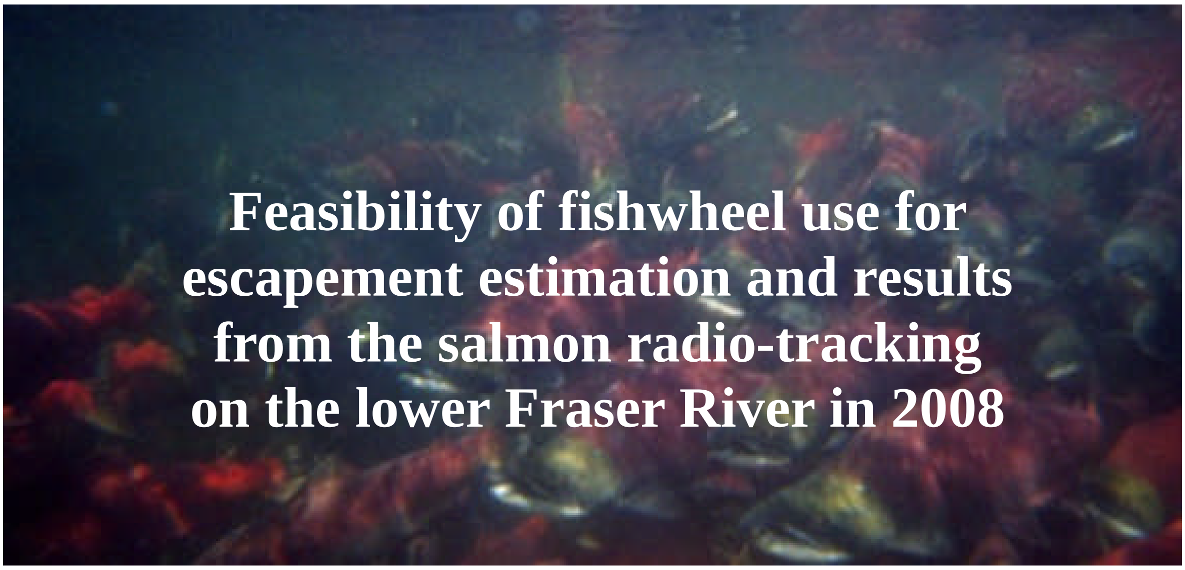

Feasibility of fishwheel use for escapement estimation and results from the salmon radio-tracking on the lower Fraser River in 2008

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Feasibility of fishwheel use for escapement estimation and results from salmon radio-tracking on the lower Fraser River in 2008

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EXECUTIVE SUMMARY

The purpose of this project was to continue the development of lower river live capture, tagging and sampling facilities that would, in conjunction with catch monitoring and hydroacoustics, provide reliable species specific estimates of abundance for salmon returns to the Fraser River. A combination of annual mark-recapture efforts using conventional external tags and periodic radio-telemetry studies to assess mark-recapture assumptions and the nature of any in-river losses could provide managers with more reliable estimates of spawning escapement, harvest, environmental impacts and enroute losses. The facility could provide a continuous source of salmon for biological sampling to assess species and stock composition, fish health, size, age and sex composition. This report documents the second consecutive year (2008) of using fishwheels in the lower Fraser River to capture and tag adult salmon.

The primary objectives of the 2008 project were to: 1) implement a full-scale live capture and tagging facility at Mission and in the Fraser canyon for each salmon species; 2) tag a representative sample of all salmon species, steelhead and sturgeon caught in these fishwheels, and collect DNA samples for sockeye, Chinook and steelhead; 3) use the mark-recapture data from fisheries and fishwheel samples to compute in-season escapement estimates for each of the target species; 4) provide biosampling data needed for species and stock composition estimates; and 5) provide an adequate supply of sockeye for future periodic assessments of in-river survival using radio-telemetry techniques.

To achieve these objectives, two regular-sized fishwheels (Mission-South and Mission-Middle) were operated at the Mission Railway Bridge between 18 June and 21 October; one large (Crescent-Large) and one regular-sized (Crescent-Regular) fishwheel were operated 9 km downstream near Crescent Island between 5 July and 23 October; and one regular-sized fishwheel (Siska) was operated in the Fraser Canyon near Frenchman’s Bar between 1 August and 21 September.

Summary of Findings

- Based on abundance estimates at Mission, catch efficiencies for adult sockeye were highest at the Crescent-Large fishwheel (0.04%), followed by the Crescent-Regular (0.03%), Mission-Middle (0.01%), and Mission-South (0.01%) fishwheels;
- Similar to 2007, catch efficiencies at the Mission-South fishwheel located at pier 1 of the Mission Railway Bridge were higher when water levels and velocities were higher early in the season;
- In contrast to 2007, the fishwheel operated closest to pier 2 (Mission-Middle) at the Mission Railway Bridge caught more sockeye salmon than the fishwheel operated 3-5 m from the pier (Mission-South);
- The combined catches at the four lower-river fishwheels included 1,394 sockeye (incl. 33 jacks), 1,111 Chinook (incl. 856 jacks), 563 steelhead (incl. rainbow trout), 363 coho, 199 chum, and 3 pink salmon. Based on an estimated abundance of 1,487,000 sockeye salmon at the Mission hydroacoustic site in 2008, the combined fishwheel catches represented 0.09% of the run.
- At the four lower-river fishwheels, spaghetti tags were applied to 1,205 sockeye (of which 110 were also radio-tagged), 215 Chinook, 211 coho, 155 chum, 6 steelhead, and 1 pink salmon. Biological samples (DNA and scales) were obtained from most of the tagged sockeye, Chinook, coho, and steelhead;

- The Siska fishwheel caught 1,480 sockeye, 296 coho, 209 Chinook, 35 steelhead, and 6 chum salmon. Spaghetti tags were applied to 267 sockeye; and 3 tagged sockeye and 1 tagged coho were recaptures of tags released from the lower-river fishwheels.
- Fixed-station receivers were set up and maintained at 9 sites between Crescent Island (~11 km below Mission) and the Fraser-Chilcotin confluence (368 km upstream of Mission), and at one site on the Chilko (557 km from Mission).
- Of the sockeye tagged in the lower Fraser River in 2008, 121 were recovered during in-river fisheries above Mission, including 102 spaghetti tagged fish and 19 radio-tagged fish.
- Sockeye drop back rates were substantial from areas with major gillnet fisheries;
- Multi-year analysis for summer-run sockeye indicated that the migration speeds were significantly faster in 2005 and 2006 than in 2007 and 2008.
- Substantial increases in catch rates and catch-sampling efforts are needed for a viable mark-recapture program using conventional tags in the lower Fraser River.
- Radio-telemetry combined with the Qualark hydroacoustic enumeration approach is a viable method for in-season evaluation of Mission sockeye abundance estimates.
- Chinook jack abundance was likely underestimated in existing gillnet test fisheries.
- Uncertainties in species composition estimates could be the reason for observed differences between the Mission and Qualark sockeye estimates.
- Substantial differences were observed in species composition between the off-shore Whonnock gillnet test fishery and the near-shore fishwheel sites in 2007 and 2008. It is important that both areas be reliably sampled to provide an accurate estimate of the daily species composition for the daily Mission hydroacoustic counts. Mission hydroacoustic counts should be separated between the near-shore and off-shore strata and Whonnock test fishery data be used to estimate the species composition of the off-shore counts and fishwheel data be used to estimate the species composition of the near-shore counts.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX A: Fixed-Station Receiver Locations and Performance

APPENDIX B: Fishwheel Effort and Catch

APPENDIX C: Fishery Returns, Mobile Detections, and Spawning Ground Recoveries

INTRODUCTION

The management of the Fraser River salmon fisheries is complex. Five species of salmon migrate through the Fraser toward hundreds of terminal spawning areas (Roos 1991). Chinook (*Oncorhynchus tshawytscha*) populations are divided into five major age-timing groups for management and analysis purposes (PSC 2002; English et al. 2007). There are more than 30 separate populations of Fraser sockeye (*O. nerka*) that spawn throughout the watershed (Roos 1991), and which are managed as four separate run-timing groups (PSC 1989). In addition, there are numerous populations of coho (*O. kisutch*), pink (*O. gorbuscha*) and chum (*O. keta*) salmon that co-migrate and are harvested in mixed-stock ocean and in-river fisheries. Salmon run in the Fraser River starting as early as April and continuing well into October each year. Decisions to open and close fisheries are based on a combination of pre-season and in-season estimates of run timing, stock composition, and abundance. Pre-season forecasts are based on the size of return in the brood year, estimates of spawning success, fry-to-smolt survival, and historic spawner-recruit relationships. In-season abundance estimates result from test-fishing in near-shore marine waters, gillnetting in the lower Fraser, and hydroacoustic monitoring at Mission (Woodey 1987). Reliable and timely information on returning abundance and in-river survival of salmon and steelhead (*O. mykiss*) populations is required to manage the expanding harvests in Fraser River fisheries. Concerns regarding weak stocks (e.g., interior coho and steelhead, Cultus sockeye, spring-run Chinook) have increased the demand for more terminal and selective fisheries. The integration of stock assessment with harvesting efforts is important for building sustainable stock assessment systems.

The Mission abundance estimates are an important source of data for decision makers and are used to manage marine and freshwater fisheries in-season. The Mission hydroacoustic program estimates the daily passage of all salmon species migrating upstream. The total salmon estimated from acoustics is then partitioned into species (and into stocks) based on the species (and stock) composition of the test-fishing sets that occur nearby. In recent years, in-season estimates from the Mission program have been met with criticism. In 2005, Mission in-season estimates overestimated sockeye passage due to the greater than expected overlap in the upstream migrations of pink and sockeye salmon, and a concurrent underestimation of the pink component of the species composition. In 2006, Mission in-season estimates were greatly underestimated, accounting for 79% of the estimated total sockeye escapement to spawning areas. The in-season estimate of the number of sockeye that passed Mission was only 46% of the final post-season estimate.

Because of the importance of having a reliable assessment tool in the lower river, managers have begun considering other means of escapement estimation. Fishwheels (Meehan 1961; Donaldson and Cramer 1971) have been proposed as a potential tool. Fishwheels could provide a lower-river live-capture and tagging facility that would, in conjunction with catch monitoring, provide reliable species-specific estimates of abundance for salmon returns to the Fraser River. A combination of annual mark-recapture efforts using conventional external tags and periodic radio-telemetry studies to assess mark-recapture assumptions, could provide managers with more reliable estimates of spawning escapement, harvest, environmental impacts, and en-route losses, if sufficient numbers of fish can be caught and tagged (Link and English 1996; Robichaud and English 2007). Fishwheels could also provide a continuous source of salmon for biological sampling to assess species and stock composition, fish health, physiology, size, age and sex composition.

In 2007, as part of a feasibility study, three fishwheels were deployed and operated at the Mission Railway Bridge from mid-June through September (Robichaud et al. 2008). Results from the 2007 study indicated that the highest catch efficiencies were achieved by a fishwheel operated adjacent to the south bank from late June through the end of July. Catch efficiencies for sockeye at this site were highest in mid-July when water depths were just slightly deeper than the fishwheel baskets. Also, two fishwheels fishing side by side in deeper water (10 m) resulted in reasonably good sockeye catches in both fishwheels during the peak of the summer-run stocks in mid-August and consistent catches of pink salmon from mid-August through mid-September. However, overall catch rates in 2007 did not achieve the samples sizes required for a successful long-term sampling and marking platform near Mission.

Assuming 5-7% of the sockeye passing Mission could be sampled for mark rates from re-captures above Mission, a mark-rate target of 0.07-0.13% of the population is required to obtain abundance estimates within 19-26% of the true abundance 95% of the time. Using preliminary estimates of the number of sockeye passing Mission (1,275,740), we estimated that the fishwheels deployed at the Mission Railway Bridge in 2007 caught 0.04% of the passing sockeye. While the Mission Railway Bridge provided the unique opportunity to deploy fishwheel across the entire river channel, the data indicated that the deployment of additional fishwheels or larger fishwheels at the Mission Railway Bridge site would not increase the catch rates by the 2-3 times required for a long-term sampling and marking platform. However, a suitable shoreline site where multiple fishwheels could be fished throughout the salmon migration has the potential to substantially increase catch rates. Finding a site with these characteristics was one of the main goals of the 2008 project.

In addition to improving catch rates, a second goal of the 2008 project was to gather data necessary to ensure the fish captured are representative of the size classes migrating past the fishwheel site. Results from the 2007 study also suggested that the fishwheels operated at the Mission Railway Bridge had a tendency to catch smaller individuals (e.g., large fraction of Chinook jacks relative to adults, higher fraction of 4-yr-old sockeye relative to other Pacific Salmon Commission (PSC) test fisheries). The changes to the size and location of the fishwheels for 2008 were designed to provide a more representative sample for sockeye and other salmon species. We also assessed size and behaviour of salmon as they approach the fishwheels using Dual-Frequency Identification Sonar (DIDSON) multi-beam hydroacoustics technology.

In addition to the Mission Railway Bridge and Crescent fishwheels, one additional fishwheel was deployed in the Fraser Canyon near Frenchman's Bar and operated by the Siska First Nation. The Siska fishwheel provided increased access to middle and upper Fraser Chinook, sockeye, and coho stocks. Coupled with DNA analyses, these fishwheel catches could provide in-season indications of the relative abundance needed to reduce harvest pressure for weak stocks and identify the extent of harvest opportunities for abundant stocks. This fishwheel could also provide recapture information for fish tagged at the four lower-river fishwheels.

Lastly, the feasibility of using radio-telemetry and mark-rates from the Qualark hydroacoustic-telemetry to derive in-season abundance estimates for sockeye was assessed in 2008. Daily sockeye abundance estimates at the Qualark site were derived using DIDSON multi-beam hydroacoustics technology operated by Fisheries and Oceans Canada (DFO). Only 100-120 radio-tags were available for this feasibility study so tagging efforts were focused on expected three-week peak abundance period for summer-run sockeye stocks that would migrate passed the Mission and Qualark hydroacoustic sites. Other sockeye run-timing groups were not suitable for these assessments in 2008 because returns were too small (Early Stuart) or a large portion of the forecast return was destined for tributaries between Mission and Qualark (e.g., early summer returns to the Chilliwack River and late-summer returns to the Harrison watershed).

The primary objectives for the 2008 project were to:

- implement a full-scale live capture and tagging facility at Mission and in the Fraser canyon for each salmon species;
- tag a representative sample of all salmon species, steelhead and sturgeon caught in these fishwheels, and collect DNA samples for sockeye, Chinook and steelhead;
- use the mark-recapture data from fisheries and fishwheel samples to compute in-season escapement estimates for each of the target species;
- provide biosampling data needed for species and stock composition estimates; and
- provide an adequate supply of sockeye for future periodic assessments of in-river survival using radio-telemetry techniques.

MATERIALS AND METHODS

Study Area

The main study area extended from a site 2 km upstream of Crescent Island (rkm 69) to the upper reaches of the Fraser River (Figure 1). Sockeye were captured, tagged, and released at two fishwheel locations. The first location was 2 km downstream from the Mission hydroacoustic site (rkm 79) at the Mission Railway Bridge in Mission, BC. The second location was near Crescent Island approximately 10 km downstream of the Mission hydroacoustic site. Radio-telemetry receivers were deployed along the Fraser River mainstem and at major tributary confluences. A receiver was deployed at the downstream end of Crescent Island to detect any radio-tagged fish that dropped-back down river after being released. Two additional receivers were deployed at the Mission hydroacoustic site to detect the time at which radio-tagged fish moved upstream past the hydroacoustic site.

Study Design

The basic components of the proposed study were:

1. operating two fishwheels attached to the Mission Railway Bridge to capture, tag, and release adult salmon immediately downstream of the Mission acoustic site;
2. operating one large (twice the size of the other three fishwheels) and one regular-sized fishwheel in a faster flowing section of the river near Crescent Island to capture, tag, and release adult salmon;
3. operating one regular-sized fishwheel in the Fraser Canyon near Frenchman’s Bar (Siska First Nation) to obtain mark-rate information for fish tagged at the lower-river fishwheels;
4. using DIDSON multi-beam hydroacoustic techniques to assess the behaviour of fish as they approach the Crescent Island fishwheels and estimate the fishwheel catch efficiency;

5. time the sampling effort to target the main sockeye run-timing groups and to tag Chinook and steelhead incidentally;
6. applying approximately 100 radio tags to summer-run sockeye salmon over a 3-week period at the peak of their migration;
7. tracking radio-tagged fish using fixed stations located at strategic locations in the Fraser River drainage;
8. applying spaghetti tags to sockeye and Chinook salmon from all run-timing groups in order to estimate escapement past Mission and through fisheries with reasonable precision; and
9. monitoring recreational, commercial, and First Nation fisheries to recover an adequate proportion of the spaghetti tags.

In February 2008, the Fraser River downstream of Mission was explored for suitable sites where fishwheels could be operated both close to shore and close to the river bottom over the range of water levels and velocities typically observed during the period of salmon migration. Depth is an important factor because fishwheel baskets that fish close to the riverbed minimize the vertical space available for approaching fish to avoid the fishwheel. Water velocity is important because it powers the turning of the baskets. If velocities are too slow then the baskets will not rotate effectively and fish are better able to avoid capture. Distance from shore is important because salmon tend to migrate close to shore during high flow conditions. The only suitable site found was located 2 km upstream from Crescent Island on the left bank of the Fraser River (herein referred to as the "Crescent" site).

Environmental Data

Hydrometric data from stations located at Hope (#08MF005) and Mission (#08MH024) on the Fraser River were obtained from Environment Canada (Environment Canada 2009). The Hope station is located 80 rkm upstream from the Mission Railway Bridge and has a gross drainage area of 217,000 km^2. The Mission station is located on the north bank of the Fraser River immediately downstream of the Mission Railway Bridge (drainage area = 228,000 km^2).

Fraser River water temperature at Qualark Creek (rkm 176) was recorded from June through October 2008 (D. Patterson, SFU, pers. comm.). Water temperature of the Fraser River at the fishwheel sites was recorded daily using a boat-mounted sonar equipped with a temperature sensor.

Fishwheel Deployment and Operation

Mission Railway Bridge

Three regular-sized (or "small") fishwheels and one large fishwheel were operated in 2008. Two of the small fishwheels were operated side by side at Pier 2 of the Mission Railway Bridge in the lower Fraser River at Mission, BC. These were the same fishwheels operated at the bridge in 2007 and were similar in design to those that have operated on the Nass River, BC, since 1992 (Link and English 1996; Alexander and Bocking 2004) and on the Copper River in Alaska since 2001 (Smith et al. 2005). Each of the small fishwheels had two, welded-aluminum pontoons (11.6 m long x 0.9 m wide x 0.5 m deep) that were comprised of seven independent, pressure-tested compartments. The fishwheels had three baskets (3.4 m long x 3.0 m width x 2.1 m deep) that were framed with aluminum tubing (3.8 cm square) and lined with white, knotless, nylon mesh (6.4 cm stretch). The baskets were attached to a 3.7 m long axle and designed to fish up to 3 m below the water surface. A tower (6.1 m high) and boom assembly (4.9 m long) was used to raise and lower the baskets. An aluminum tank (4.3 m long x 0.6 m wide x 1.5 m deep) for holding captured fish was fitted inside each pontoon. The bottom of each holding tank was fitted with windows of extruded aluminum mesh to allow for ample water circulation. As the river's current propels the rotating baskets, upstream-migrating fish are captured and directed down plywood chutes and into the holding tanks on either side of the fishwheel.

The fishwheels were installed at the Mission Railway Bridge in a similar manner as in 2007 (Figure 2). Wire rope (1.3-cm dia.) was wrapped around the base of a bridge pier and the ends were connected using a turnbuckle and cable clamps. Car tires and rubber mats were placed under the wire rope to prevent it from abrading against the concrete pier. The turnbuckle was used to cinch the wire rope against the tires and pier and thus provide a strong, stable system for attaching the fishwheel. A log (0.5 m dia. x 15 m long) was then placed alongside the pier and attached to the wire rope. The log moved up and down with changes in stage height and kept the fishwheel closest to the pier away from the concrete pier base. Once the wire rope and log were secure, the fishwheels were attached to the wire rope at three different locations. The main attachment point was a wire-rope bridle (1.3-cm dia.) attached to the bow of each pontoon. The second attachment point consisted of a polypropylene rope bridle (1.9-cm dia.) that was also attached to the bow of each pontoon. The third attachment point was a polypropylene rope (1.9-cm dia.) tied to a cleat on the pier-side pontoon of the fishwheel towards the bow. This method of installation was "non-invasive" and did not require any holes to be drilled into the concrete structures of the bridge. At the end of the season, the fishwheels and all materials used to attach them to the piers were removed.

The small fishwheels were stored over the winter near Hatzic Slough, 4.5 km upstream from the Mission Railway Bridge, and towed downstream by Catherwood Towing (Mission, BC) for installation.

Crescent Island

One small fishwheel and a new, large fishwheel were operated at the Crescent site in 2008. Major components of the large fishwheel were fabricated by Neid Enterprises (Terrace, BC) and transported by flatbed truck to the assembly site located on the left bank of the Fraser River near the Matsqui First Nation band office. On 5 May, staff from LGL Limited, a senior fisheries technician from the Nisga'a First Nation, and two fisheries technicians from the Matsqui First Nation began assembly of the large fishwheel. Pontoons for the large fishwheel were similar in width and depth to those of the small fishwheels but were 17.7 m long. The three fishwheel baskets (6.1 m long by 4.3 m wide by 3 m deep) were framed with aluminum tubing (3.8 cm square) and lined with nylon mesh (6.4 cm stretch). The baskets were attached to an axle (5.2 m long) and designed to fish 5.8 m below the surface. The two holding tanks had the same dimensions as tanks in the other fishwheels.

The tower and boom assembly of the large fishwheel was originally designed and constructed similar to those of the small fishwheels; however, it became clear in late May that this design was not capable of safely hoisting the larger basket assembly. An engineer (All-Span Engineering and Construction Ltd., Delta) was hired to work with LGL staff to completely re-design the fishwheel tower and boom assembly. From 6-24 July, the original tower and boom assembly was dismantled and the fishwheel was re-built. On the new design, the tower uprights were 5.2 m high and the boom arms were 7.0 m long, both made of 15.2-cm square aluminum tubing (Figure 3). The boom arms were braced along their lengths with an additional piece of 15.2-cm square tubing. Additional bracing (10.2-cm square tubing) between the tower uprights, and between the tops of the tower uprights and booms arms, further supported the structure. Two hoists (Warn DC3000LF with 1,363 kg rating) powered by 12-V batteries were mounted on 20.3-cm square steel beams (4 m long) that were welded to each pontoon at the stern of the fishwheel. The hoists were used to tilt the tower and boom arm backwards towards the stern of the fishwheel, while simultaneously lifting the basket assembly up and out of the water.

On 30 April, Valley Towing Limited (New Westminster, BC) drove nine piles into the river bed at the Crescent site for attaching the fishwheels, floating shoreline abutment, deflector logs and barrier net (Figure 4). This was necessary because there were no existing attachment points (e.g., large trees) at the site. The piles were driven in April so that the fishwheels could be installed and operated as water levels began to recede following freshet. Unfortunately, four of the piles were knocked over during freshet (piles 3, 4, 8 and 9 in Figure 4). On 3 July, three of these piles (piles 3, 4 and 8) were replaced with larger diameter ones that were driven deeper into the substrate; while pile 7 was knocked over by the barge and not replaced. Three piles (piles 3, 4, and 7 in Figure 4) were removed by Valley Towing on 25 February 2009 since they were deemed unnecessary for future studies.

A floating shoreline abutment and weir, designed LGL staff working with Hugh Tuttle, P. Eng., was fabricated by Ramsay Group (Sidney, BC), trucked to New Westminster, and then transported to the Crescent site by barge on 3 July. The abutment had three main uses: 1) it held the fishwheels offshore in water deep enough to turn their baskets; 2) it allowed the fishwheels to be shifted inshore or offshore as water levels changed so that the baskets could be fished as close to the river bottom as possible; and 3) it supported a fish guidance weir along the downstream side which prevented fish from passing upstream between the small fishwheel and shore. The abutment was constructed of two steel pontoons (6.1 m long x 76 cm dia. pipe) and two steel stretcher pipes (8.2 m long x 32 cm dia.; Figure 5). The weir had a triangular aluminum frame (7.6 m base x 3.7 m high) and vertical aluminum rails (1.9 cm dia. tubing).

The floating shoreline abutment was secured to two pilings and a tree using wire (1.3 cm dia) and polypropylene (1.9 cm dia.) rope. The small fishwheel was placed alongside the abutment and offset slightly downstream to increase the likelihood that fish guided offshore by the weir would be captured in the fishwheels. The large fishwheel was then placed alongside the outside pontoon of the small fishwheel. The fishwheels were secured to the three pilings located 50 m upstream, to each other, and to the abutment. Logs and tires were placed between the fishwheels and abutment to prevent abrasion.

Several logs were placed parallel to the river flow upstream of the fishwheels and attached to two pilings. These logs were used to deflect floating debris away from the fishwheels, abutment, and weir.

As water levels dropped late in the season, a barrier net (30.5 m long x 12.2 m deep with 7.6 cm stretch knotless nylon mesh) was installed off the stern of the offshore pontoon on the large fishwheel. The purpose of the barrier net was to prevent fish that were approaching the fishwheels from moving offshore and thus avoiding capture.

A power-assist unit was used on the Crescent-Regular fishwheel in an effort to maintain the rotation rate at 2 RPM during periods of the tidal cycle when river currents were too low to turn the baskets. The power-assist unit consisted of a gas-powered hydraulic motor, hydraulic hoses filled with environmentally friendly vegetable oil, and a reducer unit that was connected to the fishwheel axle.

Fraser Canyon (Frenchman's Bar)

The Siska First Nation installed and operated one regular-sized fishwheel along the left bank of the Fraser River in the Fraser Canyon near Frenchman's Bar. The fishwheel was located against a rock wall and held in place with wire rope attached to steel anchor pins set into the rocks along shore. A chain-link fence was used to prevent fish from moving upstream between the inside edge of the baskets and shore.

Fishwheel Effort

The lower-river fishwheels were operated 24-h per day except for stoppages to repair damage caused by floating debris (e.g., logs), re-position the fishwheels, and accommodate in-river fisheries (some fishers attached their set gill nets to the bridge piers). Fishwheel speed (revolutions per minute, RPM) was determined one or more times each day by measuring the time required for the fishwheel baskets to complete three revolutions.

Daily fishing effort of the fishwheels was calculated in two ways. First, total effort was calculated as the number of hours that a fishwheel operated on a given calendar day from midnight to midnight. Total effort indicated the amount of down time (i.e., non-operational time) associated with each day. Second, the effort used to determine catch per unit effort (CPUE, fish/h) was calculated as the number of hours that a fishwheel fished between sampling sessions. For example, if fish were last sampled at 2200 hours on day t and last sampled on day t+1 at 2000 hours, then only 22 h of fishing effort was used to obtain the effort for calculating CPUE on day t+1 (assuming uninterrupted fishwheel operation). However, in this example, the daily fishing effort on day t+1 would be 24 h because the fishwheel operated continuously for the entire calendar day. Effort for calculating CPUE on day t+1 could also exceed 24 h if the last sampling session on day t was earlier in the day than the last sampling session on day t+1. To calculate CPUE, the total number of fish captured during visits on a given calendar day was divided by that day's fishing effort.

The fishwheels were visited a minimum of two times each day and all fish were counted, sampled (if applicable) and released back into the river during each visit.

Fish Tagging Procedures

Fish were removed from the live tanks using a dip net and placed in a V-shaped trough filled with a constant supply of fresh river water (using buckets or a bilge pump). All salmon were measured for fork length (FL), sexed, and examined for scale loss and injuries. Scale (for ageing) and DNA samples were collected from all sockeye, Chinook, and coho salmon. DNA was a tissue sample taken from the adipose fin and scales were taken from the "preferred area" (along the diagonal connecting the back of the dorsal fin with the front of the anal fin, and 2-3 rows above the lateral line).

At the four lower-river fishwheels, uninjured adult salmon and steelhead that were longer than the minimum size-threshold (40 cm for coho, 45 cm for sockeye, and 50 cm for Chinook) received a spaghetti tag. Spaghetti tags were threaded through the dorsal musculature adjacent to the dorsal fin and tied with an overhand knot. For sockeye salmon fishwheel, the initial goal was to also apply 100 radio tags (~ 33 per week) to summer-run fish over a three-week period during the peak of their migration in August. Radio tags were orally inserted into the stomach of sockeye salmon using a plastic, tag applicator. The tag number, duration of the tagging procedure and release time were recorded for all tagged salmon. Sturgeon were measured for length and girth, and received a passive integrated transponder (PIT) tag if they were not tagged already. All other fish species were counted and released.

Radio-transmitters

The radio transmitters used during this study were model MCFT-3A micro coded fish transmitters manufactured by Lotek Wireless, Inc. (Newmarket, ON). They were 16 mm in diameter, 46 mm long, and had a 460-mm-long antenna. The transmitters were powered by 3 V batteries with an expected life of 761 d. The transmitters were programmed to stop transmitting after 154 d to minimize interference with other studies. Tags transmitted on six different frequencies (320, 360, 440, 460, 600 and 800 kHz) within the 150 MHz band. Within each frequency, three different pulse intervals (4.5, 5.0 and 5.5 s) were used to reduce the incidence of signal collisions when several transmitters were present at the same location at the same time.

Tracking Systems

Radio-tagged salmon were monitored using fixed stations and mobile tracking. Both monitoring systems used SRX400 or SRX400A radio receivers manufactured by Lotek Wireless, Inc., and 3-element or 4-element Yagi antennas manufactured by Maxrad, Inc. (Hanover Park, IL) or Grant Systems Engineering Inc. (King City, ON).

Fixed Stations

The fixed-station tracking involved the deployment of antennas and receivers at strategic locations along the Fraser River to provide data on study-area entry times, in-river movement patterns, and coarse spawning destinations.

Fourteen fixed stations at 10 locations described as part of a larger study by English et al. (2004) were established along the Fraser River and at strategic junctions with large tributaries and within one major tributary (Figure 1) to monitor radio-tagged fish movements towards spawning areas. Specific locations were chosen to monitor the arrival of radio-tagged fish into the study area, to document departures from the mainstem of the Fraser River into spawning tributaries, and to bracket areas where mortality might arrive from natural sources or from fisheries. The first two fixed stations (Mission North and Mission South) upstream of the tagging site were located near the Mission hydroacoustic site. Because the entry time of radio-tagged fish into the study area was of importance to the study, we maximized radio-coverage at the Mission site by deploying two receivers, positioned 0.73 km apart and on opposite sides of the river. Details of the fixed station locations are given in Appendix Report A.

Each fixed station consisted of two or three antennas (see Appendix Table A1), antenna switching hardware, a receiver, a 12 V battery, an enclosure to protect the equipment, and a solar panel to charge to battery. Antennas were placed more than 10 m above the water level, either in a tree or on an aluminum mast. Antennas were aimed to detect radio-tagged fish that were present downstream of the station, up a tributary (if present), and upstream of the station. Since each fish detection is associated with a particular antenna, sequential detection data can be used to determine the direction of a fish's movements.

The detection range of each fixed station was tested in the upstream and downstream direction of the mainstem, and up the tributary. Ranges were tested by drifting a radio tag, at 2 m depth, at one-half and three-fourths of the channel width. In each case, adjustments were made to the antenna position and signal gain to ensure that tags were detectable across most of the river channel, and that there was good separation among antennas in the areas covered. At Mission, the antennas at the two fixed stations were aimed in different directions so that noise from radios and equipment would not affect all antennas at the same time. At most fixed-station receiver sites, the antenna adjustments and detection range tests were performed in 2005 (as part of a previous study; see Robichaud and English 2006), the antennas were not removed after the 2005 study, and were, following annual range testing, used again in 2006, 2007, and 2008.

Plots of the daily detections of radio-tagged fish and noise levels recorded by each receiver (Appendix Figure A1) were used to assess the effect of signal collisions and environmental noise on the ability to detect radio-tagged fish, and to identify any gaps in the monitoring period. Details of receiver performance are provided in Appendix Table A2.

Telemetry Data Management

Data from fixed stations were downloaded at regular intervals, which depended on the number of radio-tagged fish passing the location and the accessibility of the station. Most stations were downloaded every 7 d. For most downloads, a diagnostic program was run before erasing the internal memory in the receiver, to ensure that all data had been transferred, the file was readable, and the receiver and antennas had been operating properly.

The downloaded data were processed and analyzed using LGL's custom database software, *Telemetry Manager*. *Telemetry Manager* facilitates data organization, record validation, and analysis through the systematic application of user-defined criteria. Raw data were archived so that the temporal or spatial resolution, or noise filtering criteria could be changed by the user at any time without altering the raw data. An important aspect of radio-telemetry is the removal of false records in receiver files, for example, those that arise from electronic noise. In this study, the following criteria were set for records to be considered valid: 1) power levels had to be greater than 30 (on a 1 to 232 scale); 2) detections had to be paired within a single zone and recorded within 20 minutes of each other (single records, or records separated by more than 20 minutes were rejected); 3) detections had to be recorded at zones that were geographically located between the locations of previous and subsequent valid detections; and 4) detections requiring unrealistic travel times were removed. Once false records were removed, *Telemetry Manager* created a compressed database of sequential detections for each fish. Each record included the tag number, zone number (antenna number, fixed station number, or a general location), the first and last time and date for sequential detections in a specific zone, and the maximum power for all detections in that interval. The compressed database was used to determine when each fish entered the study area, residence times at each fixed-station, rates of movement between detection sites and sites of last detection.

