Puntledge River Impoundment and Diversion Dam Fishway Assessment 2006

06Pun.05

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Prepared with financial support of:

BC Hydro Bridge Coastal Fish and Wildlife Restoration Program

April 2007

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 for a 20-year period post expansion. 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) throughout the migration period at various lake levels and flows. Ensuring chinook access through the dams benefits all species that historically had access into Comox Lake. This study was repeated in 2006 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. Video surveillance commenced in May 2006 and terminated in January 2007.

During the monitoring period approximately 237 summer-run chinook were counted passing through the diversion dam fishway into the headpond while only 18 chinooks were counted through the camera tunnel at the impoundment dam. This amounts to only 7.6 % success rate for fish accessing Comox Lake, a significant decline from the 2005 study when 75% of the fish in the headpond successfully migrated through the impoundment dam fishway. It is suspected that a large proportion of the chinook in the headpond may have accessed the lake through the Comox dam sluice gates.

The success rate of summer chinook migration from the lower hatchery to the diversion dam could not be estimated. More fish were counted passing through the diversion dam fishway than were recorded at the lower hatchery fishway, indicating that the summer chinook migration period commenced before the study got underway. Video surveillance at the fishways will continue in 2007 and will complement a radio telemetry study of chinook migration through Reach C and B of the Puntledge River.

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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 for a 20-year period post expansion. 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 vision for the rebuilding of Puntledge River summer chinook is to re-establish a self-sustaining return through restoration of fisheries habitats and augmentation of river discharges within the system. Ensuring fish access into the upper river and Comox Lake during the migration period is an important step towards achieving this goal. This report details a study conducted in 2006 to monitor summer chinook movement through the fishways at the diversion and impoundment dams and the lower Puntledge hatchery to determine how the fishways operate throughout the chinook migration period at various lake levels and flows. This study's main focus is summer chinook migration which will be used as a proxy for all species that historically had access to Comox Lake.

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 held in the cooler depths of Comox Lake during the summer to escape high water temperatures. This evolved migration and lake-holding behavior was likely a key factor in reducing pre-spawning mortality. They would then drop back downstream in the fall and spawn in the reach below the lake outlet or in the upper watershed, a common behavior observed in other lake headed watersheds in B.C. (R. Bailey, pers. comm.). The initial impoundment dam did not provide fish access until 1922 when a timber fishway was constructed. This was modified in 1946 and again in 1958 with concrete structures. However all of these fishway modifications now appear to have been unreliable at providing access to the lake, except under ideal lake levels and flows (anon, 1958; Rimmer et al., 1994). 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, (Rimmer et al., 1994) replacing the pool/weir style fishway with the expectation that it would provide better passage for summer steelhead. However, the new design was never monitored for effectiveness.

During a radio telemetry study on the Puntledge River in 2002, the fishway at the Comox Lake impoundment dam was observed to be completely ineffective at providing fish passage at low lake levels (Komori Wong Environmental and Bigsby, 2003). At very low lake levels there was no flow observed flowing over the lower most weir at the entrance to the fishway. These observations prompted BC Hydro and government agencies to immediately develop interim measures to improve fish passage until a more permanent solution could be found. In 2003, some minor changes were made (Bigsby, 2003) which included removal of the upper orifice plate and adjustments to stop logs in each pool throughout the summer. Further modifications were completed in the summer of 2004 to improve attraction flow and fish passage (Guimond 2006). This included modifying the orifice dimensions to increase discharge and increasing the drop over the entrance weir to improve attraction to the fishway.

Following the 2004 changes to the fishway, chinook migration was monitored at the impoundment dam and the lower Puntledge Hatchery using standard VHS video recorders and underwater cameras. This system was replaced with a more efficient and reliable digital video management system (DVMS) in 2005 through BCRP funding. Results from the 2005 assessment demonstrated that modifications to the fishway at the impoundment dam were successful in providing access into the lake throughout the entire chinook migration period. Over 75% of adults that entered the headpond migrated into Comox Lake in 2005, confirming that summer chinook were successful in negotiating the submerged orifices of the Comox Dam fishway.

1.2 Goals and Objectives

The main objective of this assessment is to implement recommendations in the 2005 study (Guimond 2006) and obtain additional data regarding fish access through the fishways at all 3 locations (i.e. lower hatchery, diversion dam and impoundment dam). This will further enhance our understanding and confidence in the adequacy of the fishways to provide passage for summer run chinook salmon (and steelhead) into the upper watershed throughout the migration period at various lake levels and flows.

