FEASIBILITY OF ADULT BULL TROUT SPAWNER ASSESSMENT by RESISTIVITY FISH COUNTER on WILLISTON RESERVOIR TRIBUTARIES

December 2011

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December 2011

Prepared for the

BC HYDRO
Fish and Wildlife Compensation Program – Peace Region
EXECUTIVE SUMMARY

Since 2001, the Peace Fish and Wildlife Compensation Program (FWCP-P) has funded some measure of annual bull trout (*Salvelinus confluentus*) monitoring program on tributaries of Williston Reservoir. The monitoring program utilizing redd counts has merit in that for a relatively low budget, data can be collected on bull trout spawner numbers, but the data suffer from low precision to evaluate trend data over time without significant expansion either in geographical coverage or time, both which have significant increased annual budgetary requirements.

In this report we evaluate the potential for utilizing an electronic resistivity counter to enumerate out-migrating adfluvial bull trout kelts and traditional redd surveys to provide accurate estimates of the escapement in the several tributaries within the watershed. The monitoring program builds upon a studies conducted since 2006 in the Kootenay Region, where electronic resistivity counts (jointly funded by FWCP and by HCTF) along with redd survey counts (funded by FWCP) demonstrated that two independent methods of spawner enumeration can, where combined, provide a reliable estimates of escapement that may allow for redd count expansion factors to be generated for index sections of streams.

The main objectives of these proposed studies is to: 1) utilize electronic resistivity counters to enumerate adfluvial out-migrating bull trout 2) conduct redd surveys throughout the watershed, 3) establish an index of abundance for bull trout and 4) establish a standardized methodology for the conservation and management of bull trout populations in the Williston Reservoir region.
ACKNOWLEDGEMENTS

Funding for this project was provided by the Fish and Wildlife Compensation Program – Peace region (FWCP-P). Bull trout, an endemic char, are valuable assets in the Peace Region and many dedicated people are involved in their protection, management and conservation. Specifically, Arne Langston is acknowledged for his efforts in arranging access to the study area and in providing background information on the management and conservation of these unique char.

The Fish and Wildlife Compensation Program is a joint initiative between BC Hydro and the Ministry of Environment to conserve and enhance fish and wildlife populations affected by the construction of BC Hydro dams in the Peace Region.
INTRODUCTION

Bull trout (Salvelinus confluentus), an endemic char, are considered an indicator species of the health and status of many watersheds as a result of their wide distribution in BC. Locally, these char are a popular sport fish species on Williston Reservoir. However, the status and health of most bull trout populations are in comparison to other fish species poorly documented. Williston Reservoir and many of its tributaries post impoundment are known to support various adfluvial populations of bull trout. Concerns over population declines due to unknown fishing mortality, reservoir management regimes, habitat alterations and climate change have led management agencies to list bull trout as a species of concern in BC. In an attempt to better understand the population dynamics of Williston Reservoir bull trout, an annual monitoring program utilizing a resistivity fish counter (i.e. Aprahamian 1993, McCubbing et al 1999) is proposed to complement existing redd count surveys (Andrusak et al 2011) that are established on four tributaries of the reservoir: Scott Creek, Point Creek, Davis River and Misinchinka River. Over time an index of abundance on this system will inform fisheries managers on the status of these bull trout population and their sustainability within the recreational fishery. The data collected may also be transferable to evaluate the health status of other local populations.

As with many salmonids populations, bull trout are highly sensitive to habitat alteration, degradation and fragmentation (Rieman and McIntyre 1995). Williston Reservoir and many of its fish populations have undergone major perturbations as a result of human impacts. As well, the effects of climate change could have serious implications to bull trout populations, since they require cold water temperatures (Selong et al. 2001; Dunham et al. 2003).

Redd surveys within some watersheds provide an excellent, fairly inexpensive method of monitoring regional trends in bull trout populations. Although such surveys are considered less expensive and less invasive than alternate sampling methods, concern over the sensitivity, precision and accuracy of such monitoring has long been expressed (Rieman and Myers 1997; Dunham et al. 2001; Muhlfeld et al. 2006). However when combined, redd counts calibrated with electronic resistivity counts can provide far more accurate escapement estimates, thus, reducing much of the uncertainty associated with redd survey counts (Andrusak and McCubbing 2006, Andrusak 2008, 2009). Furthermore, the combined methodologies have the ability to provide a standardized methodology for monitoring of bull trout populations.

