Columbia River Project Water Use Plan

Columbia River White Sturgeon Management Plan Monitoring Program and Physical Works

Annual Report: 2016

Implementation Period: July 2015 to June 2016

- **CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use**
- **CLBMON-20 Mid Columbia River White Sturgeon Spawning Habitat Assessment**
- **CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon**
- **CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility**
- **CLBMON-24 Mid Columbia River Sturgeon Genetics**
- **CLBMON-25 Kinbasket Juvenile Sturgeon Detection and Habitat Use**
- **CLBMON-26 Kinbasket Sturgeon Recolonization Risk Assessment and Habitat Suitability**
- **CLBMON-27 Mid Columbia River Sturgeon Incubation and Rearing Study**
- **CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring**
- **CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring**
- **CLBMON-30 Lower Columbia River Opportunistic Assessment of High Flow Events**
- **CLBMON-54 Mid Columbia Effects of REV 5 Flow Changes on Incubation and Early Rearing Sturgeon**
- **CLBWORKS-24 Mid Columbia Experimental Aquaculture**
- **CLBWORKS-25 Mid Columbia Sturgeon Conservation Aquaculture**
- **CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery**
- **CLBWORKS-27 Lower Columbia Bentonite Addition Experiment**
- **CLBWORKS-28 Lower Columbia River Planning and Assessment of WSG Turbidity**
- **CLBWORKS-34 Lower Columbia Sturgeon Conservation Aquaculture Program**

Licences for Kinbasket storage (27068 and 39432), Mica diversion (39431), Revelstoke diversion and storage (47215), and Arrow storage (27066)

July 31, 2016

BC Hydro Columbia River Project Water Use Plan
Columbia River White Sturgeon Management Plan
Monitoring Programs and Physical Works Annual Report: 2016

1 Introduction

This document represents a summary of the status and the results of the Columbia River White Sturgeon Management Plan Water Use Plan (WUP) monitoring programs and physical works to June 30, 2016, as per the Columbia River Order under the *Water Act*, dated January 26, 2007. There are 12 monitoring programs and six physical works.

2 Status

The following table outlines the dates that Terms of Reference (TOR) for the Columbia River White Sturgeon Management Plan WUP monitoring programs and physical works were submitted to and approved by the CWR.

Table: 2-1: Dates of Columbia River White Sturgeon Management Plan WUP TOR Submissions and Approvals by the Comptroller of Water Rights

Monitoring Program & Physical Works TOR	Order Clause	Original ToR Submission		Most Recent ToR Resubmission	
		Date Submitted	Date Approved	Date Submitted	Date Approved
CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use	Schedule F.1.a	Feb 22, 2008	Apr 24, 2008		
CLBMON-20 Mid Columbia River White Sturgeon Spawning Habitat Assessment	Schedule F.1.b	Feb 22, 2008	Apr 24, 2008	Aug 21, 2009	Nov 10, 2009
CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon	Schedule F.1.c, Schedule F.1.d	Jun 15, 2007	Jul 11, 2007		
CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility	Schedule F.1.e	Jun 15, 2007	Jul 11, 2007	Apr 16, 2009	Apr 30, 2009
CLBMON-24 Mid Columbia River Sturgeon Genetics	Schedule F.1.f	Scheduled for 2017			
CLBMON-25 Kinbasket Juvenile Sturgeon Detection and Habitat Use	Conditional List 9.b	Conditional			
CLBMON-26 Kinbasket Sturgeon Recolonization Risk Assessment and Habitat Suitability	Clause 10.c Conditional List	Jan 07, 2009	Mar 19, 2009		
CLBMON-27 Mid Columbia River Sturgeon Incubation and Rearing Study	Schedule F.1.g	Jan 07, 2009	Mar 19, 2009		
CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring	Schedule F.1.h	Feb 22, 2008	Apr 24, 2008		
CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring	Schedule F.1.i	May 12, 2008	Jun 25, 2008		
CLBMON-30 Lower Columbia River Opportunistic Assessment of High Flow Events	Schedule F.1.j	Jan 07, 2009	Mar 19, 2009		
CLBMON-54 Mid Columbia Effects of REV 5 Flow Changes on Incubation and Early Rearing Sturgeon	Clause 2.e of the Amended Order	Aug 21, 2009	Oct 19, 2009		
CLBWORKS-24 Mid Columbia Experimental Aquaculture	Schedule F.3.a	Apr 17, 2008	May 12, 2008		
CLBWORKS-25 Mid Columbia Sturgeon Conservation Aquaculture	Schedule F.3.b	Apr 17, 2008	May 12, 2008		
CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery	Schedule F.3.c	Apr 17, 2008	May 12, 2008		
CLBWORKS-27 Lower Columbia Bentonite Addition Experiment	Conditional List 10.a	Conditional			
CLBWORKS-28 Lower Columbia River Planning and Assessment of WSG Turbidity	Schedule F.2.a	Mar 31, 2010	Jun 03, 2010		
CLBWORKS-34 Lower Columbia Sturgeon Conservation Aquaculture Program	Schedule F.3.b	Apr 17, 2008	May 12, 2008		

