LAKE REVELSTOKE RESERVOIR BULL TROUT RADIO TELEMETRY PROGRESS REPORT

PREPARED BY
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FOR
Columbia Basin Fish & Wildlife Compensation Program

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Lake Revelstoke Reservoir
Bull Trout Radio Telemetry

Progress Report 2001-2002

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Columbia Basin Fish and Wildlife Compensation Program
Revelstoke, B.C.
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Executive Summary

Bull trout are supremely well adapted to live in the rugged, glacial environment of the Canadian Columbia River system, occupying the position of top predator in the aquatic food chain. They are, however, especially sensitive to impacts related to human activities, such as logging, hydroelectric development, mining, and urban development, and are particularly vulnerable to angling. Despite what are considered to be the healthiest bull trout populations within the species' range, British Columbia bull trout were blue-listed in 1994, meaning they are considered vulnerable, and therefore, are afforded special consideration.

The goal of this project is to determine spawning and migratory movements of Lake Revelstoke Reservoir bull trout and identify spawning locations. This information is valuable for managing and protecting adfluvial bull trout by identifying critical habitats and run timing. Radio telemetry is an efficient and cost effective means of determining this kind of information and has been used extensively to determine spawning movements of bull trout. This project represents the final phase in a basin wide plan to investigate bull trout spawning locations and migratory movements in the large Columbia River reservoirs as part of a conservation strategy for the species.

This is a first year progress report containing preliminary data only, a final report with complete interpretation will be prepared at the end of the project. Due to the sensitive nature of information related to bull trout spawning, staging, and overwintering locations, site specific data are not included in this report and are available once permission has been obtained from the Ministry of Water, Land and Air Protection.

Twenty-eight bull trout were radio tagged between 30 May and 27 June, 2001. Aerial tracking by fixed wing aircraft and using a Lotek SRX-400 receiver began on July 17, 2001, and was conducted every two weeks until September 30, 2001. Fish were tracked to locations in Bigmouth (and its tributaries), Soards, Scrip, Ruddock, Hoskins, Kirbyville, and Birch Creeks, as well as one unnamed creek. Spawning locations and timing were confirmed in Louis Lee, Big Fish, Scrip, and Kirbyville Creeks. Migration timing was fairly consistent among tributaries with all fish returning to the reservoir by the beginning of October.

Eight mortalities were determined over the course of the season from which six radio tags were recovered for re-use. Surgery and handling is not considered a significant cause of mortality based on fish movements post surgery and tracking success from other bull trout radio telemetry studies.

Tracking at the Mica tailrace will continue periodically through the winter and probably one flight will be conducted in March 2002 to look for fish distribution and possible overwintering locations in the reservoir. Seventeen tags are available for implantation in 2002 and tagging will commence in April. Aerial and ground tracking will continue until all tags are deactivated. With some spawning locations and timing pinpointed, further investigation of redd site locations and habitat characteristics will be conducted in 2002/2003.
Acknowledgments

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Cover Photo: Scrip Creek
Introduction

Listed as vulnerable, ‘of special concern’, threatened, or extirpated throughout most of its range, the bull trout (Salvelinus confluentus) has become a focus of investigation and conservation efforts over the last decade. Once pilloried as an insatiable predator of more desirable fish species and killed for a bounty, the bull trout is now recognised as an important top level piscivore and a valued char species endemic only to the Pacific Northwest.

Bull trout are supremely well adapted to live in the rugged, glacial environments of the Canadian Columbia River system. They are, however, especially sensitive to impacts related to human activities, such as logging, hydroelectric development, mining, and urban development, and are particularly vulnerable to angling. Despite what are considered to be the healthiest bull trout populations within the species’ range, British Columbia bull trout were blue-listed in 1994, meaning they are considered vulnerable, and therefore, are afforded special consideration.

The goal of this project is to determine spawning and migratory movements of Lake Revelstoke Reservoir bull trout and identify spawning locations. This information is valuable for managing and protecting adfluvial bull trout by identifying critical habitats and run timing. Radio telemetry is an efficient and cost effective means of determining this kind of information and has been used extensively to determine spawning movements of bull trout (e.g. O’Brien 1999; Baxter and Nellestijn 2000; Oliver 2000; Bray and Mylechreest, in prep.)

This project represents the final phase in a basin wide plan to investigate bull trout spawning locations and migratory movements in the large Columbia River reservoirs as part of a conservation strategy for the species. The Duncan, Arrow, and Kinbasket Reservoir projects are either complete or are nearing completion in 2002.

