Proposed

***Species at Risk Act***
Action Plan Series

# Action Plan for the White Sturgeon (*Acipenser transmontanus*) in Canada

## White Sturgeon

2023

Canada

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For copies of the action plan, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, residence descriptions, recovery strategies, and other related recovery documents, please visit the Species at Risk Public Registry.

**Cover illustration**: Juvenile White Sturgeon. Photo by David Gluns.

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# Preface

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 the protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of action plans for species listed as extirpated, endangered, or threatened for which recovery has been deemed feasible. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the sole competent minister under SARA for Upper Fraser River, Upper Columbia River, and Kootenay River[1] nationally significant populations. The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for Nechako River nationally significant population as the distribution and critical habitat of the population overlap with part of the property of Fort St. James National Historic Site under Parks Canada's jurisdiction. The competent ministers have prepared this action plan to implement the recovery strategy, as per section 47 of SARA.

In preparing this action plan, the competent ministers have considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this action plan has been prepared in cooperation with the British Columbia (BC) Ministry of Environment and Climate Change Strategy, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Nechako White Sturgeon Recovery Initiative, and Canadian members of the Upper Columbia River White Sturgeon Recovery Initiative and Kootenai White Sturgeon Technical Working Group, as per subsection 48(1) of SARA.

As stated in the preamble to SARA, success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan and will not be achieved by Fisheries and Oceans Canada (DFO), Parks Canada or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this action plan for the benefit of the White Sturgeon and Canadian society as a whole.

Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines recovery measures to be taken by DFO, Parks Canada, and other jurisdictions and/or organizations to help achieve the population and distribution objectives identified in the recovery strategy. Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[1] Renamed White Sturgeon (Upper Kootenay River population) in 2019 (SOR/2019-287, order amending the federal *Species at Risk Act*) but referred to as Kootenay River population within this action plan for consistency with the recovery strategy.

# Acknowledgments

This action plan was prepared by Heather Stalberg (DFO) with contributions from Erin Gertzen, Ahdia Hassan and Maggie Boothroyd. The development of the action plan was the result of collaborative efforts and contributions from many individuals and organizations. Louise Porto (Wood consultant) and Larry Hildebrand (RiverRun Consulting) compiled an initial list of actions, both completed to-date and anticipated future needs, to help recover the four SARA-listed White Sturgeon nationally significant populations (NSPs). Species experts, including Steve McAdam (BC Ministry of Environment and Climate Change Strategy), Sarah Stephenson (BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development; FLNRORD), Nikolaus Gantner (FLNRORD), James Crossman (BC Hydro), Brian Toth (Lheidli T'enneh/Carrier Sekani Tribal Council), Martin Nantel (DFO), and Herb Klassen (DFO) reviewed and contributed to the information compiled. Following distillation of information, broad membership of the basin-level White Sturgeon technical working groups reviewed the action plan tables.

# Executive summary

Within Canada, White Sturgeon (*Acipenser transmontanus*) occurs only in British Columbia. In the 2003 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment, six nationally significant populations[2] (NSPs) were described based on geography, genetics and demographics: Lower Fraser River, Middle Fraser River, Upper Fraser River, Nechako River, Upper Columbia River, and Kootenay River[3]. The latter four NSPs were listed as endangered under the *Species at Risk Act* (SARA) in 2006.

This action plan covers the four NSPs currently listed under SARA: Upper Fraser River, Nechako River, Upper Columbia River and Kootenay River. This action plan is considered one in a series of documents that are linked and should be taken into consideration together, including the COSEWIC status reports (COSEWIC 2003, 2012), recovery potential assessment (Wood et al. 2007), and recovery strategy (DFO 2014).

White Sturgeon is the largest and one of the longest-lived freshwater fish species in North America. The species' most distinguishing features include a mainly cartilaginous skeleton, long scaleless body covered with rows of large bony plates (called scutes) on the back and sides, shark-like (heterocercal) tail, and four barbels (whisker-like sensory organs) between the mouth and an elongated snout. Fish of over 6 m in length and over 100 years of age have been reported in the Fraser River.

This action plan outlines measures that provide the best chance of achieving the population and distribution objectives for the species, including the measures to be taken to address the threats and monitor the recovery of the species. The recovery goal and population and distribution objectives for White Sturgeon are identified in section 7 of the recovery strategy.

Section 1.2 of this action plan outlines the measures to be taken under the following strategies:

A. meet or exceed recovery population targets within specified timeframe
B. protect critical habitats
C. restore natural recruitment
D. clarify and mitigate threats
E. address information gaps that inhibit conservation of White Sturgeon
F. increase stakeholder and general public awareness of White Sturgeon and its conservation needs
G. maintain and where necessary restore ecosystem functions relevant to White Sturgeon

For White Sturgeon, critical habitat was identified to the extent possible, using the best available information, in section 8 of the recovery strategy.

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[2] In November 2012, COSEWIC reassessed White Sturgeon and divided the species into four Designatable Units (DUs). These DUs differ in genetic structure and distribution from the six NSPs previously identified in the COSEWIC 2003 assessment; however, this action plan was prepared in response to the 2006 SARA listing of the Upper Fraser River, Nechako River, Upper Columbia River and Kootenay River NSPs and the 2014 recovery strategy, with the understanding that adaptations to recovery approaches and DUs may be required in the future.

[3] Renamed White Sturgeon (Upper Kootenay River population) in 2019 (SOR/2019-287, order amending the federal *Species at Risk Act*) but referred to as Kootenay River population within this action plan for consistency with the recovery strategy.

An evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation is provided in section 3.

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# 1. Recovery actions

## 1.1 Context and scope of the action plan

Within Canada, White Sturgeon (*Acipenser transmontanus*) occurs only in British Columbia. In the 2003 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment, six nationally significant populations[4] (NSPs) were described based on geography, genetics and demographics: Lower Fraser River, Middle Fraser River, Upper Fraser River, Nechako River, Upper Columbia River, and Kootenay River[5]. The latter four NSPs were listed as endangered under the *Species at Risk Act* (SARA) in 2006.

This action plan covers the four NSPs listed under SARA: Upper Fraser River, Nechako River, Upper Columbia River, and Kootenay River. This action plan is considered one in a series of documents that are linked and should be taken into consideration together with the four SARA-listed White Sturgeon NSPs, including the COSEWIC status reports (COSEWIC 2003, 2012), recovery potential assessment (Wood et al. 2007), and recovery strategy (Fisheries and Oceans Canada [DFO] 2014). Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in a recovery strategy for the species. A recovery strategy also provides background information on the species, its threats, and critical habitat.

White Sturgeon is the largest and one of the longest-lived freshwater fish species in North America. Populations of White Sturgeon occur in three major drainages on the Pacific coast of North America: the Fraser, Columbia, and Sacramento river systems. The species occurs primarily in freshwaters but fish within some populations enter marine waters and are known to enter rivers, estuaries, and bays along the Pacific Coast. Within Canada, White Sturgeon occur within the Fraser watershed, including the Nechako watershed, and within the Columbia watershed, including the Columbia and Kootenay rivers, and Arrow and Kootenay lakes. White Sturgeon within the Upper Columbia River, Kootenay River and Nechako River watersheds continue to experience recruitment failure. Details on distribution and abundance of Canadian populations are found in section 2 of the recovery strategy (DFO 2014).

The species' most distinguishing features include a mainly cartilaginous skeleton, long scaleless body covered with rows of large bony plates (called scutes) on the back and sides, shark-like (heterocercal) tail, and four barbels (whisker-like sensory organs) between the mouth and an elongated snout. Fish of over 6 m in length and over 100 years of age have been reported in the Fraser River.

[4] In November 2012, COSEWIC reassessed White Sturgeon and divided the species into four Designatable Units (DUs). In some areas, these DUs differ in genetic structure and distribution from the six NSPs previously identified in the COSEWIC 2003 assessment. The geographic extents of the Upper Columbia River, Kootenay River, and Lower Fraser River NSPs are the same as the geographic extents of the Upper Columbia River, Upper Kootenay River, and Lower Fraser River DUs, respectively. The Middle Fraser River, Upper Fraser River, and Nechako River NSPs were combined into a single DU referred to as the Upper Fraser River DU.

[5] Renamed White Sturgeon (Upper Kootenay River population) in 2019 (SOR/2019-287, order amending the federal *Species at Risk Act*) but referred to as Kootenay River population within this action plan for consistency with the recovery strategy.

The threats to White Sturgeon in the wild are: loss of habitat quality and quantity; habitat fragmentation; altered hydrograph components[6]; pollution; fishing and industrial effects (direct and indirect); reduced turbidity; altered thermal regime; effects of small population size; hatchery and aquaculture effects on health and population; reduced or altered food supply (including fishing of White Sturgeon prey base); change in ecological community (predation / competition); and, disease. The risk of threats differs among populations. Details are described in section 4 of the recovery strategy (DFO 2014).

Section 7 of the recovery strategy defined the recovery goal and population and distribution objectives for the White Sturgeon as:

- Recovery goal:
    - Ensure that each of the populations is sustainable throughout their natural range, are self-sustaining through natural reproduction, and to increase or restore opportunities for beneficial use, if and when feasible.

- Population and distribution objectives[7]:
    1. Prevent extirpation of White Sturgeon in each of the four identified populations by preventing net loss of reproductive potential.
    2. Initiate, within 5 years, pilot studies towards restoration of natural recruitment for each population that is affected by dams. Within 10 years, identify methods for each population that, if and when implemented, have a high likelihood of restoring recruitment to a level sufficient to achieve the other recovery measures listed herein.
    3. Reach or exceed all of the following population and distribution targets for survival or recovery within 50 years:
        a. 1,000 mature individuals in an approximately 1:1 sex ratio at maturity;
        b. distribution over the natural range, with the exception of Duncan Reservoir, Slocan Lake, the lower Kootenay River between Corra Linn and Brilliant Dams, and the Columbia River upstream of Revelstoke Dam; and,
        c. ongoing natural recruitment sufficient to meet all other targets.
    4. Reach or exceed population and distribution targets for beneficial use within specified timeframes. As success is achieved in meeting the biological recovery targets, the beneficial use targets and timelines will be established and adjusted. Such targets may vary among populations.