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 tunnels designed and installed in the fishways for the 2005 video surveillance project (Guimond 2006) were left in place over the winter except at the Comox dam fishway. At this site the tunnel and camera box were removed prior to the winter so that modifications could be made before installation in 2006. The aluminum picket fence screen was left in place in the fishway weir orifice. The Comox dam fishway tunnel camera box was modified to operate as a “side-view” system similar to installations at the diversion dam and lower hatchery fishways (Appendix D; Photos 1&2). This improves image view and reduced maintenance requirements. Details of the tunnel design are described in Guimond 2006. A new environmental enclosure was installed at the Comox dam to house the video monitoring equipment (Appendix D; Photo 3).

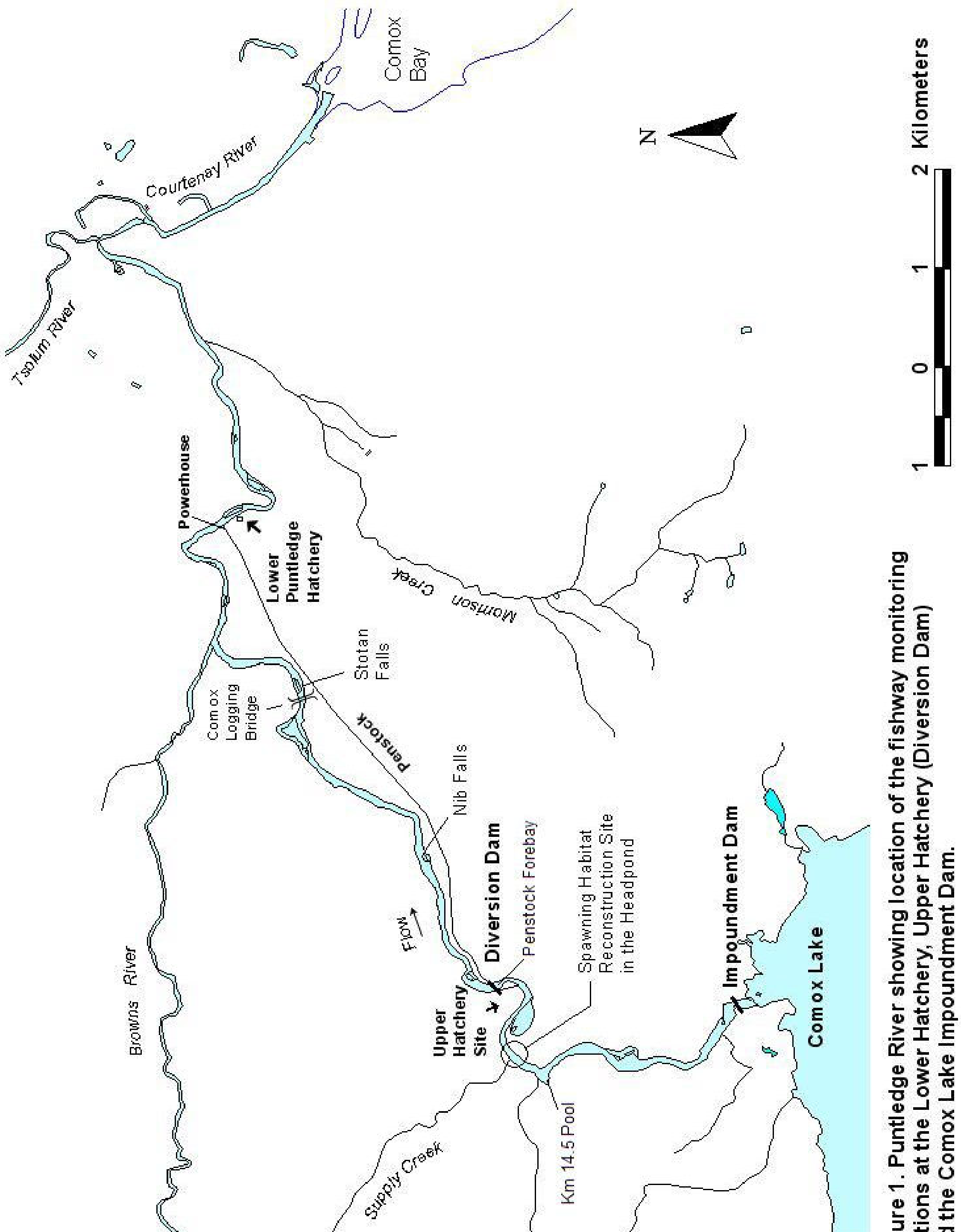

Figure 1. Puntledge River showing location of the fishway monitoring stations at the Lower Hatchery, Upper Hatchery (Diversion Dam) and the Comox Lake Impoundment Dam.