This project is cooperatively funded by Downie Street Sawmills Ltd., Louisiana Engineered Forest Products Ltd., Revelstoke Community Forest Corporation, and the Columbia Basin Fish and Wildlife Compensation Program (CBFWCP). The CBFWCP is a joint initiative between BC Hydro and the BC Government and arises out of BC Hydro’s obligations with respect to fish and wildlife under its water licences for existing Columbia River dams. The CBFWCP’s mandate is to conserve and enhance fish and wildlife habitat and populations that have been affected by construction of BC Hydro projects.

This is a first year progress report containing preliminary data only, a final report with complete interpretation will be prepared at the end of the project. Due to the sensitive nature of information related to bull trout spawning, staging, and overwintering locations, site specific data are not included in this report and are available once permission has been obtained from the Ministry of Water, Land and Air Protection.

Study Area

Completed in 1984, the Revelstoke Dam was the last major mainstem dam constructed on the Columbia River. The ~130 km long reservoir lies in the narrow valley between the Monashee Mountains to the west and the Selkirk Range to the east (Figure 1). Its northern and southern
boundaries are formed by the Mica Dam and Revelstoke Dam, respectively. Lake Revelstoke Reservoir has a surface area of 11 530 ha, a mean width of 0.9 km, mean depth of 46 m, and maximum depth of 125 m at the forebay. Flooding of the Columbia River and valley to create the reservoir inundated 2 800 ha of river and 8 700 ha of forested land (clearcut prior to flooding) (Environment Research Consultants (ERC), 1976). Approximately 80 km of tributaries were submerged by the reservoir waters, in some cases most or all of the low gradient or accessible portions.

Prior to inundation, Lake Revelstoke tributaries and the mainstem Columbia River were used for spawning and/or rearing by several fish species that were either river resident or that migrated upstream from the Arrow Reservoir, including bull trout, rainbow trout (*Oncorhynchus mykiss*), and kokanee (*Oncorhynchus nerka*) (ERC, 1976; Lindsay, 1977). Loss of habitat upstream of the Revelstoke Dam project is considered to have had a significant negative impact, particularly to the Arrow Reservoir fishery (Lindsay, 1977). The construction of Lake Revelstoke Reservoir, however, has created a new lacustrine aquatic community and fisheries rehabilitation should, therefore, be considered in terms of aquatic communities within the reservoir drainage.

The sport fishery in Lake Revelstoke Reservoir has become increasingly dominated by kokanee, which represented 93% of the total catch in 2000 (Bray and Campbell 2000). Catches of rainbow trout and bull trout are quite low by comparison although low catches of bull trout, in particular, may be partly a reflection of angler and creel efforts being concentrated in the lower reservoir from May to September. In 1995, the reservoir was closed to angling from Bigmouth Creek north to Mica Dam to protect bull trout populations. Lake Revelstoke is an especially difficult reservoir to survey due to numerous access points and many informal pullouts out of view of the highway.

**Methods**

**Capture**

Bull trout were captured by angling from May 30 – June 27, 2001. Fish were angled at four locations in the reservoir: Mica tailrace, Pitt Creek, Scrip Creek, and Kirbyville Creek areas. The former two locations are in the reservoir area closed to angling. Our goal is to tag 20 fish from each of the closed and open areas of the reservoir.

Bull trout were caught from the surface up to a maximum of 15 m depth. As soon as a fish of reasonable size (~500 mm FL) was caught, it was placed in a cooler filled with reservoir water and brought to shore where it was transferred to a holding sleeve and allowed to rest for at least three hours, sometimes overnight, in the cool flow of a tributary. At the Mica tailrace, fish were held in net pens rather than sleeves as there is no tributary close to a suitable tagging site.

Each fish was assessed for its suitability for tag implantation based on size and condition. A minimum fish weight of 800 g was necessary to keep the tags at the recommended 2% of body weight. In order to tag fish with the most probability of spawning that year, fish were selected for a range of sizes >50 cm and >800 g. Radio tags used are Lotek MCFT-3A coded tags programmed for 8 hours operation and 16 hours off. Forty tags are assigned to six different frequencies.
Surgery
Fish were anaesthetised using a mixture of 1.5 ml of clove oil emulsified in ~3 ml ethanol and mixed into 20 L of fresh water. Fish were usually left in the anaesthetic for approximately 7 minutes in order for them to reach the desired level of anaesthesia.

