Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

COLUMBIA RIVER WHITE STURGEON
MANAGEMENT PLAN

- CLBWORKS-28 Lower Columbia River – Planning and Assessment of White Sturgeon Physical Works

March 23, 2010
1.0 MONITORING PROGRAM RATIONALE

During the Columbia River Water Use Plan (CRWUP) process, the Consultative Committee (CC) agreed that a key focus of fish management in the Columbia River mainstem should be on white sturgeon (*Acipenser transmontanus*). White sturgeon in the Canadian portion of the Columbia River, were listed as endangered under Canada’s Species at Risk Act (SARA) in 2006. This listing also includes populations of white sturgeon from the Nechako, Kootenay, and Fraser rivers. The listing for the Columbia River population is directed primarily at those sturgeon found between the Canada-US border and Revelstoke Dam (REV). There are estimated to be approximately 1200 mature sturgeon in this area with the majority found downstream of Hugh L. Keenleyside Dam (HLK) (Irvine et al. 2007; Wood et al. 2007).

The major concern to date with respect to white sturgeon in the Columbia River is that the level of natural recruitment is insufficient to maintain self-sustaining populations. Although existing adult white sturgeon have successfully spawned in multiple river locations (Pend d’Oreille and Columbia River Confluence: Golder 2008a; Revelstoke: Golder 2008b), insufficient young are surviving through the early life stages (eggs, larvae, and juveniles) to become sexually mature adults. The exact causes of recruitment failure among sturgeon found in the lower Columbia River reach remain uncertain. However, it is generally agreed that hydroelectric dam construction and operation have had an impact in several key areas including, but not limited to, access to habitats, movements, and flows related effects. White sturgeon habitat in the Columbia River has changed substantially since the building of the Canadian Columbia River Treaty dams starting in 1968. Collectively, the operation of dams and power plants for power and flood control on the Columbia River have substantially reduced spring and early summer river flows during sturgeon spawning and incubation periods and increased winter flows and the range of daily water level fluctuations. A logical recovery response would therefore be to alter the hydrograph in the lower Columbia reach to mimic the natural flow regime as much as possible, especially during spawning and early life stage periods. The Columbia River, Water Use Plan (CRWUP 2005) Consultative Committee (CC) considered such a mitigative response, but concluded that anything more than opportunistic operational changes faced significant practical and financial impediments.

The CC asked BC Hydro to explore alternatives to operational changes, and the resulting options focused on limited flow modifications in conjunction with turbidity supplementation (Hildebrand et al. 2003). The turbidity supplementation component of the plan involved the addition of bentonite clays upstream of the Waneta spawning site during the spawning period when flows at the border were below 90 kcfs. The objective was to achieve an increase in turbidity greater than 10 NTUs. The report recognized legal and regulatory issues associated with the addition of suspended sediments, involving conflicts with legislative standards on both sides of the border. It also spoke to issues with public perceptions and methodological limitations, including the ability of existing programs to detect age 1+ juvenile responses to treatments. Despite continued uncertainty regarding the exact cause(s) of recruitment failure, based on this report, the CC recommended a turbidity augmentation program be
initiated in lieu of operational changes. The CC recommendation was conditional on the results of a feasibility study which would combine the development of a plan to deliver the agent and monitor the results, and to explore regulatory concerns around the introduction of turbidity agents to the river and related fisheries and ecosystem issues. That recommendation was captured in the Columbia River WUP as CLBWORKS 28, Lower Columbia River – Planning and Assessment of White Sturgeon Turbidity Experiments.

As an initial response to the uncertainty regarding the cause(s) of recruitment failure the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) Technical Working Group (TWG) underwent a recruitment failure hypotheses review between 2006 and 2008 (Gregory and Long 2008). The purpose of the review was to reach consensus on those hypotheses which best explained white sturgeon recruitment declines in the Columbia system, to identify research required to better define the pathways of impact, and to define mitigative measures or management responses with the best likelihood of alleviating the causes of recruitment loss. The process considered impacts including flow regime effects and the benefits of cover provided by the suspended sediment load in the Columbia at spawning sites. The process identified the following hypotheses along with related potential mitigative measures:

a) Changes in flow patterns (magnitude and timing) and reduction in turbidity reduce the survival of early life stages.
   i) Turbidity augmentation
   ii) Flow manipulation – depth and velocity
   iii) Backwater habitat influence manipulation

b) Diminished suitability and availability of habitat (primarily related to substrate conditions) near spawning areas has led to reduced survival of early life stages.
   i) Substrate modification – cleaning
   ii) Substrate modification – addition

c) Changes to fish community has resulted in increased predation on eggs, free embryos, larvae and juvenile sturgeon and significantly reduced survival.
   i) Predation control program – general
   ii) Walleye reduction program

d) Food of the appropriate type and size is not available at the right time and place to promote survival of young sturgeon.
   i) Fertilize transboundary reach
   ii) Seeding of varial zones
   iii) Embayment fertilization

Furthermore, discussions of research needs during the hypothesis review focused on the benefits of studies that would address information gaps through the reconstruction of historic data. This would include stock structure analysis and impact timelines for each hypothesis. Therefore, the need for historic reconstruction is critical to help in guiding mitigative actions.

