Peace River Water Use Plan

Monitoring Program Terms of Reference

GMSMON-4 WAC Bennett Dam Entrainment

TOR Revision 1

May 21, 2021

GMSMON-4 - WAC Bennett Dam Entrainment Monitoring Program Terms of Reference Revision 1

REVISION OVERVIEW

The GMSMON-4 Terms of Reference (TOR) (February 9, 2008) is intended to be a conditional monitoring program to be implemented in the event of the spill to monitor the entrainment of fish through the WAC Bennett Dam spillway. This monitoring is required in the event of a spill under the Peace Project Water Use Plan (WUP) Order dated August 9, 2007, Schedule D, Clause 3 (b) as follows:

b) spillway entrainment at WAC Bennett Dam during spillway discharge that exceeds a daily average of 205 cubic metres per second for at least 2 days.

The objectives of GMSMON-4 are to: estimate the number, size, and species of fish entrained; determine the relationship between spill discharge and entrainment rate; estimate acute mortality caused by spillway entrainment; develop an understanding of the relative impact to reservoir populations; and to determine if there is a relationship between entrainment rates and diel/spatial variables (e.g., time of day, depth of fish; BC Hydro 2008).

The methods specified to monitor entrainment include a hydroacoustic survey to detect the presence of fish in the water column and differentiate fish size as the fish approach the spillway gate. Fish index sampling was also implemented in Williston Reservoir to document species assemblage in the vicinity of the spillway, and in some years within the lower Peace Arm more broadly. Additional fish sampling was specified for Dinosaur Lake to document species, size, and condition of fish mortalities observed downstream of the WAC Bennett Dam/GM Shrum (GMS) facility following spills. A pilot mortality assessment was to be carried out concurrently to estimate the mortality rate of fish entrained through the spillway but has not been implemented to date.

Monitoring under this TOR has been triggered by two spill events so far. One occurred in the summer of 2012 and the most recent in the summer of 2020. Hydroacoustic indexing in 2012 provided the most recent population estimates since the conclusion of GMSMON-13 Williston Fish Index in 2007. Comparable approaches (i.e. using mobile hydroacoustic surveys upstream of GMS) were not completed in the 2020 monitor and only index netting to characterize fish populations was conducted in the Williston forebay. Methodological refinements in 2012 and 2020 monitors show updated hydroacoustic techniques in the spillway entrance improved estimation of entrainment rates. However, uncertainties remain in addressing mortality rate and relative population-level impacts of entrainment across variable spill conditions. A key data gap is a poor understanding of the basic biological characteristics of the fish community in Williston Reservoir. Recent surveys indicate that shifts in the community may be occurring. Thus, to better understand the potential impact of entrainment on populations in Williston Reservoir, more robust fisheries indexing is required. Furthermore, the resulting mortality rate associated with entrainment remains

poorly understood, and a new sampling methodology is proposed to provide better quantitative estimates of injury and mortality across species, sizes, and operational contexts.

Table 1: Key changes to the GMSMON-4 TOR and rationale for their inclusion

Section	Change	Rationale
1.0 Program Rationale	• Added the history to the Background. • Management questions and hypotheses remain the same though more information is provided for clarity	• Identifies data gaps in monitoring to date. • Ensure spill discharges meet the criteria specified in Schedule D of the Order (Spill Protocol Management Plans) • information added for clarity
2.1 Objective and Scope	• Broadens the scope of fish indexing in the Peace Reach of Williston Reservoir	• Understand size-classes known to be entrained and cover a broader spatial and temporal scale
2.2 Revision to Approach and 2.3 Methods	• Specifies an appropriate alternative cost-effective method for determining mortality rate of entrained fish (e.g., SensorFish)	• Understand the mortality rate of fish entrained through the spillway • Better answer the management questions
2.5 Schedule	• Recommends extending GMSMON-4 until the WUPOR and account for up to three more spill events during that period	• Understand population trends and how those are affected by entrainment mortality • Understand entrainment impacts across variable flows, when available, along with refinements to methods
2.6 Budget	• Budget has been updated to encompass the scope, schedule and method changes	• Based on the rationale stated above

1.0 Program Rationale

1.1 Background

The Peace Water Use Plan Committee (hereafter known as the Committee) recognized that fish are entrained through the spillway during the spill events and consequently recommended that a monitoring program be implemented to track this fish entrainment issue during spill releases at the Williston Project.