Under section 47 of SARA, the competent minister must prepare one or more action plans based on the recovery strategy. Therefore, action planning for species at risk recovery is an iterative process. The implementation schedule in this action plan may be modified in the future depending on the progression towards recovery.

## 1.2 Measures to be taken and implementation schedule

[6] Altered hydrograph components may be related to flow regulation, flow diversion, and anthropogenic activities causing climate change.

[7] The only population objective that is directly applicable for the Upper Fraser NSP is objective 1, since the population is thought to be at or near historic levels. All population and distribution objectives are applicable for the other three SARA-listed NSPs.

Success in the recovery of this species is dependent on the actions of many different jurisdictions; it requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this action plan.

This action plan provides a description of the measures that provide the best chance of achieving the population and distribution objectives for Upper Fraser River, Nechako River, Upper Columbia River, and Kootenay River White Sturgeon NSPs, including measures to be taken to address threats to the species and monitor its recovery, to guide not only activities to be undertaken by DFO, but those for which other jurisdictions, organizations, and individuals have a role to play. As new information becomes available, these measures and the priority of these measures may change. DFO strongly encourages all Canadians to participate in the conservation of the White Sturgeon through undertaking measures outlined in this action plan. DFO recognizes the important role of the technical working groups for White Sturgeon, and their member organizations and agencies in the implementation of measures for this species.

Section 7.5 of the recovery strategy divides the recovery effort into seven strategies, and their associated research and management activities. Tables 1 to 5 describe measures to be taken under the following strategies. It is important to note that many of the recovery measures relate to more than one strategy.

**Strategy A: meet or exceed recovery population targets within specified timeframe**

- A-1: set up conservation aquaculture where needed
- A-2: monitor population trends
- A-3: establish parameters for beneficial use

**Strategy B: protect critical habitats**

- B-1: identify habitat requirements for all life stages
- B-2: define critical habitat (including related ecological processes)
- B-3: identify critical habitats for designation and protection
- B-4: protect, maintain and enhance critical habitat for White Sturgeon
- B-5: ensure habitat diversity, connectivity and productivity
- B-6: work cooperatively to develop plans to protect habitat

**Strategy C: restore natural recruitment**

- C-1: determine accuracy of recruitment index time series
- C-2: identify temporal correlations between significant recruitment shifts (peaks or drops) and environmental changes
- C-3: examine potential mechanism of recruitment effect
- C-4: undertake meso-scale field trials
- C-5: undertake larger scale field trials
- C-6: design and implement longer term restoration program
- C-7: determine the habitat requirements for dam affected population enhancement or recovery
- C-8: initiate, within 5 years, pilot studies towards restoration of natural recruitment for each population that is affected by dams
- C-9: within 10 years, identify methods for each population that, if and when implemented, can restore recruitment to a level sufficient to achieve the other recovery measures listed herein

**Strategy D: clarify and mitigate threats**

- D-1: clarify the following threats and their relative risks:
    - D-1a: fishing
    - D-1b: pollution
    - D-1c: predation
- D-2: clarify threats to:
    - D-2a: food supply
    - D-2b: habitat (including effects of flow regulation)
- D-3: undertake specific actions to address risks:
    - D-3a: protect, maintain and enhance critical habitat
    - D-3b: address illegal harvest
    - D-3c: minimize bycatch and mitigate impacts from fisheries through regulation and best practices
    - D-3d: limit and address pollutant discharges and contaminant loading, especially adjacent to important or critical habitats
    - D-3e: protect, maintain and enhance water quality
    - D-3f: mitigate interactions of White Sturgeon with industrial structures and activities
    - D-3g: manage risks from conservation hatchery introductions
    - D-3h: better understand, maintain and enhance food availability for all life stages of each population
- D-4: monitor threat indicators and population trends
- D-5: work cooperatively to develop plans to mitigate threats to White Sturgeon

**Strategy E: address information gaps that inhibit conservation of White Sturgeon**

- E-1: address basic biological data gaps

**Strategy F: increase stakeholder and general public awareness of White Sturgeon and its conservation needs**

- F-1: maintain and where possible increase awareness and stewardship of White Sturgeon throughout its natural range
- F-2: engage in effective public education of the species and its conservation needs
- F-3: support learning and communication across all working groups
- F-4: ensure participation from community and technical experts

**Strategy G: maintain and where necessary, restore ecosystem functions relevant to White Sturgeon**

- G-1: incorporate the needs of healthy White Sturgeon populations into the management of White Sturgeon prey species, especially salmon and resident sportfish
- G-2: accommodate other species' needs during recovery of White Sturgeon
- G-3: closely manage non-native predatory fish species
- G-4: dialogue with regulatory agencies that have influence or jurisdiction over White Sturgeon prey species

To simplify the tables in this section, the above coding for the strategies, and their associated research and management activities, has been used.

Tables 1 to 4 identify the measures to be undertaken collaboratively between DFO and its partners, other agencies, organizations, or individuals to support the recovery of the Upper Fraser River, Nechako River, Upper Columbia River, and Kootenay River White Sturgeon NSPs, respectively. Implementation of these measures will be dependent on a collaborative

approach, in which DFO is a partner in recovery efforts, but cannot implement the measures alone.

Table 5 identifies the remaining measures that represent opportunities for other jurisdictions, organizations or individuals to lead for the recovery of Kootenay River White Sturgeon. If your organization is interested in participating in one of these measures, please contact the Species at Risk Pacific Region office at sara.xpac@dfo-mpo.gc.ca.

Further information on completed activities will be found in the Report on the Progress of Recovery Strategy Implementation for White Sturgeon (*Acipenser transmontanus*) in Canada for the period 2014 to 2019, currently being drafted.

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

**List of tables in this section (measures to be taken and implementation schedule):**

**Table 1. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners for the Upper Fraser River White Sturgeon nationally significant population (NSP).**

| # | Strategy / activity | Recovery measures | Priority[8] | Threats addressed | Timeline[9] | Partners |
|---|---|---|---|---|---|---|
| 1 | A-2; D-3g | Update the 2005 risk assessment for Nechako conservation aquaculture (see measure 3 in table 2 for details) | High | Effects of small population size; hatchery and aquaculture effects on health and population | Short-term | NWSRI TWG[10], academia |
| 2 | A-2, D-3g, D-4 | To inform the risk assessment for Nechako conservation aquaculture, continue research and monitoring (see measure 4 in table 2 for details) | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, long-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |

[8] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[9] Timeline:

- short-term is 0 to 5 years (2022 to 2026), medium-term is 6 to10 years (2027 to 2031), long-term is greater than 10 years (2032+)
- ongoing is an action currently underway and continuing
- as needed is applied when an action is required, possibly multiple times, but the timing is uncertain
- uncertain is applied when implementation timing of the action is unknown.

[10] Nechako White Sturgeon Recovery Initiative Technical Working Group (NWSRI TWG), whose scope includes Nechako and Upper Fraser NSPs: BC Ministry of Environment and Climate Change Strategy (BC ENV), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), DFO, Lheidli T'enneh First Nation, Tl'azt'en First Nation, Carrier Sekani Tribal Council, Freshwater Fisheries Society of BC (FFSBC), University of British Columbia (UBC), and Rio Tinto Alcan. Note: Rio Tinto Alcan participates in Nechako recovery measures only and Lheidli T'enneh First Nation participates in Upper Fraser River recovery measures only.

| # | Strategy / activity | Recovery measures | Priority[8] | Threats addressed | Timeline[9] | Partners |
|---|---|---|---|---|---|---|
| 3 | A-2, D-4, E-1 | Undertake juvenile and adult monitoring to assess:<br>• population abundance<br>• population structure (size/age/sex)<br>• habitat use<br>• movement (including between NSPs) and tributary use (for example, using telemetry)<br>• mortality (predation, bycatch, natural) | High | All | Ongoing, long-term | BC ENV, FLNRORD, First Nations |
| 4 | A-2, D-2 a | Conduct a population viability analysis, including:<br>• assessing historic population size and habitat capacity, including trends in food supply<br>• exploring any genetic and demographic effects of a naturally small population size<br>• undertaking a sensitivity analysis of the population structure and reproductive parameters<br>• forecasting population trends | High | Effects of small population size | Ongoing, long-term | BC ENV, FLNRORD, First Nations, academia |
| 5 | A-3 | Develop a policy outlining beneficial use[11] targets and timelines, if and when population recovery is sufficient to support beneficial use | High | Fishing and industrial effects | Uncertain | First Nations, FLNRORD |
| 6 | B-1 | Research food requirements for all life stages | Medium | Reduced or altered food supply | Long-term | BC ENV, FLNRORD, First Nations |
| 7 | B-1, B-2 | Identify, both spatially and temporally, the habitats and associated attributes for:<br>• spawning and incubation<br>• larvae<br>• early and late juveniles<br>• holding and feeding adults<br>• overwintering | High | Loss of habitat quality and quantity | Ongoing, short-term for spawning; medium-term for others | BC ENV, FLNRORD, First Nations |

[11] Beneficial use is defined in the Recovery Strategy for White Sturgeon (*Acipenser transmontanus*) in Canada (DFO 2014) as "…use of white sturgeon, if and when feasible, in Aboriginal Food, Social, and Ceremonial fisheries, and recreational fisheries, including those with and without retention (harvest)."

