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Canadian Science Advisory Secretariat
Pacific Region | Science Advisory Report 2021/011

RECOVERY POTENTIAL ASSESSMENT FOR LOWER FRASER RIVER WHITE STURGEON 2020

Juvenile Lower Fraser River White Sturgeon (Photo Credit: Corey Wright)

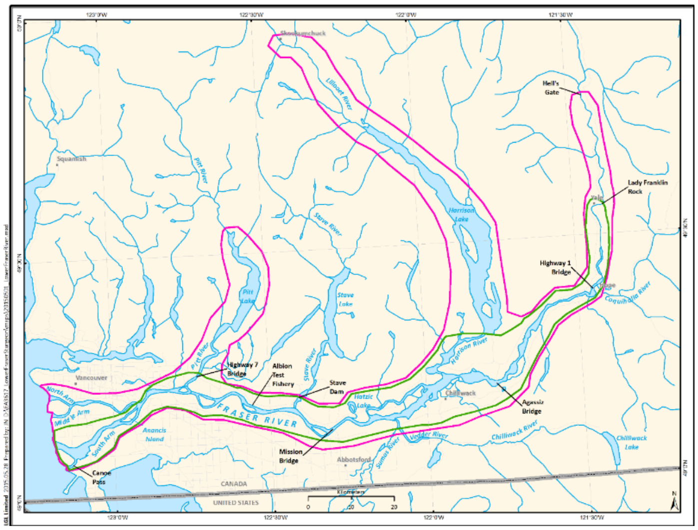

Figure 1. Location map for the Lower Fraser White Sturgeon Designatable Unit (DU) Area within red line presents the extent of known/observed distribution of White Sturgeon within the Lower Fraser River White Sturgeon DU. The area inside the green line is the “core assessment area” used for the production of White Sturgeon abundance estimates presented in Nelson et al. (2020) and Challenger et al. (2020). Figure reproduced from Nelson et al. (2020).

Context:

In 2003, White Sturgeon within the lower Fraser River were identified as one of six Nationally Significant Populations (NSP) of White Sturgeon in Canada (COSEWIC 2003). As a whole, the six NSPs were assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), however the Lower Fraser River White Sturgeon population was not subsequently listed under the Species At Risk Act *(SARA). Following the Endangered status by COSEWIC, a White Sturgeon Recovery Potential Assessment (RPA) (Wood et al. 2007) and the White Sturgeon Recovery Strategy (DFO 2014a) were published.*

Subsequent to the 2003 COSEWIC assessment of White Sturgeon, COSEWIC replaced the NSP terminology with “Designatable Units” (DU). In 2012, COSEWIC assessed the Lower Fraser River White Sturgeon DU as Threatened. In support of the SARA listing process following the 2012 COSEWIC assessment, a subsequent Lower Fraser River White Sturgeon RPA was initiated in 2015 but not finalized. Because no final RPA was published, this new RPA was developed.

This Science Advisory Report is from the September 22-24, 2020 regional peer review on Recovery Potential Assessment – White Sturgeon, Lower Fraser Designatable Unit. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada (DFO) Science Advisory Schedule](#) as they become available.

SUMMARY

- Lower Fraser River White Sturgeon is the Designatable Unit (DU) of White Sturgeon (*Acipenser transmontanus*) that reside in the mainstem of the Fraser River, and accessible tributaries and lakes, from the marine estuary to Hells Gate. Most of the information about this DU has been obtained from the “core assessment area” defined in Figure 1.
- Modelling results indicate that the abundance of age 7 to 55 (fork length 60 to 279 cm) has declined by 25% since 2006, to a 2019 estimate of 44,809 fish. The estimated abundance for juvenile (60 to 99 cm fork length) White Sturgeon has declined by > 70% from 2004 to 2019.
- Reconstructions of historic juvenile recruitment to age 7 have shown variable (increasing and decreasing) trends within an overall range similar to the estimated change since 2000.
- Somatic growth rates have been declining; the average annual growth for 60-179 cm (fork-length) White Sturgeon from 2016-2019 (3.4 cm/year) is 69% of that from 2010-2012 (4.9 cm/year).
- The total population of Lower Fraser River White Sturgeon is forecast to continue to decline if juvenile recruitment remains at similar levels to those estimated for the last 10 years (i.e. 2010 to 2019).
- Long maturation times for White Sturgeon indicate that any changes to early juvenile recruitment (i.e. recruitment to age 1) could take up to 20 years before impacting adult life stages (i.e., 2040 and beyond).
- Several threats were identified and evaluated with the following threats classified as medium level risks: past in-river gravel extraction, White Sturgeon bycatch in FSC (Food Social, and Ceremonial) fisheries, shoreline modification, and food availability.
- Past in-river gravel extraction was identified as a medium threat and may have reduced productivity of some spawning areas, particularly with substantial gravel removals from 2000 to 2010.
- White Sturgeon bycatch in FSC net fisheries was identified as a medium threat, particularly in relation to the use and operation of set nets.
- Shoreline modification was identified as a medium threat: many of these modifications (e.g. tidal/flood gates, dykes, rip-rap) have limited White Sturgeon access to a significant amount of off-channel rearing habitat.
- Food availability was identified as a medium threat because both White Sturgeon growth rates and juvenile abundance have declined during years when the biomass of Chum Salmon and Eulachon entering the Fraser River had declined. Salmon (multiple species) and Eulachon are important sources of food and nutrients for the lower Fraser River ecosystem. The need to further explore relationships between White Sturgeon abundance/growth and other salmon species was identified.
- With the uncertainty in the causes of declining juvenile recruitment, it is difficult to determine which mitigative measures would be most effective at reversing this decline. It is likely that multiple measures will be required.
- Examples of mitigation measures and alternative activities and their anticipated effects on White Sturgeon mortality and recruitment are provided in Table 4 of this document.