3 Schedule

The following table outlines the current schedule for the monitoring programs and physical works being delivered for the Columbia River White Sturgeon Management Plan WUP.

Table 3-1: Monitoring Programs and Physical Works Schedule as of June 30, 2016

Monitoring Programs	2007 WLR YR1	2008 WLR YR2	2009 WLR YR3	2010 WLR YR4	2011 WLR YR5	2012 WLR YR6	2013 WLR YR7	2014 WLR YR8	2015 WLR YR9	2016 WLR YR10	2017 WLR YR11	2018 WLR YR12	2019 WLR YR13 Final Review
CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use		✓	✓	✓									
CLBMON-20 Mid Columbia River Spawning Habitat Assessment				×	✓	✓	✓						
CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon	✓	✓	✓	✓	✓	✓	✓	✓	✓	■	■		
CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility	✓	✓	✓	✓	✓	✓	✓	✓	✓	■			
CLBMON-24 Mid Columbia River Sturgeon Genetics											■	■	
CLBMON-25 Kinbasket Juvenile Sturgeon Detection and Habitat Use	C*												
CLBMON-26 Kinbasket Sturgeon Recolonization Risk Assessment and Habitat Suitability				✓	✓	✓	✓						
CLBMON-27 Mid Columbia River Sturgeon Incubation and Rearing Study			✓	✓	✓								
CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring		✓	✓	✓	✓	✓	✓	✓	✓	■	■	■	■
CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring		✓	✓	✓	✓	✓	✓	✓	✓	■	■	■	■
CLBMON-30 Lower Columbia River Opportunistic Assessment of High Flow Events			✓	✓	✓	✓	✓	✓	✓	■	■	■	
CLBMON-54 Mid Columbia Effects of REV 5 Flow Changes on Incubation & Early Rearing Sturgeon				×	✓	✓	✓						
Physical Works													
CLBWORKS-24 Mid Columbia Experimental Aquaculture		✓	✓	✓	✓	✓							
CLBWORKS-25 Mid Columbia Sturgeon Conservation Aquaculture						✓	✓	✓	✓	■	■		
CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery		✓	✓										
CLBWORKS-27 Lower Columbia Bentonite Addition Experiment	C*								del	■	■	■	
CLBWORKS-28 Planning and Assessment of WSG Turbidity				✓	✓	✓							
CLBWORKS-34 Lower Columbia Sturgeon Aquaculture Program		✓	✓	✓	✓	✓	✓	✓	✓	■	■	■	■

Legend:
- ■ = Program to be undertaken/initiated in identified year
- u/w = Project is underway
- ✓ = Program completed for the year
- del = Program is delayed
- × = Program started, but encountered operational or hydrological delays
- C* = Program is on the conditional list

4 Monitoring Programs and Physical Works Terms of Reference

The monitoring programs and physical works being implemented under the Columbia River White Sturgeon Management Plan WUP are described in Terms of Reference. These Terms of Reference and the reports for work completed to date can be found here:

http://www.bchydro.com/toolbar/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river/columbia-sturgeon.html

5 Status of Monitoring Programs

5.1 CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use

This monitoring program was initiated in 2008 and was carried out over a three-year monitoring period ending in 2011. The final report from this work helped inform CLBMON-26 described below.