| # | Strategy / activity | Recovery measures | Priority[8] | Threats addressed | Timeline[9] | Partners |
|---|---|---|---|---|---|---|
| 8 | B-1 | Determine the environmental cues, including hydrologic events, for holding and spawning, and once spawning sites have been identified, monitor pre-spawning movements and habitat use at putative staging locations | Low | Loss of habitat quality and quantity; altered hydrograph components | Ongoing, medium-term | BC ENV, FLNRORD, First Nations |
| 9 | B-1, B-5, D-2b | Estimate quantity, distribution, and quality of both historic and current available habitats (using air photo analysis or other appropriate methods) | Low | Loss of habitat quality and quantity | Long-term | BC ENV, FLNRORD, First Nations |
| 10 | B-4, B-5, D-3a | Identify, and where appropriate, design and implement habitat restoration opportunities | Low | Loss of habitat quality and quantity | Long-term, as needed | BC ENV, FLNRORD, First Nations |
| 11 | D-1b, D-4 | Monitor and assess concentrations of organic and inorganic contaminants in White Sturgeon, their food supply and habitats, and determine their effects on population dynamics, abundance and recruitment | Low | Pollution | Long-term | BC ENV, FLNRORD, First Nations |
| 12 | D-2a, D-3h, D-4 | Develop an understanding of the functional relationship between White Sturgeon vital rates/indicators (for example, survival, growth, reproduction) and food supply (for example, White Sturgeon telemetry study following salmon migration routes) | High | Reduced or altered food supply | Ongoing, long-term | BC ENV, FLNRORD, First Nations |

| # | Strategy / activity | Recovery measures | Priority[8] | Threats addressed | Timeline[9] | Partners |
|---|---|---|---|---|---|---|
| 13 | D-3c, D-4, F-1, F-2 | Minimize White Sturgeon bycatch and mortality in salmon fisheries. This includes:<br>• utilizing the "Every Fish Counts" boat kit program, which provides equipment to safely release White Sturgeon and repair nets<br>• community awareness programs<br>• on-site community bycatch monitoring for each participating First Nation<br>• continuing licence requirement that intercepted White Sturgeon be released unharmed and no dead White Sturgeon be retained in Food, Social, and Ceremonial salmon fisheries<br>• continuing to integrate White Sturgeon bycatch considerations into salmon Integrated Fisheries Management Plans | High | Fishing and industrial effects | Ongoing, long-term | NWSRI CWG[12], BC ENV, FLNRORD, First Nations |
| 14 | F-1, F-2, B-4, D-3a | Continue to increase public awareness of White Sturgeon conservation through outreach activities. This includes:<br>• distributing outreach materials/brochures/videos<br>• continuing the “Every Fish Counts” boat kit program<br>• communicating best practices for activities that impact White Sturgeon and their habitats<br>• communicating SARA prohibitions, including critical habitat protection | High | All | Ongoing, long-term | NWSRI CWG, BC ENV, FLNRORD, First Nations, public |
| 15 | F-3, B-6, D-5, G-4 | Continue to coordinate Upper Fraser White Sturgeon recovery activities through the NWSRI technical working group and community working group, and partners, and facilitate learning between populations through meeting with other White Sturgeon technical working groups and the National Recovery Team[13] | High | All | Ongoing, long-term | NWSRI TWG and CWG, BC ENV, FLNRORD, First Nations |

[12] Nechako White Sturgeon Recovery Initiative Community Working Group (NWSRI CWG), comprised of approximately 20 individuals representing First Nations, non-governmental organizations, industry, local, regional, provincial and federal governments, and interested public.
[13] National Recovery Team membership: DFO and BC ENV co-chairs, chairs for each basin-level technical working group, and First Nations.

| # | Strategy / activity | Recovery measures | Priority[8] | Threats addressed | Timeline[9] | Partners |
|---|---|---|---|---|---|---|
| 16 | G-1 | Consider White Sturgeon food supply needs in Integrated Fisheries Management Planning processes for relevant prey species | High | Reduced or altered food supply | Ongoing, short-term | BC ENV, FLNRORD, First Nations |

**Table 2. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners for the Nechako River White Sturgeon nationally significant population (NSP).**

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 1 | A-1 | Continue to adaptively manage, operate, and improve conservation aquaculture through the Nechako White Sturgeon Conservation Centre until such time as natural recruitment meets the population objectives. Continue to:<br>• rear wild or broodstock-origin eggs and larvae for release in accordance with technical working group recommendations and agency approvals<br>• contribute eggs and larvae in excess of conservation needs to research initiatives | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, as needed | NWSRI TWG[16], FFSBC |
| 2 | A-1, D-3g | Update the 2004 conservation aquaculture breeding plan | High | Effects of small population size; hatchery and aquaculture effects on health and population | Short-term | NWSRI TWG, FFSBC, FLNRORD |

[14] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[15] Timeline:

- short-term is 0 to 5 years (2022 to 2026), medium-term is 6 to 10 years (2027 to 2031), long-term is greater than 10 years (2032+)
- ongoing is an action currently underway and continuing
- as needed is applied when an action is required, possibly multiple times, but the timing is uncertain
- uncertain is applied when implementation timing of the action is unknown.

[16] Nechako White Sturgeon Recovery Initiative Technical Working Group (NWSRI TWG), whose scope includes Nechako and Upper Fraser NSPs: BC Ministry of Environment and Climate Change Strategy (BC ENV), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), DFO, Lheidli T'enneh First Nation, Tl'azt'en First Nation, Carrier Sekani Tribal Council, Freshwater Fisheries Society of BC (FFSBC), University of British Columbia (UBC), and Rio Tinto Alcan. Note: Rio Tinto Alcan participates in Nechako recovery measures only and Lheidli T'enneh First Nation participates in Upper Fraser River recovery measures only.

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 3 | A-2, D-3g | Update the 2005 risk assessment for Nechako conservation aquaculture. The update will:<br>• ensure the scope of the risk assessment includes the three NSPs within the Upper Fraser River DU (that is, Nechako River, Upper Fraser River, and Middle Fraser River NSPs), as well as the Lower Fraser River DU<br>• encompass risks associated with genetic mixing (including effects on the three NSPs within the Upper Fraser River DU), disease, geographic range overlap, distribution, proportion of hatchery to wild fish, imprinting and ability of hatchery fish to find/select suitable spawning locations, and demographic/ecological impacts (including any effects on wild fish survival, growth, reproduction and recruitment throughout the Upper Fraser River DU)<br>• identify how and when the risks will be mitigated<br>• identify the approach to reporting management actions<br>• be reviewed through a peer review process | High | Effects of small population size; hatchery and aquaculture effects on health and population | Short-term | NWSRI TWG, BC ENV, FLNRORD, academia |
| 4 | A-2, D-3g, D-4 | To inform the risk assessment for Nechako conservation aquaculture, continue:<br>• research on genetic population identification (for example, additional nuclear DNA markers to allow identification of parentage of hatchery-produced White Sturgeon), genetic distinctiveness, and microchemistry (for example, fin ray chemistry)<br>• adult and juvenile monitoring (for example, level of movement between NSPs) | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, short-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |
| 5 | A-2, B-1, B-5, C-7, D-4 | Undertake juvenile monitoring to assess:<br>• juvenile population abundance and distribution in the Nechako watershed, including the Stuart watershed<br>• habitat use by early (<2 years) and late (>2 years) juvenile White Sturgeon | High | All | Ongoing, long-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 6 | A-2, B-1, B-2, B-5, C-7, D-2a, D3-h, D-4 | Undertake adult and spawn monitoring to assess:<br>• adult population abundance and distribution in the Nechako watershed, including the Stuart watershed<br>• pre-spawning movements, habitat use, and distribution at spawning locations (both natural and restored)<br>• adult overwinter and feeding sites, and associated habitat attributes<br>• identification of additional spawning sites<br>• collection of eggs and larvae at and downstream of spawning sites | Medium | All | Ongoing, as needed | BC ENV, MFLNRORD, First Nations, NWSRI TWG, academia |
| 7 | A-2, B-2, C-3, C-7, D-4 | Research survival and recruitment limitations for early life stages and juveniles, including an analysis of juvenile survival rates over time | High | All | Ongoing, long-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |
| 8 | A-2, C-9, D-4 | Develop a comprehensive research and monitoring plan through a peer review process | High | All | Short-term | NWSRI TWG |
| 9 | A-2, D-4 | Track and evaluate habitat conditions over time within geographic range of Nechako White Sturgeon, focusing on habitat that is limiting recruitment (for example, spawning and early rearing), including:<br>• changes in channel morphology and substrate composition changes (for example, sand and fine deposits), and potential relationship to Nechako White Sturgeon life history phases and recruitment, including survival rate of eggs | Medium | Loss of habitat quality and quantity; altered hydrograph components | Ongoing, long-term | NWSRI TWG |
| 10 | A-3 | Develop a policy outlining beneficial use[17] targets and timelines, if and when population recovery is sufficient to support beneficial use | High | Fishing and industrial effects | Long-term, uncertain | First Nations, FLNRORD |

[17] Beneficial use is defined in the Recovery Strategy for White Sturgeon (*Acipenser transmontanus*) in Canada (DFO 2014) as "…use of white sturgeon, if and when feasible, in Aboriginal Food, Social, and Ceremonial fisheries, and recreational fisheries, including those with and without retention (harvest)."