The WAC Bennett Dam Entrainment study addresses two management plans, the Peace Spill Protocol (PSP) and the Peace River Flood Pulse Plan (BC Hydro 2003). Both positive and negative impacts are expected from a spill and this monitoring program will focus on the negative impact of fish loss through entrainment. As part of the PSP, this study will address the uncertainty of (i) the relative magnitude of fish entrained through the spillway, (ii) the relationship between discharge rate and numbers of fish entrained, (iii) acute fish mortality caused by spillway entrainment, and (iv) the relative impact to reservoir populations. As part of the Peace River Flood Pulse Plan, the results from this monitoring program may act as a weighting against the ecological merits of flood pulses. The monitoring programs within both of these management plans will be conducted opportunistically as no planned spill release is proposed. Spill events on the Peace system exceeding generation capacity of 205 m^3/sec were historically rare, occurring only four times since 1968-2003. Four additional spills events have occurred for other reasons during this period (BC Hydro 2003). These eight spills, in total, roughly equate to a spill occurring on average once

every five years. Since the introduction of the WUP, GMSMON-4 has monitored entrainment in two years (2012 and 2020). The frequency of spills at GMS is expected to increase in future years as a result of uncertainty in future hydrologic conditions.

1.2 Management Questions

The management questions for GMSMON-4 remain unchanged from the original TOR, however explanatory notes have been added to clarify outstanding aspects of each management questions.

1) *What is the magnitude of fish entrainment through the spillway during a spill event?*

To date, management question 1 has been addressed by estimating the number of fish entrained via hydroacoustic monitoring and contrasting this with population information from other studies in the Peace WUP (i.e., GMSMON-13: Williston Fish Index). Results from MON-13 (completed in 2008) and MON-4 (completed in 2012 and 2020) indicate a trend of shifting fish communities in the Peace Reach of Williston Reservoir. To adequately describe the population-level consequences of entrainment, index sampling in Williston Reservoir remains an important component of GMSMON-4. With the completion of GMSMON-13 and given observations that suggest a shift in community composition may be occurring, the scope for fish index sampling has been expanded herein.

2) *Is there a relationship between spill discharge rate and numbers of fish entrained through the spillway?*

The purpose of management question 2 is to establish a relationship between spill discharge rate and numbers of fish entrained, which is useful for predicting the impact of future spills on fish in Williston Reservoir. It is also important is to establish if certain species or size classes of fish appear to be more susceptible to entrainment or mortality under different operating conditions. Over the past two monitoring cycles, limited spill velocities have been present for monitoring. In 2020 – a spill event that saw relatively stable spill discharge velocities – effort was directed towards monitoring entrainment variation over time and observed short-term, large-scale entrainment events, indicating that flow rate may not be the sole driver of entrainment rate (Golder, 2021). Continued monitoring across variable flows, when available, along with refinements to hydroacoustic methods (2.2.1) will improve the capacity to address management question 2.

3) *What species and sizes of fish are entrained through the spillway?*

Management question 3 is essential for determining the relative impact of spills on different fish populations in Williston Reservoir, and will continue to be addressed by pairing observations derived from hydroacoustic monitoring (management question 1 and 2) with fish indexing in Williston Reservoir. In 2020, declines in capture of Kokanee and Peamouth Chub were reported, along with the first observations of Redside Shiner and Lake Trout in Williston Reservoir fisheries surveys (Golder, 2021). Overall, a fish indexing component that targets size-classes known to be entrained and covers a broader spatial and temporal scale is required to answer management question 3.

4) What rate of mortality is occurring in fish entrained through the spillway?

Management question 4 has not been adequately addressed to date, with the only entrainment mortality estimates predating the WUP. Estimating the mortality rate of entrained fish will not inform estimates on relative impact of entrainment on Williston Reservoir populations, as all entrained fish are functionally lost to this system, regardless of mortality. Management question 4 is valuable for understand what role, if any, spills at GMS play in subsidizing downstream communities.

