

Upper Columbia White Sturgeon Recovery Initiative

Operational Plan 2013-2017



This Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) Operational Plan is a supplement to the December 2012 UCWSRI Recovery Plan¹ and describes specific actions that will be implemented in order to achieve the goals and objectives of the Recovery Plan. This document was developed, reviewed, and will be periodically updated by the UCWSRI Technical Working Group (TWG). The purpose, role and membership of the UCWSRI and the UCWSRI-TWG are described in the Recovery Plan (pages 7-8).

The December 2012 UCWSRI Recovery Plan (Recovery Plan) identifies recovery goals, objectives, and population targets, and a suite of strategies and associated measures to achieve those goals, objectives and population targets. The Recovery Plan also identifies approximate timeframes (i.e., short, medium and long term) within which the conservation measures will be implemented and within which results can be expected.

The purpose of this Operational Plan is to identify ongoing and planned implementation actions designed to address the strategies and conservation measures identified in the Recovery Plan and to summarize progress associated with those actions. This Operational Plan identifies activities that will occur during 2013-2017 and will be reviewed and updated by the UCWSRI-TWG on a regular basis (approximately bi-annually) consistent with the goals and objectives of the Recovery Plan. Implementation of specific actions and the schedules presented in this Operational Plan are contingent upon new data collected as part of monitoring and research activities as well as resources available for plan implementation. Evolving knowledge, economic, social, and legal considerations will guide decisions on proceeding with and/or modifying various elements of this Operational Plan.

This Operational Plan includes: 1) a summary of the UCWSRI recovery goal and objectives, 2) a summary of the current recovery targets (i.e., interim benchmarks), and 3) a table listing ongoing and planned implementation actions for each conservation strategy and where applicable, identification of associated management implications.

1.1 Recovery Goal and Objectives

The following goals are identified in the Recovery Plan:

- Working together to build a healthy future for the sturgeon in the Upper Columbia River in British Columbia and Washington.
- Ensure that the population is sustainable throughout their natural range, self-sustaining through natural reproduction and to increase or restore opportunities for beneficial use, if and when feasible.²

¹ Hildebrand, L. R. and M. Parsley. 2013. Upper Columbia White Sturgeon Recovery Plan – 2012 Revision. Prepared for the Upper Columbia White Sturgeon Recovery Initiative. 129p. + 1 app. Available at: www.uppercolumbiasturgeon.org

² This goal is adopted from Canada's National White Sturgeon Recovery Strategy.

The following objectives are identified in the Recovery Plan:

- Identify and address factors limiting natural recruitment.
- Monitor status and trends of populations within the recovery areas.
- Continue supplementation to rebuild abundance and maintain genetic diversity.

Recovery efforts are focused on the following three areas that provide suitable habitat within the white sturgeon historical geographic range, those are:

- Arrow Lakes Reservoir Reach from Revelstoke Dam to HLK in Canada
- Upper Transboundary Reach from HLK to the Canada-U.S. boundary
- Lower Transboundary Reach from Canada-U.S. boundary to Grand Coulee Dam in the U.S.

Any changes to these areas of focus will be identified in future iterations of this UCWSRI Operational Plan along with an explanation of the rationale for those changes.

1.2 Targets

Recovery targets are interim benchmarks by which progress toward recovery will be measured. A minimum of 25+ years will be required to approach many of these recovery targets because of the long life span and generation time of sturgeon. Targets identified in the Recovery Plan are based on population viability guidelines identified in the scientific literature and are similar to those adopted in the draft Canadian National Recovery Strategy for White Sturgeon³ and in recovery plans for other vulnerable sturgeon populations.

Targets for the Upper Columbia River White Sturgeon are listed below (additional detail is provided in the Recovery Plan pages 81-82):

1. Minimum interim adult population sizes of 2,000 adults in the upper Transboundary Reach (Canada), 5,000 adults in the lower Transboundary Reach (U.S.)
2. Naturally-produced recruitment and juvenile population sizes sufficient to support desired adult population sizes in the potential recovery areas.
3. Stable size and age distributions in each population.
4. Genetic diversity (including rare allele frequencies) is preserved and is similar to that measured during the late 1990s or early 2000s.
5. Abundance and natural production rates are sufficient to support beneficial uses including subsistence harvests by First Nations and Native American Indians and recreational fishery uses.

1.3 Recovery Plan Strategies, Measures and Implementation Actions

The following sections list the strategies and measures identified in the Recovery Plan and present a table for each strategy summarizing specific implementation actions. Not all of the measures identified in the Recovery Plan currently have actions associated with them; however, all strategies and measures are identified in this Operational Plan in order to facilitate future review and updates to the Operational Plan. The order of presentation is consistent with the presentation of conservation strategies in the Recovery Plan and does not reflect a prioritization of strategies or associated measures.

³ The interim recovery population target for the Upper Columbia pop in the recovery strategy is 1,000 mature individuals (25 years of age or older) and a 1:1 sex ratio. This is an interim target for the next 10 years at minimum.