Since the initial CC report’s recommendation was primarily targeted at turbidity augmentation in the lower Columbia River and more recent work has identified multiple competing hypotheses, it is recommended that CLBWORKS 28 [Lower Columbia River – Planning and Assessment of White Sturgeon Turbidity Experiments] be modified to incorporate up to date information. This will include examining the feasibility of physical works that are developed to test hypotheses that could address recruitment failure in the lower Columbia River.
1.1 Management Questions

Key management uncertainties encountered during development of the Columbia River Water Use Plan included how the operations of HLK Dam may adversely affect spawning habitat suitability for adult sturgeon, spawning incidence and success, juvenile survival, and ultimately, recruitment of white sturgeon in the lower Columbia River. Discussions regarding possible mitigative actions were limited due to the lack of available information. The fundamental management questions to be addressed through this feasibility of white sturgeon physical works are as follows:

1) Which white sturgeon recruitment failure hypotheses, based on historical recruitment analysis, are the most critical to decide on physical works?

2) Based on evaluations carried out to address the first management question, what physical works have the highest probability of improving conditions for natural white sturgeon recruitment in the lower Columbia River?

3) What programs can be undertaken to develop mitigative physical works to address white sturgeon recruitment in the lower Columbia River, including monitoring their effectiveness?

1.2 Management Hypotheses

This study is not designed to test specific hypotheses regarding white sturgeon recruitment failure in the Columbia River but rather rank currently proposed hypotheses and examine their feasibility in developing mitigative actions. This feasibility study uses an analytical approach to rank recruitment failure hypotheses based on currently available data that will help guide mitigative actions. Recruitment failure hypotheses are summarized in Gregory and Long (2008), which describes the outcomes of an exercise undertaken by the TWG. This study is designed to provide information in the form of historical recruitment analysis that will make use of existing biological and physical data. These timelines will aid in ranking hypotheses and developing associated response measures related to high ranking hypotheses. Further to the impact timelines, work will also involve review of literature, interviews with those with the expertise to provide new input, and interpretation of resulting information and results from ongoing monitoring programs. The study is expected to inform the development of CLBWORKS #27, a program that will implement several mitigative options for white sturgeon recovery in the lower Columbia River.

1.3 Key Water Use Decisions

Information gained through this feasibility program, when considered with baseline information acquired through other lower Columbia River sturgeon monitoring programs, may be used to 1) develop historic impact pathways that will highlight important areas of uncertainty and will influence the ranking of recruitment failure hypotheses, 2) highlight important recruitment failure hypotheses through a ranking process that will serve to inform both mitigative options and future study needs, and 3) develop new, or modify, proposed physical works aimed at addressing recruitment failure of white sturgeon in the Columbia River. Furthermore, information obtained from this program will help inform other ongoing white sturgeon monitoring work in the lower Columbia River.
2.0 MONITORING PROGRAM PROPOSAL

2.1 Objectives and Scope

The primary objectives of this feasibility program are to:

a) Develop and integrate findings of reconstructed recruitment timelines with reconstructed impact timelines using currently available biological and physical data.

b) Rank hypotheses for those most likely to be causes of recruitment failure using information from objective analysis and the primary literature;

c) Rank response measures for those recruitment failure hypotheses that are most likely to be causes of recruitment failure and that are most likely to be mitigable;

d) Select high ranking recruitment failure hypotheses and potential responses (mitigation strategies) within each of the highly ranked hypothesis that could guide physical works in the lower Columbia River; and

e) Develop plans, timelines and costs required for programs associated with the recommended physical works.

This study is intended to provide the necessary information for assessing the feasibility of various physical works that can be implemented in the lower Columbia River.

2.2 Approach

The TWG undertook a review of recruitment failure hypotheses for Columbia River white sturgeon and determined that the most probable causes of failure in the lower river were a lack of:

a) spawning conditions (with suitable depth, velocity, substrate, temperature and potentially turbidity),

b) free-embryo hiding habitat, where predators can be avoided (similar parameter types as required for spawning),

c) larval habitat (similar parameters to above, but including suitable types and abundance of prey), and

d) juvenile rearing habitat (similar parameters to above).

