Columbia River Project Water Use Plan Monitoring Program Terms of Reference

COLUMBIA RIVER WHITE STURGEON MANAGEMENT PLAN

- CLBMON-29 Lower Columbia River Juvenile Sturgeon Detection Program

May 16, 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 provide detailed Terms of Reference for the following programs:

CLBMON-29 A 12-year monitoring program designed to describe life history aspects of juvenile white sturgeon, as well as provide input to the ongoing consideration of recruitment failure hypotheses, the evaluation of the effects of future management responses, and information to guide conservation culture stocking targets.

Table 1: Columbia River White Sturgeon Management Plan Monitoring Program Terms of Reference Submission Information

<table>
<thead>
<tr>
<th>Name of Monitoring Program</th>
<th>Order Clause Fulfilled</th>
<th>Submitted with this Package</th>
<th>Previously Submitted To CWR</th>
<th>Submission Date</th>
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Monitoring Study No. CLBMON-29
Lower Columbia Juvenile Sturgeon Detection Program

1.0 MONITORING PROGRAM RATIONALE

The lower Columbia River white sturgeon (*Acipenser transmontanus*) in Canada was listed as one of four endangered populations under the Species at Risk Act (SARA) in 2006. The lower Columbia River is defined here as being that reach of the Columbia River downstream of Hugh L. Keenleyside Dam (HLK). This reach supports within wide confidence intervals, an estimated 948 adult sturgeon and another 2,003 sturgeon are estimated to reside between the border and Grand Coulee Dam (Wood et al. 2007). Despite some evidence of limited natural recruitment in this river reach, the number is considered insufficient to maintain a self-sustaining population. The population of white sturgeon was forecast by the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) to become functionally extinct by 2044 in the absence of effective recovery measures (UCWSRI 2002).

The Columbia River Water Use Plan (WUP) recommended giving priority to conservation and recovery of white sturgeon (Consultative Committee (CC) 2004). However, in recognition of its high value power generation, the Columbia River was designated to remain a working river. Direct management responses then must be limited to non-operational habitat improvements designed to improve spawning success and juvenile survival. In order to meet this goal, data are required to assess habitat use and suitability/availability for both wild and introduced juvenile sturgeon found in the river and Lake Roosevelt reservoir downstream (Figure CLBMON-29-1). Included in the dataset should be life history measures which are indicative of habitat quality including abundance and growth, development and condition, evidence of food availability and survival rates.

The CC report described this juvenile sturgeon program as providing “annual monitoring (of) the relative abundance and distribution of juvenile sturgeon in the lower Columbia River” (CC 2004). The rationale indicated monitoring was to “provide information on the patterns of habitat use of juvenile sturgeon to better understand potential cause(s) of recruitment failure and (opportunities for) feasible mitigative actions” (CC 2004). The rationale assumed that, with the release of hatchery supplemented juvenile sturgeon into the system, the probable bottleneck(s) affecting juvenile sturgeon survival could be identified and non-operational changes identified, which when implemented could result in natural recruitment of age 1+ sturgeon.

The B.C. Comptroller of Water Rights (CWR) issued a Water License Order directing operations of BC Hydro’s projects on the Columbia River (Mattison 2007). The Order, Schedule F(1)(h), specifies that this juvenile detection program shall “monitor the abundance, distribution and patterns of habitat use of juvenile white sturgeon in the lower Columbia River in relationship to discharges from Hugh L. Keenleyside Dam (HLK).” This Terms of Reference is designed to provide the necessary support for the WUP goals and Water License Order.
Figure CLBMON-29-1: Vicinity map illustrating the lower Columbia Reach downstream of the Hugh L. Keenleyside Dam to the upper Lake Roosevelt reservoir and areas of known juvenile sturgeon rearing (provided courtesy of Golder Associates Ltd.).
1.1 Background

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 installation and operations are implicated. Assessing the potential effects of water management in the lower Columbia River is complicated by the cumulative nature of operations on known spawning sites and related free embryo habitat. These sites are affected by the operations of HLK, as well as of dams on the Kootenay and Pend d’Oreille rivers. Besides affecting access to upstream habitat, the facilities on these systems have altered the hydrograph such that freshet pattern is altered and reduced, and winter flows are increased. Load shaping by facilities can also impact the diel shape of the hydrograph during the falling limb of the freshet, and drawdown operations of Lake Roosevelt result in changes in habitat conditions in the river downstream of the border. Further, water quality appears to have been altered including shifts in temperature patterns and reductions in turbidity, especially during freshet.