Fish were placed on their dorsal side in a surgical trough lined with wetted foam and then draped with a sterile sheet having only a small opening over the incision area. After first wiping the incision area twice with Betadine® antiseptic, a 3 cm incision was made along the ventral line above the pelvic fin insertion. The tag antenna was threaded onto a 16 gauge needle which was inserted through the left flank and the antenna pulled through. The radio tag was placed inside the abdominal cavity with care being taken to avoid kinks in the antenna and the incision closed with three stitches, the middle stitch always being a mattress type suture to ensure closure of the peritoneum. Absorbable sutures used included 2-0 monofilament, 2-0 chromic gut, 3-0 gut, and 2-0 Vicrål® all on cutting needles. As soon as the sutures were started, water was run from a suspended sitz bag through a tube placed in the fish’s mouth to irrigate the gills and speed recovery. Sterile procedures were followed as much as possible to minimise risk of infection. Tags, instruments, and needles were soaked in ethanol, drapes were autoclaved and wrapped, sterile latex gloves were worn, and the person conducting the surgery wore a face mask.

Each fish was measured (mm FL), weighed (g), sampled for scales and tissue, and photographed (Photo 1). About 12 scales from the left flank were removed individually using fine forceps and placed between two microscope slides. A small (<1 cm²) piece of tissue was clipped from one tip of the caudal fin and preserved in ethanol (95%) for potential DNA analysis in the future. Fish were then transferred to a floating bag or net pen until they were sufficiently recovered (could swim vigorously) to release back into the reservoir near their point of capture.

Tracking
Aerial tracking by fixed wing aircraft and using a Lotek SRX-400 receiver began on July 17, 2001, and was conducted every two weeks until September 30, 2001. Each flight plan was recorded on a separate map sheet with fish locations marked using the plane’s GPS. The plane is fitted with two directional antennae and locations are usually accurate to within 10 metres. Ground tracking was conducted at the Mica tailrace and when fish were at spawning locations. Helicopter access was necessary for ground tracking in some tributaries, while others were accessed by boat, road, and on foot.

Temperature loggers (HOBO 2K) were placed in five tributaries from May to October and one logger at the Mica tailrace is in place all year.

Notices to alert anglers to the presence of radio tagged fish were placed in local newspapers and sent to appropriate environmental organisations. Posters were put up at Martha Creek Provincial Park, Carnes Creek Forest Recreation Site, and at the Mica Creek townsite. Local newspapers ran several stories related to the project which also increased public awareness.

Results

Twenty-eight bull trout were radio tagged between 30 May and 27 June, 2001. Ten fish were caught from the Mica tailrace, ten from the Pitt Creek area, and four each from Scrip and Kirbyville Creek areas. Sizes ranged from 485 mm to 796 mm (Figure 2) and 1100 g to 6400 g. Data on individual fish are included in Appendix I.

All but four of the 28 tagged fish were tracked at least once following implantation. As bull trout are known to spawn in alternate years it was expected that not all fish would be found this year probably holding too deep in the reservoir for detection. This is one reason why several years of tracking is necessary.

Eight mortalities were determined over the course of the tracking season (from June to December) from which six radio tags were recovered. One fish was caught by anglers 24 days after tagging and the radio tag returned. The fish was in good condition with no sign of infection and had two large, partially digested kokanee in its stomach indicating no adverse
effects from surgery. Three fish died in the Mica tailrace, two of the tags were close to shore and easily recovered. These fish are suspected to have been taken by predators, likely otters, or could have been affected by discharge activities at the Mica Dam as they all appeared to have died close to the same time. Two tags were recovered at the mouth of Kirbyville Creek, one early in the season and one following spawning. The cause of mortality is unknown but is suspected to be a predator or angler. Another tag was recovered a short distance upstream in Bigmouth Creek where it had lain since it was tracked there on July 31st, 45 days after tagging. This tag could have been shed or the fish killed by predators. Finally, a tag has remained stationary in the main reservoir below Bigmouth Creek from a fish that was tagged and released at Mica tailrace. The location suggests that this fish could have been caught and released by anglers, a source of mortality found by O’Brien and Zimmerman (2000) in the Davis River radio telemetry study. Alternatively, the tag could have been shed or the fish succumbed to predation.

Surgery and handling are not considered a significant cause of mortality based on tracking success from other bull trout radio telemetry studies (Bray and Mylechreest in prep). Other than the three tags in the tailrace, all fish identified as mortalities displayed significant movement following tagging, either upstream or far downstream (e.g. 30 km). The higher proportion of mortalities from fish tagged at the Mica tailrace does warrant further investigation into possible impacts related to discharge. At the time of tagging in June, Mica Dam was usually operating for only short test periods, with little or no discharge or flow in the tailrace.

