Puntledge River Impoundment and Diversion Dam Fishway Assessment 2007

07.Pun.02

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Prepared with financial support of:

BC Hydro Bridge Coastal Fish and Wildlife Restoration Program

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EXECUTIVE SUMMARY

Following expansion of the hydroelectric facilities on the Puntledge River in 1955, annual escapements of summer chinook declined from an average of about 3000 to below 600 by 1975. In 1965, the upper section of river was closed to adult fish and a spawning channel was constructed adjacent to the Puntledge River diversion dam as compensation for losses in summer chinook and steelhead spawning habitat. Unfortunately, survival in the channel was very poor. Since then, summer run chinook production has been dependent on hatchery returns, with over 90% of returns being of hatchery origin. Although returns have increased slightly in the last 20 years, the stock is not self-sustaining and is dependent on hatchery augmentation. DFO considers the Puntledge summer run chinook a potentially unique endangered stock and therefore a priority for recovery under the Wild Salmon Policy. Over the past 5 years, DFO along with a number of community partners has begun implementing a long-term strategy to rebuild the summer run chinook stock to historical (pre-hydro expansion) production levels. Some of these initiatives include restoration of spawning habitat, modifications to hatchery culture practices, reductions in pre-spawn mortality, pulse flows in the river and improved access to Comox Lake and tributaries in the upper watershed.

In 2005 a fishway assessment was implemented at both the diversion and impoundment dams using underwater cameras to determine if these fishways provide passage for summer-run chinook salmon (and steelhead) at various lake levels and flows throughout the migration period. Ensuring chinook access through the dams benefits all species that historically had access into Comox Lake. This study was repeated for two consecutive years and included monitoring fish passage at the lower hatchery. All fishways were equipped with an aluminum tunnel and underwater colour camera, connected to a digital recorder to record and archive video surveillance footage.

For the 2007 monitoring period, video surveillance commenced in March and terminated in December. Total numbers of summer chinook recorded at the lower hatchery, diversion and impoundment dam cameras was 34, 245 and 4 respectively. The large discrepancy in the numbers passing through the lower and upper hatchery fishways is most likely due to the ability of summer chinook to access the river upstream of the lower hatchery fence via a small flood channel on the left bank of the fence during higher discharges. Therefore a success rate for summer chinook migrating through Reach C can not be derived from the data.

The low numbers of chinook that were recorded passing through the Comox Dam fishway into Comox Lake remains a mystery. The camera in the fishway was not operating for over one month in 2007 which would have coincided with the period of peak migration through the dam as was demonstrated in 2005. Therefore, while many fish may have accessed the lake undetected, it is also suspected that chinook may be able to migrate through the sluice gates during favorable conditions.

TABLE OF CONTENTS

Executive Summary ..... **ii**
Table of Contents ..... **iv**
List of Figures ..... **v**
List of Tables ..... **v**

1 Introduction **1**
1.1 Background *1*
1.2 Goals and Objectives *2*
2 Study Area **3**
3 Methods **3**
3.1 Equipment installation/modifications *3*
3.2 Equipment monitoring *3*
3.3 Environmental data *5*
3.4 Communications *5*
4 Results **5**
4.1 Diversion Dam (Upper Hatchery) Fishway *5*
4.2 Impoundment Dam Fishway *8*
4.3 Lower Puntledge Hatchery Bypass *8*
4.4 Impoundment Dam Fishway Discharge *9*
5 Discussion **11**
5.1 Lower vs. Upper Hatchery (Diversion Dam) Chinook Counts *11*
5.2 Diversion vs. Impoundment Dam Chinook Counts *11*
5.3 Comparison of migration at Comox Dam 2005-2007 ..... *12*
6 Conclusions and Recommendations **14**
7 Acknowledgements **16**
8 References **17**

Appendices

A BCRP Financial Statement
B Performance Measures – Actual Outcomes
C Confirmation of BCRP Recognition
D Photos

LIST OF FIGURES

Figure 1. Location map of the Puntledge River showing fishway monitoring sites at the lower hatchery, upper hatchery (diversion dam) and Comox impoundment dam.....4

Figure 2. Movement of summer chinook salmon (CN) through the diversion fishway as recorded by underwater video surveillance, June 12 – Sept 6, 2007 plotted with discharge in Reach C recorded at BC Hydro Gauge 6.....6

Figure 3. Daily migration patterns of summer chinook through the diversion dam fishway, June – September 2007, and hourly average diurnal temperature (from T. Sweeten, DFO) as measured on July 27, 2007. 7

Figure 4. Summer run chinook and coho migration recorded at all 3 video monitoring stations in the Puntledge River fishways between March 1 and December 7, 2007 9

Figure 5. Revised discharge / lake elevation relationship developed for the fishway at the Comox Lake impoundment dam from data collected in 2006.....10

Figure 6. Discharge through the Comox impoundment dam fishway between June 1 and Aug 31, 2007 calculated from a discharge / lake elevation relationship developed in 2006. Velocity through the sluice gates during this period is calculated from BC Hydro data.....10

Figure 7. Comparison of the calculated daily average velocity through sluice gates 1 & 2 at the Comox Dam for monitoring years 2005-2007 in relation to the chinook salmon burst speed from Bjornn and Reiser, 1991.....13

Figure 8. Comparison of the total discharge at Comox Dam and Comox Lake elevation for monitoring years 2005-2007 (hourly average data from BC Hydro records). 14

LIST OF TABLES

Table 1. Schedule of fishway operations and video surveillance at the lower Puntledge hatchery, the upper hatchery (diversion dam), and the Comox Lake impoundment dam, March - December 2007. 7

1 INTRODUCTION

Following expansion of the hydroelectric facilities on the Puntledge River in 1955, annual escapements of summer chinook declined from an average of about 3000 to below 600 by 1975. In 1965, the upper section of river was closed to adult fish and a spawning channel was constructed adjacent to the Puntledge River diversion dam as compensation for losses in summer chinook and steelhead spawning habitat. Unfortunately, survival in the channel was very poor. Since then, summer run chinook production has been dependent on hatchery returns, with over 90% of returns being of hatchery origin. Although returns have increased in the last 20 years, the stock is not self-sustaining and is dependent on hatchery augmentation. DFO considers the Puntledge summer-run chinook a potentially unique endangered stock and therefore a priority for recovery under the Wild Salmon Policy. Over the past 5 years, DFO has implemented a long-term strategy to rebuild the summer run chinook stock to historical (pre-hydro expansion) production levels. Some of these initiatives include restoration of spawning habitat, modifications to hatchery culture practices, reductions in pre-spawn mortality, pulse flows in the river and improved access to Comox Lake and tributaries in the upper watershed.

