Bridge River Project Water Use Plan

Downton Reservoir Fish Habitat and Population Monitoring

Implementation Years 1 & 2

Reference: BRGMON-7

Study Period: 2013-2014

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BRGMON-7 Downton Reservoir Fish Habitat and Population Monitoring, 2013 and 2014 Results

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Executive Summary

Data collection for Years 1 and 2 of this proposed 10-year study were completed in 2013 and 2014. A report was not completed following Year 1 of this program, so this data report contains the methods and results for both of the years completed to-date. The primary objectives of this monitoring program are: 1) To collect comprehensive information on the life history, biological characteristics, distribution, abundance and composition of the fish community in Downton Reservoir, and, 2) To provide information required to link the effects of reservoir operation on fish populations.

Field studies for the Downton Reservoir Fish Habitat and Population Monitoring Program (BRGMON-7) were conducted in Downton Reservoir from La Joie Dam upstream to the upper extent of the reservoir, including the lower reaches of tributary streams within this section. The general approach to this monitoring program is to collect a long-term data set on the fish population and habitat conditions in Downton Reservoir in order to resolve data gaps and better inform the trade-off decisions made during the Water Use Planning process.

Four methods were employed to document the biological characteristics of the resident fish population, and generate an annual abundance index. These included:

- Tributary spawner surveys;
- General fish population index surveys in the reservoir (by boat electrofishing);
- Supplementary tagging surveys (by angling); and
- Habitat mapping.

In 2013, the index surveys followed a stratified random design similar to boat EF pilot sampling conducted on Carpenter Reservoir in 2001. In 2014 some significant changes were made to the electrofishing approach employed in Year 1. Attempts were made in Year 2 to determine if habitat-stratified capture probabilities could be quantified in this context using a mark-recapture approach to better inform the index results going forward.

The management of surface elevations in Downton Reservoir follows a seasonal pattern: lowest elevations occur in spring (generally April to May) and highest elevations, or full pool, occur in late summer to early fall (September). The lowest reservoir elevation in Year 2 was almost 11 m less than in Year 1, and the low reservoir condition persisted for over a month.

Reservoir operations certainly have the potential to impact the reservoir fish population, including rainbow trout spawning success. Rainbow trout access the lower reaches of reservoir tributaries to spawn during the late spring to early summer (i.e., mid-May to late July), which corresponds with the time when Downton Reservoir is generally starting to fill from its lowest elevation. This spawn timing is later relative to other nearby populations, which is likely an adaptation to the colder temperatures, low stream flows and low reservoir elevations that persist in the study area until mid-May. Based on spawner survey results, peak spawn timing for

Downton Reservoir rainbow trout typically occurs in late June or early July, whereas peak spawning in other nearby contexts tends to occur at least a month earlier.

Crews noted that, because the reservoir drawdown zone is devoid of vegetation cover, spawners in these sections of the tributaries are highly susceptible to predation. Eagles and bear sign were regularly observed. Based on these initial observations, predation may account for substantial losses to the spawner population, particularly within the drawdown zone.

For both index sampling sessions in 2013, the distribution of sites was selected based on the relative proportions of habitat types from a GIS mapping exercise. Approximately 6 kilometres of shoreline was sampled during both June and October sessions. Totals of 90 fish were captured by boat electrofishing in June and 194 were captured in October. Sixty sites were sampled during each session and all captured fish were rainbow trout. In total, 205 of these fish were marked with PIT tags (66 in June; 139 in October) and none were recaptured within Year 1.

In 2014, the boat EF sampling followed a two-pass mark-recapture approach with the goal of documenting habitat-stratified capture efficiency. Totals of 181 fish were captured by two-pass boat EF at 9 intensive sites in June 2014 (Marking pass *n*=92; Recapture Pass *n*=89). In October 2014, 20 fish were captured by angling and marked with PIT tags, and 153 were captured by boat EF at 12 two-pass sites plus an additional 13 single-pass index sites. In total, 329 fish were marked with PIT tags (168 in June; 161 in October). No fish from the marking pass were subsequently recaptured in the second pass during either session, so the mark-recapture approach for estimating capture efficiency was unfortunately unsuccessful in this context.

Catch-per-unit-effort (CPUE) values were generated for both Year 1 and Year 2. Going forward, these CPUE metric values can be generated annually and compared as a reflection of trends in population index between monitoring years. In both the spring and fall sample sessions, highest CPUEs were recorded in the Mid and West zones of the reservoir.

Four fish that had been tagged during previous sessions were recaptured during 2014 (i.e., 2 during each session). Two of these fish in the largest size class showed no evidence of growth between seasons or years. This suggests the possibility of significant size overlap (i.e., very slow growth) after Age-2; however, this assessment is very tenuous at this point as it is based on a very small dataset.

Visual assessment of length-frequency histograms provided an interim characterization of the approximate age class breaks for rainbow trout. Actual age class size ranges will need to be better defined by analysis of ageing structures (i.e., scales) since there is typically overlap (in some cases, significant) between age classes. Unfortunately, age data from the scale analysis was not available at the time of writing for this report.

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1) Introduction

1.1. Background

As a part of the Water Use Planning (WUP) process completed for BC Hydro's facilities in the Bridge and Seton watersheds (BRG), the Consultative Committee developed aquatic ecosystem objectives for Downton Reservoir in terms of abundance and diversity of fish populations present in the reservoir. However, due to the lack of documented information about fish populations in the reservoir available at the time, it was not possible to develop explicit population-level performance measures that reflected these objectives. Specific gaps in data and understanding were identified in: 1) the species composition, relative abundance, distribution and life history requirements of species of fish in the reservoir and adjacent tributaries, and, 2) the relationship between operating parameters of the reservoir (i.e., maximum/minimum elevation, filling schedule) and the fish population response.

Given the scope of these data gaps and the schedule of the BRG WUP it was not possible to conduct the required studies within the time available before WUP-based operational decisions needed to be made. As such, these decisions were based upon an extensive amount of qualitative judgment about which habitat and operations-related factors were most important in the regulation of fish population abundance and distribution in Downton Reservoir. To resolve these data gaps and better inform reservoir operating strategies, the Consultative Committee recommended a long term monitoring study to obtain more comprehensive information on local habitats and fish populations. 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 to provide direction for the study.

The Bridge River Power Development Water Use Plan was accepted by the provincial Comptroller of Water Rights in March 2011. Terms of Reference for the Downton Reservoir Fish Habitat and Population Monitoring program were developed and approved by late 2012, and field data collection activities were initiated in 2013. Under the WUP, monitoring for this program is scheduled to continue annually until 2021.

Data collection for Years 1 and 2 of this proposed 10-year study were completed in 2013 and 2014. There was a changeover of consultants managing the project starting in May 2014 (i.e., early in Year 2). A report was not completed by the initial consultant following Year 1 of this program, so an attempt has been made in this data report to include the methods and results for both of the years completed to-date to ensure that all available data are reported. It should also be noted that due to lessons learned during these initial years of sampling, key deficiencies in data collection methodologies and issues with the testability of some of the hypotheses included in the original study Terms of Reference (ToR) were identified. Further, recently proposed modifications to Downton Reservoir operations (related to seismic risk mitigation) have also necessitated revision to the original approach. The revised study hypotheses and the methods adapted to test them will be incorporated starting with the Year 3 program activities.

1.2. Objectives, Management Questions and Study Hypotheses

The primary objectives of this monitoring program are: 1) To collect comprehensive information on the life history, biological characteristics, distribution, abundance and composition of the fish community in Downton Reservoir, and, 2) To provide information required to link the effects of reservoir operation on fish populations to a) document impacts of the operating alternative on existing reservoir fish populations, and, b) allow better future decisions regarding preferred operation of Downton Reservoir.

The primary management questions to be addressed by this monitoring program are:

1. What are the basic biological characteristics of fish populations in Downton Reservoir and its tributaries?

This management question will be evaluated using fish population abundance or index of abundance, fish distribution and biological characteristics data. The target species is rainbow trout.

2. Will the selected alternative (N2-P) result in positive, negative or neutral impact on abundance and diversity of 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 over the course of the monitoring program. The underlying operational cause-effect relationship associated with any response may not be evident from this analysis. However, weight-of-evidence will be used to evaluate WUP operations impacts on the reservoir rainbow trout population.

3. Which are the key habitat factors that contribute to reduced or improved productivity of Downton Reservoir fish populations?

This management questions will be evaluated using basic habitat quality and quantity data collected in the reservoir in conjunction with reservoir operations data.

4. Is there a relationship between the minimum reservoir elevation and the relative productivity of fish populations?

This management question will be evaluated using a combination of weight-of-evidence as exhibited by trends in fish population abundance and trends in their biological characteristics in conjunction with trends in reservoir operation.

5. Can refinements be made to the selected alternative to, without significant impact to instream flow conditions in the Middle Bridge River, improve habitat conditions or enhance fish populations in Downton Reservoir?

This management question will be evaluated based on insights gained from results under management questions 1-4.

The primary hypothesis (and sub-hypotheses) associated with these management questions from the original study Terms of Reference are:

H_1: The abundance and diversity of Downton Reservoir fish populations are limited by habitat impacts directly related to the operation of the reservoir.

- **H_{1A}:** Operation of the reservoir at low elevations reduces fish productivity due to stranding of fish and eggs.
- **H_{1B}:** Operation of the reservoir at low elevations (i.e., <718 masl) causes significant rates of fish entrainment from the reservoir.
- **H_{1C}:** Operation of the reservoir restricts the amount available effective spawning habitat in tributaries and this limits the productivity of fish populations.
- **H_{1D}:** Operation of the reservoir at low elevations reduces aquatic productivity and this results in reduced abundance and diversity of fish populations in Downton.

These hypotheses reflect the generalized effects of reservoir operations that were understood to influence habitat suitability and fish population abundance in the Downton context. However, rather than focussing on specific surveys for fish stranding, entrainment, or spawning habitat (as each of these factors would be challenging to test at this scale), the goal was to test these hypotheses by analyzing general fish population trends and making inferences based on a weight-of-evidence approach. Also, operations within the WUP-defined ranges were not to be specifically modified for the purposes of the study. Rather, it was understood that operational contrast would naturally be achieved by conducting the study over a 10-year time frame.

Each of these hypotheses could have significant consequences for the predicted impacts of operations on fish; however, they could not be resolved with scientific data during the WUP process. In particular hypotheses H1A and H1B were critical in making decisions about the final chosen operating alternative for the BRG WUP.

1.3. Study Area

Field studies for the Downton Reservoir Fish Habitat and Population Monitoring Program (BRGMON-7) were conducted in Downton Reservoir from La Joie dam upstream to the upper extent of the reservoir, including the lower reaches of tributary streams within this section (Figures 1 and 2).

The key rainbow trout spawning tributaries identified by the program to-date include: Tributary (Trib.) #13, Trib. #16, Trib. #19, and Tram Creek.

