Columbia River Project Water Use Plan

Columbia River White Sturgeon Management Plan Monitoring Program and Physical Works

Annual Report: 2020

Implementation Period: July 2019 to June 2020

- **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 White Sturgeon Physical Works: Physical works options to address white sturgeon recruitment failure in the lower Columbia River**
- **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, 2020

BC Hydro Columbia River Project Water Use Plan
Columbia River White Sturgeon Management Plan
Monitoring Programs and Physical Works Annual Report: 2019

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, 2020, 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 Comptroller of Water Rights (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	Jul 16, 2018	Aug 03, 2018
CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility	Schedule F.1.e	Jun 15, 2007	Jul 11, 2007	Jan 09, 2019	Feb 05, 2019
CLBMON-24 Mid Columbia River Sturgeon Genetics	Schedule F.1.f	Not currently scheduled			
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	Jan 09, 2019	Feb 05, 2019
CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery	Schedule F.3.c	Apr 17, 2008	May 12, 2008		
CLBWORKS-27 Lower Columbia White Sturgeon Physical Works	Conditional List 10.a	Mar 17, 2017	Sep 29, 2017	May 30, 2018	Jun 06, 2018
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, 2020

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	2020 WLR YR14	2021 WLR YR15	2022 WLR YR16
CLBMON-19 Kinbasket Sturgeon Inventory and Habitat Use		✓	✓	✓F												
CLBMON-20 Mid Columbia River Spawning Habitat Assessment				×	✓	✓	✓	✓F								
CLBMON-21 Mid Columbia River Juvenile Sturgeon Detection and Habitat Program and Tracking of Existing Sonic Tagged Sturgeon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■
CLBMON-23 Mid Columbia River Sturgeon Egg Mat Monitoring and Underwater Videography Feasibility	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■
CLBMON-24 Mid Columbia River Sturgeon Genetics														u/w	■	
CLBMON-25 Kinbasket Juvenile Sturgeon Detection and Habitat Use	C*													☒		
CLBMON-26 Kinbasket Sturgeon Recolonization Risk Assessment and Habitat Suitability				✓	✓	✓	✓F									
CLBMON-27 Mid Columbia River Sturgeon Incubation and Rearing Study			✓	✓	✓F											
CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■
CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■
CLBMON-30 Lower Columbia River Opportunistic Assessment of High Flow Events			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	
CLBMON-54 Mid Columbia Effects of REV 5 Flow Changes on Incubation & Early Rearing Sturgeon				×	✓	✓	✓F									
Physical Works																
CLBWORKS-24 Mid Columbia Experimental Aquaculture		✓	✓	✓	✓	✓F										
CLBWORKS-25 Mid Columbia Sturgeon Conservation Aquaculture						✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■
CLBWORKS-26 Mid Columbia Sturgeon Upgrade Hatchery		✓	✓F													
CLBWORKS-27 Lower Columbia White Sturgeon Physical Works	C*								del	del	✓	✓	✓	u/w	■	
CLBWORKS-28 Planning and Assessment of WSG Turbidity				✓	✓	✓F										
CLBWORKS-34 Lower Columbia Sturgeon Aquaculture Program		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	u/w	■	■

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
- ✓F = All field work for this project is complete. No further field work is planned.
- ☒ = Relied granted
- 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 primary management question of this program was whether White Sturgeon were present in the Kinbasket Reservoir. The final report from this work helped inform CLBMON-26 described below. This project is complete.

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 (ALR) 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 were presented in the report and discussed in the context of the programs' management questions and the biology of the species. This project is complete.

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 was scheduled to be carried out over ten years ending in 2017. Cost efficiencies allowed for an additional year of monitoring with no additional budget that was completed in 2018. Following the Mid-Columbia River Technical Review in 2018, the program was extended an additional 5 years to ensure management questions could be adequately addressed. Additional sampling effort was deemed necessary to contribute to a longer-term dataset to improve confidence in the results through increased recaptures of hatchery-origin fish in the Mid Columbia River.

This monitoring program was designed to monitor the success (growth and survival) of hatchery-origin white sturgeon released into the MCR and Arrow Reservoir. The monitoring program has been successful in addressing general habitat use in the MCR through the use of telemetry on a subset of individuals. However, there has been limited success in evaluating growth and survival of fish released from the aquaculture program despite significant capture efforts expended as part of this program. To date, only 47 individuals have been captured, precluding any quantitative evaluation of survival. Low capture rates in MCR may be due to predation, slower growth, or a more challenging reservoir environment to sample. The majority of the captures have been captured within 1.5 years following release from the hatchery with only a single individual captured more than five years following the date they were released (10 years at large). While this suggests some capacity for survival, the program has yet to produce sufficient data to estimate survival or year class abundance which is required to address the management questions.