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 16 to Oct 15, 2006. A third camera/recorder system operated at the lower Puntledge hatchery from May 5 until June 9, 2006 to monitor 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. Recorded video footage on each DVMS system (diversion and impoundment dams) was viewed every 2 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 (ie. species, adipose clipped, jack, severe injury, etc).

3.3 Environmental data

A Solinst water level data logger was installed at the outlet weir of the fishway on July 28, 2006 to measure discharge through the fishway as lake levels declined. A discharge curve was developed showing the relationship between lake level and fishway discharge. This information was used to determine whether fish negotiated the fishway at low flows. 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 Open House Event at Puntledge Hatchery, 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

From June 16th to September 7th, a total of 237 summer chinook and 3 steelhead were counted by the camera entering the headpond through the diversion dam fishway (Figure 2). The diversion dam fishway was closed Sept 7th to prevent fall chinook access into the headpond. It was reopened in November for coho migration and remained open throughout the winter. During this time 249 coho were counted entering the headpond. Fishway operations and video surveillance schedules are summarized in Table 1.

4.2 Impoundment Dam Fishway

Between June 16th and August 8th the camera recorded approximately 18 summer chinook passing through the tunnel into Comox Lake. No fish were observed using the fishway between August 9th and November 3rd until coho migration commenced in November. Thirty-five coho were counted passing through the tunnel into the lake between Nov 3rd and Nov 19th. Video monitoring was terminated on January 10th and no other fish were observed by the camera during this period. Figure 3 compares total numbers of chinook observed migrating into the headpond (through the diversion dam fishway) versus the total number of fish that migrated into Comox Lake. Images captured by the video equipment with the modified tunnel were clear throughout the entire monitoring period.

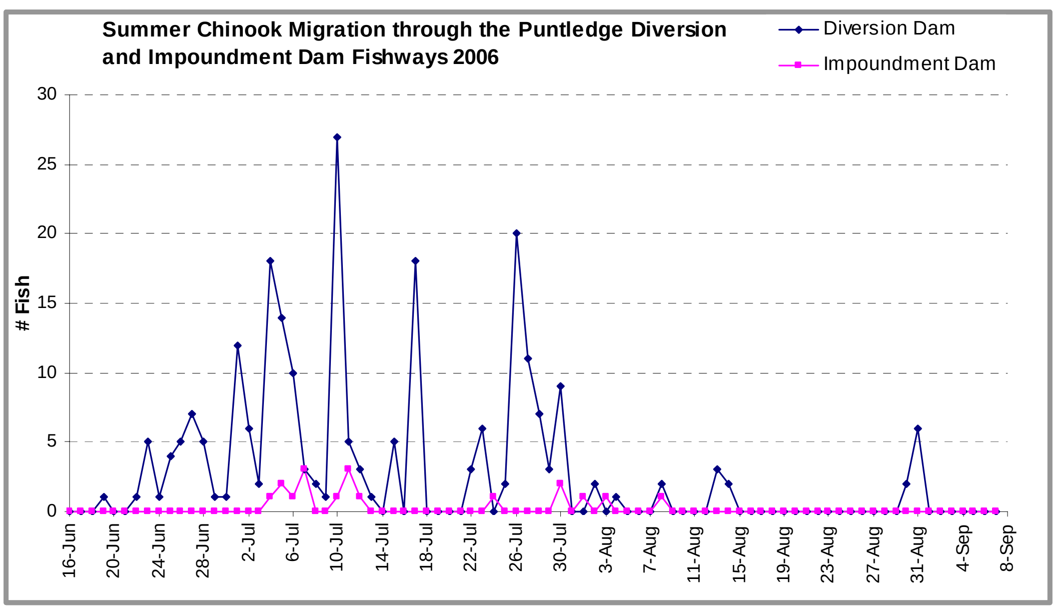

Figure 2. Movement of summer chinook salmon through the diversion and impoundment dam fishways as recorded by underwater video surveillance, June 16 – Sept. 8, 2006.

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, May 2006 – Jan 2007.