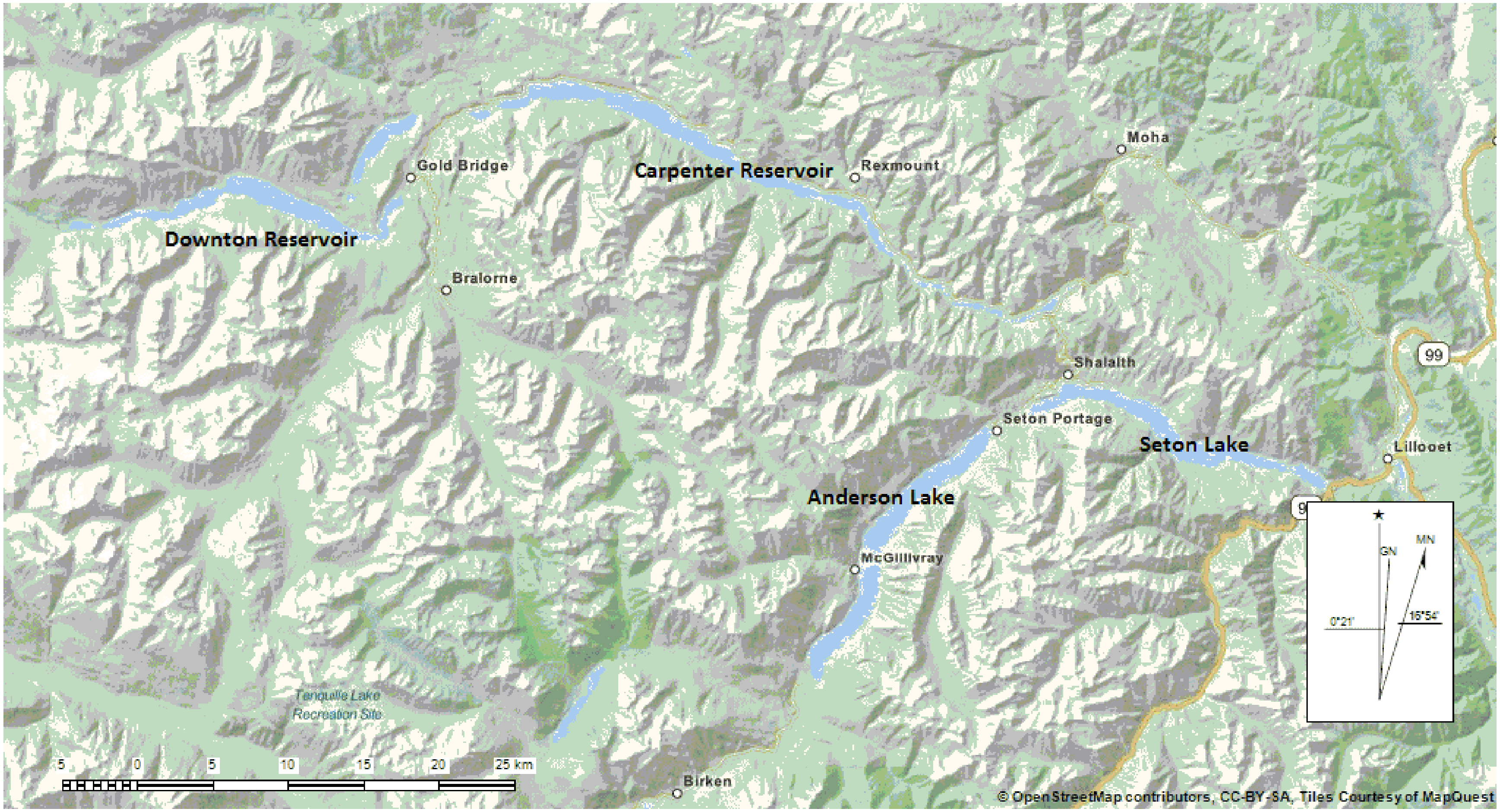


Figure 1. Bridge River and Seton River watersheds.

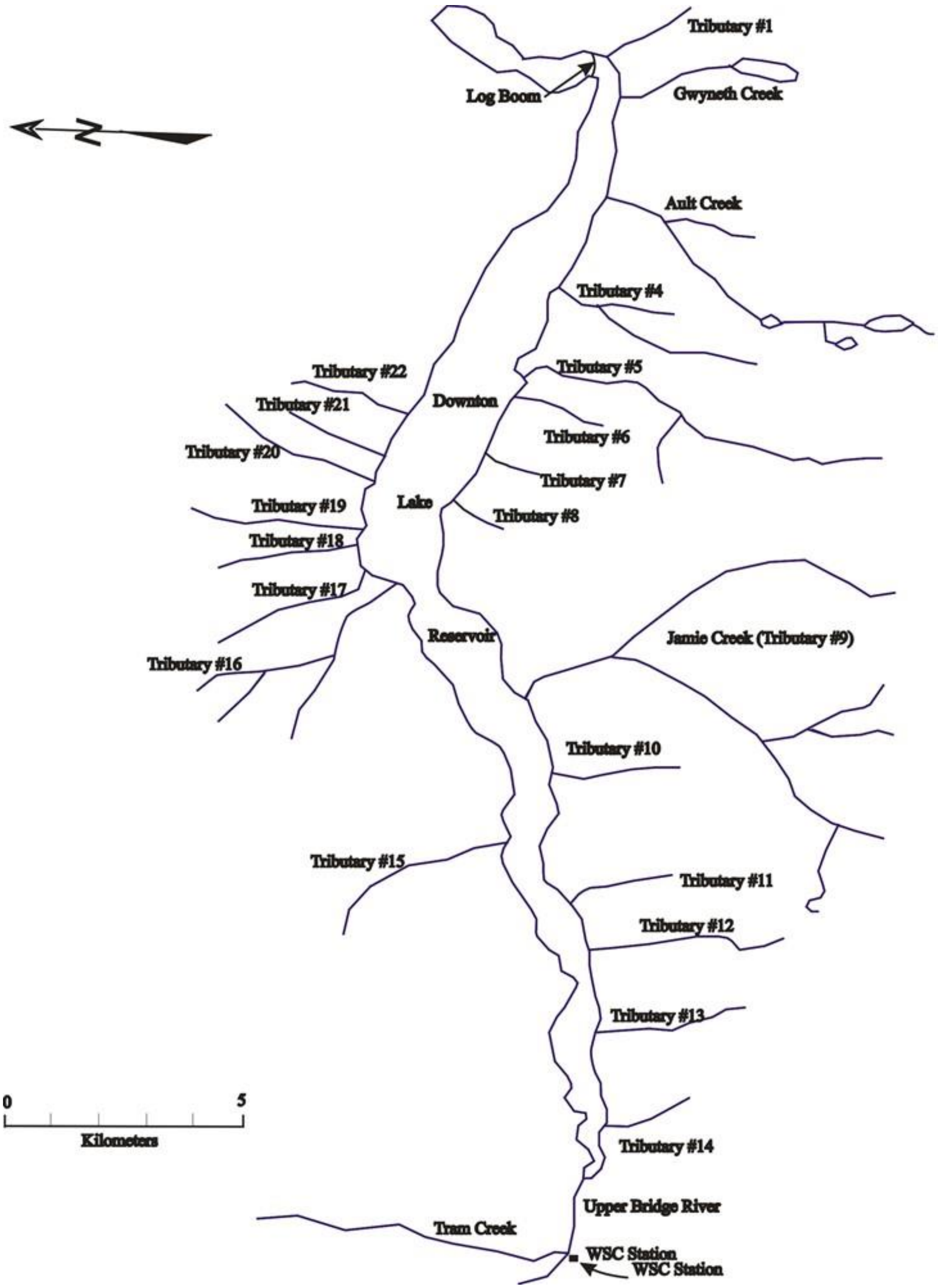


Figure 2. Downton Reservoir and relative location of tributaries. Note: La Joie Dam is situated at the top end of this map.

1.4. Sampling Schedule

As per the original ToR, the activities associated with this monitoring program were recommended by the BRG WUP Consultative Committee for a total of 10 years. The study years covered by this report (2013 and 2014) represent monitoring years 1 and 2. The schedule of field sampling activities for years 1 and 2 is presented in Table 1.

Table 1 Schedule of Field Sampling Sessions and Activities.

Task	Apr	May	Jun	Jul	Aug	Sep	Oct
1. Project Management	X	X	X	X		X	X
2. Field Studies							
a Fish Population Index Surveys			X X				X X
b Rainbow Trout Tagging		X	X				
c Tributary Spawner Surveys			X X X X	X X			
d Habitat Monitoring		X	X				X

In some cases the actual sampling events deviated from the pre-planned dates by a few days to a week or more. This is because sampling conditions and the ability to access sites depend on physical factors in the reservoir and tributaries (e.g., turbidity, inflows), ambient temperatures, weather, avalanches blocking access roads (Plate 1), etc. at the time of the surveys. When possible, dates with the most optimal conditions were selected to enhance the quality and consistency of the collected data, and ensure the safety of the field crew.

2) Methods

The general approach to this monitoring program is to collect a long-term data set on the fish population and habitat conditions in Downton Reservoir in order to resolve data gaps and better inform the trade-off decisions made at the WUP table. Collection of coincident information on reservoir operating parameters, habitat conditions, and the resident fish population (including life history information, age structure and an index of abundance) is intended to allow identification of potential broad scale changes. Trends in these changes over time can be used to test hypotheses about the relationship between reservoir operations and population response.

2.1. Sampling Design

In 2013 and 2014, field activities for this program were focussed on providing data to meet the following sampling design included in the original study ToR (BC Hydro 2012):

a) Collecting time series information on the 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. For this step, it is important to understand the relative contribution of those younger ages that recruit from habitats that are not affected by operations (e.g., in tributaries above the maximum reservoir elevation) and those habitats that are affected by operations (e.g., reservoir drawdown zone);

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;

d) Examining trends in growth or distribution changes with operations implemented over the course of the study period.

Sampling to-date indicates that rainbow trout dominate the species assemblage in the reservoir, and are likely the only salmonid species present. It is expected that rainbow trout are sensitive to habitat impacts caused by Downton Reservoir operations. For these reasons, rainbow trout will be the sole target species for monitoring in this program based on their ecological and social value, and the ability to consistently sample them.

It must be noted that a great deal of learning about site access; sampling conditions; and fish distribution, densities, and catchability occurred during the first two years of monitoring, which has helped inform the approach and strategy for this monitoring program going forward. There has also been key learning about deficiencies in data collection methodologies and issues with the testability of some of the hypotheses included in the original ToR.

Further, modifications to Downton Reservoir operations (related to seismic risk mitigation at La Joie Dam) proposed in 2014 have also necessitated revision to the original approach. These revisions were described in a ToR addendum (BC Hydro 2015) submitted to the provincial Comptroller of Water Rights in January 2015 and will be addressed in the Year 3 monitoring activities and report. While further changes of this magnitude are not expected, the sampling design will continue to be reviewed annually to account for new learning in this relatively untested and remote context.

2.2. General Fish Population Index Surveys

The general fish population index surveys are intended to provide information on the seasonal and inter-annual variation in the relative abundance, distribution and growth rate of rainbow trout in the reservoir. The index survey data is collected in near shore areas of the littoral zone by a standardized boat electrofishing (boat EF) method, which is generally most effective within the ca. 0.5 to 3.0 m range of water depths. Index surveys were conducted during both the spring (Jun) and fall (Oct) periods in 2013 and 2014.

Boat EF is conducted by running an electrical current through the water between a set of boom-mounted anodes extended off the front of the boat and a cathode array, while propelling the boat forward at slow speed (ca. 1 to 2 km/h). Within the electrical field that this generates, a proportion of fish are stunned and drawn up to the surface where they can be netted by crew members standing on a bow platform and transferred to an on-board fish holding tank. Not all stunned fish are observed by the netters, and not all of the observed fish are successfully netted, particularly in the turbid, slack-water conditions prevalent in Downton Reservoir. As such catches likely represent a relatively small (but undefined) proportion of the fish available.