Recommended changes to the methods (2.2.3) will provide a more reliable mortality rate estimate than the pilot telemetry method suggested in the original TOR while supporting the *Reservoir Sampling* component of Task 2 (BC Hydro 2008).

1.3 Management Hypothesis

The primary hypotheses to be tested are:

H_1: There is a correlation between spill discharge rate and number of fish entrained over the spillway;
H_2: The diel distribution of fish entrained through spillway is not uniform;
H_3: Spatial distribution of fish entrained through spillway is not uniform in the water column;
H_4: Entrainment through the spillway results in acute mortality to fish.

The first hypothesis (H_1) will test for a correlation between spill discharge rate and the number of fish entrained. If possible, the hypothesis can be examined more specifically (i.e., by species, life stage, etc.,) based on the level of information gathered. For H_2 and H_3, results from 1996 and 2012 studies observed higher entrainment rates in the twilight and evening hours and increased entrainment within the first 10 meters of the water column (Biosonics, 2012). Peak entrainment rates at sunrise were also observed in 2020, however entrainment rates were lower and at greater depth during the afternoon and evening (Golder, 2021). During the 2020 study, flow rates remained relatively stable, and as a result effort was made to evaluate variability in entrainment rates over constant flows. A high degree of daily variation in entrainment rates was observed, with large entrainment events occurring sporadically, and potentially corresponding to schooling behavior in entrained fish (Golder 2021).

Downstream mortality monitoring conducted in 2020 contributes to understanding H_4, however further work is needed to understand how spill discharge and timing affect mortality rate.

1.4 Key Water Use Decision Affected

The original key water-use decisions were to inform future spill strategies and the necessity of flood pulse events to maintain side channel and riparian habitat. In addition to the information from this monitoring program, other studies within the Peace Spill Protocol and the Peace River Flood Pulse Plan will influence water-use decisions. These decisions have important implications for water management and ecological values.

Understanding the population level consequences of entrainment at GMS requires improved estimates of the abundance and demographic structure of fish populations in Williston Reservoir. Since the completion of GMSMON-13 in 2008, characterization of the Williston fish community has been limited to the indexing studies for GMSMON-4 in 2012 and 2020. Given the shifts in community composition observed across these three monitoring periods, it is necessary to continue efforts to index fish populations in Williston Reservoir. This population data is needed to evaluate both the composition of fish species and sizes entrained in a given spill event (and estimate population effects), but also to document changes in the fish community that may be related to entrainment.

Results of the monitor will also be used to address an outstanding data gap concerning the role that spill volume and duration play in entrainment and mortality rate of fish in Williston Reservoir. Presently, the monitor is implemented when flows exceed 205 m^3/sec for more than 48 hours. In the 2020 investigation, monitoring occurred at flows of 522-650 m^3/sec, and were relatively stable throughout the period. Emphasis on monitoring entrainment across a range of flows, operations (gate configurations), and durations is a key consideration moving forward.

2.0 Monitoring Program Proposal

2.1 Objective and Scope

The objectives of the monitoring program (which are unchanged from the original GMSMON-4 TOR) are to:

1) Estimate the number of fish, size, and species of fish entrained through the spillway into Dinosaur Reservoir
2) Determine the relationship between spill discharge rate and number of fish entrained through the spillway during spill releases at WAC Bennett Dam
3) Determine the level of correlation between diel/spatial variables (e.g., time of day, fish depth in water column) and number of fish entrained through the spillway during spill releases at WAC Bennett Dam
4) Estimate the rate of acute mortality in fish entrained through the spillway

Monitoring of fish entrainment will occur at the spillway of the WAC Bennett Dam during the entire period of a spill or some statistically representative period of time should there be time constraints. When possible, effort will be directed towards monitoring entrainment across a range of flows and gate configurations. Results will be used to determine the relationship between numbers of fish entrained and spill discharge, as well as diel and spatial variation.