The conservation strategies identified in the Recovery Plan include the following:

- 1) Control Direct Sources of Adult and Juvenile Mortality
- 2) Rebuild Abundance through Hatchery Supplementation
- 3) Restore Natural Recruitment
 - a. Water Management
 - b. Water Quality
 - c. Contaminants
 - d. Habitat Diversity, Connectivity, and Productivity
 - e. Population Assessment, Monitoring, & Research
 - f. Education and Outreach

Each implementation action table in this Operational Plan incorporates the following information: 1) an action number (for ease of reference only), 2) the area where the action will be implemented, 3) a brief summary of the action, 4) the conservation measures addressed, 5) the implementation schedule, 6) the responsible entity, and 7) the funding status (i.e., funded – yes or no) at the time this Operational Plan was finalized.

Multiple component strategies are listed under the third strategy, “Restore Natural Recruitment”. This strategy incorporates actions designed to test hypotheses regarding the cause(s) of recruitment failure. In 2008 the UCWSRI-TWG completed a focused effort to identify refined recruitment failure hypotheses for the UCWSRI area. This effort started with a list of 100 hypotheses, and through a structured decision-making process, the TWG screened, refined and combined this initial list into five recruitment failure hypotheses for the Transboundary Reach and six recruitment failure hypotheses for the Arrow Lakes Reservoir Reach (see the Recovery Plan pages 42-49 for additional detailed descriptions)⁴. Where applicable, the action tables in Section 1.3.3 of this document also include an indication of which natural recruitment failure hypothesis is being tested by the action.

The following acronyms are used in the tables in this Operational Plan:

- ALH – Arrow Lakes Generating Station
- ALR – Arrow Lakes Reservoir Reach
- ARNRP – Arrow Lakes Nutrient Restoration Program
- BPA – Bonneville Power Administration
- BCH – BC Hydro
- BRD – Brilliant Dam and Generating Station
- BRX – Brilliant Expansion Generating Station
- CCT – Colville Confederated Tribes
- CPC – Columbia Power Corporation
- DFO – Department of Fisheries and Oceans Canada
- FLNRO – BC Ministry of Forests, Lands and Natural Resource Operations
- FWCF – Fish and Wildlife Compensation Fund
- HLK – Hugh L. Keenleyside Dam
- NPCC – Northwest Power and Conservation Council
- PTAGIS – PIT Tag Information System
- RFH – Recruitment Failure Hypothesis
- STI – Spokane Tribe of Indians

⁴ McAdam (2012), completed a subsequent weight-of-evidence evaluation which identified substrate change at spawning sites as the most plausible hypothesis for the Canadian portion of the Recovery Area.

- WDFW – Washington Department of Fish and Wildlife
- WELP – Waneta Expansion Limited Partnership
- WSFAP-PPE – White Sturgeon Flow Augmentation Program Post-Project Enhancement

1.3.1 Control Direct Sources of Adult and Juvenile Mortality

Measures to control direct sources of adult and juvenile mortality from UCWSRI Recovery Plan:

- 1.3.1.1 *Continue to prohibit fishing for and retention of sturgeon (short to long term).*
- 1.3.1.2 *Continue to limit incidental impacts and illegal harvest of sturgeon (short to long term).*
- 1.3.1.3 *Continue to monitor occurrence of sturgeon mortalities (short to long term).*
- 1.3.1.4 *Continue to monitor mortality or harm through the operations of dams and hydroelectric facilities and if deemed necessary, implement operational mitigation measures (short to long term)*

Actions to Control Direct Sources of Adult and Juvenile Mortality						
#	Area(s)	Description of Action(s)	Measure(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
1.1	US & CAN	Recreational fishing for white sturgeon in the Canadian portion of the Upper Columbia Basin and the U.S. Transboundary reach is prohibited. Enforce fishing regulations.	1.3.1.1	Ongoing	FLNRO, WDFW	N/A
1.2	CAN	In Canada, Upper Columbia White Sturgeon are protected by SARA prohibitions against killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading an individual. SARA also prohibits destroying any part of the species' critical habitat, once it is protected. Enforce prohibition and issue permits for exemptions where appropriate.	1.3.1.1, 1.3.1.2	Ongoing	DFO	N/A
1.3	CAN	Coordination and implementation of mortality response protocol (includes investigation into cause of mortality and collection of appropriate biological information).	1.3.1.3	Ongoing	DFO, BCH, CPC, Teck, FortisBC	N/A
1.4	CAN	Monitor BRD & BRX tailraces for injured sturgeon during start-up after high-risk events.	1.3.1.3, 1.3.1.4	Ongoing	CPC	Yes
1.5	CAN	Implement procedures to mitigate risk to sturgeon trapped in draft tubes for prolonged periods when stoplogs are installed through monitoring and potential salvage (at BRX, BRD & ALH).	1.3.1.4	Ongoing	CPC	Yes
1.6	CAN	Install telemetry receiver at the ALH intake channel to assess entrainment potential.	1.3.1.4	Ongoing	CPC	Yes
1.7	CAN	Implement slow ramp turbine start up procedure at BRX to reduce the risk of injury sturgeon to located in the draft tubes during unit starts.	1.3.1.4	Ongoing	CPC	Yes

Actions to Control Direct Sources of Adult and Juvenile Mortality						
#	Area(s)	Description of Action(s)	Measure(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
1.8	CAN	Development of a protocol that specifies the procedures, permitting/notification protocols, safety guidelines, and data collection required for recovery and release of a white sturgeon from HLK dam. This protocol may include facility structures such as boat locks, gates, and spillways etc.	1.3.1.4	Ongoing	BCH	Yes
1.9	CAN	Determine entrainment risk for white sturgeon at HLK through implementation of the entrainment strategy for that facility.	1.3.1.4	Ongoing	BCH	Yes
1.10	CAN	Install and pilot use of draft tube sturgeon exclusion gates at the Waneta Expansion Generating Station	1.3.1.4	Starting 2014	WELP	Yes
1.11	CAN	Determine interactions of juvenile and adult sturgeon with the HLK navigation lock and other facility structures.	1.3.1.4	Starting 2014	BCH	Yes