- A survival threshold of 10,000 adults (age 22-55, 160-279 cm fork length) was identified as the minimum number of adults needed for medium to long-term survival of the DU.
- Three complementary candidate recovery thresholds were identified: 1) 20,000 adults (age 22-55, 160-279 cm fork length), 2) total abundance of 60,000 (age 7-55, 60-279 cm fork length), and 3) a positive trend in juvenile abundance over a 50-year time window.
- Although the population is expected to be above the survival threshold into the foreseeable future; if juvenile recruitment declines further (i.e., to half of the 2010-2019 levels), adult abundance could drop below the survival threshold within 50 years.
- Six recruitment hypotheses were designed to explore a range of possible future recruitment scenarios. Using the posterior sample of age-specific abundances, posterior predictive projections were developed under each scenario to determine the likelihood of achieving survival and candidate recovery thresholds under a given hypothesis.
- Due to a long time lag between implementing mitigation measures and observing the corresponding result in adult abundances, there were some differences in the effectiveness of mitigation measures to achieve total versus adult candidate recovery thresholds within the 50-year projection window. A longer projection window (e.g., 70 years) may be needed to confirm the level of certainty for adult candidate recovery thresholds.
- To achieve the candidate recovery threshold of 60,000 total abundance within a 50-year window, and prevent any further decline in the population, juvenile recruitment must be doubled from the average recruitment estimated for 2010-2019.
- Critical to the sustainability of this population, harm needs to be reduced relative to current levels. This may be addressed through changes to habitat that would improve juvenile growth and survival, changes to fisheries, and increases in food availability.

BACKGROUND

Rationale for Recovery Potential Assessment

After the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses an aquatic species as Threatened, Endangered, or Extirpated, Fisheries and Oceans Canada (DFO), as the responsible jurisdiction for aquatic species under the *Species at Risk Act* (SARA), undertakes several actions to support implementation of SARA. Many of these actions require scientific information on the current status of the species, threats to its survival and recovery, and the species' potential for recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA) following the COSEWIC assessment. This timing allows for the consideration of peer-reviewed scientific analyses within SARA processes, including the decision whether or not to list a species on Schedule 1, and during recovery planning if the species is listed.

Based on a 2012 COSEWIC assessment (COSEWIC 2012), the Lower Fraser River White Sturgeon (*Acipenser transmontanus*) Designated Unit (DU) was assessed as a Threatened. This DU includes all White Sturgeon that reside in the mainstem of the Fraser River, and assessable tributaries and lakes, from the main marine estuary to Hells Gate (Figure 1).

Lower Fraser River

The Fraser River is a large natural river system that includes slow, deep mainstem channels, zones of swift turbulent water, and extensive floodplains, with a snowmelt-driven hydrography and prolonged spring floods. Lower Fraser River White Sturgeon is one of two DU of White

Sturgeon within the Fraser River catchment and is delineated by those living in the Fraser River catchment from the marine estuary to Hells Gate. Within this reach of the Fraser River, White Sturgeon occupy a wide variety of habitats at various life stages. White Sturgeon are also known to occur in connected tributaries and lakes, such as the Pitt River, Pitt Lake, Harrison River, and Harrison Lake. This RPA focused on abundance within the mainstem portion of the Fraser River below Hells Gate and lower portions of major tributaries identified in Figure 1. Although this DU may access marine waters, there is limited information on marine movement.

Biology, Abundance, Distribution, and Life History Parameters

White Sturgeon are a slow-growing species with delayed on-set of sexual maturity. Males tend to mature at younger ages (11 years or later), while females tend to mature later (26 years or later). Females are iteroparous and can spawn multiple times during their lifetime with 4 to 11 years between spawning events. Spawning occurs in the late spring and early summer, typically as water temperatures are rising. Ova development is slow (up to 2.5 years); the number of eggs produced by female White Sturgeon is proportional to their body size.

Based on Integrated Spatial and Age-structured Mark Recapture (ISAMR) model (Challenger et al. 2020), the total abundance of Lower Fraser River White Sturgeon age 7 to 55 (with fork lengths (FL) of 60 to 279 cm), has declined by 25% from 2006 to a 2019 estimate of 44,809 fish (Figure 2). The most substantial decline in estimated abundance has been in juveniles (age 7 to 12, or 60 to 99 cm FL) with a decline of greater than 70% from 2004 to 2019. If the current level of juvenile recruitment persists, the population is forecasted to continue to decline for thirty or more years.