Juvenile sturgeon habitat is affected by ecosystem changes associated with hydroelectric operations, which may provide for causal agents of recruitment failure. Free embryos rely on freshet flows to flush fines from sediments used for hiding while development continues, they utilize late summer flows to disperse to early feeding locations, and they may use the volume and clarity of the freshet flows as aids in avoiding predators. Once located to rearing habitat, prey abundance and the resulting rate of sub-yearling growth, which allows for escape from predators, is probably a function of the pattern of substrate flooding and related sediment conditions. Further, rate of growth and accumulation of metabolic reserves should function in survival success during the first winter of life.

The TWG provided recommendations to meet the objectives of the WUP report (UCWSRI 2006a). The recommendations provided an outline of tasks for delivery within the first 3–5 years of a program, and suggested the proportion of work on each item should vary from year to year depending on the complexity and results of previous years. The outline provides for:

1) annual or semi-annual sampling of hatchery and wild fish growth, survival, distribution, diet and abundance.

2) periodic monitoring of movements to provide information on habitat use and population interactions during the juvenile life stages.

3) use of marking to allow assessments of survival, growth and condition during recapture programs.

4) studies of free embryo activities and movements in the lab or in situ to improve an understanding of habitat requirements and related behaviour, timing and trends in abundance

Work by the UCWSRI to date has shown that sub-yearling sturgeon released into the system show reasonable survival (Golder Associates 2007). Further, in the course of a recruitment failure hypotheses review, the TWG agreed that the most probable bottlenecks occur during the life stages after hatch and during the first winter, and involve various inappropriate habitat conditions (Birch et al. 2007). As a result, this Terms of Reference focuses on the monitoring of free embryo hiding/drift and juvenile rearing habitat use periods to further determine causal agents and identify potential for habitat improvements.
There is evidence of transboundary movement of white sturgeon juveniles and adults (Golder Associates 2006). In the case of juveniles, hatchery fish released in Canada as far upstream as HLK will move into Lake Roosevelt and rear in embayments and flats in the vicinity of the more stable upper extent of the reservoir. Small numbers of unmarked, assumed to be wild, juveniles representing multiple recent year classes have also been captured in this area (Howell and McLellan 2007). There is no indication as to which spawning sites may be the origin of these unmarked juveniles, since free embryos have been documented drifting downstream of each site in Canada and the US. As a result of this information however, the TWG supports juvenile monitoring, especially to assess survival and growth of 1+ juveniles in the US.

1.2 Management Questions

Key management uncertainties encountered during development of the Columbia River WUP relate to how operations of Hugh L. Keenleyside Dam may adversely affect habitat suitability and availability for juvenile sturgeon and contribute to recruitment failure of white sturgeon in the lower Columbia River (CC 2004). Fundamental management questions to be addressed through the juvenile sturgeon detection program may include:

1) What are the relative abundance, survival rates and distribution locations of free embryo and juvenile white sturgeon in the lower Columbia River under current operating parameters?

2) What are the physical and hydraulic properties of this habitat that define its suitability as juvenile sturgeon habitat?

3) How do normal river operations affect free embryo habitat conditions in the lower Columbia River?

4) How do normal river operations affect juvenile habitat conditions in the lower Columbia River during dispersal and on a seasonal basis?

1.3 Management Hypothesis

While impoundments and water management at HLK and other dams in the Columbia watershed may be correlated with declines in sturgeon recruitment in the lower Columbia River, the precise mechanism(s) remain unclear. Early life stages through to free embryo dispersal to rearing areas appear to be most adversely affected. Mortality rates experienced by these early life stages may be impacted by spawning site selection and timing. The juvenile sturgeon detection program is not designed to provide experimental testing of research hypotheses, but rather provides baseline information that may be used to evaluate recruitment failure hypotheses and can be used in design of future operational or physical mitigative approaches.