The basic approach of this project is to develop physical works that can be implemented as mitigative actions focused on recruitment failure for white sturgeon in the lower Columbia River. This work will follow a staged process with the overall approach to build upon the recruitment failure hypothesis review completed by the Upper Columbia White Sturgeon Technical Working Group and summarized in Gregory and Long (2008) as a basis for decisions on appropriate response measures that would drive the development of physical works. The first stage of the approach will entail reconstructing historic impact timelines using a historic recruitment analysis that will incorporate currently available biological (e.g., fish ages) and physical data (e.g., water temperature, turbidity, etc.). This approach will follow the guidelines outlined in Task 3. The historic recruitment analysis work will be used to guide an initial comparison and ranking process to identify recruitment failure hypotheses that were most likely responsible for historic declines or periodic pulses in recruitment prior to 1985. Following this initial ranking process, restorative physical works options potentially available for high ranking hypotheses will be identified, evaluated, and
described in detail. This will include a secondary ranking process that will address high ranking hypotheses from the first stage in terms of their feasibility for mitigation. Finally, for recruitment failure hypothesis that are highly ranked based on the analytical and feasibility approaches, experimental designs will be developed for response measures within each of these hypotheses. The final technical report for the second stage of this work (Tasks 4 and 5 below) will include recommendations on pilot physical works projects that could be undertaken in the lower Columbia River.

2.3 Methods

2.3.1 Task 1: Project Planning and Coordination

Project coordination will involve the general administrative and technical oversight of the monitoring program. This will include, but not be limited to:

1) budget management,
2) staff selection,
3) logistic coordination,
4) technical oversight in the field and analysis components of the project, and
5) liaison with BCH, regulators and First Nations groups.

A safety plan must be developed and submitted to the BC Hydro Monitor contact for all aspects of the study that involve travel or fieldwork. This plan must be in accordance BC Hydro procedures and guidelines.

2.3.2 Task 2: Study Design

The overall design for this feasibility program is a three stage process that includes development of historic timelines and recruitment failure hypothesis ranking, an evaluation of which physical works will improve conditions in the lower Columbia River, and finally the development of physical works and associated response measures. A general approach is provided below for each of these areas.

2.3.3 Task 3: Ranking Step 1: Historic Recruitment Analysis

This project component consists of evaluating historic white sturgeon recruitment patterns and comparing them with available and reconstructed patterns for environmental variables. A similar approach has been used successfully for the Nechako white sturgeon population (McAdam et al. 2005) who examined back-calculated recruitment patterns in comparison to historic flow and sediment data. McAdam et al. (2005) demonstrated that altered riverbed sediments in response to higher flows and sediment input had a significant impact on white sturgeon recruitment due changes or loss in critical habitat. A similar approach will be taken for the Columbia white sturgeon population; however, this population requires a more complex analysis based upon current biological information. Evaluation of historic recruitment patterns will consider both a single homogeneous population as well as population subgroups identifiable by movement patterns (capture and telemetry). A key element of this analysis is the evaluation of potential differences in historic recruitment trajectories of different population subgroups, since lags in the recruitment response may be related to physical features or variables unique to a given section of river. As such, rigorous analysis will be required to ensure that any identified differences are accurate.
Comparison with historic environmental changes is challenging in the Columbia River due to high variability in the data available for use in the analysis. For example, there is good information (e.g., daily) on flow but little to no historic information on variables such as food availability, water quality, historic substrate condition, and changes in fish composition. Comparison across environmental variables based on historic data will only be developed for a limited set of environmental variables (e.g., flow, temperature, turbidity). Additionally hypotheses will be evaluated based on reconstructed timelines which conform to their affect pattern. This could specifically include the expected timing of the response (year), whether the environmental change may lead to a time lagged response, and whether the expected recruitment response would be rapid or slow. For example, fish passage limitations would be expected to occur rapidly without a time lag, and be initiated at the same time as dam construction occurred. Alternatively, changes to the fish community (e.g., species composition) would be expected to create a slower response and might be initiated at the time that an exotic species was introduced and/or significant habitat shifts occurred. This may result in temporal differences in effect depending on factors such as the site of origin of a fish introduction.

Comparison of the historic recruitment analysis and reconstructed patterns for environmental variables will then be used as the basis to compare and rank the different recruitment failure hypotheses to identify which factors likely caused observed patterns of historic recruitment failure. Outcomes from this ranking process will directly support items in Task 4.

The outcomes from Task 3 will set the stage for subsequent tasks in identifying physical works that could be implemented in the lower Columbia River. As such, it is critical that the methods and results are held to high scientific rigor and be subject to a peer review process by a panel of experts prior to finalization and incorporation into Task 4. This panel could include individuals from the technical working group, scientists outside of the Columbia white sturgeon working groups, agency representatives, and First Nations.