Detection Efficiency of Receivers

Detection efficiencies for each fixed-station receiver site were estimated by dividing the total number of unique radio-tagged fish detected at the site by the total number of unique radio-tagged fish known to have passed. The total number known to have passed included all those radio-tagged fish detected at that site, or at any site located farther upstream.

Stock Assignment

All radio-tagged sockeye tracked to known spawning destinations were assigned to a stock based on the location and timing of detection. Radio-tagged sockeye caught in various fisheries, and those that died before reaching the spawning areas, were assigned to a stock group based on a DNA analysis of their tissue sample (as per Beacham et al. 2004). Together, these data were required to determine stock-specific movement rates. Since tissue samples were analyzed for all sockeye, including those tracked to spawning destinations, the accuracy of the DNA-based stock assignments could be assessed.

In-river Movements

Travel times (and travel speeds) for each individual radio-tagged fish were calculated based on the timing between detections at the various fixed-station receivers along the river. Travel time between two receivers was calculated as the time between the first detection at the downstream receiver and that at the upstream receiver. Migration rates were calculated by dividing the distance (in km) between receivers by the travel time. Median travel times and migration rates were compared among run-timing groups and among stocks using the Kruskal-Wallis test.

Radio Tag Recovery Estimates

The number of radio tags expected to be caught in fisheries between Mission and Qualark (*MQFR*) was calculated using a harvest-rate method similar to that used in previous years (Robichaud et al. 2008). *MQFR* was the product of the number of radio-tagged sockeye that passed Mission each day (T_d) and daily harvest rates (HR_d) estimated for fisheries between Mission and Qualark associated with each of the days (d) when radio-tagged sockeye passed Mission.

$$MQFR = \sum_d (HR_d \cdot T_d)$$

Harvest data, specifically in-river catches in First Nations and recreation fisheries, were provided by Fisheries and Oceans Canada (DFO). The available sockeye harvest estimates were divided into three fisheries: (1) Mission to Harrison; (2) Harrison to Hope; and (3) Hope to Sawmill. The Qualark site is located in the lower half of the Hope to Sawmill fishing area and for the purpose of this analysis, we assumed that 20% of the harvest in the Hope to Sawmill fishery occurred downstream from Qualark. The PSC compiled the sockeye catch estimates from DFO, and estimated stock-specific escapement past Mission on a daily basis (J. Gable, PSC, pers. comm.). Daily harvest rates (HR_d) were estimated for the Mission-Qualark fishery using running three-day averages of catch and escapement:

$$HR_{fd} = \sum_{i=-1}^{1} C_{fd+i} \Big/ \sum_{i=-1}^{1} E_{fd+i} \quad \text{where } i \in \{-1,0,+1\} \text{ and } f \in \{1,2,3\}$$

where E_{d+i} was the sockeye escapement past Mission on day $d+i$, and C_{d+i} was the total sockeye catch in the Mission-Qualark fisheries associated with the fish that past Mission on day $d+i$.

Two fixed station receivers were operated adjacent to the Mission hydroacoustic site and provided the daily number of radio-tagged fish that passed Mission (T_d). Assuming that a three-day running average of the daily harvest rates is a reasonable estimate of the removal rate for the tagged sockeye that passed Mission each day, it was possible to estimate the daily number of radio-tagged fish that should have been caught, (i.e., *MQFR*, the expected number of radio tags removed).

Radio tag returns (*MQTR*) were solicited through flyers and meetings with user groups. All radio-tagged fish were marked near their dorsal fin with a yellow spaghetti tag, in order to increase the probability that the fish was scrutinized, and the radio tag was noticed. A toll-free number and a mailing address were included on the label of the radio tags. Fishers that called the toll-free number were given directions on how to arrange for a courier to pick up the tag from their home, free of charge to the fisher. Moreover, each time a fisher returned a radio tag to LGL (along with the date and location of capture) they were entered into a draw for $500. For each tag returned, a letter was mailed to the fisher describing where and when the fish had been tagged, and where it had been tracked to date.

The radio tag reporting rate was not calculated on a daily basis, since estimates would be too noisy. In 2008, all the radio-tags were applied over a three week period. The radio tag reporting rate (*RR*) was calculated for the study-period as a whole as:

$$RR_p = \sum_d MQTR_d \Big/ \sum_d MQFR_d$$

where *d* includes all days in the study period.

Fishwheel Catch Selectivity

Size and Age Selectivity

The potential for size selectivity at the fishwheels was assessed by comparing (ANOVA) the length-frequency distributions of sockeye caught in the Crescent-Large fishwheel from 31 August to 3 September with those caught in the Area 20 test fisheries (seine and gillnet) and the gillnet test fisheries at Cottonwood (26 July to 29 August), Whonnock (28 July to 2 September), and Qualark (31 July to 31 August). Data from the in-river test fisheries were truncated by date to ensure that samples from each location were collected from the same component of the population that was sampled at the Crescent-Large fishwheel from 31 August to 3 September. For Area 20 and Cottonwood, post-orbital fork lengths (POF) were transformed to fork lengths (FL) using the following equation: FL = 1.1172 * POF – 1.510. At Qualark, the following equation was used: FL = 1.1066 * POF – 0.916.

Species Composition

The species of all fish caught other than salmon was also recorded and can be used to compare species composition of the catch in the large and the small fishwheels as well as between the two locations, namely the Mission Railway Bridge and the Crescent site.

DIDSON Data Collection and Analysis:

The DIDSON was developed in 1999 by the University of Washington Applied Physics Laboratory for the U.S. Space and Naval Warfare Systems Center as a defense technology with the original purpose of harbor surveillance and underwater mine detection (Belcher et al. 2001; Belcher et al. 2002). The standard DIDSON unit has two operational frequency modes: the high frequency mode operates at 1.8 MHz and uses an array of 96 beams, each 0.3^o wide horizontally and 12^o vertically, and the low frequency mode operates at 1.1 MHz and uses an array of 48 beams, each 0.6^o wide horizontally and 12^o vertically. With both modes, the overall sampling volume covers an area 29^o wide. The DIDSON images are constructed in sequence and consist of eight sets of 12 beams (high-frequency mode) or four sets of 12 beams (low-frequency mode) fired simultaneously. Sound Metrics Inc. (www.soundmetrics.com), the DIDSON manufacturer, also produces a long-range model that operates at 700 kHz and 1.2 MHz capable of sampling out to about 60 m (the standard unit is limited to about 24 m in range). The DIDSON has recently become available for fisheries investigations and has been used primarily to assess salmon behavior at hydropower dams (Moursund et al. 2003; Ploskey et al. 2005) and enumeration of upstream migrant adult salmon in river systems (Maxwell and Gove 2004; Holmes et al. 2006; Cronkite et al. 2006; Johnson et al. 2006b). DIDSON systems have also been used to evaluate the effectiveness of fish guidance structures (Ploskey et al. 2005; Johnson et al. 2006a) and fish collection devices, including a fishwheel at Siska Canyon on the Fraser River (H. J. Enzenhofer, DFO, personal communication).

The DIDSON system used for monitoring fish behavior at the fishwheels consisted of a standard DIDSON sonar unit, 16 m cable, DIDSON topside control box, Ethernet cable and a Toshiba Laptop PC loaded with DIDSON data-acquisition software. A 2,600 W Yamaha gas-powered generator was used to provide power to the system. All topside electronics were initially located onshore during daytime sampling and later housed in a locked environmental box mounted on the fishwheel platform.

The DIDSON was deployed from an adjustable aluminum ladder mount that allowed for flexibility in aiming orientation and tilt angles (Enzenhofer and Cronkite 2005). The ladder mount was located just offshore in large cobble about 13 m from the large wheel platform (Figure 6). The DIDSON typically sat about 10 cm off the bottom. The mount was secured by driving in stakes through crevices in the rocky substrate that were slid through guides fixed to the ladder mount. The DIDSON and ladder mount were chained to trees on shore and secured with padlocks.

DIDSON data were collected in low frequency mode (1.1 MHz) to minimize noise limitations associated with using high frequency mode (1.8 MHz) at ranges beyond about 12 m. Several different orientations of DIDSON sampling were employed but the primary emphasis was to orient the sample volume just downstream of the large wheel to assess fish approach behavior to the large fishwheel baskets (Figure 7). The sample window typically began 7.7 m from the sonar and extended out 10.3 m in range. The DIDSON was tilted down 6 degrees below horizontal. Data were collected at 10 frames per second in consecutive 10-minute files and data files were ported directly to external hard drives. Data files were backed up and archived to additional hard drives.

DIDSON data processing involved manual review of imagery using DIDSON data playback software. A subset of data files were reviewed to estimate size of fish, first and last position in range from sonar, net direction (upstream or downstream), and lateral net movement (towards or away from shore). Fish size was estimated by using a sizing tool feature in the playback software that allows the user to draw a frame around the fish target that calculates length, height, and diagonal distance of the frame. All fish greater than or equal to 30 cm in length were included in the data set. Date, hour, and minute were recorded for each fish observation. Diel movement was assessed by examining fish observations relative to within day time period (dawn: 0500-0600 hours; day: 0700-0900 and 1600-1900 hours; dusk: 2000-2100 hours; and night: 2300-0400 hours). These data were used to infer trends in fish approach behaviour to the large Crescent Island fishwheel.

Relative catch efficiency of the large Crescent Island fishwheel was estimated by calculating the ratio of fish caught by the wheel relative to the number of fish observed with DIDSON. Catch efficiency was estimated for two catch periods (2045 hours on 10 August through 1004 hours on 11 August, and 1640 hours on 15 August through 0956 hours on 16 August) for adult sockeye, adult Chinook, and jack Chinook salmon. Size ranges used for identifying these fish in the DIDSON data were 30 to 49 cm for jack Chinook, 50 to 64 cm for adult sockeye, and > 64 cm for adult Chinook salmon. Previous comparisons of actual fish sizes with those estimated using the sizing tool feature in the playback software suggest that there is a positive bias of approximately 7 cm in the on-screen measurements. Therefore, the on-screen measurements were reduced by 7 cm before the fish was assigned to one of the above size ranges.

Mark-Rates for Spaghetti-Tagged Sockeye

One of the goals of the 2008 study was to assess whether fishery sampling for spaghetti-tag recoveries could be used to derive a reliable estimate of the sockeye salmon mark-rate. Catch monitoring crews were asked to examine as many as possible of the sockeye caught in First Nation fisheries above Mission and report the number of tags observed and number of fish examined for tags. It was hoped that the additional catch monitoring efforts supported by Fraser Salmon and Watersheds Program (FSWP) funding in 2008 would result in a substantial portion of the sockeye catch above Mission being examined for tags. All the information on tag returns and mark-rate for First Nation fisheries above Mission was obtained from DFO sources.

Abundance Estimates Based on Qualark Mark-Rates for Radio-tagged Sockeye

The primary purpose for applying the 110 radio-tags to summer-run sockeye in 2008 was to assess the feasibility of using radio-telemetry and mark-rates from the Qualark hydroacoustic-telemetry antenna arrays to derive an abundance estimate for summer-run sockeye that could be compared with the Mission hydroacoustic estimate for the same period. Other sockeye run-timing groups were not suitable for these assessments in 2008 because the return was expected to be too small (Early Stuart) or a large portion of the forecast return was destined for tributaries between Mission and Qualark (e.g., early-summer returns to the Chilliwack River and late-summer returns to the Harrison watershed).

Radio-tag detection data collected using underwater antennas deployed at the Qualark hydroacoustic site were combined with sockeye abundance estimates for the period when the radio-tagged fish passed Qualark, to derive a mark-rate for summer-run sockeye and a range of possible abundance estimates for summer-run sockeye that passed Mission from 6-22 August 2008.

RESULTS

Environmental Data

Fraser River water levels at Hope ranged from 3.7 to 8.7 m between 1 June and 31 October 2008 (Figure 8). Discharge at Hope showed a similar pattern and ranged from 1,220 m^3s^{-1} to 9,450 m^3s^{-1} (mean = 3,871 m^3s^{-1}) over the same period (Figure 9). The average daily water level at Mission ranged from 0.8 to 5.5 m from 1 June to 31 October (Figure 10). As water levels dropped below 3 m in mid-July, daily fluctuations in water level as a result of tidal influence increased. Discharge ranged from 6,270 to 10,700 m^3s^{-1} at Mission from 1 June to 14 July (Figure 11).

Water temperatures at the Mission Railway Bridge and Crescent fishwheel sites were similar in 2008 and ranged from 8 ^oC to 19 ^oC (mean = 14.4 ^oC) from 29 June to 23 October (Figure 12). At Qualark Creek, Fraser River water temperatures ranged from 6.4 ^oC to 19.3 ^oC from 17 June to 31 October 2008 (Figure 13). Historical water temperatures at Qualark Creek are shown in Figure 14.

Fishwheel Operation

The Mission-South fishwheel operated at the Mission Railway Bridge for 1,803 h between 18 June and 21 October 2008 (Figure 15; Appendix Table B1). From 18 June to 20 July, it operated for 743 h on the south side of the first bridge pier from the south bank (Figure 16). Fishwheel speed at this site averaged 1.7 RPM. On four occasions as water levels dropped, the fishwheel had to be stopped briefly and moved 2-3 m downstream into deeper water. The fishwheel baskets were typically less than 1 m above the river bottom. There were periods of each day from 15-24 July when the Mission-South fishwheel did not rotate during high tide. On 25 July, the Mission-South fishwheel was moved alongside the Mission-Middle fishwheel on the south side of the second bridge pier; and it fished there for 1,060 h. At this site, fishwheel speed averaged 2.3 RPM from 25 July to 5 September and 1.4 RPM from 9-21 October. The Mission-South fishwheel was stopped for the season on 21 October.

The Mission-Middle fishwheel operated adjacent to the second bridge pier from the south bank for 1,601 h from 28 June to 21 October. Fishwheel speed averaged 2.9 RPM from 28 June to 5 September and 1.3 RPM from 10-21 October. From 9-21 October, the Mission-Middle and Mission-South fishwheels did not rotate during high tide.

The Crescent-Regular fishwheel operated for total of 1,567 h from 4 July to 23 October (Figure 17, Figure 18). On 9 October, a power-assist unit was installed on the Crescent-Regular fishwheel; however, due to mechanical problems it was unable to run for extended periods and thus proved ineffective. On 11 August, the crew noticed that the Crescent-Regular fishwheel effectively stopped turning during high tides. Fishwheel speed averaged 1.8 RPM from 4 July to 5 September and 1.0 RPM from 10-23 October.

The Crescent-Large fishwheel operated adjacent to the Crescent-Regular fishwheel for 1,038 h from 28 July to 23 October. On 1 September, several items were stolen from the Crescent-Large fishwheel (2 hoists, 3 batteries, 1 water pump, and 1 tagging trough). There was evidence to suggest that fish were taken from the fishwheel as well. From 9-23 October, the Crescent-Large fishwheel did not rotate effectively during high tides. Fishwheel speed averaged 1.0 RPM from 28 July to 5 September and 0.6 RPM from 9-23 October.

All of the lower-river fishwheels were shut down during First Nation fisheries. The fishwheels were shut down from 5 September to 7 October during a scheduled project hiatus while awaiting the arrival of chum and coho salmon. Other fishwheel stoppages were required to repair damage to the basket slides caused by floating debris, remove woody debris from the baskets, and patch minor holes in basket mesh.

The Siska fishwheel operated for an estimated 895 h between 1 August and 21 September (Figure 19; Figure 20; Appendix Table B3). Fishwheel speed averaged 2.4 RPM. The Siska fishwheel was stopped due to high water between 23 August and 1 September.

Fishwheel Performance

Catch and Capture Efficiencies

Including jacks, 1,394 sockeye, 1,111 Chinook, 563 steelhead, 363 coho, 199 chum, and 3 pink salmon were captured at the four lower-river fishwheels between 18 June and 23 October (Table 1). Thirteen other fish species, including 33 white sturgeon (*Acipenser transmontanus*), and several harbour seals (*Phoca vitulina*) were also captured and released.

The first sockeye salmon was captured on 27 June at the Mission-South fishwheel and the last was captured on 17 October at the Crescent-Large fishwheel (Figure 21; Appendix Table B2). Excluding jacks, the Crescent-Large fishwheel captured the most adult sockeye (570; peak = 69/d), followed by the Crescent-Regular (417; peak = 35/d), Mission-Middle (206; peak = 21/d), and Mission-South (168; peak = 16/d). Sockeye catches were low from 18 June to 4 July, moderate and reasonably steady from 5-26 July, fairly high from 28 July to 13 August, and gradually decreased from 14 August to 5 September. Daily CPUE followed a similar pattern as catch, and the maximum daily CPUE varied from 0.7 fish/h at the Mission-South fishwheel to 2.9 fish/h at Crescent-Large fishwheel (Figure 22; Appendix Table B2).

During high water from 4-11 July, catch efficiencies at the Mission-South fishwheel at pier 1 (76 sockeye, avg. daily CPUE = 0.4 fish/h) were higher than those at the Mission-Middle fishwheel at pier 2 (19 sockeye, avg. daily CPUE = 0.1 fish/h). During low water from 17-20 July, only one sockeye was caught at the Mission-South fishwheel while 37 sockeye were caught at the Mission-Middle fishwheel. From 25 July to 5 September, when the Mission fishwheels were operated in tandem at pier 2, the Mission-Middle fishwheel (92 sockeye) caught more fish than the Mission-South fishwheel (76 sockeye).

From 28 July to 5 September, a period when all four fishwheels were operating, sockeye catches were highest at the Crescent-Large fishwheel (568 fish, avg. CPUE = 0.8 fish/h), followed by the Mission-South (71 fish; 0.1 fish/h), Mission-Middle (62 fish, 0.1 fish/h), and Crescent-Regular (43 fish; 0.1 fish/h) fishwheels. After 11 August, when water levels at Mission dropped below 2 m, 1.4 and 3.4 times more sockeye were caught at the Crescent-Regular fishwheel than at the Mission-Middle and Mission-South fishwheels, respectively.

Daily ratios (5-d moving average) of sockeye abundance at the Mission hydroacoustic site to catches at the lower-river fishwheels were compared (Figure 23). The ratios averaged 1,918:1 for the Crescent fishwheels and 10,294:1 for the Mission fishwheels. Catch efficiencies at the fishwheels tended to decrease as water levels at Mission decreased, particularly at the Mission fishwheels.

Chinook salmon were captured from 29 June (Mission-Middle) to 19 October (Crescent-Large; Figure 24, Figure 25; Appendix Table B2). Excluding jacks, most Chinook salmon were captured at the Crescent-Large fishwheel (175), followed by the Crescent-Regular (36), Mission-South (24), and Mission-Middle (20) fishwheels. Jack Chinook comprised 77% (856 fish) of the total Chinook salmon catch.

Chum salmon were captured from 17 August to 23 October, and coho salmon were captured from 15 August to 23 October (Appendix Table B3).

At the Siska fishwheel, 1,480 sockeye salmon were captured from 1 August to 20 September (Figure 26; Appendix Table B3). Of these, 1,417 were unmarked adults, 3 were recaptures (tagged at the lower-river fishwheels), and 60 were jacks. The two recaptures with tag numbers recorded were tagged at the Crescent fishwheels 6 d prior to being caught at the Siska fishwheel. In addition, 194 adult Chinook, 15 jack Chinook, 268 adult coho, 28 jack coho, 6 chum, 35 steelhead, and 3 sturgeon were caught at the Siska fishwheel. One adult coho salmon caught on 18 September was a recapture, and it was tagged 13 d earlier at the Crescent-Regular fishwheel.

DIDSON Data Collection and Analysis

DIDSON data collection at the Crescent-Large fishwheel started with setup and testing at 1900 hours on 6 August and completed at 2200 hours on 20 August (Table 2).

Based on a subset of data from 10-12 August, the mean number of fish per hour passed the site was highest during the day (18.5 fish/h), followed by the dawn (14.0 fish/h), dusk (10.8 fish/h), and night (8.6 fish/h; Figure 27). A comparison of net directional movement (i.e., whether the fish left the DIDSON sample volume heading upstream or downstream) among time periods indicated little difference in directional movement (mean numbers of fish per hour) during dawn and dusk (Figure 28). During the day, downstream movements tended to be slightly higher than upstream movements, whereas the opposite was observed during the night.

Other qualitative results included:

- Upstream migrants tended to move offshore as they approached the fishwheel. A block net was deployed on 11 August to address this behaviour and guide fish towards the baskets.
- Upstream migrants were often observed to exhibit startle and flee responses (turn around and head downstream) when approaching the fishwheel when in operation.
- Startle and flee responses were not observed during periods when the fishwheel was not operational.
- Smaller fish (about 30-40 cm in length) often appeared to be migrating in pairs or small schools of 3-6 fish.
- Several instances were noted where fish were observed in real time approaching the fishwheel and were subsequently captured in the fishwheel.

Catch efficiency of the Crescent-Large fishwheel relative to DIDSON counts were similar for the adult sockeye (0.36-0.38) and jack Chinook (0.29-0.36) detected in the DIDSON monitoring zone adjacent to the Crescent-Large fishwheel (Table 3). Adult sockeye could be readily distinguished from jack Chinook because there was no overlap in the size distribution for these two groups. Adult sockeye caught by the fishwheels during the DIDSON monitoring period averaged 59 cm (range 50-72 cm) in nose-fork length and jack Chinook averaged 40 cm (range 23-49 cm). Catch efficiencies for adult Chinook salmon ranged from 0.15 to 0.40 but when combined with the adult sockeye estimates the efficiencies for adults and jacks were very similar. There was substantial overlap in the size of adult Chinook (55-100 cm) and adult sockeye.

Fishwheel Selectivity

Length distributions for sockeye salmon varied between the fishwheels ($F_{3,1248} = 13.3$, $P < 0.001$; Figure 29). The mean length of sockeye caught at the Crescent-Large fishwheel (58.3 cm) was greater than at the Mission-South (57.5), Crescent-Regular (56.8 cm), and Mission-Middle (56.5 cm) fishwheels. Length distributions for sockeye salmon also varied between the Crescent-Large fishwheel and various test fisheries ($F_{5,8153} = 71.3$, $P < 0.001$; Figure 30). Sockeye caught at the Crescent-Large fishwheel were smaller on average than those fish caught in the Area 20 purse-seine test fishery (60.0 cm) and the Area 20 (61.2 cm), Cottonwood (60.8 cm), Whonnock (61.6 cm), and Qualark (60.6 cm) gillnet test fisheries.

Length distributions for Chinook salmon (excluding jacks measuring less than 50 cm) were similar between fishwheels ($F_{3,243} = 1.0$, $P = 0.35$; Figure 31) and ranged from a mean of 73.1 cm at the Crescent-Regular fishwheel to 78.2 cm at the Mission-Middle fishwheel.

The daily ratio of jack Chinook to sockeye salmon caught at the fishwheels was considerably lower from 27 June to 27 July (mean = 0.1:1) than it was from 28 July to 5 September (mean = 3.1:1; Figure 32). From 13-27 July, the daily proportion of sockeye caught in the fishwheels (mean = 95%) was greater than in the Whonnock gillnet test fishery (avg = 84%; Figure 33). However, from 28 July to 28 August, a period when jack Chinook catches increased at the fishwheels, the proportion of sockeye caught at the fishwheels (mean = 43%) was lower than in the Whonnock gillnet test fishery (mean = 64%).

Tags Applied

At the lower-river fishwheels, spaghetti tags were applied to 1,205 sockeye, 215 Chinook, 211 coho, 155 chum, 6 steelhead, and 1 pink salmon (Figure 34, Appendix Table B3). In addition, PIT tags were applied to 26 of the 33 sturgeon captured at the fishwheels; the remaining 6 sturgeon were already PIT-tagged (Appendix Table B3).

Of the 1,205 spaghetti-tagged sockeye salmon, 110 fish also received a radio tag (Table 4; Figure 34; Appendix Table B3). The majority (74%) of sockeye that were radio-tagged were identified as Summer-run (Figure 35). The Chilko stock made up the majority (80%) of the radio-tagged Summer-run sockeye, and the Quesnel (5%), Stellako (7%), and Stuart (7%) stocks were relatively minor in comparison (Figure 36).

At the Siska fishwheel, 267 adult sockeye salmon (max = 21/day) were spaghetti-tagged between 12 August and 2 September (Appendix Table B3).

Fixed-station Detection Efficiencies

Detection efficiencies in 2008 were perfect (100%) at the Hope, Qualark, and Chilcotin receivers, and greater than 90% at the Thompson-Fraser confluence (Table 5). Four fixed stations had detection efficiencies less than 90%. The Sawmill receiver (0% detection efficiency) had a cut antenna cable (squirrel damage?) that was not discovered until the study was over. The receiver at the Fraser-Harrison confluence (58.2%) was set up to detect fish migrating up the Harrison River and was expected to miss a portion of the fish migrating in the Fraser mainstem. Detection efficiencies of the Mission and Rosedale fixed stations (80.2 and 64.7%, respectively) were lower than expected, given that the receivers were operational during periods of sockeye passage (Appendix Table A2, Appendix Figure A1). Daily detections of radio-tagged fish and corresponding receiver noise levels recorded by each fixed-station receiver are given in Appendix Figure A1.

Tracking Histories

A total of 98 (89%) radio-tagged sockeye were detected at least once after release. Of these, 18 sockeye dropped back downriver after being tagged, and were first detected by the fixed station on Crescent Island. Three dropback sockeye were caught in fisheries downstream of Mission, and 5 were never detected again. The remaining 10 drop-back sockeye returned upriver and eventually passed the Mission fixed station.

In total, 91 of the radio-tagged sockeye (83%) were known to pass the Mission site (Table 5), although 18 were not detected during their upstream passage. These latter sockeye were first detected at the Harrison (7), Rosedale (7), and Hope (3) receivers, or in fishing nets (1). For the 18 sockeye that passed the Mission site undetected, we estimated the Mission passage time by interpolating between detections upstream and downstream of Mission, assuming a constant travel speed.

The zones of last detection of the radio-tagged sockeye are shown in Table 6. In all, 11 (12.1% of the sockeye that passed Mission) were tracked to the vicinity of spawning areas, including 3 Chilliwack, 1 Cultus Lake, and 7 Chilko sockeye. Of the sockeye that passed Mission, 19 (21%) were returned from in-river fisheries, and these fish were last tracked on the Fraser at Mission (2), Rosedale (1), Hope (4), Qualark (8), the Thompson junction (2), the Chilcotin junction (1), or were never tracked (1).

DNA Stock Assignments and Straying

Prior to the arrival of radio-tagged sockeye in known stock areas, DNA micro-satellite analyses provided estimates of stock origins for all but one of the radio-tagged sockeye. Radio-tracking provided additional insight to the stock-classifications. In total, 11 radio-tagged sockeye with DNA-based stock assignments were tracked as far as spawning destinations or their tributaries. Final stock assignments for these sockeye were used to assess the classification accuracy of the *a priori* DNA analysis.

The radio-tracking data indicated the DNA analysis assigned radio-tagged sockeye to the correct run-timing group 100% of the time. Three Chilliwack fish (Early Summer), seven Chilko fish (Summer-run), and one Cultus Lake fish (Late-run) were tracked to spawning areas, and the DNA processing had assigned all 11 fish to the correct stock. Low sample sizes precluded further detailed analyses of DNA stock assignments.

Migration Speeds

Speed of sockeye movements between Mission and Hope varied significantly among run-timing groups (χ_1^2 = 4.0; P = 0.046; Table 7; Figure 37). That is the median Summer-run migration speed (29 km/d) was significantly slower than that of Early-Summer sockeye (36.3 km/d).

Migration speeds for Summer-run stocks varied among years (Figure 38). For example, median migration speeds from Mission to Thompson Junction were significantly faster in 2005 (31.5 km/d) and 2006 (28.2 km/d) than in 2007 (23.4 km/d) and 2008 (24.3 km/d; χ^2_3 = 100.1; P < 0.0001).

Fishery Recoveries

Based on the harvest rate method described above, we estimated that 6 of the 91 radio-tagged sockeye that passed Mission would likely have been caught in fisheries between Mission and Qualark (Table 8). In fact, 5 radio-tags were reported captured by First Nation fishers in fisheries conducted between Mission and Qualark, thus suggesting that the reporting rate for these fisheries was 83%. If we only include the 78 tags applied to stocks destined to spawning locations above Qualark, we estimate that 5 of these radio-tagged sockeye would likely have been removed in the Mission-Qualark fisheries. The DNA data from the 5 of the radio-tag recoveries indicated that all of these fish were summer-run sockeye destined for spawning locations above Qualark.

Mark-rates for Spaghetti-Tagged Sockeye

Table 9 provides a summary of the sockeye catch and spaghetti tag recoveries recorded by catch monitoring crews for First Nation fisheries between Mission and Kelly Creek. The fisheries were divided into four strata: 1) Mission-Hope; 2) Hope-Sawmill; 3) Sawmill-Stein; and 4) Stein-Kelly. Catch sampling data was deemed reliable for four landing sites in the Mission-Hope strata (Hunter Creek, McDonald Beach, Peter’s and Ridgedale), however, tag recoveries were only reported for the Hunter Creek landing site and surveyors reported that fishers using the Ridgedale landing site do not report tag recoveries. Given the close proximity of the Hunter Creek and Peter’s landing sites and the magnitude of the catches reported at the Peter’s landing site, it is likely that some of the tag recoveries recorded at the Hunter Creek landing site came from catches recorded at the Peter’s Creek site. The sockeye catch sampled from these two sites combined (24,595) represented 33% of the total sockeye catch estimate for the Mission-Hope stratum (75,558).

In the Hope-Sawmill stratum, all the tag recoveries and catch sampling data was obtained from the Yale Beach landing site. The sockeye catch sampled at the Yale Beach site (41,136) represented 40% of the total sockeye catch estimate for the Hope-Sawmill stratum (102,050).

Catch sampling coverage in the Sawmill-Stein stratum was the lower than that for other strata, with only 6% (3,845) of the estimated sockeye catch (69,864) sampled for tag recoveries. In contrast, the best coverage was achieved in the Stein-Kelly stratum where 51% of the estimated sockeye catch (33,791) was sampled for tag recoveries.

In total, the above catch sampling efforts represented 31% of the estimated sockeye catch for the Mission-Kelly Creek fisheries. However, the high variability in catch sampling coverage and mark-rates between the various fishing strata coupled with the generally low mark-rate, made the reliability and utility of any abundance estimate based on these spaghetti tag mark-rate data highly suspect.

Abundance Estimates Based on Qualark Mark Rates for Radio-Ragged Sockeye

August 9-26 was the period when radio-tagged sockeye were detected at the Qualark hydroacoustic site. During this period, 48 radio tags were detected by the Qualark underwater antennas that monitored the portion of the river covered by the DIDSON hydroacoustic systems. Also during this period, DFO estimated that 152,000 sockeye passed through the portion of the river monitored by these antennas and the Qualark DIDSON hydroacoustic arrays. The mark rate derived from these estimates was combined with radio-tag detection data from Mission and other fixed-station receivers to compute a range of possible abundance estimates for the number of sockeye passing Mission that were destined for spawning areas above Qualark (Figure 39). All of the mark-recapture estimates were less than the comparable Mission estimate of 276,000 sockeye for the period when the radio-tagged fish passed Mission (August 6-22). Assuming a tagging related mortality rate of 25% (as observed in 2007, Robichaud et al. 2008), the mark-recapture estimate for this Mission passage period would be 190,000 (140,000-243,000). These 95% confidence bounds are broad (±28%) because of the low number of tags applied in this feasibility study. These bounds would be reduced to ±16% if the number of radio-tags applied was increased 3 fold (i.e. 330 tags). This number of tags is comparable to those applied in the lower Fraser River in 2005, 2006 and 2007 (Robichaud and English 2006; 2007; Robichaud et al. 2008). This estimate is based there being 58 radio tags available for capture in fisheries between Mission and Qualark or for detection at the Qualark site, and is consistent with our confirmed detections of 55 radio-tagged sockeye that were destined for spawning areas above Qualark. A total of 50 radio tags were detected by the Qualark antenna arrays (2 only detected on aerial antennas) and 5 radio tags were reported removed by First Nation fisheries between Mission and Qualark (see section on fishery recoveries).

The Mission passage timing for the 78 radio-tagged sockeye destined for spawning areas above Qualark and daily sockeye catches in First Nation fisheries between Mission-Hope are provided in Figure 40. These data indicate that tags that were detected entering the Mission-Hope fisheries during the first day of each fishing period had a slightly lower likelihood of being detected at Qualark (59%) than tagged fish that passed Mission later in a fishing period or during times when the Mission-Hope fisheries were closed (67%).

Fate of Radio-Tagged Sockeye

The fates of radio-tagged sockeye are shown by last detection location and by run timing group in Figure 41. In total, 18 (20%) of the 91 sockeye that passed Mission were considered to be en-route losses (i.e., not reported fishery removals), all of which occurred between Qualark and the Chilcotin junction. These losses occurred in areas of the Fraser River where a large proportion of the local fishing effort is concentrated.

The fates of radio-tagged sockeye last detected downstream of Sawmill are shown in Figure 42. When recoveries and dropbacks were excluded, the pattern of last detections coincided with temporal patterns of harvest for a majority of the fish (62%). This suggests that many of the missing sockeye may have been fishery removals.

Of the 91 radio-tagged sockeye that passed Mission, 24 showed a migratory pattern that included downstream movements following a period of upstream movement. Of these, 8% dropped back after being detected at the Harrison receiver and 17% after the Rosedale receiver. However, the majority of the drop backs (75%) occurred after the fish had been detected at Qualark, possibly as a result of interactions with gillnet fisheries.