The long-term strategy for the rebuilding of Puntledge River summer chinook is to re-establish a self-sustaining return through restoration of fisheries habitats and augmentation of Puntledge River discharges. Ensuring fish access into the upper river and Comox Lake during the migration period is an important step towards achieving this goal. Recent migration studies demonstrate that adult holding survival in Comox Lake between July and October is likely two times higher than adults that hold during the same period in the lower river. This report details results of monitoring summer chinook movement through the fishways at the diversion and impoundment dams and the lower Puntledge hatchery in 2007. This report also compares results from 2005-2007 to identify trends in migration at these three key locations.

1.1 Background

Prior to construction of the first impoundment dam on the Puntledge River in 1912, anadromous fish species that were able to ascend Stotan and Nibs Falls had unrestricted access into Comox Lake (anon, 1958). It is surmised that early summer-run chinook salmon migrants utilized the lake as a holding refuge during the summer to escape high

water temperatures. They would then drop back downstream in the fall and spawn in the reach below the lake outlet or in the upper watershed. This evolved migration and lake-holding behavior was likely a key factor in reducing pre-spawning mortality. The impoundment dam at the lake outlet was not equipped with a fishway until 1922, and redesigned structures were installed in 1946 and again in 1958. However all of these fishway modifications likely provided only limited access into Comox Lake, under ideal lake levels and flows (anon, 1958; Rimmer et al., 1994). Consequently, the complete obstruction to fish migration until 1922 and the sporadic access thereafter would have had a significant impact on anadromous fish stocks that utilized the lake and upper tributaries. In 1991 a new submerged orifice fishway was installed at the impoundment dam by the Ministry of Environment, replacing the pool/weir style fishway with the expectation that it would provide better passage for summer steelhead (Rimmer et al., 1994). However, the performance of new design was never monitored.

The ineffectiveness of the Comox Dam fishway was first observed in 2002 which immediately prompted BC Hydro and government agencies to develop a strategy to address the fish passage problems. This included short-term operational measures in 2003, (Bigsby, 2003) and finally, more significant modifications in the following year (Guimond 2006). Changes made to the fishway in 2004 included modifying the orifice dimensions to increase discharge and increasing the drop over the entrance weir to improve attraction to the fishway.

Project effectiveness was monitored for 4 years following the 2004 modifications, using underwater cameras, and VHS video recorders. This equipment was replaced with more efficient and reliable digital video management equipment after the first year, with funding from BCRP. Results from these assessments are summarized in Guimond 2006 and 2007.

1.2 Goals and Objectives

The objective of the fishway monitoring program is to determine how effectively the fishways operate at various lake levels and flows throughout the chinook migration period. Recommendations in the 2006 study (Guimond 2007) were implemented in the 2007 study and additional data was collected on fish access through the fishways at all 3 locations (i.e. lower hatchery, diversion dam and impoundment dam).

2 STUDY AREA

The Puntledge River encompasses a 600 km^2 area west of the city of Courtenay. The lower Puntledge River flows from Comox Lake in a north-easterly direction for 14 km where it joins with the Tsolum River. Downstream of this confluence, the waterway is referred to as the Courtenay River, which flows for another 2.6 km into the Strait of Georgia. BC Hydro operates a diversion dam 12.9 kilometers upstream of the estuary, and an impoundment dam a further 3.7 km upstream (Figure 1). Both of these facilities are equipped with fishways to allow migrating fish access into habitats in the upper watershed. The Puntledge hatchery also operates fish bypass structures in the river at their lower site, 6.6 km upstream of the estuary, and into the upper hatchery site adjacent BC Hydro's diversion dam.

3 METHODS

3.1 Equipment installation/modifications

Aluminum camera tunnels installed in the fishways for the 2006 video surveillance project were left in place over the winter. This facilitated start-up of the project since installation of these structures can be tedious and carries the greatest safety risk.

3.2 Equipment monitoring

Two underwater colour video cameras (SplashCam Deep Blue) and digital video recorders (Duplex 1600/800 manufactured by Silent Witness®) were used to monitor the movement of summer run chinook salmon through the diversion and impoundment dam fishways, 24 hrs per day from June 12 to Dec 7, 2007. A third camera/recorder system operated at the lower Puntledge hatchery from March 1 until June 18, 2007 to monitor summer chinook migration past the hatchery fence (i.e. those that do not enter the hatchery raceway for broodstock). This system provided additional information on chinook migration timing and numbers that accessed Reach C before the by-pass was closed for broodstock capture. Surveillance at the lower hatchery was started earlier than planned because the equipment was already being operated for a steelhead migration study.