Date	Lower Hatchery	Diversion Dam	Comox Dam	Comment
5-May-06	open	closed	open	Video monitoring begins at lower hatchery (fish counted above fence in river)
9-Jun-06	closed	closed	open	Broodstock collection begins at lower hatchery; 37 SCN counted on Lower hatchery camera
16-Jun-06	closed	open	open	Video monitoring begins at Upper hatchery (Diversion dam) and Comox Dam
7-Sep-06	closed	closed	open	Bypass at Diversion dam (Upper hatchery) closed; 237 SCN counted on camera
14-Sep-06	open	closed	open	Broodstock collection at the lower hatchery, and fish counted above fence into Reach C
22-Sep-06	closed	closed	open	Lower hatchery bypass closed; 5247 FCN and 832 CO counted past camera
2-Nov-06	closed	open	open	Upper hatchery by-pass re-opened
Dec ? 2006	opened	open	open	Lower hatchery bypass opened after chum spawning
14-Dec-06	opened	open	open	Video monitoring terminated at Upper hatchery; 249 CO counted past camera; During high water events from Nov 15th on, visibility was very poor due to high turbidity
10-Jan-07	opened	open	open	Video monitoring terminated at Comox Dam

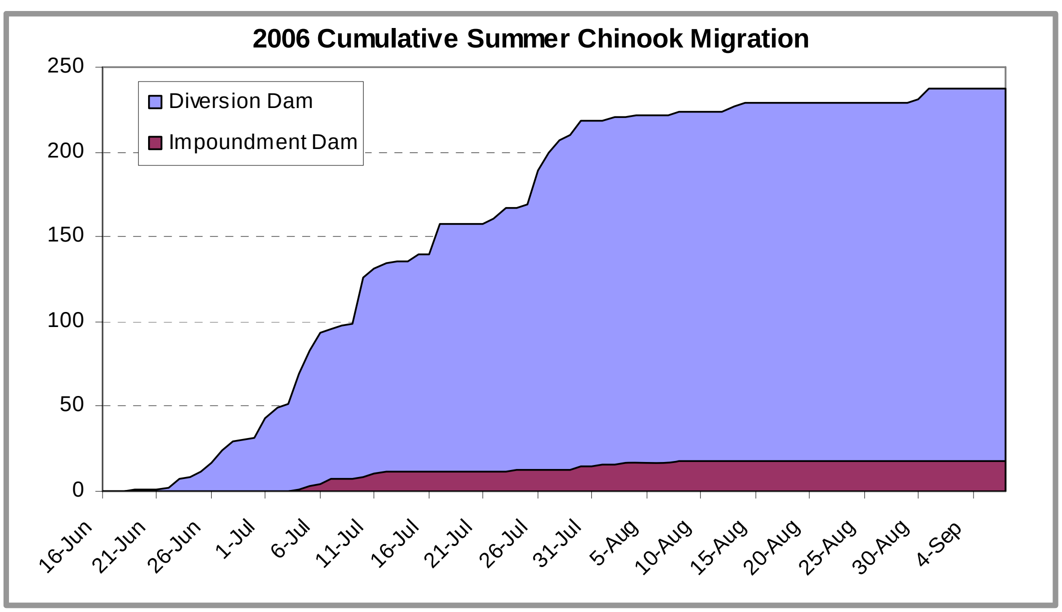

Figure 3. Cumulative summer run chinook migration through the diversion and impoundment dam fishways between June 16 and Sept. 8, 2006.

At the diversion dam, fish migrated through the tunnel during all hours of the day, but appeared to be more active between 5:00 and 21:00hrs. Likewise, the few fish that migrated through the Comox dam fishway were active during all hours (Figure 4).