5.2 CLBMON-20 Mid Columbia River White Sturgeon Spawning Habitat Assessment

This monitoring program was initiated in 2010 and was carried out over a three-year period ending in 2014. The final report also incorporates additional work that expanded the modelling through BC Hydro's Revelstoke Unit 6 environment project, which has proved beneficial to the analysis being conducted under the Columbia WUP study.

This project was based primarily on advanced hydraulic modelling which was developed over a three-year period to validate with field sampling over a range of Revelstoke Dam Discharges and Arrow Lakes Reservoir elevations. The work was implemented concurrently with CLBMON-54, due to similarities in management questions and methodology. The overall objective of these studies was to model the effects of Revelstoke Dam discharges and ALR levels on velocity/depth patterns in the White Sturgeon egg deposition/incubation and early rearing area. This objective was met and detailed results and modelling scenarios are presented in the report and discussed in the context of the programs management questions and the biology of the species.

5.3 CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon

This monitoring program was initiated in 2007 and will be carried out over ten years ending in 2017 Attached is the report for Years 7 to 9 dated June 2016 that covers capture efforts during 2013, 2014, and 2015.

The program is currently focused on fish capture to described growth and, if capture rates improve, survival of juveniles following release from the conservation aquaculture program. This was the focus of sampling in 2014 and the plan for 2015, to ensure adequate effort was expended to sample throughout the reservoir (from Macdonald Creek to Greenslide Creek).

For several years, this program relied on advancements in telemetry (acoustic positing system) to address questions regarding habitat use at different reservoir elevations that were not feasible to address using more indirect means (direct

capture being so low). However, despite the success of generally addressing that specific question, significant uncertainty remains regarding the growth and survival capacity for juvenile sturgeon released from the hatchery program. Addressing this uncertainty was identified as a key requirement for this program based on discussions at the Upper Columbia White Sturgeon Recovery Initiative Technical Working Group (UCWSRI TWG) and a technical review completed in 2012. In order to further evaluate survival following release (constant 9-months) from the hatchery, additional sizes at release are being tested for this program as this is considered to be one of the main criteria for success in the lower Columbia. In the initial years (1-5) juveniles were released at 75 grams. In Years 6-8, target size at release was 150 grams, and Years 8-10 will be 300 grams. This program will focus for the final two years of implementation on addressing growth and survival through directed capture efforts.

5.4 CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility

This monitoring program was initiated in 2007 and will be carried out over ten years ending in 2016. Attached is the report for Year 9 dated July 2016.

This monitoring program was designed to ensure consistent annual monitoring based on the outcome of the Mid-Columbia White Sturgeon Management Plan midterm review which occurred in 2012. Of note, spawning has been detected at this location in 9 of 14 years where monitoring has occurred (6 of 9 WUP years). There has been no significant change to the delivery or implementation of this program. One key focus for the remaining years of the program is to bank tissue samples (from captured larvae) for genetic analysis under CLBMON-24 towards the end of the WUP. To date, very few tissue samples have been obtained as a result of low larval capture numbers.

5.5 CLBMON-24 Mid Columbia River Sturgeon Genetics

This monitoring program is not planned to be initiated until 2017 due to the requirement for additional collection of genetic samples prior to project implementation. The program will analyze historical adult samples and samples collected from monitoring under CLBMON-23. It is unlikely that sufficient samples will be collected until 2017. If by the end of 2016, not enough samples are collected, additional discussions will occur with the UCWSRI TWG with respect to this program.