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 11 | B-1, B-2, C-2 | Research habitat requirements for early life stages (eggs, larvae), including:<br>• early life stage habitat preference and use<br>• quantity and quality of egg incubation habitat available<br>• temperature limits for incubation<br>• spatial and temporal extent of larval drift under various water velocities | High | Loss of habitat quality and quantity; altered hydrograph components; altered thermal regime | Ongoing, long-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |
| 12 | B-1, D-2a, D-2b, D3-h | Investigate food requirements for late juvenile White Sturgeon (older than two years) | Low | Reduced or altered food supply | Long-term, not started | NWSRI TWG |
| 13 | B-2, B-4, B-5, C-4, C-5 | Design a long-term restoration program (to restore natural recruitment) and associated monitoring program (to determine efficacy of the restoration effort). The restoration design will use information from:<br>• a strategic planning document<br>• research on population and distribution, survival and recruitment, and habitat use<br>• evaluation of previous habitat modifications, enhancements and meso-scale restoration field trials | High | Loss of habitat quality and quantity; effects of small population size; altered hydrograph components | Medium-term | NWSRI TWG |
| 14 | B-2, C-2, C-3, D-2a, D-2b | Using information from monitoring habitat conditions and researching habitat requirements, investigate the relationship between habitat and Nechako White Sturgeon life history and recruitment, including survival rate of eggs, larvae, and early juveniles | Medium | Loss of habitat quality and quantity; effects of small population size; altered hydrograph components | Ongoing, medium-term | NWSRI TWG |
| 15 | B-2, C-2 | Develop a strategic habitat restoration plan outlining habitat modifications, enhancements, and restoration efforts to address recruitment failure. The plan may identify high priority areas for restoration efforts, including areas identified as critical habitat. | High | Loss of habitat quality and quantity; effects of small population size; altered hydrograph components | Ongoing, long-term | NWSRI TWG |

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 16 | C-5, C-6 | Implement a long-term restoration program(s) and associated monitoring program(s) using information from the feasibility and design study | High | Loss of habitat quality and quantity; effects of small population size; altered hydrograph components | Ongoing, long-term | NWSRI TWG |
| 17 | D-1b, D-4 | Monitor and assess concentrations of organic and inorganic contaminants in White Sturgeon, their food supply and habitats, and determine their effects on population dynamics, abundance, and recruitment | Low | Pollution | Long-term | NWSRI TWG |
| 18 | D-1c, D-4, G-3 | Investigate effects of predation on Nechako White Sturgeon recovery via assessing:<br>• predator composition, including cannibalism<br>• predation rates<br>• predator stomach content analysis<br>• environmental variables such as flow<br>• White Sturgeon size and density | High | Change in ecological community | Ongoing, medium-term | NWSRI TWG, academia |

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 19 | D-1a, D-3b, D-3c, D-4 | Minimize White Sturgeon bycatch and mortality in salmon fisheries. This includes:<br>• utilizing the "Every Fish Counts" boat kit program, which provides equipment to safely release White Sturgeon and repair nets<br>• community awareness programs<br>• on-site community bycatch monitoring for each participating First Nation<br>• continuing licence requirement that intercepted White Sturgeon be released unharmed and no dead White Sturgeon be retained in Food, Social, and Ceremonial salmon fisheries<br>• continuing to integrate White Sturgeon bycatch considerations into salmon Integrated Fisheries Management Plans | High | Fishing and industrial effects | Ongoing, long-term | NWSRI TWG and CWG[18], First Nations, FLNRORD |
| 20 | D-1c, D-4, G-3 | Consider options to limit predation on Nechako River White Sturgeon, including:<br>• conditioning the response of hatchery White Sturgeon to predators<br>• researching the potential to reduce predation by modifying habitat or release strategies<br>• other management options | High | Effects of small population size; change in ecological community | Ongoing, medium-term | BC ENV, FLNRORD, First Nations, NWSRI TWG, academia |
| 21 | D-2b, D-4 | Identify flows that provide required habitat conditions at specific locations on the Nechako River for White Sturgeon <2 years old | Medium | Loss of habitat quality and quantity; altered hydrograph components | Ongoing, medium term | NWSRI TWG |

[18] Nechako White Sturgeon Recovery Initiative Community Working Group (NWSRI CWG), comprised of approximately 20 individuals representing First Nations, non-governmental organizations, industry, local, regional, provincial and federal governments, and interested public.

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 22 | D-2b, D-4 | Examine the relationship between pre- and post-recruitment failure and pre- and post-dam construction thermograph, flow regime, and habitat conditions | Medium | Loss of habitat quality and quantity; effects of small population size; altered thermal regime; altered hydrograph components | Ongoing, medium-term | NWSRI TWG |
| 23 | D-2b, D-4 | Examine the following aspects of water temperature in relation to White Sturgeon survival:<br>• rate of temperature change<br>• absolute difference in temperature<br>• peak temperature<br>• temperature trends across the Nechako system | Medium | Altered thermal regime | Medium-term | NWSRI TWG, academia |
| 24 | F-1, F-2 | Continue to increase public awareness of White Sturgeon conservation through outreach activities. This includes:<br>• continuing White Sturgeon hatchery release events<br>• distributing outreach materials/brochures/videos<br>• continuing “Sturgeon in the Classroom”<br>• continuing the “Every Fish Counts” boat kit program<br>• communicating best practices for activities that impact White Sturgeon and their habitats<br>• communicating *Species at Risk Act* (SARA) prohibitions, including critical habitat protection | High | All | Ongoing, long-term | NWSRI TWG and CWG, public |
| 25 | F-3, F-4, B-6, D-5, G-4 | Continue to coordinate Nechako White Sturgeon recovery activities through the NWSRI technical working group and community working group, and partners; and facilitate learning between populations through meeting with other White Sturgeon technical working groups and the National Recovery Team[19] | High | All | Ongoing, long-term | NWSRI TWG and CWG, BC ENV, FLNRORD, First Nations |

[19] National Recovery Team membership: DFO and BC ENV co-chairs, chairs for each basin-level technical working group, and First Nations.

| # | Strategy / activity | Recovery measures | Priority [14] | Threats Addressed | Timeline[15] | Partners |
|---|---|---|---|---|---|---|
| 26 | G-1 | Consider White Sturgeon food supply needs in Integrated Fisheries Management Planning processes for relevant prey species | High | Reduced or altered food supply | Ongoing, short-term | BC ENV, FLNRORD, First Nations |

**Table 3. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners for the Upper Columbia River White Sturgeon nationally significant population (NSP).**

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 1 | A-1 | Continue to adaptively manage, operate, and improve conservation aquaculture in the Upper Transboundary Reach and Arrow Lakes Reservoir (ALR) Reach until such time as natural recruitment meets the recovery objectives. Continue to:<br>• rear wild-caught eggs and larvae for release in accordance with UCWSRI[22] technical working group recommendations and agency approvals<br>• contribute eggs and larvae in excess of conservation needs to research initiatives | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, long-term, as needed | UCWSRI |

[20] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[21] Timeline:

- short-term is 0 to 5 years (2022 to 2026), medium-term is 6 to 10 years (2027 to 2031), long-term is greater than 10 years (2032+)
- ongoing is an action currently underway and continuing
- as needed is applied when an action is required, possibly multiple times, but the timing is uncertain
- uncertain is applied when implementation timing of the action is unknown

[22] Upper Columbia White Sturgeon Recovery Initiative (UCWSRI): Canadian members include: BC Hydro (BCH), Fortis BC (FBC), Columbia Power Corporation (CPC)/Columbia Basin Trust (CBT), Teck Metals Ltd., Canadian Columbia River Inter-Tribal Fisheries Commission (Ktunaxa Nation), Okanagan Nation Alliance, Freshwater Fisheries Society of BC (FFSBC), BC Ministry of Environment and Climate Change Strategy (BC ENV), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), DFO and private consultants; American members include: Colville Tribes, Spokane Tribe, Kootenai Tribe of Idaho (KTOI), Idaho Department of Fish and Game (IDFG), Northwest Power and Conservation Council, US Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife, Bonneville Power Administration (BPA), and private consultants.

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 2 | A-1, D-3g | Update the 2002 risk assessment for Upper Columbia conservation aquaculture. The update will:<br>• encompass risks associated with genetics, imprinting, distribution, unequal family and year class representation, and demographic/ecological impacts (including carrying capacity, food supply and effects on survival, growth, reproduction, and recruitment)<br>• identify how and when the risks will be mitigated (for example, selective harvest or other methods)<br>• identify the approach to reporting management actions<br>• be reviewed through a peer review process | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, medium-term | UCWSRI, academia |
| 3 | A-2, B-2, D-4 | Undertake adult and spawn monitoring (for example, using mark recapture and telemetry) in the Transboundary and ALR reaches to assess:<br>• abundance<br>• growth<br>• distribution<br>• habitat use<br>• movements | High | All | Ongoing, long-term | UCWSRI |
| 4 | A-2 | Undertake juvenile index monitoring to assess:<br>• abundance<br>• growth<br>• distribution<br>• habitat use<br>• movements<br>• diet<br>• survival | High | All | Ongoing, long-term | UCWSRI |

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 5 | A-3 | Develop a policy outlining beneficial use[23] targets and timelines, if and when population recovery is sufficient to support beneficial use | High | Fishing and industrial effects | Long-term, uncertain | First Nations, FLNRORD |
| 6 | B-1, B-2, C-7, D-3h | Continue research on:<br>• behaviour of yolk sac and feeding larvae (for example, cover) to determine factors affecting habitat selection and drift triggers to determine where and how survival bottlenecks for these life stages occur<br>• egg survival (for example, to examine benefit of interstitial habitats on survival) | High | Loss of habitat quality and quantity; altered hydrograph components; altered thermal regime | Ongoing, medium-term | UCWSRI |
| 7 | B-1, C-7, D-3h | Investigate food preferences and availability of food sources for larvae during initial stages of exogenous feeding | Medium | Reduced or altered food supply | Ongoing, medium-term | UCWSRI |
| 8 | B-1, B-2, C-7 | Identify spawning, egg, and larval rearing habitats in the Kinnaird area | High | Loss of habitat quality and quantity; altered hydrograph components | Ongoing, short-term | UCWSRI |
| 9 | B-1, B-2, C-7, D-3a | Undertake pre-requisite studies in support of spawning habitat restoration, including:<br>• investigating hydraulic conditions required to sustain preferred incubation substrates<br>• investigating current substrate conditions | High | Loss of habitat quality and quantity; altered hydrograph components; effects of small population size | Ongoing, short-term | UCWSRI |

[23] Beneficial use is defined in the Recovery Strategy for White Sturgeon (*Acipenser transmontanus*) in Canada (DFO 2014) as "…use of white sturgeon, if and when feasible, in Aboriginal Food, Social, and Ceremonial fisheries, and recreational fisheries, including those with and without retention (harvest)."