Boat electrofishing was conducted at night (Plate 2). At each site, the boat was maneuvered to a pre-designated starting point (GPS coordinate) from which a section of edge habitat was electrofished (see year-specific details below). The habitat type of each site was confirmed in the field. The following boat EF settings were used: Electrofisher = Smith-Root 5.0 GPP; Voltage Range = High (50 – 1000 V); % of Power = 100%; Output = ca. 6 to 8 amps; DC Current Mode; 60 DC pulses/sec.

Monitoring Year 1 (2013)

In 2013, the surveys followed a stratified random design similar to boat EF pilot sampling conducted on Carpenter Reservoir in 2001 (Paul Higgins, pers. comm.). As a part of this method, the entire shoreline of the reservoir was pre-classified (by a GIS mapping exercise) according to a set of habitat types that can be correlated with factors that influence fish use. For Downton Reservoir, the shoreline habitat was classified into the following four types:

1) Tributary mouth
2) Fluvial fans
3) Shallow slope (< 15% bank gradient)
4) Steep slope (> 15% bank gradient)

A set of GPS coordinates for 60 boat EF sites were randomly selected according to these types, with the relative number representing the total length contribution of each type. For example, <1% of the reservoir shoreline length is represented by tributary mouths, so only 1 of the 60 sites was in Type 1 habitat. Whereas 60% of the shoreline length is represented by steep slopes (Type 4), so 33 of the 60 sites (i.e., ca. 55%) were selected in this habitat type. Sites were also distributed throughout the basin so that each of the longitudinal zones (i.e., West end, Mid-reservoir, and East end) were represented. For the purposes of the data analyses, the west end has been arbitrarily defined as the portion of the reservoir (and drawdown zone) west of the UTM easting line 500000 (which lies just east of Trib. #20); the Mid-reservoir has been defined as the section between the UTM easting lines 500000 and 505000; and the east end is between easting line 505000 and the dam (at ca. 510000). These zones are illustrated on Figures 7 and 8 in Section 3, below (p. 19). One set of sites was randomly selected for the spring session, and a different set was randomly selected for the fall session (See maps in Appendix A).

Sampling effort was based on a target duration of electrofishing (i.e., 300 seconds) for each site; however, the actual number of seconds and the distance sampled were not recorded, so the effort applied for this year needed to be estimated. Each site was sampled in a single pass.

Monitoring Year 2 (2014)

In 2014 some significant changes were made to the electrofishing approach employed in Year 1. Given the sub-optimal sampling conditions in the reservoir (high turbidity, floating debris, limited means to *contain* the fish to be sampled at most sites) that persist throughout most of the year, it was clear that capture probabilities were likely quite low; however, they could not be defined based on the approach in Year 1. As such, it would be difficult if not impossible to derive an annual population estimate from the results, or determine quantitative differences in abundance between habitat types. Therefore, attempts were made in Year 2 to determine if habitat-stratified capture probabilities could be quantified in this context using a two-pass mark-recapture approach to better inform the index results going forward.

The intent was to test the feasibility of a two-phase sampling design whereby mark-recapture experiments could be implemented up front to characterize detection probabilities which could then be used to expand counts at a large number of index sites sampled by a single pass in subsequent years (similar to Korman et al. 2010). In order for this method to be successful, a sufficient sample size of fish must be available for marking and subsequent recapture, and the approach must allow for reasonable assumption of site “closure” (meaning that all marked fish are available within the sample sites for recapture during the second pass) by incorporating adequate site length and limited time between passes. However, it is important to note that these sites were not physically enclosed using nets due to their size and the nature of the terrain.

Instead of single pass sampling at a large set of randomly selected sites, an extended length of shoreline (i.e., several kilometers) was repeat-sampled during each session following a standardized mark-recapture method. A trade-off with mark-recapture is that less shoreline area can be covered since each site must be sampled twice (a marking pass and a recapture pass). In the spring session, both the marking and recapture passes were conducted by boat EF. However, during the fall session, marking was done by angling followed by a recapture pass by boat EF. This change was to account for the lack of recaptures during the spring session and the possibility that fish behaviour, habitat use and condition may have been adversely affected by 2 consecutive passes of boat EF. For this mark recapture experiment, the recapture pass was conducted approximately 24 hours after the marking pass.

The total sampled length at each location was divided up into consecutive sections according to habitat type as designated during the Year 1 habitat mapping. Each section spanned only one habitat type and was generally about 300 m in length. Habitats associated with the highest fish densities in Year 1 (e.g., tributary mouths) were selected to maximize the sample size for the mark-recapture experiment. Adjacent fan habitats (i.e., Type 2) were also sampled to extend the sampled length at each location. Other habitat types (i.e., 3 and 4) were sampled opportunistically.

All fish collection efforts were accompanied by detailed sampling of the biological characteristics of the captured fish, as well as measurement of general sampling conditions (i.e., temperature, turbidity and secchi depth). Fish were measured for length and weight, evaluated for sex and sexual maturity (as possible), and aging structures were collected. Individual coded (PIT) tags were applied to all captured fish of appropriate size and condition to provide information on capture efficiency, as well as movement and growth patterns.

2.3. Supplementary Rainbow Trout Tagging

Based on the proposed approach, the recapture of tagged fish is important for defining growth rates and movement patterns within and between study years. However, given the size of the study area and the numbers of fish sampled and tagged during the index surveys, it was recognized that the number of tagged fish available for recapture from the boat EF method alone was going to be limited. Therefore, some supplemental tagging for rainbow trout was also proposed. Due to seasonal access limitations, complex logistics, and/or budget constraints, these supplementary tagging surveys were conducted on an opportunistic basis and limited to a few dates per year.

For these supplemental tagging surveys, fish were captured by angling using hooks baited with cured salmon roe. To improve capture probability, angling effort was focussed on reservoir areas with the highest fish densities, which was generally adjacent to tributary mouths. As with the boat EF surveys: length and weight were measured, sex and maturity were assessed, ageing structures were collected, and a PIT tag was applied to all captured fish.

2.4. Tributary Spawner Surveys

Tributary spawner surveys were conducted in Year 1 and Year 2 to document the relative abundance and distribution of fish spawning in select tributaries of Downton Reservoir. The surveys focussed on rainbow trout, as the eggs deposited by this species are most likely to be impacted by backwatering impacts from the reservoir as it fills. Spawner surveys were conducted (or at least attempted) on a weekly basis during the rainbow trout spawning period (May to July in Downton Reservoir) to get a relative weekly count. Access to known spawning tributaries by road can be hampered by slides and avalanches at this time of year, which precluded some surveys.

Four tributaries were consistently assessed in Year 1. These included: Trib. #13, Trib. #16, Trib. #19, and Tram Creek (Figure 2). A record of rainbow trout spawning in these tributaries had already been established for several years before the start of this monitoring program. In Year 2, the road to the north side of the reservoir was completely blocked by heavy windfall and a large slide, which precluded land access to Trib. #16 and Trib. # 19 for the entire spawning season. Access to these tributaries by boat was also not feasible due to a combination of factors, including: more involved logistics, low drawdown of the reservoir, and budgetary limitations. As such spawner surveys were limited to Trib. #13 and Tram Creek in Year 2.

Rainbow trout spawners in each surveyed stream were enumerated by one person on each shoreline of the creek starting at the reservoir confluence walking upstream until either reaching a fish migration boundary or until no further fish were observed (for several hundred meters; Plate 3). Downton Reservoir sits in a fairly steep-sided valley, so the accessible length of most tributary streams is relatively short (i.e., less than 1 km). Each crew member wore a hat and polarized sunglasses to minimize glare and ambient light interference. Numbers of fish observed in each tributary, and their relative location (upstream or downstream of full pool), were reconciled between the two observers in the field and recorded in the field notes for each survey.

2.5. Laboratory Analysis

To assist in developing an understanding of the life history, growth characteristics and age class structure of the rainbow trout population in Downton Reservoir, fish sampling included collection of age structures (i.e., scales) from captured fish. Laboratory analysis (fish ageing) will be conducted on these samples by Mike Stamford to assess the age of specimens to facilitate size-at-age analysis. These data will allow estimation of average growth rates of the different life stages of rainbow trout in the reservoir to contribute to an understanding of how different habitats or reservoir operating strategies influence fish condition.

Scales were collected from fish captured in Year 1 and Year 2; however ageing analysis was not completed on these samples in time for inclusion in this data report.

2.6. Data Management

All field data collected for this project were recorded into field notebooks or on standardized datasheets specifically developed for this program (Appendix B). A standardized data entry template was developed in MS Excel, and all data entry was conducted by SER technicians. Data quality assurance (QA) checks were completed by the Project Manager.

All entered data were compiled into a database developed collaboratively with IFR staff for housing the BRGMON-4 (Carpenter Reservoir), BRGMON-7 (Downton Reservoir), BRGMON-8 (Seton Lake), and BRGMON-9 (Seton River) Fish Habitat and Population Monitoring data. This database will: facilitate data sharing between monitoring programs; continue to be updated each year as new data are collected and entered; and be stored in multiple locations (i.e., office computer, external hard drive, and online storage such as “Dropbox”). All data and text files have been backed up to ensure data security and integrity.

3) Results

3.1. Reservoir Elevations and La Joie Discharge

Downton Reservoir elevations and the conveyance of flows into the Middle Bridge River are regulated by BC Hydro's La Joie Dam and Generating Station. The entire Bridge-Seton hydroelectric complex is integrated and the operations of each reservoir and facility are managed based on storage, conveyance, and generation decisions that account for water management priorities, electricity demands, plant maintenance requirements, fisheries impacts, as well as other values. Downton Reservoir and the La Joie facility are situated at the upstream end of the Bridge-Seton system.

Records of La Joie Dam discharge and Downton Reservoir surface elevations were provided by BC Hydro for the periods 1 January 2013 to 31 December, 2014 and are illustrated in Figures 3 and 4.

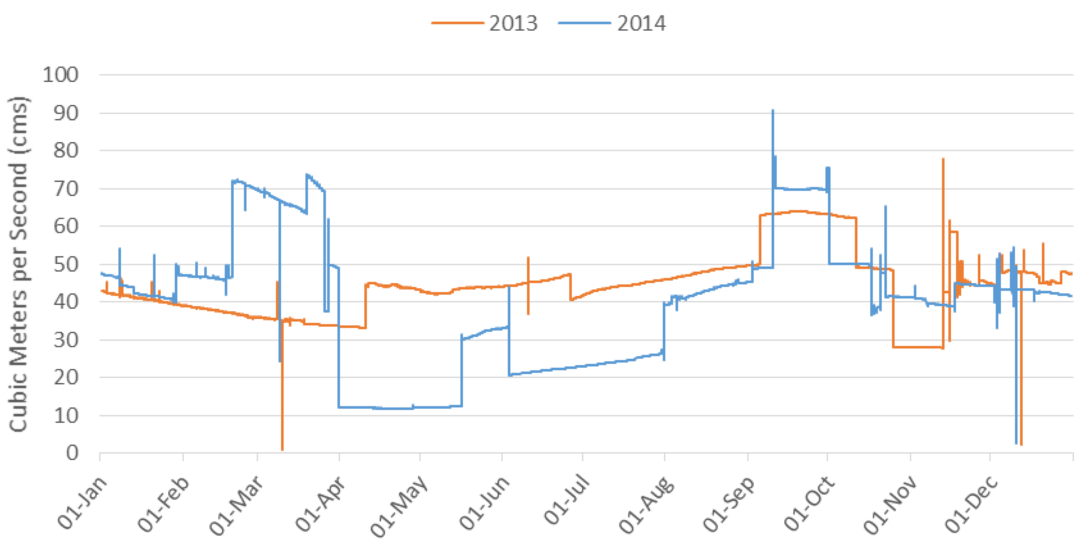


Figure 3 Hourly total discharge from La Joie Dam into the Middle Bridge River, January to December 2013 and 2014.