DISCUSSION

Fishwheel Performance

Catch rates of sockeye salmon at four lower-river fishwheels used in 2008 were approximately two times higher than catch rates at three fishwheels used in 2007. From 24 June to 5 September 2008, an estimated 1,487,000 sockeye salmon passed the Mission hydroacoustic site. Over the same period, the combined fishwheel catches (1,359 sockeye excluding jacks) represented 0.09% of the run. Individually, the fishwheels captured 0.04% (Crescent-Large), 0.03% (Crescent-Regular), and 0.01% (Mission-Middle and Mission-South) of the run. In comparison, catch rates for sockeye salmon at six fishwheels operated on the Nass River ranged from 1.3-5.5% of the run per fishwheel (mean = 2.8%) from 2000 to 2006 (Alexander et al. 2006). Catch rates observed at the Fraser fishwheels in 2008 were not sufficient to reliably estimate the abundance of sockeye salmon using mark-recapture methods.

As in 2007, hydrologic conditions of the Fraser River at the Mission Railway Bridge made it difficult to capture large numbers of salmon in 2008. For example, catch efficiencies at the Mission-South fishwheel while operating at pier 1 were best from mid-June to mid-July when water velocities were relatively high and it operated close to shore and to the river. Fish were likely bank- and bottom-oriented during this period as they tried to avoid faster-flowing water offshore. However, by 14 July, water levels and velocities had dropped substantially, fishwheel speed had decreased to less than 1 RPM, and the Mission-South fishwheel became completely ineffective at capturing fish. Under these low-water conditions, water velocities at pier 2 of the Mission Railway Bridge were fast enough to turn the fishwheel baskets for all or a portion of each day throughout the season. When fished in a side-by-side configuration alongside pier 2, the fishwheel closest to the pier (Mission-Middle) captured more sockeye than the fishwheel farthest from the pier (Mission-South); whereas the opposite occurred in 2007. However, during high tides late in the season, both fishwheels at pier 2 effectively stopped rotating, which significantly reduced their catch efficiencies.

Hydrologic conditions at the Crescent site were more favourable for fishwheel operation than at the Mission Railway Bridge, particularly for the Crescent-Large fishwheel. Water velocities offshore tended to be higher, even during low-water periods, at the Crescent site than at the Mission Railway Bridge. The floating shoreline abutment and fishwheels could be moved inshore and offshore as water levels changed which allowed the baskets to be fished as close to the river bottom as possible. Although the Crescent-Large fishwheel operated for 34-42% fewer hours than the other three lower-river fishwheels, it captured 1.4-3.4 times as many adult sockeye and 4.9-8.8 times as many Chinook salmon. The ratio of Mission sockeye abundance to fishwheel catches showed that the relative catch efficiency of the Crescent fishwheels was better than that of the Mission fishwheels, particularly during low-water periods (Figure 23). Catch efficiencies at the Mission fishwheels also tended to decrease with water levels in 2007. Catches at the Crescent-Large fishwheel may have been substantially higher had it been installed in late June (and not late July) as originally planned. Unfortunately, the Crescent-Large fishwheel had to be dismantled and modified in July because the original design for raising the baskets was not capable of supporting the heavier basket assembly.

The Siska First Nation operated a fishwheel in the Fraser Canyon near Frenchman's Bar from 1 August to 21 September 2008 (Appendix Table B3). The average daily catch rate of adult sockeye salmon at the Siska fishwheel from 7-22 August (73 fish/day) was 2.8 times higher that for Crescent-Large fishwheel and 14 times that for the two Mission fishwheels during the comparable 1-16 August period (assuming a 6-d travel time between sites).

Recommendations for Improving Capture Efficiencies

Reconnaissance in 2008 revealed no alternative fishwheel sites in the vicinity of Mission where catch efficiencies would be expected to be as high, or higher, than those observed at the Crescent site used in 2008. However, the use of a DIDSON to monitor the approach behaviour of fish provided insight on how catch efficiencies at the Crescent site could be improved. DIDSON capture efficiency data in 2008 should be viewed with caution as it is uncertain the extent to which the DIDSON sample volume adequately covered the area in which fish were vulnerable to capture by the fishwheel. The vertical component of the sample volume at the fish baskets was 2.5-3.5 m deep, which may not have covered the entire capture zone. Although we observed (in real time) several instances of fish showing up in the DIDSON sample volume and then being captured in the fishwheel baskets, it was unclear if any fish were caught in the baskets but not seen with the DIDSON. As a consequence, the catch efficiency results may be biased high. Despite the limitations of the data, the results from the comprehensive analysis of the data collected on August 10-11 and 15-16 suggested that wheel catchability was similar for the size range of fish that migrated in the vicinity of the large Crescent Island fishwheel (Figure 43).

It was clear within minutes of operating the DIDSON that upstream migrants were avoiding capture in the fishwheel by moving offshore as they approached. A barrier (lead) net should be installed on the offshore side of the Crescent-Large fishwheel that extends at least 30 m downstream from the bow of the port-side pontoon. The net should be used throughout the entire season. In 2008, an effective barrier net was not installed at the Crescent-Large fishwheel until early October.

The DIDSON results also suggested that fishwheel catchability was a function of time of day and that fish could see and thus avoid the baskets. On average, DIDSON hourly counts were higher during the day than they were during the night (Figure 27). Conversely, fishwheel catches tended to be greater at night than during the day. An examination of directional movements among time periods showed that the majority of fish observed during the day ended up heading downstream (Figure 28), likely the result of seeing the fishwheel baskets or wash associated with air expelled from the aluminum tubing used to frame the baskets. There were numerous observations of fish during the day moving upstream towards the baskets that were startled (presumably by the baskets or the air wash) and altered their direction by turning or heading downstream. In contrast, the majority of fish observed during the night were heading upstream (Figure 28), and few such startle responses were observed during night periods. Based on these findings, the ends of all aluminum tubing for the fishwheel baskets must be permanently plugged to minimize air wash and consequent startle and flee responses. The expanding foam used in previous years has not proved to be adequate.

Additionally, the power-assist unit should be installed and operated on the fishwheels as soon as fishwheel speeds slow to a point where fishwheel catchability is affected. Unfortunately, mechanical issues with the power-assist unit precluded its use at the Crescent-Regular fishwheel in 2008. It is also recommended that the axle of the Crescent-Large fishwheel be modified to accommodate the use of the power-assist unit. The power-assist unit will maintain fishwheel speed at 2 RPM, even during high tide, and undoubtedly contribute to higher catch rates.

Size Selectivity of Fishwheel Catches

Sockeye captured by the Crescent-Large fishwheel were smaller on average that those captured by other test fisheries (Figure 30). A similar pattern was observed at the Mission fishwheels in 2007. While the difference in mean size in 2008 was small (1.7-3.3 cm), it is nevertheless of concern since it is evidence that sockeye tagged at the fishwheels were not representative of the sockeye migrating through the Mission area. Smaller fish would be expected to have lower migration speeds and have different vulnerability to in-river fisheries than larger sockeye. Potential reasons why the fishwheels caught smaller sockeye include: capture avoidance by larger fish; larger fish migrating in locations with higher water velocities away from the shore and bridge piers; and variation in fish size with depth.

The first two potential reasons are based on the assumption that larger fish are stronger and faster swimmers than smaller sockeye. This swimming ability would make it easier for them to avoid the fishwheel baskets and migrate in the faster waters farther from shore or the bridge piers. However, the DIDSON data from 2008 suggested that the catch efficiencies for the Crescent-Large fishwheel were similar for adult sockeye and jack Chinook for the overnight time periods examined (Table 3). We suspect that the small but significant difference in the size of sockeye caught by the fishwheels was due to larger sockeye migrating further from the shoreline and thus outside the capture zone for the fishwheels. There is also extensive data from the Nass River showing that fishwheels can catch a representative sample of sockeye and other salmon species when deployed in areas where water velocities are high and most of the salmon are forced to migrate near the river bank (Alexander and Bocking 2003; Alexander et al. 2006; but see Link and Nass 1999). The much lower water velocities found in the lower Fraser increase the potential for larger salmon to migrate farther from shore.

If larger sockeye swim in deeper water than smaller sockeye (e.g., Hughes 2004), they would be less vulnerable to capture at locations where the smaller fishwheel baskets are not sampling the entire water column. Thus, in areas of deeper water, shallow fishwheels are biased towards the fish that swim closer to the surface.

Migration Speeds

The median migration speeds of Summer-run sockeye from Mission to Hope, Mission to Qualark, and Mission to Thompson Junction were slower than those for early-Summer sockeye in 2008 (Table 6; Figure 37). Migration speeds for Summer-run sockeye from Mission to a variety of upstream locations were slower in 2007 and 2008 than those in 2005 and 2006 (Figure

Historically, the data from the Whonnock gillnet test fishery has been used to determine the species composition at the Mission site for periods when pink salmon abundance is not a factor (i.e., even-numbered years and July in odd-numbered years). PSC biologists have recognized that the ratio of Fraser sockeye to pink salmon abundance in August-September marine test fisheries in odd-numbered years is substantially different from those derived from the Whonnock gillnet test fishery (Mike Lapointe, PSC, pers. comm.). Fishwheel data from the Mission Railway Bridge sites sampled in 2007 confirmed previous observations that pink salmon tend to be more abundant close to shore than in the center of the channel and the ratio of pink to sockeye is substantially different between near-shore and off-shore sampling locations (Robichaud et al. 2008). Fishwheel data from the Mission Bridge and Crescent Island sites sampled in 2008 revealed substantially higher abundances of jack Chinook than those observed in the Whonnock gillnet test fishery. It is suspected that jack Chinook and pink salmon tend to migrate closer to shore because of their lower swimming capabilities relative to those of adult sockeye and Chinook. Given these observed differences in species composition across the river channel it is important that both areas be reliably sampled to provide an accurate assessment of the daily species composition for the daily Mission hydroacoustic counts. Since drift gillnetting is an effective method for sampling off-shore waters and fishwheels are an effective method for sampling near-shore waters, we suggest that the data collected from both methods could be used to address the species-composition issue. Neither method alone can provide accurate species-composition estimates for the Mission hydroacoustic site, but it is possible that the two methods together could provide a viable solution.

We used data from 2007 to assess whether species-composition estimates from the Mission fishwheel and Whonnock test fishery were consistent with the PSC estimates of the number of sockeye and pink salmon that passed the Mission hydroacoustic site each day between 27 June and 20 September 2007. Figure 44 shows the substantial difference between the near-shore fishwheel samples and the off-shore gillnet test fishery samples for the period when pink salmon were migrating passed these test fishing sites and the Mission hydroacoustic site.

The daily PSC estimates of the number of sockeye passing Mission were consistent with the observed species composition estimates for each strata (gillnet test fishery for off-shore and fishwheels for near-shore), if 60-95% of the sockeye migrated offshore and 80-95% of the pink salmon migrated near shore during the late-August through mid-September period (Figure 45). In contrast, using the fishwheels species composition alone underestimated the daily sockeye abundance and using Whonnock species composition alone substantially overestimated the daily sockeye abundance. Consequently, we recommend that Mission hydroacoustic counts be separated between the near-shore and off-shore strata and Whonnock test fishery data be used to estimate the species composition of the off-shore counts and fishwheel test fishery data be used to estimate the species composition of the near-shore counts.

Plans for 2009

Further assessments using fishwheels (and tangle nets) in the Lower Fraser River have been proposed for 2009. The primary objectives for 2009 are to: 1) estimate in-river survival rates, migration rates, and impact of fisheries on in-river survival for adult sockeye and Chinook salmon; 2) obtain the species composition data required to derive reliable in-season estimates of abundance for sockeye, Chinook, and pink salmon in odd-number years; and 3) work with DFO and the PSC to derive reliable in-season estimates of abundance at Mission for sockeye, Chinook, and pink salmon in 2009. Results from 2007 and 2008 indicated that a mark-recapture program using conventional tags and fishwheels as the capture method was not viable in the lower Fraser River.

Five main components of the proposed 2009 project include: 1) the deployment and operation of two fishwheels at the Crescent Island site from late June through early September; 2) the capture and radio-tagging of 150 spring-run Chinook along the Fraser River between Hope and Yale; 3) the capture and radio-tagging of 350 sockeye at or near the Crescent Island site; 4) the tracking of radio-tagged sockeye and Chinook salmon throughout the Fraser watershed from their release site to spawning areas; and 5) the tracking of radio-tagged sockeye as they approach and pass the Qualark hydroacoustic site using aerial and underwater antenna arrays.

The fishwheels will be deployed and operated along the south (left) bank of the Fraser River at the Crescent Island site 10 km downstream from the Mission hydroacoustics site. The deployment will be similar to the configuration used from 28 July through 5 September 2008, and include: a floating shoreline abutment and fish weir, one regular-sized fishwheel, one large fishwheel, and a barrier net (7.5-cm mesh). The only major difference from the 2008 deployment will be the use of a spur-log and float design to eliminate the need for steel pilings at the site. This new attachment design coupled with the availability of all the other components from the 2008 study substantially reduces the deployment and operation cost for 2009.

Spring-run Chinook will be captured using tangle nets from mid-April to late-May at sites between Hope and Yale. Sockeye will be captured using tangle nets and day-time catches from fishwheels near the Crescent Island site. Sockeye sampling will take place 3-4 days per week from late July and late-August (i.e., targeting summer-run stocks). DNA samples will be obtained from every radio-tagged Chinook and sockeye for stock identification. Physiological samples (i.e., blood, gill tissue, and fat probe readings) may be obtained from a portion of the fish tagged in 2009. Archival thermal loggers (iButton tags) will be attached to each radio tag making it possible to reconstruct the complete thermal migration history for those fish where tags are recovered during spawning-ground surveys.

Radio-tagged Chinook and sockeye will be tracked during their upstream migration using fixed-station receivers and mobile survey techniques. Fixed-station receivers will be located at sites similar to those used in previous studies, including key locations such as: Mission, Qualark, Hells Gate, and major tributary junctions (Thompson, Chilcotin, Quesnel, and Nechako). Fixed-station data will provide reliable information on migration rates and fishery residence times for in-season comparison of the Mission and Qualark hydroacoustic data and post-season assessments of harvest rates and fishery impacts for Chinook and sockeye. DNA samples and tracking results for each radio-tagged fish will be combined to produce the stock-specific estimates needed for in-river fisheries management and run-reconstruction models. Mobile and fixed-station tracking data will be used to assess in-river survival rates for each stock. These data will be important for explaining any differences observed between the sockeye spawning-ground estimates and the hydroacoustic estimates of the number of sockeye that passed the Qualark monitoring site.

Data from past studies indicates that species composition can vary substantially between near-shore and off-shore (mid-channel) waters in the Lower Fraser River. The Whonnock gillnet test fishery likely provides a good sample of the species composition for off-shore waters, but it is not suitable for assessing near-shore waters. The opposite is true for the Crescent Island fishwheels. In addition, 2008 data indicated that the DIDSON hydroacoustic gear, drift gillnet test fishing, and radio-telemetry arrays were effective methods for assessing sockeye passage at the Qualark site. It is believed that the combination of data from these three programs (Qualark, Whonnock, and Crescent Island) and the Mission hydroacoustic site can be used to derive reliable, species-specific estimates of salmon escapement past Mission.

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TABLES

Table 1. Total catch of fish, by species, at four fishwheels operated in the lower Fraser River from 18 June and 23 October 2008.

		Fishwheel				
Common Name	Latin Name	Mission-Middle	Mission-South	Crescent-Large	Crescent-Regular	Total
Chinook salmon[a]	*Oncorhynchus tshawytscha*	36	78	850	147	1,111
Chum salmon	*Oncorhynchus keta*	1	0	183	15	199
Coho salmon[a]	*Oncorhynchus kisutch*	8	11	232	112	363
Pink salmon	*Oncorhynchus gorbuscha*	0	0	0	3	3
Sockeye salmon[a]	*Oncorhynchus nerka*	212	170	591	421	1,394
Steelhead[a]	*Oncorhynchus mykiss*	6	41	354	162	563
American shad	*Alosa sapidissima*	0	0	3	3	6
Carp	*Cyprinus carpio*	0	1	1	0	2
Largescale sucker	*Catostomus macrocheilus*	0	631	273	204	1,108
Mountain whitefish	*Prosopium williamsoni*	1	4	6	4	15
Northern pikeminnow	*Ptychocheilus oregonensis*	111	883	1,075	649	2,718
Pacific lamprey	*Lampetra tridentata*	0	4	11	6	21
Peamouth chub	*Mylocheilus caurinus*	27	83	1,746	498	2,354
Pumpkinseed sunfish	*Lepomis gibbosus*	0	5	4	1	10
Redside shiner	*Richardsonius balteatus*	13	83	54	59	209
Sculpin	Unknown sp.	0	5	1	0	6
Smolts	*Oncorhynchus spp.*	9	14	17	9	49
Threespine stickleback	*Gasterosteus aculeatus*	0	3	0	0	3
Trout	*Salvelinus sp.*	0	1	0	0	1
White sturgeon	*Acipenser transmontanus*	0	13	12	8	33
Total		424	2,030	5,413	2,301	10,168

[a] Includes catches of jacks.

Table 2. DIDSON sampling effort at the Crescent-Large fishwheel site from 6-20 August 2008.

Date	From:	To:
6-Aug	19:00	21:00
7-Aug	07:00	17:00
8-Aug	10:00	13:00
9-Aug	12:00	23:00
10-Aug	00:00	09:00
	20:00	23:00
11-Aug	00:00	23:00
12-Aug	00:00	23:00
13-Aug	00:00	23:00
14-Aug	00:00	23:00
15-Aug	00:00	23:00
16-Aug	00:00	23:00
17-Aug	00:00	23:00
18-Aug	00:00	23:00
19-Aug	00:00	23:00
20-Aug	00:00	22:00

Table 3. Relative catch efficiency for adult sockeye, adult Chinook, and jack Chinook salmon during two catch periods at the Crescent-Large fishwheel, 2008.

Catch Period	Variable	Adult Sockeye	Adult Chinook	Adult Total	Jack Chinook
10-11 August	Wheel Counts	14	2	16	20
	DIDSON Counts	37	13	50	68
	Efficiency	0.38	0.15	0.32	0.29
15-16 August	Wheel Counts	17	16	33	28
	DIDSON Counts	47	40	87	78
	Efficiency	0.36	0.40	0.38	0.36

Table 4. Summary of the 2008 radio tag releases by location and week.

	Fishwheel Location				
Tag Session	Mission-South	Mission-Middle	Crescent-Large	Crescent-Regular	Total
5-8 Aug	2		27	2	31
11-14 Aug	1	1	41		43
19-21 Aug	1	5	29	1	36
Total	4	6	97	3	110

Table 5. Numbers of radio-tagged sockeye that passed and that were detected passing the fixed-station receiver sites, 2008. The detection efficiency (the detected/passed ratio) of each receiver is also shown. No terminal zones are included as detection efficiencies for these sites cannot be computed (there are no upstream detection zones).

Fixed-station Site	Passed	Detected	Detection Efficiency
Mission Bridge	91	73	80.2%
Harrison-Fraser Confluence	79	46	58.2%
Rosedale	68	44	64.7%
Hope	61	61	100.0%
Qualark	49	49	100.0%
Sawmill	21	0	0.0%
Thompson-Fraser Confluence	17	16	94.1%
Chilcotin-Fraser Confluence	8	8	100%

Table 6. Last detection zone for radio-tagged sockeye, by stock. For each stock, fish are considered to have escaped to a spawning area if their last detection zone was one of those that are shaded in the table. Numbers in stock names correspond to run-timing groups.

	Stocks														Run-timing			
Last Detection Zone	2-Chilliwack	2-Fennell	2-Gates	2-Raft	2-Scotch	2-Seymour	3-Chilko	3-Quesnel	3-Stellako	3-Stuart	4-Cultus	4-Weaver	5-Birkenhead	n/a	Early Summer	Summer-run	Late-run	Totals
Release Site							5		1	1		1	2	1	0	7	1	11
Crescent Island							3			1			2		0	4	0	6
Mission	3			1	1		1		1	1		2	1		5	3	2	11
Cultus Lake (found dead)											1				0	0	1	1
Mission-Harrison (found dead)							1								0	1	0	1
Harrison Confluence						1	10		2			1	3		1	12	1	17
Rosedale			2				6			1					2	7	0	9
Hope				1			5	1							1	6	0	7
Qualark		1	2				7	1							3	8	0	11
Sawmill															0	0	0	0
Thompson Confluence		1					6								1	6	0	7
Chilcotin Confluence							4								0	4	0	4
Chilko							3								0	3	0	3
Fisheries																		
Downstream of Mission							2					1			0	2	1	3
Upstream of Mission [a]		1					12	2	2	2					1	18	0	19
Totals																		
Total Below Mission	0	0	0	0	0	0	10	0	1	2	0	2	4	1	0	13	2	20
Total at or Above Mission	3	3	4	2	1	1	55	4	5	4	1	3	4	0	14	68	4	90
Fates																		
Above Mission Fisheries	0	1	0	0	0	0	12	2	2	2	0	0	0	0	1	18	0	19
Escapement to Spawning Grounds [a]	3	na	na	na	na	na	7	na	na	na	1	na	na	na	3	7	1	11
Other Fate (Above Mission)	0	2	4	2	1	1	36	2	3	2	0	3	4	0	10	43	3	60

[a] one Chilko fish was caught in the Chilcotin River
na – no survey effort in spawning area.

Table 7. Migration speeds for radio-tagged sockeye for certain river reaches in 2008.

River Reach	All Sockeye	Run-timing: Early Summer	Run-timing: Summer
Migration speed (km/d)			
Mission - Hope	30.7	36.3	29.0
Mission - Qualark	26.4	32.4	25.3
Mission - Thompson Junction	24.5	26.1	24.3
Mission - Chilcotin	19.0		19.0
Thompson Junction - Chilcotin	19.0		19.0
Sample Size (n)			
Mission - Hope	49	7	42
Mission - Qualark	40	6	34
Mission - Thompson Junction	13	1	12
Mission - Chilcotin	6	0	6
Thompson Junction - Chilcotin	7	0	7

Table 8. Daily estimates of catch, harvest rate, and tag removals for Mission-Qualark fisheries, 5-23 August 2008. Data is referenced to Mission date.

		Mission-Qualark				Radio Tags at Mission		Tags Caught (Miss-Qual)	
Mission Date	Mission Sonar Estimate	First Nations	Sport	Total	HR	All Stocks	Stocks above Qualark	All Stocks	Stocks above Qualark
5-Aug	48,700	2,702	0	2,702	4.8%				
6-Aug	48,100	3,516	0	3,516	7.6%	8	7	0.6	0.5
7-Aug	34,000	3,701	0	3,701	10.2%	11	8	1.1	0.8
8-Aug	21,000	3,322	0	3,322	10.5%	6	5	0.6	0.5
9-Aug	25,300	1,369	0	1,369	6.3%	2	2	0.1	0.1
10-Aug	28,500	0	0	0	1.8%	1	1	0.0	0.0
11-Aug	35,000	261	0	261	2.9%	2	2	0.1	0.1
12-Aug	26,400	2,347	0	2,347	4.6%	12	11	0.5	0.5
13-Aug	22,900	1,233	0	1,233	8.0%	11	9	0.9	0.7
14-Aug	18,000	1,816	0	1,816	7.2%	6	5	0.4	0.4
15-Aug	23,900	1,631	0	1,631	6.3%	2	2	0.1	0.1
16-Aug	22,000	579	0	579	3.7%	2	2	0.1	0.1
17-Aug	13,900	0	0	0	1.9%	1	1	0.0	0.0
18-Aug	17,900	443	0	443	2.1%			0.0	0.0
19-Aug	15,100	531	0	531	4.6%	13	11	0.6	0.5
20-Aug	8,800	929	0	929	6.5%	8	6	0.5	0.4
21-Aug	10,500	766	0	766	6.3%	5	5	0.3	0.3
22-Aug	15,500	513	0	513	3.8%	1	1	0.0	0.0
23-Aug	9,300	69	0	69	2.2%				
Totals									
Aug. 6-22	386,800	22,957	0	22,957	5.9%	91	78	6.1	5.1
Jun.20-Sep.14	1,488,900	97,487	17,537	115,024	7.7%				

Table 9. Sockeye catch and spaghetti-tag recoveries recorded by catch monitoring crews for First Nation fisheries between Mission and Kelly Creek.

	Total catch	Sampled catch	Sample %	Spaghetti tags	Mark-rate tags/1000
Fishery					
Mission-Hope					
Hunter Creek		7,759		15	1.9
Peter's		16,836		0	0.0
Hope-Sawmill					
Yale Beach	102,050	41,136	40%	17	0.4
Sawmill-Stein					
Gillnet	69,166	3,533	5%	2	0.6
Dip Net	698	312	45%	1	3.2
Stein-Kelly					
Gillnet	16,460	7,636	46%	11	1.4
Dip Net	17,331	9,694	56%	12	1.2
Totals					
Mission-Hope	75,558	24,595	33%	15	0.6
Hope-Sawmill	102,050	41,136	40%	17	0.4
Sawmill-Stein	69,864	3,845	6%	3	0.8
Stein-Kelly	33,791	17,330	51%	23	1.3
Grand total	281,263	86,906	31%	58	0.7

FIGURES

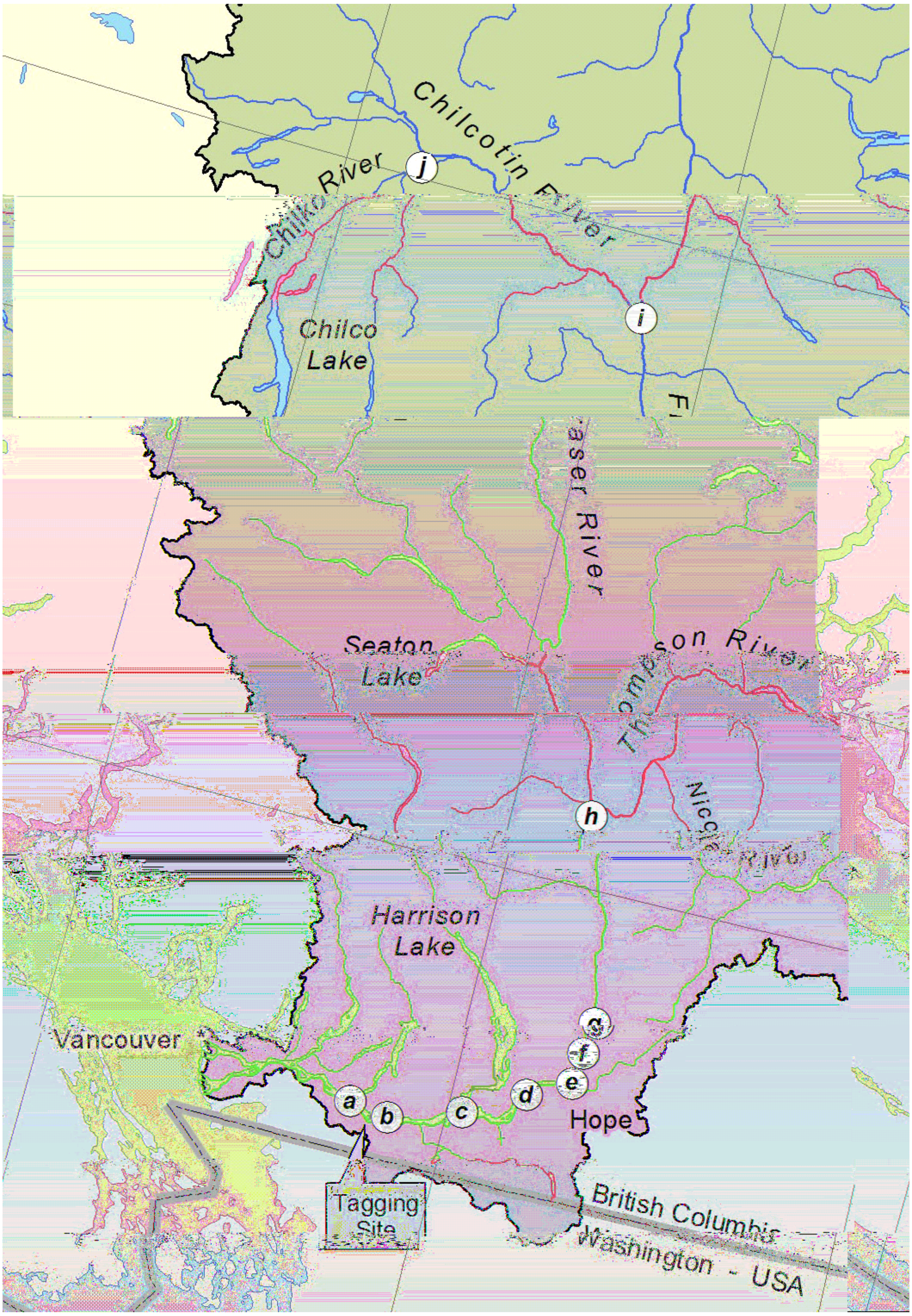


Figure 1. Location of release and fixed-station sites for the 2008 radio-telemetry study. ***a: Crescent Island; b: Mission (north and south); c: Harrison junction; d: Rosedale; e: Hope; f: Qualark Creek (2 aerial & 2 underwater stations); g: Sawmill Creek; h: Thompson confluence; i: Chilcotin confluence; j: Chilko River.***

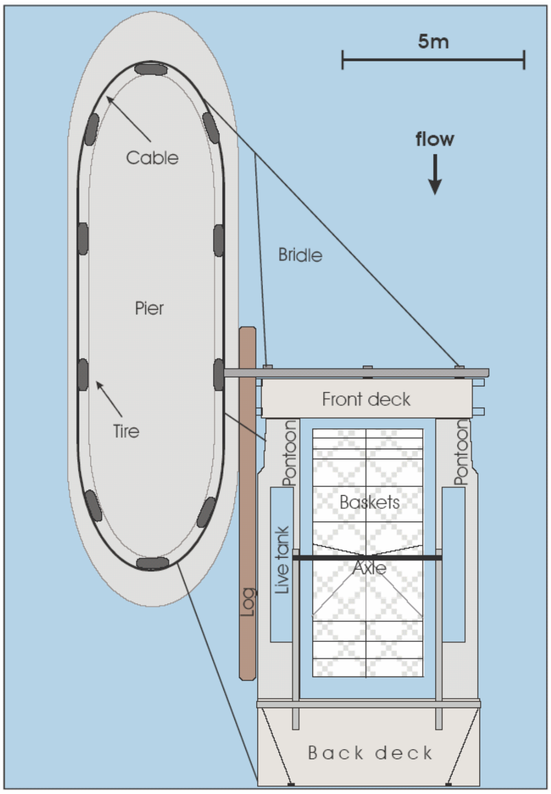


Figure 2. Schematic (top view) of a large, aluminum fishwheel attached to a concrete support pier at the Mission Railway Bridge on the Fraser River, 2008

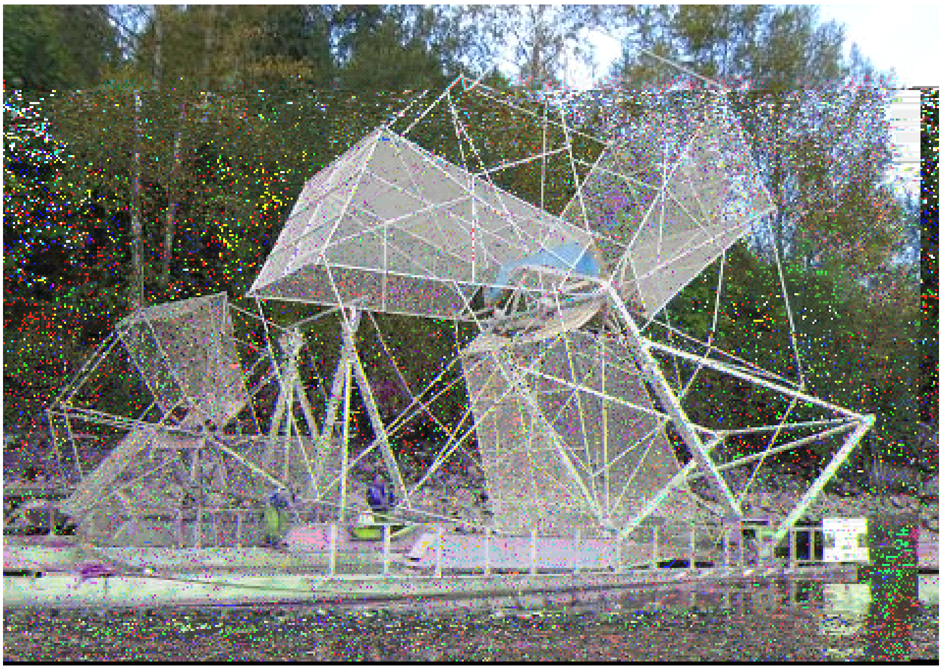


Figure 3. Side view of the large and small fishwheels at the Crescent site with their basket assemblies lifted out of the water.