1.3.2 Rebuild Abundance through Hatchery Supplementation

Measures to rebuild abundance through hatchery supplementation from UCWSRI Recovery Plan:

- 1.3.2.1 *Pursue a fish culture strategy to conserve existing population diversity (short to medium term).*
- 1.3.2.2 *Use hatchery-reared offspring of wild adults to assist in research (short to medium term).*
- 1.3.2.3 *Establish failsafe adult population(s) where feasible and acceptable (medium to long term).*

Actions to Rebuild Abundance through Hatchery Supplementation						
#	Area(s)	Description of Action(s)	Measure(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
2.1	US	Collect naturally produced larvae from the Roosevelt Reach and rear at WDFW Sherman Creek Hatchery (or other suitable facility) for Roosevelt Reach release as yearlings.	1.3.2.1	2013-2017 annually	CCT, STI, WDFW	Yes
2.2	CAN	Assess population reproductive potential in the Keenleyside Reach by increasing knowledge and data regarding size/age at maturity, spawning periodicity, sex ratios, and fecundity. These data will be collected through annual broodstock setline efforts.	1.3.2.1	2013-2017	BCH	Yes
2.3	CAN	Production (from gametes) of white sturgeon at Kootenay Sturgeon Hatchery (located at Kootenay Trout Hatchery) and release of juveniles (yearlings) annually into the Keenleyside Reach and juveniles in to the ALR Reach. (CLBWORKS-25, CLBWORKS-34)	1.3.2.1	2013-2017 annually	FFSBC, BC Hydro	Yes
2.4	CAN	Evaluation of age/size at release in the Keenleyside and ALR reaches to further refine hatchery supplementation/stocking protocols. Could include larval releases, juvenile releases in both spring and fall. Specific attention should be given to evaluating size at the time of release within and across release ages to identify thresholds for survival.	1.3.2.1	Annually beginning in 2013	BCH, FFSBC	Yes
2.5	CAN	Determine the feasibility of collecting milt from flowing males in the Keenleyside Reach for use in hatchery spawning to increase the number of adults (increase N_e while decreasing relatedness) contributing to supplemental progeny.	1.3.2.1	2013-2017	BCH, FFSBC	Yes
2.6	CAN	Evaluate genetic measures associated with adults spawning in ALR, Funded through WUP study CLBMON24.	1.3.2.1	2016	BCH	Yes
2.7	CAN	Evaluate current breeding protocols and genetic measures related to wild caught broodstock, wild caught eggs/larvae/juveniles and supplemental progeny	1.3.2.1	2013-2014	BCH, FFSBC	Yes
2.8	CAN	Determine the feasibility of establishing a streamside rearing facility in the Upper	1.3.2.1	2013-2014	BCH, CPC,	Yes

Actions to Rebuild Abundance through Hatchery Supplementation						
#	Area(s)	Description of Action(s)	Measure(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
		Transboundary reach that would focus on rearing wild caught eggs and larvae.			FFSBC	
2.9	CAN	Implementation of a streamside rearing facility in the Keenleyside reach as per the outcomes of the feasibility study	1.3.2.1	2014-2015	BCH, CPC, FFSBC	TBD
2.10	CAN/US	Continue annual assessments of performance (growth, survival, habitat use) of hatchery released juveniles to determine how effective the conservation aquaculture program is. This action will also include tracking when hatchery juveniles start to mature and are suspected to be spawning. Impacts to broodstock breeding protocols will also need to be discussed as part of this action (See also Action 7.2).	1.3.2.1	2013-2017 annually	BCH, CCT, STI, WDFW	Yes

1.3.3 Restore Natural Recruitment

The strategy “Restore Natural Recruitment”, includes six component strategies: 1) Water Management; 2) Water Quality; 3) Contaminants; 4) Habitat Diversity, Connectivity, and Productivity; 5) Population Assessment, Monitoring, and Research; and 6) Education and Outreach.

In addition to contributing to the overall goal of white sturgeon recovery, a number of the actions identified in this section of the Operational Plan are also designed to test individual UCWSRI recruitment failure hypotheses. As previously noted, in 2008 the UCWSRI-TWG completed a focused effort to identify and refine UCWSRI white sturgeon recruitment failure hypotheses. This effort resulted in consensus agreement on five recruitment failure hypotheses for the Transboundary Reach and six recruitment failure hypotheses for the Arrow Lakes Reservoir Reach (see the UCWSRI December 2012 Recovery Plan, pages 42-49 for additional details).⁵ As new information and knowledge becomes available in the future, these recruitment failure hypotheses may be updated and/or revised by the UCWSRI-TWG. Any consensus changes to the recruitment failure hypotheses described in the Recovery Plan and this Operational Plan will be described and reflected in future iterations of this Operational Plan.

In order to incorporate reference to specific recruitment failure hypotheses within the action tables in this section, a letter-numeric code has been assigned to each recruitment failure hypothesis (e.g., TB-1, TB-2, ALR-1, ALR-2, etc.).