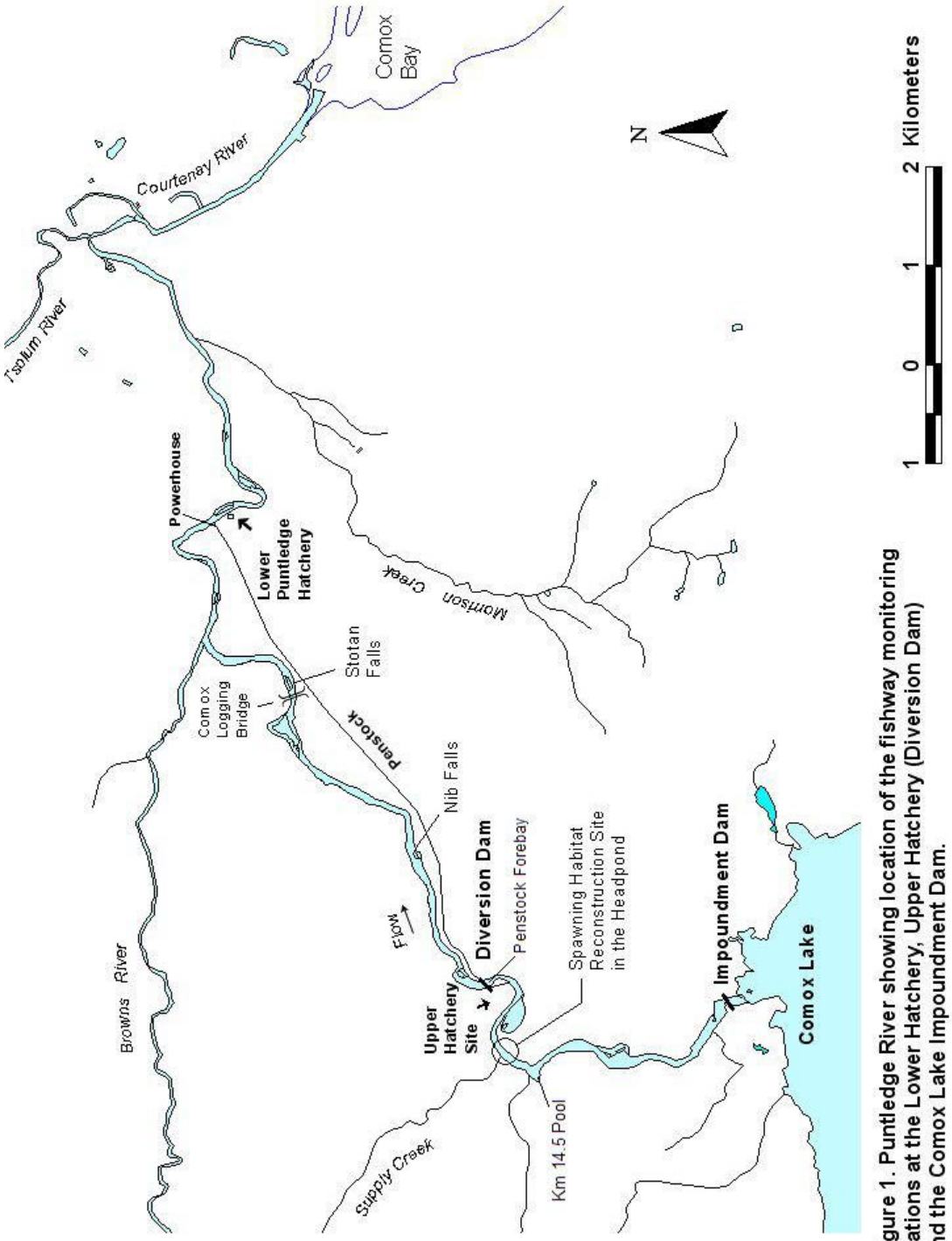

Figure 1. Puntledge River showing location of the fishway monitoring stations at the Lower Hatchery, Upper Hatchery (Diversion Dam) and the Comox Lake Impoundment Dam.

Recorded video footage on each DVMS system (diversion and impoundment dams) was viewed every few days for the first week in order to set the sensitivity of the motion detector, event recording sensitivity levels, image resolution and storage preferences.

Once all recording parameters were established, and data technicians were familiar and confident with the equipment and recordings, the units were viewed weekly. Migration events through the fishways were recorded by date and time, and whenever possible, included information on physical features and condition of fish (i.e. species, jacks, external markings, severe injury, etc).

3.3 Environmental data

Records of discharge at Gauge 6 below the diversion dam (WSC Gauge No. 08HB084), Comox Lake levels, and Comox dam sluice gate height and discharge were obtained from BC Hydro.

3.4 Communications

A Communications Plan conducted by staff of Comox Valley Project Watershed Society informed the public about the project through notices in local newspapers, displays at a BC Rivers Day, and an article in the *Watershed News* (Appendix C). A more detailed Community Outreach Program associated with this and three other BCRP projects in the Puntledge River watershed will be summarized in a separate report.

4 RESULTS

4.1 Diversion Dam (Upper Hatchery) Fishway

The camera at the diversion dam fishway operated from June 12 to September 6 with a brief outage (June 16-18) when the camera was removed for repair. A total of 245 summer chinook, 4 steelhead and 9 trout were counted by the camera entering the headpond through the diversion dam fishway during this period (Figure 2).

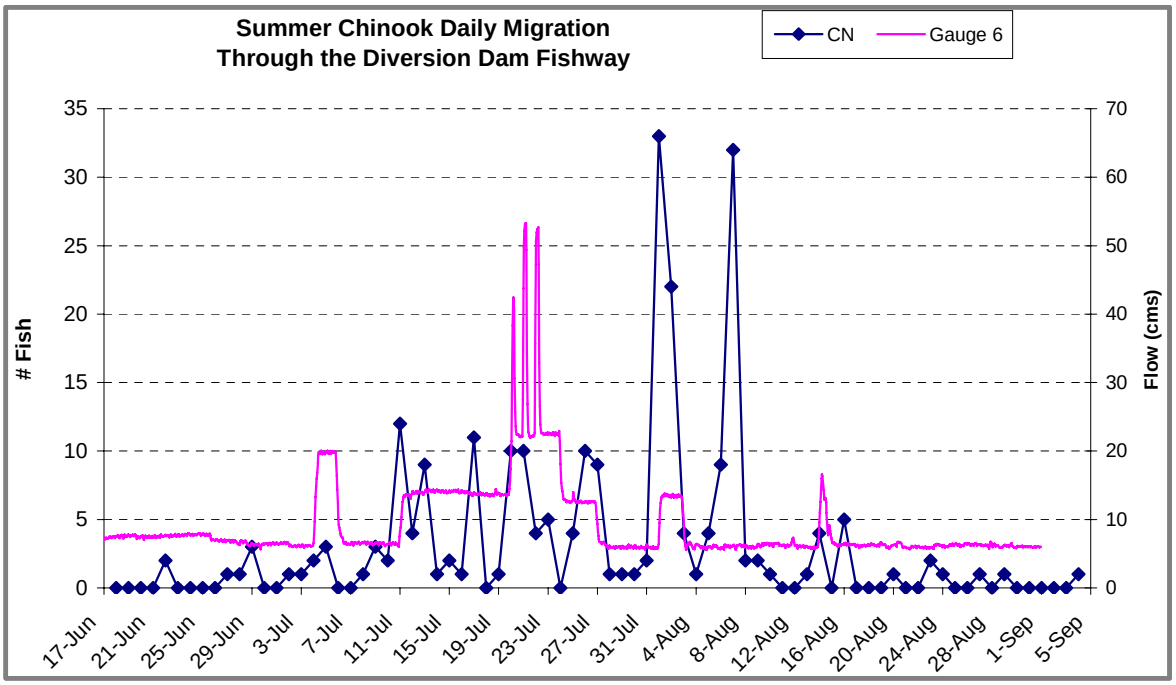

Figure 2. Movement of summer chinook salmon (CN) through the diversion fishway as recorded by underwater video surveillance, June 12 – Sept 6, 2007 plotted with discharge in Reach C recorded at BC Hydro Gauge 6.

The diversion dam fishway was closed Sept 6 to prevent fall chinook access into the headpond. It was reopened on October 30 for coho migration and remained open throughout the winter. Video surveillance was conducted from Oct 30 – Nov 22 and during this time 54 coho were counted entering the headpond. Fishway operations and video surveillance schedules are summarized in Table 1.

At the diversion dam, fish migrated through the tunnel during all hours of the day, but peak migration through the fishway occurred between the hours of 05:00 and 12:00 with a smaller period of activity from 16:00 – 20:00 (Figure 3). The diurnal pattern of movement through the fishway (peak migration) seems to coincide with the coolest past of the day. The urge to migrate may also be influenced by increasing (or decreasing) light intensity in the tunnel or the pool below the fishway entrance.

Table 1. Schedule of fishway operations and video surveillance at the lower Puntledge hatchery, the upper hatchery (diversion dam), and the Comox Lake impoundment dam, March - Dec 2007.