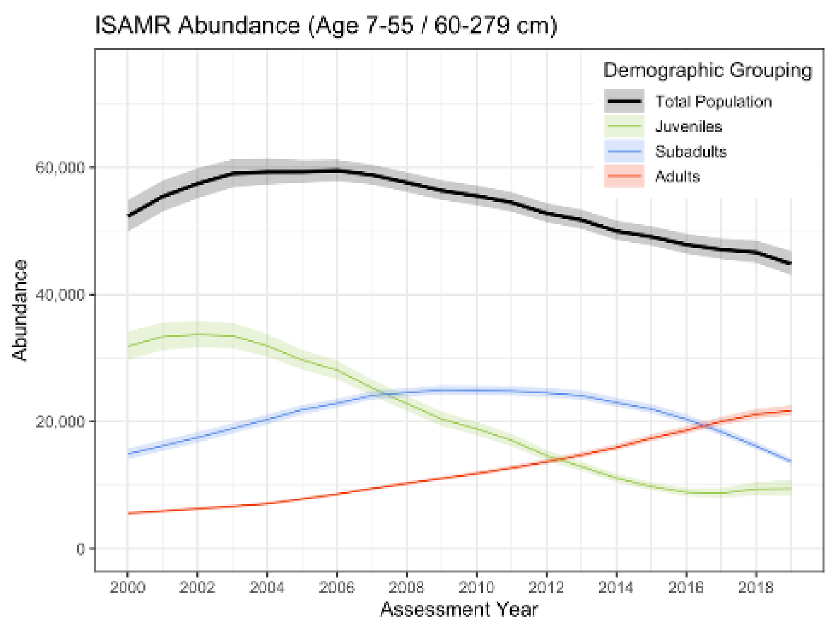

Figure 1. Abundance estimates of Lower Fraser River White Sturgeon from 2000 to 2019. Shading indicates 95% credible intervals. Total population was for 60-279 cm FL (age 7-55), juveniles were 60-99 cm FL (age 7-12), subadults were 100-159 cm FL (age 13-22), and adults were 160-279 cm (age 23-55). Figure adapted from Challenger et al. (2020).

In addition to decreases in estimated abundances, average somatic growth rates for Lower Fraser River White Sturgeon vary among years and show declining trends (Figure 3). The average annual growth for 60-179 cm FL White Sturgeon from 2016-2019 (3.4 cm/year) was 69% of that from 2010-2012 (4.9 cm/year; Nelson et al. 2020).

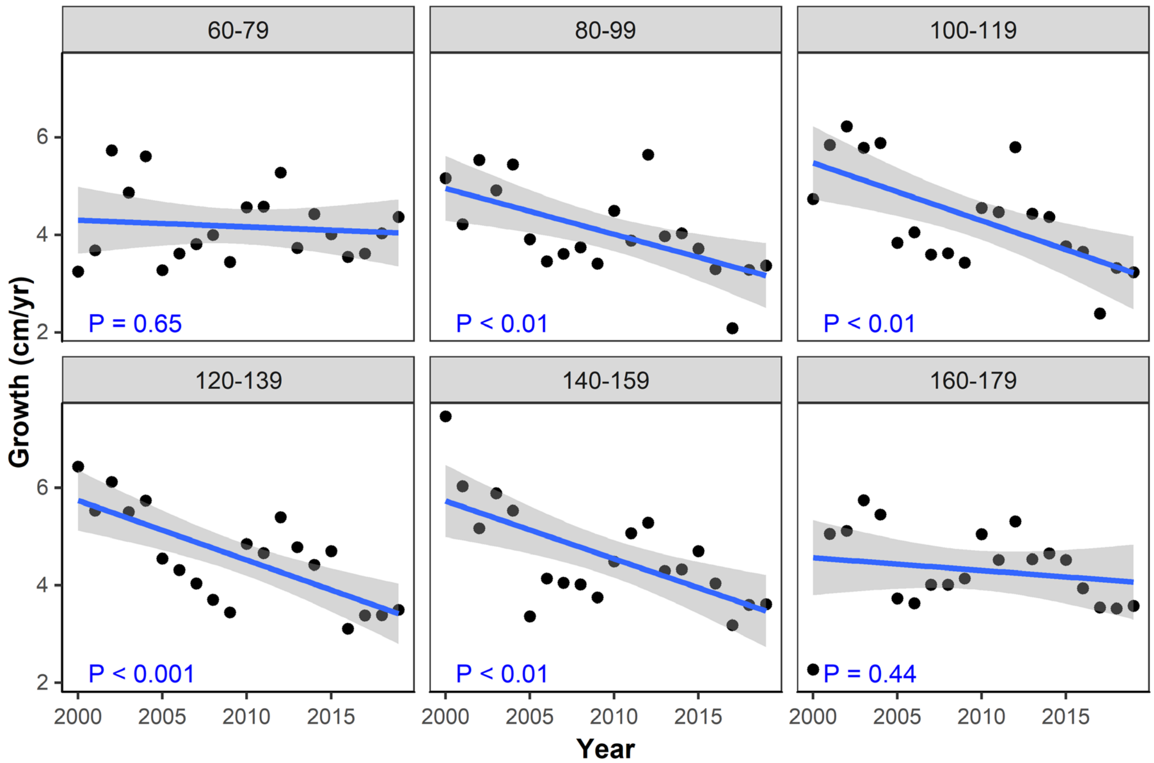

Figure 3. Average annual growth increments of 60-179 cm FL White Sturgeon in the lower Fraser River, by 20-cm FL size group for 2000-2019. Solid lines indicate simple linear regression fits, with shading indicating the 95% confidence regions for the regression lines. Annual growth estimates are the same as those presented in Nelson et al. (2020, Figure 12).