5.6 CLBMON-25 Kinbasket Juvenile Sturgeon Detection and Habitat Use

This is a conditional study that was originally intended to be implemented if juvenile white sturgeon were experimentally released into Kinbasket. A decision was made at the Mid-Columbia White Sturgeon Management Plan midterm review in 2012 to focus on questions related to sturgeon recovery in the Arrow Lakes Reservoir before conducting concurrent work in Kinbasket. This conditional study, if implemented, could focus on identifying any unresolved questions rising from CLBMON-26, described below. As of 2016, there have been no changes.

5.7 CLBMON-26 Kinbasket Sturgeon Recolonization Risk Assessment and Habitat Suitability

This monitoring program was initiated in 2010 and was carried out over a three-year period ending in 2014. The final report detailing a conservation aquaculture strategy

for this program is in draft form and will be reviewed by recovery initiative partners prior to finalization.

CLBMON-26 was designed in two phases. Phase one was an ecological risk assessment and forms the basis of the early reports submitted. At the Mid-Columbia White Sturgeon Management Plan midterm review in 2012 a decision was made to prepare a conservation aquaculture strategy that, even though not implemented, would help inform future discussions around the use of Kinbasket reservoir as a failsafe or recovery area for White Sturgeon.

5.8 CLBMON-27 Mid Columbia River Sturgeon Incubation and Rearing Study

This monitoring program was initiated in 2009 and was carried out over three years ending in 2012.

5.9 CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring

This monitoring program was initiated in 2008 and will be carried out over 12 years. Attached is the report covering Year 8 dated July 2016.

One important aspect of this program in recent years is the initiation of a systematic stock assessment that was started in 2013 to estimate the number of White Sturgeon in the transboundary reach of the Columbia River. This study represents the first systematic population estimate for the entire transboundary reach and a secondary objective is to estimate survival of hatchery released juvenile in this reach. Further, these capture efforts also allow the distribution and habitat use to be tracked annually, which helps address possible changes in adult habitat use or movements. This work is being completed in partnership with recovery team members from the United States.

The stock assessment is being implemented in two sessions annually, one in the spring and one in the fall, with five sessions completed to date. The project will continue for five years, ending in 2018 and will be very important for recovery of White Sturgeon in the Columbia as it serves as a baseline to track progress against recovery. We expect to have preliminary wild adult population estimates by the end of 2017, which will be important in determining the long-term goals of the conservation aquaculture program.

5.10 CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring

This monitoring program was initiated in 2008 and will be carried out over 12 years. Attached is a report covering Years 6 and 7 of the program dated July 2016 and a report for Year 8 dated July 2016.

Larval monitoring under this program has been successful in identifying larvae distributing from the HLK/ALH spawning area, downstream of Kinnaird, and from the Waneta spawning site downstream into the US portion of the LCR. Larval catch has predominantly consisted of young (1-3 days post hatch) individuals, suggesting early dispersal from spawning locations possibly due to habitat suitability or other factors. We also conducted experiments to measure thermal induced responses in development of White Sturgeon yolk-sac larvae (YSL) reared at 12.5, 14.0, 15.5, and 17.0°C. We quantified temperature effects on time of initial occurrence (hours post hatch, hph; accumulative thermal units, ATU) of ten developmental stages from hatch to exogenous feeding. Concurrently, seven larval morphological traits (total length, TL; total body area, TBA; yolk-sac area, YSA; head area, HA; gill filament

area, GFA; mouth area, MA; and pectoral fin area, PFA) were measured daily for fish reared at 12.5 and 17.0°C to compare endogenous resource allocation. Time of development significantly increased at warmer temperatures treatments (15.5 and 17.0°C) compared to cooler treatments (14.0 and 12.5°C) with no significant difference in ATU between 15.5 and 17.0°C, or in ATU and hph between 14.0 and 12.5°C. When standardized by relative timing of development (RTi), development was not significantly different among temperature treatments. At hatch, YSL reared in 12.5°C were larger, but not significantly, across all morphological traits. As a function of time, TL, TBA, HA, GFA, MA, and PFA were significantly larger, and YSA was significantly smaller for YSL reared in 17.0°C after 2 days post hatch and to the end of the experiment (stage 38) compared to all other temperatures. However, results were inversed as a function of developmental stage with significantly larger TL, TBA, HA, GFA, MA, and PFA, and smaller YSA (no significance) in 12.0°C reared YSL after developmental stage 38. Describing thermal induced responses in the development of White Sturgeon YSL is important to understanding recruitment processes and natural adaptability in altered systems, and can be used as a management tool to increase understanding of White Sturgeon reproductive ecology.