This report evaluates the options for developing an indicator site to initiate a monitoring program utilizing combined redd count/resistivity counter methods. Specific objectives are:

- Evaluate suitable sites for the utilization of an electronic resistivity counter to enumerate adfluvial out-migrating bull trout
- Cross reference current and historical redd count surveys data throughout the same watersheds
Determine potential for establishing an index of abundance for bull trout
- Estimate budgets and timescales for fish counter deployment
- Establish target metrics for satisfactory counter performance.

BACKGROUND

Variable life history characteristics, behaviour, spatial and temporal distributions make bull trout difficult to assess (Rieman and McIntyre 1996; Rieman and Myers 1997; Dunham et al. 2001). The success of future bull trout conservation and management decisions will be dependent on the ability of biologists to accurately assess their status or abundance. Redd surveys have provided an inexpensive and less invasive index of abundance for monitoring bull trout trends. However, despite widespread use of redd counts for monitoring population trends few studies have evaluated the validity of this method for detecting trends in population size (Muhlfeld et al. 2006). Expansion of redd counts to estimate population size is inherently difficult due to the unknown relationship that exists between the number of redds created per fish which has been demonstrated to change through the wide geographic distribution bull trout inhabit. For example, Al-Chokhachy et al. (2005) suggested an average of 2.68 bull trout/redd but indicated ranges between 1.2 to 4.3 bull trout per redd depending on the various life history forms being monitored. Data from Kaslo and Crawford creeks collected and validated in the method proposed suggest a range of between 1.8 and 2.5 redds per spawner (Andrusak 2009). It is also suggested in the literature that there is strong correlation on a logarithmic scale between escapement estimates and redd counts, but observer errors and the spatial and temporal variability in bull trout life history invite considerable uncertainty.

Establishing a quantitative standardized methodology is highly desirable for the management of Williston Reservoir bull trout populations. The combined electronic counter data in concert with redd surveys should provide a metric for more accurate monitoring of population size and trends.
STUDY AREA

Of the four potential locations which were intended for fish counter suitability evaluation in September 2011, due to inclement weather conditions and helicopter safety rules, only two were evaluated to date. These two sites, Scott Creek and the Misinchinka River both offered suitable locations for a flat pad type sensor unit and with river widths similar to those where successful operation has been undertaken in other locations.

Figure 1. The Williston Reservoir and location of the four redd count index systems: Davis River, Scott Creek, Point Creek and Misinchinka River.

METHODS

Potential site locations were determined by two observers (D. McCubbing and A. Langston) during an overflight survey in a Bell Ranger II helicopter on Sept 1, 2011 and
completed on the ground physical site surveys. Photo documentation of potential counter sites was recorded with a digital camera (Nikon D50, 250mm telephoto lens, additional photos on file), gps data/coordinates were collected by hand held gps (Garmin Oregon 450 model). Wetted and bankfull width measurements were obtained using a hand held laser range finder (Bushnell 201916 Yardage Pro Sport 450) accurate to 1m. Depths visually estimated as sites may vary annually due to gravel movement and final selection would be undertaken during the first year of proposed operation.

RESULTS

The most suitable location for a fish counter on Scott Creek was a relatively linear portion of the stream some 500m below the logging road access bridge about 2-3km above the full pool confluence of Scott Creek and the Parsnip Arm of Williston Reservoir (N 55o 45.12 W123o 32.32). The river was approximately 20-25m wide at this location depending on discharge and the substrate was mixed cobble and gravel. The banks appeared stable and the channel unlikely to migrate, but there was evidence of large amounts of wood debris from previous high-water events. Access would be from the logging road via an existing ATV trail followed by a short (less than 100m) traverse through a stand of second growth timber. Alternatively gear may be rafted down from the logging road bridge. River depths appeared wade-able under low summer flow conditions for site set up and large trees offered good moorage points for mounting chains.