The following management hypotheses may be used to guide juvenile detection program studies:

\[ H_0: \] The operations of the Columbia River dams and reservoirs are not contributing to changes in survival among juvenile sturgeon in the lower Columbia reach.
H₁: Columbia River operations (HLK alone or the cumulative operations of dams affecting the lower Columbia reach hydrograph) are affecting free embryo hiding/drift and dispersal behaviour, development and growth, and habitat selection, which result in reduced survival of early sturgeon life stages.

H₂: Columbia River operations (HLK alone or the cumulative operations of dams affecting the lower Columbia reach hydrograph) are affecting juvenile movements, growth, and location and selection of suitable rearing habitat which result in reduced survival of later juvenile life stages.

H₃: Columbia River operations (HLK alone or the cumulative operations of dams affecting the lower Columbia reach hydrograph) are affecting the suitability and availability of habitat parameters resulting in reduced survival of early life stage (free embryo to rearing juvenile) sturgeon.

1.4 Key Water Use Decisions

The lower Columbia juvenile detection program will provide information on relative abundance of early life stages, and biological characteristics and habitat selection exhibited under current operating conditions. This program will provide baseline information for comparison with juvenile responses collected under larger but opportunistic freshet flows, and therefore inform conclusions on the relevance of a more historical hydrograph on improved recruitment. The data collected during this program will also contribute to decisions regarding the feasibility of non-operational management responses designed to alleviate causal factors in recruitment failure. The present WUP recommends a turbidity augmentation experiment at flows of less than 90 kcfs as a means of minimizing predation on early life stages of sturgeon.

Currently, the TWG is exploring recruitment failure hypotheses for the lower Columbia River which may suggest other possible non-operational responses. A feasibility study is proposed to evaluate the probability of success of these responses along with their potential effects on other ecosystem components in the reach. Information collected during the juvenile detection program may assist in resolving a number of outstanding questions including:

1) What are the free embryo hiding habitat conditions and how do these compare between known spawning sites in the lower Columbia? Along with subsequent growth and survival information, these data should help identify whether turbidity augmentations, short-term flow augmentation or reservoir manipulations, or substrate improvement of free embryo habitat are feasible mitigative options.

2) Where do post-dispersal juvenile sturgeon reside, what are the habitat conditions found in these areas, and are there variations in growth and survival? It is possible that early juveniles do not live through the first winter, which may be a function of substrate condition or food availability. These data should identify opportunities for juvenile habitat improvements including reservoir manipulation, substrate improvements, nutrient augmentation, or drawdown zone re-vegetation.

In the long term, once mitigative responses are selected and improvements are being tested, the baseline juvenile detection program data will provide an important reference for post-mitigative monitoring results.
2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The lower Columbia River juvenile detection program is designed to describe life history aspects of juvenile white sturgeon, as well as provide input to the ongoing consideration of recruitment failure hypotheses, the evaluation of the effects of future management responses, and information to guide conservation culture stocking targets. The primary objectives of the juvenile sturgeon detection program are to:

1) Assess the development and condition (early hiding/drift development patterns and rearing juvenile conditions), behaviour (drift and movements), growth and survival of free embryo and juvenile sturgeon.

2) Determine early life stage distributions over time, locate free embryo hiding and juvenile rearing habitats, and define the parameters of these habitats.

3) Relate free embryo and juvenile habitat quality to variations in discharge from upstream dams and water levels of Lake Roosevelt reservoir.

4) Collect data in support of assessing the effects of current operations and the feasibility of management responses.

The scope of the juvenile program focuses on the collection of data that define free embryo and juvenile habitat conditions, the use of these data to determine the effect of existing hydraulic conditions, and to identify and assess the most suitable of several management responses to be considered in lieu of operational changes.

2.2 Approach

To date, the UCWSRI has tagged, released and tracked sub-yearling conservation culture sturgeon within the lower Columbia reach for a number of years, and is aware of the location of their rearing habitat in Canada and the US. These habitats will continue to be used to monitor growth and survival among juveniles. Under this program, more consistent effort will be directed to assuring the accuracy of survival estimates by life stage and to defining the water quality, hydraulic, and substrate parameters of these habitats.

It is proposed that telemetry efforts be refocused to wild sturgeon juveniles when captured, rather than continuing to track conservation cultured released juveniles. Existing tagged cultured juveniles will be tracked for the duration of tag life, but only non-PIT tagged and scute marked juvenile wild sturgeon caught in Canada or the US will be nanotagged in the future and tracked to determine if wild fish behaviour differs from cultured fish. Wild fish will also be sampled for fin-ray age and genetics.