To address survival following release, the size of hatchery-origin juveniles has been increased over time: 75 grams in the initial Years 1 5; 150 grams in Years 6-8; and 300 grams in Years 8-10. The monitoring study was extended five years (2018-2022) to evaluate survival of the recent and largest year classes, and to obtain a sufficient sample size to address the management questions. The study extension was supported by participants at the Mid Columbia River White Sturgeon Technical Forum in December 2018.

Attached is the report for Year 13 dated May 31st, 2020 that covers capture efforts during 2019.

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

This monitoring program was initiated in 2007 and was initially planned for ten years ending in 2016 and cost efficiencies allowed for two additional years of monitoring with no additional budget, ending in 2018. The study was supported for extension until 2022 by participants at the Mid Columbia River White Sturgeon Technical Forum in December 2018 and approved by the CWR in February 2019. This will provide a longer dataset to improve the confidence in the results which is important for a long lived species like White Sturgeon.

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, and then reviewed again in 2018. A key result from the program has been the collection of both wild-origin eggs and larvae that were transferred to the hatchery program in each of 2018 and 2019. Since the inception of the aquaculture program in 2001, wild White Sturgeon from Arrow Reservoir had not been represented in supplemental progeny that were released. Of note, spawning has been detected at this location in 13 of 18 years where monitoring has occurred (10 of 10 WUP years). There has been no significant change to the delivery or implementation of this program with the exception of increasing sampling effort to attempt to collect additional wild-origin progeny for the conservation aquaculture program. These samples will also contribute to results from genetic analysis planned under CLBMON-24 towards the end of the WUP. Prior to successes in 2018 and 2019, very few tissue samples have been obtained as a result of low larval capture numbers.

Attached is the report for Year 13 dated July 9, 2020.

5.5 CLBMON-24 Mid Columbia River Sturgeon Genetics

The purpose of this program was to analyze samples collected from monitoring under CLBMON-23 to estimate numbers of spawning adults contributing to progeny collected at the Revelstoke spawning area. However, challenges to date in collecting sufficient genetic samples have precluded this program from being developed. In 2018, monitoring was successful in collecting a larger number of progeny from spawning events. In 2019 and 2020, further samples were obtained from spawning events and these samples, combined with the ones collected in earlier years (2007-2017) are sufficient for analysis. This is timely as other pertinent genetic questions exist in the lower Columbia River and work to analyze both sets of samples can occur concurrently to ensure efficient use of resources.

This study will be delivered in partnership with other recovery team members that have genetic samples from the population (US partners) and experts in white sturgeon genetics. Given the additional emphasis on collecting wild-origin progeny under CLBMON-23 and the extension to that sampling program, this TOR was delayed to allow for additional years to be included. The draft TOR for this program are being further revised and will be submitted when external review are completed.

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, would focus on identifying any unresolved questions rising from CLBMON-26, described below.

At the Mid Columbia River White Sturgeon Technical Forum in December 2018, participants agreed that CLBMON-26 is complete; hence no need for further work under CLBMON-25 as programs on the Arrow Lakes Reservoir are still being evaluated. A review of the feasibility of utilizing Kinbasket Reservoir as a recovery area for juvenile White Sturgeon will be conducted during the Columbia River Water Use Plan Order review. For this reason, the CWR granted relief on May 13, 2020 from implementing CLBMON-25.

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.

CLBMON-26 was designed in two phases. Phase one was an ecological risk assessment and forms the basis of the early reports. 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.

At the Mid Columbia River White Sturgeon Technical Forum in December 2018, participants agreed that this study is complete. Further evaluation of Kinbasket as a

recovery area will only occur if Arrow efforts are unsuccessful. A draft report detailing a conservation aquaculture strategy for this program was initiated but not completed. As the Arrow aquaculture program is still being evaluated, no further work is required at this time.

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. The primary purpose of this study was to investigate aspects of the relationship between temperature and early life history survival and recruitment. This project is complete.

5.9 CLBMON-28 Lower Columbia River Adult Sturgeon Population Monitoring

This monitoring program was initiated in 2008 and was initially carried out over 12 years.

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. At the conclusion of 2019, 14 sessions have been completed and preliminary data analyses have estimated a wild population abundance of 1070 (802 - 1427) individuals.

This project has been identified as critical by recovery initiative partners as it is providing data that are important for recovery of White Sturgeon in the Columbia. Cost efficiencies will allow for additional years of monitoring with no additional request for budget; therefore, the stock assessment is being extended until 2022 to further refine population abundance estimates, identify natural recruitment, and better define movements of both wild and hatchery-origin fish.

