Columbia River Project Water Use Plan

Physical Works Terms of Reference

COLUMBIA RIVER WHITE STURGEON MANAGEMENT PLAN

- CLBWORKS-25 Mid Columbia River White Sturgeon Conservation Aquaculture

April 4, 2008
TERMS OF REFERENCE FOR THE COLUMBIA RIVER PROJECT WATER USE PLAN

COLUMBIA RIVER WHITE STURGEON MANAGEMENT PLAN

1.0 OVERVIEW

This document presents Terms of Reference for the mid and lower Columbia River white sturgeon culture program being delivered under the Columbia River White Sturgeon Management Plan. This program will

This document provides detailed Terms of Reference for the following programs:

1) CLBWORKS-24 Mid Columbia River White Sturgeon Experimental Aquaculture: An experimental aquaculture program is required in the short term to provide juveniles for assessing impacts of flow treatment on sturgeon survival, and impacts of Arrow operations on juvenile habitat availability and suitability and juvenile survival.

2) CLBWORKS-25 Mid Columbia River White Sturgeon Conservation Aquaculture: In the longer term, a conservation aquaculture program is required to support the Arrow sturgeon population until such a time that stock abundance/age structure and habitat conditions can support a self-sustaining population and address residual impacts from providing lower than optimal spawning, incubation and rearing flows. If flow and stage conditions required to support a self-sustaining (or hatchery-supplemented) population are not economically feasible, a decision may be made to direct all or part of the conservation aquaculture effort to Kinbasket Reservoir.

3) CLBWORKS-26 Mid Columbia River White Sturgeon Upgrade Hatchery: Upgrades of the culture facilities at the Kootenay Hatchery in Wardner are required to support the experimental and conservation aquaculture program in the mid Columbia River.

4) CLBWORKS-34 Lower Columbia River White Sturgeon Conservation Aquaculture: Annual funding is required to support the ongoing sturgeon conservation culture program in the lower Columbia River, which is designed to provide fish for research purposes and provide artificial recruitment to the population.

Table 1  Columbia River White Sturgeon Management Plan Monitoring Program

<table>
<thead>
<tr>
<th>Name of Monitoring Program</th>
<th>Order Clause</th>
<th>Submitted with this Package</th>
<th>Previously Submitted To CWR</th>
<th>Submission Date</th>
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<tr>
<td>CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use</td>
<td>Schedule F: 1.a</td>
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<td>CLBMON-20 Mid Columbia River Spawning Habitat Assessment</td>
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<td>CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon</td>
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1.0 STUDY RATIONALE

This Terms of Reference (ToR) outlines the terms by which the Columbia Basin Water Use Plan (WUP) will provide annual support for the production of larval and sub-yearling juvenile white sturgeon for release into the middle Columbia River downstream of the Revelstoke Dam (REV). This ToR is submitted in response to the Order under the Water Act (File No. 76975-35/Columbia) issued by the Comptroller of Water Rights (CWR) on 26 January 2007.

Schedule F of the order includes the provision in lieu of operational constraints of the following:

“3b) conservation aquaculture to support the sturgeon population until such a time as stock abundance/age structure and habitat conditions can support a self-sustaining population.”

The order is based on the Consultative Committee (CC) report (BC Hydro 2005) which recognized several possible long term directions for the mid Columbia program including:

1. Initiate a conservation aquaculture program for development of an Arrow Lakes Reservoir failsafe population.
2. Develop a self-sustaining (in the long term) population in a Kinbasket Reservoir/upper Columbia River recovery area.
3. Initiate a conservation aquaculture program for development of a Kinbasket Reservoir failsafe (non-reproducing) population.

The CC recommended that the conservation aquaculture strategy for this program be robust enough to allow for the determination of whether or not wild production is possible and where recovery efforts would be best directed in either the mid Columbia or Kinbasket. The Mid Columbia White Sturgeon Conservation Aquaculture project will help support either population until conditions can support a self-sustaining population by addressing recruitment needs under conditions of less than optimal habitat and flows, and replacing juvenile production lost under these conditions.