The lower Columbia River juvenile detection program will also emphasize understanding of free embryo drift behaviour and hiding habitat use downstream of spawning sites at Waneta and upstream of Kinnaire. Benthic drift sampling nets (anchored D-ring sleds equipped with velocity meters) will be used at intervals downstream of these sites to help define the locations of hiding habitat and timing of drift and dispersal behaviour. This technique will also allow for comparing relative abundance, development rates, and growth and condition between locations. Once identified, substrate conditions can be assessed at each location for comparison purposes.
To assist with understanding whether or not food limitations are impacting free embryo or juvenile sturgeon, stomach samples will be collected and examined for evidence of starvation, and the ability of the fish to capture sufficient prey (prey type and abundance).

While the program has been developed as per the WUP, the program described in this ToR may be altered annually if the techniques are not proving successful or if additional information is required, and may be significantly modified after 3–4 years when it is expected a major review will be conducted. This approach is in alignment with the direction received from the TWG (UCWSRI 2006a, UCWSRI 2008).

2.3 Tasks

2.3.1 Task 1: Project Planning and Coordination

This task involves planning for and coordinating of general administrative and technical oversight of the monitoring program. This will include but not be limited to 1) budget management, 2) study team selection, 3) logistic coordination, 4) technical oversight in field and analysis components, and 5) data management and facilitation of data transfer.

A safety plan must be developed and submitted to the BC Hydro project manager for all aspects of the study involving field work in accordance with BC Hydro procedures and guidelines. Specific safety training needs should be identified.

Given white sturgeon are now listed as endangered under the SARA, care must be taken to protect sturgeon from injury or mortality related to sampling. Acceptable handling techniques for sturgeon have been developed by the UCWSRI and accepted by the BC MoE (UCWSRI 2006b). These standards should be observed at all times. Planned injury to or sacrificing of juveniles for data collection must be pre-approved and permitted under SARA. Unexpected mortalities must be reported to the responsible authorities. The causal activity may be suspended pending review with the DFO and approval to recommence.

2.3.2 Task 2: Study Design

The lower Columbia River juvenile detection program study design follows the recommendations of the TWG both in the tabular juvenile monitoring study summary provided in 2006 (UCWSRI 2006a), and from the minutes of the juvenile assessment workshop on March 6, 2008 (UCWSRI 2008). The program is divided into free embryo hiding/drift habitat location and sampling, rearing juvenile habitat location and sampling, movement studies, and a collection of laboratory studies and population characteristics assessments. The latter include wild fish ageing and genetic assessment, survival estimates, and stomach analyses. Inclusive in each component are data management, analyses and reporting allowances.

2.3.3 Task 3: Field Studies

Biological Sampling of Captured Juvenile Sturgeon

Each fish collected should be sampled for a suite of measurements including: scute mark, PIT tag and nanotag identifier number, length (fork and total, ±1 mm), and weight (±2 g for sub-yearlings, less accuracy for older fish). External body condition must be recorded according to accepted protocols (B.C. Ministry of Environment,
2003). Sub-sampling may also be considered for other morphometric measurements suitable to inter-population comparisons. Wild fish should be used for fin-rays sections and DNA tissue. Stomach sub-sampling is recommended for free embryos and culture juveniles, even though it requires sacrificial sampling, to identify the extent of starvation and establish prey preference and abundance in the stomachs.

**Free Embryo Drift Sampling and Identification of Hiding Habitat**

The primary sampling method used will be deployment of drift sampling devices to capture drifting white sturgeon free embryo. The study design should maximize spatial and temporal coverage of potential spawning sites upstream of Kinnaird, and at least between Waneta and the border, within the allocated budget. For 2008, the TWG has suggested 3 or 4 points of sampling below Waneta to begin to document drift behavioural patterns, and bracketing of the area around Kinnaird to focus in on the more likely spawning areas. The study area, especially below Waneta, can display dynamic changes in depth and velocities in response to load shaped operations, tributary inflows, and potentially Lake Roosevelt reservoir water levels. The sampling protocols should be designed to repeatedly sample for free embryo over the study area. Sampling will need to occur over a broad area and through a period of approximately 6 weeks during and after spawning. Upon hatch, free embryos either hide or are actively or passively entrained in the river flows and when they do, are captured in drift samples. A pattern of hiding and drift similar to that observed in the US portion of the lower Columbia reach below Northport will occur until the young are about 21-days-old, or when exogenous feeding begins. At that time, individuals are expected to volitionally disperse to low velocity habitats that are suitable for feeding and rearing. The contractor should review available data on drift behaviour in documented instances before deciding on the frequency of sampling and information needs to provide for a comparison analysis with other populations.