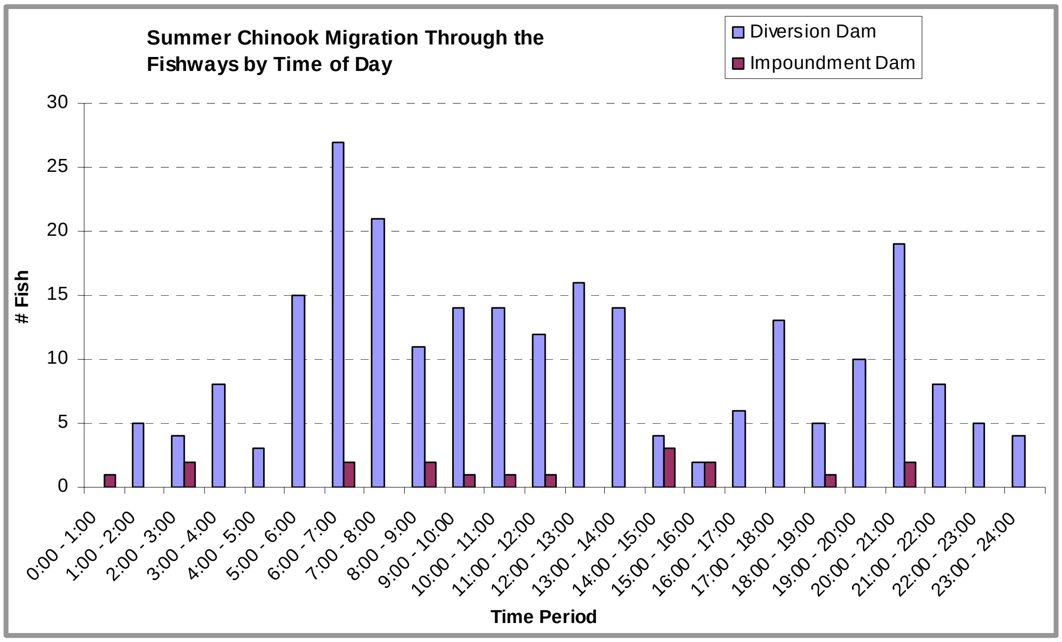

Figure 4. Daily migration patterns of summer chinook through the diversion and impoundment dam fishways, June – September 2006.

4.3 Lower Puntledge Hatchery Bypass

Video surveillance commenced at the lower hatchery on May 5, 2006 and recorded 37 summer chinook passing through the tunnel to access the reach above the barrier fence until the by-pass was closed on June 9th. From June 9th until September 14th, the by-pass was closed, and all fish were diverted into the lower hatchery for broodstock collection. When the by-pass to the upper river was re-opened on the 14th, video surveillance resumed and within an eight day period (Sept 14th – Sept 22nd) 5247 fall chinook and 832 coho salmon were counted passing the camera. Figure 5 summarizes total numbers of summer chinook and coho salmon counted at all fishway cameras during the entire monitoring period.

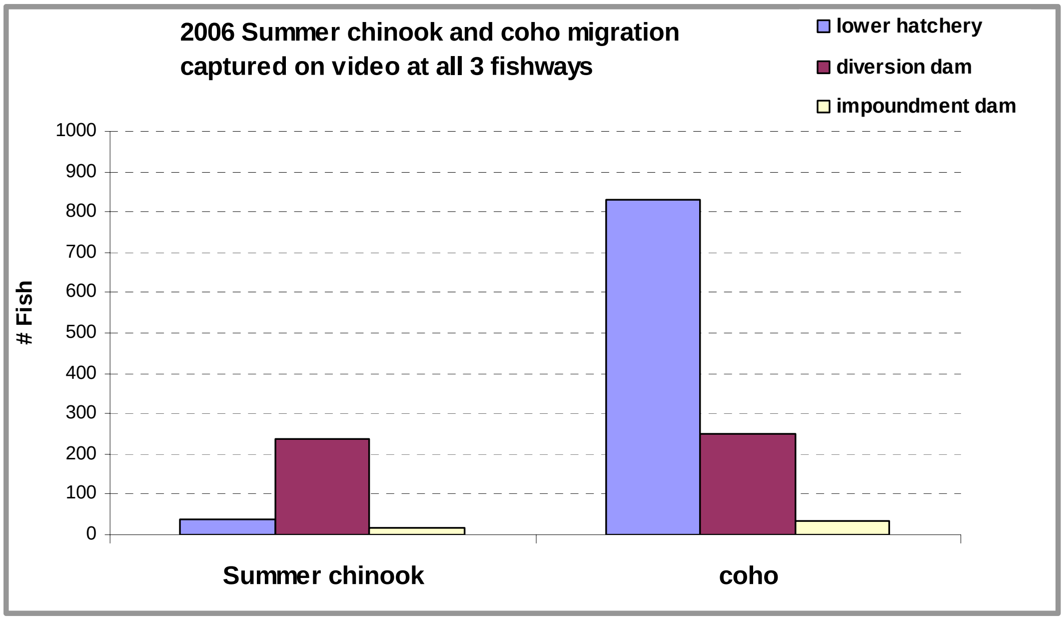

Figure 5. Summer run chinook and coho migration recorded at all 3 video monitoring stations in the Puntledge River fishways between May 5, 2006 and January 10, 2007.