Fish index surveys will be undertaken as near or prior to the spill and span the lower reach of the Peace Arm of Williston Reservoir to identify the species present in the forebay, and if this varies from other reaches before and after spills. Monitoring methodology will be consistent with previous surveys (LGL 2012) and expand upon key areas of uncertainty highlighted in recent work (Golder, 2020).

The rate of fish mortality will be estimated using an approach that characterizes the conditions experienced by fish across a variety of flow scenarios. The study

would apply the observed physical conditions during spillway passage to model injury and mortality probabilities and examine factors influencing mortality rate such as variation in spill discharge and gate configurations, and fish species and size.

Implementation of this study is conditional on the opportunistic occurrence of a spill event where spill discharge (Qsdi) is greater than 205 m^3/sec (7240 cubic feet per second) at WAC Bennett Dam occurs for two days or longer. The study will be implemented for each spill event that meets this criterion.

2.2 Revision to Approach

This monitor will be carried out as a series of four independent components, each corresponding to the critical uncertainties identified in this revision. The following summarizes refinements to each approach and rationale for methodology changes, which are detailed in Section 2.3.

2.2.1 Entrainment Monitoring

The hydroacoustic approach outlined in the original TOR suggested upward facing transducers could be more effective at detecting fish in the water column. Hydroacoustic monitoring was implemented in 2012 during two spills from June 26 to July 11 and from July 24 to August 2 and used downward-facing transducers (Biosonics 2012). High fish abundances were found at mid-column depths and the 2012 GMSMON-4 report recommended installation of both horizontal and downward facing transducers to detect fish throughout the water column and better estimate the number of entrained fish (Biosonics 2012). The 2020 assessment implemented this recommendation and found that the vertical transducer revealed similar entrainment rates as 2012, while the horizontal transducer improved target identification in the upper water column, and improved model derived estimates in the lower water-column as well (Golder 2021). The horizontal transducer detected approximately three times as many targets as the vertical transducer, and improved estimation of smaller size classes (<75mm) which represent the largest proportion of entrained fish. In 2012 BioSonics develop an equation relating spill rate at GMS to the number of fish entrained. The 2020 data suggest that the 2012 entrainment model likely underestimates entrainment rate, a result that is likely driven by better enumeration methods from inclusion of horizontally oriented sonar. Future entrainment monitoring will benefit from employing both horizontally and vertically oriented split beam sonars.

Stationary hydroacoustic monitoring in the spillway bay will be initiated to enumerate entrained fish in each spill event where GMSMON-4 is triggered and will follow the methodologies refined in 2020 (2.3.1).

2.2.2 Fish Community Indexing

The most recent community index estimates were conducted using hydroacoustic surveys in 2012 (LGL, 2012). Comparable approaches were not completed in the 2020 monitor, which used index netting to characterize fish populations in the Williston forebay. When compared to the 1974, 1988, 2000 and 2008 results, the species composition in the Peace Reach and the vicinity of WAC Bennett Dam appeared to be shifting from a Lake Whitefish dominated fish fauna to a Kokanee and Peamouth Chub dominated one (LGL, 2012). Results

from 2020 index sampling revealed further shifts in community structure that were not previously identified, including declines of Rainbow Trout, Kokanee and Peamouth Chub, as well as the first record of Lake Trout and Redside Shiner during gill net surveys in Williston Reservoir. Further, capture rates varied both spatially and temporally, with gill net sets in the vicinity of the spillway (<500m) capturing zero fish despite considerable sampling effort. This trend of decreasing abundance near the spillway may be reflective of spillway avoidance, or conversely of reduced population resulting from entrainment. Index netting methods were also not adequate to characterize the species composition of fish in smaller size range, with the expected minimum capture length of 116 mm (Golder, 2021).

Community indexing under GMSMON-4 will be implemented in each of the next three monitoring seasons and has been expanded to better assess the spatial and temporal aspects of sampling efficiency (2.3.2).