We have been successful in describing the overall composition and prey selectivity in the diet of hatchery reared juvenile White Sturgeon. This work is summarized in a recent publication in the North American Journal of Fisheries Management (Crossman et al. 2016[1]). The efficacy of two sampling methods, non-lethal gastric lavage (GL) and lethal sampling to remove stomach contents (SC), were evaluated across different ages, size classes, and river sections. Gastric lavage samples (n=108) were collected from fish angled in October 2012 and 2013. In 2012 only, a subsample of individuals were euthanized following the gastric lavage procedure, and stomach contents were collected (n=48). Benthic grabs (BG; n=45) were collected from areas of juvenile capture to describe food availability. Identifiable prey taxa were recovered from 60.3% of GL and 98% of SC among juvenile White Sturgeon sampled. While the diet of juvenile White Sturgeon was comprised of a diverse number of prey taxa (n = 16), most were selected less than their availability in the river. Prey diversity in SC was influenced by river section, not by fish size or age; fish in deeper, slower water consumed the highest number of prey taxa (mean = 4.6). Further, there was no significant overlap in diets among river sections, with the dominant prey taxa selected differing among river sections and years. Prey in GL, SC, and BG samples explained 56, 60, and 76% respectively, of the total prey taxa identified (n=25). Gastric lavage was 69% efficient at describing SC and a minimum of 100 GL samples were required from the wild to describe the diet to a comparable level as found with SC. Where lethal sampling is not an option, our results indicate GL, if conducted on appropriate numbers of fish, is effective at describing sturgeon diets and provides data that can be used to study the feeding ecology of threatened or endangered species. Survival analyses for juvenile White Sturgeon captures over the life of this program have found that annual survival has been higher than originally expected. This has resulted in an abundance estimate of over 30,000 hatchery origin juveniles in the transboundary reach of the Columbia River, spanning the lower Columbia River in Canada and Lake Roosevelt in the USA. Discussions surrounding numbers of hatchery juveniles at larger are being discussed with recovery team partners. Finally, the distribution of juvenile White Sturgeon in the

[1] Crossman, J.A., Jay, K.J. and Hildebrand, L.R., 2016. Describing the Diet of Juvenile White Sturgeon in the Upper Columbia River Canada with Lethal and Nonlethal Methods. North American Journal of Fisheries Management, 36(2), pp.421-432.

LCR is restricted primarily to deeper (>10 m), slow moving (< 1.0 m/s), habitats with smaller substrates (e.g., sand, small gravel). These habitats are widely distributed through the upper reaches (e.g., Robson) and are restricted to eddy habitats downstream of the Kootenay River confluence to the US border. These habitats are currently not limited by the operational regime of the river, irrespective of the time of year. Additional data will help to further address this question over a longer time period that includes more operational scenarios.

5.11 CLBMON-30 Lower Columbia River Opportunistic Assessment of High Flow Events

This monitoring program was initiated in 2009 and will be carried out over ten years. Work is ongoing and the results of a detailed movement analysis related to flows and environmental variables will be presented in a report submitted next year.

In order to address the effects of higher flow years on White Sturgeon movements, spawning site selection, and habitat use a long term data set is required. Importantly, both 2011 and 2012 were years of high sustained flows, where Columbia River discharge at the international borders reached levels that could not be achieved operationally. These years serve as the test years in the long-term database being developed. One of the key management questions is relating spawning site selection and years of higher flows, to determine if additional sites are used in those years. This has proved challenging due to the logistics associated with sampling equipment at higher flows (e.g., 2012 flow year) and a relatively small dataset on spawning locations outside of the primary site at Waneta. Spawning (documented through egg and larval captures) had only been identified to occur at the Waneta area prior to the monitoring studies under the Columbia River Water Use Plan being implemented. Results from recent WUP work reveal that spawning occurs downstream of HLK and ALH in some years, though it is not known if this site is used annually for spawning and continues to be the focus of additional monitoring. Spawning also occurs on an annual basis in the Kinnaird area, as egg and larval captures have been collected from 2007-2015. However, the main geographical boundaries and how they may change is years of higher flows, remains uncertain. Finally, there are multiple sites used for spawning south of the international border on an annual basis. Additional years of data are required to address this management question in further detail.