The management of surface elevation in Downton Reservoir follows a seasonal pattern: lowest elevations occur in spring (generally April to May) and highest elevations, or full pool, occur in late summer to early fall (September). In Year 1 of the monitoring program, reservoir elevation started out 2.8 m higher (in January) than in Year 2, and ended 5.0 m lower in December (Figure 4). However, most notably, the lowest reservoir elevation in Year 2 was almost 11 m less than in Year 1 (2013 minimum = 719.7 masl; 2014 minimum = 709.0 masl), and the reservoir remained around 710 masl for over a month (29 March to 13 May 2014).

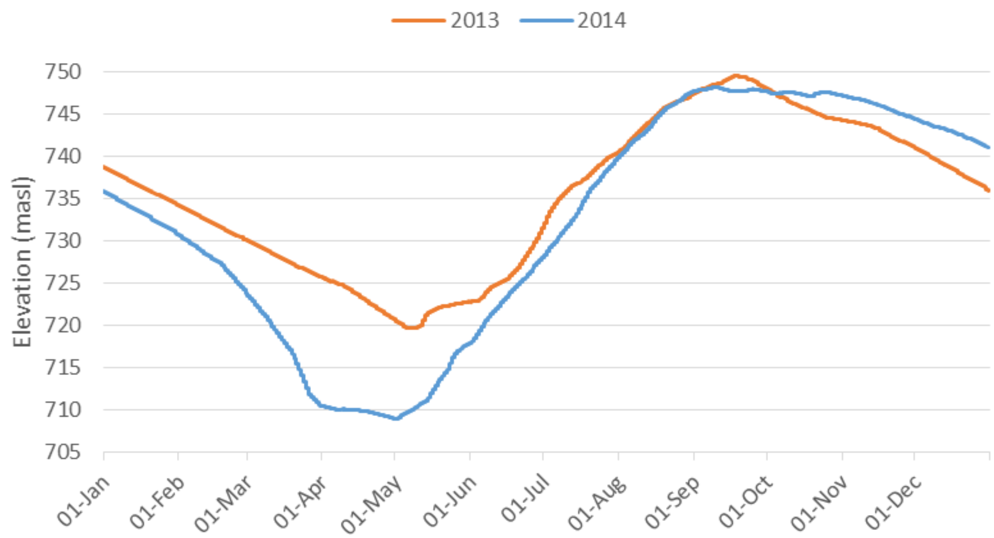


Figure 4 Hourly surface elevations in Downton Reservoir, 2013 and 2014.

The mean drawdown rate in Year 1 was ca. -15 cm per day. The mean drawdown rate in Year 2 was nearly double that value at -28 cm per day. Fill rates were more similar during both Year 1 and Year 2 at +26 cm and +32 cm per day, respectively.

Reservoir operations certainly have the potential to impact the reservoir fish population, particularly rainbow trout spawning success. Rainbow trout access the lower reaches of reservoir tributaries to spawn during the late spring to early summer (i.e., mid-May to late July), which corresponds with the time when Downton Reservoir is generally starting to fill from its lowest elevation. This spawn timing is later relative to other nearby populations, which is likely an adaptation to the colder temperatures, low stream flows and low reservoir elevations that persist in the study area until mid-May. Based on spawner survey results, peak spawn timing for Downton Reservoir rainbow trout typically occurs in late June or early July (see Section 3.2), whereas peak spawning in the Lower Bridge River tends to occur at least a month earlier in May (Sneep and Hall 2012).

In light of planned modifications to the operation of Downton Reservoir and La Joie Dam related to seismic risk mitigation, concerns have been raised about the effects of low reservoir elevations on the accessibility of tributary habitats to rainbow trout spawners. This issue will be more explicitly monitored starting in Year 3.

3.2. Tributary Spawner Surveys

Five tributary spawner surveys were conducted in Year 1 between 28 May and 25 June 2013. In Year 2, seven surveys were conducted between 8 May and 15 July 2014. The total counts in each tributary for each survey are presented in Figures 5 and 6. The date of peak spawner count was very similar between 2013 and 2014. The highest number of rainbow trout spawners was observed on 18 June and 19 June in 2013 and 2014, respectively.

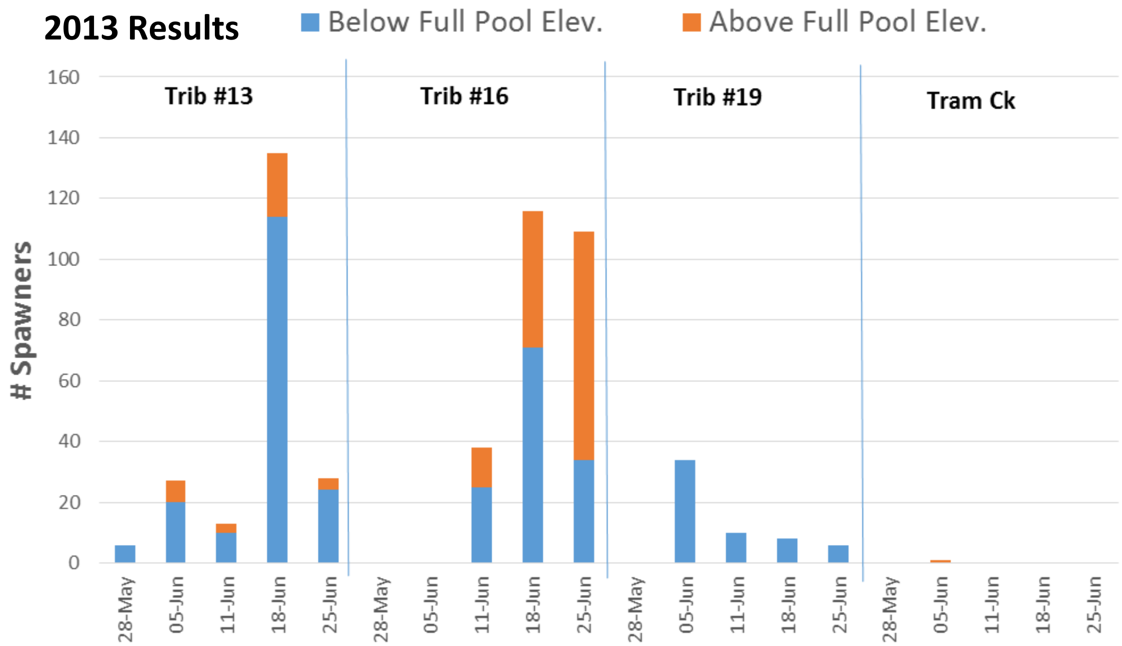


Figure 5 Results of surveys to enumerate rainbow trout spawners in selected Downton Reservoir tributaries, May to June 2013. The blue bars represent the number observed in the creek below full pool elevation, and the orange bars represent the proportion above.

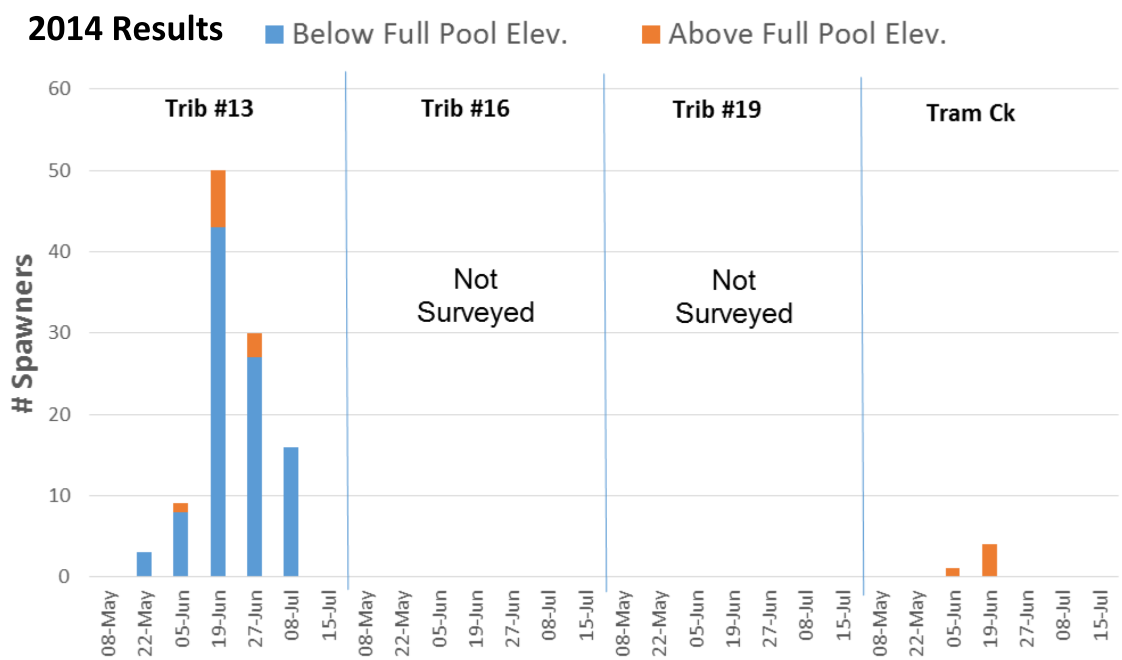


Figure 6 Results of surveys to enumerate rainbow trout spawners in selected Downton Reservoir tributaries, May to July 2014. Note: Tribs. #16 and #19 could not be surveyed in 2014.

Many of the tributaries in the study area are characterized by high gradients above the reservoir basin and some did not have surface flow connectivity to the reservoir during the rainbow trout spawning period (due to low flows and porous substrate; Plate 4). Spawning use of the Upper Bridge River remains unknown due to the high turbidity conditions throughout the year which precluded the visual-based assessment methods applied in study years 1 and 2 (Plate 5). Visibility in the surveyed creeks was generally moderate (ca. 1 to 2 m) – fish in shallow habitats were readily observed; however, turbidity affected visibility to the bottom of deeper pools on some dates.

Four tributaries were assessed in 2013 and two were assessed in 2014. Tribs #16 and #19 could not be surveyed in 2014 because extensive windfall and a large slide across the access road on the north side of the reservoir precluded access to these sites. However, Trib. #13 and Tram Creek were surveyed on a regular basis and showed generally similar trends in the spawning start, peak and end timing to the 2013 results, although peak and total numbers observed in Trib. #13 were lower. Survey timing and effort were consistent during both years; potential differences in relative survey conditions (i.e., stream discharge and visibility) between years are unknown as data on these variables were not available from Tisdale Environmental Consulting in 2013. The lower numbers observed in this tributary may be related to the substantially lower reservoir elevations in April and May 2014, which could have impacted access for some proportion of fish; although there isn't enough data to confirm or reject this possibility at this point.