![Figure 2. Potential resistivity fish counter locations on Scott Creek with an average width of 22m.](image)

The most suitable location for a fish counter on the Misinchinka River was a long pool flat habitat some 3km below Atunatche Creek (N55o19.27W 122o37.85). This is approximately 20km below the existing index redd count site and 35km upstream of the Misinchinka and Parsnip rivers confluence. Williston Reservoir (at full pool) is a further
~15km downstream from the two river’s confluence. The bank full river width was approximately 35-40m wide at this location depending on discharge and the substrate was mixed cobble and gravel. Wetted widths at the time of survey were much less ~22m. The banks appeared only partially stable with a high likelihood that the channel may migrate between survey years, and there was much local evidence of large amounts of wood debris from previous high-water events. Access would be from the highway via an existing ATV trail (~1km) followed by a short (100 to 200m) traverse through a stand of low brush. Alternatively gear may be rafted down from upstream where the highway is closer to the main river channel. River depths appeared wade-able under low summer flow conditions for site set up.
Figure 3. Potential resistivity fish counter location on the Misinchinka River, approximately 3km downstream of its confluence with Atunatche Creek

Of primary importance is the requirement to distance the enumeration equipment from spawning locations to reduce recycling of spawners. In the case of the two sites selected, it appears that there is little spawning on the immediate location of the potential enumeration site based on redd count observations (FWCP-P data on file, pers comm. A Langston). There is some uncertainty of the possible occurrence of non-target species during the spawning period but this could be quantified by undertaking a diver swim in the locations selected during the late summer early fall if data do not already exist.

Finally consideration should be given to the size of the target watersheds and access requirements. While Scott Creek and the Misinchinka River do not have as extensive redd count data as the Davis River, they offer the opportunity of road access to the chosen site locations. This reduces operating costs and the risk of data loss through the inability to fly into the remote Davis River and Point Creek’s potential counter sites during periods of extended poor weather. Furthermore the smaller watershed and higher density of redds observed in the index reach of Scott Creek, would likely improve data quality while minimising flood risk damage.
Electronic Resistivity Counter

The resistivity counter detects the passage of fish across an array of three electrodes (positive, ground and negative), placed across the river, or in a channel, in an insulated base (Aprahamian et al 1996). The counter electronics continually monitors the resistance (bulk resistance) of the water above the counting array and calibrates for changes in this resistance every 30 minutes. When a fish passes over the three electrodes, a change in resistance occurs, since a fish is more conductive than the water it displaces. This change of resistance is recorded and analyzed by the counter using a firmware algorithm to determine if it fits a typical fish pattern. Should the counter assess that a fish has passed over the array: the time, direction of travel and peak signal size (maximum change of resistance measurement) of the fish event, is recorded and stored for later downloading and analysis (see Aprahamian et al 1996 for more details of counter design and operation).

The proposed design of the flat pad sensor units in this project is similar to that used on the Chilcotin River (McCubbing 2008, Figure 4) with an outer high density plastic frame into, which were set 3 stainless steel electrodes (McCubbing 2008). The flat pads will be held in place by a large chain across the river. Sand bags or rocks will placed on the periphery of each pad to ensure fish passed over the sensor units.

Figure 4. Chilcotin River flat pad counter installed and operational, 2007 and 2008. River is ~23m wide at counter location.
The Logie 2100C counter will be hard wired into the electrodes and positioned on the bank along with a power source (batteries) in a metal work box. Typically the counter can be operated for up to one month without battery changes, but it is strongly recommended in the first year of operation that the data be checked and downloaded on a more regular basis; weekly or every other week, given the proposed new location of operation.

**Counter Operation**

Data collected from the counter will stored as buffer files (on the counter) and downloaded on a regular basis by field staff. The data contains the date of download, settings of the counter followed by fish records. The fish records contain a date, time, conductivity, channel of count, direction of travel (up or down) and estimated Peak Signal Strength (PSS) (Table 1).

**Table 1.** An example of a fish record from the electronic resistivity counter.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Channel Conductivity</th>
<th>Channel #</th>
<th>Channel Direction</th>
<th>PSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/9/2006</td>
<td>3:51:06</td>
<td>100</td>
<td>3</td>
<td>U</td>
<td>98</td>
</tr>
</tbody>
</table>

Graphical trace records will be collected for fish through a short period of the migration window (due to increased power draw). This data will be logged direct to portable PC/data logger for storage, as the counter memory is insufficient for this purpose. Graphical trace data and signal size will be used for analysis and assisted in the assessment of fish behaviour, directional movement and counter performance (i.e. noise events vs. fish events) (Figure 5). This type of data which can be collected in addition to standard counter output allows for increased confidence in fish counter performance.