2.2.3 Entrainment Mortality

Downstream Mortality Monitoring

To estimate the number of fish mortalities resulting from spillway operation, the original GMSMON-4 TOR specified a mark-recapture study. Estimation of entrainment mortality in the system was difficult as assumptions of the mark-recapture program could not be met, and netting of fish was limited to the water surface. The 2002 entrainment study (BC Hydro 2002) focused efforts on a mark recapture program similar to the 1996 study. This study provided estimates of mortality but no estimate of entrainment rate. In both the 1996 and 2002 studies, lake whitefish experienced the greatest mortality. The TOR specified the pilot study should collect fish from two species, implant live fish and carcasses from each species with telemetry tags, and release three groups of up to 25 fish each into the spillway, or spillway tailrace, to compare the spatial and temporal movement of the live and deceased fish and estimate survival. Pilot mortality assessments were not undertaken in 2012 as the focus of the hydroacoustic monitoring was estimating the rate of entrainment as it related to operations (Biosonics 2012). The pilot mortality study was also not initiated in 2020 because of short lead times and complications in contractor and equipment mobilization resulting from the COVID-19 pandemic (Golder 2021).

Entrainment mortality monitoring in 2020 field sampling involved the enumeration of deceased fish found downstream of the spillway following spill events (Diversified, 2021). This approach has been useful to confirm the presence of entrainment mortality; however, has limited ability to quantitatively estimate the proportion of fish mortalities and any biological or operation covariates. Downstream fish mortality monitoring will be conducted under each GMSMON-4 monitoring period and will provide qualitative data that can support further mortality estimates provided from modelling assessments (2.3.3).

Entrainment Mortality Assessment

Previous assessments of adult bull trout, lake trout and kokanee entrainment via intake structures has been undertaken at GMS under the Peace River Fish Entrainment Strategy (FES). The results of these acoustic telemetry studies have highlighted multiple challenges with operationalizing such a study, including difficulty with fish capture, low post-tagging survival of kokanee and juvenile fish,

challenging conditions for receiver deployment and recovery in the forebay and tailrace of GMS, and limited detection efficiency of tagged fish in noisy downstream environments such as during a spill event (Harrison et al 2019; Algera et al 2020). Future implementation of the mortality assessment as outlined in the TOR is likely to be challenged by the same circumstances identified in the FES studies, and would likely necessitate data from multiple spill events to provide more certainty to the results. Further, the small release groups and anticipated uncertainty in movement (e.g., away from spillway), as well as confounding influence of tagging on mortality would likely bias mortality estimates.

The GMSMON-4 TOR specifies that collection of mortality rate data is not exclusive to the proposed method if an appropriate alternative cost-effective method is determined. Recent technological developments in sensor and data logging provide a novel approach for evaluating entrainment impacts by measuring the pressure and acceleration forces experienced by fish during entrainment. Data loggers, such as the SensorFish (Advanced Telemetry Systems Inc, Isanti, Minnesota), can include temperature, pressure, and acceleration sensors, and a gyroscope, with data recorded for approximately five minutes with ~2000 measurements per second as the device is put through a specific structure (e.g., turbine or spillway). Such an approach will allow estimation of mortality without requiring the capture and subsequent observation of wild fish. An advantage of this approach is that it allows for data on passage conditions to be collected across a range of operational configurations (i.e., spill velocities) and data can be extrapolated to model injury and mortality probabilities across a range of species and size classes. Therefore, data collection using SensorFish can proceed in only one spill event and the model can be used to retroactively calculate injury and mortality rates. While this approach avoids the limitations of telemetry studies detailed above, it also does not enumerate absolute mortality values (which will be influenced by factors that affect entrainment rate). The objective will be to use the qualitative observations of downstream mortality, and upstream enumeration of entrained fish, with the model of injury and mortality probability to understand the relative impacts of different operational configurations on mortality.

2.3 Methods

2.3.1 Entrainment Monitoring

Hydroacoustic equipment will be rented or purchased (as required) and installed at a date that is as close as possible to the start of the spill and maintained throughout the spill. If possible, installation will occur just prior to the start of a spill if there is a high degree of certainty of a spill. The general approach will be to deploy horizontally and vertically oriented split-beam transducers to estimate fish passage rates and estimate vertical and horizontal distribution of fish through the Spillway Operating Gates (SPOG's), following the approach used in 2020 (Golder 2021). Effort should be made to enumerate fish targets in both SPOG's across a number of flow rates to validate the flow-entrainment rate equation developed by BioSonic (2012). Equipment and data collection will be monitored remotely to ensure proper functioning.