ASSESSMENT

Habitat and Residence Requirements

Throughout their life history, White Sturgeon used a range of habitat within the lower Fraser River. During overwintering (November to April) they are known to congregate in particular areas (e.g. Pitt River, Hatzic Eddy, and the Matsqui side-channel). Spawning habitat typically consists of gravel or cobble substrate with faster or turbulent water flows. There are 14 confirmed spawning areas in the lower Fraser River; however, there are potentially others in side-channels and/or the mainstem. Juvenile habitat typically consists of a wider range of depths with slow to moderate water velocities and fine substrate. For feeding habitat, White Sturgeon make use of the mainstem Fraser River (from the estuary to Hells Gate) and both Pitt and Harrison river catchment. Although they forage in a variety of habitat types and locations, acoustic tagging studies have shown that White Sturgeon migrate to specific locations that have higher food availability (e.g. Eulachon and Pacific salmon) at particular times of the year (Robichaud et al. 2017). Overall, there is limited information about habitat requirements of this DU, particularly at juvenile life stages. This was identified as a source of uncertainty that is currently being addressed through studies focused on assessing juvenile White Sturgeon abundance and habitat preferences (English and Robichaud, 2020[1]; Burns et al. 2020[2]).

SARA defines “residence” as “a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating”. The concept of ‘residence’ does not apply to this species.

Threats and Limiting Factors to the Survival and Recovery

The threats to the survival and recovery of Lower Fraser River White Sturgeon are provided in Table 1. This table was developed based on guidance provided by DFO (2014b). The table focuses on anthropogenic threats, which are defined as “any human activity or process that has caused, is causing, or may cause harm, death, or behavioural changes to a wildlife species at risk, or the destruction, degradation, and/or impairment of its habitat, to the extent that population-level effects occur. For this process, the highest threat risks identified were past in-river gravel extraction, White Sturgeon bycatch in FSC (Food Social, and Ceremonial) fisheries, shoreline modification, and food availability, which were all identified as medium threats to the DU. Each of these threats is described below in the order that they appear in Table 1.

The first medium threat identified was in-river gravel extractions and its potential to reduce productivity of some spawning and larval rearing areas, particularly with substantial gravel removal from 2000 to 2010. While there is uncertainty in the causal mechanisms linking gravel removal to juvenile recruitment, improvements in age 7 recruitment in 2016 and 2017 (Challenger et al. 2020), seven to ten years since industrial gravel removal was prohibited, suggest that this threat may be important to juvenile recruitment. Maintaining the current moratorium on gravel extraction is important to addressing this threat.

Shoreline modification was identified as a medium threat to White Sturgeon based on the extensive development along the river. Extensive use of dykes, rip-rap, tidal gates, and flood gates to protect shoreline development limit White Sturgeon access to a significant amount of off-channel rearing habitat. However, because of the limited shoreline modifications during the recent period of population decline, the causal certainty is low and there is limited evidence this threat is impacting recovery.

White Sturgeon bycatch in First Nation FSC gillnet fisheries was identified as a medium threat. Both drift nets and set nets can cause mortality, but the use and operation of set nets were noted as having a higher associated mortality rate. FSC gillnet fisheries could account for 10 to 33% of the estimated 29,000 decline of 60 to 159 cm FL sized White Sturgeon from 2003 to 2019 (Challenger et al. 2020).

Finally, food availability was identified as a medium threat, in particular adult salmon and Eulachon returns to the Fraser River, which are both a source of food and nutrients for the lower Fraser River ecosystem. The positive relationships between juvenile (age 7) White Sturgeon recruitment and both Chum Salmon and Eulachon biomass were identified (Figure 4); however, other food sources (e.g. Sockeye and Pink salmon), that were not investigated, are also likely to be important for various life stages of White Sturgeon. The need to further explore relationships

[1] English, K.K., and Robichaud, D. 2020. Lower Fraser juvenile White Sturgeon monitoring program: using size-selective angling techniques, 2019-2020. Report for Fraser River Sturgeon Conservation Society, Vancouver, BC, and Habitat Conservation Trust Foundation, Victoria, BC.

[2] Burns, C.W., Robichaud, D., and English, K.K. 2020. Lower Fraser River juvenile White Sturgeon (*Acipenser transmontanus*) habitat assessment: year 1. Report for Fraser River Sturgeon Conservation Society, Vancouver, BC, and Vancouver Fraser Port Authority, Vancouver, BC.

between White Sturgeon abundance/growth and other salmon species was identified as future work.

In addition to the threats outlined in Table 1, several natural factors that could limit the survival and recovery of Lower Fraser River White Sturgeon were noted and include: increases in species that prey on White Sturgeon (e.g. seals, birds, and other fish species); siltation of White Sturgeon spawning areas, reduced inputs of gravel to the sturgeon spawning areas in the gravel reach; and natural changes in water temperature, river discharge, and flow through spawning, rearing, and overwintering areas.