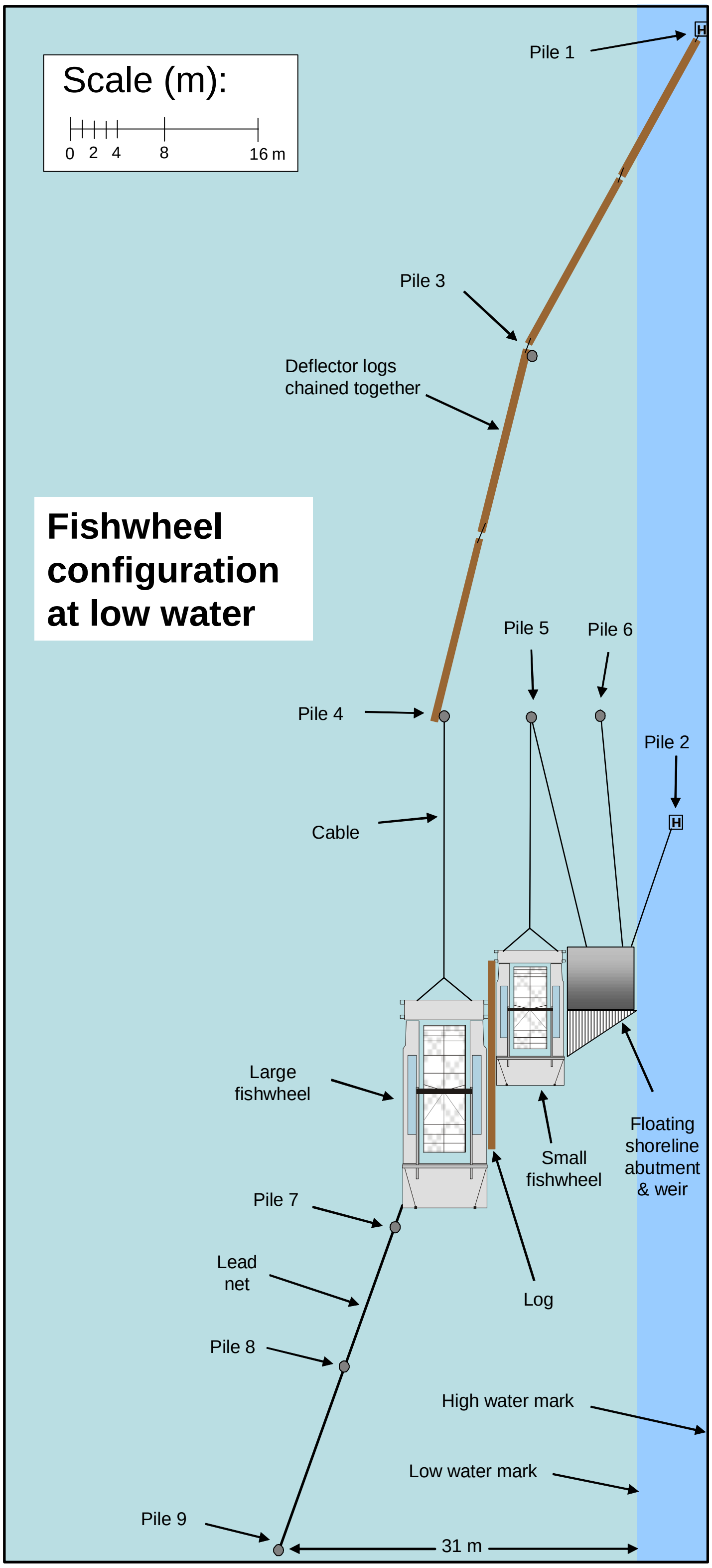


Figure 4. **Schematic of the Crescent site showing the proposed locations for the pilings, fishwheels, floating shoreline abutment, deflector logs and barrier net.**

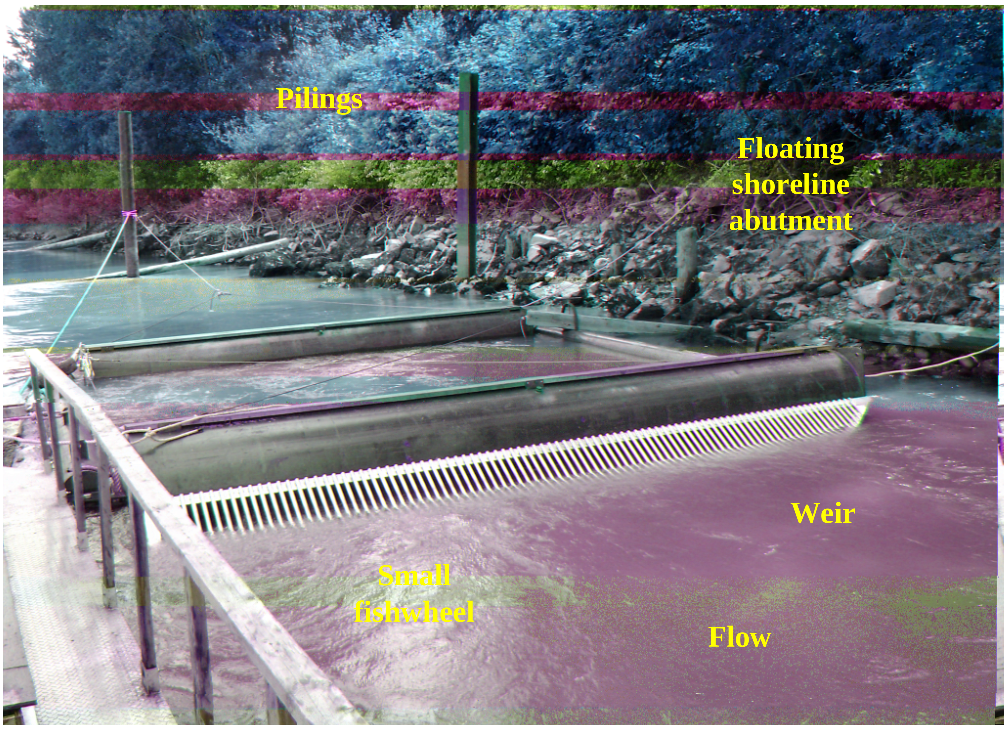


Figure 5. Floating shoreline abutment and weir at the Crescent fishwheel site, 7 July 2008.

Figure 6. Photo showing DIDSON ladder mount positioned just off shore and downstream of the large fishwheel near Crescent Island.

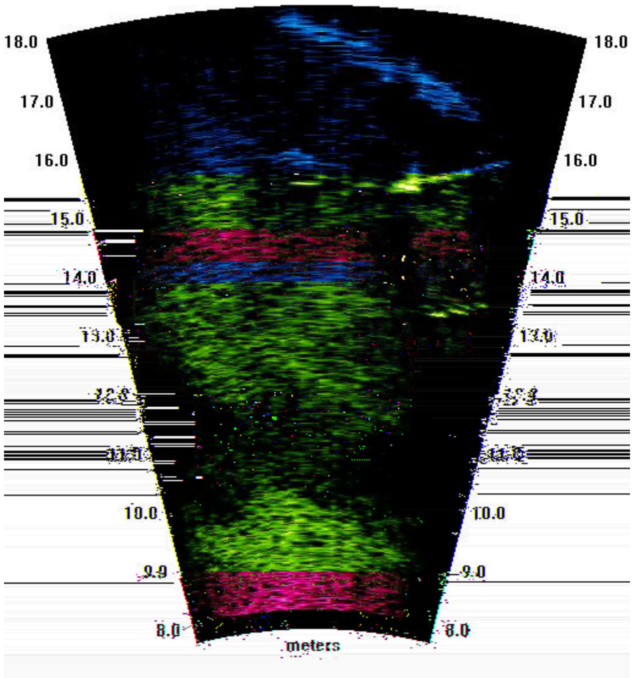


Figure 7. **Still frame of DIDSON imagery showing the outline of a basket from the Crescent Island large fishwheel. Flow is from right to left. For sampling fish approach behaviour to the large fishwheel, we rotated the field-of-view slightly downstream to maximize the area sampled prior to fish encountering the fishwheel.**

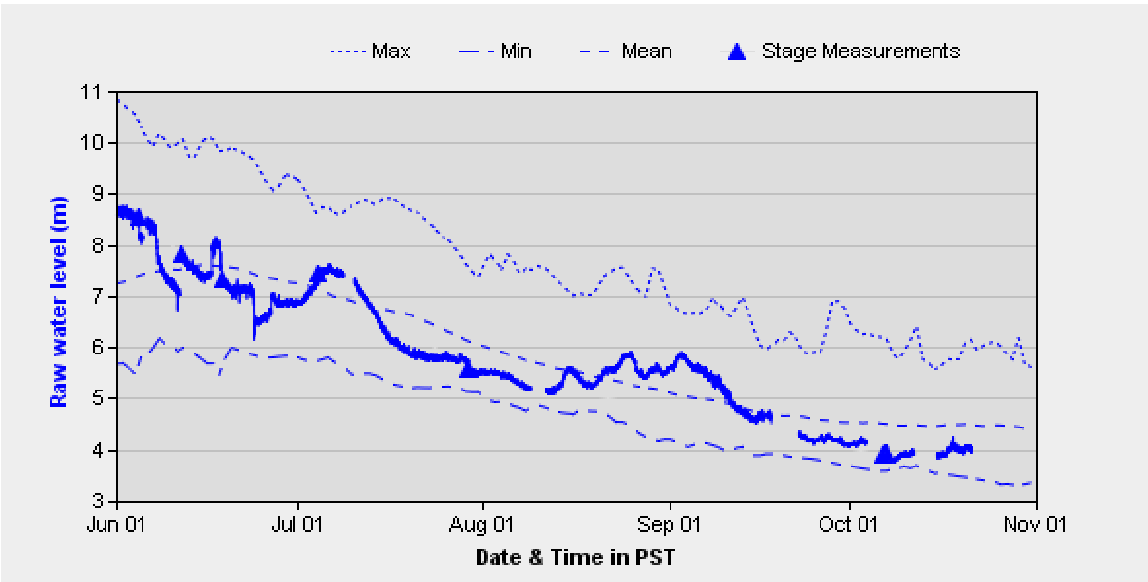


Figure 8. **Fraser River water level (m) measured at the hydrometric station (08MF005) in Hope, BC from 1 June to 31 October 2008. Also shown are the historical mean, minimum, and maximum values (Environment Canada 2009).**

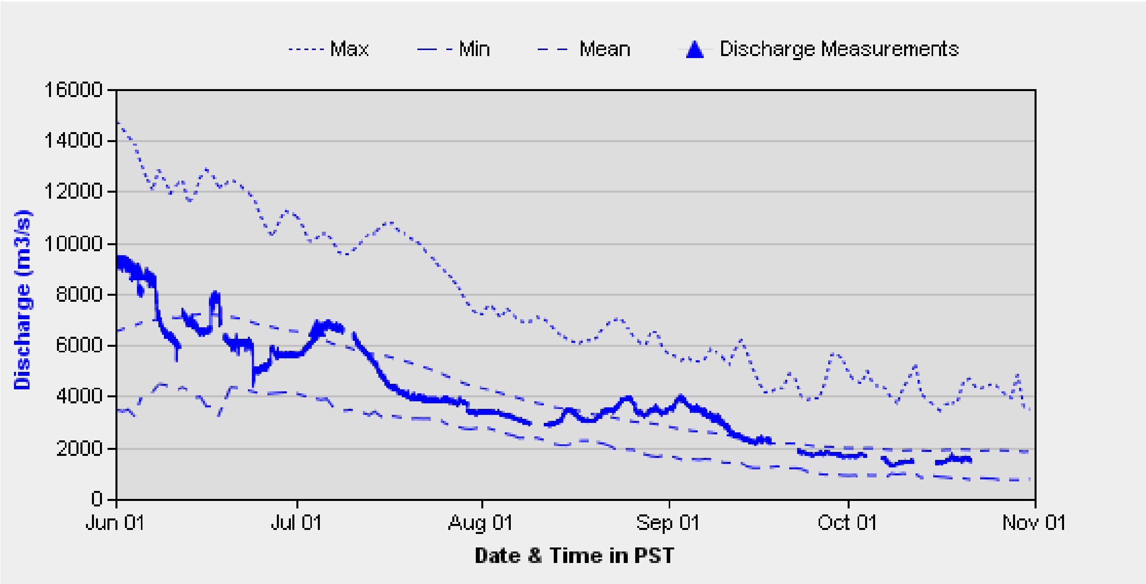


Figure 9. Fraser River discharge ($m^3 \cdot s^{-1}$) measured at the hydrometric station (08MF005) in Hope, BC from 1 June to 31 October 2008 (Environment Canada 2009). Also shown are the historical mean, minimum, and maximum values (Environment Canada 2009).

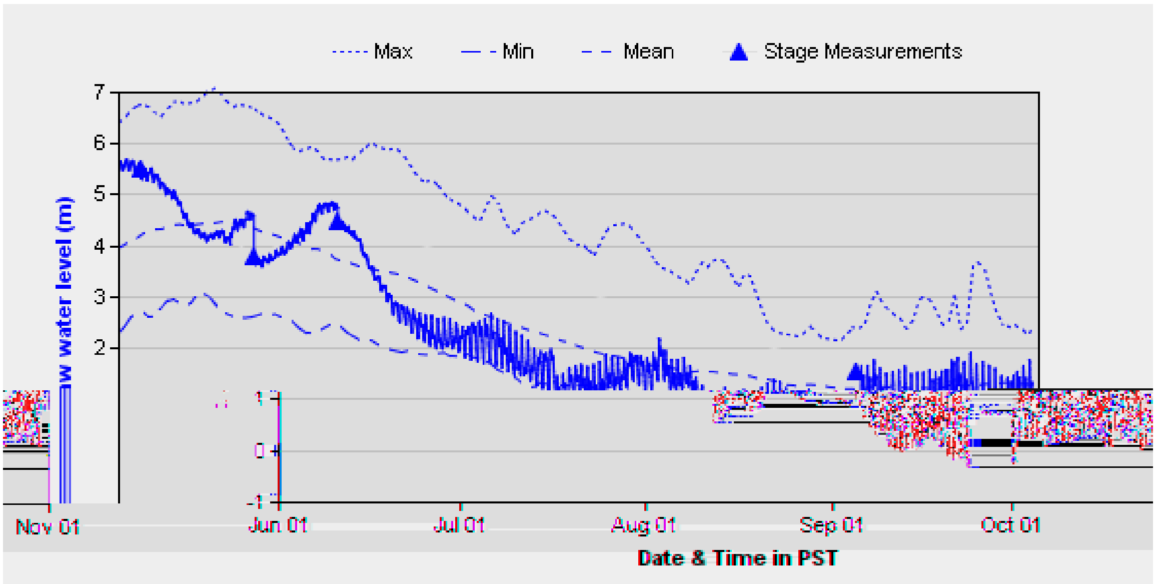


Figure 10. Fraser River water levels (m) measured at the hydrometric station (08MH024) in Mission, BC from 1 June to 31 October 2008. Also shown are the historical mean, minimum, and maximum values (Environment Canada 2009).

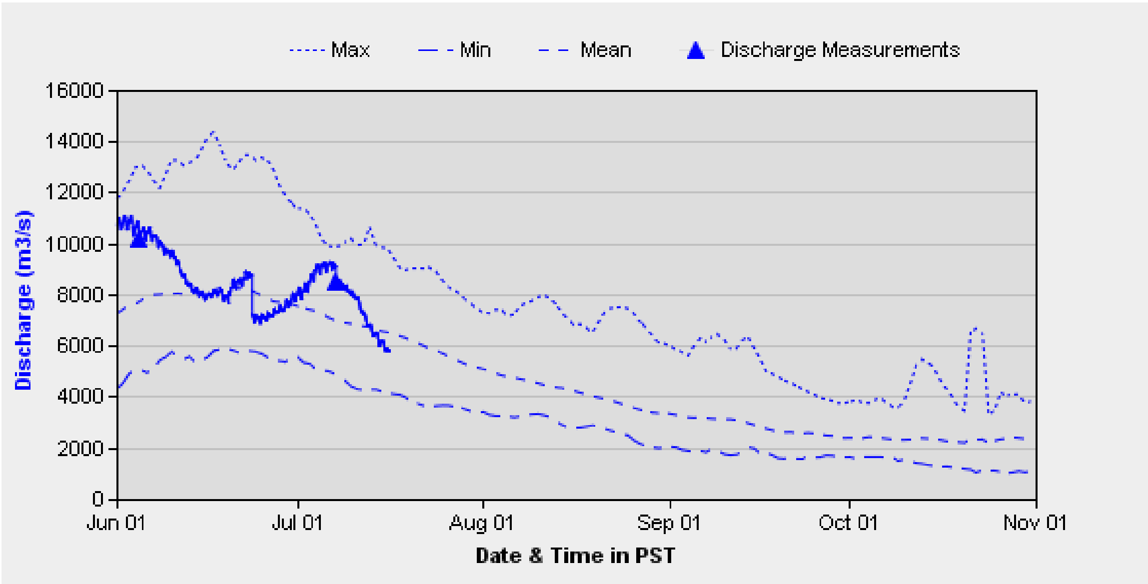


Figure 11. **Fraser River discharge (m^3s^{-1}) measured at the hydrometric station (08MH024) in Mission, BC from 1 June to 31 October 2008. Also shown are the historical mean, minimum, and maximum values (Environment Canada 2009).**

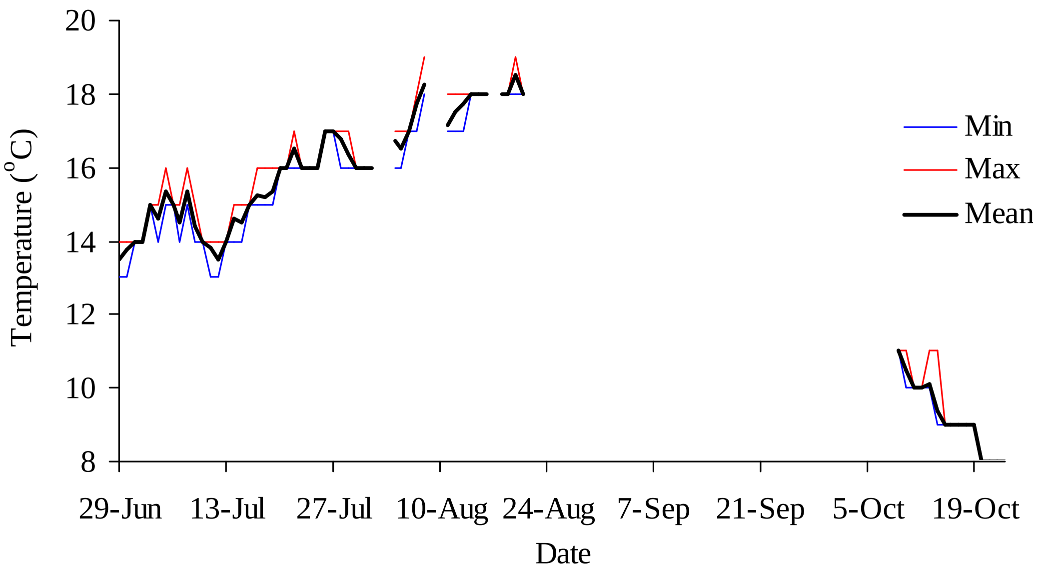


Figure 12. **Fraser River water temperatures (°C) measured at Mission Railway Bridge and Crescent fishwheel sites, 29 June to 23 October 2008.**

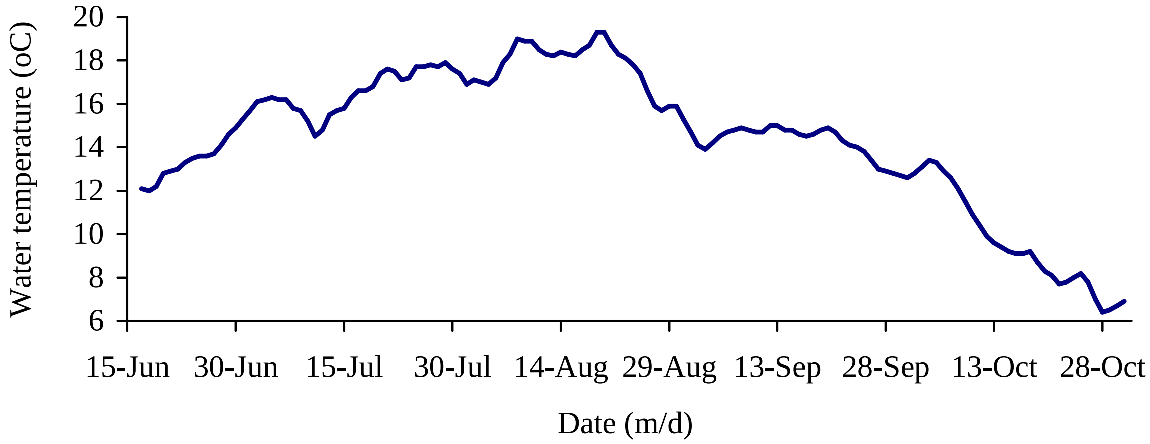


Figure 13. Fraser River water temperature (°C) measured at Qualark Creek from 17 June to 31October 2008 (D. Patterson, SFU, pers. comm.).

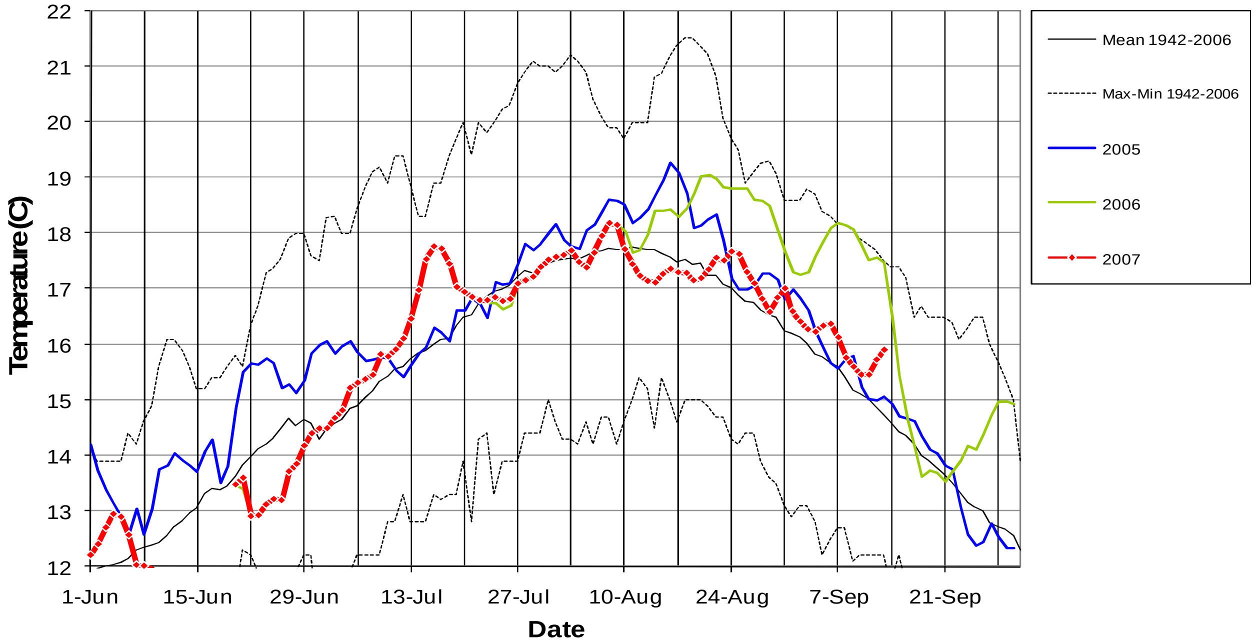


Figure 14. Fraser River water temperature (°C) measured at Qualark Creek from 1 June to 31October in 2005, 2006 and 2007. The mean, minimum, and maximum values observed from 1942-2006 are also shown (D. Patterson, SFU, pers. comm.).

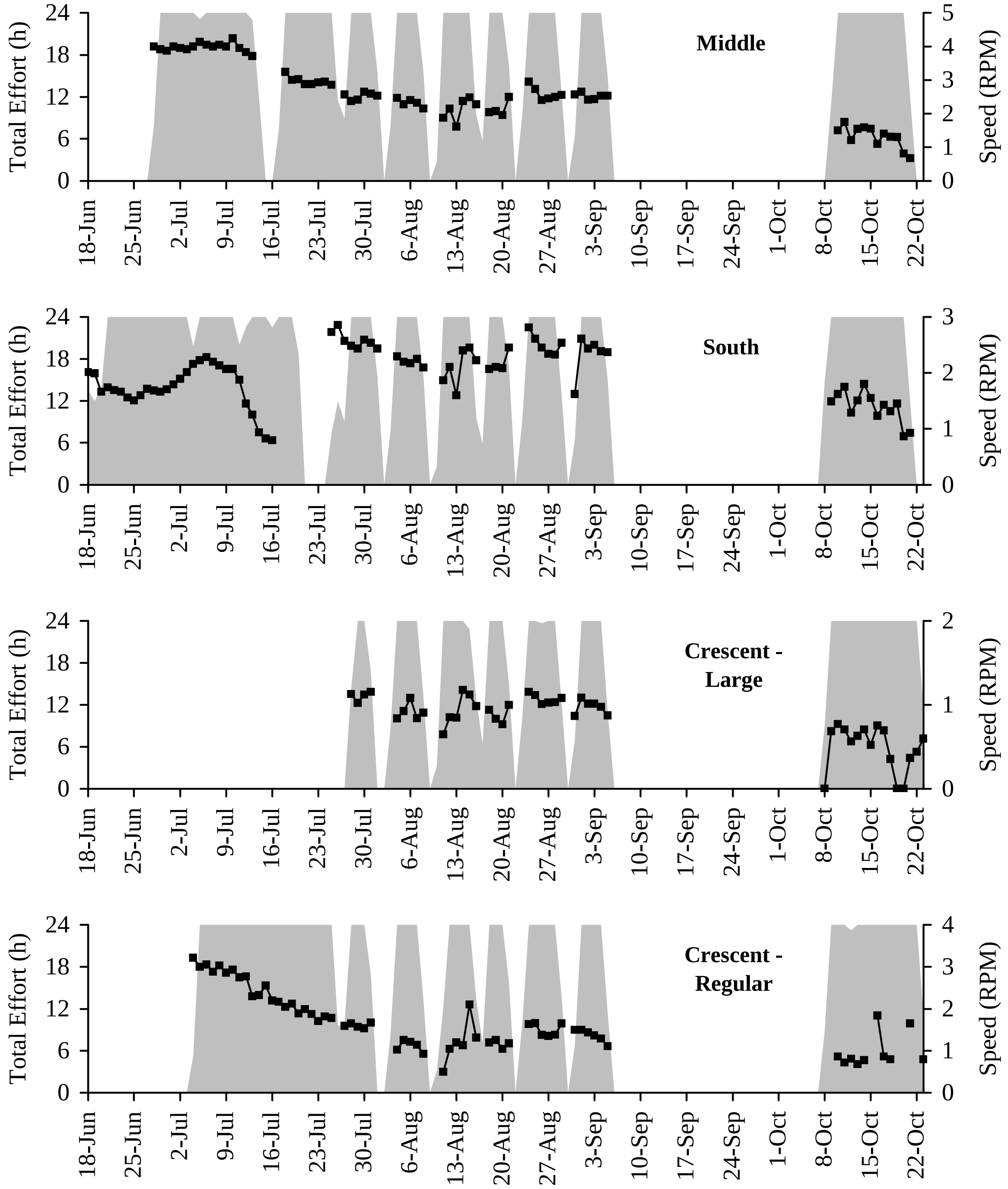


Figure 15. Total effort (h) and speed (RPM) for fishwheels operated at Mission Railway Bridge (Mission Middle and Mission South) and Crescent Island site (Crescent Large and Crescent Regular) in 2008.

Figure 16. Photo of the Mission-South fishwheel operating adjacent to the first pier of the Mission Railway Bridge, 18 June 2008.

Figure 17. Photo of the Crescent site showing the position of the floating shoreline abutment, and both Crescent-Regular and Crescent-Large fishwheels, 6 August 2008.

Figure 18. Photo of the Crescent site showing the position of the floating shoreline abutment, fishwheels, and barrier net (attached to the orange float in the background), 8 October 2008.

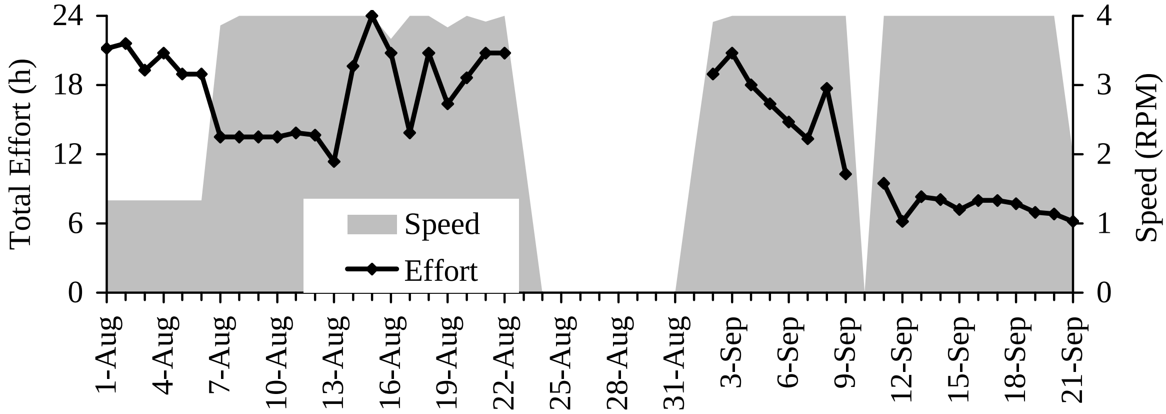


Figure 19. Total effort (h) and speed (RPM) for the Siska fishwheel operated in the Fraser Canyon near Frenchman's Bar, 2008.

Figure 20. Photo of the Siska fishwheel operating along the left bank of the Fraser River in the Fraser Canyon near Frenchman's Bar, 1 August 2008.

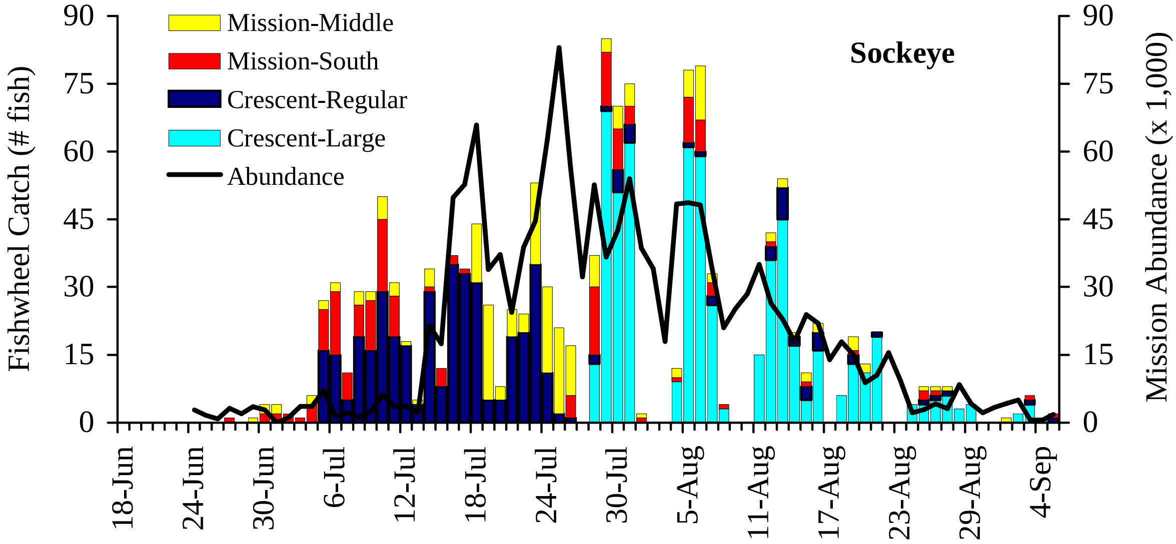


Figure 21. Daily sockeye abundance estimates at the Mission hydroacoustic site and sockeye catches for the four fishwheels operated in the lower Fraser River, 2008.