The 2008 hypotheses are listed below:

Transboundary Reach consensus recruitment failure hypotheses (2008)	
TB-1	Changes in flow patterns (magnitude and timing) and reduction in turbidity reduce the survival of young sturgeon (Age 0).
TB-2	Diminished suitability and availability of habitat (primarily related to substrate conditions) downstream of spawning areas has led to reduced survival of early life stages (0 to 365 days; the smaller the juvenile, the more likely the effect).
TB-3	Changes to the fish community have resulted in increased predation on eggs, free embryos, larvae and juvenile sturgeon and significantly reduced survival (0 to 365 days).
TB-4	Contaminated effluent from smelter and pulp mill sources leads to direct or indirect toxicity, impacted health, reduced spawning success, and reduced habitat and prey availability (0 to 365 days).
TB-5	Food of the appropriate type and size is not available at the right time and place to promote survival of young sturgeon (Age-0).

Arrow Lakes Reservoir (ALR) Reach consensus recruitment failure hypotheses (2008)	
ALR-1	Changes in flow and temperature patterns (magnitude and timing) reduce the success of or delay spawning, egg development, and post-hatch embryo growth and development. As a result, the over-wintering fitness of post-hiding phase juveniles is impacted and survival is reduced (Pre-spawn and spawning adults, incubating eggs, and 0-365 day old juveniles).

⁵ McAdam (2012) completed subsequent weight-of-evidence evaluation that supports a focus on the effects of substrate at spawning sites in Canada.

Arrow Lakes Reservoir (ALR) Reach consensus recruitment failure hypotheses (2008)	
ALR-2	Changes in flow patterns (magnitude and timing) and reduction in turbidity reduce the survival of eggs and young sturgeon (egg incubation and 0-40 days post-hatch).
ALR-3	The suitability and availability of habitat (primarily related to substrate conditions) downstream of spawning areas has led to reduced survival of eggs and early life stages (Incubating eggs, 0-40 day larvae, and 25-365 day larval/juvenile stages).
ALR-4	The installation of HLK eliminated the ability of mature adults from below the dam to access spawning habitat in the mid-Columbia reach upstream of Arrow Lakes resulting in lost recruitment (Mature adults (25+ years)).
ALR-5	Changes to the fish community have increased predation on eggs, free embryos, larvae and juvenile sturgeon and significantly reduced survival (0-365 days).
ALR-6	Food of the appropriate type and size is not available at the right time and place to promote survival of young sturgeon (11-365 days).

1.3.3.1 Water Management

Water management measures from UCWSRI Recovery Plan:

- 1.3.3.1.1 *Monitor and evaluate the effects of flow on natural recruitment using opportunistic flow years that will minimize impacts on other uses of basin waters (short to long term).*
- 1.3.3.1.2 *Implement flow requirements that promote natural spawning, incubation, rearing, recruitment, and survival of Columbia River White Sturgeon (short to long term).*
- 1.3.3.1.3 *Continue to assess impacts of dam discharge and reservoir operations on White Sturgeon early life stages (short to long term).*
- 1.3.3.1.4 *Future Treaties, agreements, or water licences should promote White Sturgeon recovery (short to long term).*

Water Management Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
3.1	US	Lower Transboundary Reach (U.S.) Phase 1 - larval release experiments. Mass Marking Techniques. Complete the calcein and OTC mass-marking experiments initiated in 2012.	1.3.3.1.3	TB-2	Phase 1 2013	CCT, STI, WDFW	Yes
3.2	US	Lower Transboundary Reach (U.S.) Phase 2a – Larval Release Experiments. Develop study plan for paired larval release experiments and subsequent evaluation. Activity will test the hypothesis that dispersing early larvae (first feeding) are not reaching suitable rearing habitats in the Roosevelt Reach. .	1.3.3.1.3	TB-2	Phase 2a 2013	CCT	Yes
3.3	US	Lower Transboundary Reach (U.S.) Phase 2b – Larval Release Experiments. Conduct paired releases of early larvae (immediately prior to first feeding) at experimental locations. All larvae will be marked if more than one marking technique is available; otherwise DNA will be used to differentiate between release groups and wild origin fish. Evaluate the relative survival of release groups at sub-yearling and yearling ages using catch in the sub-yearling gill net sampling and in trawl surveys.	1.3.3.1.3	TB-2	Phase 2b 2014 -2017	CCT, STI, WDFW	Yes
3.4	US	Lower Transboundary Reach (U.S.) Phase 3 – Feasibility Studies for Larval Transport Alternatives. Assuming larvae released at the downstream experimental release location exhibit greater survival, identify alternatives for larval transport to appropriate rearing areas. Conduct studies to examine	1.3.3.1.3	TB-2	Phase 3 2016-2017	CCT, STI, WDFW	Yes