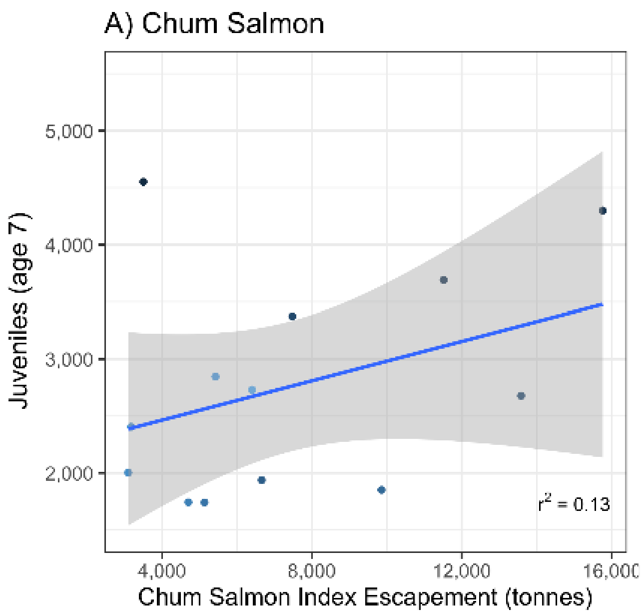

Figure 4. Relationship between Chum Salmon and Eulachon biomass entering the lower Fraser River from 2000-2012 and juvenile (age 7) Lower Fraser River White Sturgeon abundance estimates seven years later (2007-2019). Solid lines indicate simple linear regression fits, with shading indicating the 95% confidence regions for the regression lines.

*Table 1. List of identified threats associated with each COSEWIC threat category and the risk assessment associated with each threat. This table was developed using the threat-assessment methods that are outlined by DFO (2014b). Next to each **Threat Risk** classification, the **Casual Certainty** is provided in brackets with values ranging from (1) for Very high to (5) for Very low.*

COSEWIC Threat Categories	Specific Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
1. Residential and commercial development								
Threats discussed elsewhere (e.g., 7. Natural system modifications)								
2. Agriculture & aquaculture								
Threats discussed elsewhere (e.g., 9. Pollution)								
3. Energy production & mining								
3.2 Mining & Quarrying	Gravel extraction	Known	Medium	Medium	Medium (3)	Historical/ Current	Continuous	Extensive
4. Transportation & service corridors								
4.3 Shipping Lanes	Boat strikes, noise, wakes, dredging	Known	Low	Low	Low (4)	Historical/ Current	Recurrent	Narrow
5. Biological resource use								
5.4 Fishing & Harvesting Aquatic Resources	Recreational fishing	Known	Low	Low	Low (4)	Current	Continuous	Broad
5.4 Fishing & Harvesting Aquatic Resources	Bycatch in Commercial fisheries[1]	Known	Low	Low	Low (4)	Current	Recurrent	Broad
5.4 Fishing & Harvesting Aquatic Resources	Bycatch in Food, Social, & Ceremonial fisheries	Known	Medium	High	Medium (2)	Current	Continuous	Broad
5.4 Fishing & Harvesting Aquatic Resources	Illegal harvests	Known	Unknown	Low	Unknown (4)	Current	Recurrent	Narrow
6. Human intrusions & disturbance								
6.1 Recreational / Boating Activities	Noise and boat strikes	Known	Low	Low	Low (4)	Current	Recurrent	Broad
6.3 Work & Other Activities / Science Activities	Handling stress from tagging	Known	Low	Very low	Low (5)	Current	Recurrent	Restricted
7. Natural systems modifications								
7.2 Dams & Water Management/use	Shoreline modifications, including tidal and flood gates	Known	Medium	Low	Medium (4)	Current	Continuous	Broad
7.3 Other Ecosystem Modifications	Modifications to catchment surfaces	Known	Unknown	Very low	Unknown (5)	Historical/ Current	Recurrent	Broad
7.3 Other Ecosystem Modifications	Food availability	Known	Medium	Medium	Medium (3)	Historical/ Current	Continuous	Extensive

COSEWIC Threat Categories	Specific Threat	Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
8. Invasive & other problematic species & genes								
8.1 Invasive Non-native/Alien Species	Invasive Non-native/Alien Species	Known	Unknown	Very low	Unknown (5)	Current	Single	Narrow
8.2 Introduced Pathogens and Viruses		Remote	Unknown	Very low	Unknown (5)	Current	Recurrent	Broad
8.3 Introduced Genetic Material	Nechako Hatchery program	Likely to occur	Low	Very low	Low (5)	Anticipatory	Recurrent	Broad
9. Pollution								
9.1 Household Sewage & Urban Wastewater	Run-off	Known	Unknown	Low	Unknown (4)	Current	Recurrent	Broad
9.2 Industrial & Military Effluents	Run-off	Known	Unknown	Low	Unknown (4)	Current	Recurrent	Broad
9.3 Agricultural & Forestry Effluents	Run-off	Known	Unknown	Low	Unknown (4)	Current	Recurrent	Broad
10. Geological events								
10.3 Avalanches/landslides	Hells Gate impediment	Known	Low	Very low	Low (5)	Historical	Single	Restricted
11. Climate change & severe weather								
11.2 Droughts	Side-channel reductions	Known	Low	Very low	Low (5)	Anticipatory	Continuous	Extensive
11.3 Temperature Extremes	River temperature	Known	Low	Low	Low (4)	Anticipatory	Continuous	Extensive

[11] Commercial fishing includes: Area E gillnet fishery, First Nations Economic Opportunity fisheries and Demonstration fisheries.

Recovery Targets

In defining recovery targets for this DU, an abundance of 10,000 adults (age 22-55, 160-279 cm FL) was used as a survival threshold (DFO 2014a). In addition to the survival threshold, three complementary candidate recovery thresholds were identified: 1) 20,000 adults (age 22-55, 160-279 cm FL); 2) 60,000 total abundance (age 7-55, 60-279 cm FL); and 3) a positive trend in juvenile abundance over a 50-year time window. These recovery thresholds are summarized in Table 2.