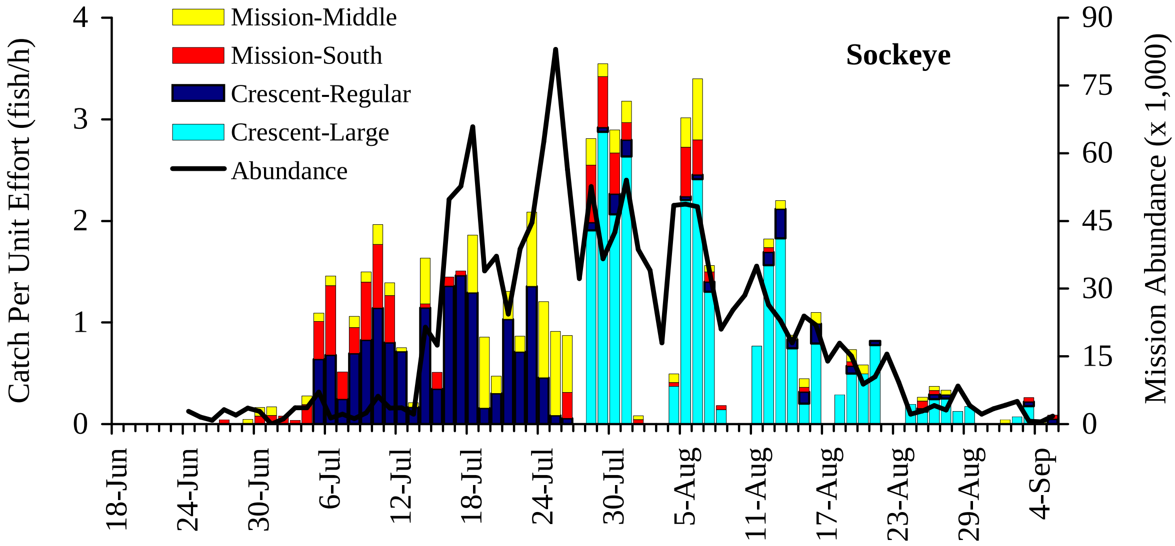
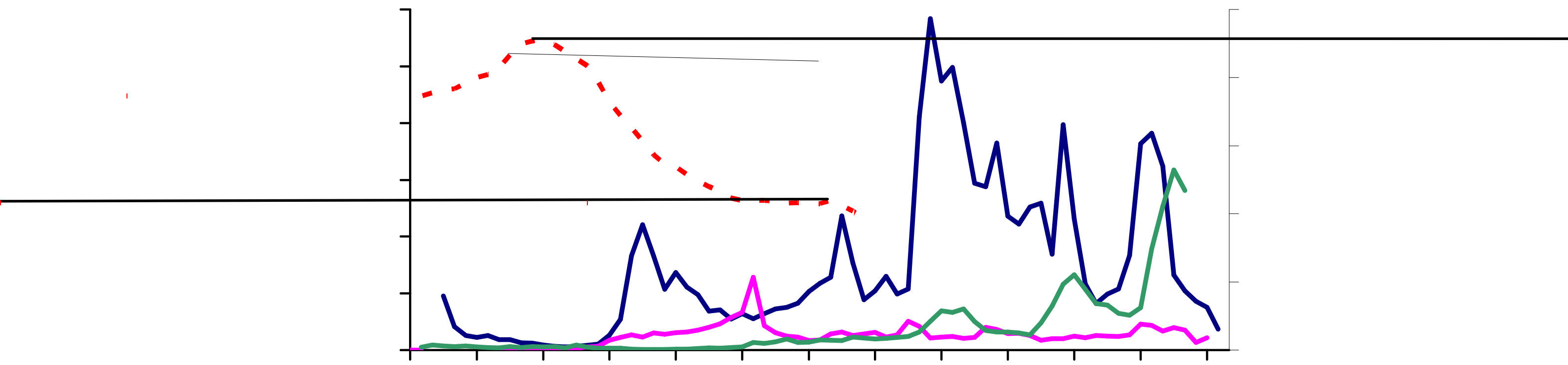


Figure 22. **Daily sockeye abundance estimates at the Mission hydroacoustic site and sockeye catch per unit effort (CPUE) for four fishwheels operated in the lower Fraser River, 2008.**



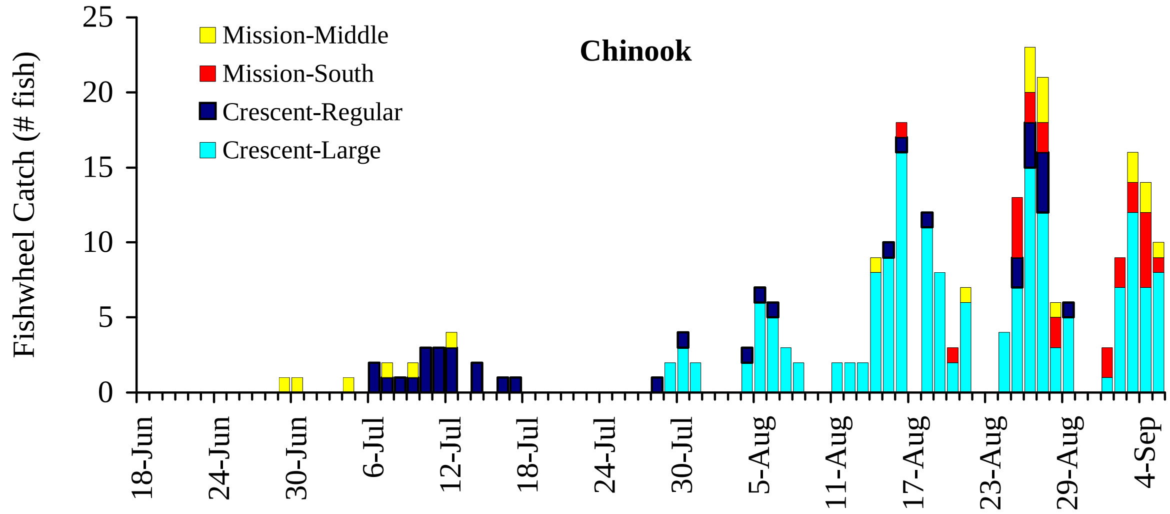


Figure 24. Daily Chinook catches for the four fishwheels operated in the lower Fraser River, 2008.

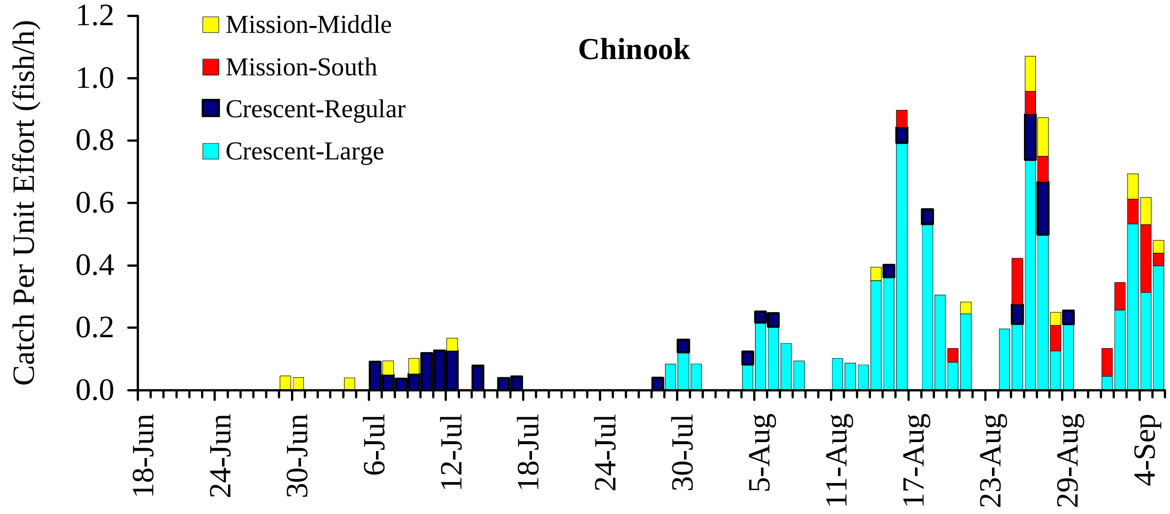


Figure 25. Daily Chinook catch per unit effort (CPUE) for the four fishwheels operated in the lower Fraser River, 2008.

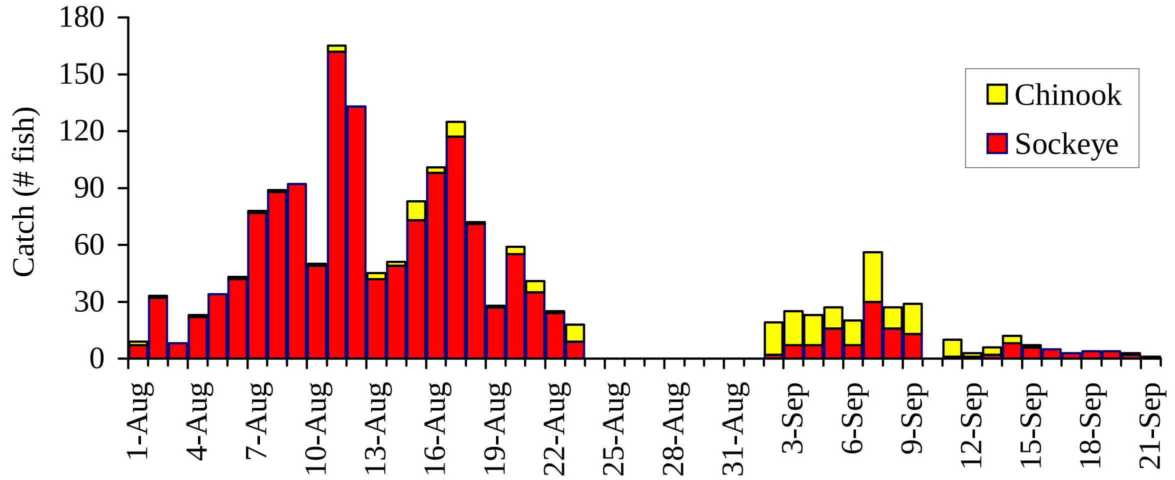


Figure 26. Daily catch of adult sockeye and Chinook salmon (excluding jacks) at the Siska fishwheel, 2008.

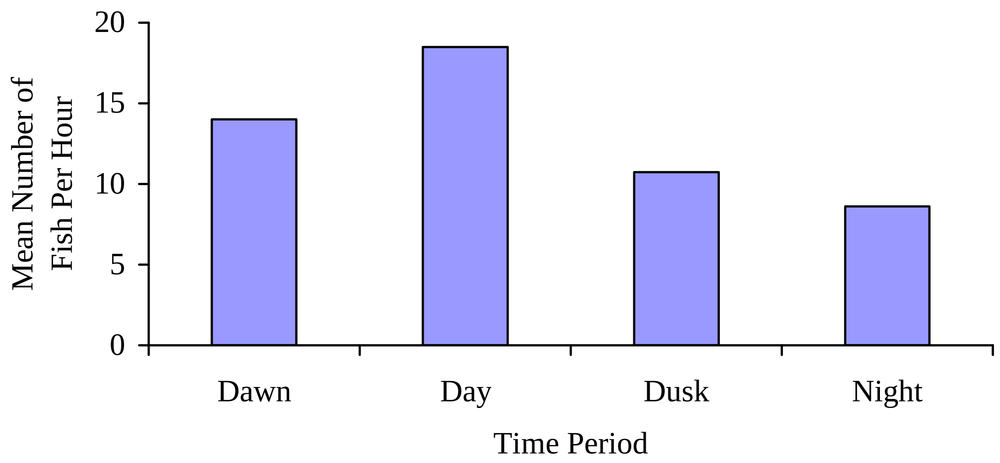


Figure 27. Mean number of fish per hour, by time period, observed with DIDSON at the Crescent-Large fishwheel, 10-12 August 2008.

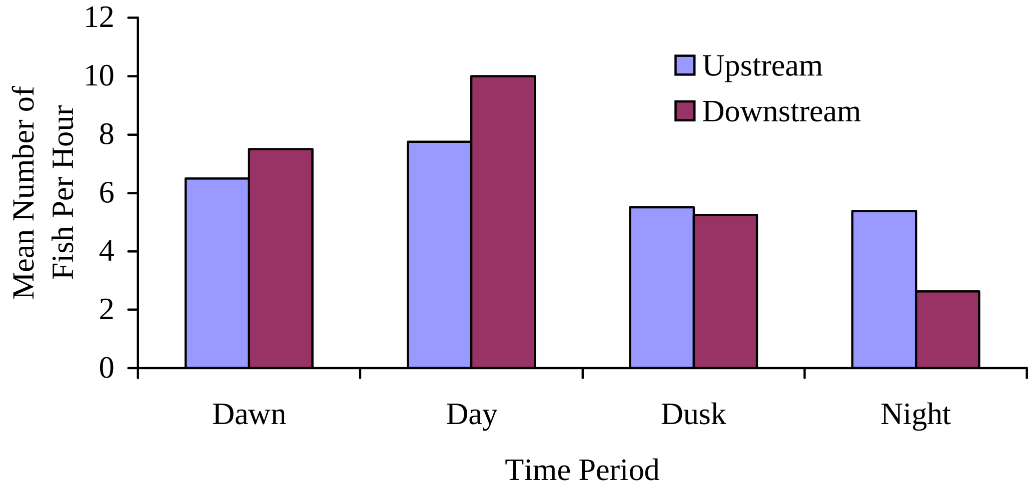


Figure 28. Net directional movement and mean number of fish per hour, by time period, observed with DIDSON at the Crescent-Large fishwheel, 10-12 August 2008.

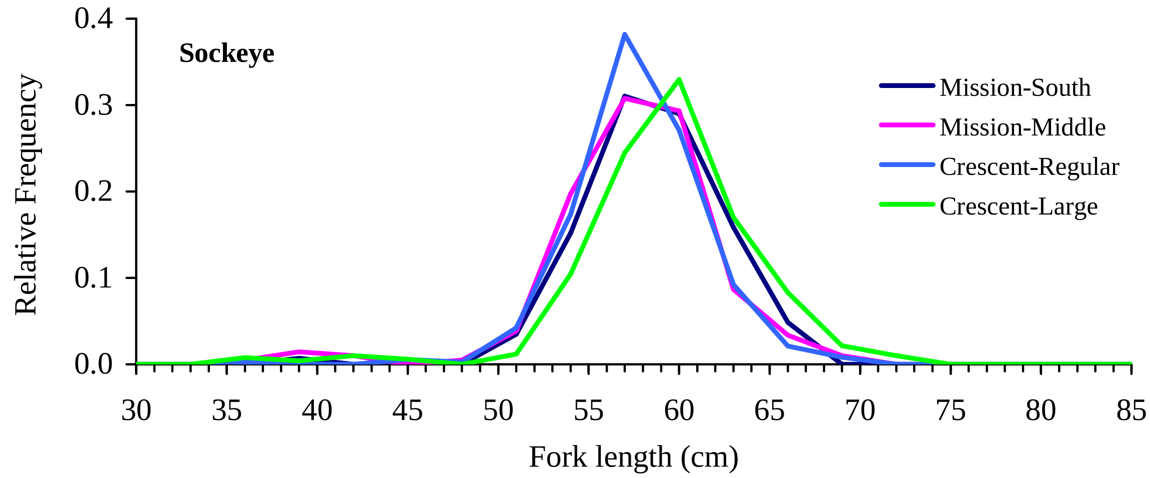


Figure 29. The relative length-frequency distributions of sockeye salmon caught in the four fishwheels in the lower Fraser River, 2008.

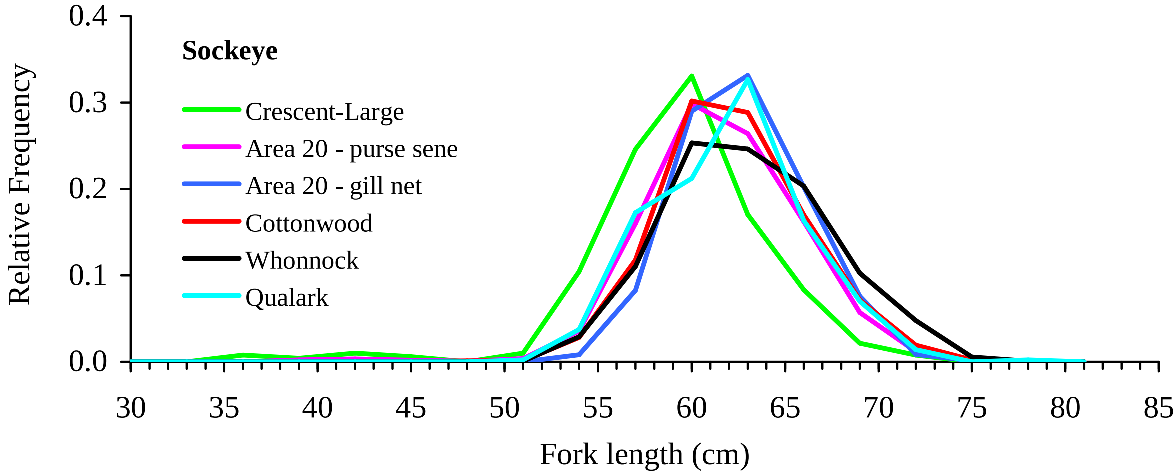


Figure 30. The relative length-frequency distributions of sockeye salmon caught in the Crescent-Large fishwheel, Area 20 purse-seine test fishery, and the Area 20, Cottonwood, Whonnock, and Qualark gillnet test fisheries, 2008.

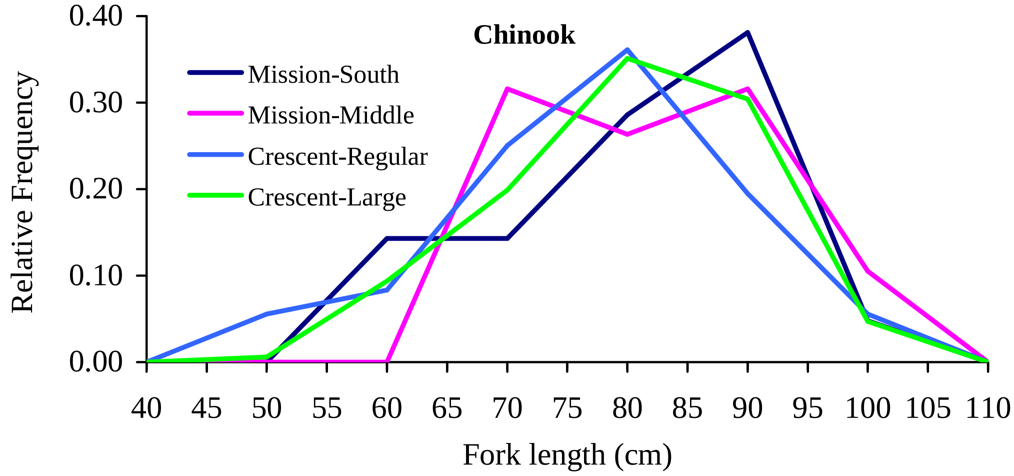


Figure 31. The relative length-frequency distributions of Chinook salmon measuring 50 cm or longer that were caught at four fishwheels in the lower Fraser River, 2008.

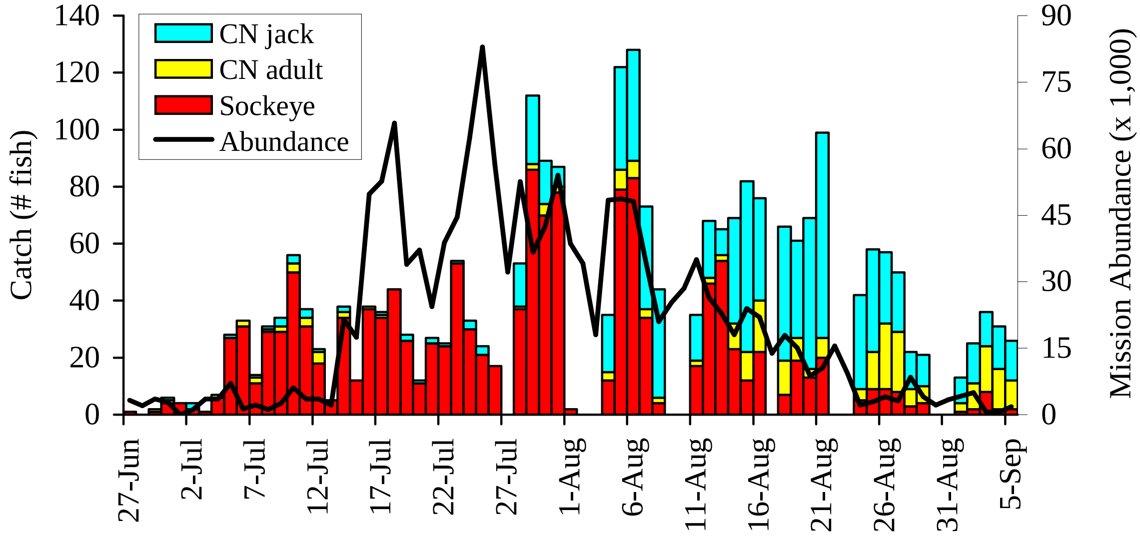


Figure 32. Daily sockeye abundance estimates at the Mission hydroacoustic site and catches of sockeye, adult Chinook (FL ≥ 50 cm), and jack Chinook (FL < 50 cm) salmon at the four fishwheels in the lower Fraser River, 2008.

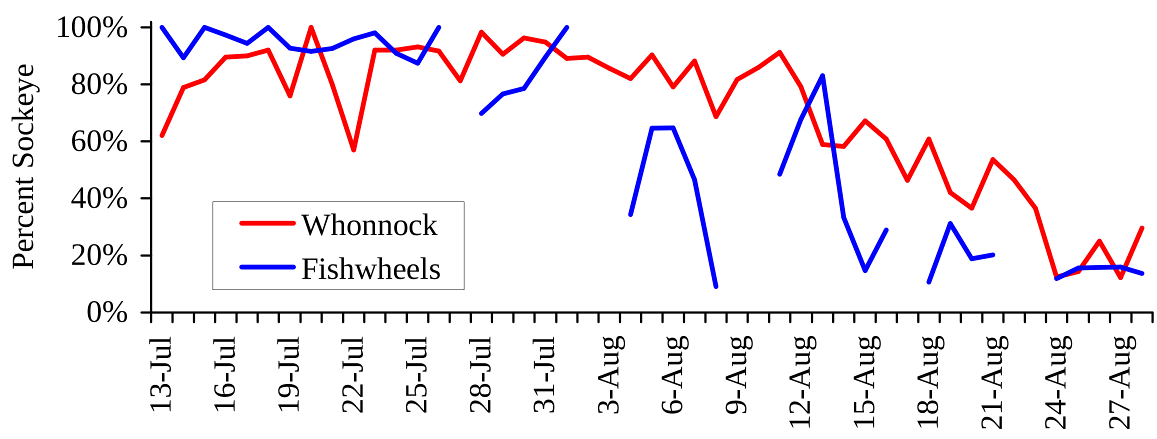


Figure 33. Percentage of catch at the lower-river fishwheels and in the Whonnock gillnet test fishery that was comprised of sockeye salmon (remainder are Chinook), 2008.

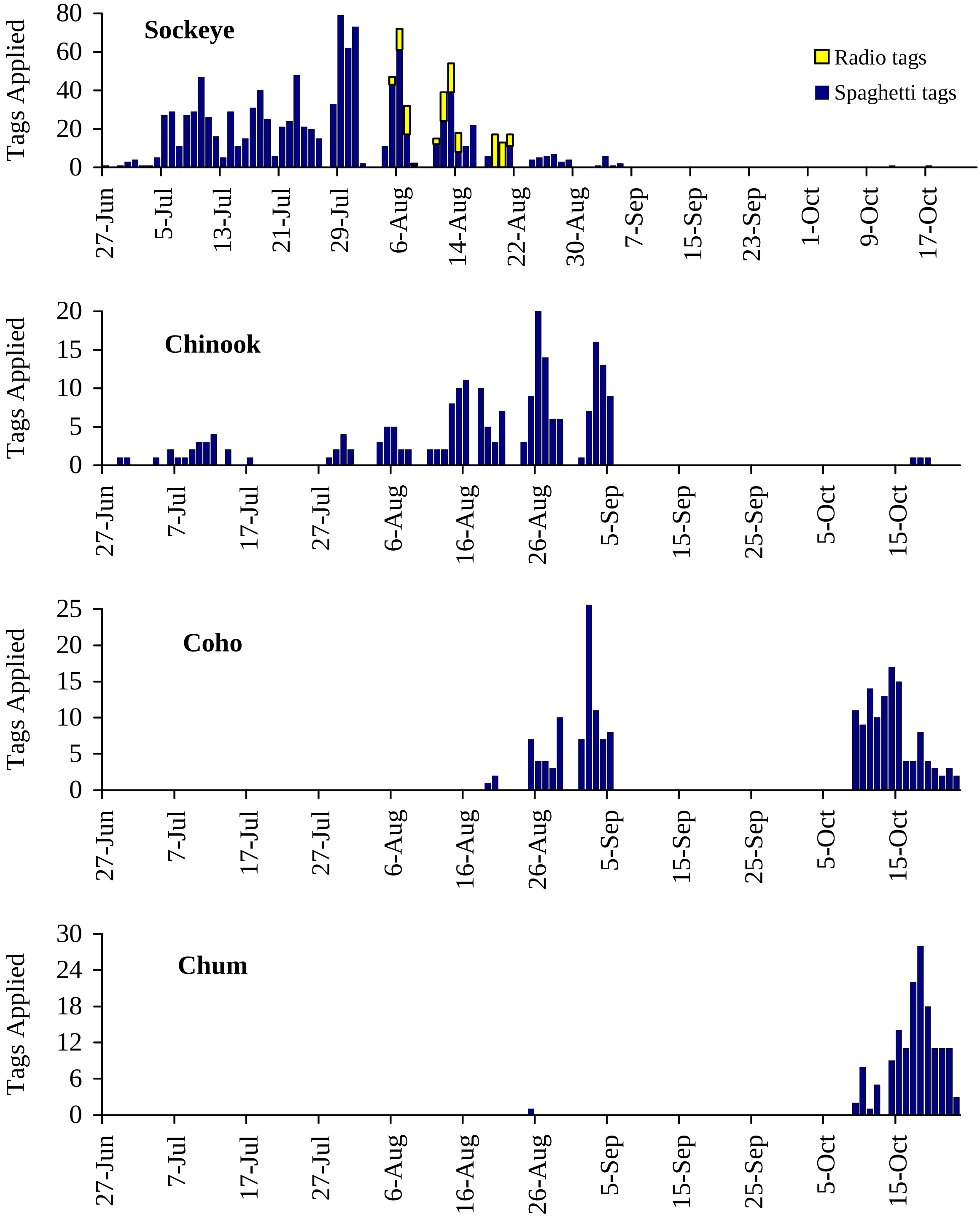


Figure 34. Number of sockeye, Chinook, coho, and chum salmon tagged at four fishwheels operated in the lower Fraser River, 2008.

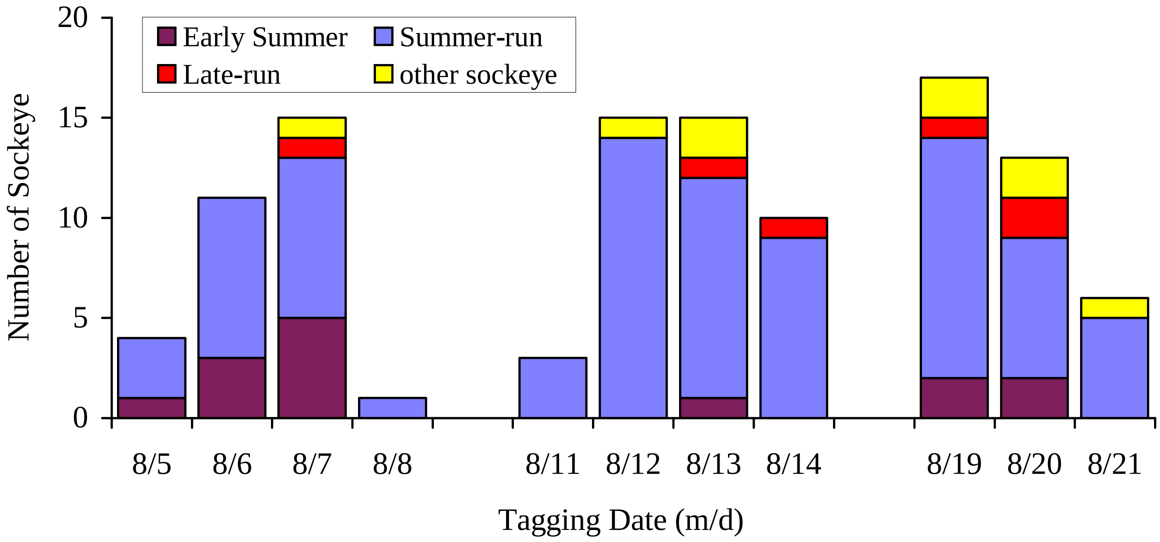


Figure 35. Stock composition of sockeye salmon radio-tagged in 2008, by tagging date.

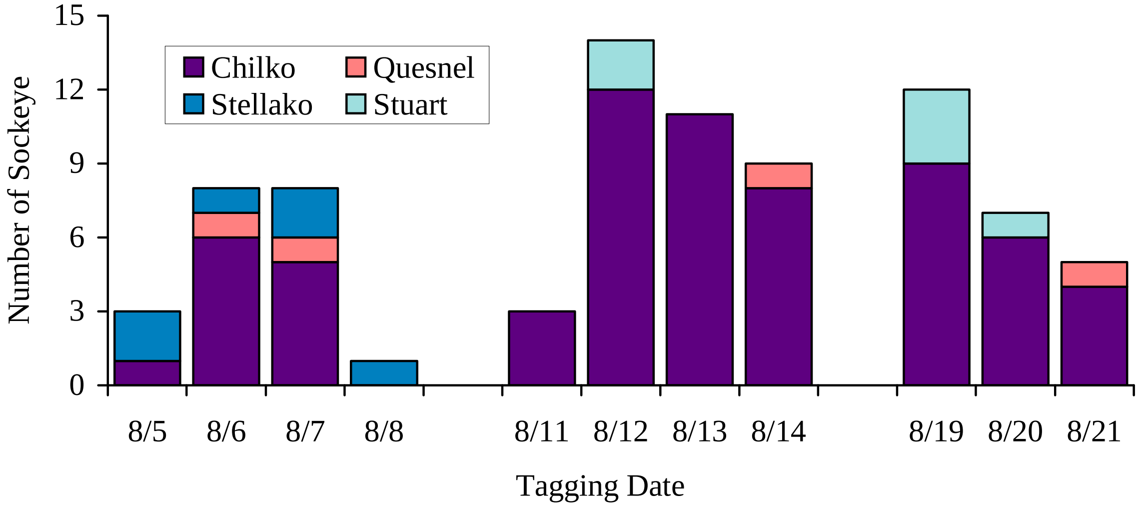


Figure 36. Stock composition of Summer-run sockeye salmon radio-tagged in 2008, by tag date.

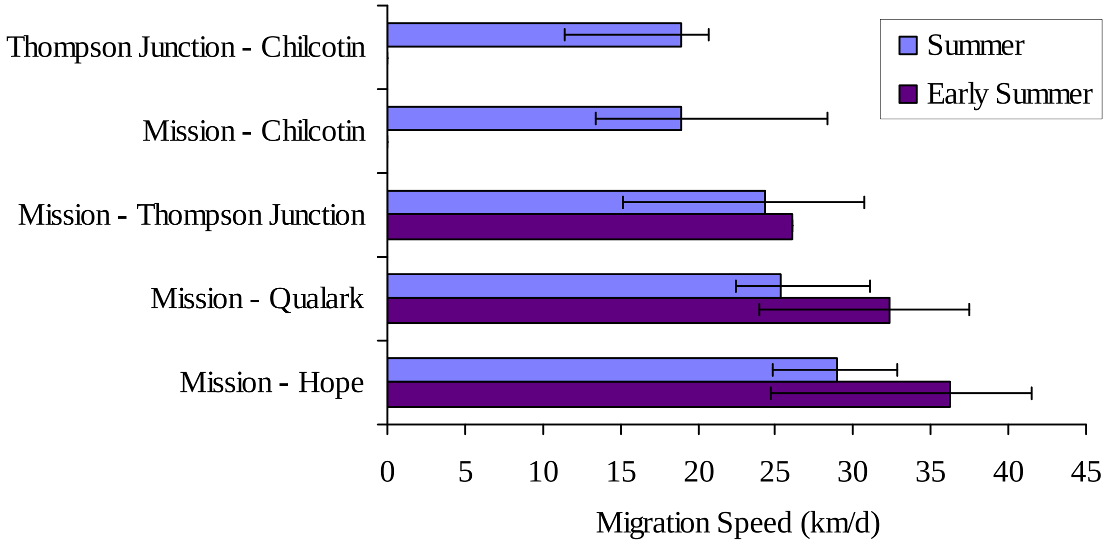


Figure 37. Migration speeds in several Fraser river reaches for radio-tagged Early-summer and Summer-run sockeye in 2008. Error bars represent 95% confidence in the median value (generated using the method recommended in Zar, 1984). Statistical comparisons (see text) were done using non-parametric Kruskal Wallis tests; overlapping error bars do not preclude statistical significance.

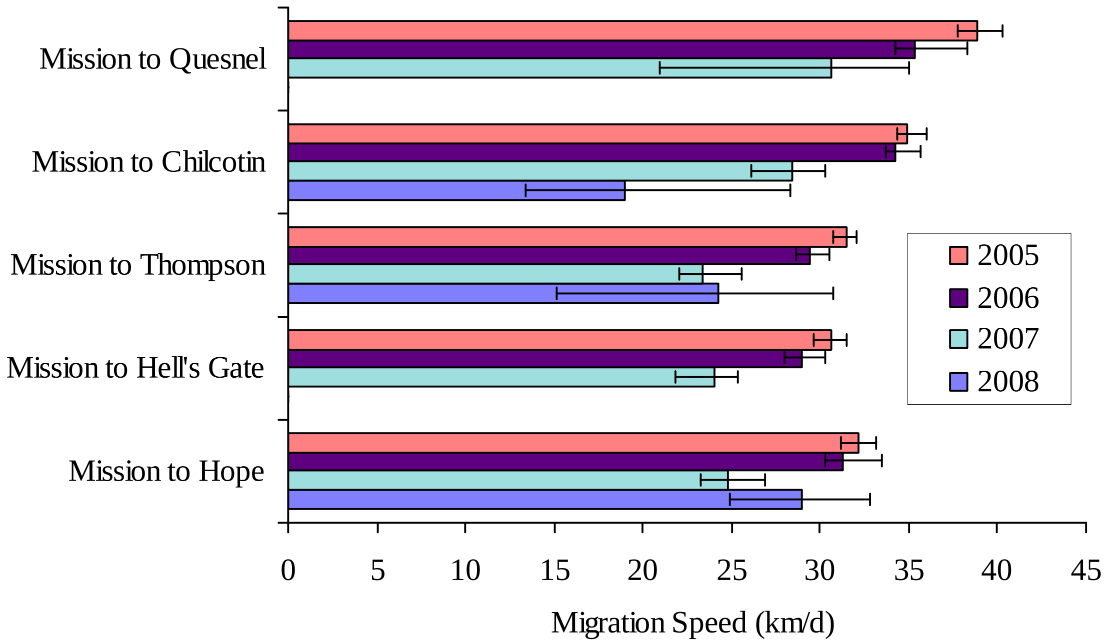


Figure 38. Migration speeds from Mission to several Fraser River destinations for radio-tagged Summer-run sockeye, 2005-2008. Error bars represent 95% confidence in the median value (generated using the method recommended in Zar, 1984). Statistical comparisons (see text) were done using non-parametric Kruskal Wallis tests; overlapping error bars do not preclude statistical significance.