Water Management Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
		the biological, social, and economic impacts of implementing potential larval transport alternatives. Possible follow-up actions could include experimental implementation of alternatives that would balance the biological, social, and economic impacts with the potential for providing detectable natural recruitment.					
3.5	US	Characterize dynamic habitat conditions (velocity, depth, temperature) in the reach between the border and Gifford under various hydro-operations and conduct statistical analyses to determine if and when differences occur in the years when detectable recruitment occurred. Phase 1 – Characterize Dynamic Habitat includes hydrographic survey and development of a digital elevation model (DEM) of bathymetry of the Roosevelt Reach from Kettle Falls to the International Border. Acoustic Doppler Current Profile transects of the Roosevelt Reach from Kettle Falls to the International Border. Development of a hydro-dynamic model of velocity for the Roosevelt Reach from Kettle Falls to the International Border using ADCP data.	1.3.3.1.3	TB-1	Phase 1 2013-2015	CCT	Yes
3.6	US	Characterize dynamic habitat conditions (velocity, depth, temperature) in the reach between the border and Gifford under various hydro-operations and conduct statistical analyses to determine if and when differences occur in the years when detectable recruitment occurred. Phase 2 – Model Habitat-Recruitment Relationships includes modeling dynamic habitat conditions (velocity, depth, temperature) under various hydro-operation scenarios. Conduct multivariate statistical analysis to determine relationships between habitat, hydro-operations, and recruitment.	1.3.3.1.3	TB-1	Phase 2 2015-2016	CCT	Yes
3.7	US	If it is determined that there are differences in the habitat-recruitment relationship between years with and without recruitment, feasibility studies will be conducted to examine the potential to experimentally implement potential hydro-operations experiments.	1.3.3.1.3	TB-1	Phase 3 2017	CCT	Yes

Water Management Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
		Phase 3 – Feasibility studies for US hydro-operation alternatives will include studies to examine the biological, social, and economic impacts of implementing potential hydro-operations alternatives. A follow up, may include experimental implementation of those alternatives that balance the biological, social, and economic impacts with the potential for providing detectable natural recruitment.					
3.8	CAN	Maintain Target Minimum Flows at Brilliant to the extent possible to maintain productivity and habitat conditions in the lower Kootenay River.	1.3.3.1.1, 1.3.3.1.2	N/A	Ongoing	CPC	Yes
3.9	CAN	Implement the minimum flow requirements of the WSFAP-1998 at Waneta to maintain flows during the spawning period	1.3.3.1.2	TB-1	2013-2014	Teck	Yes
3.10	CAN	Implement the minimum flow requirements of the WSFAP-PPE following commissioning of the Waneta Expansion project	1.3.3.1.2	TB-1	2015-2017	WELP	Yes
3.11	CAN	Develop a long-term database of white sturgeon movements to evaluate habitat use and spawning site selection under a variety of flow and operational regimes.	1.3.3.1.3	TB-1 & TB-2	Ongoing	BCH	Yes
3.12	CAN	Assess the effects of flow on egg predation at Waneta and specifically whether the WSFAP-PPE has a detectable effect on recruitment success.	1.3.3.1.3 (also 1.3.3.4.5)	TB-1 & TB-3	2012-2017	WELP	Yes
3.13	CAN	Describe habitat use for juvenile and adult sturgeon through both direct (capture) and passive (telemetry) methods to determine if habitat use is correlated to operations.	1.3.3.1.3	TB-1 & TB-2	2013-2017	BCH	Yes
3.14	CAN	Conduct a telemetry program to monitor sturgeon use of habitat below ALH/HLK, and Brilliant.	1.3.3.1.3	TB-2 & TB-5	Ongoing	CPC, BCH	Yes
3.15	CAN	Development of a hydrograph to maximize benefits (e.g. during spawning and early rearing) to white sturgeon residing in the lower Columbia River between Hugh Keenleyside Dam and the Canada/US border. Success to be determined through modeling exercises under various Columbia River Treaty scenarios.	1.3.3.1.4	TB-1 & TB-2	2013-2014	BCH	Yes

Water Management Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
3.16	CAN	Avoid planned outages at ALH during sturgeon spawning.	1.3.3.1.2, 1.3.3.1.3	TB-1	Ongoing	CPC	Yes
3.17	CAN	Model the effects of ALR levels and Revelstoke Dam discharge on spawning habitat suitability for early life stages.	1.3.3.1.1, 1.3.3.1.2	ALR-1, ALR-2 & ALR-3	2013-2014	BCH	Yes
3.18	CAN	Implement and maintain a year round minimum flow from Revelstoke Dam of 5 kcfs to maintain a larger wetted area near the white sturgeon spawning grounds during periods of reduced generation.	1.3.3.1.2	ALR-1 & ALR-2	Ongoing	BCH	Yes
3.19	CAN	Describe juvenile white sturgeon habitat use in the ALR as it relates to reservoir levels and release location. Assessment to be conducted using acoustic telemetry and fish capture using gill nets and setlines.	1.3.3.1.3	1.3.3.1.1.1	2013-2017	BCH	Yes
3.20		Undertake hydraulic and sediment transport modeling for the Pend d'Oreille confluence area to evaluate the potential time course of substrate change at the Waneta spawning site	TBD	TB-1	2014-17	TBD	Tentative

1.3.3.2 Water Quality

Water quality measures from UCWSRI Recovery Plan:

- 1.3.3.2.1 *Continue to assess the effects of altered thermal regimes, total dissolved gases, and water clarity on the timing of spawning, and metabolic rates, growth, and survival of egg through juvenile stages (medium to long term).*