Table 2. Candidate recovery thresholds and survival thresholds for Lower Fraser River White Sturgeon.

Name	Type	Abundance	Age/Size Categories	Description
Adult Survival Threshold	Survival Threshold	10,000	Age 22-55 (160-279 cm FL)	Mature adult abundance threshold suggested for medium- to long-term survival.
Adult Recovery Threshold	Candidate Recovery Threshold	20,000	Age 22-55 (160-279 cm FL)	This demographic represents mature White Sturgeon. While the adult abundance threshold is currently being met, we expect the numbers to fall below this level by the end of the decade (i.e., 2030; Challenger et al. 2020).
Total Recovery Threshold	Candidate Recovery Threshold	60,000	Age 7-55 (60-279 cm FL)	This demographic includes juveniles, subadults, and adults. The proposed threshold was estimated to have occurred within recent histories (i.e., 2005; Challenger et al. 2020) and therefore is believed to reflect abundances that are attainable under current environmental conditions.
Juvenile Trend Recovery Threshold	Candidate Recovery Threshold	Positive trend over the 50-year window	Age 7-12 (60-99 cm FL)	Increases in juvenile abundances are required to rebuild the population: therefore, a positive linear increase in juvenile abundances (age 7-12) over the 50-year period is the juvenile trend recovery threshold.

Scenarios for Mitigation of Threats and Alternatives to Activities

Six recruitment hypotheses were developed to explore a range of possible future recruitment scenarios and their effect on the probability of attaining the candidate recovery thresholds. Hypotheses were designed to cover a variety of natural and management scenarios, including a combination of both. Using the posterior sample of age-specific abundances, posterior predictive projections were developed under each scenario in order to determine the likelihood of achieving the survival threshold and the candidate recovery thresholds (Table 3). Each threshold probability is presented using the risk/certainty classification categories identified by the Intergovernmental Panel on Climate Change ‘guidance note’ on treatment of uncertainty

(Mastrandrea et al. 2010). The justification and details of the six hypotheses are in the subsection below titled *Recruitment Hypotheses*.

As shown in Table 3, there were some differences in the effectiveness of mitigation actions to achieve adult and total candidate recovery thresholds over the 50-year projection window. This was due to the longer time lags between taking action and observing the corresponding result in the adult population. As such, a longer projection window (e.g. 70 years) may be needed to confirm the final risk/certainty category for adult thresholds.

To achieve the candidate recovery threshold of 60,000 total abundance within a 50-year window, and to prevent any further decline in the population, juvenile recruitment must be doubled from the average recruitment estimated for the 2010 to 2019 period.

Recruitment Hypotheses

H1: Chronic Low Recruitment – Recent estimated recruitment rates into the sampled age-7 population has shown chronically low, but stable, rates since ~2011 at approximately 1,900 to 2,800 individuals (Challenger et al. 2020). Although there are two recent yearly estimates that suggest recruitment may be increasing, at this time there is insufficient evidence to support the existence of a stable increasing trend.

H2: Chronic Moderate Recruitment – Prior to 2011, estimated recruitment into age-7 was much higher than at present, peaking in 2001 (Figure 2). Current low recruitment may not be indicative of future recruitment levels. Future increases above current lows may or may not persist, but would increase average long-term recruitment over H1. To simulate a scenario of moderate improvements to recruitment, the average age-7 recruitment from 2005-2014 was used instead of 2010-2019, as the former period had moderately higher recruitment. A 10-year period was used to transition from current recruitment levels to recruitment under the moderate scenario.

H3: Recruitment Decline – Chronic low recruitment has persisted for approximately the last 10 years due to multiple factors that are difficult to quantify. Given the uncertainties regarding the factors that have contributed to the recent levels of recruitment, it is possible that recruitment may decline further. To simulate this possibility, the low recruitment hypothesis (H1) was halved with a 10-year transition period, and then held stable for subsequent years.

H4: Recruitment Increase – For species that take years between spawning events, and that spawn large numbers of eggs per individual, occasional recruitment pulses are expected, especially if environmental factors dictate reproductive success in any given year. The available data indicate that the Lower Fraser River White Sturgeon population experienced higher recruitments to age-7 from 1998-2003 (Figure 2; Challenger et al. 2020), but the cause for this pattern is unknown. Nevertheless, the estimates suggest that in the recent past, the population had the capacity for juvenile recruitment levels that were higher than current levels. Assuming that current environmental conditions could still support higher levels of recruitment, this scenario considers the impact of long-term natural recruitment improvements. The previous peak in age-7 recruitment (from 1998-2003) was approximately 3.24 times higher than recruitment in the last 10 years (i.e., 2010-2019). Because the scenarios are 50 years long, and it is unlikely that this peak in recruitment is sustainable for that duration, we used 66% of this historic peak (i.e., 2.16 times the 2010-19 average) to represent long-term natural recruitment improvements.

H5: Management Actions –Key threats (Table 1), potential mitigative actions and their anticipated effects on recruitment, juvenile survival, and adult survival (assuming that multiple actions were implemented and effective for many years) are presented in Table 4. While the list is reasonably exhaustive, it is unlikely that all of the potential mitigative actions could be performed concurrently. This modelling scenario assumes that the actions undertaken would include: maintain the gravel mining moratorium, change to fisheries activities, and improve juvenile White Sturgeon habitat (e.g. replacement of some of the old tidal and flood gates with "fish-friendly gates"). It is also unlikely that these actions would be fully implemented to their maximum anticipated effect. Given this limitation, half of the maximum anticipated effect for juvenile survival (age 7-12), adult survival (age 23-55), and recruitment was used in the simulation (Table 4). Juvenile survival improvements for ages under age 7 were already included in the estimated increase in recruitment and were therefore not included. There will also likely be a delay before mitigative actions can be implemented, plus a transition period before the full mitigative effect is realized. As a result, a 10-year lag period followed by a 10-year transition period was assumed.