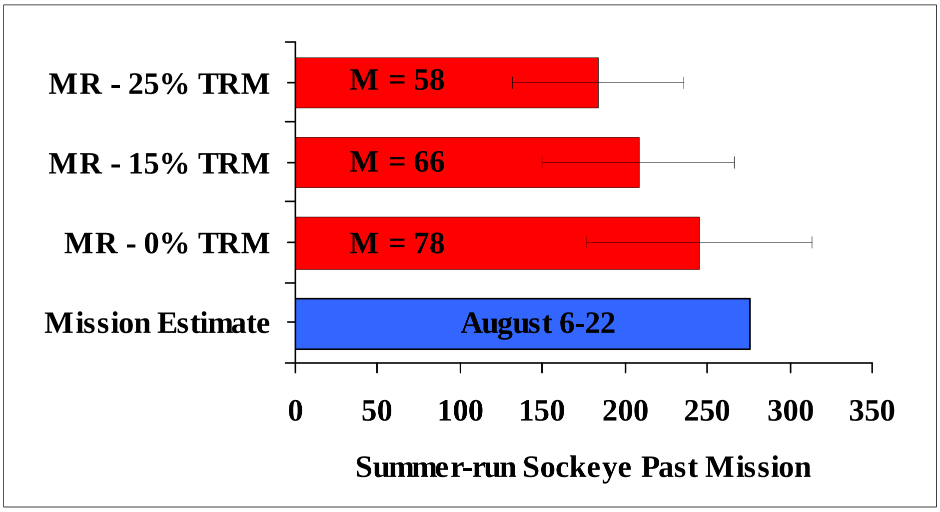


Figure 39. **Estimates of the number of sockeye that passed Mission from 6-22 August 2008 derived using different assumptions regarding tagging related mortality (TRM) and mark-rate samples from the Qualark receivers and hydroacoustic site..**

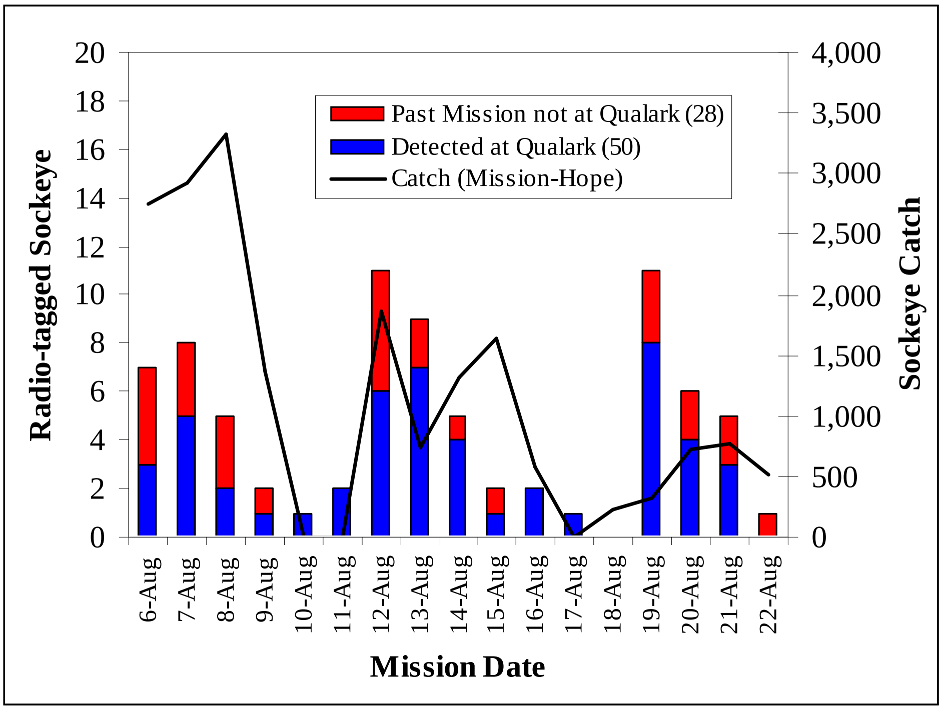


Figure 40. **Timing of Mission passage for the 50 radio-tagged sockeye detected at Qualark and 28 radio-tagged sockeye detected at Mission but not at Qualark.**

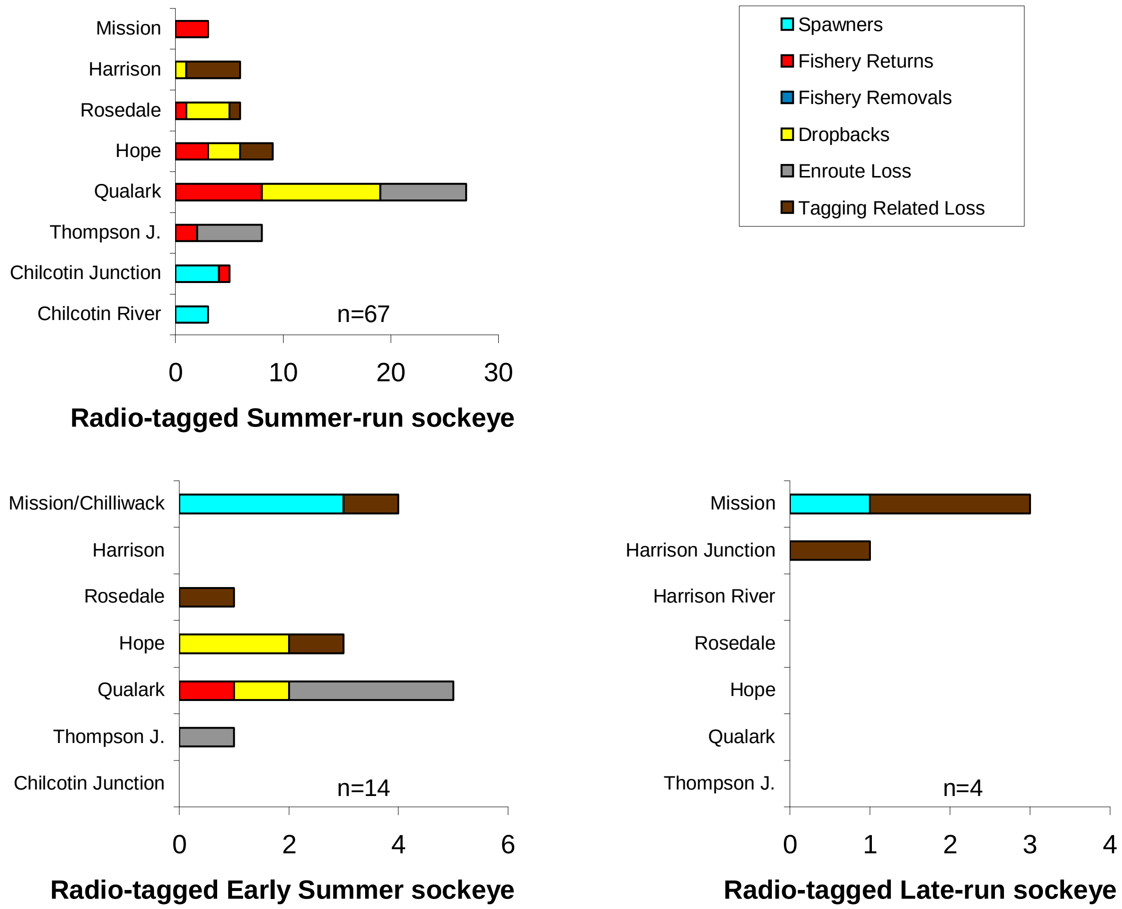


Figure 41. Fate of radio-tagged sockeye, by zone of last detection and by run-timing group, 2008. Fishery removals were assigned to zones proportionally to fishery returns. Tagging related losses were assigned to zones proportionally to last (non-fishery) detections downstream of Sawmill.

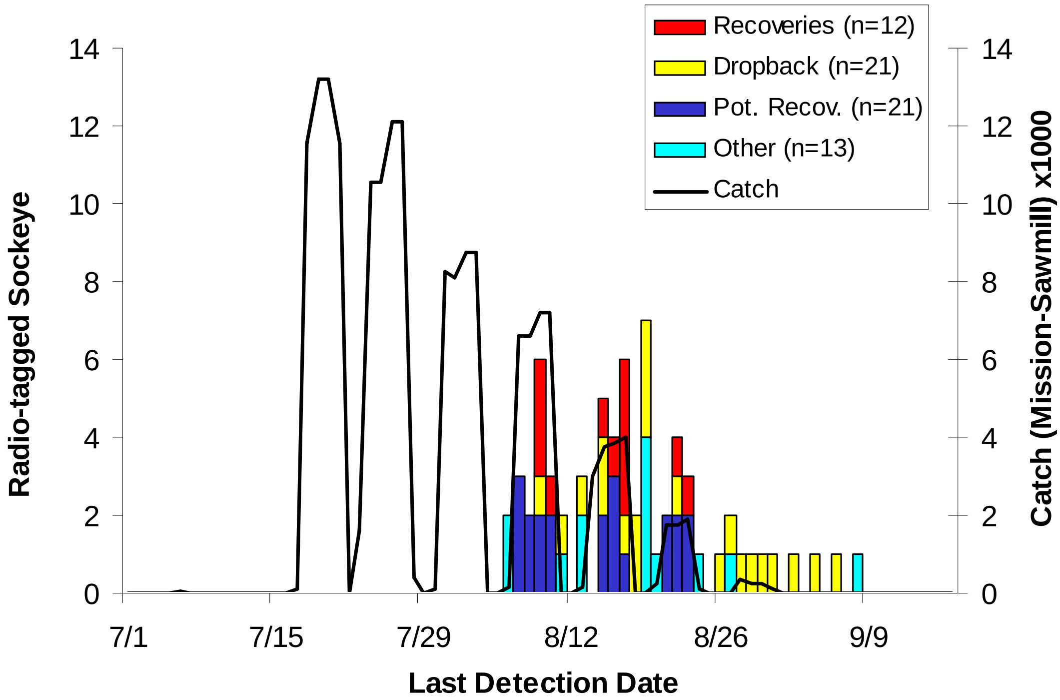


Figure 42. Date of last detection for radio-tagged sockeye that were lost downstream of Sawmill Creek, by fate. "Other" fish were not recoveries and had not dropped back. "Other" fish that were last detected during fishery openings have been coded as "potential recoveries."

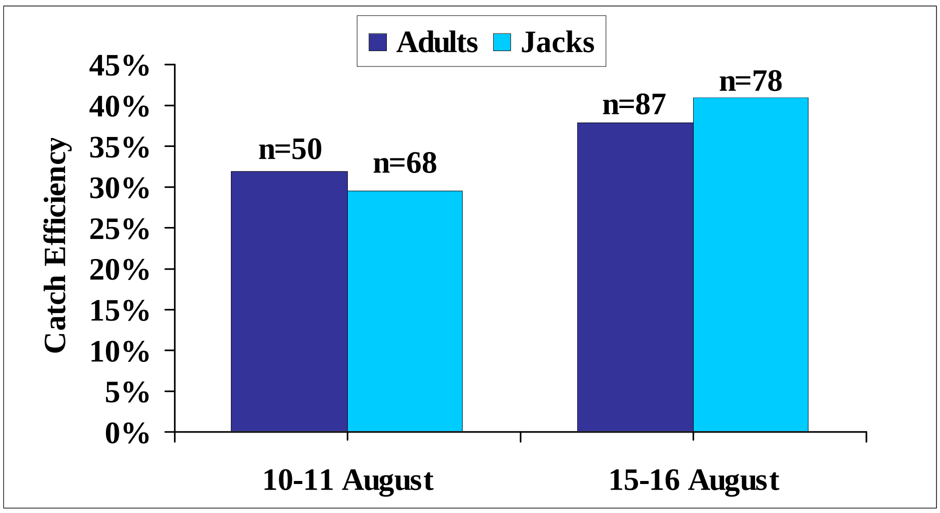


Figure 43. Estimated capture efficiency of the large Crescent Island fishwheel for adult sockeye and Chinook salmon and jack Chinook that passed through the DIDSON sampling area during the overnight periods on 10-11 August and 15-16 August 2008.

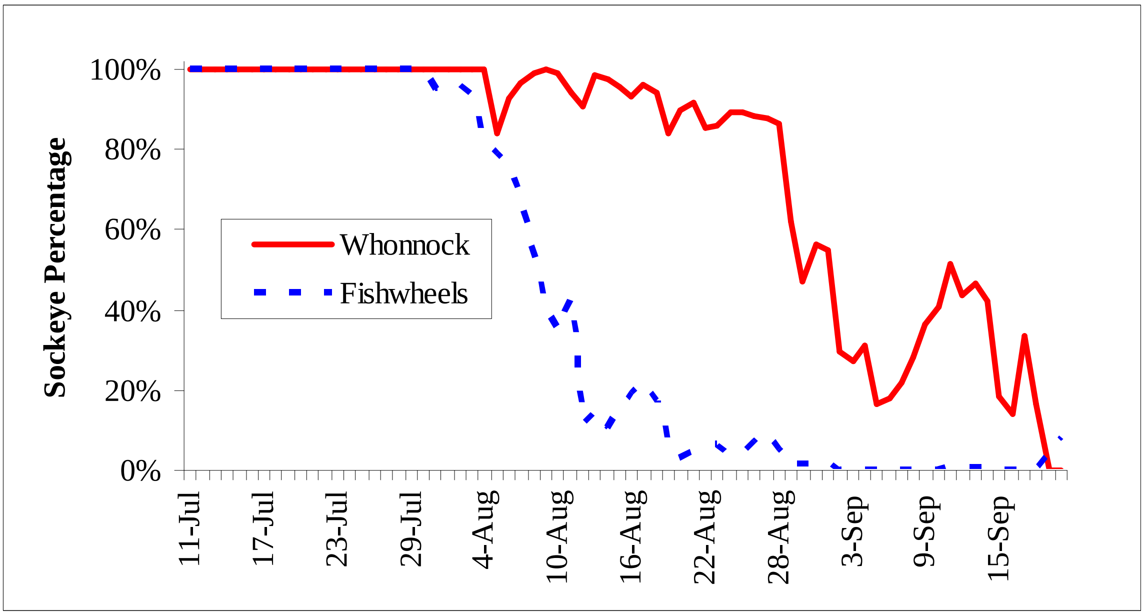
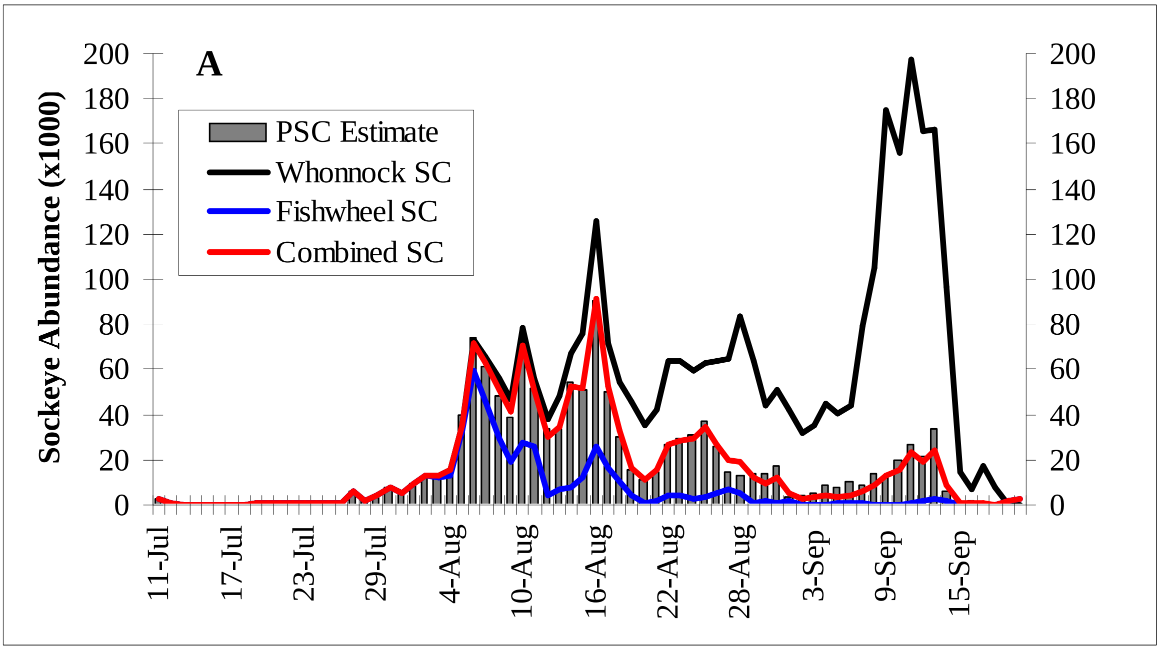


Figure 44. Sockeye percentage of the daily salmon catch for the Whonnock test fishery and Mission fishwheels, 11 July – 20 September 2007.



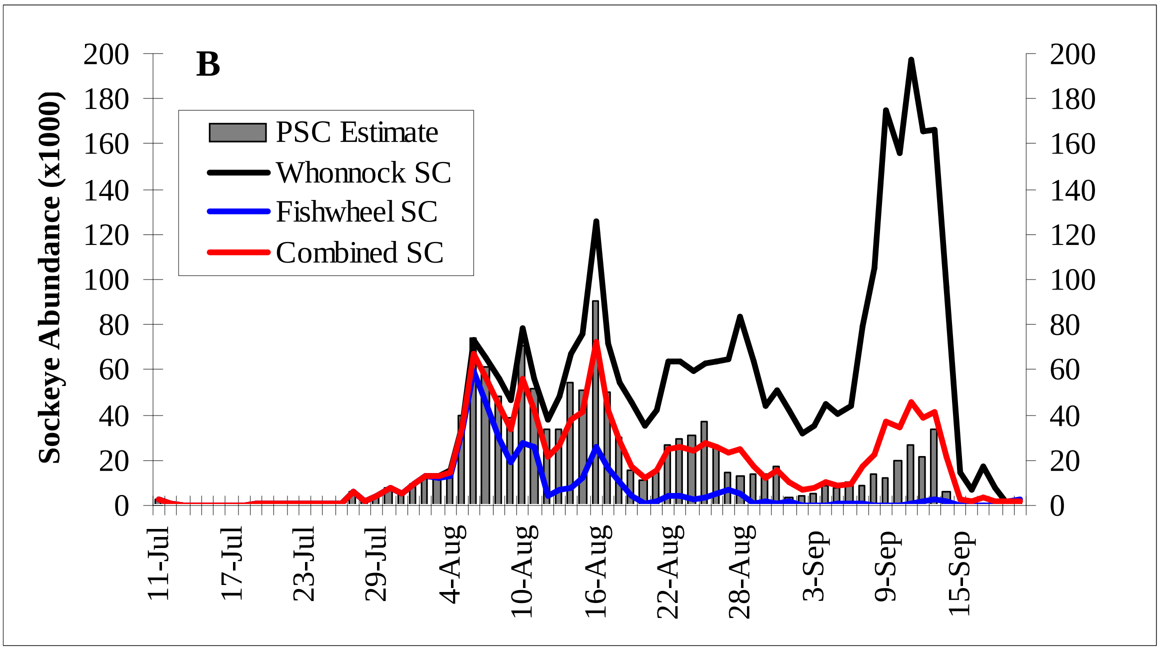


Figure 45. Comparison of the PSC estimates of daily sockeye passage with those estimated using the total Mission hydroacoustic counts and three alternative species composition (SC) estimates: 1) Whonnock SC only, 2) fishwheel SC only and 3) Whonnock SC for off-shore and fishwheel SC for near-shore. The two graphs are based on two different distributions of sockeye and pink salmon (A - 95% of sockeye migrating off-shore, 95% of pink salmon migrating near-shore; B – 60% of sockeye migrating off-shore, 80% of pink salmon migrating near-shore).

APPENDICIES

APPENDIX A

Fixed-station Receiver Locations and Performance

APPENDIX REPORT A

Description of fixed-station receiver sites

Fourteen fixed station receivers were set-up at 10 sites in 2007 to monitor radio-tagged Sockeye moving up the Fraser River (Figure 1; Appendix Table A1). All of the stations were installed, tested, and operational before any radio-tagged fish were released into the river (first fish released 5 August).

Fixed stations usually had two to three directional antennas (usually "Yagi" models) secured to a tree trunk or to an aluminium pole >10 m above ground, a peripheral unit to switch between antennas, a Lotek model SRX_400 receiver, a 12 V deep cycle battery to power it, a waterproof metal enclosure to house the receiver, and a co axial cable joining the antennas to the switcher unit. Two stations were operated with Orion receivers instead of Lotek equipment. Several stations had solar panels and a voltage regulator to keep the batteries charged. One site (Mission South) was powered by an AC source. Koski et al. (1996) described the operations of the antenna-switching units and the antenna orientations used to determine presence and movement of radio-tagged fish. Maintenance of the receiver sites included checking the 12 V battery power levels, any necessary maintenance due to damage or other factors, and downloading data from the receiver using a portable laptop computer.

Differentiation of directionality was tested when the stations were set up. Following the basic setup procedure (antennas raised, cables connected to the receiver, etc.), an active radio tag was attached to a weighted rope, and lowered to a depth of 5-10 m in the river where possible. Signal reception and signal strength of the radio tags were tested at different positions and depths. Typically, testing was conducted in the center channel from a position starting 500-700 m upstream of the station to a point approximately 500-700 m downstream of the station. At most fixed-station receiver sites, the antenna adjustments and detection range tests were performed in 2005 (as part of a previous study; see Robichaud and English 2006), and the antennas were left in place over the winter. In previous years, radio tags were walked along the banks upstream and downstream to test signal reception. This process was repeated in 2008. Gain settings (described below) refer to the power of the antenna, the higher the gain the farther away a transmitter could be detected. Optimal gains were those that maximized detection distance while preventing background noise from interfering with radio tag detection.

Receiver stations along the mainstem of the Fraser River (not at a tributary junction) generally had two antennas to detect signals from upstream and downstream locations. Stations at the confluence of a tributary had three antennas to distinguish between signals emanating from the mainstem (up and downstream) and from within the tributary. Station setup and antenna position were identical in the stations used in 2002-2007 (English et al. 2003, 2004; Robichaud and English 2006, 2007; Robichaud et al. 2008) unless otherwise noted.

Driving directions, receiver settings, and operational details

Crescent Island: The Crescent Island receiver site was located directly across from the Fraser-Stave confluence (rkm 68), approximately 10 km downstream from the release site. To access the site, travel by boat approximately 11 km downstream from the Mission launch. The site was located in a large cottonwood tree at the downstream end of the island. Four antennas were mounted 20 m up the tree, and scanned upstream and downstream on either side of the island. In 2005, the site was tested by drifting the radio tag at 2 m depth from 500 m upstream of the station to 500 m downstream of the station. The test involved three transects including ¼, ½, and ¾ of the channel widths. Results indicated that at a gain of 75, the radio tag was easily detected on all transects. There was some sporadic coding of noise from industry located on the north bank.

Mission North: The Mission North receiver site was located just upstream of the Mission rail bridge (rkm 79), approximately 1 km upstream from the release site. Traveling west on the highway from Mission to Harrison, take the first driveway to the right downstream of the Tourist Information Booth. This leads to the BC Frozen Foods parking lot and factory. Park at the end of the lot closest to the road and take the trail that crosses the railway track down to the river bank. The receiver was located upstream of the pathway. Two antennas were mounted 20 m above the water in a large cottonwood tree. The first antenna scanned downstream, and the other upstream.

Testing of this station involved walking the radio tag along the bank approximately 100 m upstream and downstream of the site. All antennas tested well with good power levels and good separation between antennas. This station was located directly in front of frequent train traffic and occasional boat traffic, which was an issue of concern. Before this study, a noise analysis of background interference was done at this station, and it was determined that 75 was the optimal gain for 2006. The same gain settings were used for 2007.

Mission South: The Mission South receiver site was also located just upstream of the Mission rail bridge (rkm 79) on the opposite shore from Mission North, approximately 1 km upstream from the release site. Traveling north on the Mission-Abbotsford Highway, turn right on Harris Road, just before the Mission Bridge. Then left on Bell Road, then left on Page Road, and right on Sim Road. Head down to Kelleher Road and turn left. The test fishery site is at the end of this road on the left. The antennas were mounted in a cottonwood tree is straight in front of you. Setup consisted of two antennas mounted about 10 m above water. One antenna scanned downstream, and the other scanned upstream. The battery charger at this station was powered from the AC voltage source at the Pacific Salmon Commission acoustic site.

This station was tested in the same manner as Mission North, with similar results. Background noise from boat traffic was a slight concern at this site. Gains were initially set to 75. Results were less efficient than in 2006 due to abnormally high water levels. Shortly after installation the station was vandalized, with some equipment being stolen. As a result, there were some issues with amplification of the signals from the antennas to the receiver, again resulting in less than optimal station performance until the amplifiers were repaired/replaced. Gains were eventually set to 90 to combat the issue of high water/turbidity levels and amplifier performance so that fish travelling deeper or further out in the channel might be detected.

Harrison Confluence: The Harrison Confluence receiver site was located at the mouth of the Harrison River (rkm 109), approximately 30 km upstream from the release site. Going west on Hwy #7 (Lougheed Hwy) take a left on School Rd. just before the Harrison River Bridge. Follow this then take a left on Kilby Road. Proceed until a small railway overpass on the right. Turn and go under the railway tracks. Travel through some houses on the Skowlitz Reservation up onto a dyke and turn left. Park at the gate if it is locked. Drive/walk up the dyke about 250m. The antennas were on a cottonwood tree nearest the water on the right hand side, at the most logical spot at the junction of the Harrison.

Testing of this station involved walking the radio tag along the dyke approximately 150 m upstream and downstream of the site. All antennas tested well with good power levels and good separation between antennas. Although there was slight concern over local train and boat traffic, the station functioned effectively at a gain setting of 75.

Rosedale Bridge: The Rosedale Bridge receiver site was located just upstream of the Rosedale Bridge near Agassiz (rkm 123), approximately 45 km upstream from the release site. Traveling north on Hwy #9 (Agassiz Highway), take the first right on Whelpton Road after crossing the Rosedale-Agassiz Bridge. Take another right on Bridge Road. The road eventually winds underneath the bridge. Park just beyond the intersection with the overhead bridge and proceed by foot to the seventh tree on the left. Two antennas were mounted about 13 m above water in a cottonwood tree. The first scanned downstream, and the second scanned upstream.

Testing of this station involved walking the radio tag along the road approximately 100 m upstream and downstream of the site. All antennas showed good power levels and good separation between antennas when checked with the test tag. Gains at this station were set at 75 for the duration of the field season.

Hope: The Hope receiver site was located just downstream of Hope on Bristol Island (rkm 159), approximately 81 km upstream from the release site. From Chilliwack, head east on Highway 1. Take exit 165, turn left over the highway and proceed east on Frontage Road past the Husky Station. Continue to the next intersection with Highway 1. Valley Helicopters is on the left. Turn left just past Valley Helicopters and continue on across the railroad tracks. At the fork, turn right. The access road to the station site is a small dirt/gravel trail between the trees just before the first building on the right. Follow the trail out to the bank above the river. There were two antennas mounted about 20 m above water in a spruce tree. The first antenna scanned downstream, and the second scanned upstream.

Testing of this station involved walking the radio tag along the shore approximately 100 m upstream and downstream of the site. All antennas showed good power levels and good separation between antennas when checked with the test tag. Gains at this station were set quite high at 80 as there generally were no noise issues.

Qualark: The Qualark site was located at a DFO DIDSON site approximately 19 km north of the town of Hope on Highway 1. Four receivers (2 Lotek SRX, and 2 Grant Systems Orion) were installed at this site.

Two of the receivers were located on the near bank. From the highway, turn right about 0.5 km after passing the Hope River Gas Bar onto a small gravel road that crosses the railroad tracks. A gate stands across the road just before the tracks that can be unlocked by the DFO staff at the site (call ahead), otherwise it is a short hike (500 m) into the site. There is a steep road that branches off to the right. This road goes right down to a landing and to the location of two of the four receivers installed at the Qualark site. Conversely, you can proceed past the road about 20 m, park at the DFO building, and go down a stairway to the landing where these two receivers were located. At this site, there was one Lotek SRX receiver hooked up to aerial antennas, and one Orion receiver hooked up to an underwater dipole antenna. The aerials for the SRX stations were mounted to the railings along the edge of the landing (approximately 10 feet from the station itself). The dipole antenna was mounted to the end of DFO's moving fence/catwalk that contains the sensors for their DIDSON equipment. The signal for the Orion stations had to be amplified due to the long runs of co-axial cable needed to allow for the changing position of the DIDSON fence, which varied according to the water level of the Fraser River.

The remaining two receivers were located on the far bank, and access was by boat. A local native fisherman was contacted prior to arrival to ferry staff across to the other side of the river during setup and downloads. The setup on the other side of the river was basically identical to that on the near shore, except that the Orion station was mounted to the base of the DFO shack support beams, and the SRX station was mounted directly to the deck of the shack. Power to the aerial stations was provided by solar panels while the Orion stations were powered directly by a battery charger hooked up to an AC power source.

Testing of the site was done by having the fisherman take the tag up river a few hundred metres and then drift by the sites. All antennas showed good power levels and good separation between antennas when checked with the test tag. It should be noted that the original plan was to use units called DSP's hooked up to SRX receivers in the Orion stations, but the DSP units were unable to read the frequencies of the tags, so these stations initially had SRX units installed in them. During this period, the gains/noise for the station on the near side of the river were set to 80/0, and 70/65 (due to local noise from boat and rail traffic) for the station on the opposite side of the river. These units were swapped for Orion units on August 18th. The gain/noise settings for the aerial stations were 70/0 for the near station and 80/50 for the far station.

Sawmill Creek: The Sawmill Creek receiver site was located just upstream of the mouth of Sawmill Creek (rkm 192.8), approximately 114.8 km upstream from the release site. From Yale, head north for approximately 6 km and park on the first pull-out on the right after crossing over the Sawmill Creek Bridge. There is a small path leading down to the train tracks, cross over the tracks, and follow a wide trail for 100 m upstream. Two antennas were mounted approximately 5 m up a large spruce tree, which was situated on a cliff, 30 m above the water.

This site was not tested in the actual river due to remote and difficult access. However, the station was tested by walking the radio tag along the old railway road approximately 100 m upstream and downstream of the site, with both antennas giving good detection levels. Given the optimal height of the antennas and narrowness of the channel, the station likely performed very efficiently. There was some noise generated by passing trains that may have hampered detection efficiency slightly. Also, part way through the summer, power levels and detection numbers (per tag) seemed to drop off somewhat. It is not clear what caused this but it is possible that the co-axial connections at the antennas themselves may have needed replacement. Connections at the switcher were replaced but the height of the antennas in the tree did not allow for the safe changing of the connections at the antennas for the single field biologist. Despite the reduced power levels and lower number of detections per tag, the station still performed well enough to detect radio tags passing by the location. Gains for this site were set at 75 for this site.

Fraser-Thompson Confluence: The Fraser-Thompson confluence receiver site was located across from the mouth of the Thompson River (rkm 260), approximately 182 km upstream from the release site. Once in Lytton, head north towards Lillooet across the Thompson. About 2 km down that road, take the ferry to cross the Fraser. Then travel up the road and take the first main road to the left. Head south down the Fraser for about 2 km until you are across from the mouth of the Thompson River. The station is on your left, about 100 m from the road. The 3 antennas were visible from the road, mounted about 10 m up a large spruce tree. The tree was on a steep bank, on the far side of the meadow, about 20 m above water. The first antenna scanned downstream, the second scanned the Thompson River, and the third scanned upstream. The GPS coordinates for this site are (50.23202° N; 121.58930° W).

Testing of this station involved walking the radio tag along the ridge approximately 100 m upstream and downstream of the site. All antennas showed good power levels and good separation between antennas when checked with the test tag. Gains at this station differed for each antenna as there were some noise issues due to local train traffic and construction. Gains were 75, 73, and 70 with a noise blank of 65.

Fraser-Chilcotin Confluence: The Fraser-Chilcotin confluence receiver site was at the mouth of the Chilcotin River (rkm 465), approximately 387 km upstream from the release site. From Williams Lake, head west on Highway 20 (toward Alexis Creek, Bella Coola). Cross the Fraser River ("Sheep Creek Bridge"), drive past the Toosey IR, and turn left (south) on the "Big Creek - 2000 Road." There are signs to the Junction Wildlife Area. Drive south past the entrance to Junction, proceed down the switchbacks, and cross the Chilcotin River (this is "Farwell Canyon"). Proceed up the hill on the south side of the canyon. Turn left at 27 ¾ km, the road is narrow with several shallow mud puddles. Stay left on this road at all "major" intersections, and stay on the well used path. It is the lowest elevation road paralleling the south side of the Chilcotin River on the main ridge. There are other roads above this one with similar road leading to the bush and is easily missed. It would probably be easiest to call Dave Willis prior to arrival so he can meet with you and show you in to the site. Contact Keri Benner at DFO in Kamloops to obtain his number. The DFO crews stay in a cabin just outside of Chilko Lake lodge. When the station was installed, crew flew into Chilko Lake Lodge from Victoria and was picked up at the airstrip by Dave Willis. Given the amount of driving involved to reach the site, this is likely the best way of accessing the site. The equipment is located in the smaller of 2 cabins located just downstream of the main house. The cabin is unlocked due to the remoteness of the site and the fact that there are always DFO staff on site. Two antennas are mounted approximately 10 m up a small conifer, antenna 1 scanning downstream and antenna 2 scanning upstream.