Water Quality Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
4.1	US	Install and maintain water quality monitoring stations at various sites in the Lower Transboundary Reach to collect abiotic data (i.e. temperature, and turbidity).	1.3.3.2.1	TB-1	2014-2017, Annually	STI	Yes
4.2	CAN	Use preferred spill gate sequence at BRD to minimize downstream TGP effects of spill.	1.3.3.2.1	TB-4	Ongoing	CPC	Yes
4.3	CAN	Maintain current flow, temperature, turbidity database for Keenleyside Reach	1.3.3.2.1	TB-1 & TB-2	Ongoing	BCH	Yes
4.4	CAN	Ongoing monitoring of total dissolved gases as required for hydro facilities in the Keenleyside Reach	1.3.3.2.1	TB-2	Ongoing	BCH	Yes
4.5	CAN	Determine effects of temperature regime on larval development to improve aging estimates for wild caught larvae and contribute to knowledge pertaining to functional ecology.	1.3.3.2.1	TB-2	Ongoing	BCH	Yes
4.6	CAN	Assess the effect of the Waneta Expansion on TGP production at Waneta and recalibrate the Waneta TGP model	1.3.3.2.1	N/A	2015-2016	WELP	Yes

1.3.3.3 Contaminants

Contaminants measures from UCWSRI Recovery Plan:

1.3.3.3.1 Determine concentrations of organic and inorganic contaminants in sturgeon, their foods, and habitats (short term).

1.3.3.3.2 Encourage and support efforts by other entities to assess contaminant effects and monitor contaminant levels (long term).

Contaminants Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
5.1	US)	Assess contaminant bioaccumulation in Transboundary Reach (U.S.) by conducting an analysis of contaminants in a subsample of hatchery fish. Samples will be obtained from fish that are euthanized to determine reproductive characteristics.	1.3.3.3.1	TB-4	2014-2017	CCT	Yes
5.2	US	Conduct histopathology examination of early life stage white sturgeon Transboundary Reach (U.S.) exposed to relevant contaminants (general physiological impacts, sensory epithelium impacts) and complete comparisons to naturally produced fish collected from the river.	1.3.3.3.1	TB-4	2015-2017	CCT	Yes
5.3	US	Conduct behavioural assays of early life stage white sturgeon Transboundary Reach (U.S.) exposed to relevant contaminants. Develop general descriptions of behaviour in the presence of contaminants and evaluate impacts on predator avoidance and feeding success.	1.3.3.3.1	TB-4	2015-2017	CCT	Yes
5.4	CAN	Stable Isotope analysis for juvenile organ/tissue samples collected in fall of 2012 in the Keenleyside Reach	1.3.3.3.1	TB-5	2013-2014	BCH, MTA University	Yes
5.5	CAN	Contaminant analysis from adult sturgeon mortality samples (3) that occurred in summer 2012.	1.3.3.3.1, 1.3.3.3.2	TB-4	2013	Environ. Canada	Yes

1.3.3.4 Habitat Diversity, Connectivity, and Productivity

Habitat diversity, connectivity, and production measures from UCWSRI Recovery Plan:

- 1.3.3.4.1 *Project future impacts and limitations associated with continuing large scale habitat changes due to basin development and climate change (medium to long term).*
- 1.3.3.4.2 *Investigate means to restore habitats and natural functions of the Columbia River that are beneficial to sturgeon while also minimizing impacts on other uses of the river (short to long term).*
- 1.3.3.4.3 *Consider passage alternatives for restoring free movements of sturgeon at such time as new information demonstrates the feasibility, benefits, and lack of risk (long term).*
- 1.3.3.4.4 *Evaluate feasibility, benefits, and risks of increasing sturgeon population productivity by increasing nutrient availability (long term).*
- 1.3.3.4.5 *Assess the impacts of predators, particularly exotic predators, on early sturgeon life stages (short to medium term).*
- 1.3.3.4.6 *Support the examination of toxic/abrasive sediments in suitable rearing habitats (short to long term).*

Actions to Address Habitat Diversity, Connectivity, and Productivity							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
6.1	US	Evaluate predation effects (walleye and sculpin) on early life stages of white sturgeon in the Lower Transboundary Reach. This action will test the hypothesis that changes in the fish community have resulted in increased predation on eggs, free embryos, larvae, and juvenile (Age 0) white sturgeon and significantly reduced survival.	1.3.3.4.5	TB-3	2014-2017 Annually	STI	Yes
6.2	US	Process existing invertebrate samples to identify community composition, abundance, and sizes of available food resources for white sturgeon (age-0) in the Lower Transboundary Reach. This will test the hypothesis that food of the appropriate type and size is not available at the right time and place to promote survival of young sturgeon (Age-0).	1.3.3.5.5	TB-5	2014-2016	STI	Yes
6.3	CAN	Conduct early life stage habitat suitability studies below the ALH/ site to assess the feasibility for an enhancement project.	1.3.3.4.1, 1.3.3.4.2	TB-5	2012-2015	BCH, CPC	Yes
6.4	CAN	Continue the Arrow Lakes Reservoir Nutrient Restoration Program to increase food in the ALR and upper Transboundary reach.	1.3.3.4.4	TB-5	Ongoing	FWCF & CPC	Yes