H6: Management Actions and Recruitment Increase – The final scenario considers a combination of both recruitment improvements and management actions. This scenario is a combination of H4 & H5, and therefore represents the "best case" scenario among the set of hypotheses under consideration.

Allowable Harm

As indicated by the modelling results, recovery to population levels observed in the mid-2000s is unlikely unless natural productivity increases and/or human-induced mortality decrease from recent levels. The survival of the Lower Fraser River White Sturgeon population is an entirely different matter. This population has survived substantial changes in habitat over thousands of years, and survived much higher human-induced mortality rates (i.e., in the late 1800s and early 1900s) than they experience today. To ensure the long-term survival of Lower Fraser River White Sturgeon, adult abundance must not be allowed to go below the 10,000-adult survival threshold. Furthermore, two candidate recovery thresholds were identified as 20,000 adults, and 60,000 total (age 7 to 55) within a 50-year recovery window.

To achieve the candidate recovery threshold of 60,000 total abundance within a 50-year window, and to prevent further declines in the population, juvenile recruitment must be doubled from the average recruitment that was estimated from 2010 to 2019 (i.e., H4 in Table 3).

Critical to the sustainability of this population, we must ensure that harm is reduced at all life stages. This may be addressed through changes to habitat that would improve juvenile growth and survival, changes to fisheries, and increases in food availability (see *Scenarios for Mitigation of Threats and Alternatives to Activities* section of this document).

Table 3. Results from population projections assessing the likelihood of meeting the recovery thresholds within a 50-year timeframe.

		Adult Population			Total Population	
Scenario	**Juvenile Trend**	**Threshold: 10,000†**	**Threshold: 20,000†**	**Trend**	**Threshold: 60,000†**	**Trend**
H1: Chronic Low Recruitment	Stable	About as likely as not	Very Unlikely	Negative	Very Unlikely	Negative
H2: Chronic Moderate Recruitment	Positive	About as likely as not	Unlikely	Negative	Unlikely	Negative
H3: Recruitment Decline	Negative	Very Unlikely	Very Unlikely	Negative	Very Unlikely	Negative
H4: Recruitment Increase	Positive	Very Likely	About as likely as not	Positive	About as likely as not	Positive
H5: Management Actions	Positive	Very Likely	Unlikely	Negative	Unlikely	Negative
H6: Management Actions + Recruitment Increase	Positive	Very Likely	About as likely as not	Positive	Likely	Positive

† The International Panel of Climate Change adopted several risk/certainty categories that are now widely used to categorically describe probabilities of scenarios occurring. Very likely ≥ 0.90, Likely ≥ 0.66, About as likely as not 0.33-0.66, Unlikely ≤ 0.33, Very Unlikely ≤ 0.10 (Mastrandrea et al. 2010).

Table 4. Examples of potential mitigation measures and alternatives to threatening activities, and estimates of the relative benefits to juvenile and adult mortality and recruitment to Age 7 for each mitigation measure or alternative to threatening activity.

				Anticipated Effects [2,3]			
				Mortality Reductions			
COSEWIC Threat Categories	**Specific Threat**	**Threat Risk**	**Examples of Mitigation/Alternative Activities**	**Juvenile, Age < 7**	**Juvenile, Age 7-12**	**Adult, Age 22-55**	**Recruitment Increase**
1. Residential and commercial development							
Threats discussed elsewhere (e.g., 7. Natural system modifications)							
2. Agriculture & aquaculture							
Threats discussed elsewhere (e.g., 9. Pollution)							
3. Energy production & mining							
3.2 Mining & Quarrying	Gravel extraction	Medium (3)	Maintain moratorium on gravel extraction	0%	0%	0%	0-20%
4. Transportation & service corridors							
4.3 Shipping Lanes	Dredging, boat strikes, wakes	Low (4)	Manage boat traffic and dredging to minimize impacts on sturgeon and sturgeon prey species.	0-1%	0-1%	0-1%	0%
5. Biological resource use							
5.4 Fishing & Harvesting Aquatic Resources	Recreational fishing	Low (4)	Level 1: Ensure anglers follow handing guidelines; Level 2: Reduce fishing effort; Level 3: Complete closure of recreational fishery	0%	0%	0-1%	0-10%
5.4 Fishing & Harvesting Aquatic Resources	Bycatch in Commercial fisheries [1]	Low (4)	Level 1: Ensure fishers follow handing guidelines; Level 2: Seasonal closures to reduce sturgeon bycatch; Level 3: Only permit selective fishing methods	0-1%	0-2%	0-1%	0-10%
5.4 Fishing & Harvesting Aquatic Resources	Bycatch in Food, Social, and Ceremonial fisheries	Medium (2)	Level 1: All nets attended & sturgeon quickly released; Level 2: Seasonal closures to reduce sturgeon bycatch; Level 3: Only permit selective fishing methods	2-5%	2-5%	1-2%	20-50%
5.4 Fishing & Harvesting Aquatic Resources	Illegal harvests	Unknown (4)	Increased monitoring and enforcement	ne	ne	ne	ne
6. Human intrusions & disturbance							
6.1 Recreational Boating Activities	Noise and boat strikes	Low (4)	Level 1: Restricted time & areas for propeller motors; Level 2: no use of propeller motors	0%	0%	0-1%	0%
6.3 Work & Other Activities / Science Activities	Handling stress from tagging	Low (5)	Reduce sample size for adult sturgeon.	0%	0%	0-1%	0%