In 2013, the majority of spawners in Trib. #13 and Trib. #16 were observed in the zone below full pool elevation during almost every survey (i.e., from 60% to 90% of the total). The smaller proportion (i.e., from 10% to 40%) represented the surveyed zone above full pool elevation in these creeks. This result was repeated for Trib. #13 in 2014 (at least 80% of spawners were observed below full pool elevation). All of the fish observed in Trib. #19 were below full pool. Tram Creek is a tributary to the Upper Bridge River; as such, all of this habitat, and the spawners counted in it, are outside the influence of the reservoir.

Crews noted that, because the reservoir drawdown zone is devoid of vegetation cover, spawners in these sections of the tributaries are highly susceptible to predation. Eagles were observed capturing and feeding on spawners, and other evidence of this activity (guano, fish remains) was prevalent around the creeks. Bear sign was also regularly observed in the soft mud of the drawdown zone in the vicinity of tributaries (Plate 6). Based on these initial observations, predation may account for substantial losses to the spawner population, particularly within the drawdown zone.

Based on all of these initial results, it is important to clarify the proportion of spawners that use the section of the drawdown zone that will actually become inundated by the reservoir during the incubation period (i.e., before the fry emerge from the gravel and disperse). The top of this zone may be lower than the full reservoir pool elevation. Also, it will be informative to document differences in habitat characteristics (i.e., substrate size and embeddedness, gradient, cover, barriers) above and below full pool since these may be important factors behind the distributional patterns observed to-date. Collection of data on these metrics will be incorporated into the sampling plan starting in Year 3 and going forward.

To the extent possible, survey dates and survey frequency (i.e., weekly) will continue to be standardized to ensure the best possible comparisons of spawner timing and relative abundance between monitoring years. Consideration could be given to conducting *in situ* incubation experiments with rainbow trout eggs to more directly assess the impact of reservoir inundation on egg survival and development. The modified operation of La Joie Dam (i.e., reduced full pool elevation) may provide benefits in terms of a reduced proportion of eggs inundated by the reservoir.

3.3. Fish Indexing Surveys

2013 Random Index Sampling

In 2013, totals of 90 fish were captured by boat electrofishing in June and 194 were captured in October. Sixty sites were sampled during each session and all captured fish were rainbow trout (Tables 2 and 3; Plate 7). In total, 205 of these fish were marked with PIT tags (66 in June; 139 in October) and none were recaptured within Year 1. Fish that were too small (< 100 mm fork length) or in poor condition when processed, were not tagged.

Table 2 Relative numbers of sites by habitat type for boat electrofishing index surveys, June and October 2013.

Index Session	# of Sites	Proportion of Sites by Habitat Type[a]			
		Trib. Confl.	Fluvial Fans	Shallow Slope	Steep Slope
June	60	8 (13%)	19 (32%)	ns[b]	33 (55%)
October	60	1 (2%)	21 (35%)	16 (27%)	22 (37%)

[a] Relative contribution of each type to the total number provided in brackets.
[b] Shallow slope habitats (Type 3) were not sampled during the June 2013 session.

Effort (site length in meters, or number of electrofishing seconds) was not recorded for index sampling sites in 2013; however, 300 seconds of electrofisher time was the target effort for each site (Gene Tisdale, pers. comm.). Based on this approximate value, and incorporating the average speed (i.e., meters-per-second) of electrofisher sampling by habitat type in 2014, Catch-per-unit-effort (CPUE) values were estimated. For both index sampling sessions in 2013, the distribution of sites was selected based on the relative proportions of habitat types from a GIS mapping exercise. Approximately 6 kilometres of shoreline was sampled during both June and October sessions (average site length = ca. 100 m est.).

Table 3 Summary of fish capture results from boat electrofishing index surveys in June and October 2013. All captured fish were rainbow trout.

Metric	Units	Index Sessions							
		June				October			
		Confl.	Fan	Shallow	Steep	Confl.	Fan	Shallow	Steep
Sites	#	8	19	ns[a]	33	1	21	16	22
Effort[b]	total seconds	~ 2400	~5700	-	~9900	~300	~6300	~4800	~6600
Catch	# of fish	27	31	-	32	14	111	37	32
	# of fish marked	66				139			
	# of recaptures	0				0			
CPUE[c]	fish/site	**3.4**	**1.6**	**-**	**1.0**	**14.0**	**5.3**	**2.3**	**1.5**
		1.5				**3.2**			
	(fish/sec)·100	**1.1**	**0.5**	**-**	**0.3**	**4.7**	**1.8**	**0.8**	**0.5**
		0.5				**1.1**			
	(fish/meter)·100	**5.1**	**1.6**	**-**	**0.8**	**21.0**	**5.1**	**2.7**	**1.2**
		1.7				**3.6**			

[a] Shallow slope habitats (Type 3) were not sampled during the June 2013 session.
[b] Effort was not recorded in 2013 so values are based on a target of ca. 300 seconds of electrofishing time per site (Gene Tisdale, pers. comm.).
[c] Number of meters per site for this calculation was estimated based on meters-per-second covered by habitat type during 2014 sampling. The metric "(fish/meter) ·100" refers to the number of fish captured per 100 m of sampled shoreline length.

In June 2013, when the reservoir was low, the majority of effort (ca. 9900 seconds est.) was directed at Steep (Type 4) habitats, followed by Fluvial Fans (Type 2; ca. 5700 s) and Tributary Confluences (Type 1; ca. 2400 s). Shallow (Type 3) habitats were not sampled during this session. The CPUE (by all measures) was greatest in Type 1 habitats, followed by Type 2, and then Type 4; although differences were fairly modest during this session. Total CPUE values (for all types) in June were: 1.5 fish/site; 0.5 fish/100 s (est.); or 1.7 fish/100 m (est.). Going forward, these CPUE metric values (pooled by habitat type and total for the reservoir) can be generated annually and compared as a reflection of trends in population index between monitoring years.

In October 2013, when the reservoir was near full, the distribution of effort was as follows: Type 4 = ca. 6600 s; Type 2 = ca. 6300 s; Type 3 = ca. 4800 s; Type 1 = ca. 300 s. Relative to the June results, CPUE values were higher, particularly in Type 1 and 2 habitats (although the Type 1 value is based on only one site for this session). The trend in CPUE values between habitat types was the same: highest values were recorded for Type 1, lowest values were in Type 4. Total CPUE values (for all types) in October were: 3.2 fish/site; 1.1 fish/100 s (est.); or 3.6 fish/100 m (est.).

It is clear from these results that tributaries and their confluence areas provide important habitats for rainbow trout in Downton Reservoir. They are a source of spawning areas, thermal refuge, dissolved oxygen, and food (largely in the form of drifting invertebrates and juvenile fish). Given these important contributions, it is not surprising that the highest fish densities tend to be concentrated around tributary confluence areas and their adjacent habitats during both spring and fall. Similar to the results of a productivity assessment in Carpenter Reservoir in 2000, high turbidity and large seasonal fluctuation in surface elevation likely limit the colonization of aquatic vegetation and, in turn, aquatic invertebrate production within the reservoir (Josh Korman, pers. comm.). These factors, combined with other physical habitat characteristics (e.g., the high proportion of fines in bottom sediments, limited interstitial cover) are also likely drivers behind the observed patterns in habitat-stratified fish distribution. Following the field-based habitat mapping and survey to be completed in Year 3, an additional analysis of the fish capture results could include an assessment of CPUE based on proximity to tributaries.

A summary of the distribution of effort (# of sites), catch, and CPUE by longitudinal zone of the reservoir (as defined in Section 2.2) is provided in Table 4. In both the spring and fall sample sessions, highest CPUEs were recorded in the Mid and West zones of the reservoir. The distribution of catches according to habitat type and zone of the reservoir are illustrated for the June and October sessions in figures 7 and 8, respectively.

Table 4 Summary of the seasonal fish distribution according to longitudinal zone of Downton Reservoir, June and October 2013.

Sample Session	Metric	Longitudinal Zone of the Reservoir[a]		
		West	Mid	East
June	# of Sites	21	17	22
	Catch (# of Fish)	34	37	19
	CPUE (fish/m)·100	**1.6**	**2.2**	**0.9**
October	# of Sites	40	12	8
	Catch (# of Fish)	137	44	11
	CPUE (fish/m)·100	**3.4**	**3.7**	**1.4**

[a] As defined in Section 2.2; West is furthest from the dam and East is closest to the dam.

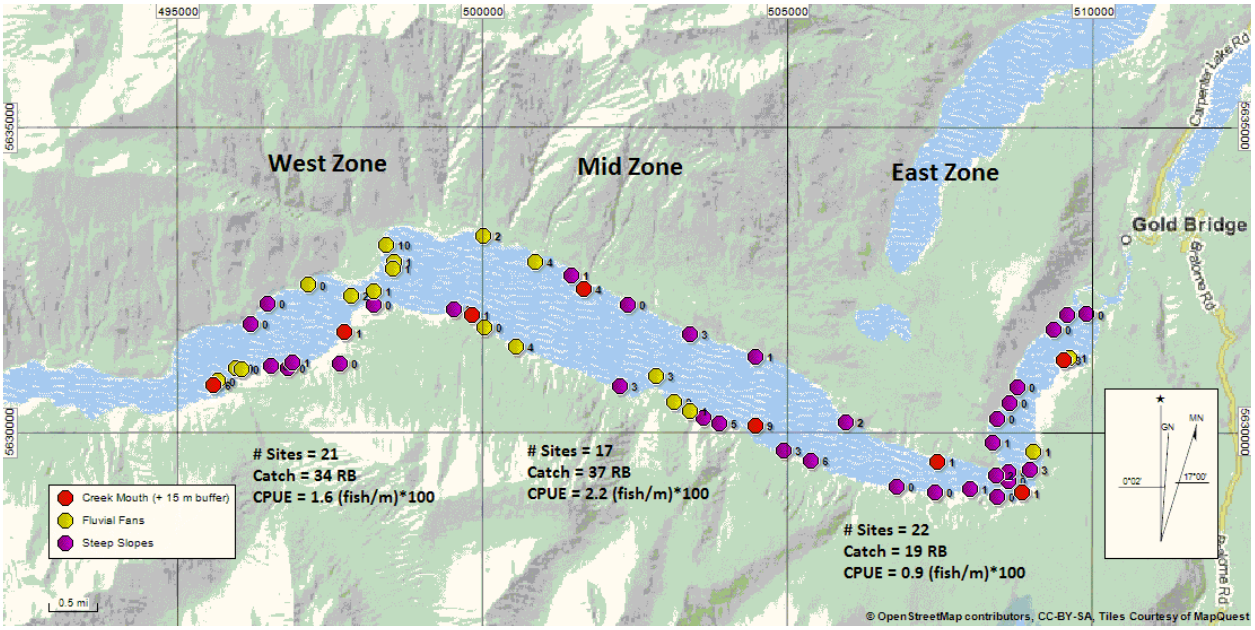


Figure 7 The distribution of sites and catches of rainbow trout by habitat type and longitudinal zone of the reservoir, June 2013. Catches at individual sites are represented by the numbers next to each coloured dot.