2.3.2 Fish Community Indexing

A mobile hydroacoustic survey will be conducted to determine the species composition and relative size and abundance of fish in the Peace Reach of Williston Reservoir. The mobile survey will closely follow transects in the vicinity of the Bennett Dam forebay surveyed under GMSMON-4 in 2012 (LGL 2012). Following Sebastian et al.'s (2009) recommendations hydroacoustic surveys will also use a side-looking transducer in addition to a down-looking transducer to detect fish close to the surface. Index netting will be conducted to validate acoustic targets at a subsample of locations (following LGL, 2012) and to the extent possible should also replicate the littoral and pelagic index sites surveyed in 2020 (i.e., include multiple sites). In particular, effort should be made to describe fish targets <116 mm, for example via the use of appropriate index nets to fully characterize the size classes of observed entrained fish.

To accurately assess the impacts to reservoir populations, it is important to sample during the same season as spills events are occurring, and to identify any diel aspects of depth distribution (i.e., depth use during day vs night). To gain an understanding of species present in the vicinity prior to spills, index netting near the spillway (<500 m) should near or prior to the initiation of spills. Fish index surveys will be implemented in each of the next three spill monitoring periods, to maintain an understanding of how fish communities are changing over time and ensure correlations with entrained fish targets under 2.3.1 are using relevant fisheries data.

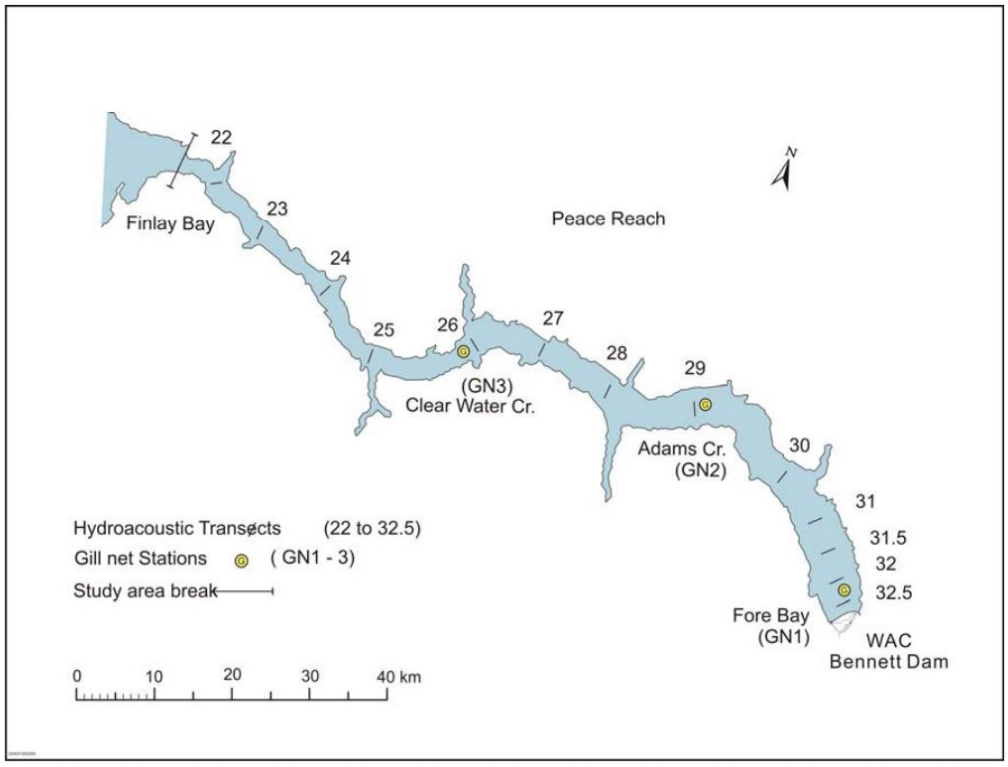

Figure 1. Map of the Peace Reach of Williston Reservoir showing location of hydroacoustic transects and gillnet stations from GMSMON-13 (Sebastian, 2008)