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 10 | B-2, B-4, B-5, C-4, C-5 | Design a long-term restoration program (to restore natural recruitment) and associated monitoring program (to determine efficacy of the restoration effort). The restoration design will use information from:<br>• pre-requisite studies<br>• research on population and distribution, survival and recruitment, and habitat use<br>• evaluation of previous restoration field trials | High | Loss of habitat quality and quantity; altered hydrograph components; effects of small population size | Ongoing, short-term | UCWSRI |
| 11 | B-5, C-7 | Conduct early life stage habitat suitability studies for all spawning areas | Medium | Loss of habitat quality and quantity; altered hydrograph components; altered thermal regime | Ongoing, medium-term | UCWSRI |
| 12 | B-5, C-7 | Assess the feasibility of increasing egg, larval, and juvenile survival at the Revelstoke spawning area | Medium | Loss of habitat quality and quantity; altered hydrograph components; altered thermal regime | Ongoing, short-term | UCWSRI |
| 13 | B-5 | Assess the impact and recovery implications from disruption of movement and related habitat fragmentation caused by hydroelectric facilities, and consider passage alternatives at facilities to restore free movement of White Sturgeon, if required | Low | Loss of habitat quality and quantity; habitat fragmentation | Uncertain | UCWSRI |
| 14 | B-6, C-4, C-5, C-6, C-7, C-8, F-4 | Where possible, implement flow requirements that promote natural spawning, incubation, rearing, recruitment, and survival of White Sturgeon | High | Loss of habitat quality and quantity; altered hydrograph components | Ongoing, long-term | BCH, FLNRORD, BC ENV, FFSBC, First Nations, United States (US) Agencies/Co-managers, UCWSRI |

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 15 | C-3 | Evaluate recruitment failure hypotheses through synthesis of studies on recruitment limitations (growth and survival) associated with water quality, water clarity, water flow, substrate, contaminants, total dissolved gas, competition, and predation | Medium | All | Ongoing, medium-term | UCWSRI |
| 16 | C-6 | Implement a long-term restoration program(s) and associated monitoring program(s) using information from the feasibility and design study | High | Loss of habitat quality and quantity; altered hydrograph components; effects of small population size | Long-term | UCWSRI |
| 17 | C-7, D-4 | Use juvenile monitoring data to:<br>• track trends in recruitment and survival in response to opportunistic high flow events, habitat modifications, and other environmental variables<br>• determine the relationship between habitat availability and use, and growth and survival<br>• approximate the impacts of dam operations on habitat availability and use, water quality (turbidity), and growth and survival | High | All | Ongoing-long-term | UCWSRI |
| 18 | D-1b, D-3d, D-3e, D-4 | Monitor and assess concentrations of organic and inorganic contaminants in White Sturgeon, their food supply and habitats, and determine their effects on population dynamics, abundance, and recruitment | Medium | Pollution | Ongoing, long-term | UCWSRI |
| 19 | D-1c, D4 | Monitor non-native species that occur within the Columbia watershed, identify species that may impact White Sturgeon recovery (for example, through predation and competition), and implement control measures (for example, through removal and bounty programs) as needed | Medium | Change in ecological community | Ongoing, long-term | UCWSRI |
| 20 | D-2a,D-3h, D-4 | Assess energetic effects of the river's altered thermal regime (for example, increased winter temperatures) downstream of the Hugh L. Keenleyside reach on White Sturgeon | Low | Altered hydrograph components; altered thermal regime | Ongoing, medium-term | UCWSRI |

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 21 | D-2b, D-4 | Assess availability of habitat and prey for juvenile White Sturgeon in Arrow Lakes | Medium | Loss of habitat quality and quantity; habitat fragmentation; reduced or altered food supply | Ongoing, short-term | UCWSRI |
| 22 | D-2b, D-3f, D-5, E | Continue to monitor occurrence of White Sturgeon harm and mortalities associated with hydroelectric facility operations and maintenance in Canadian waters, and if deemed necessary, implement mitigation measures | High | Fishing and industrial effects | Ongoing, long-term | FLNRORD, BC ENV, BCH, industry |
| 23 | D-5, F-3 | Continue to coordinate Upper Columbia White Sturgeon recovery activities through the bi-national UCWSRI and partners; and facilitate learning between populations through meeting with other White Sturgeon technical working groups and the National Recovery Team[24] | High | All | Ongoing, long-term | UCWSRI |
| 24 | E | Finalize stock structure analysis including completion of fin ray microchemistry, genetics, aging, and movement studies to determine possible historic breeding groups, effective breeders per group, and potential genetic bottlenecks | Medium | Effects of small population size | Ongoing, short-term | UCWSRI |
| 25 | E | Assess the trends in abundance and distribution of prey species throughout the range of the Upper Columbia NSP, including in tributaries, and their impacts on growth, survival, and reproduction of White Sturgeon | Low | Reduced or altered food supply | Long-term | UCWSRI |

[24] National Recovery Team membership: DFO and BC ENV co-chairs, chairs for each basin-level technical working group, and First Nations.

| # | Strategy / activity | Recovery measures | Priority [20] | Threats addressed | Timeline [21] | Partners |
|---|---|---|---|---|---|---|
| 26 | F-1, F-2, F-3, F-4, G-4, D-3c | Continue to increase public awareness of White Sturgeon conservation through outreach activities. This includes:<br>• regularly reporting progress on recovery initiatives during UCWSRI meetings<br>• communicating updates on the BCH Fish, Wildlife and Compensation and UCWSRI websites<br>• distributing outreach materials/brochures/videos<br>• communicating best practices for activities that impact White Sturgeon and their habitats<br>• communicating SARA prohibitions, including critical habitat protection and poaching | Medium | All | Ongoing, long-term | UCWSRI, academia, environmental non-governmental organizations, public |
| 27 | F-3 | Continue to develop and update the Upper Columbia White Sturgeon database(s) to facilitate data sharing among partner groups | High | All | Ongoing, long-term | UCWSRI |

**Table 4. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners for the Kootenay River White Sturgeon nationally significant population (NSP)[25].**

| # | Strategy / activity | Recovery measures | Priority [26] | Threats addressed | Timeline [27] | Partners |
|---|---|---|---|---|---|---|
| 1 | A-2, D-3g, D-4 | Assess risk of all hatchery related operations within the annual Kootenai Tribe of Idaho (KTOI) program review. This includes:<br>• assessing risks associated with genetics (including year class and family overrepresentation), disease, and autopolyploidy[28]<br>• assessing demographic and ecological impacts, including carrying capacity, and growth in lake and river habitats<br>• identifying how and when the risks will be mitigated (for example, evaluate the need for selective harvest or other methods)<br>• documenting this information via meeting notes accessible to all partners | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, long-term | BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), First Nations, KTOI, Idaho Department of Fish and Game (IDFG), Bonneville |

[25] Kootenay River White Sturgeon moves between Canada and the US, with the spawning reach in US waters. The Libby Dam, which has significant influence on Kootenay River flows, is also located in the US. Given this, a number of current US led measures are included in table 5 as they provide useful context for other measures in the document. The US has been undertaking conservation measures for White Sturgeon for many years, including legislative, research, habitat improvements, and enhancement including a hatchery. Further information on US recovery actions can be found in the Kootenai River White Sturgeon Recovery Plan.

[26] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[27] Timeline:

- short-term is 0 to 5 years (2022 to 2026), medium-term is 6 to 10 years (2027 to 2031), long-term is greater than 10 years (2032+)
- ongoing is an action currently underway and continuing
- as needed is applied when an action is required, possibly multiple times, but the timing is uncertain
- uncertain is applied when implementation timing of the action is unknown.

[28] White Sturgeon are polyploids with eight sets of chromosomes (8N); spontaneous autopolyploidy has been detected in hatchery settings through identification of 12N juveniles.

| # | Strategy / activity | Recovery measures | Priority [26] | Threats addressed | Timeline [27] | Partners |
|---|---|---|---|---|---|---|
| | | | | | | Power Administration (BPA), United States (US) agencies, academia |
| 2 | A-3 | Develop a policy outlining beneficial use[29] targets and timelines, if and when population recovery is sufficient to support beneficial use | High | Fishing and industrial effects | Long-term, uncertain | First Nations, FLNRORD |
| 3 | B-1, B-2, E | Conduct lab and/or *in situ* studies to investigate habitat use and drift by yolk sac larvae (for example, survival), and feeding larvae (for example, cover, food availability) | High | Loss of habitat quality and quantity; altered hydrograph components; reduced or altered food supply | Medium-term | FLNRORD, First Nations, KTOI, IDFG, BPA, US agencies, academia |
| 4 | B-5, B-4, C-1, C-4, C-5, D-3a | Restore floodplain habitat and connectivity as opportunities arise in Canadian waters. For example:<br>• continue to breach dikes to provide more off-channel habitat and release nutrients into the mainstem river, such as in the Creston floodplain<br>• re-contour banks and channel beds to make use of present day hydrograph | High | Loss of habitat quality and quantity; habitat fragmentation; altered hydrograph components | Ongoing, long-term | FLNRORD, First Nations, Creston Valley Wildlife Management Area (CVWMA), KTOI, IDFG, US Fish and Wildlife Service (USFWS), BPA, US agencies, academia |

[29] Beneficial use is defined in the "Recovery Strategy for White Sturgeon (*Acipenser transmontanus*) in Canada" (DFO 2014) as "…use of white sturgeon, if and when feasible, in Aboriginal Food, Social, and Ceremonial fisheries, and recreational fisheries, including those with and without retention (harvest)."