Date	Lower Hatchery	Diversion Dam	Comox Dam	Comment
1-Mar-07	open	closed	open	Video monitoring begins at lower hatchery (for Steelhead monitoring)
17-Mar-07	open	closed	open	First Summer chinook recorded migrating above hatchery fence
12-Jun-07	open	open	open	Video monitoring begins at Upper hatchery (Diversion dam) and Comox Dam
June 16-18	open	open	open	Diversion dam fishway camera down for repair
18-Jun-07	closed	open	open	Broodstock collection begins at lower hatchery; 34 SCN counted on Lower hatchery camera
19-Jun-07	closed	open	open	Comox Dam camera visibility poor during day, nil during night. Outage for the fishway was requested to BC Hydro for camera maintenance.
31-Jul-07	closed	open	open	Comox Dam visibility nil during daylight hours
29-Aug-07	closed	open	open	Completed maintenance of Comox Dam camera.
1-Sep-07	open	open	open	Lower hatchery bypass opened. Access to Reach C and hatchery for Fall CN brood collection.
6-Sep-07	open	closed	open	Bypass at Diversion dam (Upper hatchery) closed; 245 SCN counted on camera
17-Sep-07	open	closed	open	Lower hatchery fishway closed; bypass to Reach C remained open
27-Sep-07	closed	closed	open	Closed Lower Hatchery bypass to Reach C; opened fishway into Hatchery Raceway 2
30-Oct-07	opened	opened	open	Lower hatchery bypass opened; Diversion Dam fishway opened for coho.
22-Nov-07	open	open	open	Video monitoring terminated at Diversion Dam.
7-Dec-07	open	open	open	Video monitoring terminated at Comox Dam

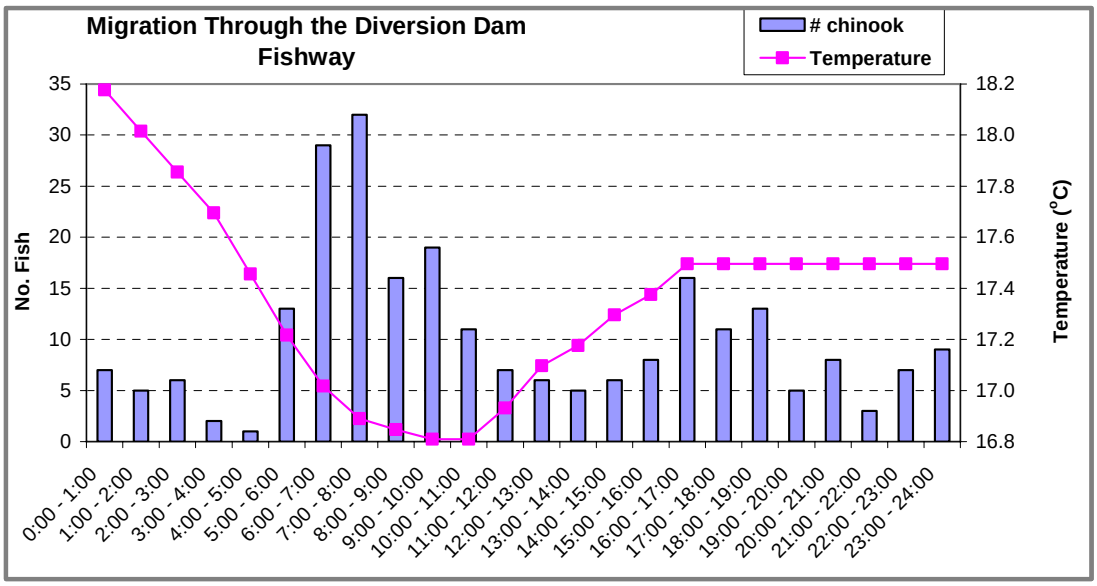

Figure 3. Daily migration patterns of summer chinook through the diversion dam fishway, June – September 2007, and hourly average diurnal temperature (from T. Sweeten, DFO) as measured on July 27, 2007.

4.2 Impoundment Dam Fishway

The camera in the Comox Dam fishway tunnel was left in place after the 2006/07 monitoring program and only the digital recorder and TV monitor were removed for the winter. Operation of the camera and monitoring equipment commenced June 12. It was noted at this point that image quality from the camera was slightly blurred due to algae growth on the camera lens and/or plexiglass wall of the tunnel over the winter/spring. Nevertheless, fish migrating through the fishway could still be detected during daylight hours, but not during night. An outage request to BC Hydro was made on June 19 to schedule maintenance and cleaning of the camera. The outage request was finally granted on August 29 due to delays caused by requirements for BC Hydro to complete a Hazard Assessment and Procedure for the Comox fishway, as well as a high reservoir level. Maintenance included cleaning of the plexiglass wall of the tunnel and camera lens and replacement of bulbs in the lights. Image quality (both day and night viewing) after the maintenance work was excellent. The number of summer chinook recorded by the camera prior to this date was zero and only 4 were counted following the maintenance/cleaning. Thirty-four coho were counted passing through the tunnel into the lake between Nov 2 and Dec 5. Video monitoring was terminated on December 7.

4.3 Lower Puntledge Hatchery Bypass

Video surveillance commenced at the lower hatchery on March 1, 2007 and recorded 34 summer chinook passing through the tunnel to access the reach above the barrier fence until the by-pass was closed on June 18. The first summer chinook jack was observed passing through the lower hatchery fishway on March 17, 2007.

From June 18 until September 1, the by-pass was closed, and all fish were diverted into the lower hatchery for broodstock collection. The lower hatchery bypass was reopened concurrently with the hatchery fishway for Fall chinook migration and broodstock collection on September 1. Video surveillance resumed and a total of 2541 Fall chinook, 787 pink and 201 coho salmon were recorded passing through the fishway until September 27. Figure 4 summarizes total numbers of summer chinook and coho salmon counted at all fishway cameras during the entire monitoring period.

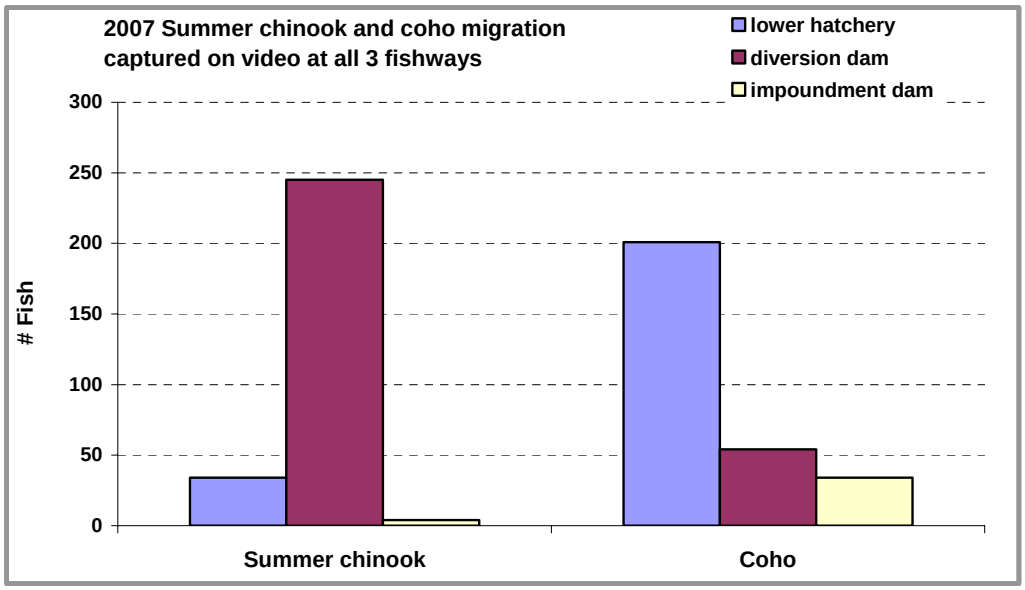

Figure 4. Summer run chinook and coho migration recorded at all 3 video monitoring stations in the Puntledge River fishways between March 1 and December 7, 2007.