4.4 Impoundment Dam Fishway Discharge

Discharge through the fishway at the Comox impoundment dam ranged from a maximum of 1.3 cms (45.5 cfs) in the early summer when Comox Lake was near full pool (~134.5 m), to a minimum of 0.094 cms (3.3 cfs) in late October when Comox Lake was at 131.21, its lowest recorded level in 2006 (Figure 6). A relationship between lake elevation and fishway discharge has been developed (Figure 7). It should be noted that the above relationship is for operation of the fishway without making any adjustments to the stop logs in the fishway cells. In 2005, all of the stop logs on the two cells upstream of the outlet weir were removed, (i.e. 5 stop logs from the cell immediately upstream of the last weir, and 6 from the next cell upstream). This left only the steel plates in these cells with approximately 8 inches of water flowing over each plate at the time (August 26, 2005), slightly increasing fishway discharge and providing fish two options for upstream passage. It is uncertain whether these stop logs were replaced when flows in the fishway increased above 0.85 cms (30 cfs) as recommended (M. Sheng, pers. comm.).

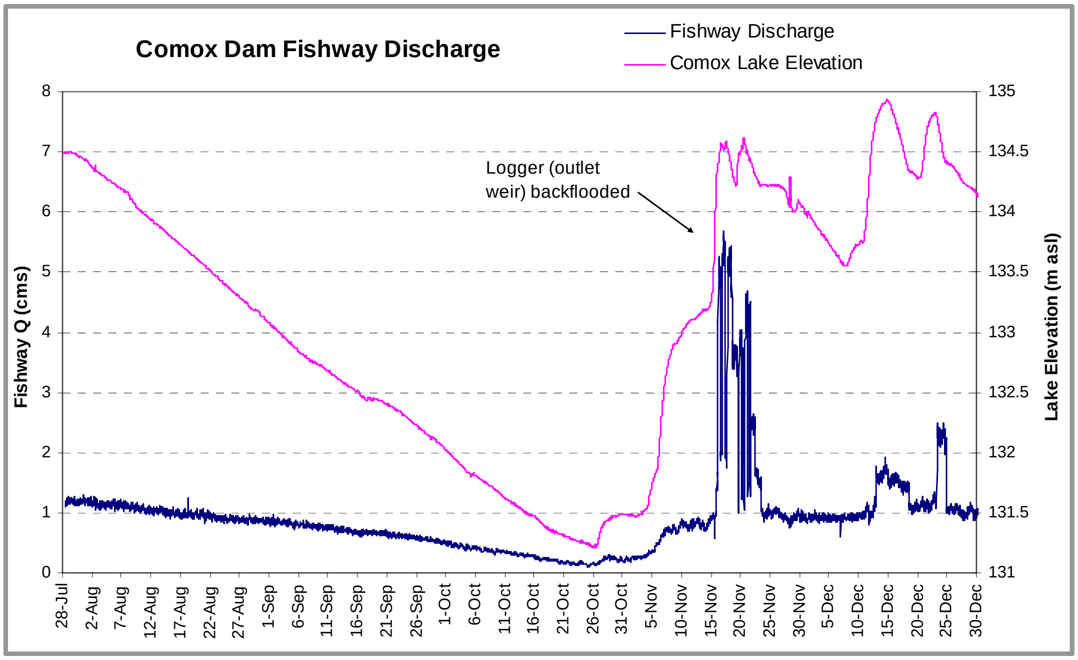

Figure 6. Discharge recorded through the Comox impoundment dam fishway between July 28 and Dec 31, 2006 with Comox Lake elevation.