COSEWIC Threat Categories	Specific Threat	Threat Risk	Examples of Mitigation/Alternative Activities	Anticipated Effects [2,3] Mortality Reductions: Juvenile, Age < 7	Juvenile, Age 7-12	Adult, Age 22-55	Recruitment Increase
7. Natural systems modifications							
7.2 Dams & Water Management/use	Shoreline modifications (incl. tidal and flood gates)	Medium (4)	Replace tidal gates with sturgeon friendly gates.	1-3%	1-2%	0%	10-30%
7.3 Other Ecosystem Modifications	Modifications to catchment surfaces	Unknown (5)	Mitigate for any habitat loss.	ne	ne	ne	ne
7.3 Other Ecosystem Modifications	Food availability	Medium (3)	Reduce fisheries for prey species, Big Bar Slide passage	1-3%	1-2%	0%	30-50%
8. Invasive & other problematic species & genes							
8.1 Invasive Non-native/Alien Species	Invasive Non-native/Alien Species	Unknown (5)	Cull all invasive non-native/alien species	ne	ne	ne	ne
8.2 Introduced Pathogens and Viruses		Unknown (5)	Monitor pathogens and viruses	ne	ne	ne	ne
8.3 Introduced Genetic Material	Nechako Hatchery Program	Low (5)	Reduce hatchery releases and cull all hatchery strays.	ne	ne	ne	ne
9. Pollution							
9.1 Household Sewage & Urban Wastewater	Run-off	Unknown (4)	Better mgmt of sewage and wastewater	ne	ne	ne	ne
9.2 Industrial & Military Effluents	Run-off	Unknown (4)	Better controls on effluents	ne	ne	ne	ne
9.3 Agricultural & Forestry Effluents	Run-off	Unknown (4)	Better controls on effluents	ne	ne	ne	ne
10. Geological events							
10.3 Avalanches/landslides	Hells Gate, Big Bar impediment	Low (5)	Improve fish passage for sturgeon prey species	ne	ne	ne	ne
11. Climate change & severe weather							
11.2 Droughts	Side-channel reductions	Low (5)	Manage flows for important side-channels	1-2%	1-2%	0%	10-20%
11.3 Temperature Extremes	River temperature	Low (4)	Close fisheries during high temperature periods.	0%	0%	0-1%	0-10%
Maximum Total				2-7%	1-5%	1-2%	70-200%

[1] Commercial fishing includes: Area E gillnet fishery, First Nations Economic Opportunity fisheries and Demonstration fisheries.
[2] Anticipated effects were estimated on a relative basis for some examples mitigation/activities and reported as “ne” where the potential effect was “not estimated”.
[3] Mortality Reduction and Recruitment Increase ranges capture the three levels of mitigation measures presented under the “Biological Resource Use” subheading.

Sources of Uncertainty

Significant knowledge gaps related to the threats for Lower Fraser River White Sturgeon were identified, including:

- the identification of important rearing habitats for juvenile White Sturgeon in the lower Fraser River;
- key drivers that affect juvenile White Sturgeon recruitment in the lower Fraser River;
- reliable estimates of White Sturgeon bycatch in lower Fraser River gillnet fisheries;
- reliable estimates of White Sturgeon caught and released by lower Fraser River anglers;
- limited information about illegal harvest in the lower Fraser River;
- limited knowledge around cumulative sub-lethal effects of capture events on survival and recruitment;
- limited knowledge on the effects of other threats and limiting factors on the population (e.g., pollution, predation, temperature, prey availability/choice); and
- the proposed candidate recovery thresholds are based on limited information about key factors affecting juvenile recruitment, population viability, and extinction risk.

Future Work

During the course of the regional peer review, several topics were identified for future work, including:

- explore the relationship between other salmon species and juvenile recruitment;
- sensitivity analysis on the effect of alternative growth curves on the ISAMR model;
- additional data and analyses to relate age and length under more recent growth conditions;
- ongoing juvenile monitoring program information should be incorporated into future analyses; and
- maintain a monitoring and assessment program that will provide sufficient information needed to assess status and trends for the Lower Fraser River White Sturgeon DU.
- reviewing more recent literature on Lower Fraser River White Sturgeon life history parameters (e.g. Hildebrand et al. 2016 and RL&L Environmental Services Ltd. 2000[3]).

[3] RL&L Environmental Services. 2000. Fraser River White Sturgeon Monitoring Program -comprehensive report (1995 to 1999). Report for BC Fisheries, Victoria, BC.

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SOURCES OF INFORMATION

This Science Advisory Report is from the September 22-24, 2020 regional peer review on Recovery Potential Assessment – White Sturgeon, Lower Fraser Designatable Unit. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

All figures and tables presented in this report were taken from the working paper titled *Recovery Potential Assessment for Lower Fraser River White Sturgeon 2020*, prepared by Karl English, Wendell Challenger, David Robichaud and Josh Korman for the peer review.

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