Drift samplers may need to be purposely built for this study, and modifications to existing designs should be considered. Existing free embryo drift samplers (often referred to as D-ring samplers to describe the shape of the entry frame) have been designed with a semi-circular 0.8 m by 0.4 m entrance frame and a 3.6 m long 0.16 cm knotless mesh drift net, tapering to an 11.4 cm diameter collection bottle attached. Samplers have been held in place using bridled anchoring systems deployed from river boats. Careful consideration must be given to the length of time the samplers are deployed before retrieval to allow for optimal capture success, captured free embryo condition, and the speed with which the nets fill with debris. This timing will affect both the efficiency of the sampler and the drag of the material in the water, and therefore its ability to stay in position.

**Juvenile Monitoring and Identifying of Rearing Habitat**

Juvenile monitoring will be undertaken in the US at the upper end of the Lake Roosevelt reservoir and less frequently in Canada, at selected rearing and overwintering locations. These may include Marcus Flats and the mouth of the Kettle River in the US, and Waneta Eddy and downstream of HLK in Canada. It is expected that gillnets will be the primary technique used, currently bottom sets are used in the autumn (October), incorporating panels measuring 1.8 m deep, 15.2 m to 45.7 m in length, and consisting of 5.1 cm stretch mesh equipped with a bridled anchoring system and surface floats. In addition, a remotely operated video or camera sled may be used to establish the presence of sturgeon in an area prior to sampling with
collecting gear. Reliance will be placed on continued use of remote equipment and
gillnet sampling to assess juvenile habitat preference, relative abundance, and
distribution. Gill netting may be supplemented with volunteer angling, or in the US by
beam trawl, to sample fish for biological characteristics. Remote PIT tag readers may
be employed, if that technology proves to be a suitable, cost effective alternative to
provide for survival estimates. The budget currently allows for juvenile sampling
every second year over the term of the program however, specific timing of this
component of the work will depend on available data, juvenile release plans, and the
timing of parallel work in the US. No juvenile sampling is proposed for the lower

Distribution of Tagged and Marked Juvenile Sturgeon

The TWG has proposed discontinuing nanotagging of conservation cultured juveniles
released into the system, and instead concentrate on tagging and monitoring the
movements of wild, naturally-recruited juveniles, most likely captured in the US
(UCWSRI 2008). It will be assumed that juveniles captured without a PIT tag or scute
mark are naturally recruited. Juvenile fish will be tagged via surgical insertion of a
Vemco nanotag (V9 or V13). Tracking the nanotagged fish will be conducted with a
grid of anchored receivers (Vemco VR2 or VR2W Remote Telemetry Receiver
Stations). The VR2/VR2W grid is already in place in the lower Columbia Reach and
is maintained under CLBMON #28 Lower Columbia River Adult Sturgeon Monitoring
and Broodstock Collection project. The anchoring systems of the receivers should be
checked regularly and adjusted as required in response to changing hydraulic
conditions in the reach. Monitoring is expected to provide information on movements,
habitat use and possibly sub-population interaction. Logged data should be
downloaded regularly and once checked for data discrepancies (e.g. tag collisions)
will be forward to the WDFW for data storage.

Defining Properties of Juvenile Sturgeon Habitat

Habitat descriptors should include depth, velocity and turbulence, substrate, cover
and water quality. Such descriptors are common among other juvenile habitat studies
The contractor will be expected to ensure the descriptors being sampled adequate
cover data needs for comparison to other sturgeon studies especially in the
Columbia River.