Attached is the report covering Year 12 dated July 29, 2020.

5.10 CLBMON-29 Lower Columbia River Juvenile Sturgeon Monitoring

This monitoring program was initiated in 2008 and was carried out over 12 years. Cost efficiencies during implementation will allow for additional years of monitoring with no additional request for budget; therefore the juvenile monitoring study is being extended until 2022.

Work under this program to describe survival, growth, and habitat use of hatchery-origin white sturgeon following release from the aquaculture program into the river has been very successful and used directly to inform management decisions related to stocking targets. Monitoring results have found there are 5,043 (3,823 – 6,648) hatchery origin white sturgeon at large in the lower Columbia River, extending the estimated extirpation of the population by several decades. Recent work has described the reproductive structure of the hatchery-origin population. Results suggest that a small proportion of males have reached maturity and may be contributing to spawning events.

Larval monitoring under this program has been successful in identifying larvae distributing from the Hugh L. Keenleyside (HLK)/Arrow Lakes Hydro (ALH) spawning area, downstream of Kinnaird, and from the Waneta spawning site downstream into the US portion of the lower Columbia River. These progeny are captured in the wild

and transferred to the hatchery for rearing and release in an attempt to increase genetic diversity in the conservation aquaculture program.

Attached is the report covering Years 11 and 12 dated July 2020.

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. The program is focused on larger analyses of long-term datasets to evaluate how sturgeon habitat use and movements are influenced by environmental variables. These analyses were started in early 2019 but are not complete given more time than expected to develop databases and models. The first step was developing a large relational database to manage all data types required for the analysis including life history information (e.g. capture and biological information), environmental covariates (e.g. flows or habitat), animal movements (e.g. telemetry), and other important program components (e.g. hatchery programs). That database is complete and comprehensive analysis of long-term telemetry data is underway to evaluate how environmental variables (flow and temperature) influence habitat use and the probabilities of movement between key habitats (e.g. between staging and spawning habitats).

A long-term data set has been developed to address the effects of higher flow years on White Sturgeon movements, spawning site selection, and habitat use. Importantly, both 2011 and 2012 were years of high (>200 kcfs) sustained flows (>4 weeks), 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 data set with the expectation that natural recruitment of wild juveniles would be detected through the CLBMON-29 juvenile monitoring program.

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 2007-2017. However, the main geographical boundaries and how they may change in years of higher flows, remains uncertain.

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 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 this Columbia WUP study. This project is complete.

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. The purpose of this program was to provide larvae and juveniles for release into the Mid Columbia to evaluate survival, habitat use, and impacts of Arrow operations on juvenile habitat availability and suitability (CLBMON-21). This project 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 carried out over six years. The project was supported for extension until 2022 by participants at the Mid Columbia River White Sturgeon Technical Forum in December 2018 and approved by the CWR in February 2019.

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 to help address questions of survival under CLBMON-21.

Attached is the report for Year 8 dated July 20, 2020.

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. This project is complete.

6.4 CLBWORKS-27 Lower Columbia White Sturgeon Physical Works: Physical works options to address white sturgeon recruitment failure in the lower Columbia River.

This project was initiated in 2018. Workshops were held in May 2019 and February 2020 to evaluate the suitability of current conditions at the known White Sturgeon spawning areas in the Lower Columbia River and to identify restoration options at spawning areas based on biological and technical feasibility. A final restoration alternative was selected for consideration in Phase 2 of this program.

The final report is attached dated July 2020. Development of the Terms of Reference for Phase 2 Construction Design is underway.

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. This project is complete.

6.6 CLBWORKS-34 Lower Columbia Sturgeon Conservation Aquaculture Program

This physical works was initiated in 2008 and was carried out over 12 years ending in 2019. Cost efficiencies will allow for additional years of this physical works with no additional request for budget; therefore the LCR sturgeon aquaculture program is being extended until 2022.

Starting 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. A small streamside trailer was 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. The program was then fully adopted in 2015 and the traditional broodstock program was suspended for the lower Columbia going forward. Wild-origin progeny have been successfully collected, reared, and released annually from 2015-2020. 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.

Attached is the report for Year 12 dated July 20, 2020.

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, 2020.