The CC report supports the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI), Technical Working Group (TWG), (Spence 2004) which argued that “a conservation aquaculture program is required to: i) support the population until such time as stock abundance/age structure and habitat conditions (including spawning, incubation and rearing flows and reservoir levels) can support a self-sustaining population, and ii) address residual impacts from providing lower than optimal spawning, incubation and rearing flows.”
The Water License Requirements (WLR) program White Sturgeon Management Plan divides the operational delivery of aquaculture for the mid Columbia into two projects. CLBWORKS#24 Mid Columbia White Sturgeon Experimental Aquaculture provides for delivery during the first four years of the program (2008-2011). During this time, the focus will be on providing for larval and sub-yearling juvenile releases designed to assist with monitoring habitat selection and use, and early survival.

The Revelstoke Unit 5 (REV5) project is expected to become operational in late 2010, and starting in 2012 aquaculture production will be provided by CLBWORKS#25. The plan calls for the first of three staged reviews of the mid Columbia program in 2011 to determine if the re-establishment of a population will continue below REV (mid Columbia) or whether efforts will shift to upstream of Mica Dam (MCA) (Kinbasket reach). If the program continues in the mid Columbia, the focus is expected to shift to monitoring discharge and reservoir operational effects on habitat use, with operations including a minimum flow provision (5 kcfs) and testing of flow treatments designed to improve conditions for spawning and early life stage survival. Approaches upstream of MCA in the Kinbasket reach have still to be developed, but are expected to take a similar approach to that of the lower Columbia (development of an artificially recruited population, and assessment and restoration of suitable habitat to support a self-sustaining population). Under either scenario, various numbers of different life stages may be required for release, which will be provided by CLBWORKS#25.

The Water Act Order further indicates that Water License Requirement (WLR; the delivery team for WUP) support will include the “upgrade of existing (hatchery) facilities …” as required for delivery of this project. In the case of the mid Columbia, capital expenditures required to increase the productive capacity of the culture facilities and to modify the facilities to produce post-hatch and fed larvae are budgeted and delivered under CLBWORKS #26 – Mid Columbia Sturgeon Upgrade Hatchery.

1.1 Background

Canadian Columbia River populations of white sturgeon were listed as endangered under the Species at Risk Act (SARA) in 2006. Habitat for white sturgeon in the Canadian Columbia River has been hydrographically altered and fragmented by the construction of dams and reservoirs (Figure CLBWORKS-25 - 1). The population residing in Arrow Lakes Reservoir is currently estimated at approximately 50 individuals (Golder Associates Ltd. 2006), all older than the 1968 year-class. There are only anecdotal reports of sturgeon in the Kinbasket reservoir (upstream of MCA), and a limited survey to locate and estimate the abundance of these fish was unsuccessful (RL&L Environmental Services Ltd. 1996). Larval and juvenile sturgeon releases are proposed as a means of evaluating habitat use, movements and survival, and rebuilding the stock in both of these Columbia River reaches.

Recruitment failure was recognized as a problem for the Columbia River stock as early as 1994, and resulted in the establishment in 2001 of the UCWSRI. The initiative published a recovery plan in 2002 which provided direction for recruitment failure research, stock monitoring, and public awareness (UCWSRI 2002a). An integral part of the plan was the initiation of a conservation culture program designed to provide fish for research purposes and to begin to provide artificial recruitment to
the population. The program operates under the guidelines of a breeding plan (UCWSRI 2002b), and is delivered by the Freshwater Fisheries Society of British Columbia (FFSBC) out of the Kootenay Sturgeon Conservation Hatchery (KSCH) provided through their facilities in Wardner, B.C.

Figure CLBWORKS#25 – 1: Map showing white sturgeon distribution and relative abundance in the Columbia watershed in Canada. The mid Columbia reach is labeled as Arrow Lakes Reservoir, while the reach upstream of Mica Dam is labeled as Kinbasket Reservoir.
As part of the experimental flow treatment and aquaculture plan developed for the sturgeon population upstream of the Hugh L. Keenleyside (HLK) Dam, the Water Use Plan Consultative Committee (CC) recommended a 10-year work plan aimed at better understanding juvenile white sturgeon capabilities in the mid and upper Columbia River. The UCWSRI TWG was involved in the Water Use Plan process and contributed to the resulting mid Columbia sturgeon management plan. Following a review of the plan related to the environmental assessment of the REV5 project, the TWG submitted a modified plan and schedule for the mid Columbia (McAdam 2006). Included in the new plan was the ongoing production of juvenile sturgeon (larvae or sub-yearlings) for release following the installation of REV5 (2011). The production goals and location of releases (mid Columbia or Kinbasket reach) will be determined during the first of three scheduled program reviews set for 2011, 2014 and 2017. The conservation aquaculture project takes over where the experimental project ends and provides for larval and juvenile production and release requirements during 2012 to 2017.