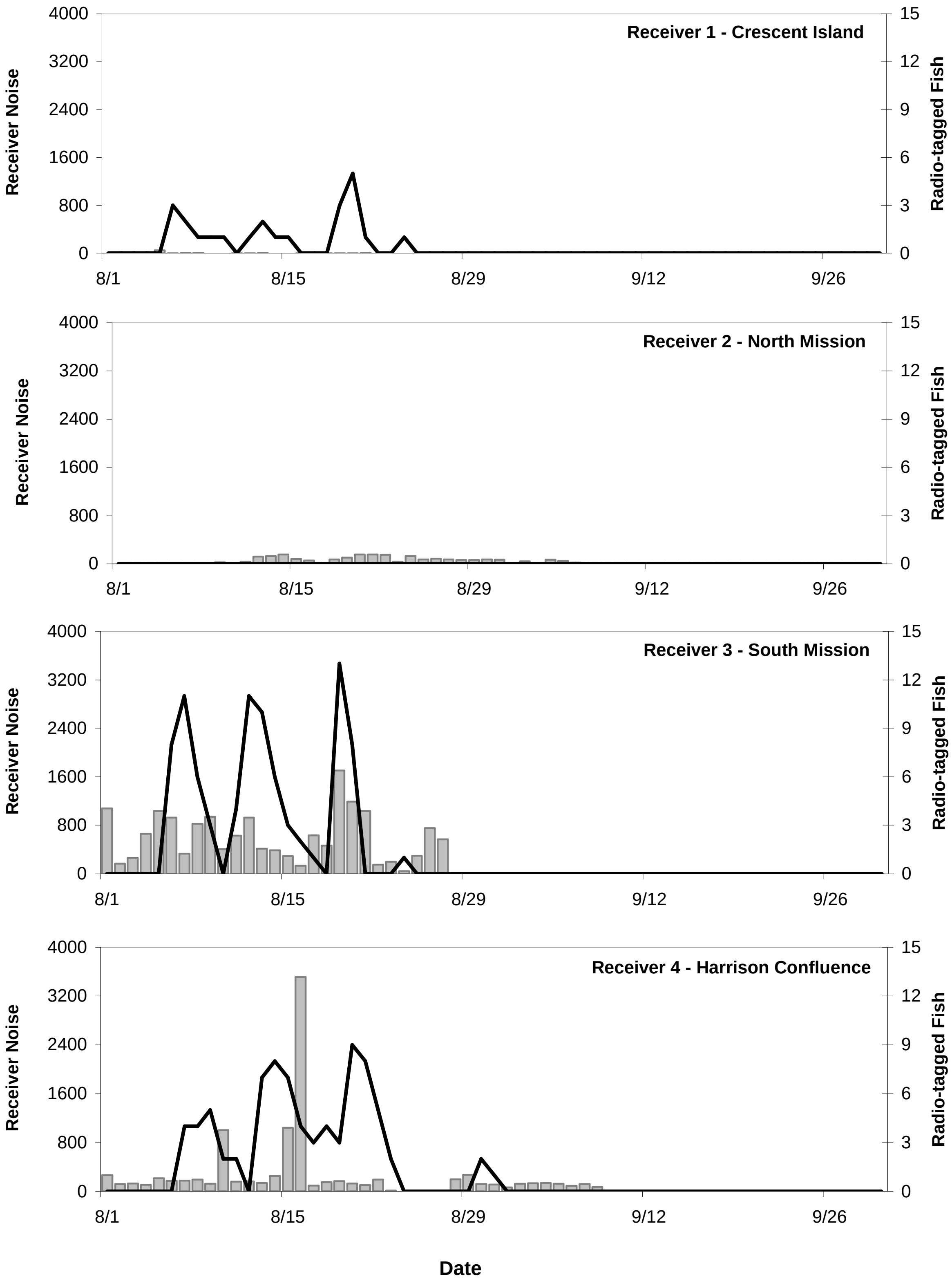
Testing of this station involved walking the radio tag along the bank approximately 100 m downstream and 100 m upstream of the station. Antenna 1 scanned downstream on the Chilko while antenna 2 scanned upstream. Both antennas tested well with good power levels and good separation between antennas. Noise was not an issue despite nearby boat traffic so gains were set at 75 and the station ran efficiently. The station was maintained by DFO staff throughout the study period.

Appendix Table A1. Orientation of each antenna at each fixed-station receiver site, 2008.

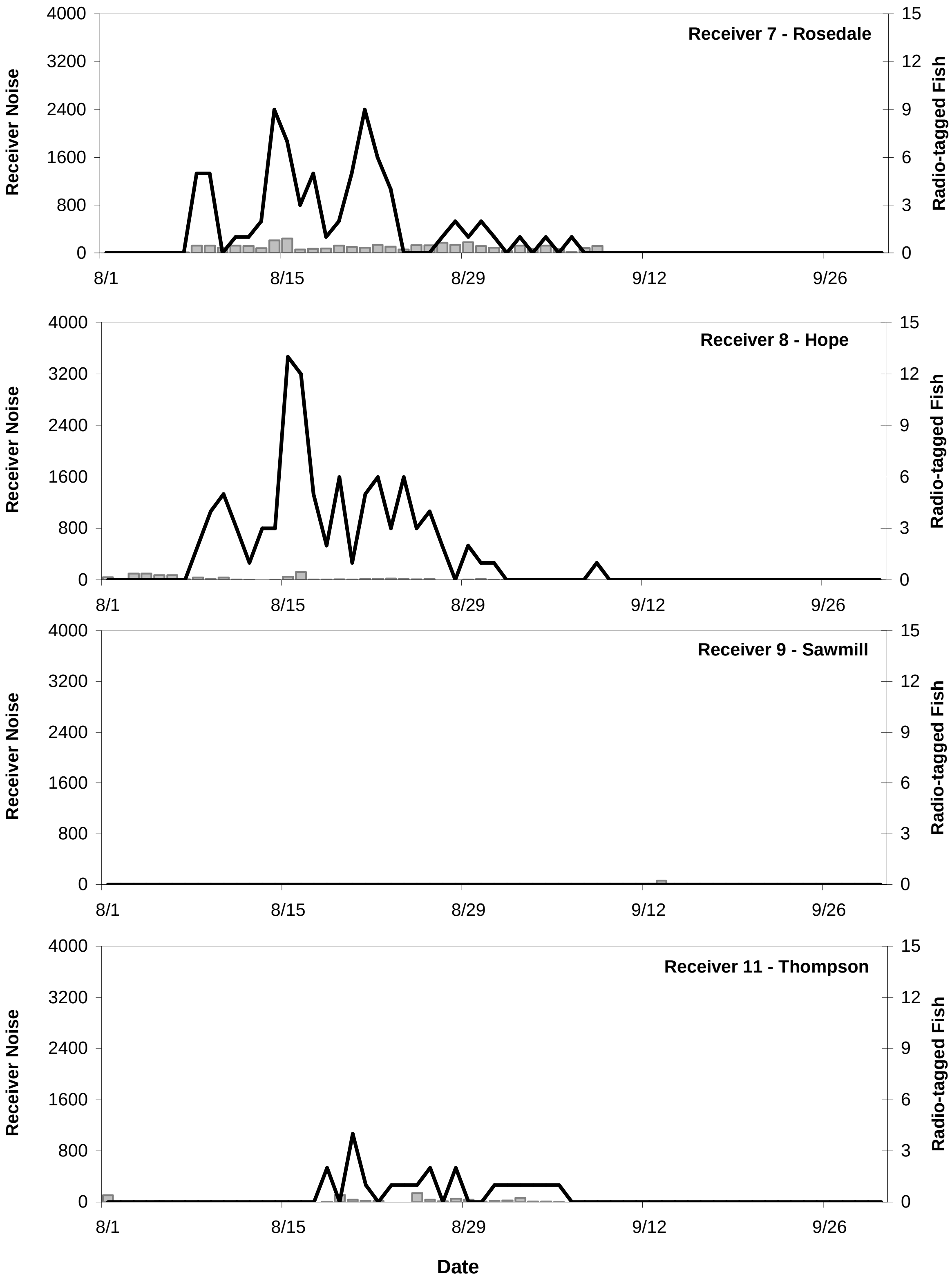
Fixed Station Receiver Site	Antenna	Antenna Orientation
Cresent Island	1	Downstream Main Channel
Cresent Island	2	Downstream Back Channel
Cresent Island	3	Upstream Main Channel
Cresent Island	4	Upstream Back Channel
Mission North	1	Downstream
Mission North	2	Upstream
Mission South	1	Downstream
Mission South	2	Upstream
Harrison Confluence	1	Downstream Fraser
Harrison Confluence	2	Upstream Harrison River
Harrison Confluence	3	Upstream Fraser
Rosedale	1	Downstream
Rosedale	2	Upstream
Hope	1	Downstream
Hope	2	Upstream
Sawmill	1	Downstream
Sawmill	2	Upstream
Qualark Orion Near Bank	1	cross bank
Qualark Orion Far Bank	1	cross bank
Qualark Lotek Near Bank	1	Downstream
Qualark Lotek Near Bank	2	Upstream
Qualark Lotek Far Bank	1	Downstream
Qualark Lotek Far Bank	2	Upstream
Thompson Confluence	1	Downstream Fraser
Thompson Confluence	2	Upstream Thompson River
Thompson Confluence	3	Upstream Fraser
Chilcotin Confluence	1	Downstream Fraser
Chilcotin Confluence	2	Upstream Chilcotin River
Chilcotin Confluence	3	Upstream Fraser
Chilko	1	Downstream
Chilko	2	Upstream

Appendix Table A2. Fixed-station monitoring efficiency (percent operational) by week for all sites monitored from 13 July to 28 September, 2008.

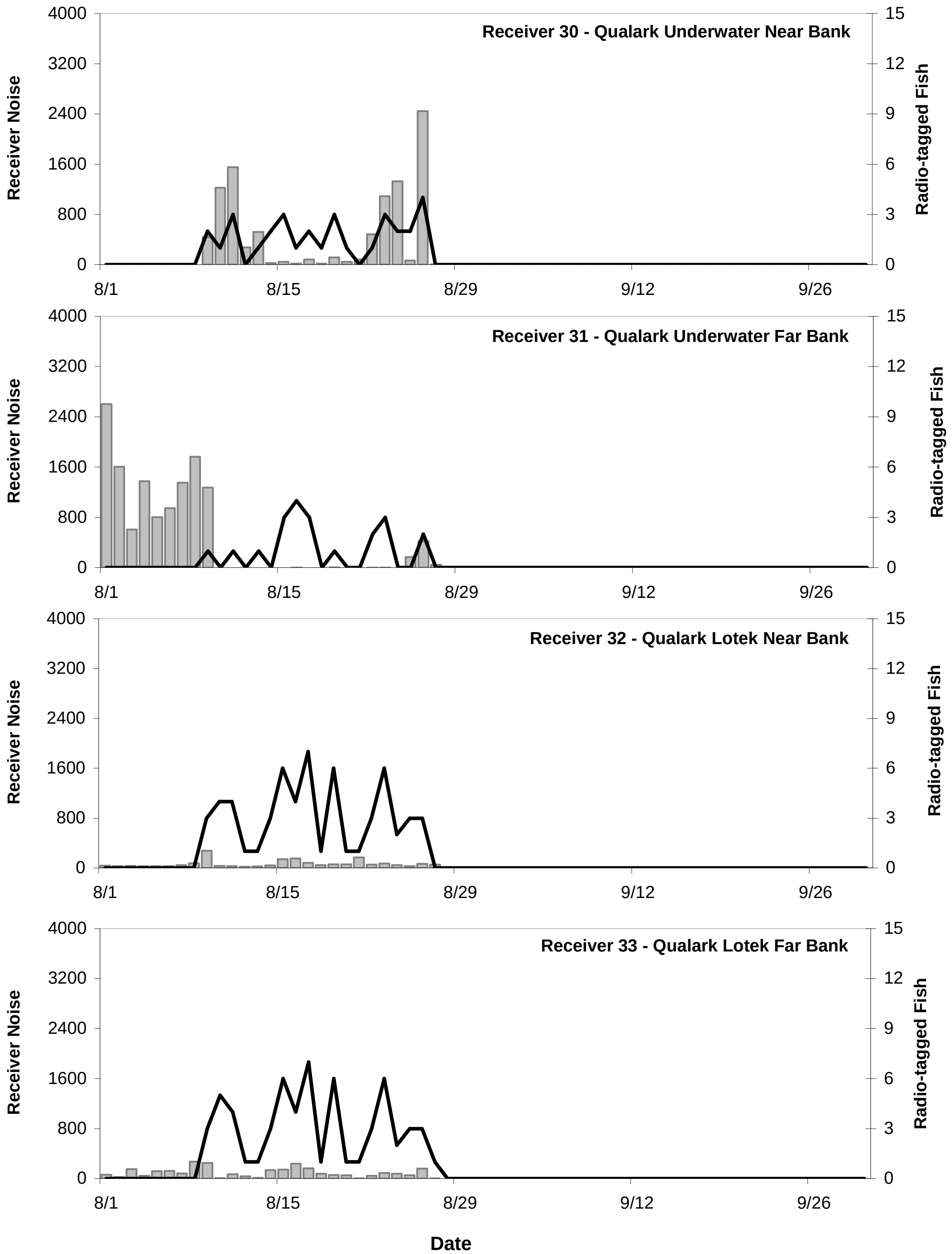
	Fixed-Station Receiver Site													
Week Start Date	Crescent Island	Mission North	Mission South	Harrison Conf.	Rosedale	Hope	Sawmill	Thompson Conf.	Chilcotin Conf.	Chilko	Qualark Orion Near	Qualark Orion Far	Qualark Lotek Near	Qualark Lotek Far
13 Jul	100%			100%	100%	100%	100%	100%						
20 Jul	100%		100%	100%	100%	100%	100%	100%						
27 Jul	75%		100%	100%	10%	89%	100%	100%		0%	100%	100%	100%	100%
3 Aug	59%	100%	100%	100%	30%	100%	100%	98%	100%	10%	100%	100%	100%	100%
10 Aug	100%	100%	100%	100%	100%	100%	67%	0%	100%	34%	100%	100%	100%	100%
17 Aug	100%	100%	86%	100%	100%	100%	0%	88%	100%	100%	58%	30%	100%	100%
24 Aug	100%	100%	100%	44%	100%	100%	46%	100%	100%	100%	61%	46%	100%	100%
31 Aug	100%	83%		100%	100%	100%	100%	100%	100%	100%				
7 Sep	100%	100%		100%	100%	100%	100%	100%	100%	100%				
14 Sep									100%	100%				
21 Sep									100%	97%				
28 Sep									100%	100%				
Overall	**91%**	**96%**	**97%**	**93%**	**79%**	**99%**	**74%**	**84%**	**100%**	**76%**	**84%**	**75%**	**100%**	**100%**



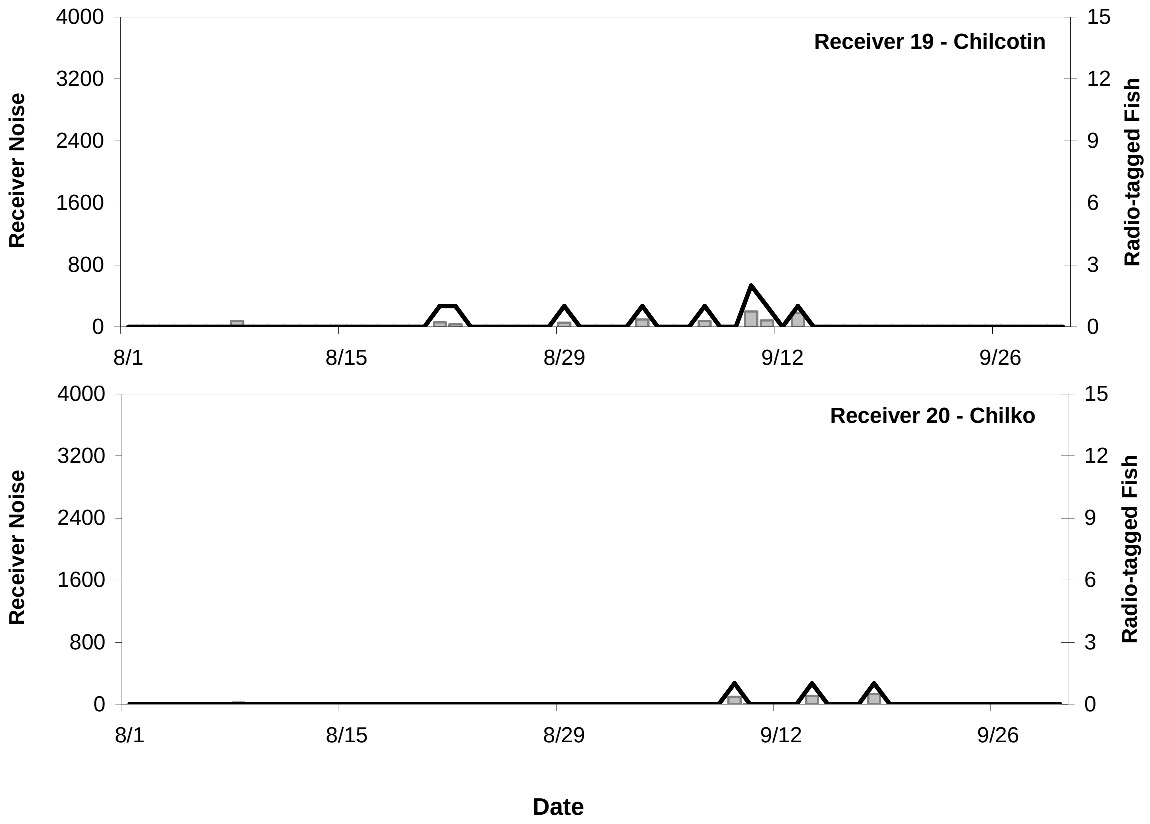
Appendix Figure A1. **Receiver noise/collisions (bars) and total number of radio-tagged fish detected (line) by day from 1 August - 30 September, 2008.**



Appendix Figure A1 continued.



Appendix Figure A1 continued.



Appendix Figure A1 continued.

APPENDIX B

Fishwheel Effort and Catch

Appendix Table B1. **Total effort, effort used to calculate CPUE, and average daily fishwheel speed (RPM) for four fishwheels operated in the lower Fraser River, 2008.**

	Mission-South			Mission-Middle			Crescent-Large			Crescent-Regular		
Date	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM
18-Jun	13.5	3.3	2.0									
19-Jun	12.0	22.0	2.0									
20-Jun	13.7	4.6	1.7									
21-Jun	24.0	25.5	1.7									
22-Jun	24.0	23.4	1.7									
23-Jun	24.0	24.5	1.7									
24-Jun	24.0	23.4	1.6									
25-Jun	24.0	24.1	1.5									
26-Jun	24.0	24.3	1.6									
27-Jun	24.0	23.5	1.7									
28-Jun	24.0	25.2	1.7	7.8	0.0	4.0						
29-Jun	24.0	21.2	1.7	24.0	21.7	3.9						
30-Jun	24.0	24.8	1.7	24.0	24.4	3.9						
1-Jul	24.0	23.6	1.8	24.0	23.8	4.0						
2-Jul	24.0	25.0	1.9	24.0	25.3	4.0						
3-Jul	24.0	28.3	2.0	24.0	28.0	3.9						
4-Jul	19.8	20.6	2.2	24.0	24.9	4.0				5.3	0.0	3.2
5-Jul	24.0	24.3	2.2	23.1	23.7	4.1				24.0	25.1	3.0
6-Jul	24.0	20.5	2.3	24.0	20.6	4.0				24.0	22.1	3.1
7-Jul	24.0	22.1	2.2	24.0	22.1	4.0				24.0	20.5	2.9
8-Jul	24.0	27.4	2.1	24.0	27.4	4.0				24.0	27.4	3.0
9-Jul	24.0	19.4	2.1	24.0	19.5	4.0				24.0	19.4	2.9
10-Jul	24.0	25.5	2.1	24.0	25.5	4.2				24.0	25.4	2.9
11-Jul	20.0	19.5	1.9	24.0	23.6	4.0				24.0	23.7	2.7
12-Jul	22.6	22.9	1.5	24.0	24.0	3.8				24.0	23.9	2.8
13-Jul	24.0	23.7	1.3	23.0	22.7	3.7				24.0	24.1	2.3
14-Jul	24.0	25.2	0.9	12.0	8.9					24.0	25.4	2.3
15-Jul	24.0	24.2	0.8							24.0	23.1	2.6
16-Jul	22.5	21.9	0.8							24.0	25.8	2.2
17-Jul	24.0	22.6		7.3						24.0	22.6	2.2
18-Jul	24.0	25.4		24.0	23.0	3.2				24.0	23.9	2.0

Appendix Table B1 continued.

	Mission-South			Mission-Middle			Crescent-Large			Crescent-Regular		
Date	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM
19-Jul	24.0	18.1		24.0	30.1	3.0				24.0	31.9	2.1
20-Jul	18.7	30.1		24.0	18.1	3.0				24.0	16.5	1.9
21-Jul		0.0		24.0	21.8	2.9				24.0	18.4	2.0
22-Jul		0.0		24.0	25.3	2.9				24.0	28.2	1.9
23-Jul		0.0		24.0	24.6	2.9				24.0	25.8	1.7
24-Jul		0.0		24.0	23.5	3.0				24.0	25.0	2.1
25-Jul	7.5	0.0	2.7	24.0	24.8	2.9				24.0	22.4	1.8
26-Jul	11.9	19.4	2.9	11.5	19.6					9.6	18.6	
27-Jul	9.1	0.0	2.6	8.9		2.6				9.6	0.0	1.6
28-Jul	24.0	26.7	2.5	24.0	26.8	2.4	14.4	6.8	1.1	24.0	25.2	1.7
29-Jul	24.0	23.9	2.4	24.0	23.9	2.4	24.0	24.0	1.0	24.0	23.9	1.6
30-Jul	24.0	22.3	2.6	24.0	22.1	2.6	24.0	24.7	1.1	24.0	24.9	1.5
31-Jul	24.0	23.7	2.5	24.0	23.7	2.6	16.7	23.5	1.2	16.8	24.4	1.7
1-Aug	15.5	24.0	2.4	15.6	24.0	2.5		0.0			0.0	
2-Aug		0.0						0.0			0.0	
3-Aug	7.7	0.0		7.8			8.5	0.0		8.3	0.0	
4-Aug	24.0	24.2	2.3	24.0	24.3	2.5	24.0	24.3	0.8	24.0	24.2	1.0
5-Aug	24.0	20.7	2.2	24.0	20.6	2.3	24.0	27.7	0.9	24.0	28.1	1.3
6-Aug	24.0	20.4	2.2	24.0	20.1	2.4	24.0	24.5	1.1	24.0	23.3	1.2
7-Aug	24.0	31.3	2.3	24.0	31.3	2.3	24.0	19.9	0.8	24.0	20.8	1.1
8-Aug	15.6	22.7	2.1	15.6	23.0	2.2	13.2	21.4	0.9	13.3	21.8	0.9
9-Aug		0.0						0.0			0.0	
10-Aug	2.6	0.0		2.7			3.3	0.0		3.1	0.0	
11-Aug	24.0	19.3	1.9	24.0	19.5	1.9	24.0	19.6	0.6	12.3	7.7	0.5
12-Aug	24.0	23.4	2.1	24.0	23.3	2.1	24.0	23.0	0.9	24.0	23.1	1.0
13-Aug	24.0	24.3	1.6	24.0	24.4	1.6	24.0	24.6	0.8	24.0	24.2	1.2
14-Aug	24.0	23.6	2.4	24.0	23.4	2.4	24.0	22.8	1.2	24.0	23.2	1.1
15-Aug	24.0	23.2	2.4	24.0	23.2	2.5	22.8	24.8	1.1	24.0	26.1	2.1
16-Aug	9.6	18.4	2.2	9.4	18.3	2.3	12.8	20.2	1.0	13.3	20.4	1.3
17-Aug	5.8	0.0		5.7			6.4	0.0		7.1	0.0	
18-Aug	24.0	21.2	2.1	24.0	21.1	2.0	24.0	20.6	0.9	24.0	21.5	1.2
19-Aug	24.0	24.7	2.1	24.0	24.6	2.1	24.0	26.3	0.8	24.0	26.2	1.3
20-Aug	24.0	22.2	2.1	24.0	22.3	2.0	24.0	22.4	0.8	24.0	22.4	1.0

Appendix Table B1 continued.

	Mission-South			Mission-Middle			Crescent-Large			Crescent-Regular		
Date	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM	Total effort (h)	CPE effort (h)	RPM
21-Aug	16.8	26.5	2.4	16.5	26.2	2.5	15.0	24.5	1.0	15.8	24.8	1.2
22-Aug		0.0						0.0			0.0	
23-Aug	9.3	0.0		9.5			10.3	0.0		10.0	0.0	
24-Aug	24.0	20.1	2.8	24.0	20.3	3.0	24.0	20.4	1.2	24.0	20.4	1.6
25-Aug	24.0	26.7	2.6	24.0	27.0	2.7	24.0	32.9	1.1	24.0	32.9	1.7
26-Aug	24.0	27.0	2.4	24.0	26.7	2.4	23.7	20.3	1.0	24.0	20.7	1.4
27-Aug	24.0	24.2	2.3	24.0	24.2	2.4	24.0	24.1	1.0	24.0	23.8	1.4
28-Aug	24.0	24.1	2.3	24.0	24.0	2.5	24.0	23.9	1.0	24.0	24.0	1.4
29-Aug	12.5	21.6	2.5	12.3	21.6	2.6	11.9	23.5	1.1	13.4	23.6	1.7
30-Aug		0.0						0.0			0.0	
31-Aug	6.5	0.0	1.6	6.4		2.6	7.1	0.0	0.9	6.9	0.0	1.5
1-Sep	24.0	22.5	2.6	24.0	22.7	2.6	24.0	22.1	1.1	24.0	22.4	1.5
2-Sep	24.0	22.8	2.4	24.0	22.4	2.4	24.0	27.2	1.0	24.0	26.0	1.4
3-Sep	24.0	24.9	2.5	24.0	24.9	2.4	24.0	22.5	1.0	24.0	23.3	1.4
4-Sep	24.0	23.0	2.4	24.0	22.9	2.5	24.0	22.4	1.0	24.0	22.4	1.3
5-Sep	15.2	24.5	2.4	15.1	24.6	2.5	11.2	20.1	0.9	11.6	20.3	1.1
8-Oct	14.8	0.0					9.0	0.0		8.8	0.0	
9-Oct	24.0	32.6	1.5	11.0	4.9		24.0	26.4	0.7	24.0	26.3	
10-Oct	24.0	22.1	1.6	24.0	22.1	1.5	24.0	22.2	0.8	24.0	22.1	0.9
11-Oct	24.0	21.1	1.7	24.0	21.0	1.7	24.0	19.9	0.7	24.0	19.4	0.7
12-Oct	24.0	26.8	1.3	24.0	26.9	1.2	24.0	27.8	0.6	23.2	27.3	0.8
13-Oct	24.0	22.6	1.5	24.0	22.6	1.5	24.0	22.1	0.6	24.0	22.8	0.7
14-Oct	24.0	25.1	1.8	24.0	25.1	1.6	24.0	25.7	0.7	24.0	24.8	0.8
15-Oct	24.0	23.1	1.6	24.0	23.1	1.6	24.0	25.2	0.5	24.0	25.1	
16-Oct	24.0	25.0	1.2	24.0	25.1	1.1	24.0	22.1	0.8	24.0	22.5	1.8
17-Oct	24.0	22.7	1.4	24.0	22.7	1.4	24.0	25.1	0.7	24.0	24.8	0.9
18-Oct	24.0	26.6	1.3	24.0	26.6	1.3	24.0	24.8	0.4	24.0	25.1	0.8
19-Oct	24.0	16.4	1.5	24.0	16.5	1.3	24.0	23.1		24.0	21.3	
20-Oct	24.0	30.8	0.9	24.0	30.6	0.8	24.0	24.3		24.0	26.4	
21-Oct	11.8	19.9	0.9	11.8	19.8	0.7	24.0	24.1	0.4	24.0	24.1	1.7
22-Oct							24.0	23.4	0.4	24.0	23.4	
23-Oct							11.5	21.5	0.6	11.0	18.8	0.8
Total effort (h)	1,803			1,601			1,038			1,567		
% operational	89%			89%			88%			90%		

Appendix Table B2. Fishwheel catch and catch per unit effort (CPUE) for sockeye and Chinook salmon for four fishwheels operated in the lower Fraser River, 2008.

	Sockeye Salmon[a]								Chinook Salmon[a]							
	Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg		Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg	
Date	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
18-Jun	0	0.0							0	0.0						
19-Jun	0	0.0							0	0.0						
20-Jun	0	0.0							0	0.0						
21-Jun	0	0.0							0	0.0						
22-Jun	0	0.0							0	0.0						
23-Jun	0	0.0							0	0.0						
24-Jun	0	0.0							0	0.0						
25-Jun	0	0.0							0	0.0						
26-Jun	0	0.0							0	0.0						
27-Jun	1	0.0							0	0.0						
28-Jun	0	0.0							0	0.0						
29-Jun	0	0.0	1	0.0					0	0.0	1	0.0				
30-Jun	2	0.1	2	0.1					0	0.0	1	0.0				
1-Jul	2	0.1	2	0.1					0	0.0	0	0.0				
2-Jul	2	0.1	0	0.0					0	0.0	0	0.0				
3-Jul	1	0.0	0	0.0					0	0.0	0	0.0				
4-Jul	4	0.2	2	0.1					0	0.0	1	0.0				
5-Jul	9	0.4	2	0.1			16	0.6	0	0.0	0	0.0			0	0.0
6-Jul	14	0.7	2	0.1			15	0.7	0	0.0	0	0.0			2	0.1
7-Jul	6	0.3	0	0.0			5	0.2	0	0.0	1	0.0			1	0.0
8-Jul	7	0.3	3	0.1			19	0.7	0	0.0	0	0.0			1	0.0
9-Jul	11	0.6	2	0.1			16	0.8	0	0.0	1	0.1			1	0.1
10-Jul	16	0.6	5	0.2			29	1.1	0	0.0	0	0.0			3	0.1
11-Jul	9	0.5	3	0.1			19	0.8	0	0.0	0	0.0			3	0.1
12-Jul	0	0.0	1	0.0			17	0.7	0	0.0	1	0.0			3	0.1
13-Jul	0	0.0	1	0.0			4	0.2	0	0.0	0	0.0			0	0.0
14-Jul	1	0.0	4	0.5			29	1.1	0	0.0	0	0.0			2	0.1
15-Jul	4	0.2					8	0.3	0	0.0					0	0.0
16-Jul	2	0.1					35	1.4	0	0.0					1	0.0
17-Jul	1	0.0					33	1.5	0	0.0					1	0.0
18-Jul	0	0.0	13	0.6			31	1.3	0	0.0	0	0.0			0	0.0

Appendix Table B2 continued.

	Sockeye Salmon[a]								Chinook Salmon[a]							
	Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg		Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg	
Date	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
19-Jul	0	0.0	21	0.7			5	0.2	0	0.0	0	0.0			0	0.0
20-Jul	0	0.0	3	0.2			5	0.3	0	0.0	0	0.0			0	0.0
21-Jul			6	0.3			19	1.0			0	0.0			0	0.0
22-Jul			4	0.2			20	0.7			0	0.0			0	0.0
23-Jul			18	0.7			35	1.4			0	0.0			0	0.0
24-Jul			19	0.7			11	0.5			0	0.0			0	0.0
25-Jul			19	0.8			2	0.1			0	0.0			0	0.0
26-Jul	5	0.3	11	0.6			1	0.1	0	0.0	0	0.0			0	0.0
27-Jul																
28-Jul	15	0.6	7	0.3	13	1.9	2	0.1	0	0.0	0	0.0	0	0.0	1	0.0
29-Jul	12	0.5	3	0.1	69	2.9	1	0.0	0	0.0	0	0.0	2	0.1	0	0.0
30-Jul	9	0.4	5	0.2	51	2.1	5	0.2	0	0.0	0	0.0	3	0.1	1	0.0
31-Jul	4	0.2	5	0.2	62	2.6	4	0.2	0	0.0	0	0.0	2	0.1	0	0.0
1-Aug	1	0.0	1	0.0					0	0.0	0	0.0				
2-Aug																
3-Aug																
4-Aug	1	0.0	2	0.1	9	0.4	0	0.0	0	0.0	0	0.0	2	0.1	1	0.0
5-Aug	10	0.5	6	0.3	61	2.2	1	0.0	0	0.0	0	0.0	6	0.2	1	0.0
6-Aug	7	0.3	12	0.6	59	2.4	1	0.0	0	0.0	0	0.0	5	0.2	1	0.0
7-Aug	3	0.1	2	0.1	26	1.3	2	0.1	0	0.0	0	0.0	3	0.2	0	0.0
8-Aug	1	0.0	0	0.0	3	0.1	0	0.0	0	0.0	0	0.0	2	0.1	0	0.0
9-Aug																
10-Aug																
11-Aug	0	0.0	0	0.0	15	0.8	0	0.0	0	0.0	0	0.0	2	0.1	0	0.0
12-Aug	1	0.0	2	0.1	36	1.6	3	0.1	0	0.0	0	0.0	2	0.1	0	0.0
13-Aug	0	0.0	2	0.1	45	1.8	7	0.3	0	0.0	0	0.0	2	0.1	0	0.0
14-Aug	0	0.0	1	0.0	17	0.7	2	0.1	0	0.0	1	0.0	8	0.4	0	0.0
15-Aug	1	0.0	2	0.1	5	0.2	3	0.1	0	0.0	0	0.0	9	0.4	1	0.0
16-Aug	0	0.0	2	0.1	16	0.8	4	0.2	1	0.1	0	0.0	16	0.8	1	0.0
17-Aug																
18-Aug	0	0.0	0	0.0	6	0.3	0	0.0	0	0.0	0	0.0	11	0.5	1	0.0

Appendix Table B2 continued.