4.4 Impoundment Dam Fishway Discharge

In 2006, a relationship between lake elevation and fishway discharge was developed using water level data collected at the fishway outlet and lake elevation between July and October 2006. Re-examination of the data used in developing this relationship found a small error. A new relationship is illustrated in Figure 5. Discharge at the fishway was not measured in 2007, however, using this discharge / lake elevation relationship, discharge through the fishway can be calculated (Figure 6). Discharge through the fishway at the Comox impoundment dam between July 1 - August 31, 2007 ranged from 0.95 to 1.14 m^3/s (Figure 6). It is assumed that chinook would have no difficulty negotiating the fishway under these flows. Velocities through the two sluice gates during this period were below the chinook salmon burst speed (6.83 m/s) from Bjornn and Reiser 1991.

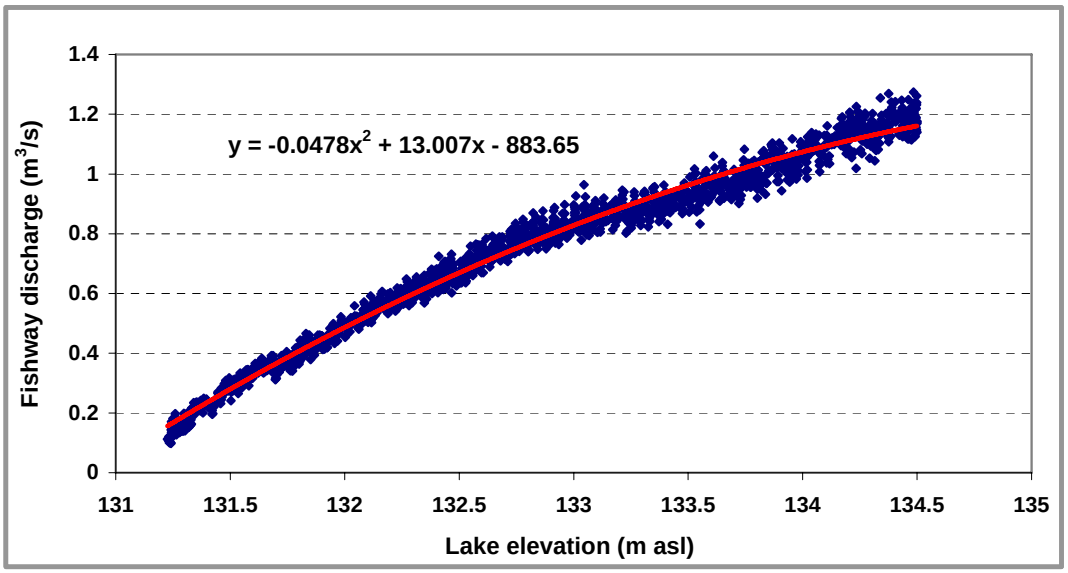

Figure 5. Revised discharge / lake elevation relationship developed for the fishway at the Comox Lake impoundment dam from data collected in 2006.

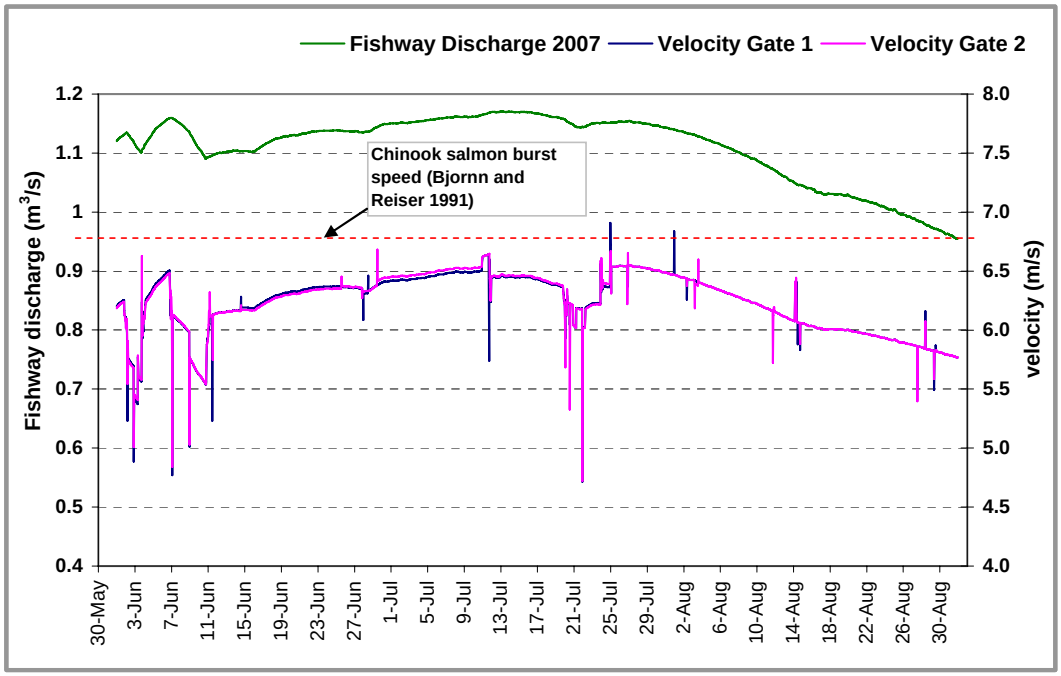

Figure 6. Discharge through the Comox impoundment dam fishway between June 1 and Aug 31, 2007 calculated from a discharge / lake elevation relationship developed in 2006. Velocity through the sluice gates during this period is calculated from BC Hydro data.

5 DISCUSSION

5.1 Lower vs. Upper Hatchery (Diversion Dam) Chinook Counts

A large difference in summer chinook counts between the lower (37) and upper hatchery (237) fishways was found in the 2006 monitoring program. It was suspected that early summer chinook migrations were being missed (lower hatchery camera began operating May 5, 2006). This led to a recommendation to begin video surveillance of the lower hatchery bypass in March 2007. In spite of this change, the difference in counts between the two sites remained similar to 2006 (i.e. a total of 34 and 245 counted at the lower and upper site, respectively). After further investigation, it now is presumed that adults are able to by-pass the hatchery fence in the lower river through a flood channel on the left bank during high river discharges. BC Hydro currently releases ~85 cm/s into Reach C for a kayak pulse flow event, typically around the beginning of June. It is also common for Hydro to spill water into the river during high Comox Lake inflows and snow melt events in the Spring. At these elevated flows, adults that are able to by-pass the fishway camera at the lower hatchery would account for the discrepancy between the lower and upper cameras.