| # | Strategy / activity | Recovery measures | Priority [26] | Threats addressed | Timeline [27] | Partners |
|---|---|---|---|---|---|---|
| 5 | D-1b | Monitor and assess concentrations of organic and inorganic contaminants in White Sturgeon, their food supply and habitats, and determine their effects on population dynamics, abundance, and recruitment | High | Pollution | Ongoing, long-term | FLNRORD, First Nations, KTOI, IDFG, BPA, US agencies, academia |
| 6 | D-2b, D-3f, D-5 | Continue to monitor occurrence of White Sturgeon harm and mortalities associated with hydroelectric facility operations and maintenance in Canadian waters, and if deemed necessary, implement mitigation measures | Medium | Fishing and industrial effects | Ongoing, long-term | FLNRORD, BC Ministry of Environment and Climate Change Strategy (BC ENV), BC Hydro (BCH), industry |
| 7 | D-3a, D-3h, D-5 | Consider the needs of White Sturgeon in management of reservoir, and river levels and flows | High | Loss of habitat quality and quantity; altered hydrograph components | Long-term | FLNRORD, First Nations, BCH, Fortis BC (FBC), KTOI, IDFG, BPA, US agencies, academia |
| 8 | D3-g, A-1 | Develop method to differentiate between wild and hatchery-origin juveniles (for example, develop genetic markers that allow for accurate parental assignment) | High | Effects of small population size; hatchery and aquaculture effects on health and population | Ongoing, medium-term | FLNRORD, BPA, KTOI, IDFG, US agencies, academia |

| # | Strategy / activity | Recovery measures | Priority [26] | Threats addressed | Timeline [27] | Partners |
|---|---|---|---|---|---|---|
| 9 | D-5, F-3, F-4, G-4 | Continue to coordinate recovery activities and regularly share data and findings on recovery efforts between regulatory agencies, co-managers, interested parties, KTOI Annual Program Review, and Kootenai River White Sturgeon Recovery Team (KRWSRT)[30] to facilitate adaptive management approaches as new findings or concerns emerge; and facilitate learning between populations through meeting with other White Sturgeon technical working groups and the National Recovery Team[31] | High | All | Ongoing | FLNRORD, BC ENV, First Nations, BPA, KTOI, IDFG, USFWS, MFWP, USACE, US agencies, academia stakeholders |
| 10 | F-1, F-2 | Continue to increase public awareness of White Sturgeon conservation through outreach activities. This includes:<br>• continuing hatchery release program for elementary school aged children<br>• distributing outreach materials/brochures/videos<br>• communicating best practices for activities that impact White Sturgeon and their habitats<br>• communicating *Species at Risk Act* prohibitions, including critical habitat protection and poaching | High | All | Long-term | FLNRORD, First Nations, industry, BPA, KTOI, IDFG, public |

[30] Kootenay River White Sturgeon Recovery Team (KRWSRT) official membership: KTOI, US Army Corps of Engineers (USACE), BPA, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD), IDFG, MFWP, and University of Idaho.
[31] National Recovery Team membership: DFO and BC ENV co-chairs, chairs for each basin-level technical working group, and First Nations.

**Table 5. Measures that represent opportunities for other jurisdictions, organizations or individuals to lead for the Kootenay River White Sturgeon nationally significant population (NSP).**

| # | Strategy / activity | Recovery measures | Priority[32] | Threats addressed | Suggested other jurisdictions or organizations[33] |
|---|---|---|---|---|---|
| 1 | A-1 | Continue to adaptively manage, operate and improve conservation aquaculture in the US and continue to release hatchery juveniles in the US and Canada in accordance with Annual Program Review, KRWSRT, and co-managers' advice, and agency approvals | High | Effects of small population size; hatchery and aquaculture effects on health and population | FLNRORD, First Nations, KTOI, IDFG, BPA, US agencies, academia |
| 2 | A-2 | Continue to monitor the survival, growth, age, and abundance of wild adult White Sturgeon and hatchery fish using appropriate stock assessment methodologies and adaptively refine sampling design to ensure appropriate monitoring across lake and river habitats | High | All | FLNRORD, First Nations, KTOI, IDFG, BPA, US agencies, industry, academia |
| 3 | B-4, D-3a | Work with land owners and users to improve integrity of important habitats | High | Loss of habitat quality and quantity | FLNRORD, First Nations, KTOI, IDFG, CVWMA, BPA, US agencies, academia |
| 4 | B-5 | Support the design and implementation of long-term restoration programs to ensure habitat diversity and connectivity in the US portion of the Kootenai River | High | Loss of habitat quality and quantity; habitat fragmentation; altered hydrograph components; effects of small population size | FLNRORD, First Nations, KTOI, IDFG, BPA, United States (US) agencies, academia |

[32] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[33] Canadian partners: BC Hydro (BCH), Fortis BC (FBC), Freshwater Fisheries Society of BC (FFSBC), BC Ministry of Environment and Climate Change Strategy (BC ENV), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), Creston Valley Wildlife Management Area (CVWMA); American partners: Kootenai Tribe of Idaho (KTOI), Idaho Department of Fish and Game (IDFG), Bonneville Power Administration (BPA), US Fish and Wildlife Service (USFWS), Montana Fish, Wildlife and Parks (MFWP), US Army Corps of Engineers (USACE), and US Geological Survey (USGS).

| # | Strategy / activity | Recovery measures | Priority[32] | Threats addressed | Suggested other jurisdictions or organizations[33] |
|---|---|---|---|---|---|
| 5 | C-2, C-7, D-4 | Use monitoring data to:<br>• track trends in recruitment and survival in response to Libby Dam flow events, habitat modifications and restoration projects, and other environmental variables (for example, turbidity)<br>• determine the relationship between habitat availability and use, and growth and survival | High | All | FLNRORD, First Nations, KTOI, IDFG, BPA, US agencies, academia |
| 6 | C-3, D-1c, D-2a, D-2b, D-4 | Examine natural spawning, incubation, rearing, and survival of White Sturgeon in relation to:<br>• Kootenay River flows and Kootenay Lake elevations<br>• altered food web and insufficient nutrient resources<br>• lack of habitat connectivity and complexity in diked river sections in both Canada and the US | High | Loss of habitat quality and quantity; altered hydrograph components; habitat fragmentation; reduced or altered food supply; change in ecological community | FLNRORD, First Nations, CVWMA, BCH, FBC, KTOI, IDFG, BPA, US agencies, academia |
| 7 | C-6 | Undertake pre-requisite studies in support of spawning habitat restoration, including evaluation of meso-scale and larger restoration field trials | High | Loss of habitat quality and quantity; altered hydrograph components; effects of small population size | FLNRORD, First Nations, FBC, CVWMA, KTOI, IDFG, BPA, US agencies, academia |
| 8 | D-1c, C-3 | Research the rate of egg and larvae consumption by predators to determine if predation on early life stages is a significant contributor to recruitment failure | Low | Change in ecological community | Other agencies, First Nations, stakeholders |
| 9 | D-2a, C-3, D-4, G-1, G-2 | Investigate linkages between White Sturgeon productivity, growth and survival and:<br>• Kootenay Lake and Kootenai River nutrient restoration programs<br>• effects of dams and levees on nutrient deficiencies<br>• long-term kokanee population monitoring results<br>• other projects that enhance food availability | High | Reduced or altered food supply | FLNRORD, BCH, First Nations, BPA, KTOI, IDFG, US agencies, academia |
| 10 | D-2b | Contribute to the annual Libby Dam White Sturgeon spawning flow planning and examine the effects of changes in flow patterns and dam operations on early life stages and on spawn site selection and migration extent | High | Loss of habitat quality and quantity; altered hydrograph components; altered thermal regime | FLNRORD, First Nations, FBC, BPA, KTOI, IDFG, US agencies, academia |

| # | Strategy / activity | Recovery measures | Priority[32] | Threats addressed | Suggested other jurisdictions or organizations[33] |
|---|---|---|---|---|---|
| 11 | D-2b, C-3 | Model river flows and lake levels, including lake backwatering, to determine effect on larval drift | Medium | Altered hydrograph components | FLNRORD, First Nations, BPA, KTOI, IDFG, US agencies, academia |

# 2. Critical habitat

## 2.1 Identification of the species' critical habitat

### 2.1.1 General description of the species' critical habitat

Critical habitat is defined in SARA as "…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan for the species." [subsection 2.(1)]

Also, SARA defines habitat for aquatic species as "… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced." [subsection 2.(1)]

Critical habitat for each of the four SARA-listed White Sturgeon NSPs was identified to the extent possible in sections 8.1 to 8.6 of the recovery strategy (DFO 2014). The recovery strategy also contains details about the identified critical habitat including geographic location and biophysical functions, features, and attributes for each SARA-listed White Sturgeon NSP.

## 2.2 Activities likely to result in the destruction of critical habitat

Examples of activities likely to result in destruction of critical habitat may be found in section 8.7 of the recovery strategy (DFO 2014).

## 2.3 Proposed measures to protect critical habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a final recovery strategy or action plan that is included in the Species at Risk Public Registry. Protection of Upper Fraser River NSP, Nechako River NSP, Upper Columbia River NSP and Kootenay River NSP's critical habitat from destruction was accomplished in 2016 through four SARA critical habitat orders made under subsections 58(4) and (5), which invoked the prohibition in subsection 58(1) against the destruction of the identified critical habitat. The protection of Nechako River White Sturgeon critical habitat located in the Nechako River Bird Sanctuary was accomplished through a critical habitat description published in the Canada Gazette under subsection 58(2) of SARA, which triggered the prohibition against the destruction of any part of that critical habitat.

# 3. Evaluation of socio-economic costs and benefits

SARA section 49(1) requires that an action plan includes an evaluation of the socio-economic costs and benefits to be derived from the implementation of the action plan. This evaluation attempts to address the incremental and non-incremental socio-economic costs of implementing the action plan within Canada as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general, nor does it attempt a cost-benefit analysis. The analysis does not address the costs associated with social and cultural loss of access to the species by Canadians, including Indigenous peoples. The intent of this evaluation is to inform

the public and to guide decision-making on the implementation of the action plan by DFO and its partners.

## 3.1 Background

Many recovery measures for the four SARA-listed NSPs of White Sturgeon began with their legal listing under SARA in 2006 or prior to listing. Activities related to conservation aquaculture, population monitoring, habitat identification, research on biological information gaps, habitat restoration, and stewardship actions for White Sturgeon are already being undertaken by the Government of Canada, the Government of British Columbia, Indigenous organizations, universities, United States (US) governments and partners[34], and other stakeholders.

## 3.2 Methodology

This evaluation of socio-economic costs and benefits identifies the anticipated socio-economic impacts associated with the measures listed in tables 1-5 of this action plan. The evaluation attempts to address the costs and benefits expected to occur if the action plan is fully implemented. It is not intended to be a detailed analysis of all costs and benefits. There are also costs (and benefits) that may arise due to ongoing actions, such as research, which may warrant further incremental recovery measures. An order-of-magnitude estimate of potential costs and benefits is provided where sufficient information is available; otherwise, a qualitative statement regarding potential impacts is provided. This evaluation examines incremental and non-incremental[35] actions separately.