	Sockeye Salmon[a]								Chinook Salmon[a]							
	Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg		Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg	
Date	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
19-Aug	1	0.0	3	0.1	13	0.5	2	0.1	0	0.0	0	0.0	8	0.3	0	0.0
20-Aug	0	0.0	2	0.1	11	0.5	0	0.0	1	0.0	0	0.0	2	0.1	0	0.0
21-Aug	0	0.0	0	0.0	19	0.8	1	0.0	0	0.0	1	0.0	6	0.2	0	0.0
22-Aug																
23-Aug																
24-Aug	0	0.0	0	0.0	4	0.2	0	0.0	0	0.0	0	0.0	4	0.2	0	0.0
25-Aug	2	0.1	1	0.0	4	0.1	1	0.0	4	0.2	0	0.0	7	0.2	2	0.1
26-Aug	1	0.0	1	0.0	5	0.2	1	0.0	2	0.1	3	0.1	15	0.7	3	0.1
27-Aug	0	0.0	1	0.0	6	0.2	1	0.0	2	0.1	3	0.1	12	0.5	4	0.2
28-Aug	0	0.0	0	0.0	3	0.1	0	0.0	2	0.1	1	0.0	3	0.1	0	0.0
29-Aug	0	0.0	0	0.0	4	0.2	0	0.0	0	0.0	0	0.0	5	0.2	1	0.0
30-Aug																
31-Aug																
1-Sep	0	0.0	1	0.0	0	0.0	0	0.0	2	0.1	0	0.0	1	0.0	0	0.0
2-Sep	0	0.0	0	0.0	2	0.1	0	0.0	2	0.1	0	0.0	7	0.3	0	0.0
3-Sep	1	0.0	0	0.0	4	0.2	1	0.0	2	0.1	2	0.1	12	0.5	0	0.0
4-Sep	0	0.0	1	0.0	0	0.0	0	0.0	5	0.2	2	0.1	7	0.3	0	0.0
5-Sep	1	0.0	0	0.0	0	0.0	1	0.0	1	0.0	1	0.0	8	0.4	0	0.0
8-Oct																
9-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
10-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
11-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
12-Oct	0	0.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
13-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
14-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
15-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
16-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
17-Oct	0	0.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0
18-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0
19-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0
20-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Appendix Table B2 continued.

	Sockeye Salmon[a]								Chinook Salmon[a]							
	Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg		Mission-South		Mission-Middle		Crescent-Large		Crescent-Reg	
Date	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
21-Oct	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
22-Oct					0	0.0	0	0.0					0	0.0	0	0.0
23-Oct					0	0.0	0	0.0					0	0.0	0	0.0
Total	168		206		570		417		24		20		175		36	

[a] Jacks captured at the fishwheels were not included in this table.

Appendix Table B3. **Final version of the in-season 'Daily Catch Summary' table that was produced daily and posted three times per week on the PSC webpage during the study period, 2008.**

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
Mission-South	18-Jun	90	2.0	13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	19-Jun	91	2.0	12.0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1	76
	20-Jun	109	1.7	13.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
	21-Jun	104	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	72
	22-Jun	107	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	36
	23-Jun	109	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	55
	24-Jun	116	1.6	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	53
	25-Jun	120	1.5	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	83
	26-Jun	113	1.6	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78
	27-Jun	105	1.7	24.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
	28-Jun	107	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	56
	29-Jun	109	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	69
	30-Jun	106	1.7	24.0	2	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	79
	1-Jul	101	1.8	24.0	2	2	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	102
	2-Jul	95	1.9	24.0	2	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	49
	3-Jul	90	2.0	24.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	49
	4-Jul	84	2.2	19.8	4	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	65
	5-Jul	81	2.2	24.0	9	9	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	93
	6-Jul	79	2.3	24.0	14	13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	32
	7-Jul	82	2.2	24.0	6	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	81
	8-Jul	85	2.1	24.0	7	6	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	78
	9-Jul	87	2.1	24.0	11	11	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	50
	10-Jul	87	2.1	24.0	16	16	0	0	2	0	0	0	2	0	0	1	0	0	0	2	2	71
	11-Jul	96	1.9	20.0	9	8	0	0	0	0	0	0	1	0	0	1	0	0	0	2	2	66
	12-Jul	124	1.5	22.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
	13-Jul	144	1.3	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to:** **October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	14-Jul	192	0.9	24.0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	35
	15-Jul	219	0.8	24.0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
	16-Jul	226	0.8	22.5	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
	17-Jul			24.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	18-Jul			24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	19-Jul			24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	20-Jul			18.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21-Jul			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	22-Jul			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23-Jul			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24-Jul			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25-Jul	66	2.7	7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26-Jul	63	2.9	11.9	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	27-Jul	70	2.6	9.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28-Jul	73	2.5	24.0	15	13	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3
	29-Jul	74	2.4	24.0	12	9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	11
	30-Jul	70	2.6	24.0	9	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	31-Jul	71	2.5	24.0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
	1-Aug	74	2.4	15.5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	2-Aug			0.0	Fishwheel shutdown during fishery																	
	3-Aug			7.7	Fishwheel shutdown during fishery																	
	4-Aug	79	2.3	24.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	5-Aug	82	2.2	24.0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	6-Aug	83	2.2	24.0	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	7-Aug	80	2.3	24.0	3	1	2	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1
	8-Aug	86	2.1	15.6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to:** **October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	9-Aug			0.0	Fishwheel shutdown during fishery																	
	10-Aug			2.6	Fishwheel shutdown during fishery																	
	11-Aug	97	1.9	24.0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	12-Aug	86	2.1	24.0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	13-Aug	113	1.6	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	14-Aug	75	2.4	24.0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	15-Aug	74	2.4	24.0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	16-Aug	81	2.2	9.6	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	5
	17-Aug			5.8	Fishwheel shutdown during fishery																	
	18-Aug	87	2.1	24.0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	5
	19-Aug	86	2.1	24.0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4
	20-Aug	87	2.1	24.0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	7
	21-Aug	74	2.4	16.8	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3
	22-Aug			0.0	Fishwheel shutdown during fishery																	
	23-Aug			9.3	Fishwheel shutdown during fishery																	
	24-Aug	64	2.8	24.0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	25-Aug	69	2.6	24.0	2	0	0	0	0	4	1	0	2	0	0	0	0	0	0	0	0	3
	26-Aug	74	2.4	24.0	1	1	0	0	0	2	2	0	6	1	0	0	0	0	0	0	0	4
	27-Aug	77	2.3	24.0	0	0	0	0	0	2	2	0	5	0	0	0	0	0	0	0	0	7
	28-Aug	78	2.3	24.0	0	0	0	0	0	2	2	0	2	0	0	0	0	0	0	0	0	2
	29-Aug	71	2.5	12.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
	30-Aug			0.0	Fishwheel shutdown during fishery																	
	31-Aug	111	1.6	6.5	Fishwheel shutdown during fishery																	
	1-Sep	69	2.6	24.0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	0	0	0	4
	2-Sep	74	2.4	24.0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3
	3-Sep	72	2.5	24.0	1	1	0	0	0	2	2	0	2	1	0	0	0	0	0	0	0	3

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	4-Sep	76	2.4	24.0	0	0	0	0	0	5	5	0	5	3	0	0	0	0	0	0	0	3
	5-Sep	76	2.4	15.2	1	1	0	0	0	1	1	0	5	0	0	0	0	0	0	0	0	3
					Fishwheel shutdown from 5 September to 8 October																	
	8-Oct			14.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9-Oct	121	1.5	24.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	10-Oct	111	1.6	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11-Oct	103	1.7	24.0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
	12-Oct	140	1.3	24.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	13-Oct	120	1.5	24.0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
	14-Oct	100	1.8	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	15-Oct	116	1.6	24.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	16-Oct	147	1.2	24.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	17-Oct	126	1.4	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18-Oct	137	1.3	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19-Oct	124	1.5	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20-Oct	208	0.9	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21-Oct	194	0.9	11.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Total				**1,803**	**168**	**139**	**4**	**2**	**4**	**24**	**20**	**0**	**54**	**8**	**3**	**25**	**2**	**0**	**0**	**13**	**11**	**1,731**
Mission-Middle	28-Jun	45	4.0	7.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29-Jun	46	3.9	24.0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	30-Jun	47	3.9	24.0	2	2	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	2
	1-Jul	45	4.0	24.0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	2-Jul	46	4.0	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	3-Jul	46	3.9	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	4-Jul	45	4.0	24.0	2	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	5

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to:** **October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	5-Jul	44	4.1	23.1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	6-Jul	45	4.0	24.0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	7-Jul	45	4.0	24.0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	4
	8-Jul	45	4.0	24.0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	9-Jul	45	4.0	24.0	2	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2
	10-Jul	43	4.2	24.0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	11-Jul	46	4.0	24.0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	12-Jul	47	3.8	24.0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	8
	13-Jul	49	3.7	23.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	14-Jul			12.0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	15-Jul				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16-Jul				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17-Jul			7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18-Jul	56	3.2	24.0	13	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	19-Jul	60	3.0	24.0	21	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	20-Jul	60	3.0	24.0	3	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	21-Jul	63	2.9	24.0	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	22-Jul	63	2.9	24.0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	23-Jul	62	2.9	24.0	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	24-Jul	61	3.0	24.0	19	18	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
	25-Jul	63	2.9	24.0	19	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	26-Jul			11.5	11	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	27-Jul	70	2.6	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28-Jul	76	2.4	24.0	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	29-Jul	75	2.4	24.0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	30-Jul	68	2.6	24.0	5	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	31-Jul	70	2.6	24.0	5	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1-Aug	71	2.5	15.6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2-Aug			0.0	Fishwheel shutdown during fishery																	
	3-Aug			7.8	Fishwheel shutdown during fishery																	
	4-Aug	73	2.5	24.0	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	5-Aug	79	2.3	24.0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	6-Aug	75	2.4	24.0	12	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	7-Aug	78	2.3	24.0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5
	8-Aug	84	2.2	15.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	9-Aug			0.0	Fishwheel shutdown during fishery																	
	10-Aug			2.7	Fishwheel shutdown during fishery																	
	11-Aug	96	1.9	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	12-Aug	84	2.1	24.0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13-Aug	112	1.6	24.0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14-Aug	76	2.4	24.0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
	15-Aug	73	2.5	24.0	2	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
	16-Aug	79	2.3	9.4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	17-Aug			5.7	Fishwheel shutdown during fishery																	
	18-Aug	88	2.0	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19-Aug	87	2.1	24.0	3	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	20-Aug	92	2.0	24.0	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	21-Aug	72	2.5	16.5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	3
	22-Aug			0.0	Fishwheel shutdown during fishery																	
	23-Aug			9.5	Fishwheel shutdown during fishery																	
	24-Aug	61	3.0	24.0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
	25-Aug	66	2.7	24.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	26-Aug	75	2.4	24.0	1	1	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	4
	27-Aug	74	2.4	24.0	1	1	0	0	0	3	2	0	1	0	0	0	0	0	0	0	0	2
	28-Aug	72	2.5	24.0	0	0	0	0	0	1	1	0	2	1	0	0	0	0	0	0	0	3
	29-Aug	71	2.6	12.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30-Aug			0.0	Fishwheel shutdown during fishery																	
	31-Aug			6.4	Fishwheel shutdown during fishery																	
	1-Sep	68	2.6	24.0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2-Sep	75	2.4	24.0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
	3-Sep	74	2.4	24.0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2
	4-Sep	71	2.5	24.0	1	1	0	1	0	2	2	0	2	1	0	0	0	0	0	0	0	0
	5-Sep	71	2.5	15.1	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	1
					Fishwheel shutdown from 5 September to 9 October																	
	9-Oct			11.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10-Oct	120	1.5	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11-Oct	103	1.7	24.0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	12-Oct	149	1.2	24.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	13-Oct	117	1.5	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14-Oct	114	1.6	24.0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
	15-Oct	116	1.6	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16-Oct	164	1.1	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17-Oct	128	1.4	24.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	18-Oct	138	1.3	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19-Oct	138	1.3	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20-Oct	222	0.8	24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21-Oct	268	0.7	11.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
Middle Total				**1,601**	**206**	**182**	**6**	**6**	**0**	**20**	**17**	**0**	**16**	**4**	**4**	**0**	**0**	**0**	**1**	**0**	**0**	**166**
Crescent-Large	28-Jul	160	1.1	14.4	13	12	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	12
	29-Jul	176	1.0	24.0	69	66	0	1	0	2	2	0	20	0	0	0	0	0	0	0	0	64
	30-Jul	161	1.1	24.0	51	45	0	0	1	3	3	0	13	0	0	0	0	0	0	0	0	85
	31-Jul	156	1.2	16.7	62	60	0	2	0	2	2	0	6	0	0	0	0	0	0	1	1	87
	1-Aug			0.0	Fishwheel shutdown during fishery																	
	2-Aug			0.0	Fishwheel shutdown during fishery																	
	3-Aug			8.5	Fishwheel shutdown during fishery																	
	4-Aug	215	0.8	24.0	9	8	0	0	0	2	2	0	18	0	0	0	0	0	0	0	0	48
	5-Aug	195	0.9	24.0	61	43	4	1	1	6	4	0	30	0	0	0	0	0	0	0	0	218
	6-Aug	167	1.1	24.0	59	43	11	2	0	5	4	0	34	0	0	1	0	0	0	0	0	114
	7-Aug	215	0.8	24.0	26	12	13	0	0	3	2	0	33	0	0	0	0	0	0	0	0	145
	8-Aug	199	0.9	13.2	3	0	1	0	0	2	2	0	33	0	0	0	0	0	0	0	0	74
	9-Aug			0.0	Fishwheel shutdown during fishery																	
	10-Aug			3.3	Fishwheel shutdown during fishery																	
	11-Aug	279	0.6	24.0	15	12	3	1	0	2	2	0	15	0	0	0	0	0	1	0	0	159
	12-Aug	212	0.9	24.0	36	20	13	4	0	2	2	0	18	0	0	0	0	0	0	0	0	89
	13-Aug	213	0.8	24.0	45	30	15	0	1	2	2	0	7	0	0	0	0	0	0	0	0	167
	14-Aug	153	1.2	24.0	17	6	10	3	2	8	8	0	32	0	0	0	0	0	0	1	1	128
	15-Aug	161	1.1	22.8	5	5	0	0	0	9	9	0	43	0	0	0	0	0	0	0	0	88
	16-Aug	183	1.0	12.8	16	16	0	0	0	16	9	0	32	0	1	0	0	0	0	0	0	51
	17-Aug			6.4	Fishwheel shutdown during fishery																	
	18-Aug	192	0.9	24.0	6	6	0	1	0	11	9	0	44	0	0	0	0	0	0	0	0	101
	19-Aug	217	0.8	24.0	13	0	12	0	0	8	5	0	29	1	0	0	0	0	0	2	2	90
	20-Aug	235	0.8	24.0	11	0	11	0	0	2	2	0	47	0	0	0	0	0	0	1	1	170

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	21-Aug	181	1.0	15.0	19	10	6	0	0	6	6	0	63	0	0	0	0	0	0	0	0	129
	22-Aug			0.0	Fishwheel shutdown during fishery																	
	23-Aug			10.3	Fishwheel shutdown during fishery																	
	24-Aug	156	1.2	24.0	4	4	0	1	0	4	3	0	26	0	0	0	0	0	0	1	0	35
	25-Aug	162	1.1	24.0	4	3	0	1	0	7	6	0	30	6	0	0	0	0	1	3	1	102
	26-Aug	179	1.0	23.7	5	3	0	0	0	15	13	0	17	3	0	0	0	0	0	0	0	68
	27-Aug	176	1.0	24.0	6	6	0	0	0	12	9	0	14	4	0	1	0	0	0	1	0	91
	28-Aug	175	1.0	24.0	3	3	0	0	0	3	3	0	7	3	1	0	0	0	0	0	0	96
	29-Aug	167	1.1	11.9	4	4	0	0	0	5	5	0	10	10	0	0	0	0	0	0	0	88
	30-Aug			0.0	Fishwheel shutdown during fishery																	
	31-Aug			7.1	Fishwheel shutdown during fishery																	
	1-Sep	166	1.1	24.0	0	0	0	0	0	1	0	0	6	3	0	1	0	0	0	1	1	99
	2-Sep	178	1.0	24.0	2	1	0	0	0	7	5	0	9	16	0	0	0	0	2	1	1	168
	3-Sep	178	1.0	24.0	4	4	0	1	0	12	12	0	9	11	0	1	1	0	0	0	0	143
	4-Sep	185	1.0	24.0	0	0	0	0	0	7	6	0	7	2	0	0	0	0	0	0	0	138
	5-Sep	206	0.9	11.2	0	0	0	0	0	8	7	0	9	7	0	1	0	0	0	0	0	111
					Fishwheel shutdown from 5 September to 8 October																	
	8-Oct			9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9-Oct	263	0.7	24.0	0	0	0	0	0	0	0	0	0	10	11	0	0	0	2	0	0	3
	10-Oct	234	0.8	24.0	0	0	0	0	0	0	0	0	1	7	8	0	0	0	7	0	0	1
	11-Oct	255	0.7	24.0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	1	0	0	0
	12-Oct	320	0.6	24.0	1	1	0	0	0	0	0	0	0	7	6	2	2	0	5	0	0	17
	13-Oct	287	0.6	24.0	0	0	0	1	0	0	0	0	0	10	4	0	0	0	0	0	0	25
	14-Oct	255	0.7	24.0	0	0	0	0	0	0	0	0	0	13	11	0	0	0	11	0	0	32
	15-Oct	345	0.5	24.0	0	0	0	1	0	0	0	0	0	8	8	0	0	0	18	0	0	21
	16-Oct	239	0.8	24.0	0	0	0	1	0	0	0	0	1	2	5	0	0	0	11	0	0	38

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) Data to: October 23, 2008

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	17-Oct	259	0.7	24.0	1	1	0	0	0	1	1	0	1	7	1	0	0	0	22	0	0	0
	18-Oct	506	0.4	24.0	0	0	0	0	0	1	1	0	0	6	3	0	0	0	31	0	0	0
	19-Oct			24.0	0	0	0	0	0	1	1	0	0	10	2	0	0	0	34	0	0	2
	20-Oct			24.0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	12	0	0	1
	21-Oct	492	0.4	24.0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	11	0	0	4
	22-Oct	409	0.4	24.0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	11	0	0	4
	23-Oct	302	0.6	11.5	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0
Crescent-Lge Total				**1,038**	**570**	**424**	**99**	**21**	**5**	**175**	**147**	**0**	**675**	**163**	**69**	**7**	**3**	**0**	**183**	**12**	**8**	**3,306**
Crescent-Reg.	4-Jul	56	3.2	5.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5-Jul	60	3.0	24.0	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
	6-Jul	59	3.1	24.0	14	14	0	0	0	2	2	0	0	0	0	1	0	0	0	0	0	13
	7-Jul	63	2.9	24.0	5	5	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	9
	8-Jul	60	3.0	24.0	19	18	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	9
	9-Jul	63	2.9	24.0	16	16	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	8
	10-Jul	62	2.9	24.0	29	26	0	0	0	3	3	0	1	0	0	0	0	0	0	0	0	21
	11-Jul	66	2.7	24.0	19	16	0	0	0	3	3	0	2	0	0	0	0	0	0	0	0	12
	12-Jul	65	2.8	24.0	17	15	0	0	0	3	3	0	1	0	0	0	0	0	0	0	0	13
	13-Jul	79	2.3	24.0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
	14-Jul	78	2.3	24.0	29	24	0	0	0	2	2	0	2	0	0	0	0	0	0	0	0	3
	15-Jul	71	2.6	24.0	8	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
	16-Jul	82	2.2	24.0	35	13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8
	17-Jul	83	2.2	24.0	33	30	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	14
	18-Jul	88	2.0	24.0	31	28	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
	19-Jul	85	2.1	24.0	5	5	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	8
	20-Jul	96	1.9	24.0	5	3	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	13

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to:** **October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	21-Jul	91	2.0	24.0	19	16	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	9
	22-Jul	96	1.9	24.0	20	20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	11
	23-Jul	106	1.7	24.0	35	30	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	10
	24-Jul	99	1.8	24.0	11	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	10
	25-Jul	101	1.8	24.0	2	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	12
	26-Jul			9.6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27-Jul	113	1.6	9.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28-Jul	109	1.7	24.0	2	2	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	31
	29-Jul	115	1.6	24.0	1	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	19
	30-Jul	118	1.5	24.0	5	5	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	19
	31-Jul	108	1.7	16.8	4	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	18
	1-Aug			0.0	Fishwheel shutdown during fishery																	
	2-Aug			0.0	Fishwheel shutdown during fishery																	
	3-Aug			8.3	Fishwheel shutdown during fishery																	
	4-Aug	176	1.0	24.0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	25
	5-Aug	144	1.3	24.0	1	0	0	0	0	1	1	0	6	0	0	0	0	0	0	0	0	100
	6-Aug	149	1.2	24.0	1	1	0	1	0	1	1	0	5	0	0	0	0	0	0	0	0	65
	7-Aug	158	1.1	24.0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	56
	8-Aug	195	0.9	13.3	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	43
	9-Aug			0.0	Fishwheel shutdown during fishery																	
	10-Aug			3.1	Fishwheel shutdown during fishery																	
	11-Aug	363	0.5	12.3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10
	12-Aug	173	1.0	24.0	3	3	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	16
	13-Aug	151	1.2	24.0	7	7	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	24
	14-Aug	160	1.1	24.0	2	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	18
	15-Aug	86	2.1	24.0	3	3	0	0	0	1	1	0	15	0	1	0	0	0	0	0	0	20

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	16-Aug	137	1.3	13.3	4	4	0	0	0	1	1	0	4	0	0	0	0	0	0	0	0	17
	17-Aug			7.1	Fishwheel shutdown during fishery																	
	18-Aug	151	1.2	24.0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	28
	19-Aug	144	1.3	24.0	2	0	1	0	0	0	0	0	2	0	1	0	0	0	0	2	1	30
	20-Aug	173	1.0	24.0	0	0	0	0	1	0	0	0	4	2	0	0	0	0	0	0	0	29
	21-Aug	153	1.2	15.8	1	1	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	40
	22-Aug			0.0	Fishwheel shutdown during fishery																	
	23-Aug			10.0	Fishwheel shutdown during fishery																	
	24-Aug	110	1.6	24.0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	21
	25-Aug	109	1.7	24.0	1	1	0	0	0	2	2	0	4	1	0	0	0	0	0	1	1	35
	26-Aug	131	1.4	24.0	2	1	0	1	0	3	3	0	2	2	0	0	0	0	0	0	0	27
	27-Aug	133	1.4	24.0	1	0	0	0	0	4	1	0	1	1	0	0	0	0	0	1	1	31
	28-Aug	130	1.4	24.0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	1	64
	29-Aug	109	1.7	13.4	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	12
	30-Aug			0.0	Fishwheel shutdown during fishery																	
	31-Aug	120	1.5	6.9	Fishwheel shutdown during fishery																	
	1-Sep	120	1.5	24.0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	52
	2-Sep	126	1.4	24.0	0	0	0	0	0	0	0	0	4	17	0	0	0	0	0	0	0	106
	3-Sep	132	1.4	24.0	1	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	91
	4-Sep	140	1.3	24.0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	98
	5-Sep	163	1.1	11.6	1	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	94
					Fishwheel shutdown from 5 September to 8 October																	
	8-Oct			8.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9-Oct			24.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	10-Oct	209	0.9	24.0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	1	0	0	1
	11-Oct	249	0.7	24.0	0	0	0	0	0	0	0	0	1	4	0	1	1	0	0	0	0	0

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to:** **October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	12-Oct	222	0.8	23.2	0	0	0	0	0	0	0	0	2	4	4	0	0	0	0	0	0	11
	13-Oct	266	0.7	24.0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	1
	14-Oct	233	0.8	24.0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	1	0	0	4
	15-Oct			24.0	0	0	0	0	0	0	0	0	0	8	7	0	0	0	3	0	0	4
	16-Oct	98	1.8	24.0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	2
	17-Oct	209	0.9	24.0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	3	0	0	0
	18-Oct	226	0.8	24.0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	0	0	1
	19-Oct			24.0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	1
	20-Oct			24.0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	1	0	0	0
	21-Oct	109	1.7	24.0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	1	0	0	0
	22-Oct			24.0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0
	23-Oct	226	0.8	11.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Crescent-Reg Total				**1,567**	**417**	**350**	**1**	**4**	**3**	**36**	**31**	**0**	**111**	**68**	**44**	**5**	**1**	**0**	**15**	**8**	**7**	**1,491**
Mission+Crescent Total				**6,008**	**1,361**	**1,095**	**110**	**33**	**12**	**255**	**215**	**0**	**856**	**243**	**120**	**37**	**6**	**0**	**199**	**33**	**26**	**6,694**
Siska FW	1-Aug	51	3.5	8.0	7	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	2-Aug	50	3.6	8.0	32	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	3-Aug	56	3.2	8.0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4-Aug	52	3.5	8.0	22	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	5-Aug	57	3.2	8.0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6-Aug	57	3.2	8.0	42	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	7-Aug	80	2.3	23.2	77	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	8-Aug	80	2.3	24.0	88	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	9-Aug	80	2.3	24.0	92	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
	10-Aug	80	2.3	24.0	49	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444) **Data to: October 23, 2008**

Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies
	11-Aug	78	2.3	24.0	162	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
	12-Aug	79	2.3	24.0	128	12	0	5	1	0	0	0	0	5	0	0	0	0	0	0	0	0
	13-Aug	95	1.9	24.0	41	21	0	1	0	1	0	0	2	0	0	0	0	0	0	0	0	0
	14-Aug	55	3.3	24.0	49	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	15-Aug	45	4.0	24.0	71	21	0	2	0	9	0	0	1	2	0	0	0	0	0	0	0	0
	16-Aug	52	3.5	22.0	97	21	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	1
	17-Aug	78	2.3	24.0	116	21	0	1	0	8	0	0	0	0	0	0	0	0	0	0	0	0
	18-Aug	52	3.5	24.0	71	21	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	19-Aug	66	2.7	23.0	25	19	0	2	0	1	0	0	0	6	0	0	0	0	0	0	0	0
	20-Aug	58	3.1	24.0	55	20	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	1
	21-Aug	52	3.5	23.5	35	20	0	0	0	6	0	0	0	3	0	0	0	0	1	0	0	0
	22-Aug	52	3.5	24.0	24	14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	23-Aug			12.0	9	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
	24-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31-Aug			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1-Sep			12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2-Sep	57	3.2	23.5	2	2	0	0	0	16	0	0	1	4	0	0	0	0	0	0	0	0
	3-Sep	52	3.5	24.0	7	4	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0
	4-Sep	60	3.0	24.0	7	6	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
	5-Sep	66	2.7	24.0	7	7	0	9	0	9	0	0	2	4	8	0	0	0	0	0	0	0

Appendix Table B3 continued.

Fraser Fishwheels - Daily Catch Summary 2008 (phone: 1-866-221-3444)																							**Data to:**	**October 23, 2008**
Location-Fishwheel	Date	Seconds for 3 revs	Rotation Speed (RPM)	Hours Operating	SockeyeAdultCaught	SockeyeAdultSpagTag	SockeyeAdultRadioTag	SockeyeJackCaught	SockeyeRecaptures	ChinookAdultCaught	ChinookAdultSpagTag	ChinookAdultRadioTag	ChinookJackCaught	CohoAdultCaught	CohoJackCaught	SteelheadAdultCaught	SteelheadAdultSpagTag	SteelheadAdultRadioTag	ChumCaught	SturgeonCaught	SturgeonPITTagApplied	OtherSpecies		
	6-Sep	73	2.5	24.0	1	1	0	6	0	12	0	0	1	3	6	0	0	0	0	0	0	0		
	7-Sep	81	2.2	24.0	13	12	0	17	0	22	0	0	4	2	3	0	0	0	0	0	0	0		
	8-Sep	61	3.0	24.0	9	8	0	7	0	8	0	0	3	3	2	0	0	0	0	0	0	0		
	9-Sep	105	1.7	24.0	7	5	0	6	1	16	0	0	0	9	5	0	0	0	0	0	0	0		
	10-Sep			0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	11-Sep	114	1.6	24.0	1	1	0	0	0	9	0	0	0	25	0	0	0	0	0	0	0	0		
	12-Sep	175	1.0	24.0	1	1	0	0	0	2	0	0	0	8	0	0	0	0	0	0	0	0		
	13-Sep	130	1.4	24.0	2	2	0	0	0	4	0	0	0	10	0	0	0	0	4	1	0	0		
	14-Sep	134	1.3	24.0	8	7	0	0	0	4	0	0	0	19	0	3	0	0	0	0	0	1		
	15-Sep	150	1.2	24.0	6	7	0	0	0	1	0	0	0	15	0	7	0	0	0	0	0	0		
	16-Sep	135	1.3	24.0	5	3	0	0	0	0	0	0	0	32	0	7	0	0	0	0	0	0		
	17-Sep	135	1.3	24.0	3	3	0	0	0	0	0	0	0	24	0	3	0	0	0	0	0	6		
	18-Sep	140	1.3	24.0	4	4	0	0	0	0	0	0	0	34	0	4	0	0	0	0	0	4		
	19-Sep	155	1.2	24.0	2	2	0	2	0	0	0	0	0	34	3	6	0	0	0	1	0	7		
	20-Sep	158	1.1	24.0	1	2	0	1	0	0	0	0	1	11	0	3	0	0	1	1	0	8		
	21-Sep	175	1.0	12.0	0	0	0	0	0	1	0	0	0	3	1	2	0	0	0	0	0	2		
Siska Total				**895**	**1,420**	**267**	**0**	**60**	**3**	**194**	**0**	**0**	**15**	**268**	**28**	**35**	**0**	**0**	**6**	**3**	**0**	**30**		

APPENDIX C

Fishery Returns, Mobile Detections, and Spawning Ground Recoveries

Appendix Table C1. Sockeye radio tags recovered from fisheries or found near shore, and reported before 31 December, 2008.

Tag No.	Sampling Period	Run-timng Group	Recovery Date	Zone	Recovery Location
4	IR_1	Summer-run	7 Aug	FN Fishery D/S Mission	Alex Fraser Bridge
88	IR_3	Late-run	21 Aug	FN Fishery D/S Mission	d/s of Port Mann Bridge on Fraser at top of shady Island
110	IR_2	Summer-run	15 Aug	FN Fishery D/S Mission	under Alex Fraser Bridge - Delta
2	IR_1	Summer-run	10 Aug	FN Fishery between Mission and Sawmill	Coquihalla
3	IR_1	Summer-run	9 Aug	FN Fishery between Mission and Sawmill	Queen's Island
8	IR_1	Summer-run	9 Aug	FN Fishery between Mission and Sawmill	Tracked above Qualark
11	IR_1	Summer-run	9 Aug	FN Fishery between Mission and Sawmill	Bridal Falls on Fraser River near Peters Rd., Hope, BC
38	IR_2	Summer-run	16 Aug	FN Fishery between Mission and Sawmill	Strawberry Island
39	IR_2	Summer-run	17 Aug	FN Fishery between Mission and Sawmill	between Yale and Hope beach - C04a
41	IR_2	Summer-run	17 Aug	FN Fishery between Mission and Sawmill	Yale Beach
45	IR_2	Summer-run	15 Aug	FN Fishery between Mission and Sawmill	Strawberry Island
50	IR_2	Summer-run	17 Aug	FN Fishery between Mission and Sawmill	between Yale and Hope beach - C04a
57	IR_2	Summer-run	17 Aug	FN Fishery between Mission and Sawmill	Yale Beach
81	IR_3	Early Summer	22 Aug	FN Fishery between Mission and Sawmill	Yale Beach
100	IR_3	Summer-run	23 Aug	FN Fishery between Mission and Sawmill	Bridal Falls on Fraser River near Peters Rd., Hope, BC
25	IR_1	Summer-run	13 Aug	FN Fishery U/S Sawmill	Spuzzum
34	IR_2	Summer-run	19 Aug	FN Fishery U/S Sawmill	Bridge River
67	IR_3	Summer-run	31 Aug	FN Fishery U/S Sawmill	Kanaka Bar
83	IR_3	Summer-run	7 Sep	FN Fishery U/S Sawmill	Bridge River
86	IR_3	Summer-run	30 Aug	FN Fishery U/S Sawmill	Stein
95	IR_3	Summer-run	14 Sep	FN Fishery U/S Sawmill	near Hanceville on Chilko River
103	IR_2	Summer-run	27 Aug	FN Fishery U/S Sawmill	10 mile - near Lillooet
27	IR_1	Early Summer	28 Aug	Found along Chilliwack River	Chilliwack
78	IR_3	Late-run	21 Sep	Found on bank of Cultus Lake	Cultus Lake shore
102	IR_2	Summer-run	23 Aug	Found along Chilliwack River	Main bank of River, Deroche below Queen's Island