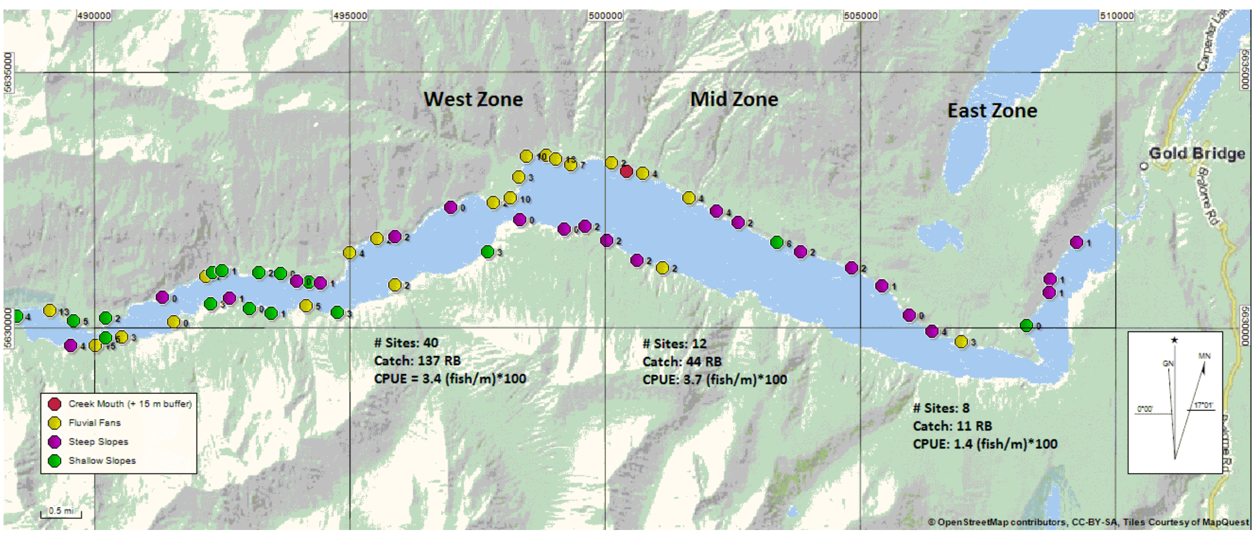


Figure 8 The distribution of sites and catches of rainbow trout by habitat type and longitudinal zone of the reservoir, October 2013. Catches at individual sites are represented by the numbers next to each coloured dot.

Between-Season and Between-Year (2013 to 2014) Recaptures

Four fish that had been tagged during previous sessions were recaptured during 2014 (i.e., 2 during each session). Original capture and recapture information is summarized in Table 7. Three fish were recaptured almost exactly one year after the original capture date; Two of these fish were recaptured in the same location (Ault Creek confluence) and the other had moved 7.6 km from the Trib. #16 fan east towards the dam on the north shore. One fish that was captured and tagged at the Trib. #19 confluence in June 2014, was recaptured at the Jamie Creek confluence during the October session (distance = 4.7 km southwest).

Table 7 Summary of inter-session fish recaptures (monitoring Year 1 to Year 2).

Tag Code[a]	Original Capture Data				Recapture Data				Dist. (km)
	Date	Location	FL (mm)	Wt (g)	Date	Location	FL (mm)	Wt (g)	
086704	22-May-13	Ault Cr. Confl.	329	350	9-Jun-14	Ault Cr. Confl.	324	278	0.0
077392	25-Jun-13	Ault Cr. Confl.	302	n/a	9-Jun-14	Ault Cr. Confl.	300	224	0.0
650514	9-Jun-14	Trib. #19 Confl.	320	296	6-Oct-14	Jamie Cr. Confl.	320	n/a	4.7
585156	8-Oct-13	805	172	71	7-Oct-14	842	280	259	7.6

[a] The prefix to each of these tag codes is: 900 226000

One fish was likely Age-2 based on size (172 mm) when initially captured, and an Age-3 size (280 mm) when recaptured a year later based on length-frequency analysis (see section below). The other fish were larger (Age-3 to Age-4), but showed no evidence of growth between seasons or years. This suggests the possibility of significant size overlap (i.e., very slow growth) after Age-3; however, this assessment is very tenuous at this point as it is based on a very small dataset.

2014 Targeted Mark Recapture

In 2014, the boat EF sampling followed a two-pass mark-recapture approach with the goal of documenting habitat-stratified capture efficiency. If capture probabilities could be quantified, they could then be applied to catch results in order to generate more robust population estimates. To improve the chances of success for the mark-recapture experiments, an increased focus was placed on habitats with the highest fish densities (and catch rates) based on the 2013 results: tributary confluence areas (Type 1) and fluvial fans (Type 2). The idea was that if capture efficiencies could be quantified in these areas, then the mark-recapture experiments would be extended to the other (Type 3 and 4) habitats. On the other hand, if it was not possible to establish capture probabilities in 'preferred' habitats, it likely isn't feasible in the lower density areas.

Totals of 181 fish were captured by two-pass boat EF at 9 intensive sites in June 2014 (Marking pass *n*=92; Recapture Pass *n*=89). In October 2014, 20 fish were captured by angling and marked with PIT tags, and 153 were captured by boat EF at 12 two-pass sites plus an additional 13 single-pass index sites (Tables 5 and 6). As in 2013, all captured fish were rainbow trout. In total, 329 fish were marked with PIT tags (168 in June; 161 in October); As in 2013, only fish > 100 mm fork length and in good condition were tagged. No fish from the marking pass were subsequently recaptured in the second pass during either session, so the two-pass mark-recapture approach for estimating capture efficiency was unfortunately unsuccessful in this context. This is likely due to a combination of factors, including: spotty fish distribution, violation of the site-closure assumption (i.e., marked fish may have left the site between passes), and poor visibility conditions. As a result, we will not continue the two-pass mark recapture approach in favour of the single pass index sampling approach at a larger number of sites. We will continue to mark all fish of appropriate size with PIT tags to inform population distribution and growth rate, and potentially contribute to an open population model for estimating population size by the end of the monitor.

Table 5 Relative numbers of sites by habitat type for boat electrofishing mark-recapture surveys, June and October 2014.

M-R Session	# of Sites	Proportion of Sites by Habitat Type[a]			
		Trib. Confl.	Fluvial Fans	Shallow Slope	Steep Slope
June	9	3 (33%)	4 (44%)	1 (11%)	1 (11%)
October	12 (+13)[b]	4 (16%)	8 (32%)	4 (16%)	9 (36%)

[a] Relative contribution of each type to the total number provided in brackets.

[b] 12 two-pass mark-recapture sites in types 1 & 2 habitats plus an additional 14 single-pass index sites in types 3 & 4 habitats were completed in October 2014.

Though the CPUE values were higher in 2014 due to the more intensive sampling at sites characterized by higher fish densities, the general trends were similar. Highest CPUE values were recorded at tributary confluences (Type 1); the CPUEs for other habitats were lower and more similar between types. CPUEs in June were higher than in October; again, likely due to the higher proportion of Type 1 sites sampled during the spring session.

Table 6 Summary of fish capture results from boat electrofishing mark-recapture surveys in June and October 2014. All captured fish were rainbow trout.

Metric	Units	Mark-Recapture Sessions							
		June				October			
		Confl.	Fan	Shallow	Steep	Confl.	Fan	Shallow	Steep
Sites	#	3	4	1	1	4	8	4	9
Effort	total seconds	3519	4860	2103	1259	1128	7609	3823	8059
	total meters	700	1595	602	500	200	2481	1202	2750
Catch	# of fish	100	60	8	13	30	54	31	38
	# of fish marked	96	54	8	10	20	45	30	36
	# of recaptures	0	0	0	0	0	0	0	0
CPUE	fish/site	**16.7**	**7.5**	**4.0**	**6.5**	**7.5**	**6.8**	**7.8**	**4.2**
		10.1				**6.1**			
	(fish/sec)·100	**2.8**	**1.2**	**0.4**	**1.0**	**2.7**	**0.7**	**0.8**	**0.5**
		1.5				**0.7**			
	(fish/meter)·100	**14.3**	**3.8**	**1.3**	**2.6**	**15.0**	**2.2**	**2.6**	**1.4**
		5.3				**2.3**			

Length-Frequency and Size-at-Age Assessment

Length-frequency histograms for rainbow trout captured by boat electrofishing during June and October sessions in 2013 and 2014 are presented in Figures 9 to 12. The vertical dashed lines in each of these figures indicate the approximate age class breaks based on visual assessment of the histograms. These 'breaks' need to be better defined by analysis of ageing structures (i.e., scales), which were collected in Year 1 and Year 2, since there is typically size overlap (in some cases, significant) between age classes. However, age data from the scale analysis was not available at the time of writing for this report (see Section 3.5), so size-at-age ranges suggested here will need to be calibrated once the ageing data become available.

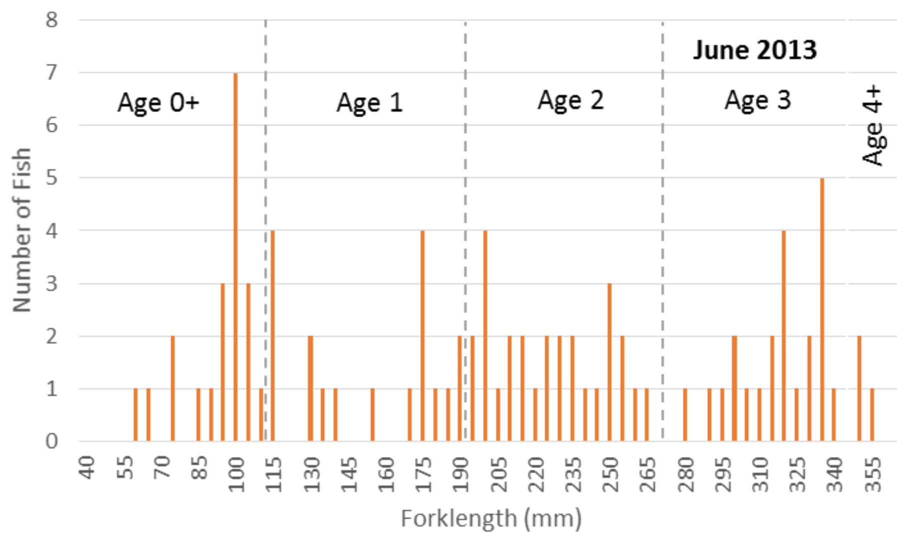


Figure 9 Length frequency histogram for rainbow trout captured during a boat electrofishing index survey in Downton Reservoir, June 2013.

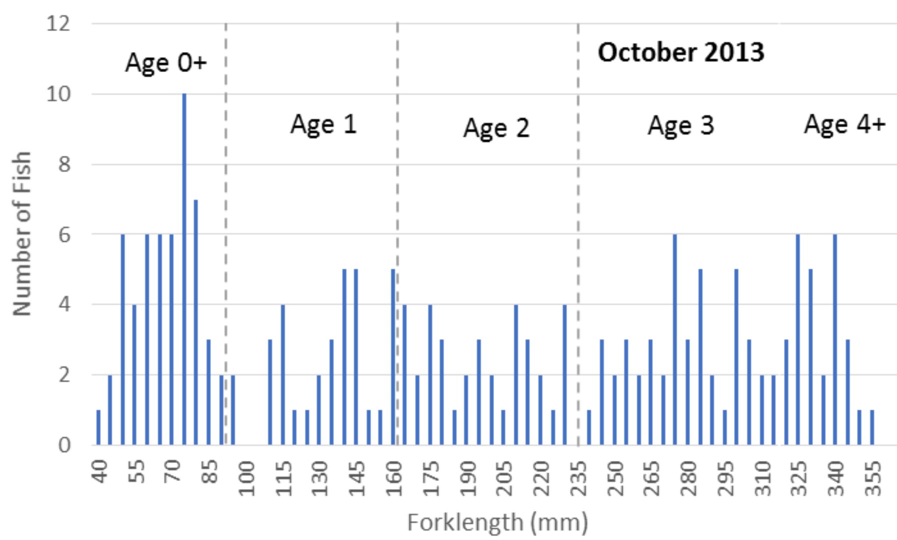


Figure 10 Length frequency histogram for rainbow trout captured during a boat electrofishing index survey in Downton Reservoir, October 2013.

