

Bridge-Seton Water Use Plan

Monitoring Program Terms of Reference

- BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring Terms of Reference

Addendum 1

March 5, 2015

A1 Addendum to BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring Terms of Reference

A1.1 Addendum Rationale

During the Bridge River Water Use Plan (WUP) development process, the primary operational change with potential impacts on the productivity of Seton Lake was considered to be the seasonal timing of diversion from Carpenter Reservoir into Seton Lake. However due to a key information gap pertaining to Seton Lake Reservoir resident fish population the impacts of Carpenter diversions on resident fish could not be adequately assessed during the WUP development process.

The key data gap was related to poor understanding of the basic biological characteristics of resident fish species inhabiting the lake. To resolve this data gap the Bridge River Consultative Committee (BRG CC) recommended long term monitoring study to obtain more comprehensive information on Seton Lake habitats and resident fish populations. To this end, a set of management questions related to fisheries management goals and associated hypotheses regarding potential environment responses to the selected WUP operations were also defined.

However, after implementing the study for the first two years, some key deficiencies in the effectiveness of data collection methodologies and resident fish distribution assumptions (in pelagic versus littoral habitats) were identified as described below. Please refer to Table 1 for a summary of the key changes and the rationale for their inclusion.

A1.1.1 Deficiencies in data collecting approaches:

Some data collection approaches (e.g., boat electrofishing, mark-recapture methods) recommended in the original design were found to be ineffective for the identified target species in the Seton Lake context. Specifically the capture rate of target fish species in the littoral zone has been unsatisfactory for meeting the objectives of this monitoring program.

A1.1.2 Deficiencies in spawner survey effectiveness:

Tributary spawner surveys are found to be ineffective due to: poor visibility during the spawning period; limited availability of spawning habitat in the tributaries to Seton Lake; and the ability of target species to access and use preferred spawning habitats either within the lake itself or outside of the study area.

A1.1.3 Deficiencies in fish distribution assumptions:

At least two of the three target species for this monitoring program (i.e., bull trout and Gwenuis) are distributed in the pelagic zone of the lake where preferred food items, such as zooplankton and salmonid smolts, are available.

Due to these deficiencies this monitoring study needs to be revised in order to refine the data collection approaches to improve its ability to answer the management questions. The changes made are outlined below.

A1.2 Management Questions

The management questions remain unchanged from the original Terms of Reference (TOR) but some explanatory notes have been added to this Addendum to clarify how the management questions will be answered.

- 1) What are the basic biological characteristics of resident fish populations in Seton Lake and its tributaries?

This management questions will be evaluated using fish population abundance or index of abundance, fish distribution and biological characteristics data. Target species include rainbow trout, bull trout and Kokanee (Gwenis)

- 2) Will the selected operating alternative (N2-2P) result in positive, negative or neutral impact on abundance or index of abundance and diversity of target fish populations?

This management question will be evaluated using weight-of-evidence as exhibited by trends in fish population abundance and trends in their biological characteristics in conjunction with trends in reservoir operation. The underlying operational cause-effect relationship associated with any response may not be evident from this analysis alone. However, reservoir productivity data from BRGMON-6 will be used to evaluate WUP operations impacts on underlining reservoir productivity that could in turn be linked to impacts on productivity of the resident fish population

- 3) Is there a relationship between the quality, quantity, and timing of water diverted from Carpenter Reservoir on the productivity of Seton Lake resident target fish populations?

This management question will be evaluated using basic habitat quality and diversion timing data collected in the reservoir in conjunction with trends in fish abundance and productivity data collected through BRGMON-6 study

- 4) Can refinements be made to the selected alternative to improve habitat conditions or enhance resident fish populations in Seton Lake?

This management question will be evaluated based on insights gained from results under Management Questions 1-3.

A1.3 Detailed Hypotheses about the Impacts of Seton Lake Operation on resident Fish Populations

The primary null hypothesis (and sub-hypotheses) associated with these management questions are updated as summarized below:

- H₁: The index of target species abundance in Seton Lake is stable over the monitoring period.
- H₂: The measured habitat variables (temperature, turbidity) do not explain observed patterns of fish distribution in Seton Lake.
 - H_{2a}: Patterns of fish distribution are not correlated with temperature profile.
 - H_{2b}: Fish are distributed evenly within the lake (upstream vs. downstream).
 - H_{2c}: Patterns of fish distribution are not correlated with turbidity.

- H₃: The measured habitat variables (described in H_{2a} and H_{2c} above) do not substantially change between operation and shutdown events of the BR1 and BR2 plants over the monitoring period.
- H₄: Potential food source variables explain observed patterns of target fish distribution in Seton Lake.
- H_{4a}: Patterns of Gwenois distribution are correlated with zooplankton abundance.
- H_{4b}: Patterns of bull trout distribution are correlated with *Oncorhynchus nerka* distribution.
- H₅: The annual abundance index of target species is independent of discharge from the BR1 and BR2 plants.
- H_{5a}: The annual abundance index (by species) is independent of *total* BR1 and BR2 discharge.
- H_{5b}: The annual abundance index (by species) is independent of *the within-year variability* in BR1 and BR2 discharge.

These hypotheses will be tested using data from general fish population monitoring and habitat quality and quantity data. Weight-of-evidences will be used to assess the potential impacts of WUP operations in conjunction with data from BRGMON-6. The range of operations across the years of monitoring should provide the operational contrast required to evaluate these hypotheses. They will be tested using inferences based on weight-of-evidence, rather than direct tests at specific sites.