**Task 4: Ranking Step 2: Feasibility of Mitigation Options**

Since the feasibility of mitigation will vary between different contributors to recruitment failure, a second ranking exercise also consider both high ranking causes and the feasibility of restoration measures. This ranking process will build upon the recruitment failure hypothesis review completed by the Upper Columbia White Sturgeon Technical Working Group (TWG) and summarized in Gregory and Long (2008) as a basis for decisions on appropriate response measures that would drive the development of physical works. This ranking step will address those hypotheses that are ranked highly in the outcomes of task 3. Hypotheses should be ranked for those that are most likely to be successful (based on all available information) and result in a change that can be biologically detected through ongoing monitoring programs (e.g., CLBMON 28 – Lower Columbia adult white sturgeon monitoring). Ranking results from the historic impact timeline analysis will aid in the ranking process by providing currently absent information on the hypotheses that are most likely to be causing recruitment failure in Columbia River white sturgeon. The first step in the process will likely involve a review of the Recruitment Failure Hypothesis Review (RFHR) undertaken by the TWG. A literature review should also be completed identifying past and current studies that support/disprove the various hypotheses in the RFHR and add knowledge to both the ranking process and the subsequent evaluation of physical works. The hypothesis ranking process can be
developed using several approaches but should be as independent and objective as possible. This process should include an interview of experts either with demonstrated white sturgeon experience or those with expertise in related species recovery methods. The information from the literature review should be incorporated to ensure that the best available scientific knowledge is used to determine the probability of success for the various recruitment failure hypotheses. Outcomes from both the interviews and the literature review should be used to develop response measures for each high ranking hypothesis, and possibly multiple response measures for certain hypotheses.

2.3.4 Task 5: Development and Assessment of lower Columbia Physical Works
Following the ranking of hypothesis and associated response measures, physical works will need to be developed. A physical work is a change/ alteration/ reconstruction of a new or existing feature in a system where operational changes are not possible due to constraints. Physical works will need to be developed for top ranking response measures from Task 4. This may include only the highest ranked hypothesis, the top competing hypotheses, or a selection of hypotheses based on logical breaks in ranking scores from Task 4. The number of potential physical works that will be developed will depend on the outcomes from Tasks 3 and 4. Consultation with the BC Hydro technical representative and project partners will be conducted prior to the development of physical works. The following information should be developed and assessed for each response measure:

- Rationale and supporting information including legal, environmental, and regulatory considerations
- Timeline for work (annually, biological windows, monitoring etc)
- Approach
- Experimental design
- Cost estimates

The outcome will be to formalize a report recommending physical works outlining all the details needed to implement and guide the projects.

2.3.5 Task 6: Data Analysis and Reporting
Project reporting will consist of two technical reports. The first will focus on the development and outcomes of the historic recruitment analysis and the ranking of hypotheses. The second will focus on the evaluation of physical works and required information needs. Progress reports will be provided for preliminary work on a monthly basis, and include any preliminary results collected to date.

The final technical reports should include:
1) an executive summary,
2) a description of methods,
3) a results section including all data analyses,
4) a discussion section that will include
   a) a summary of findings, especially as they relate to key management questions,
   b) a comparison to data on other sturgeon populations,
5) recommendations for future physical works (to only be included in the second technical report).

Decisions on next steps will follow consultation with the regulatory agencies and TWG.

Reports will follow the standard format that is being developed for WUP programs. Draft versions of reports should be submitted in Microsoft Word for ease of editing. Final 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. All data should be provided in electronic format.

2.4 Interpretation of Program Results

The results of this study will provide information on the feasibility of various physical works that can be initiated in the lower Columbia River to address recruitment failure in white sturgeon.

2.5 Schedule

This study is scheduled to occur over one year (2010). It is expected that this work will be initiated in March 2010 under a Contribution Agreement with the Ministry of Environment. The Contribution Agreement will be directed at reconstructing the historical impact timelines, which will need to be completed first as it will inform the subsequent hypothesis ranking exercise and the development of physical works target at the response measures under the various recruitment failure hypotheses. A RFP for these latter tasks will be issued in the summer of 2010 following the development of historic impact timelines.

The schedule for work will be generally as follows:

1) March -June 2010: Development of historic impact timelines
2) June 2010: Preliminary findings report from the timeline work to be submitted
3) June – October 2010: Ranking of main hypotheses and development of physical works and associated experimental designs.
4) September 30, 2010: Draft final report for the timeline work
5) November 15, 2010: Draft final report for the evaluation and development of physical works
6) November 31, 2010: Final report for the timeline work
7) December 31, 2010: Final report for the evaluation and development of physical works

2.6 Budget

The total budget for this feasibility program is estimated at $149,215.96 (including 2 per cent rate of inflation and 5 per cent contingency).
3.0 REFERENCES