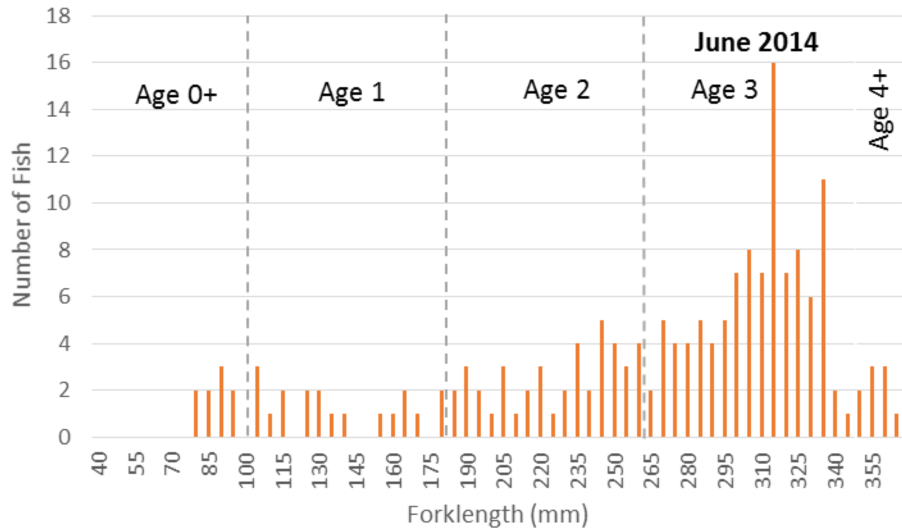


Figure 11 Length frequency histogram for rainbow trout captured during a boat electrofishing mark-recapture survey in Downton Reservoir, June 2014.

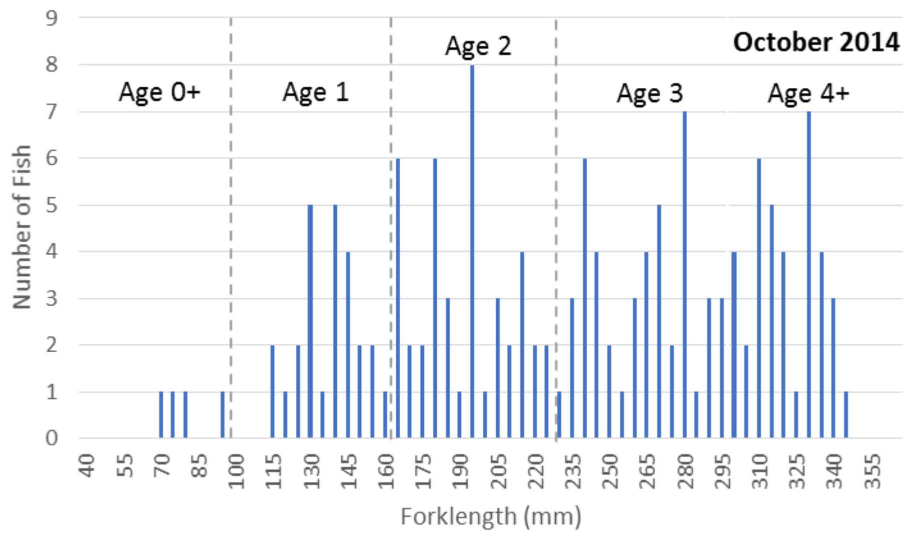


Figure 12 Length frequency histogram for rainbow trout captured during a boat electrofishing mark-recapture survey in Downton Reservoir, October 2014.

Due to the timing of the index sampling surveys, the new year class of Age 0+ rainbow trout are first sampled in the fall, by which time they were 40 to 95 mm forklength (average growth rate = ca. 0.5 mm/day). Length-frequency data from the June 2013 survey suggest that the size range of Age 0+ fish are between 55 and 110 mm by the end of their first year. By fall, after another season of growth, these fish are considered Age 1 and range between ca. 90 to 160 mm. Winter represents a period of slower growth, so by the next spring these Age 1 fish are between ca. 105 and 180 mm (at the end of their second year). Age 2 fish were approximately 165 to 230 in October and between ca. 195 and 265 mm in June. The high end of the size range likely represents Age 3 fish and older, but there tends to be so much overlap between age classes in that size range that it was not possible to estimate the breaks for these older classes from the histograms.

The length-frequency data reflect a skewed distribution of sizes for both the spring and fall 2014 surveys: there was a higher proportion of larger fish than smaller fish in these samples. This is not likely an accurate representation of the size distribution in the reservoir during Year 2 due to the focus of the mark-recapture approach on habitats with higher densities of fish. Tributary confluence areas probably represent feeding areas and pre-spawning aggregations more than rearing habitats in Downton Reservoir.

3.4. Supplemental Tagging Surveys

Four supplemental tagging surveys were conducted in Year 1 and three were conducted in Year 2. In addition to the number of fish tagged by boat EF sampling during the fish indexing surveys (described in Section 3.3), totals of 182 and 31 rainbow trout were caught by angling in 2013 and 2014, respectively, and all fish were a tag-able size (Table 8); Sizes ranged from 192 to 437 mm across years. Two of the four fish recaptured during the boat EF surveys were originally caught by angling during these supplemental tagging events. Angling is thought to subject the fish to less sampling-induced stress, which is why this method was also chosen for marking fish during the October 2014 mark-recapture survey. These angling surveys also provided additional scale samples for ageing purposes.

Table 8 Numbers of PIT tags applied by sampling method during 2013 and 2014. Note: the numbers applied to fish captured by boat EF are included for comparison purposes.

	2013		2014		Total (To-Date)
	Boat EF	Angling	Boat EF	Angling	
# of PIT tags applied	205	182	309	31	727

The angling surveys were conducted in the confluence areas of the following tributaries: Ault Creek, Gwyneth Creek, Jamie Creek, and Tribs. #6, 15, 16, 18, and 19.

3.5. Laboratory Analyses (Scale Ageing)

Scale samples were collected from 109 rainbow trout in 2013, and 180 in 2014 for fish ranging in size from 59 to 437 mm. A selection of ca. 100 of these samples will be submitted for ageing. Unfortunately the lab isn't available to begin reading the scales until May 2015. As such, these data were not available at the time of writing for this report.

4) Management Questions, Study Hypotheses and Interim Status

Status of Management Questions for Years 1 and 2

Primary Objectives	Management Questions	Year 2 (2014) Status for Management Questions
1) To collect comprehensive information on the life history, biological characteristics, distribution, abundance and composition of the fish community in Downton Reservoir, and 2) To provide information required to link the effects of reservoir operation on fish populations to a) document impacts of the operating alternative on existing reservoir fish populations, and, b) allow better future decisions regarding preferred operation of Downton Reservoir.	1. What are the basic biological characteristics of fish populations in Downton Reservoir and its tributaries?	The program is on track to answer Management Question (MQ) 1 by establishing an index of abundance, distribution and biological characteristics data for rainbow trout.
	2. Will the selected alternative (N2-P) result in positive, negative or neutral impact on abundance and diversity of fish populations?	The program is on track to answer MQ 2 by establishing an annual index of abundance and documenting the biological characteristics of the rainbow trout population over time. Trends in these metrics, in conjunction with trends in reservoir operation, will provide information for addressing this MQ.
	3. Which are the key habitat factors that contribute to reduced or improved productivity of Downton Reservoir fish populations?	Based on the information collected in Year 1 and 2, the program is on track to characterize the relative importance of various habitat types in the reservoir for rainbow trout. Specific, targeted habitat data collection linked to reservoir operation level will begin in Year 3, providing additional information for addressing this MQ. That being said, it will be a challenge to differentiate the role of specific habitat factors from other key variables such as reservoir operation, minimum elevation, stream events, etc. over the course of the monitoring period.
	4. Is there a relationship between the minimum reservoir elevation and the relative productivity of fish populations?	The program is on track to answer MQ 4 by establishing an annual index of abundance and documenting the age structure of the rainbow trout population over time. The goal is to address this MQ by correlating abundance of younger ages of fish (recruitment) with minimum reservoir elevations by year. However, it is anticipated that differentiating the role of min. reservoir level from other key variables such as reservoir operation, habitat factors, stream events, etc. will be a significant challenge.
	5. Can refinements be made to the selected alternative to, without significant impact to instream flow conditions in the Middle Bridge River, improve habitat conditions or enhance fish populations in Downton Reservoir?	The program is on track to providing the relevant information for answering this MQ; however, the annual fish abundance index, biological characteristics data, and key habitat factors data for all years of the monitoring program will be required for addressing this MQ.

Responses to Study Hypotheses for Years 1 and 2

Primary Objectives	Study Hypotheses	Year 2 (2014) Responses to Study Hypotheses
1) To collect comprehensive information on the life history, biological characteristics, distribution, abundance and composition of the fish community in Downton Reservoir, and 2) To provide information required to link the effects of reservoir operation on fish populations to a) document impacts of the operating alternative on existing reservoir fish populations, and, b) allow better future decisions regarding preferred operation of Downton Reservoir.	**H_1:** The abundance and diversity of Downton Reservoir fish populations are limited by habitat impacts directly related to the operation of the reservoir.	H_1: not rejected; more data needed. Requires focussed surveys to document habitat characteristics at key reservoir elevations (e.g., low, full, and modified maximum – as proposed in the Year 3 workplan) and a linkage to fish abundance index.
	H_{1A}: Operation of the reservoir at low elevations reduces fish productivity due to stranding of fish and eggs.	H_{1A}: not rejected (N/A). This hypothesis is not directly addressed by the data collected for this monitoring program – To be revised as a part of the ToR addendum.
	H_{1B}: Operation of the reservoir at low elevations (i.e., <718 masl) causes significant rates of fish entrainment from the reservoir.	H_{1B}: not rejected (N/A). This hypothesis is not directly addressed by the data collected for this monitoring program – To be revised as a part of the ToR addendum in Year 3.
	H_{1C}: Operation of the reservoir restricts the amount available effective spawning habitat in tributaries and this limits the productivity of fish populations.	H_{1C}: not rejected; more data needed. Requires focussed survey to systematically document tributary access and habitat characteristics at the range of reservoir elevations during the rainbow trout spawning & incubation period. Surveys for this purpose have been included in the Year 3 workplan.
	H_{1D}: Operation of the reservoir at low elevations reduces aquatic productivity and this results in reduced abundance and diversity of fish populations in Downton Reservoir.	H_{1D}: not rejected. This hypothesis is not directly addressed by the data collected for this monitoring program – To be revised as a part of the ToR addendum in Year 3.

5) References

BC Hydro. January 2012. Bridge-Seton Water Use Plan – Monitoring Program Terms of Reference. BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring. Prepared for the BC Comptroller of Water Rights.