5.2 Diversion vs. Impoundment Dam Chinook Counts

Summer chinook broodstock collection did not occur at the upper Puntledge hatchery facility in 2007. All 245 adults recorded at the diversion dam fishway were released into the headpond. The impoundment dam fishway camera was, for the most part, out of order during most of July and August, the peak migration period for access into Comox Lake (based on 2005 data). The headpond was surveyed periodically by boat in late August and September to obtain an estimate of the number of chinook that remained in the headpond. Typically, chinook in the headpond would hold in the impoundment dam tailrace pool, the large pool at ~ km 14.7 (upstream of the new spawning platform) and occasionally in the penstock forebay. The latter site is inaccessible by boat, as is the tailrace pool, in addition to being turbulent and therefore impossible to see fish holding. Small schools of adults (25-50 fish) were seen on some events at km 14.7, however it was difficult to get an accurate count.

Contingency funds were provided by BCRP to conduct additional helicopter surveys of the Cruickshank and Upper Puntledge rivers and the headpond in order to determine whether large numbers of summer chinook accessed Comox Lake and the upper tributaries. The helicopter survey occurred on October 5, 2007 during clear skies and favorable viewing conditions and when chinook would likely be on the spawning grounds. The flight included a

survey of the headpond area, the Cruickshank River and major tributaries (Eric, Rees and Comox creeks) and the Upper Puntledge River (including Forbush and Willemar Lakes). A second helicopter survey was planned for later in October, but did not take place due to weather and scheduling difficulties. It was hoped that if large numbers of chinook accessed Comox Lake via the fishway during July-August when the camera was not operating, or if they were able to access the lake through the dam sluice gates, as has been suggested in previous years, then perhaps many of these fish would spawn in the lake tributaries. This was observed during the 2005 radio telemetry study (Taylor and Guimond, 2006). In that year, 9 out of 14 radio tagged fish (or 64%) that accessed the lake (or were released into the lake directly) were located in the Cruickshank and Upper Puntledge rivers in October. A radio telemetry study conducted concurrently to the fishway monitoring program in 2007 found that only 5 tagged chinook accessed the headpond, none of which enter the lake. In addition, 8 of 10 radio tagged summer chinook released directly into Comox Lake in July dropped down into the headpond at the beginning of October to spawn below the dam. The other 2 lake-released chinook were located in the upper Puntledge River during the helicopter survey.

Results from the heli survey did not yield any counts of chinook on the spawning grounds in the Cruickshank or Upper Puntledge rivers. Approximately 180 chinook were counted in the headpond between the impoundment and diversion dams. This count is likely underestimated due to the difficulties observing fish along the shaded river margins or in turbulent areas of the river. If this is taken into account, there may be only a small number of summer chinook that may have accessed the lake (i.e. less than 20%). However, prior to the heli survey, it is possible that fish may have accessed the lake and then dropped back below the dam to spawn in early October.

5.3 Comparison of migration at Comox Dam 2005-2007

The significant difference in migration rate through the Comox Dam fishway between 2005 and 2007 has generated some interesting theories. In 2005, over 75% of the chinook that migrated into the headpond continued to migrate through the fishway into Comox Lake. This rate was significantly lower in 2006 and again in 2007. It has been suggested that the lower numbers of chinook recorded using the fishway may be due to chinooks accessing the lake through the Comox Dam under sluice gates. Using BC Hydro's records of gate openings and discharge for each of the sluice gates at the Comox Dam for 2005-2007, velocities through both gates was higher than the burst speed of 6.83 m/s (22.4 ft/s) for chinook salmon (Bjornn and Reiser 1991) in 2005. In contrast gate velocities were lower in 2006 and 2007 (Figure 7) suggesting that chinook can access the lake via the fishway in years when conditions through

the sluice gates are unfavorable. Although total sluice discharge and lake levels were lower in 2005 than 2007, the calculated daily average velocities through the dam were higher likely forcing fish to use the fishway (Figure 8). However, this behaviour has not been confirmed. Of the 5 radio tagged fish that migrated into the headpond during the 2007 WUP Telemetry study, none successfully accessed the lake.

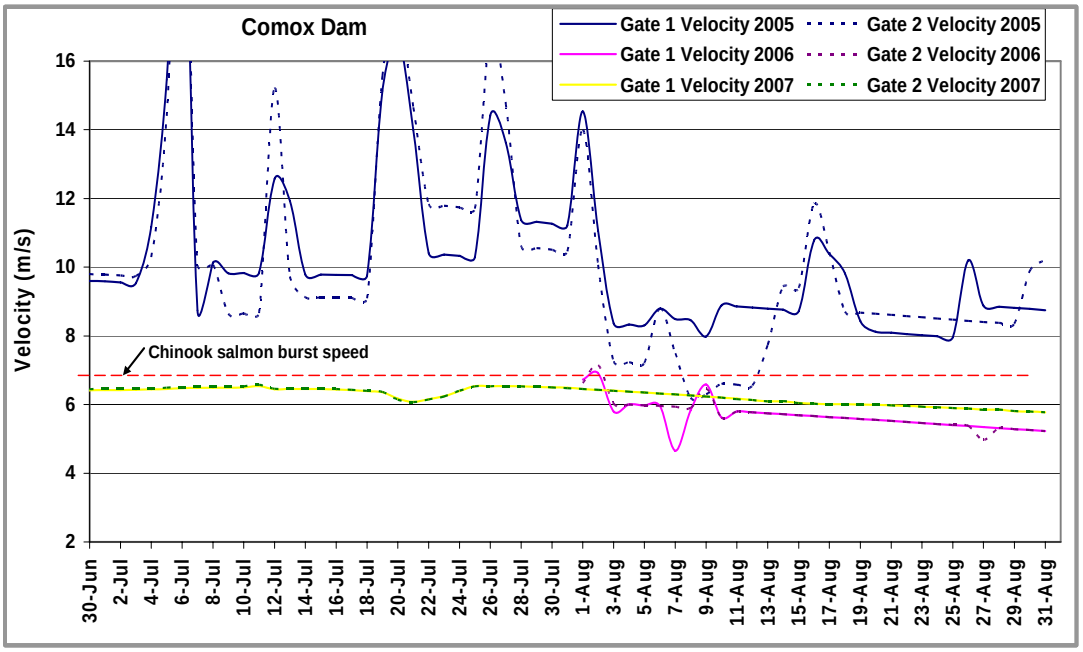

Figure 7. Comparison of the calculated daily average velocity through sluice gates 1 & 2 at the Comox Dam for monitoring years 2005-2007 in relation to the chinook salmon burst speed from Bjornn and Reiser, 1991.