Since the Columbia sturgeon culture program started, it has relied on various forms of support. Initially funded by BC Hydro and the province’s Habitat Conservation Trust fund, it is now funded by a combination of resources including major contributions from BC Hydro and the Fish and Wildlife Compensation Program – Columbia Basin (FWCP), and a number of other supporters including the FFSBC, grant foundations and other industrial sources. Reliability of full funding has not been assured. In order to provide for dependable financial resources for the maintenance of the culture program, the CC decided to include several levels of conservation culture program support in the Columbia River WUP sturgeon management program. The Water Use Plan divided the delivery of Mid Columbia sturgeon culture between various projects which are outlined in Table CLBWORKS-25 -1.

This ToR provides for the production and release of sub-yearling, post-hatch larvae and/or fed larvae in the Columbia River either downstream of Revelstoke Dam (to assess effects of flow treatments on juvenile survival) or upstream of Mica Dam (to re-establish a population and examine opportunities for habitat restoration). The CC recommended annual support for this program of $370,000 in 2004 dollars. This ToR provides for support for the culture program for period of 2012-2018.

1.2 Management Questions

The Mid Columbia River White Sturgeon Conservation Aquaculture program does not in itself answer any WUP management questions. Rather it provides juvenile sturgeon for release that are then monitored to answer questions regarding juvenile movements, habitat use, and annual survival either under different flow conditions (mid Columbia reach) or in a different habitat (Kinbasket reach).

1.3 Key Water Use Decision Affected

The key water use decision of this program is the continued and unaffected provision of juvenile sturgeon for stocking purposes to evaluate juvenile habitat preferences, survival rates and conditions, and movements. The releases will also contribute to the rebuilding of the mid Columbia or Kinbasket sub-populations.
Table CLBWORKS## -1: Columbia River Water Use Plan Breakdown for Mid Columbia and Kinbasket Reach White Sturgeon Culture Deliverables

<table>
<thead>
<tr>
<th>Task</th>
<th>Activities Description</th>
<th>Period Delivered</th>
<th>Project Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broodstock Acquisition</td>
<td>Preparation – bait collection, equipment preparation;</td>
<td>Preparation – Sept-Oct of the previous year, and</td>
<td>FFSBC contributions covered under CLBWORKS#34; all</td>
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<tr>
<td></td>
<td>Capture – Set-lining or angling; sampling and identification of broodstock; sonic</td>
<td>March-April of brood year; Capture – May-June of the</td>
<td>other expenses covered under CLBMON#28</td>
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<tr>
<td></td>
<td>tagging and marking as required;</td>
<td>brood year;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2008-2018</td>
<td></td>
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<tr>
<td>Broodstock Transport,</td>
<td>Transport and holding – between river and hatchery, stock maintenance, genetic</td>
<td>Transport and holding – May-July; Breeding – June-July;</td>
<td>CLBWORKS#34</td>
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<tr>
<td>Holding, Breeding and Release</td>
<td>assessment; Breeding – adult selection, maturation, breeding</td>
<td>Release – July-August;</td>
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<td>Release – following recovery, sonic tagging and marking as required</td>
<td>2008-2018</td>
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<td>Wild Egg Incubation and Larval</td>
<td>Collection of eggs from mats, canister incubation to release</td>
<td>July –September</td>
<td>CLBMON#23a</td>
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<td>Hatchery Incubation,</td>
<td>Incubation to hatch, rearing, marking/tagging and release</td>
<td>Incubation/hatch – July-August; First feeding and</td>
<td>CLBWORKS#24</td>
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<tr>
<td>Larval Development,</td>
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<td>larval release – August-Sept; Rearing and marking/</td>
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<td>Feeding/rearing,</td>
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<td>tagging – Sept-May; Release – May;</td>
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<td>Larval Development,</td>
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<td>Facilities Construction</td>
<td>Location and construction of facilities to incubate and first feed large numbers of</td>
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2.0 WHITE STURGEON CONSERVATION CULTURE PROPOSAL

2.1 Objectives

The objectives of the White Sturgeon Conservation Aquaculture program are outlined in Columbia River Water Use Plan documents (BC Hydro 2005) and in the TWG letter of support for the REV5 project (McAdam 2006). Current plans call for broodstock to provide families for these objectives to be collected from the lower Columbia River, although alternatives may be considered.