Actions to Address Habitat Diversity, Connectivity, and Productivity							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
6.5	CAN	Describe feasibility of a substrate enhancement program and associated monitoring for the HLK/ALH spawning area.	1.3.3.4.1, 1.3.3.4.2	N/A	2013-2014	BCH	Yes
6.6	CAN	Implementation of a substrate enhancement program for the HLK/ALH spawning area based on outcomes of feasibility work.	1.3.3.4.1, 1.3.3.4.2	TB-2	2015-2017	BCH, CPC, MoE	Tentative
6.7	CAN	Describe existing habitat, and suitability, throughout the Keenleyside Reach.	1.3.3.4.1, 1.3.3.4.2	TB-2	2013-2017	BCH	Yes
6.8	CAN	Describe current spawning habitat attributes and the effects of reservoir elevations and Revelstoke Dam discharge on this habitat for the Revelstoke spawning area in the ALR.	1.3.3.4.1, 1.3.3.4.2	ALR-1 & ALR-2	2013-2014	BCH	Yes
6.9	CAN	Determine the quantity of warm water (>14°C) available in Revelstoke reservoir through data collection and reservoir modelling exercises and, if feasible, describe changes that could be made to temperatures downstream of REV Dam at the white sturgeon spawning area.	1.3.3.4.2	ALR-1	2013-2015	BCH	Yes
6.10	CAN	Describe diet preferences and food availability for both larval and juvenile stages in the Keenleyside Reach, specifically downstream from the spawning area at HLK/ALH.	1.3.3.4.4	TB-5	2013-2017	BCH, CPC	Yes
6.11	CAN	Describe seasonal mysid shrimp abundance in the Keenleyside Reach, consistent with information being collected in the ALR through the nutrient addition program.	1.3.3.4.4	TB-5	2013-2017	BCH	Yes
6.12	CAN	Describe feasibility of a substrate enhancement program and associated monitoring for the Waneta spawning area. Includes evaluations of multiple options (instream structure, substrate addition) and regulatory considerations (e.g. cross border movement of remnant slag).	1.3.3.4.1, 1.3.3.4.2	TB-2?	2014-2017	BCH	Yes
6.13	CAN	As soon as planning studies identify suitability, implement substrate enhancement for the Waneta spawning site	1.3.3.4.1, 1.3.3.4.2	TB-2	2015-2017	BCH, MoE	Tentative

1.3.3.5 Population Assessment, Monitoring, & Research

Population assessment, monitoring and research measures from UCWSRI Recovery Plan:

- 1.3.3.5.1 *Conduct periodic adult stock assessments (short term for Transboundary Reach; medium term for ALR Reach).*
- 1.3.3.5.2 *Continue to investigate the feasibility of establishing a failsafe population or an additional recovery area in the Upper Columbia River recovery area (short to medium term).*
- 1.3.3.5.3 *Conduct regular spawning investigations at key spawning sites (short to long term).*
- 1.3.3.5.4 *Conduct regular juvenile indexing (short to long term).*
- 1.3.3.5.5 *Determine recruitment bottlenecks (short to long term).*
- 1.3.3.5.6 *Develop and improve population analysis methods (short to medium term).*
- 1.3.3.5.7 *Improve the understanding of ecological interactions (medium to long term).*
- 1.3.3.5.8 *Encourage and support applied biological research (short to long term).*

Population Assessment, Monitoring, & Research Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
7.1	US	Compare histology samples of post-feeding larvae collected during larval collection efforts to reference specimens to identify potential starvation effects.	1.3.3.5.5.	TB-5	2013-2017 Annually	STI	Yes
7.2	US	Monitor abundance, survival, growth, condition of wild and hatchery white sturgeon in Lower Transboundary Reach (U.S.). Use capture-recapture techniques with two capture-recapture occasions (spring and late summer). See also 2.10 (US and Canada)	1.3.3.5.1	N/A	Annually 2013-2017	CCT, STI, WDFW	Yes
7.3	CAN	Continue to evaluate possible establishment of population in ALR and Kinbasket Reach	1.3.3.5.2	N/A	2013-2017	BCH	Yes
7.4	CAN	Use acoustic telemetry to describe habitat use and movements to help identify spawning areas, including use based on differing flow regimes.	1.3.3.5.3	TB-1 & TB-2	Ongoing	BCH	Yes
7.5	CAN	Monitor sturgeons spawning at HLK/ALH location annually (BCH and CPC)	1.3.3.5.3	TB-1	Annually, 2013-2017	BCH and CPC	Yes
7.6	CAN	Monitor sturgeon spawning at Waneta and conduct post-project numerical	1.3.3.5.3	TB-1	Annually,	BCH and	Yes

Population Assessment, Monitoring, & Research Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
		model validation study of Waneta Eddy. (CPC and BCH)			2013-2017	CPC	
7.7	CAN	Describe numbers of adults spawning at different locations in the Keenleyside Reach using molecular methods. A secondary goal is to evaluate percent of the spawning population represented by different gear types (Egg Mat vs Drift Net).	1.3.3.5.3, 1.3.3.5.5, 1.3.3.5.7, 1.3.3.5.8	N/A	2013-2014	BCH, WELP	Yes
7.8	US	Monitor for sub-yearling wild white sturgeon to detect natural recruitment in Lower Transboundary Reach (U.S.). Employ standardized, spatially balanced, random fall gill net survey.	1.3.3.5.4	N/A	Annually, 2013-2017 annually	CCT, STI, WDFW	Yes
7.9	CAN	CLBMON-23 Mid Columbia River Sturgeon Spawn Monitoring	1.3.3.5.4	ALR-1	2013-2017	BCH	Yes
7.10	CAN	CLBMON-29: Monitor abundance, survival, growth, condition of wild and hatchery white sturgeon in the Keenleyside Reach. Employ a standardized, spatially balanced, random setline survey.	1.3.3.5.4	TB-3	2013-2017	BCH	Yes
7.11	CAN	Juvenile diet analysis to describe prey type, prey availability and differences attributable to different habitats. Includes mysis shrimp data collection in the Keenleyside reach to pair with ALR nutrient addition program.	1.3.3.5.4, 1.3.3.5.4	TB-5	2013-2014	BCH	Yes
7.12	CAN	Juvenile ageing work: Develop ageing estimates for known age juveniles using otoliths and fin rays to determine accuracy when ageing wild juveniles.	1.3.3.5.4, 1.3.3.5.4	TB-1	2013-2014	BCH	Yes
7.13	CAN	Larval developmental staging guide: developed for staging and ageing wild caught larvae. Help improve estimates of spawning timing.	1.3.3.5.6, 1.3.3.5.8	TB-1 & TB-2?	2013	BCH	Yes
7.14	CAN	Evaluate effects of habitat conditions on survival of egg and yolk sac larval stages (e.g., substrate and velocity conditions). Actions may combine laboratory/flume studies with in-stream studies.	TBD	TBD	2014-2017	TBD	TBD
7.15	CAN	Evaluate effects of habitat conditions on survival of feeding larvae. This may require a variety approaches to fully understanding this challenging but important life stage.	TBD	TBD	2015-19	TBD	TBD