Differential GPS should be used to track geographic coordinates and elevation of the
habitats. Water depths can be measured using onboard sonar or manual sounding
equipment. A boat-mounted velocity meter should be used to obtain velocity profiles
(including a near bottom velocity) over a range of dam discharges and reservoir
elevations at the habitat sites. Turbulence can be subjectively monitored during
habitat sampling. Substrate conditions can be sampled by active analysis or through
remote passive observation techniques, but must be demonstrated to be replicable
within reasonable confidence limits. Cover conditions in the site will likely require a
remote passive observation technique.

Water quality parameters collected should include water temperature, TSS/turbidity,
TGP and a standard sweep of basic water quality parameters and contaminants.
There are many acceptable techniques for field and lab sampling of these
parameters, but the accuracy and detection limits should be suitable to allow
differentiation between habitat sites, if necessary, and comparison to other juvenile
sturgeon habitats. Physical and chemical habitat parameters are to be monitored as part of the CLBMON #44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring; these data should be available to define basic water quality parameters.

More detailed habitat work is expected once habitat selection and preferred sites have been documented. Simple depth measures can be expanded to bathymetry mapping. In other riverine habitat work designed to describe sturgeon spawning habitat at the confluence of the Pend d'Oreille and Columbia rivers, a boat mounted broadband Acoustic Doppler Current Profiler (ADCP) was used to define detailed hydraulic velocity and turbulence conditions (Shields and Rigby 2005). Broad category substrate conditions can be defined using certain ADCP models or sidescan sonar techniques, or transects can be run using a remotely operated camera sled. Recruitment failure hypotheses being considered by the TWG include habitat changes affected life stages such as free embryo hiding success, dispersal conditions, and rearing habitat conditions and the degree of attention given to habitat descriptions should allow identification of potential correlations with recruitment failure effects.

**Laboratory Studies – Evidence for Starvation, and Hiding/Drift Behaviour**

The TWG is in the process of summarizing laboratory information on the preference of early life stages for different substrates and at this time further information on this topic should focus on determining relevance to field conditions. The TWG however, has identified two areas of interest for laboratory studies which would have relevance to field monitoring including: i) starvation identification, and ii) drift behaviour under variable habitat conditions.

The first topic would focus on providing photographs by developmental stage to help identify starvation in field samples. It would also determine how long free embryos can live without food, and still successfully begin to feed, develop and grow. Another question of interest is how consistent a food supply is required for allow a fish to survive through the first winter of life? The laboratory work must provide for live or at least natural frozen food sources. This work should account not only the lab studies but also related histology.

The drift behaviour studies would look at how behaviour may change in colder water temperatures or more turbid waters, and may vary dependant on ambient light (diel patterns). The work could also fill in any gaps on the effect of substrate conditions on hiding and drift. It is doubtful laboratory information can inform a field understanding of velocity effects on drift, but other parameters may be studied. Questions include the timing of drift and hiding under different habitat conditions, whether free embryos show one particular behaviour under different conditions, or whether they “hop” downstream in and out of the substrate. The work should have relevance to field monitoring locations, timing, and sampling techniques.

Laboratory work will be separately contracted to a reputable lab which can perform the work requested within the budget allocated. As such, the budget approaches laboratory work as a set deliverable allocated a fixed sum, and does not provide for analyses and reporting under project per diems.
2.3.4 Task 4: Data Analysis

Drift sampling data should be analyzed for behavioural information and the timing of drift and dispersal. Habitat conditions associated with hiding/drift data should be summarized and compared between lower Columbia River sites and data from other populations. Information on free embryo developmental stage, condition and growth, as well as the incidence of prey in the stomach or evidence of starvation should be tabularized for presentation. The contractor may be required to archive samples for genetic analyses as well. Free embryos preserved in formalin can be used for staging and gut analyses; preservation in alcohol will be required for genetic analyses.

Juvenile samples will be analyzed for length-weight and age at size relationships and relative growth. Stomach content data should be summarized with respect to prey type and abundance. Wild fish fin-ray samples and DNA samples will be archived, and analyzed prior to preparation of each technical report. Fin-ray samples should be polished to improve accuracy and photographic for reading and to provide a long term ageing record. DNA analyses are currently undecided but may involve analyses to allow correlation to genetic profiles associated with specific spawning sites. Habitat conditions from rearing areas should be compared with other areas of the lower Columbia River reach and with other sturgeon populations. Telemetry movement data should be displayed in summary tables and graphs, and correlated to the extent possible with habitat variables.