Objectives for this study include:
1. The successful incubation, rearing and annual release of healthy sub-yearling juveniles, or unfed or fed larvae in sufficient numbers and combinations to provide for studies and management plans for either the mid Columbia or Kinbasket reaches during 2012-2018.

2. The annual marking and tagging of all sub-yearling/yearling releases according to protocol, including scute removal to designate brood year, Passive Integrated Transponder (PIT) tagging, sonic nano-tagging and other tagging as may be required.

3. Annual participation in public awareness and educational activities including but not necessarily limited to release events, school events, public events, open houses workshops etc.

4. Provision of research, testing and pilot programs exploring techniques for improved efficiencies and an ability to provide for broader genetic diversity of released stock.

2.2 Approach

The Mid Columbia River White Sturgeon Conservation Aquaculture program will be provided by the FFSBC as the only entity within the province of BC which has the necessary expertise and facilities to provide government-sanctioned sturgeon culture facilities capable of the requirements of the breeding plan (UCWSRI 2002b).

The program will include all culture activities provided for by the FFSBC as well as the purchase of tags used in the normal operations of the programs (usually PIT or sonic nano-tags). It does not include experimental programs undertaken within the hatchery which are not part of the normal production of juvenile sturgeon for release under the WLR program, maintenance and provision of fish for experimental purposes outside of those programs supported through the WLR program, and public awareness activity costs beyond those delivered by the staff of the FFSBC and agreed to with the WLR program managers.

A detailed approach of the conservation aquaculture program will be developed following the review of the mid Columbia sturgeon plan scheduled for 2011. Modifications may include release targets, timing, fish sizes, and both release locations and locations of remote incubation and rearing facilities (see CLBWORKS #26 Mid Columbia Sturgeon Upgrade Hatchery). The UCWSRI TWG is expected to be a key advisory body during the review, and will assist the WLR sturgeon management program with decisions on the approach.

2.3 Methods

The exact methods to be used for the Mid Columbia White Sturgeon Conservation Aquaculture project will depend on the results of the management program review scheduled for 2011. The methods described here are general approaches to the culture of different life stages of white sturgeon for release and monitoring projects.
2.3.1 Task 1: Project Coordination

Project coordination involves the general administration and technical oversight of the program. This will include but not be limited to: 1) budget management, 2) staff selection, 3) logistics coordination, 4) technical oversight in field and analysis components, and 5) liaison with regulatory and other interested parties. This task will continue throughout the assessment.

Various permits will be required to conduct the conservation culture program. These include provincial Fish Collection permits, federal SARA research permits, and various approvals provided by the BC-Canada Fish Transplant Committee. The FFSBC will secure those permits/approvals necessary for the transport, handling, culture and release of white sturgeon caught in and release to the Columbia River. It is expected that sturgeon spawners for experimental aquaculture production will be collected from the lower Columbia River below HLK due to the limited number of adults found in the Arrow Lakes Reservoir and middle river. Fish Collection permits to allow the capture of adult spawners has been obtained in the past by BC Hydro and that process may or may not be followed in the foreseeable future dependant on the recommendations of the TWG.

A safety plan must be developed and submitted to the BC Hydro contact, for all aspects of the study in accordance with BC Hydro procedures and guidelines. Specific safety training may be required.

2.3.2 Task 2: Broodstock Acquisition, Spawning and Adult Release

Broodstock Acquisition

Annual broodstock acquisition and handling will follow the process outlined in CLBWORKS #34. At this time, it is not expected that additional spawners will be required to meet the objectives of the mid Columbia program, however if additional adults are required, the program will be modified to allow their acquisition within budgetary limits. The TWG will be consulted regarding the suitability of any changes to the approach.