**Spawning Movements**

Fish were tracked to locations in Bigmouth (and its tributaries), Soards, Scrip, Ruddock, Hoskins, Kirbyville, and Birch Creeks, as well as one unnamed creek. Spawning locations and timing were confirmed in Louis Lee, Big Fish, Scrip, and Kirbyville Creeks (Photos 2-4). Migration timing was fairly consistent among tributaries with all fish returning to the reservoir by the beginning of October (Figure 3, Table 1).

Radio tagged fish in Lake Revelstoke Reservoir displayed a similar pattern of immigration, residence, and emigration as shown from other Columbia River reservoir telemetry studies (O’Brien 1999; Bray and Mylechreest in prep). Fish were generally ascending tributaries at a rate of 0.2 - 0.5 km/day and exiting at a rate of 1 - 4 km/day. Spawning movements corresponded with mean daily stream temperatures of 6.2 - 12 °C and seasonal timing around the fall equinox when daylight approaches 12 hours (Appendix II).

As data on specific locations of bull trout spawning, staging, and overwintering could be used to cause significant harm to populations through illegal or over harvesting, this information is subject to a confidentiality policy by the Ministry of Water, Land and Air Protection (MWLAP). Any person or company having a demonstrated need for these data can apply to the MWLAP to have the information released. In order to keep this a publicly available document, any data that could be used to identify specific bull trout locations have been omitted, but are available as a separate appendix.
Table 1. Immigration, residence, and emigration timing per tagged fish and tributary. Timing is based on closest actual tracked date, and therefore, is only an estimate.

<table>
<thead>
<tr>
<th>Code</th>
<th>Tributary</th>
<th># Days of Immigration (maximum)</th>
<th># Days of Residence</th>
<th># Days of Emigration</th>
<th>Total estimated days in tributary</th>
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<td>76</td>
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<td>&lt;18</td>
<td>?</td>
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<tr>
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<td>28</td>
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<td>76</td>
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<tr>
<td>25</td>
<td>Scrip</td>
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<td>36</td>
<td>Scrip</td>
<td>28</td>
<td>18</td>
<td>&lt; 10</td>
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<td>13-48</td>
<td>&lt; 3 - &lt; 10</td>
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</table>

Photo 2. A bull trout pair actively spawning in Big Fish Creek. The male in the foreground is a radio tagged fish.
Photo 3. A bull trout redd in Scrip Creek. At the time a large bull trout was holding in the pool upstream.

Photo 4. Two male bull trout in Scrip Creek. A female is digging a redd close to the bank and the males are engaging in aggressive behaviour. The second male was driven off.
Figure 3. Example of a typical spawning migration pattern exhibited by Lake Revelstoke Reservoir bull trout. Blue lines and diamond points indicate reservoir movement while pink lines and square points indicate upstream movement in a theoretical tributary. Following spawning, many fish were located back in the reservoir.

Other Migratory Movements and Tracking Results
Several bull trout did not enter tributaries to spawn, but were tracked during the season. The radio tag signals can be received only if they are in sufficiently shallow water (at least <10 m deep); therefore fish which retreat to the coldwater depths of the reservoir would not be located.

Code 6 supplied the most number of tracking locations not related to spawning. Of interest with Code 6 was a pattern of visiting stream mouths, a distinctive behaviour also exhibited by bull trout radio tagged in the Arrow Reservoir (Bray and Mylechreest in prep.). Other individuals were usually located only at the Mica tailrace, sometimes only when water levels and discharge were low or in fall when many bull trout appear to return to the Mica tailrace, probably to take advantage of the kokanee congregating there.

Future Work
Tracking at the Mica tailrace will continue periodically through the winter and probably one flight will be conducted in March 2002 to look for fish distribution and possible overwintering locations in the reservoir. Seventeen tags are available for implantation in 2002 and tagging will commence in April. Our objective is to tag at least 10 fish in the lower reservoir (Downie Arm and south) to track fish into the more southern tributaries. Tags have a minimum life of 870 days, therefore, those implanted in June 2001 should be active until October 2003, allowing us to
track fish through three spawning seasons (and those implanted in 2002 will be active until 2004). Aerial and ground tracking will continue until all tags are deactivated. With some spawning locations and timing pinpointed, further investigation of redd site locations and habitat characteristics will be conducted in 2002/2003.

Temperature loggers will be redeployed in several tributaries in spring 2002. Some units will be set at known spawning locations all year to cover both spawning and incubation periods.
Literature Cited


Lindsay, R. A. 1977. Investigations on fish populations that will be affected by the Revelstoke 1880 dam. Volume II. Prepared for BC Hydro and Power Authority.


Appendix II - Temperature Data for Bigmouth Creek, Kirbyville Creek, and Mica Tailrace, and graph of hours of daylight.