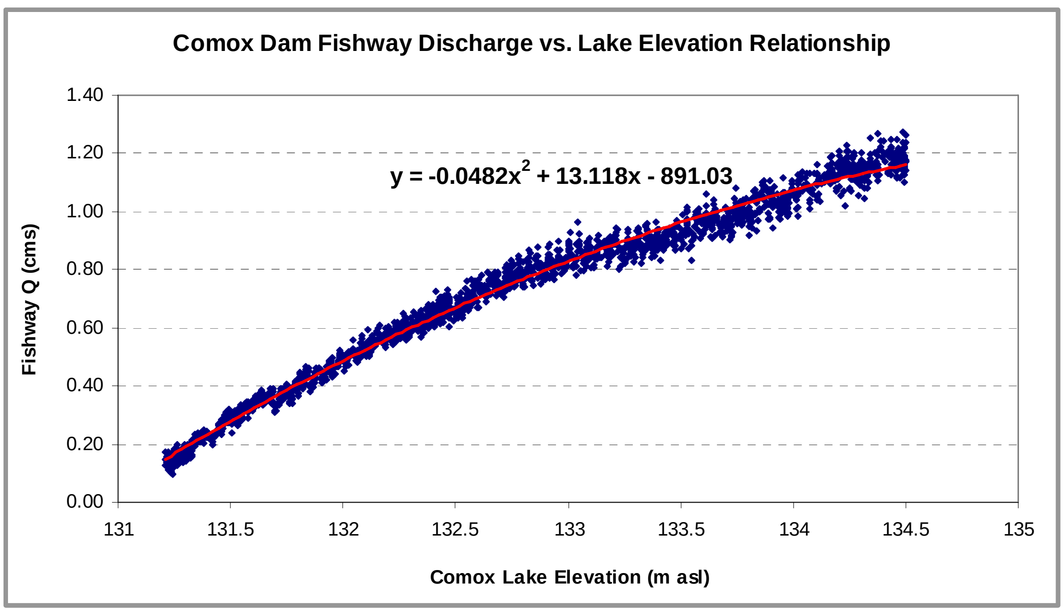

Figure 7. Discharge / Lake elevation relationship developed for the fishway at the Comox Lake impoundment dam.

5 DISCUSSION

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

Two explanations have been suggested for the large difference in the number of summer chinook that were counted passing the lower hatchery camera tunnel (37 between May 5 and June 9) and the number that were counted through the upper hatchery or diversion dam fishway (237). Video surveillance at the lower hatchery commenced on May 5th, 2006 but early summer chinook migrants may have entered the river much earlier. Since the first summer chinook to pass the camera tunnel was not observed until May 17th, it was thought that video monitoring captured the beginning of the migration period. However, the actual commencement of the summer chinook migration may have been missed. Puntledge hatchery personnel estimate the beginning of the summer run migration to be late April/early May. This would mean that 200 early migrants would have passed by the lower hatchery prior to May 5th. The second explanation to the large difference in numbers is that there were several high flow events between May and June whereby adults may have been able to access the reach above the barrier fence at the lower hatchery by a flood channel on the left bank. If adults utilized this channel, they would have escaped being recorded by the video surveillance equipment in the fish by-pass structure on the right bank. The river discharge (Reach D flow) necessary to activate this flood channel nor the conditions and flows within the flood channel for chinook migration were assessed. These two explanations will be further investigated in a subsequent study. Interestingly, video surveillance has already commenced at the lower hatchery and a summer chinook jack was recorded passing through the tunnel on March 17, 2006.

5.2 Diversion vs. Impoundment Dam Chinook Counts

Summer chinook broodstock collection did not occur at the upper Puntledge hatchery facility in 2006. Therefore all 237 adults recorded at the diversion dam fishway were given access into the headpond. Unlike 2005 when over 75 % of adults that entered the headpond migrated into Comox Lake, only 18 of the 237 chinook (7.6 %) were recorded migrating into the lake through the fishway in 2006. A boat survey of the headpond reach in early September found an estimated 100 adult chinook holding at the Km 14.5 pool, upstream of the spawning platform at the Supply Creek confluence, and no adults were observed at the tailrace pool of the impoundment dam. The significant difference in migration through the fishway between 2005 and 2006 is puzzling, particularly in light of the fact that only ~100 were accounted for in the headpond. Spawning surveys conducted in October further supports this estimate with only 22 adults observed spawning at the new platform and 55 at the historic spawning grounds below the impoundment dam. One suggestion for the disappearance of over 100 chinook is that they may have dropped back down below the diversion dam. However, based on low chinook counts made by hatchery personnel in the pool immediately below the diversion dam throughout the summer, if fish were indeed dropping below the diversion dam, they were either quickly re-entering the headpond reach (and therefore being counted again) or continued migrating downstream. Evidence from past radio telemetry studies does not lend support to this. Although some radio tagged summer chinook were reported to have dropped below the diversion dam during the migration studies, it was usually fish that were severely stressed and weakened from prolonged exposure to lethal temperatures in the river (Taylor and Guimond 2006).