Mark-recapture and related information (e.g. remote PIT tag reader records) accumulated through juvenile sampling or movement studies should be periodically modeled and analyzed to assess survival rates. Sufficient sampling will be necessary to ensure the precision of survival rate estimates. New length data should be periodically compared to fin-ray ages to assess possible ageing underestimates. Mortality can be verified through age-frequency data using catch-curves.

2.3.5 Task 5: Reporting

A brief data report will be prepared by January 30 for each year; technical reports will offset the need for a data report in 2010, 2013, 2016 and 2019. The data reports will summarize methods employed, present data collected that year, provide preliminary analyses and subjective interpretations of the results, and make recommendations regarding subsequent year's work. Annual reports will be finalized by March 1 of each year.

Technical reports are envisaged each following data collection in 2011, 2014 and 2017. These periods have been selected to correspond to likely SARA incidental effects permitting review periods. These reports will summarize work to date, and include recommendations on program modification. To varying degrees technical reports will provide:

a) an executive summary
b) a description of methods employed;
c) a data summary and preliminary data analysis;
d) a comparison of results between years and with other populations;
e) a detailed summary of findings as they relate to hypotheses and the key management questions; and

f) any recommendations related to next steps.

Reports will follow the standard format that is being developed for the WUP monitoring programs. Draft reports should be submitted in Word to allow for electronic editing. All 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 or in the Word file as separate files.

2.4 Interpretation of Results

The results of the lower Columbia River juvenile detection program will be used to characterize free embryo and juvenile movements and distribution patterns, relative abundance, habitat preferences, growth rates, survival, provide information on potential new hypotheses and physical works options, and provide baseline information necessary to evaluate physical works experiments and effects of opportunistic flows.

2.5 Schedule

This monitoring program will occur over 12 years of implementation of the Columbia River Water Use Plan (from 2008 through 2017). A proposed annual schedule for activities to be addressed through this Terms of Reference is as follows:

i) Free embryo sturgeon drift sampling will be conducted annually from mid June through the end of July to correspond with similar sampling in the US. Basic habitat parameter sampling to be conducted concurrently.

ii) Juvenile sampling involving camera sleds, gillnetting, angling or beam trawl sampling to occur during the autumn for 4 weeks, usually during October. Currently juvenile sampling is scheduled to be conducted bi-annually in 2009, 2011, 2013, 2015, and 2017. Basic habitat parameter sampling to be conducted concurrently.

iii) Water quality sampling collected throughout the year under other projects (e.g., CLBMON #44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring).

iv) Detailed habitat sampling either collected concurrent with the drift sampling (i.e. velocity and turbulence conditions) or during low water levels (substrate composition) either in May or late September over the first 3 years of the program. Bathymetry sampling can also be done at any time of year and modified to meet benchmarked gauges.

v) Wild juveniles will be tagged annually during the autumn juvenile sampling in the US or Canada, tracked with the fixed acoustic receiver array, and the results analyzed at technical reporting intervals in 2011, 2014, and 2017.

vi) Ageing, genetics analyses and survival estimates to be assessed and analyzed at technical reporting intervals in 2011, 2014 and 2017.

vii) Data analysis scheduled for August through January annually.
   a. Draft report submitted – January 30 annually
   b. Final report submitted – March 1, annually

Laboratory studies will occur off site at a reputable lab during and following the period of hatch, usually from July through to the end of August. Lab work should occur over the first 3–4 years of the program.

2.6 Budget

The total annual cost of the juvenile monitoring program for the Lower Columbia varies from year to year depending on the activities scheduled for that year. The average annual cost for the 12 years, adjusted for inflation (2%) and including a 5% contingency, is $241,854. The budget is based on the estimated costs provided by the TWG in October 2006 (UCWSRI 2006a), as well as further information provided recently (UCWSRI 2008). Fin-ray ageing costs have been recently re-assessed and now include preparatory polishing and photography; genetic analyses costs have also been updated. The budget for the maintenance of the VR2/VR2W array in the lower Columbia below HLK for the duration of the program is provided under project CLBMON #28 Lower Columbia River Adult Sturgeon Monitoring and Broodstock Collection and, therefore, is not included in this budget except for tag purchase and insertion, and analyses and reporting.

3.0 REFERENCES


