
	Medium	Correlation between the threat and population viability, expert opinion, etc.
	Low	Assumed or plausible threat only
<b>Level of Concern</b>	High	Overall level of concern for recovery of the species taking into account all of the above factors.
	Medium	
	Low	

\* Population viability is defined as the ability of a population to persist and to avoid an uplisted status (e.g., threatened or endangered)

## **APPENDIX B: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES**

A strategic environmental assessment (SEA) is conducted on all Species at Risk recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Management planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the Plan itself, but are also summarized below.

This Management Plan will clearly benefit the environment by promoting the recovery of Green Sturgeon, thereby positively contributing to Goal 5 (Wildlife Conservation) of the [Federal Sustainable Development Strategy](#) (FSDS). Because of shared threats, and similar techniques used to fill knowledge gaps and complement existing knowledge, the majority of actions contained in this Plan can also potentially benefit other fish species, and recovery planning initiatives for those that are species at risk. Maintaining biodiversity within Canadian Pacific waters helps to encourage the resiliency of various North Pacific Ocean ecosystems. As such, the Management Plan also positively contributes to the FSDS' Goal 6 (Ecosystem/Habitat Conservation and Protection).

The potential for the Management Plan to inadvertently lead to adverse effects on the environment and other species was considered. The SEA concluded that this Plan will benefit the environment, and potentially other species, and will not entail any significant adverse effects. The benefits stemming from the use of ships to perform research outweigh the relatively small negative impacts that Management Plan-specific use of those research platforms have on air pollution (FSDS Goal 2), water quality (FSDS Goal 3), anthropogenic noise and disturbance due to vessel presence.

## **APPENDIX C: RECORD OF COOPERATION AND CONSULTATION**

The Green Sturgeon (*Acipenser medirostris*) is an anadromous fish that was originally assessed in November 2004 as 'Special Concern' by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC), and recently reassessed under the same status in November 2013. Green Sturgeon was listed as a species of Special Concern under the *Species at Risk Act* (SARA) in September 2006 and is currently listed as such.

Green Sturgeon resides throughout the coastal marine and freshwater environments of the Province of British Columbia. As such, the Minister of Fisheries and Oceans (DFO) and the Minister responsible for the Parks Canada Agency are the competent ministers for Green Sturgeon in Canadian waters. DFO established a working group of technical experts to develop the initial draft of this Management Plan. Given that Green Sturgeon migrates through both Canadian and U.S. waters, bilateral government input and collaboration was sought. See the Acknowledgements section of this document for a list of contributing authors.

A draft of the Management Plan, along with a discussion guide and feedback form was made available online via the DFO Pacific Region Consultation website for a public comment period from June 30 to July 30, 2014. This consultation was primarily web-based, but included mail-outs, emails and faxes to all coastal First Nations to solicit input and feedback on the draft Management Plan. Notification of the consultation period was also sent by electronic mail to a distribution list of stakeholders, ENGOs, government agencies, and several Departmental advisory committees including the Groundfish Integrated Advisory Board (GIAB), Halibut Advisory Board (HAB), Sablefish Advisory Committee (SAC), Groundfish Trawl Advisory Committee (GTAC), and the Groundfish Hook & Line Advisory Committee (GHLAC). Where appropriate, all feedback received during this consultation period has been incorporated into the final Management Plan.

## APPENDIX D: GREEN STURGEON BYCATCH DATA

### Information Requests

Fisheries and Oceans Canada (DFO) is responsible for the compilation and maintenance of official fisheries catch statistics according to governmental standards and procedures. This work is facilitated in Pacific Region by the Regional Data Services Unit.

DFO's Fisheries Operations System (FOS) stores catch data from logbooks recorded by fishers and onboard observers through various catch monitoring programs in various Pacific Region commercial fisheries, including the commercial salmon, groundfish trawl, and groundfish hook and line fisheries, where Green Sturgeon have been caught incidentally. PacHarvTrawl is the database that was used to house Groundfish Trawl catch records prior to implementation of FOS in 2007. Recreational fisheries catch records are stored in DFO's Catch and Release Estimation Tool (CREST) database system.