2.3.3 Downstream Mortality Monitoring

Downstream mortality monitoring in Dinosaur Reservoir will commence as soon as possible after the start of spill at WAC Bennett Dam and will continue for at least four days. Repeat sampling events will be required if spill duration extends beyond one week. Sampling will begin upstream near the Gething Creek fan and may extend as far downstream as the 500 kV powerline. Surface sampling with dip-nets will be used to collect mortalities. Sampling will begin at first light and continue until mid-day or until there is a notable decline in fish observed. Once mid-stream sampling has ended, the banks and any back-eddies should be surveyed for any collected mortalities.

Data to be collected during mortality monitoring includes:

- Sampling location (GPS coordinates)
- Species
- Length (mm)
- Condition (i.e., dead, moribund, injured or behaviourally effected, active)
- Injury type (physical or Gas Bubble Trauma)
- Gas bubble trauma (GBT) symptoms (yes or no, and symptom description)
- Photos of all dead, moribund, injured or behaviourally effected fish
- All dead or moribund fish are to be collected, properly labelled and maintained frozen for future sampling
- All live fish are returned to the river

2.3.4 Entrainment Mortality Assessment

Mobile deployed data logging sensors (SensorFish or equivalent technology) will be purchased and used to characterize physical conditions experienced during passage of entrained fish. A series of logger deployments will be conducted across a biologically relevant range of flows. Sensor values recorded will include temperature, pressure, acceleration and gyroscope measures which will be compared to lab derived estimates of barotrauma and survivorship for a range of species and size classes. The Hydropower Biological Evaluation Toolset (HBET) provides a suite of analytical tools to evaluate physical and biological performance of SensorFish (Hou et al. 2018). The timing of the study will make use of pre-planned spill events (i.e., will not spill solely for the study), and where possible spill conditions may be modified to accommodate study design (i.e., evaluate different spill velocities). The entrainment mortality assessment will only be conducted in one spill event, with a focus towards later field seasons, to facilitate hindcasting of mortality estimates.

A product of this study will be the development of a model to estimate injury and mortality probability across a range of fish sizes and species, based on hydraulic experience during entrainment. This model will be used to calculate entrainment mortality estimates for concurrent and previous spill events based on the results of the hydroacoustic assessment of entrainment rate.

2.4 Interpretation of Monitoring Program Results

The information from the study will contribute to the overall assessment of environmental response to spills. If the hydroacoustic assessment and mortality assessment indicate that large numbers of fish are suffering acute mortality from entrainment, then this will suggest a need to assess spill strategies and mitigate the negative impacts on reservoir fish. Additionally, if this study in combination with Williston Reservoir Fish Index (GMSMON-13) suggests that the relative impact to upstream populations is substantial then this will further support the need to assess spill strategies. Establishing a correlative relationship between spill discharge rate (or environmental variable such time of day) and number of fish entrained will assist in the development of spill strategies to mitigate the negative impacts. Similarly, better understanding the relationship between entrainment mortality and spill discharge duration, timing, and rate, may inform operational strategies to minimize impacts to Williston Reservoir fish populations.

2.5 Schedule

Entrainment monitoring (2.3.1), fisheries index surveys (2.3.2) and downstream mortality monitoring (2.3.3) are to be implemented in each of the three spill events of the monitor, while entrainment mortality assessments (2.3.4) are to be implemented only in one spill event prior to WUPOR.

2.6 Budget

The budget accounts for implementing monitoring of three spill events between 2021 and WUPOR. Additional funds are requested to cover the methods, effort and schedule outlined in this TOR revision. Each spill monitoring event requires contractor mobilization/demobilization, the rental or purchase of specialized equipment, installation, removal, and/or calibration of the equipment in order to accommodate ongoing advancements in hydroacoustic monitoring technology. The implementation cost is estimated to require an additional $786,126 without contingency, and $864,739 with contingency.

Total Revised Program Cost $864,739

3.0 References

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