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

Monitoring Programs & Physical Works	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	$13,209	$1,452	$14,661	$2,435		
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 - 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		
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		
C05M21A MID COL Juvenile Stu	$2,466,620	$1,888,136	$464,754	$2,352,890	$113,730	Efficiencies found.	
C05M21A MID COL Juvenile Stu - OR DM	$139,992	$102,675	$29,848	$132,523	$7,469		
C05M21A MID COL Juvenile Stu - OR Imp	$2,326,628	$1,785,461	$434,907	$2,220,368	$106,260		
C05M23A MID COL Sturgeon Egg	$1,846,489	$1,394,496	$259,318	$1,653,813	$192,676	Efficiencies found.	
C05M23A MID COL Sturgeon Egg - OR DM	$116,589	$106,854	$19,318	$126,171	($9,582)		
C05M23A MID COL Sturgeon Egg - OR Imp	$1,729,900	$1,287,642	$240,000	$1,527,642	$202,258		
C05M24A MID COL Sturgeon Gen	$0	$4,154	$1,258	$5,413	($5,413)	A TOR is being developed for this project.	
C05M24A MID COL Sturgeon Gen - OR DM	$0	$4,154	$1,258	$5,413	($5,413)		
C05M24A MID COL Sturgeon Gen - OR Imp	$0				$0		
C05M25A KIN: Juv Sturg Detect	$0	$1,563		$1,563	($1,563)	Relief granted	
C05M25A KIN: Juv Sturg Detect - OR DM	$0	$1,563		$1,563	($1,563)		
C05M25A KIN: Juv Sturg Detect - OR Imp	$0				$0		
C05M26A KIN: Sturg Recoloniz	$325,523	$266,280		$266,280	$59,243	Project complete.	
C05M26A KIN: Sturg Recoloniz - OR DM	$51,455	$26,260		$26,260	$25,195		
C05M26A KIN: Sturg Recoloniz - OR Imp	$274,068	$240,020		$240,020	$34,048		
C05M27A MID COL Sturg Incub	$375,879	$361,272		$361,272	$14,607	Project complete.	
C05M27A MID COL Sturg Incub - OR DM	$56,570	$36,585		$36,585	$19,985		
C05M27A MID COL Sturg Incub - OR Imp	$319,309	$324,688		$324,688	($5,379)		
C05M28A LC: Adult Sturg	$3,483,799	$2,068,316	$435,077	$2,503,393	$980,406	Efficiencies found.	
C05M28A LC: Adult Sturg - OR DM	$422,141	$150,041	$33,336	$183,376	$238,765		
C05M28A LC: Adult Sturg - OR Imp	$3,061,658	$1,918,275	$401,741	$2,320,017	$741,641		
C05M29A LC:Juv Sturgeon	$3,120,256	$2,140,044	$651,936	$2,791,980	$328,276	Efficiencies found.	
C05M29A LC:Juv Sturgeon - OR DM	$218,003	$141,530	$31,674	$173,205	$44,798		
C05M29A LC:Juv Sturgeon - OR Imp	$2,902,253	$1,998,513	$620,262	$2,618,775	$283,478		
C05M30A LC: Opportunist	$526,741	$409,768	$28,716	$438,484	$88,257		
C05M30A LC: Opportunist - OR DM	$131,917	$71,165	$3,578	$74,744	$57,173		
C05M30A LC: Opportunist - OR Imp	$394,824	$338,602	$25,138	$363,740	$31,084		
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	$1,783,845	$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	$2,158,928	$362,508	$2,521,436	$638,370	Efficiencies found.	
C05W25A MID COL Consr Sturg - OR DM	$83,368	$38,705	$16,165	$54,870	$28,498		
C05W25A MID COL Consr Sturg - OR Imp	$3,076,438	$2,120,223	$346,343	$2,466,566	$609,872		
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		
C05W27A LC Recruitment Failure	$682,179	$556,524	$20,657	$577,181	$104,998	A TOR is being developed for this project.	
C05W27A LC Recruitment Failure - OR DM	$164,199	$107,450	$20,657	$128,107	$36,092		
C05W27A LC Recruitment Falure - OR Imp	$517,980	$449,075		$449,075	$68,906		
C05W28A LC Pln Wsg Tur	$182,520	$77,554		$77,554	$104,966	Project complete.	
C05W28A LC Pln Wsg Tur - OR DM	$33,304	$16,468		$16,468	$16,836		
C05W28A LC Pln Wsg Tur - OR Imp	$149,216	$61,086		$61,086	$88,130		
C05W34A LC Sturg Aqua	$2,773,383	$1,948,733	$614,809	$2,563,542	$209,841	Efficiencies found.	
C05W34A LC Sturg Aqua - OR DM	$152,467	$67,164	$15,668	$82,832	$69,635		
C05W34A LC Sturg Aqua - OR Imp	$2,620,916	$1,881,569	$599,141	$2,480,710	$140,206		

OR - Ordered Remissible
ONR - Ordered Non-Remissible