Section 20(1)(b) of the *Access to Information Act* prevents DFO from disclosing to a third party, records containing financial, commercial, scientific or technical information that is confidential information. Further, Section 20(1)(c) of the Act prevents DFO from giving out information, the disclosure of which could reasonably be expected to prejudice the competitive position of the licence holder. For this reason, data requests that consist of individual catch records are generally not available for distribution outside of DFO. However, catch records can be aggregated (spatial and/or temporal) to address this issue. The bycatch data for Green Sturgeon presented in this Management Plan summarizes the annual aggregated catch by area from the groundfish hook and line and trawl fisheries, and is therefore in compliance with the *Access to Information Act*.

Requests for updates to these summary statistics can be submitted to the Data Services Unit by providing the following request:

*The annual catch (in Kilograms) of species code 082, (Green Sturgeon) from 1996 to present, by PMFC area, including subtotals for each year and area.*

*The annual catch (in Kilograms) of species code 081, (Sturgeons) from 1996 to present, by PMFC area, including subtotals for each year and area.*

Requests can be provided to the Data Services Unit voicemail at: 604-666-2716. Leave a message describing the above information request, along with your name, your phone/fax number, and your mailing address if you wish to have the information mailed to you. Alternately, email the contents of this request to: [catchstats@dfo-mpo.gc.ca](mailto:catchstats@dfo-mpo.gc.ca).

All data should be considered preliminary. Consult with the applicable Fishery Manager or Biologist as to the nature of particular data.

## Notes on Groundfish Trawl At-Sea Observer Data

At-Sea observers for the groundfish trawl fishery (partial observer coverage prior to 1996) have a resource manual that provides photos and descriptions of Green Sturgeon and offers a descriptive comparison to White Sturgeon. Observers report Green Sturgeon encounters; however in some cases, the species of sturgeon is not distinguished, and encounters are simply recorded as “Sturgeon”. White Sturgeon are also recorded, and it is expected that some White Sturgeon are recorded with the generic “Sturgeon” code as well. Catch records with weight under 10 lbs may also be miscoded sturgeon poacher. It is not known what proportion of records coded as “Sturgeon” represents Green Sturgeon.

The piece count of each record is generally not recorded for Green Sturgeon in the trawl fishery. The methods commonly used to determine the weight of each catch record for Green Sturgeon are:

- **Whole Haul:** The observer weighs the fish and records the weight and utilization in their catch data. Documenting the number of pieces on the catch data form with the weight has not been required for this method.
- **Piece Count x Average Weight:** The observer counts the number of pieces and multiplies this number by the average weight (measured or visual average weight) to determine the total weight. In this case the observer is required to record the number of pieces on their catch data form. This method applies where the observer is able to count all of the individuals of a species encountered and their subsequent utilization.
- **Visual Estimate:** The observer estimates the total weight for a species catch record. Catch records made by visual estimate do not require pieces to be recorded. This method may be used for Green Sturgeon if the observer is not certain that they saw all pieces in the catch. It is important to note for Green Sturgeon records that “visual estimate” will be the default method documented if there was only “one” piece in the catch and the “estimated” average weight – in this case ‘pieces’ is not a required field for completion on the catch estimation form. It is quite likely that for visual estimates of Green Sturgeon for weights of 10 to 75 or 100 lbs the number of pieces was one.

## Notes on Other Fisheries Catch Data

In the groundfish hook and line/trap fishery (partial catch monitoring coverage prior to 2006), pieces for each record are recorded in the data as it is a required field for catch records in this fishery.

In the commercial salmon fisheries, catch data consist primarily of mail or phone-in information from fishers, as well as landed catch, bycatch, and biological samples collected by DFO-certified dockside observers. Note that catch monitoring requirements

vary between the commercial salmon fisheries in terms of targeted salmon species, area, and gear type.

Catch monitoring programs (and resultant catch data) in the recreational fisheries have historically been salmon-focused; however, increased efforts have been made to expand catch monitoring to include all species. The DFO creel survey program includes aerial overflights to estimate effort, with actual catch information retrieved by fisheries technicians through angler interviews. The recreational catch data is also supplemented by catch information from catch logbooks and submitted to the Department by individual anglers, fishing guides, as well as fishing lodges.

As catch monitoring requirements vary between commercial groundfish (trawl and hook and line/trap) and other fisheries, caution should be used to interpret bycatch data from commercial salmon and recreational fisheries. The lack of or a low number of Green Sturgeon bycatch data in those fisheries may not necessarily indicate that species interception is low or negligible, but may be more of an indication that collection of bycatch data is not currently required. This issue could be addressed by developing a set of Green Sturgeon bycatch data requirements – an action identified in this Management Plan – in order to assist in the collection and assessment of bycatch data in these fisheries.