5.12 CLBMON-54 Mid Columbia Effects of REV 5 Flow Changes on Incubation and Early Rearing Sturgeon

This monitoring program was initiated in 2010 and was carried out over a three-year period ending in 2014. The final report also incorporates additional work that expanded the modelling through BC Hydro's Revelstoke Unit 6 environment project, which has proved beneficial to the analysis being conducted under the Columbia WUP study.

This project was based primarily on advanced hydraulic modelling which was developed over a three-year period to validate with field sampling over a range of Revelstoke Dam Discharges and Arrow Lakes Reservoir elevations. The work was implemented concurrently with CLBMON-20, due to similarities in management questions and methodology. The overall objective of CLBMON-54 was to examine the effects of the additional (5^{th}) generating unit at Revelstoke Dam on the spawning and early life stage habitat at the known spawning area. Results of this work demonstrated that the additional flows of Revelstoke unit 5 were only slightly

beneficial to the conditions experienced at the spawning location and more suitable early life stage habitat exists in the area then previously known. Suitable spawning parameters (depths and flows) existed over most operational scenarios tested.

6 Status of Physical Works

6.1 CLBWORKS-24 Mid Columbia Experimental Aquaculture

This physical works was initiated in 2007 and was carried out over five years ending in 2012. It is complete and CLBWORKS-25 has been initiated to continue conservation aquaculture in the Mid-Columbia.

6.2 CLBWORKS-25 Mid Columbia Sturgeon Conservation Aquaculture

This physical works was initiated in 2012 and will be carried out over five years ending in 2017. Attached is the report for Year 4 dated May 2016.

This program is a continuation of CLBWORKS-24. One primary goal of CLBWORKS-25 is to release juvenile sturgeon of a larger body size compared to historical values in order to help address questions of survival under CLBMON-21.

6.3 CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery

This physical works was initiated in 2008 and ended in 2010 with the construction of temporary rearing facilities that could be located on the banks of the Columbia River (e.g., Revelstoke). Currently, the facilities are under operation at the Kootenay Trout hatchery pending a decision in 2009 to not relocate them to the banks of the Columbia without more certainty in how streamside rearing would fit within recovery goals.

6.4 CLBWORKS-27 Lower Columbia Bentonite Addition Experiment

This physical works is now planned for implementation in late 2016 and early 2017. The Terms of Reference have been delayed and will be submitted by October 6, 2016. Following technical discussions and the outcomes of CLBWORKS-28, the implementation of this conditional study will occur over multiple phases.

The first phase will include a scoping exercise to evaluate substrate restoration at several locations in the Columbia River and will include hydraulic modelling. This is needed due to sensitivities in implementation of physical works due to limited knowledge regarding what changes are needed to substrates at White Sturgeon spawning grounds used in the lower Columbia. Once these changes can be identified, construction details and any associated post monitoring will be resubmitted in a phase two terms of reference. Additional phases will be submitted as required.

6.5 CLBWORKS-28 Lower Columbia River Planning and Assessment of WSG Turbidity

This physical works was initiated in 2011 and was carried out over two years ending in 2013. This study has helped to inform development of Terms of Reference and associated physical works options under CLBWORKS-27 by investigating likely causes of recruitment failure as they relate to physical and environmental conditions in the lower Columbia River. This work has been peer reviewed by several technical experts and also serves as an important study discussing historical recruitment patterns for this population.

6.6 CLBWORKS-34 Lower Columbia Sturgeon Conservation Aquaculture Program

This physical works was initiated in 2008 and will be carried out over 12 years ending in 2019. Attached is the report for Year 8 dated May 2016.