Many of the measures listed in this action plan represent a continuation of current activities or responsibilities and commitments of DFO and/or other groups into the foreseeable future (that is, designated as underway). Given these activities would continue regardless of the action plan, they are considered non-incremental to the action plan and carry no incremental costs. In addition, measures that are currently in the planning phase may carry additional, but still non-incremental, costs in the future as the measures move into the implementation phase. For this evaluation, only the costs of measures not currently in the planning phase or underway are considered incremental. The discount rate applied was 7% and the timeframe of the analysis was 13 years. All present value calculations are in 2020 dollars.

## 3.3 Socio-economic benefits of implementing this action plan

The benefits of recovery actions to restore the four SARA-listed White Sturgeon NSPs outlined in this action plan are not quantified but likely positive. Beyond the unquantifiable non-market benefits of species recovery, the recovery actions are also likely to provide broader ecosystem benefits, which in turn provide additional non-market benefits. Examples of ecosystem benefits and benefits to each SARA-listed White Sturgeon NSP are listed in table 6. However, some recovery efforts for White Sturgeon may have negative effects on other native fish or wildlife species. This includes alteration of flows in dam-affected systems, use of aquaculture as a stop-gap measure to address recruitment failure, and the management of fisheries for White

[34] Includes the US federal government, US Tribes, US states (Idaho, Montana, and Washington), and private US corporations.

[35] Non-incremental costs are defined as costs that would have been incurred irrespective of this action plan. Therefore, the figures presented in this section are the present values of future cost that would have been incurred irrespective of this action plan.

Sturgeon prey species (refer to section 10.1 of the recovery strategy for details; DFO 2014). While the net impact has not been assessed, the overall ecosystem benefits as a consequence of these recovery efforts may be lowered to some extent.

Additional benefits of recovery actions would occur if recovery measures result in improved outcomes for the four SARA-listed NSPs that will allow for beneficial use, if and when recovery is sufficient to support beneficial use. Benefits could accrue from beneficial use, which is defined as the “use of White Sturgeon, if and when feasible, in Aboriginal Food, Social, and Ceremonial fisheries, and recreational fisheries, including those with and without retention (harvest)” (DFO 2014).

**Table 6. Examples of benefits of the White Sturgeon action plan to the ecosystem and species.[36]**

| Nationally significant population (NSP) | Benefits of actions to the ecosystem | Benefits of the actions to the NSP |
|---|---|---|
| Upper Fraser River White Sturgeon | Other species of conservation concern that occur within the range of Upper Fraser River White Sturgeon NSP may benefit from broader actions, such as restoration, stewardship and outreach activities. Other species include Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Sockeye Salmon (*Oncorhynchus nerka*; Bowron designatable unit (DU) assessed as endangered; COSEWIC 2017) and Chinook Salmon (*Oncorhynchus tshawytscha*; Upper Fraser River Stream Spring DU assessed as endangered; COSEWIC 2018). | Continuation of monitoring activities may fill important knowledge gaps, such as location of early life stage habitats and prey availability, which can inform management actions that may increase the chance for long-term survival and recovery of the Upper Fraser River White Sturgeon NSP. Long term survival and recovery of White Sturgeon also benefits the ecosystem by helping to maintain ecosystem integrity.<br><br>Community awareness programs can promote recovery by engaging the public and providing education on conservation efforts, and potentially mitigate threats (for example, the emergency bycatch program aims to minimize bycatch mortalities). |
| Nechako River White Sturgeon | Other species of conservation concern that occur within the range of Nechako River White Sturgeon NSP may benefit from broader actions, such as restoration, stewardship and outreach activities. Other species include COSEWIC assessed Sockeye Salmon (*Oncorhynchus nerka*; Early Stuart and Late Stuart DUs assessed as endangered and Francois DU assessed as special concern; COSEWIC 2017) and Chinook Salmon (*Oncorhynchus tshawytscha*; Middle Fraser, Stream, Summer population assessed as threatened; COSEWIC 2018). | Continuation of the conservation aquaculture program and further work to clarify and mitigate threats (including habitat restoration to restore natural recruitment) will increase the chance for long-term survival and recovery of the Nechako River White Sturgeon NSP. Long term survival and recovery of White Sturgeon also benefits the ecosystem by helping to maintain ecosystem integrity.<br><br>Continuation of monitoring activities may fill important knowledge gaps, such as survival rates of juveniles, which may aid in management and recovery. Monitoring will also inform on progress towards meeting population and distribution objectives. |

[36] Note that, while some efforts may result in ecosystem or species-specific benefits, some recovery efforts may have negative effects on other native fish or wildlife species (refer to section 10.1 of the recovery strategy for details; DFO 2014).

| Nationally significant population (NSP) | Benefits of actions to the ecosystem | Benefits of the actions to the NSP |
|---|---|---|
| Upper Columbia River White Sturgeon | Other species of conservation concern that occur within the range of Upper Columbia River White Sturgeon NSP may benefit from broader actions, such as restoration, stewardship and outreach activities. Other species include Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), Shorthead Sculpin (*Cottus confusus)*, and Columbia Sculpin (*Cottus hubbsi*), all federally listed as special concern, as well as Umatilla Dace (*Rhinichthys umatilla*; COSEWIC assessed as threatened; COSEWIC 2010), and the mollusc Shortface Lanx (*Fisherola nuttallii*; COSEWIC assessed as endangered; COSEWIC 2016). | Continuation of the conservation aquaculture program and further work to clarify and mitigate threats (including habitat restoration to restore natural recruitment) will increase the chance for long-term survival and recovery of the Upper Columbia White Sturgeon NSP. Long term survival and recovery of White Sturgeon also benefits the ecosystem by helping to maintain ecosystem integrity.<br><br>Continuation of monitoring activities may fill important knowledge gaps, such as survival and growth rates of hatchery-origin juveniles, which may aid in management and recovery. Monitoring will also inform on progress towards meeting population and distribution objectives. |
| Kootenay River White Sturgeon | Other species of conservation concern that occur within the range of Kootenay River White Sturgeon NSP may benefit from broader actions, such as restoration, stewardship and outreach activities. Other species include Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*; federally listed as special concern), provincially red listed Burbot (*Lota lota maculosa*), and other species that use these aquatic habitats including the Northern Leopard Frog (Rocky Mountain population; *Lithobates pipiens*; federally listed as endangered) and Western Painted Turtle (Rocky Mountain population; *Chrysemys picta bellii*; federally listed as special concern). | Continuation of the conservation aquaculture program and work to clarify and mitigate threats (including habitat restoration and experimental flow management at Libby Dam to restore natural recruitment) will increase the chance for long-term survival and recovery of the Kootenay River White Sturgeon NSP. Long term survival and recovery of White Sturgeon also benefits the ecosystem by helping to maintain ecosystem integrity.<br><br>Continuation of monitoring activities may fill knowledge gaps, such as identifying important habitat for early life stages in Canada, which may aid in management and recovery. Monitoring will also inform on progress towards meeting population and distribution objectives. |

## 3.4 Socio-economic costs of implementing this action plan

### Underway non-incremental costs

Prior to the publication of this action plan, various measures have been undertaken by Canadian and US governments, Indigenous partners, industry, environmental non-governmental organizations, universities, and other organizations and stakeholders. As mentioned in section 3.2 of this action plan, those measures which are already underway or being planned are considered non-incremental for the purpose of this action plan. While cumulative costs to Canadians (that is, the sum of costs incurred prior) have not been quantified, the cost of non-incremental measures spanning into the future have been estimated. For the four SARA-listed White Sturgeon NSPs, future costs of measures initiated prior to this action plan are estimated to be $3.4 million annualized for activities taken by DFO and other Canadian partners[37]. Meanwhile, the future costs of all non-incremental recovery measures to non-Canadian partners for the Kootenay River White Sturgeon NSP are estimated to be nearly $10.5 million annualized. Future costs of all non-incremental recovery measures to non-Canadian partners for the Upper Columbia River White Sturgeon NSP are expected but the amount is uncertain. These non-incremental costs are expected to continue and remain similar for at least the short-term (within 5 years) to medium-term (6 to 10 years).

Note that there may be additional impacts on Indigenous people and their communities associated with some recovery measures. DFO will continue to work with Indigenous groups and partners to analyze the costs associated with ongoing and future recovery measures.

Upper Fraser River White Sturgeon NSP

The total cost of underway and ongoing activities for the Upper Fraser River White Sturgeon NSP are estimated to be in excess of $120,000 annualized. These costs will be borne by other Canadian parties, with contributions from DFO. The most significant quantified costs to Canadians for the Upper Fraser River White Sturgeon NSP are long-term research, monitoring and assessment activities. Examples include: identification and mapping of habitats and associated attributes for spawning and incubation, larvae and early and late juveniles; monitoring for population abundance, population structure, movement, mortality, and habitat-use trends.

Nechako River White Sturgeon NSP

The total costs of underway and ongoing activities (non-incremental costs) for the Nechako River White Sturgeon NSP are estimated to be in excess of $1.4 million annualized. These costs will be borne by other Canadian parties, with contributions from DFO. The most significant quantified costs to Canadians for the Nechako River White Sturgeon NSP is the operation of the Nechako White Sturgeon Conservation Centre; about 38% of the Nechako River White Sturgeon NSP's non-incremental costs is attributed to this measure. Other significant non-incremental measures include research and monitoring projects undertaken and funded by DFO and other Canadian partners. Examples of research projects include: defining survival and recruitment limitations for early life stages and juveniles; and juvenile abundance and distribution monitoring in the Nechako and Upper Fraser watersheds.

[37] Annual costs are calculated up to and including 2033.