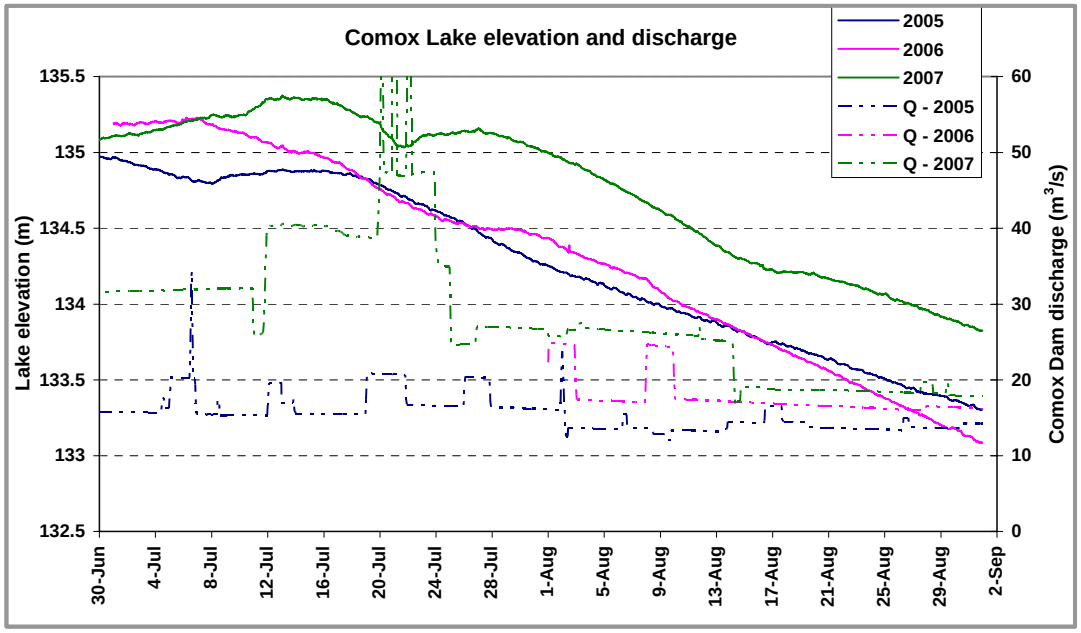

Figure 8. Comparison of the total discharge at Comox Dam and Comox Lake elevation for monitoring years 2005-2007 (hourly average data from BC Hydro records).

A second theory for the low numbers of chinook migration through Comox Dam may be their reluctance to migrate beyond the area that they were released as smolts (upper Puntledge Hatchery). According to hatchery records, the last release of summer chinook smolts to the upper watershed occurred in the Spring of 2004 (L. Frisson, pers. comm.). Thus the majority of returns from this colonization program would have terminated in 2007 (only a small percentage of Puntledge summer chinook returns are 5 yr olds that will return in 2008). This theory will be further investigated.

Chinook adults will be encouraged to migrate through the Comx Dam fishway by tethering chinook carcasses in the fishway. This will hopefully provide a scent that will attract adults into the lake.

6 CONCLUSIONS AND RECOMMENDATIONS

Although this was the final year of BCRP funding for the fishway monitoring, DFO and Puntledge Hatchery plan to continue to operating the cameras at the lower and upper hatchery as well as Comox Dam to monitor escapement of summer chinook and other stocks that access the fishways. Furthermore, monitoring fishway migration complements the WUP radio telemetry summer chinook migration studies that will be conducted between 2008 and 2010.

Monitoring migration of untagged fish through the 3 fishways will verify if the radio telemetry tagged fish are exhibiting similar behaviors and possibly identify any missed signals from a radio-tagged fish entering the headpond reach or Comox Lake. To be of value, it will be imperative that all cameras are functioning properly with optimal image quality throughout the entire chinook migration period so that all radio-tagged and untagged adults can be recorded. Scheduling maintenance on these installations will require cooperation from BC Hydro and DFO Puntledge Hatchery staff (in the case of the Comox Dam fishway, B.C. Hydro requires 2 weeks notification to shutdown the fishway so that the camera and tunnel can be cleaned). A recent outage of the Comox Dam fishway (February 20, 2008) allowed technicians to clean the camera tunnel and camera which had become completely fouled since the last maintenance event on August 29, 2007 (Appendix D Photo 3). In addition, lights in the tunnel were replaced and cables that had been vandalized during the winter were repaired. Interestingly, of the 3 tunnel/camera installations, the unit at the Comox Dam fouled more quickly and requires the most maintenance. Despite this recent cleaning, this site will likely need to be inspected again in advance of chinook migration monitoring in 2008 to ensure it is in optimal working order.

The following recommendations are provided for monitoring the three fishway cameras in 2008:

1. Commence operation of the lower and upper hatchery and impoundment dam cameras early in the spring to identify trends in the commencement of the summer chinook migration period.

2. Schedule maintenance of the Comox Dam fishway 2 weeks in advance of the monitoring start-up date to ensure that video surveillance and data collection is not disrupted during peak summer chinook migration.

3. Ensure that antennae from esophageal radio tags and other external tags used on adult chinook during the radio telemetry study are placed on the right side of the fish so that they will be visible to fishway cameras.

4. Countinue helicopter surveys at the headpond and upper River tributaries flowing into Comox Lake

5. Tether chinook carasses in the impoundment dam fishway to increase attraction for migrating chinook.

7 ACKNOWLEDGEMENTS

We are grateful for the financial support for this study from BC Hydro Bridge Coastal Fish and Wildlife Restoration Program (BCRP), and Fisheries and Oceans Canada. Specifically we would like to thank BC Hydro for assistance with scheduling camera maintenance at the Comox Dam, and provision of lake elevation, discharge and gate height records; Laurent Frisson (DFO Puntledge Hatchery) for equipment installation, maintenance and monitoring; and all Puntledge Hatchery staff at who have been involved with various components of the project.

8 REFERENCES

Anon. 1958. The fisheries problems associated with the power development of the Puntledge River, Vancouver Island, B.C. Memo. Report. Dept. Fisheries, Vancouver, B.C. 39 p. + app.

Bigsby, A. 2003. An Outline of Comox Dam Fishway Modifications. Draft report prepared for Fisheries and Oceans Canada, Habitat and Enhancement Branch, Nanaimo, B.C.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. p. 83-138. *In* Meehan, W. R. (ed.). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland: American Fisheries Society. 751 p.

Guimond, E. 2006. Puntledge River impoundment and diversion dam fishway assessment 2005. Prepared for Fisheries and Oceans Canada, Habitat and Enhancement Branch, Nanaimo, BC and BC Hydro BCRP, Burnaby, BC.