1.3.3.6 Education and Outreach

Education and outreach measures from UCWSRI Recovery Plan:

- 1.3.3.6.1 *Support active communication and coordination with interested stakeholders to raise awareness of the need to protect White Sturgeon (short to long term).*
- 1.3.3.6.2 *Pursue opportunities to link Upper Columbia River Sturgeon recovery activities with other efforts (short to long term).*
- 1.3.3.6.3 *Implement regular recovery progress reporting to government, aboriginal communities, local agencies, communities, and the general public (short to long term).*
- 1.3.3.6.4 *Develop coordinated data and reporting systems to facilitate program implementation (short to long term).*
- 1.3.3.6.5 *Support regulatory mechanisms and planning processes to protect White Sturgeon and their habitats (short to long term).*
- 1.3.3.6.6 *Monitor sturgeon by-catch in the recreational fishery and develop angler awareness programs to reduce harm (short to long term).*

Education and Outreach Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
8.1	US & CAN	TWG and CWG coordination	1.3.3.6.1, 1.3.3.6.2	N/A	Ongoing	CWG & TWG	Yes
8.2	US & CAN	Maintain UCWSRI web site (uppercolumbiasturgeon.org)	1.3.3.6.1, 1.3.3.6.2	N/A	Ongoing	CWG & TWG	Partial
8.3	US & CAN	Develop a relational database management system that encompasses data collected by all of the UCWSRI partners. The database will include capture data from stock assessment surveys (setline, gill netting), early life history data (egg substrates, plankton netting, trawling), as well as aquaculture releases, broodstock spawning matrices, telemetry data (detections), and potentially other data, such as environmental conditions from monitoring or macro-invertebrate studies. It will have a web-based interface for data upload, query, and download, customized reporting tools, and tiered levels of access. It will also have a component that facilitate public access to some data, such as for school children to search for data related to the sturgeon they released at public release events. The database will be maintained/updated on an annual basis.	1.3.3.6.4	All	Database development 2013-2014	CCT, STI, and other UCWSRI partners	Yes

Education and Outreach Actions							
#	Area(s)	Description of Action(s)	Measure(s) Addressed	RFH(s) Addressed	Schedule	Entity(s)	Funded (Yes/No)
8.4	US & CAN	Develop a relational database management system that encompasses conservation Aquaculture data collected by all of the UCWSRI partners.	1.3.2.1 1.3.3.6.4	N/A	Database development TBD	CCT, STI, WDFW, FFSBC & other UCWSRI members	No
8.5	US & CAN	Maintain/update UCWSRI partner relational database on an annual basis.	1.3.3.6.4	All	2014-2017 annually	CCT, UCWSRI partners	Yes
8.6	US	Upload all U.S. white sturgeon capture data associated with a PIT tag to PTAGIS to improve data sharing with partners. This will also make the data on PIT tagged white sturgeon accessible to other researches in the Columbia Basin per BPA and the NPCC.	1.3.3.6.4	N/A	2013-2017, annually	CCT, STI	Yes?
8.7	CAN	Annual public white sturgeon release for school children/community	1.3.3.6.1	N/A	Annual 2013-2017	BCH, FortisBC	Yes
8.8	CAN & US	The CWG completed an UCWSRI communication plan in January 2013 that incorporates a situational analysis and prioritized outreach activities.	All	N/A	TBD	All	Partially

1.4 Operational Plan Update Record

Updates to this Operational Plan were completed on the following dates:

Date (Month/Year)	Operational Plan Sections Updated	Notes
April 1, 2014	First final version of Operational Plan completed at April 2014 UCWSRI-TWG meeting.	Final document distributed May 2014.

Citations

Hildebrand, L. R. and M. Parsley. 2013. Upper Columbia White Sturgeon Recovery Plan – 2012 Revision. Prepared for the Upper Columbia White Sturgeon Recovery Initiative. 129p. + 1 app. Available at: www.uppercolumbiasturgeon.org

McAdam, S. O. 2012. Diagnosing causes of white sturgeon (*Acipenser transmontanus*) recruitment failure and the importance of substrate condition to yolk sac larvae survival. PhD thesis. UBC. 189 pp.