BC Hydro. January 2015. Addendum to BRGMON-7 Downton Reservoir Fish Habitat and Population Monitoring Terms of Reference. Prepared for the BC Comptroller of Water Rights.

Korman, J., J. Schick and A. Clark. 2010. Cheakamus River Steelhead Juvenile and Adult Abundance Monitoring; Implementation Year 2. Reference CMSMON-3. Report prepared for BC Hydro and the Deputy Comptroller of Water Rights, February 2010.

Sneep and Hall 2012. Lower Bridge River Aquatic Monitoring – Year 2011 Data Report. Prepared for BC Hydro and the Deputy Comptroller of Water Rights, August 2012.

6) Photos

Plate 1 The ability to access sites can depend on factors such as windfall, slides and avalanches blocking access roads. This photo was taken on the Bridge Main on 8 May 2014.

Plate 2 Boat EF is conducted by running an electrical current through the water between a set of boom-mounted anodes extended off the front of the boat and a cathode array, while propelling the boat forward at slow speed.

Plate 3 Rainbow trout spawners were surveyed by walking the shoreline of the creek starting at the reservoir confluence and heading upstream.

Plate 4 Many of the tributaries in the study area are characterized by high gradients above the reservoir basin and some did not have surface flow connectivity to the reservoir during the rainbow trout spawning period (due to low flows and porous substrate), May 2014.

Plate 5 Spawning use of the Upper Bridge River remains unknown due to the high turbidity conditions throughout the year which precluded the visual-based assessment methods applied in study years 1 and 2.

Plate 6 Bear sign was regularly observed in the soft mud of the drawdown zone around spawning tributaries.

Plate 7 Downton Reservoir rainbow trout.

Plate 8 Tributary channels are incised through the fine substrate materials that dominate the drawdown zone. Overhead cover is virtually non-existent within these areas.

Plate 9 View of the reservoir drawdown zone at low pool looking east, May 2014. Note: The new Jamie Creek IPP is just visible on the right of the photo.

Plate 10 View of the reservoir drawdown zone at low pool looking west, May 2014.

Plate 11 Downton Reservoir just above the log boom at low pool, May 2014.

Appendix A – Year 1 Site Distribution Maps for Boat EF Index Surveys

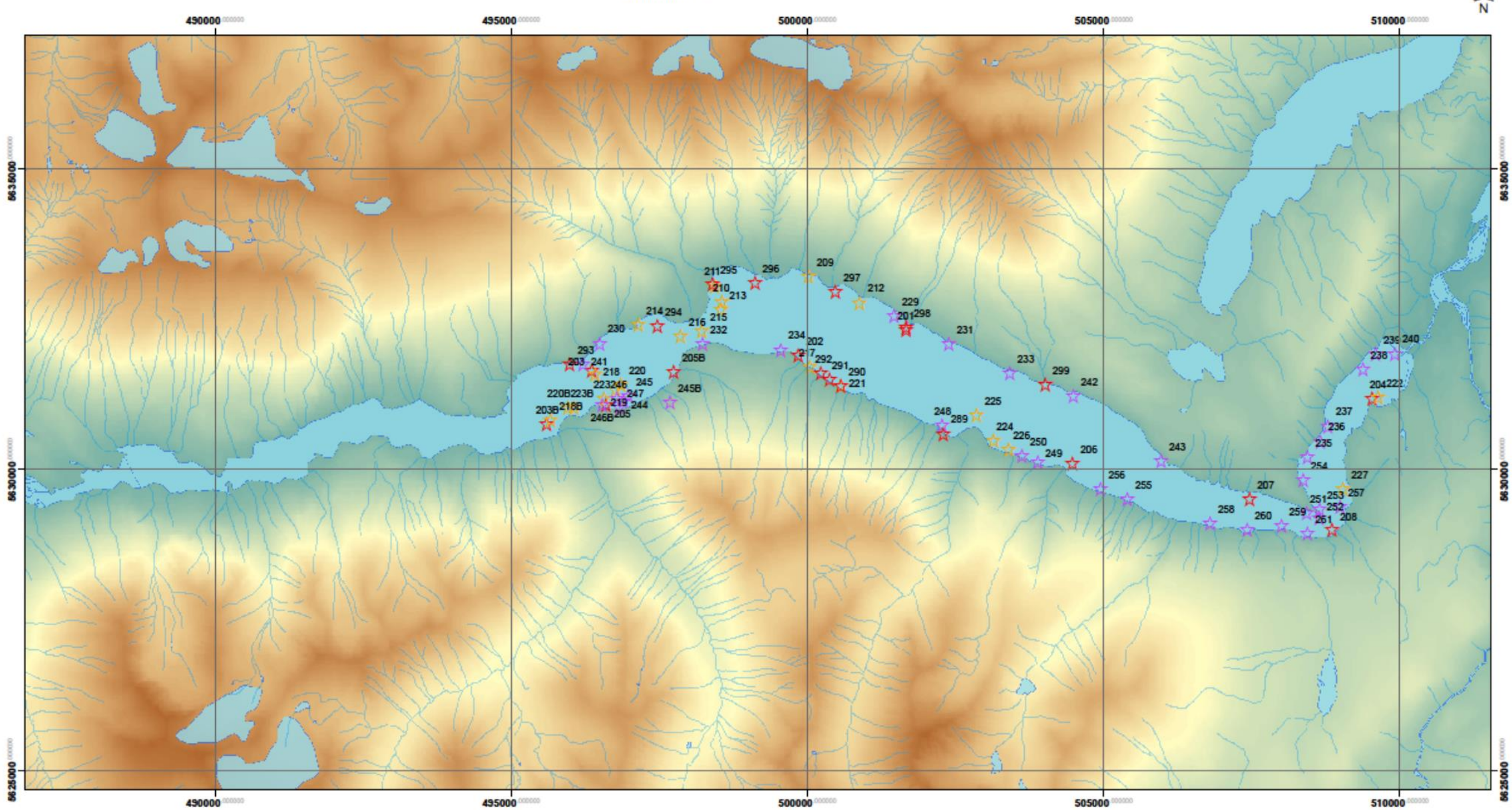
Downton Lake Fish Habitat Random Samples June 2013

Sample Points

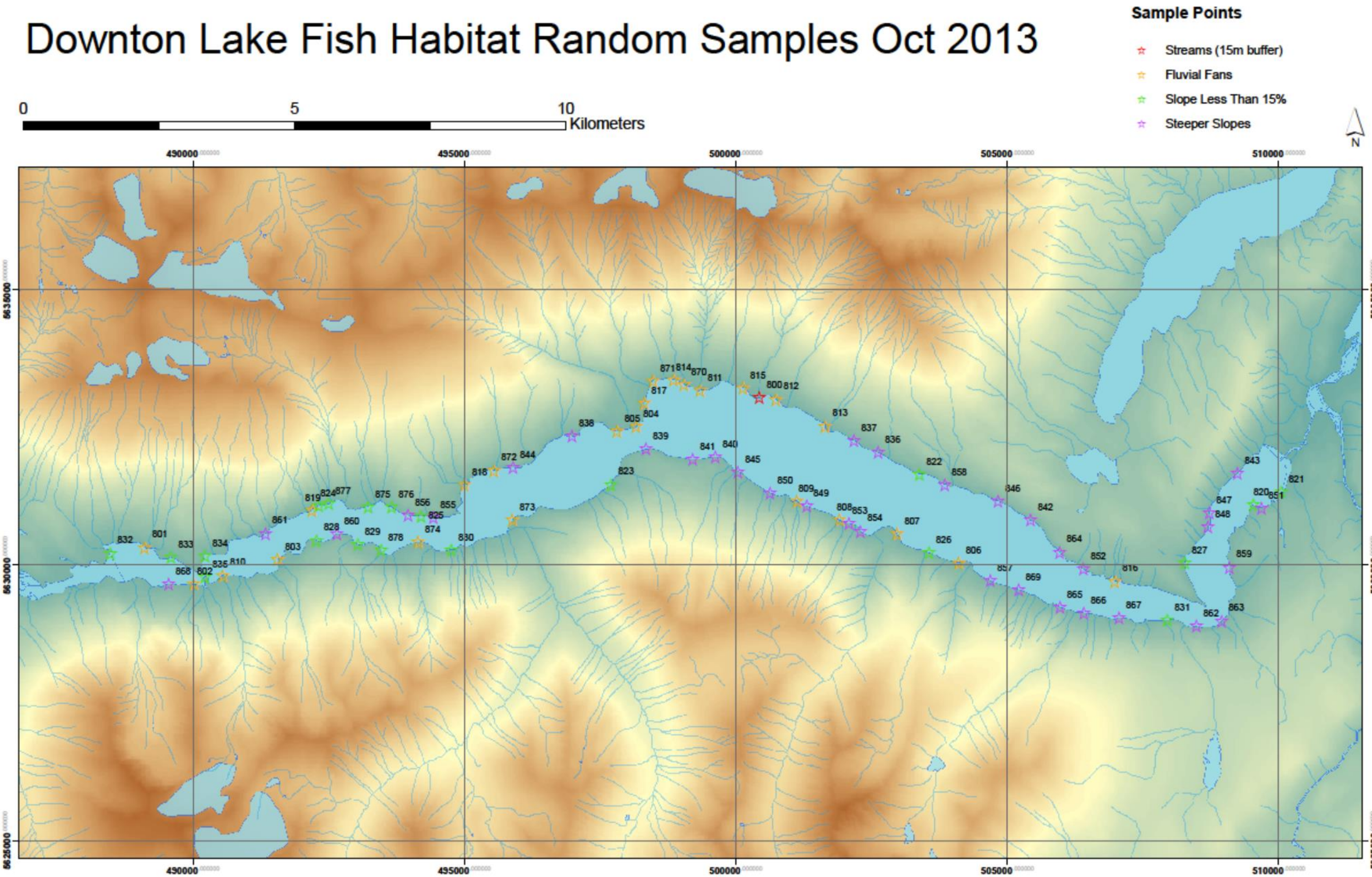
- Streams (15m buffer)
- Fluvial Fans
- Slope Less Than 15%
- Steeper Slopes

0 5 10 Kilometers

N



Downton Lake Fish Habitat Random Samples Oct 2013



Appendix B – Sample Data Forms

Sample Site Form

Waterbody: ____________________

Date (dd-mmm-yy)	Site ID	Habitat Type	Waypoint ID		UTM (Downstream)		UTM (Upstream)		Site Marked	Site Ln (m)	Crew	Comments
			Downstream	Upstream	Easting	Northing	Easting	Northing				
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Habitat Type: **1** = Stream Mouth (+/- 15 m) **2** = Fluvial Fan **3** = Shallow Slope (<15%) **4** = Steep Slope (>15%)

Fish Sampling & Biological Information Form

Waterbody: ____________________ Capture Method: ____________________

Date (dd-mmm-yy)	Site ID	Species	Length (mm)	Weight (g)	Scale Sample		Recap	PIT Tag Data		Sex (M/F)	Maturity (Mat/Imm)	Spawning Condition (Green/Gravid/Ripe/Spent)	Comments
					✓	Code		Type	Code				
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Bycatch Tally Form

Waterbody: ____________________ Capture Method: ____________________

Date	Site	Fish Species Tally									
(dd-mmm-yy)	ID	RB	BT	MW	KO	CH	CO	BSU	PMC	NSC	Other