Guimond, E. 2007. Puntledge River impoundment and diversion dam fishway assessment 2006. Prepared for Comox Valley Project Watershed Society and BC Hydro BCRP, Burnaby, BC.

Rimmer, D. W., R. A. Ptolemy and J. C. Wightman. 1994. Puntledge summer run steelhead. Draft discussion paper, Ministry of Environment, Lands and Parks, Fisheries Section, Nanaimo, B.C. 32 p. + app.

Taylor, J.A. and E. Guimond. 2006. Puntledge River 2005 summer run chinook radio telemetry study. Prepared for Fisheries and Oceans Canada, Nanaimo, BC. and BC Hydro, Burnaby, BC.

Personal Communication

L. Frisson Fisheries and Oceans Canada, Puntledge Hatchery

Appendix A - Financial Statement Form **Project #: 07.Pun.02**

INCOME	BUDGET			ACTUAL		
	BCRP	Other (Cash)	Other (in-kind)	BCRP	Other (cash)	Other (in-kind)
Total by Source	$19,029.00		$21,307.00	$19,028.90		$21,419.75
Grand Total Income (BCRP + Other)	**$40,336.00**			**$40,448.65**		
EXPENSES						
Project Personnel						
Biologist (contractor)	$4,800.00			$5,946.60		
Technicians (contractor)	$5,000.00			$5,097.50		
Statistician	$1,484.00			$0.00		
DFO (Biologists, Engineer)			$2,400.00			$2,400.00
DFO (Eng. Tech.)			$4,500.00			$4,500.00
Communications Technician	$1,350.00			$1,350.00		
Volunteers			$320.00			$320.00
Material and Equipment						
Small tools/supplies & equipment rental	$250.00			$82.43		
Cameras, lights, repair	$650.00			$246.36		
video surveillance equipment	$0.00		$12,000.00			$12,000.00
Heli survey	$2,850.00			$2,916.36		
Newsletter	$375.00			$375.00		
Travel	$540.00		$150.00	$173.25		$252.50
Adiministration						
Office space, equip, supplies						
Photocopies and printing						
Telecommunications						
Insurance						
Production of As-built Drawings						
Admin Fees (10%)	$1,730.00		$1,937.00	$1,618.75		$1,947.25
Total Expenses	**$19,029.00**	**$0.00**	**$21,307.00**	**$17,806.25**	**$0.00**	**$21,419.75**
Grand Total Expenses (BCRP + others)	**$40,336.00**			**$39,226.00**		
Balance (Grand Total Income - Grand Total Expenses	**$0.00**			**$1,222.65**		
BCRP Balance (surplus)	**($1,223)**					

* Any unspent BCRP financial contribution to be returned to: BC Hydro, BCRP
6911 Southpoint Drive (E14)
Burnaby, B.C. V3N 4X8

Appendix B - Performance Measures

Project # 07.Pun.02

Performance Measures – Target Outcomes												
Project Type	**Primary Habitat Benefit Targeted of Project (m^2)**	**Primary Target Species**	**Habitat (m^2)**									
			Estuarine	In-Stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous	Upland	Wetland
Impact Mitigation												
Fish passage technologies	Area of habitat made available to target species	**Sum CN Sum ST**		**3.7km**	**>8 km**							
Drawdown zone revegetation/stabilization	Area turned into productive habitat											
Wildlife migration improvement	Area of habitat made available to target species											
Prevention of drowning of nests, nestlings	Area of wetland habitat created outside expected flood level (1:10 year)											
Habitat Conservation												
Habitat conserved – general	Functional habitat conserved/replaced through acquisition and mgmt											
	Functional habitat conserved by other measures (e.g. riprapping)											
Designated rare/special habitat	Rare/special habitat protected											
Maintain or Restore Habitat forming process												
Artificial gravel recruitment	Area of stream habitat improved by gravel plmt.											
Artificial wood debris recruitment	Area of stream habitat improved by LWD plcmt											
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing											
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved											
Habitat Development												
New Habitat created	Functional area created											

Appendix C – Confirmation of BCRP Recognition

Article in the Comox Valley Record describing the Puntledge River Fishway Assessment Project, November 7, 2007.

COMOX VALLEY RECORD • Wednesday, November 7, 2007 A23

Smile, chinook, you're on camera

This past summer staff at the Puntledge River Hatchery were able to get a fairly accurate count of the number of summer-run chinook salmon returning to the river to spawn.

Using a new way of observing fish in the hatchery's fishway, employing underwater cameras and digital recorders, biologists are monitoring the movements of this unique and endangered salmon stock.

The underwater cameras are part of the Fishway Assessment Project, and have been installed at three locations along the Puntledge River — at the lower hatchery, the diversion dam and the impoundment dam.

With technical assistance from Fisheries and Oceans Canada's Puntledge Hatchery and funding provided by BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program, the Comox Valley Project Watershed Society has led the Fishway Assessment project into its third year.

"The video-monitoring tools give us at the hatchery accurate counts of fish numbers," says Lorne Frissen from the Puntledge Hatchery.

The main objective of the project is to determine whether summer-run chi- the river, such as Stotan and Nymph falls.

Historically, before hydro development and its associated modifications to the river, summer-run chinook took advantage of high river flows during the spring to make the 16.5-km journey from the estuary to Comox Lake.

Comox Lake offers a cool respite where summer-run chinook can hold until they are ready to spawn in the fall. After spending the summer in the lake, the chinook either move farther up into the Upper Puntledge River and Cruikshank River or drop down into the headpond area of the Puntledge River (just below the impoundment dam).

This year, over 240 summer-run chinook were captured on video as they migrated through the diversion dam fishway at the Upper Puntledge River Hatchery into the headpond. At least one-third of these fish are currently spawning at a spawning habitat area constructed in the headpond in 2005. This area historically supported a few thousand summer-run chinook.

The Comox Valley Project Watershed Society encourages the public to take advantage of this opportunity to witness the summer and fall chinook spawning season in the Puntledge River. When visiting the river be cautious of high flows due to heavy rains and flood management. These two stocks spawn at the same time and can be safely viewed at the following sites until the beginning of November.

- Bull Island side-channel upstream of Stotan Falls;
- Barbers Pool outlet;
- Below the Puntledge Diversion Dam;
- Approximately 800 metres upstream of the Upper Puntledge Hatchery in the headpond.

Remember when viewing spawning fish it is important to not disturb them, so make sure pets are kept out of the river.

— Comox Valley Project Watershed Society

Appendix D – Photos

Photo 1. View of the camera tunnel from the top of the Comox dam fishway during low lake elevations (131.2 m), February 20, 2008.

Photo 3. Camera tunnel installation in the Comox Dam fishway before cleaning, February 20, 2008. Plexiglass wall of tunnel is completely covered in sludge and macroinvertebrate growth.

Photo 2. Camera tunnel installation in the Comox Dam fishway before cleaning, February 20, 2008.

Photo 4. Camera tunnel installation in the Comox Dam fishway after cleaning, February 20, 2008.