The FFSBC will provide staff (on an as-required basis) to assist BC Hydro and the UCWSRI TWG with the capture and identification of mature, reproductively-suitable sturgeon. It is expected the broodstock will continue to be collected from the Columbia River downstream of HLK, but other options may be considered during the program review. Capture will be provided by the use of baited hooks either set by set line, or presented through active angling. FFSBC staff will ensure that sturgeon handling occurs in accordance with the UCWSRI white sturgeon capture, transport and handling manual (UCWSRI 2006), and that data collection from spawners meets the protocol provided by the initiative and regulators. Mature adults will be examined for reproductive condition, and if acceptable, will be transported to the Wardner facility for possible breeding. An annual spawner target of 10 females and 10 males has been established. Suitable holding and transport facilities (which allow for acceptable temperature, oxygen and gas saturation conditions) will be provided to move spawners from the river to the KSCH in a safe and timely fashion.
Broodstock Holding and Breeding

Families selected for annual release may involve specific crosses in an effort to align adaptive responses with habitat conditions. Breeding directions will be provided by the TWG to meet this requirement. As a result, the capture history of spawners must be tracked and crosses matched, where possible.

Upon arrival at the hatchery, the adult sturgeon will be placed in fiberglass maturation tanks, and monitored for health, disease and reproductive status. Adults will be fed live trout during the period they are held for breeding purposes. Gonads and gametes will be examined surgically for degree of maturation. The timing of breeding potential will be tracked using tools such as egg stage PI (Polarization Index) and GVBD (germinal vesicle breakdown) factor. Females will be induced to spawn through injections of the hormone LHRHa; males will be encouraged to release milt through temperature manipulation and LHRHa injections.

When gametes are observed to be ready for reproduction, sufficient eggs to provide for targeted juvenile numbers will be withdrawn from the female using manual expression or extraction using a modified cesarean section. Milt will be extracted from males through a combination of abdominal massage and collection through a tube into a large syringe. Surgical extraction is not normally used on males, and adults of both sexes will not be sacrificed for breeding purposes. For fertilization, excess coelomic fluid is decanted from the eggs (coelomic fluid impacts sturgeon sperm motility) and a diluted milt solution added to the eggs. The mixture is gently and slowly stirred by hand or using a feather; mixing continues until the first few sticky eggs are observed (usually 2 minutes). Excess fluid is again poured off, and a de-adhesion process (using a prepared Fullers earth solution) is initiated to prevent the fertilized eggs from clumping. The de-adhesion process continues until all of the eggs have lost their stickiness (usually 1 hour). Total spawned egg numbers are then estimated volumetrically using counts of 3 sub-sampled aliquots of eggs.

The TWG is expected to regularly review the breeding plan which may dictate changes to family crosses, and decisions regarding selection of families for release based on expected adaptive fitness.

Broodstock Release

Once an adult has been bred, which can occur several times for males, they are held for roughly 3 days until it is safe to return them to the capture location for release. Adults will each be tagged with a PIT tag and may be additionally tagged with radio or sonic tags and marked with scute removal in order to track movement or assist with future identification. Adults will be weighed and measured prior to release, checked for condition, marks and tags, and sub-sampled for fin ray age. Broodstock used for larval releases will also be sampled and analyzed for genetic information, to allow for future identification of recaptured progeny. The same holding and transport facilities will be used to carry them back to the river, where they will be released to the Columbia River as near as possible to the capture area.

2.3.3 Task 3: Incubation and Larval Development

Incubation
Fertilized eggs will be placed in Modified MacDonald Jars (“upwellers”) for incubation with water outflow from the jars directed to aluminum free-embryo troughs segregated by family or subfamily. FFSBC staff will ensure adequate flow to maintain egg separation and oxygenation, while guarding against egg loss from the jars as they become more buoyant during development. Dead eggs will be removed at intervals to control the development of fungal infestations. Egg condition and numbers will be monitored to ensure adequate numbers are available to meet targeted juvenile release goals.

**Larval Development**

As the eggs hatch, embryos move vertically passing over the lip of the jars with water outflow to the collection troughs. Free embryo numbers per family or subfamily are estimated through inventory of the un-hatched eggs. For the first 10-15 days, the larvae consume their yolk reserves and continue to develop body parts and organs. As they develop and settle, they shift to exogenous feeding. Originally fed a semi-moist artificial food, they can also be assisted to start exogenous feeding with natural foods. Throughout the embryo development stage, dead embryos and larvae will be removed regularly to control disease.