As highlighted in 2014, this program started piloting the use of wild eggs and larvae as supplemental progeny in the hatchery program. This was based on the results of genetic work conducted under CLBMON-28 which suggested that more wild adults could be represented in supplemental hatchery progeny using this method compared to the traditional broodstock program. Starting in the spring of 2014, a pilot program was initiated to investigate this as a conservation aquaculture option going forward. A small streamside trailer was been established on the banks of the Columbia River near the Waneta spawning grounds. Results from the 2014 pilot year for the streamside facility were successful, with over 1,000 wild origin juveniles released into the LCR. Due to successes in 2014, the facility is now being operated from 2015-2017 and the traditional broodstock program has been suspended for the lower Columbia going forward. Additional discussions are occurring at the UCWSRI TWG to determine long-term population goals and how this aquaculture program can meet those targets while augmenting genetic diversity through techniques like the culture of wild origin progeny.

7 Monitoring Programs and Physical Works Costs

The following table summarizes the Columbia River White Sturgeon Management Plan WUP monitoring programs and physical works costs approved by the Comptroller and the Actual Costs to June 30, 2016.

Table 7-1: Columbia River White Sturgeon Management Plan WUP Monitoring Programs and Physical Works Costs

Monitoring Programs	Costs approved by CWR	Life to Date Actuals (LTD)	Estimated to Complete (Forecast)	Total Forecast (LTD and Forecast)	Variance Total to Approved	Explanation	Corrective Action
CLB MP5 White Sturgeon Annual Report	$17,096	$7,879	$9,217	$17,096	$0		
C05M19A KIN: Sturgeon Invent	$591,767	$548,372		$548,372	$43,395	Project Complete	
C05M19A KIN: Sturgeon Invent - OR DM	$47,474	$33,419		$33,419	$14,055		
C05M19A KIN: Sturgeon Invent - OR Imp	$544,293	$514,953		$514,953	$29,340		
C05M20A MID COL White Sturge - OR	$313,123	$193,150		$193,150	$119,973	Project Complete	
C05M20A MID COL White Sturge - OR DM	$37,623	$24,819		$24,819	$12,804		
C05M20A MID COL White Sturge - OR Imp	$275,500	$168,331		$168,331	$107,169		
C05M20A MID COL White Sturge - ONR	$65,316	$41,194		$41,194	$24,122	Project Complete	
C05M20A MID COL White Sturge - ONR Imp	$65,316	$41,194		$41,194	$24,122		
C05M21A MID COL Juvenile Stu	$1,761,966	$1,280,372	$477,882	$1,758,254	$3,712	Project on Track	
C05M21A MID COL Juvenile Stu - OR DM	$167,316	$81,209	$32,869	$114,078	$53,238		
C05M21A MID COL Juvenile Stu - OR Imp	$1,594,650	$1,199,162	$445,013	$1,644,176	($49,526)		
C05M23A MID COL Sturgeon Egg	$1,504,542	$1,048,034	$283,900	$1,331,934	$172,608	The unspent implementation funds will be put towards an additional year of data collection to provide samples to CLBMON24. A letter to be submitted requesting this additional year.	
C05M23A MID COL Sturgeon Egg - OR DM	$155,990	$77,307	$30,273	$107,580	$48,410		
C05M23A MID COL Sturgeon Egg - OR Imp	$1,348,552	$970,727	$253,627	$1,224,354	$124,198		
C05M26A KIN: Sturg Recoloniz	$325,523	$266,280	$20,000	$286,280	$39,243	Project nearing completion, only reporting costs remain	
C05M26A KIN: Sturg Recoloniz - OR DM	$51,455	$26,260		$26,260	$25,195		