**Figure 5.** Example of a typical graphical fish trace of an upstream bull trout on the upper Kaslo River.
As well, digital video of some daytime records and/or Blueview validation of night time records (Espinoza and McCubbing in prep) will be collected through a period of peak migration. The digital video recorder (12v DVR) will be linked to a fixed outdoor camera positioned on a nearby tree or on a stand (~ 4-5 m height). Similar to the graphics trace data, digital video data will be used for analysis and assistance in the assessment of fish behaviour, directional movement and counter performance.

**Fish Counter Enumeration Estimates**

Fish counter estimates will target kelted bull trout as on the upper Kaslo River in 2008 through 2010 and will be calculated by methods similar to those used on the Deadman River in 1999 (McCubbing et al 1999). In summary they will be calculated by the following process:

1. All obvious spurious debris or wave action from graphics data will be removed from the raw data set. These are usually characterized by large numbers of events on a single channel over a short period of time and do not have typical graphical trace forms.

2. All trace data will be visually examined and used as an efficiency check for counter validation.

3. Validation data where obtained from digital video data for all daytime events and Blueview data for night-time records will be used to assess counter efficiency.

4. A daily summary of up and down counts will be examined to determine, at what time during the migration window kelted fish began dropping back over the counter.

5. A value for net down counts will be determined for char passage based on peak signal size distributions and the pattern of downstream counts.

Thus the total downstream count for each size class of fish will be estimated as follows:

\[
E = \sum_{t=1}^{\infty} \left( \frac{D_t}{q_{down}} - \frac{U_t}{q_{up}} \right)
\]  

where \( U_t \) is the total number of daily upstream detections classified as fish by the firmware algorithm, \( D_t \) is the corresponding number of daily downstream detections, \( q_{up} \) is the detection efficiency of upstream moving fish and \( q_{down} \) is the detection efficiency of downstream moving fish, both of which will be assessed independently from video validation experiments. McCubbing and Espinoza (2011 in prep) have estimated \( q_{up} \) to
be 85-90% and $q_{down}$ to be 75-85% for chinook spawners while Andrusak 2010 indicated downstream counter efficiency on bull trout kelts at Kaslo Creek may be greater than 95%. The parameter $k$ is the day that kelts began migrating downstream. This parameter is estimated by simply examining the pattern of upstream and downstream detections over the season. A relatively consistent occurrence of downstream detections occurring sometime in mid to late September is assumed to signal initiation of kelt downstream migration (Andrusak 2010).

Target operation is >80% efficiency with less than 5% variance to include all periods of bull trout kelt outmigration.

### Redd Counts

Redd counts will be undertaken as in previous years on all four target watersheds during fish counter evaluations. The methods will remain standardised to historical data but may also be expanded on the target watershed to include a complete count upstream of the fish counter location (Andrusak et al 2011). The budget estimates provided in this report DO NOT include the costs involved in this aspect of the Williston bull trout spawner enumeration program.

### BUDGETS

It is envisaged that a one year budget of $79,090 will be required to purchase equipment, set up on site, operate, analyse and report on a resistivity based bull trout enumeration program on either Scott Creek or the Misinchinka River in 2012. These two locations are suitable and both have merit over the less accessible Point Creek and Davis River sites, which were not evaluated due to weather related access issues during the Sept 1, 2011 evaluation survey. Prior to any further development of final site selection, a land based site inspection and water conductivity test should be conducted in the summer of 2012 or in the year of proposed operation.

Note: Operating costs for subsequent survey years will be much reduced by ~ $34,000 the results of capital equipment purchases in year 1.

### REFERENCES


McCubbing, D.J.F. 2008. Technical note to DFO (Kamloops) regarding the utilization of flat pad resistivity fish counter methods to enumerate Chinook salmon on the Chilcotin River. 8pp.


### APPENDIX-1.

**Williston Reservoir Resistivity Bull Trout Counter Project**

2012 Prices $\text{add 2\% per annum for inflation thereafter}$

<table>
<thead>
<tr>
<th>Labor</th>
<th>Source</th>
<th>Task</th>
<th>#</th>
<th>Time</th>
<th>Rate</th>
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<td>InStream</td>
<td>Set up</td>
<td>4</td>
<td>Days</td>
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<td>3000</td>
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<tr>
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<td>Data Analysis</td>
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<td>Days</td>
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<td>4500</td>
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<tr>
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<td>Report Production</td>
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<td>Days</td>
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<tr>
<td>Biologist</td>
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<td>Set up and removal</td>
<td>3</td>
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<td>1950</td>
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**Equipment**

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<td></td>
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**Travel**

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Total 79090