Upper Columbia River White Sturgeon NSP

The total costs of underway and ongoing activities (non-incremental costs) for the Upper Columbia River White Sturgeon NSP are estimated to be in excess of $1.6 million annualized going forward. These costs will be borne by other Canadian parties, with contributions from DFO. The most significant quantified costs to Canadians for the Upper Columbia River White Sturgeon NSP is the operation and management of conservation aquaculture at the Kootenay Trout Hatchery; about 34% of the Upper Columbia River White Sturgeon NSP's non-incremental costs is attributed to this measure. Other significant non-incremental measures include research, monitoring and assessment activities undertaken by Canadian and US partners (for example, Washington State). Examples include: conducting regular juvenile indexing, monitoring spawning activity at all known spawning sites, and monitoring White Sturgeon harm and mortalities including assessing the impact associated with hydroelectric facility operations and other industrial activities in Canadian waters.

Kootenay River White Sturgeon NSP

The Kootenay River White Sturgeon NSP is unique in that most of the costs are borne by the Bonneville Power Administration, with support from the US Government, US Tribes, and US states (Idaho and Montana). The total costs of underway and ongoing activities (non-incremental) supported by non-Canadian partners are estimated to be nearly $10.5 million annualized going forward. These measures include the operation of conservation aquaculture facilities, large-scale habitat restorations, experimental flow management at Libby Dam, research, and monitoring activities. Additionally, total non-incremental costs borne by DFO and other Canadian partners are estimated to be $160,000 annualized. Of these, the most significant costs are related to habitat restoration, research and stewardship. Examples include restoration of floodplain habitat and connectivity, and evaluation of population monitoring study design.

Incremental costs

Across the four SARA-listed White Sturgeon NSPs, the cost of incremental measures as a direct result of this action plan to the Government of Canada and other Canadian parties is considered low (present value of less than $1 million, or $110,000 annualized) and the benefits are expected to be positive. The benefits are expected to accrue to all Canadians while the costs are distributed between the federal government, provincial partners and stewardship groups with up to 32% of costs being borne by the Government of Canada. Table 7 summarizes the list of measures that are considered incremental. Detailed information for each White Sturgeon NSP follows.

**Table 7. List of incremental recovery measures by White Sturgeon nationally significant population (NSP).**

| NSP | Incremental recovery measures |
|---|---|
| Upper Fraser River | Table 1 measures #4, #5, #6, #9, #10, #11, #16 |
| Nechako River | Table 2 measures #10, #12 |
| Upper Columbia River | Table 3 measures #5, #25 |
| Kootenay River | Table 4 measure #2 and table 5 measure #18 |

### Upper Fraser River White Sturgeon NSP

For the Upper Fraser River White Sturgeon NSP, seven incremental measures will be implemented as a result of the action plan. The present value costs of these measures are estimated to be over $750,000, or $90,000 annualized. It is estimated that 38% of these costs will be borne by DFO, while the rest will be borne by other Canadian parties, such as the Government of BC and private industry. The two largest measures (by cost) that will be undertaken include: identify, and where appropriate, design and implement habitat restoration opportunities (table 1, measure 10); and, monitor and assess concentrations of organic and inorganic contaminants in White Sturgeon, their food supply and habitats, and determine their effects on population dynamics, abundance and recruitment (table 1, measure 11). These two measures account for 72% of the estimated incremental costs for this NSP.

### Nechako River White Sturgeon NSP

For the Nechako River White Sturgeon NSP, there are two incremental measures that will be implemented as a result of this action plan. The present value costs of these measures are estimated to be over $120,000, or $15,000 annualized. It is estimated that 5% of these costs will be borne by DFO, while the rest will be borne by other Canadian parties, such as the Government of BC and private industry. These measures are: develop a policy outlining beneficial use targets and timelines, if and when population recovery is sufficient to support beneficial use (table 2, measure 10); and investigate food requirements for late juvenile White Sturgeon (older than two years; table 2, measure 12).

### Upper Columbia River White Sturgeon NSP

For the Upper Columbia River White Sturgeon NSP, there are two incremental measures as a result of this action plan. The present value costs of these measures are estimated to be over $42,000, or $5,000 annualized. It is estimated that 10% of these costs will be borne by DFO, while the rest will be borne by other Canadian parties, such as the Government of BC and BC Hydro. These measures are: develop a policy outlining beneficial use targets and timelines, if and when population recovery is sufficient to support beneficial use (table 3, measure 5); and, assess the trends in abundance and distribution of prey species throughout the range of the Upper Columbia NSP, including in tributaries, and their impacts on growth, survival, and reproduction of White Sturgeon (table 3, measure 25).

### Kootenay River White Sturgeon NSP

For the Kootenay River White Sturgeon NSP, there are two incremental measures as a result of this action plan. The present value cost of the Canadian measure is estimated to be $4,000, or $500 annualized. It is estimated 100% of these costs will be borne by DFO. The first measure, which will be implemented on the Canadian side, is to develop a policy outlining beneficial use targets and timelines, if and when population recovery is sufficient to support beneficial use (table 4, measure 2). The second measure is to research the rate of egg and larvae consumption by predators to determine if predation on early life stages is a significant contributor to recruitment failure (table 5, measure 18). The costs are uncertain, but it is likely that this measure will be covered by non-Canadian parties (that is, US partners) within their budget for the Kootenay River White Sturgeon NSP monitoring activities and with in-kind support from the Government of BC, First Nations and stewardship groups.

## 3.5 Distributional impacts

As outlined in section 1.2 above, implementation of this action plan will require commitment and cooperation among many organizations and groups. The action plan includes contributions from federal and provincial governments, Indigenous partners, non-governmental organizations, industry stakeholders, universities, and others. It is also possible that new groups would become involved in future recovery efforts. Probable partners have been identified in tables 1 to 5.

The benefits are expected to accrue to all Canadians while the costs are distributed amongst DFO and the partners identified above. Of the incremental costs, it is estimated that 32% will be borne by DFO, with the rest borne by other Canadian parties. Of the non-incremental costs for all four SARA-listed White Sturgeon NSPs, it is estimated that 4% will be borne by DFO, 20% by other Canadian parties, and the majority is borne by US Government, US Tribes, and US states to support recovery of Upper Columbia River and Kootenay River White Sturgeon NSPs.

The costs incurred when implementing the recovery measures in this action plan may also change. The Government of Canada will monitor the impacts of these measures as efforts continue to protect and recover these four-SARA listed White Sturgeon NSPs.

# 4. Measuring progress

The performance measures presented in the associated recovery strategy (DFO 2014) provide a way to define and measure progress toward achieving the population and distribution objectives.

Reporting on implementation of the action plan (under section 55 of SARA) will be done by assessing progress towards implementing the recovery measures.

Reporting on the ecological and socio-economic impacts of the action plan (under section 55 of SARA) will be done by assessing the results of monitoring the recovery of the species and its long term viability, and by assessing the implementation of the action plan.

# 5. References

COSEWIC. 2003. COSEWIC assessment and update status report on the white sturgeon *Acipenser transmontanus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 51 pp.

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# Appendix A: effects on the environment and other species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2010), *Species at Risk Act* (SARA) recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. 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 and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies 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 action plan itself, but are also summarized below in this statement.

By promoting the recovery for the four White Sturgeon nationally significant populations, this action plan will benefit the environment, thereby contributing to FSDS Theme III (Protecting Nature and Canadians), Goal 4 (Conservation and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians). Specifically, it will help to attain the following associated target: to have populations of federally listed species at risk exhibit trends that are consistent with the objectives of recovery strategies and management plans.

The actions identified in this plan address threats such as: loss of habitat quality or quantity; altered hydrograph components; pollution; change in ecological community; and, altered prey base. By addressing these threats, the actions will contribute to overall ecosystem health, which is likely to provide benefits to other species that coexist in the Upper Fraser, Nechako, Upper Columbia and Kootenay rivers (refer to table 6 for details on co-occurring species). As well, ecological services to both Canadians living in the area and United States citizens living in proximate areas downstream of the transboundary populations of the Columbia River and Kootenay River will be provided.

Risks associated with the threat of "hatchery and aquaculture effects" from the conservation aquaculture facilities in the Nechako and Upper Columbia Rivers, and the juvenile releases into Canadian waters of the Kootenay River from the Kootenai Tribe of Idaho's Upper Kootenai River hatcheries in the United States, will be mitigated through the application of best practices in production, monitoring, and, importantly, applying adaptive management to modify operations and management actions as appropriate. To this end, actions associated with mitigating this threat include: updating breeding plans; comprehensively updating risk assessments; identifying transparent reporting mechanisms; and, advancing research on genetics, and potential demographic, distributional and ecological effects from aquaculture-origin White Sturgeon.

Given the above, it is unlikely that the recovery measures recommended within this document will negatively impact other fish or wildlife species, and, the benefits to the environment and other species are expected to outweigh any adverse effects that may occur.

# Appendix B: record of cooperation and consultation

Action plans are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in *Species at Risk Act* (SARA) section 48. To the extent possible, this action plan has been prepared in cooperation with the British Columbia (BC) Ministry of Environment and Climate Change Strategy (MOE), BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), Nechako White Sturgeon Recovery Initiative, and Canadian members of the Upper Columbia River White Sturgeon Recovery Initiative and Kootenai White Sturgeon Technical Working Group. The action plan was developed collaboratively through the efforts and contributions of many individuals and organizations. Consultants generated an initial list of both actions to date and anticipated future needs to help recover the four SARA-listed White Sturgeon nationally significant populations. Technical Working Groups reviewed the draft action plan tables for accuracy and completeness.

The draft action plan was circulated to White Sturgeon technical working groups, Indigenous organizations, local and regional governments, academia, environmental non-governmental organizations, and industry for external review from November 30, 2021 to January 7, 2022. Input from one species expert, one environment non-governmental organization, two industry representatives, and one Indigenous organization was received. Concurrently, the draft action plan was circulated to the Government of BC, Parks Canada and Environment and Climate Change Canada for Species at Risk Coordinating Committee review. Input from the Government of BC and Parks Canada was received. All comments were considered in the development of the proposed action plan.

Additional Indigenous, stakeholder and public input will be sought through the publication of the proposed action plan on the Species at Risk Public Registry for a 60-day public comment period. Comments received will inform the final document.