C05M26A KIN: Sturg Recoloniz - OR Imp	$274,068	$240,020	$20,000	$260,020	$14,048		
C05M27A MID COL Sturg Incub	$375,879	$360,581		$360,581	$15,298	Project Complete	
C05M27A MID COL Sturg Incub - OR DM	$56,570	$35,893		$35,893	$20,677		
C05M27A MID COL Sturg Incub - OR Imp	$319,309	$324,688		$324,688	($5,379)		
C05M28A LC: Adult Sturg	$3,483,799	$1,397,716	$815,868	$2,213,584	$1,270,215	Efficiencies found during project implementation	Broodstock capture has been suspended in favour of wild egg and larval collections. Budget being reassessed for additional effort at known spawning sites.
C05M28A LC: Adult Sturg - OR DM	$422,141	$112,191	$53,032	$165,223	$256,918		
C05M28A LC: Adult Sturg - OR Imp	$3,061,658	$1,285,525	$762,836	$2,048,361	$1,013,297		
C05M29A LC:Juv Sturgeon	$3,120,256	$1,425,376	$891,411	$2,316,787	$803,469	Efficiencies found during project implementation	Due to increasing numbers of juvenile sturgeon, additional revisions to survival models and collection of juvenile data required. Budget being reassessed.
C05M29A LC:Juv Sturgeon - OR DM	$218,003	$104,176	$43,350	$147,526	$70,477		
C05M29A LC:Juv Sturgeon - OR Imp	$2,902,253	$1,321,200	$848,062	$2,169,261	$732,992		
C05M30A LC: Opportunist	$526,741	$218,687	$86,555	$305,242	$221,499	Efficiencies found during project implementation	
C05M30A LC: Opportunist - OR DM	$131,917	$52,504	$19,751	$72,256	$59,661		
C05M30A LC: Opportunist - OR Imp	$394,824	$166,182	$66,804	$232,986	$161,838		
C05M54A MCR Effect of Flow	$328,107	$197,128		$197,128	$130,979	Project Complete	
C05M54A MCR Effect of Flow - ONR DM	$38,208	$18,727		$18,727	$19,481		
C05M54A MCR Effect of Flow - ONR Imp	$289,899	$178,401		$178,401	$111,498		
C05W24A MID COL Expersturg	$1,783,846	$1,783,846		$1,783,846	$0	Project Complete	
C05W24A MID COL Expersturg - OR DM	$50,606	$23,510		$23,510	$27,096		
C05W24A MID COL Expersturg - OR Imp	$1,733,239	$1,760,335		$1,760,335	($27,096)		
C05W25A MID COL Consr Sturg	$3,159,806	$1,258,764	$1,150,444	$2,409,209	$750,597	Efficiencies found during project implementation	Juveniles being released into the mid-Columbia are now targeted at 300 grams which will result in increased rearing costs. Budget being reassessed
C05W25A MID COL Consr Sturg - OR DM	$83,368	$18,874	$14,779	$33,653	$49,715		
C05W25A MID COL Consr Sturg - OR Imp	$3,076,438	$1,239,891	$1,135,665	$2,375,556	$700,882		
C05W26A MID COL Upgrd Sturg	$585,560	$532,938		$532,938	$52,622	Project Complete	
C05W26A MID COL Upgrd Sturg - OR DM	$9,018	$6,743		$6,743	$2,275		
C05W26A MID COL Upgrd Sturg - OR Imp	$576,542	$526,194		$526,194	$50,348		
C05W28A LC Pln Wsg Tur	$182,520	$77,139		$77,139	$105,381	Project Complete	
C05W28A LC Pln Wsg Tur - OR DM	$33,304	$16,053		$16,053	$17,251		
C05W28A LC Pln Wsg Tur - OR Imp	$149,216	$61,086		$61,086	$88,130		
C05W34A LC Sturg Aqua	$2,773,383	$1,472,534	$854,594	$2,327,128	$446,255	Efficiencies found during project implementation	Variation in the annual numbers of juveniles reared for stocking as the program relys on the collection of wild progeny. Budget reassessed annually.
C05W34A LC Sturg Aqua - OR DM	$152,467	$46,030	$15,278	$61,308	$91,159		
C05W34A LC Sturg Aqua - OR Imp	$2,620,916	$1,426,504	$839,316	$2,265,819	$355,097		

OR - Ordered Remissible

ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.