### 2.3.4 Task 4: Larval and Juvenile Rearing and Marking

Early larvae for annual sub-yearling releases will continue to be reared in troughs, until they reach about 45 days of age when they are transferred to circular, self-cleaning fiberglass tanks. Larvae for fed larval releases below Revelstoke will be transferred as eggs collected at the KSCH facility, disinfected and then shipped to the facility in Revelstoke. Once hatched, these larvae will be reared in a separate facility consisting of sufficient small circular fiberglass tanks to support the necessary numbers of larvae.

Food is at first introduced to larvae in small quantities to familiarize them with the scent of the food being used, and to allow observations of the start of ingestion. Precautions must be taken to remove excess food and maintain good water quality during the initiation of feeding. Bacterial growth under early feeding conditions can contribute to larval mortality. Feeding is conducted more frequently and at lower rates early in rearing; once the juveniles grow large enough to handle artificial pellets, feeding rates and frequencies can be modified.

Larvae to be released will be volumetrically sub-sampled for numbers, size and growth, and examined for disease or deformity, just prior to release. For juveniles reared for release as sub-yearlings, sub-sampling will take place at regular intervals to track survival, growth and condition. Once juvenile mortality rates appear under control and as tank biomass begins to limit rearing efficiencies, attention will be directed to decisions of culling. Ultimately the UCWSRI TWG will make decisions of stocking densities by family or subfamily, and culling should be designed to meet these targets. Culling should be conducted in such a way as to limit un-intentional selective pressure.

Larval releases will be identified on juvenile recapture using DNA markers in lieu of physical marks or tags. To provide for this analysis, tissue samples will be collected.
from the spawners and a genetic analysis will be completed to be used to identify unmarked juveniles upon recapture.

All sub-yearling juveniles to be annually released must be marked with scute removal according to a marking system (UCWSRI 2002b), and PIT tagged. Selected larger juveniles (up to 50) may be tagged with sonic nanotags to allow monitoring of movements, habitat use and survival.

2.3.5 Task 5: Juvenile Release

The FFSBC will provide for suitable transport (which allows for acceptable temperature, and dissolved oxygen conditions) for juvenile release in a safe and timely fashion. It should be noted that developing sturgeon larval mortality associated with gas supersaturation has been observed and should be considered for transport (Shrimpton et al. 1993). The exact approach (numbers, location and timing) of releases will be provided by the TWG and described under a release plan, currently being developed.

Larvae will be released in the late summer or fall depending on whether or not they have been transferred to feed. Sub-yearling sturgeon are usually released in the spring of the year at an average size of 15 cm and at an average weight of 30–40 g (at up to 50 g). Alternatively, they may be released later (if additional growth is required for nano-tagging, 50+ g) or in the fall (if seasonal release experiments are incorporated into the study design). Juvenile releases should consider the hydrograph (if located downstream of a hydro-facility) and release sites and times selected to minimize the likelihood of stranding. If necessary, FFSBC will provide acclimation services at the release sites to address concerns with stranding. In addition, staff must be available to assist with public awareness and educational activities during the release events.

2.3.6 Task 6: Miscellaneous Projects

During the course of the program, it may be necessary to undertake studies to develop techniques for improved culture efficiencies or to provide for greater genetic diversity among juvenile releases. These projects may be requested by BC Hydro in consultation with the UCWSRI TWG or may be identified and recommended by the FFSBC and approved by WLR management staff. Activities will depend on the remaining availability of resources.

2.3.7 Task 7: Public Awareness

FFSBC staff are expected to be involved in public awareness events as requested by BC Hydro or the UCWSRI to a similar level considered in the current budget. Such events will include annual juvenile releases by school children and public, and may include various open houses, displays, and educational or environmental gatherings. Consideration will be given to availability of FFSBC staff and remaining budgetary resources.
2.4 Interpretation of Results and Reporting

The FFSBC will ensure all required data are collected from adult sturgeon and their progeny as directed by the UCWSRI, and that data records are fully maintained (e.g. data forms listed in UCWSRI 2006). Quarterly data reports will be required prior to quarterly invoice payments. The content in these reports is tentatively listed below:

1. August 31 – broodstock capture, holding and breeding (including genetic assessment); incubation results; and post-hatch unfed larval release information
2. December 31 – early rearing, and fall juvenile and fed larval release information, plus calendar year expenditures and proposed budget for the upcoming year
3. March 31 – winter rearing, marking and tagging of spring releases
4. May 31- spring sub-yearling rearing and release information

An annual report is required following the spring release for the brood year. The annual report will include a full description of the methods used during the year, a summary of the records provided in the quarterly reports, incidents or levels of harm and mortality observed during the year among adults and young, and recommendations for changes in methods for the upcoming year. Additional analyses may be required by the UCWSRI TWG.