A2 Monitoring Program Proposal

A2.1 Approach

The general approach to this monitoring program will be to collect a comprehensive long term data set on fish populations and habitat conditions in Seton Lake to resolve current gaps in resident fish populations and scientific understanding about how Carpenter diversion influences fish population abundance and diversity. Through collection of coincident information on reservoir operating parameters, habitat conditions and fish population information (age structure and abundance) it may be possible to identify changes in population structure during the period of monitoring. Evidence of measurable and biologically significant impacts (for instance using 10% cut-off reference point for changes over time) can be used to test hypotheses about the relationships between reservoir operations, habitat conditions and population response. This will be accomplished by:

- a) Collecting time series information on the relative abundance and biological characteristics of resident fish populations and reservoir habitat conditions;
- b) Correlating abundance of younger ages of fish (recruitment) with reservoir operating parameters;
- c) Implementing a “stock synthesis” approach to estimating recruitment anomalies associated with operating impacts, which combines age composition and relative trend data collected during monitoring to better define recruitment changes; and

- d) Examining trends in growth. The advantage of this approach is that it provides an explicit method for linking habitat conditions created by implementation of reservoir operating parameters to specific parameter (growth) response of fish populations.

A2.2 Methods

General Fish Population Index Surveys

General fish population index surveys are proposed to provide information on inter-annual variation in the relative abundance, distribution and growth rate of target species in Seton Lake. Gill net sampling at index sites distributed throughout the lake (up and downstream of the outflow of the Bridge 1 (BR1) and Bridge 2 (BR2) plants). The contractor is expected to collaborate with the BRGMON-6 study team to select suitable locations and as well as determine number of sampling sites. Fish sampling will be accomplished during one eight-day session in September each year. Fish will be sampled for length, weight, age structure, and stomach contents (for food source confirmation).

Habitat and Limnological Surveys

Habitat surveys are proposed to document habitat availability in the littoral and pelagic zones of Seton Lake. The habitat surveys will include:

- a) Habitat mapping – characterizing and mapping the entire shoreline of Seton Lake according to the following general habitat types (Tributary mouth, Fluvial fan, Shallow <15% slope, Steep >15% slope). This task will be completed in Monitoring Year 3 only. Habitat mapping will be conducted by boat and all points will be georeferenced.
- b) Spawning habitat – Documenting the availability of potential littoral spawning habitat (i.e., for Gwenuis) within the Seton Lake drawdown zone. This task will be completed in Monitoring Year 3 only and should be conducted at low lake elevation.
- c) Water quality – to investigate the impacts of BR1 and BR2 plant operations on resident fish populations, supplemental physical habitat information will be collected (targeting a range of plant operations). These include but may not be limited to: 1) installation and maintenance of thermograph arrays in the lake; 2) seasonal turbidity and light penetration/water clarity monitoring; 3) temperature and turbidity profiles at each of the fish sampling locations.

Food Source Assessment

The food source assessment will be completed by analyzing the stomach contents from a representative sample (i.e., 30+) of each target fish species. This information will be useful for determining the food source composition for the various species, age classes, and zones within the lake. This information could then be linked to lake productivity data collected under the BRGMON-6 program to ascertain any potential differences or changes within the lake related to plant operation during the monitoring period. The contractor is expected to collaborate with BRGMON-6 team to establish data sharing protocol and any potential cost sharing mechanism.

A2.3 Laboratory Analysis

Laboratory analysis will be conducted to assess the age of specimens and allow development of relationships between size and age of fish. These data allow estimation of average growth rates of the different life stages and species of fish in the lake and gain better understanding of how different habitats or operating strategies influence fish growth rate.

Stomach contents will also be collected from a subset of sampled fish and sent to a laboratory for analysis of food item composition. This will assist in identifying the feeding strategies between the different species and age classes of target fish within the littoral and pelagic zones of the lake and support linkages to the lake productivity data collected under the BRGMON-6 program.

A2.4 Budget

There are no changes requested to the total approved budget in this Addendum.

Table 1: BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring: Key changes and rationale for their inclusion

Section	Change	Rationale
1.3 Detailed Hypotheses	Updated hypotheses 1 Added hypotheses (and sub-hypotheses) 2-5	Added and updated hypotheses to ensure that data collected will answer management questions.
2.1 Approach	Expanded the approach section	To include additional ways in which to collect evidence of potential impacts
2.3 Methods	Modifications include: <ul style="list-style-type: none"> • Change to fish index survey methods in space and time • Addition of gill netting • Addition of habitat mapping • Spawning habitat surveys in littoral zone • Food source assessment 	Some data collection approaches (e.g., boat electrofishing, mark-recapture methods) recommended in the original design were found to be ineffective for the identified target species in the Seton Lake context. Specifically the capture rate of target fish species in the littoral zone has been unsatisfactory for meeting the objectives of this monitoring program. Tributary spawner surveys are found to be ineffective due to poor visibility during the spawning period, limited availability of spawning habitat in the tributaries to Seton Lake, and the ability of target species to access and use preferred spawning habitats either within the lake itself or outside of the study area. At least two of the three target species for this monitoring program (i.e., bull trout and Gwenis) are distributed in the pelagic zone of the lake where preferred food items, such as zooplankton and salmonid smolts are available.