Reports will follow the standard format that is being developed for WUP monitoring programs. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided either as embedded objects in the Word file or as separate files.

2.5 Schedule

The sturgeon conservation aquaculture program is a year-round process. In the case of white sturgeon, it follows the life cycle of the fish, beginning each year with broodstock acquisition in May-June, and ending with larval releases in August-September and of sub-yearling juveniles in November or May.

In terms of the schedule of the Mid Columbia White Sturgeon Conservation Aquaculture program, the following milestones comprise an annual schedule:

i) Submission of expenditure records for the previous calendar year,
ii) Agreement and signoff of the plan for the year before the end of March
iii) Broodstock acquisition preparations during March-April (collection of spawning kokanee for bait usually occurs the previous fall),
iv) Broodstock acquisition during May-July,
v) Spawning of families and subfamilies during June-July,
vi) Incubation and larval collection during July-August,
vii) Release of spawned adults back to the lower Columbia River in June-August,
viii) Release of larvae in August-September,
ix) Juvenile rearing during September to May,
x) Scute marking and PIT and sonic nano-tagging in October or March,
xii) Continuous data collection and analyses once the broodstock are in the
    hatchery until the last juveniles are released,
xiii) Quarterly status reports provided in advance of quarterly payments (end of
    May, August, December and March), and
xiv) An annual report submitted following the last juvenile releases to encompass
    all data by the end of May.

2.6 Budget

The estimated budget to provide Mid Columbia White Sturgeon Conservation
Aquaculture provisions is $370,000 annually (in 2004 dollars) for the period 2012 to
2018.

It is recognized that some components of the hatchery operations are outside the
control of managers and may increase support requirements (e.g. propane costs for
heating). It is assumed that these increasing costs will be cover by the usual WLR
rates of a 2% annual inflation rate applied since 2004, and a 5% contingency.

The average cost over the 6 years of the program is estimated at $439,491. FFSBC
will be expected to develop a budget following the management plan review and prior
to project implementation in 2011. Funds will be provided to the FFSBC through a
contribution agreement that ensures the conditions and schedules described in the
ToR are met. Recommended milestone activities and proportional payments are
identified below (Table CLBWORKS-25-2).

Table CLBWORKS#25 – 2: Recommended FFSBC-BCH Contribution Agreement Annual Milestone
Activities and Proportional Payments by Brood Year

<table>
<thead>
<tr>
<th>Date</th>
<th>Activities</th>
<th>Percentage of Contract</th>
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| August 31  | Broodstock acquisition, transport (both directions), holding, feeding, treatment,
genetic sampling/parentage assessment, breeding (family crosses), release of adults; incubation, hatch, larval handling, survival monitoring, unfed larval releases; first feeding, early culling. | 30                     |
| December 31| 4.0 months of juvenile rearing, fed larval releases, tagging and marking of any fall release fish, sub-yearling juvenile fall releases | 30                     |
| March 31   | 3.0 months of juvenile rearing, tagging and marking of spring release fish; public awareness and educational involvement; research or testing of techniques to improve culture efficiency and genetic contribution | 20                     |
| May 31     | Final 1.5 months of juvenile culture; sub-yearling juvenile spring releases | 20                     |

Costs for the partial calendar year 2018 are required to capture the end of the 2017 brood
year, which runs from broodstock captured in June 2017 through to sub-yearling releases in May 2018.
3.0 REFERENCES

Order under the Water Act (File No. 76975-35/Columbia) under the Water Act, received by BC Hydro on 31 January 2007


McAdam, S. 2006. Revelstoke Unit 5 Operation and the Water Use Plan Mid Columbia White Sturgeon 10 year Monitoring Plan. Letter from Mr. S. McAdam, Co-Chair, Technical Working Group, Upper Columbia White Sturgeon Recovery Initiative to Mr. Dan Ohlsen, Revelstoke Unit 5 Core Committee, and Ms. Pat Vonk, BC Hydro Water License Requirements. October 26, 2006. 3 p. + 1 table