It is more probable that the other 119 or so chinook accessed Comox Lake directly through the sluice gates. It is assumed that chinook could potentially swim through the gates when velocity through the gates is < 6.83 m/s (22.4 ft/s) based on the burst speed of chinook (Bjornn and Reiser 1991). Records of gate height and discharge for each of the sluice gates at the Comox Dam were provided by BC Hydro for the period August 1 to October 31, 2007. Using this information, the velocity through each gate was calculated and results indicate that chinook salmon may have been capable of passing through the gates at the dam as early as August 1st. Figure 8 displays the average velocity through each gate. Water velocity under the gate is affected by friction caused by the edges of the submerged opening. Since velocity is greater in the centre of the opening compared to around the edges, suitable velocities for fish access may have been underestimated. Nonetheless, based on a maximum burst speed of 6.83 m/s, the average velocity calculated through the gates roughly coincides with the date that summer chinook were last observed passing through the camera tunnel (August 8th). It is assumed that the fishway would have been operating effectively at this time with a discharge of around 1 cms (~35 cfs). Since gate height and discharge data for earlier periods were not examined, chinook access through the sluice gates before August 1st can not be ruled out.

Illegal fishing for chinook in the headpond may also be a contributing factor to the missing fish. The extent of poaching throughout the headpond is unknown though it has been observed immediately in the tailrace pool downstream of the impoundment dam.

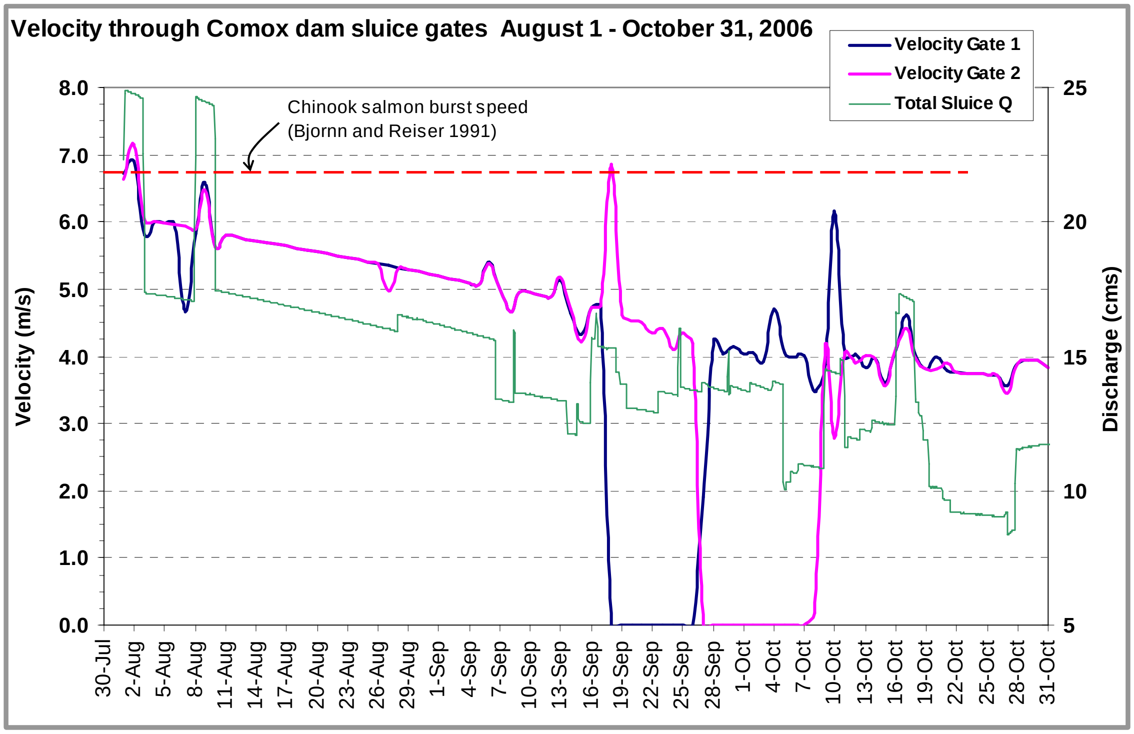

Figure 8. Average velocity through the Comox impoundment dam sluice gates, August 1 to October 31, 2006.

6 CONCLUSIONS AND RECOMMENDATIONS

All tunnel/camera installations at the fishways operated efficiently and effectively, providing clear video footage of fish migration throughout the period of operation, in one case from June 2006 to January 2007. None of the tunnels to required maintenance or cleaning of the plexiglass windows during the study period. Colour cameras mounted on the side of the tunnel provide the best view, allowing the observer to easily differentiate species as well as identify other features such as the physical condition of fish, and if there were external marks or clips (Appendix D; Photos 7 & 8). The LED lighting used inside the tunnel at the Comox Dam in 2005 was replaced with two underwater pond lights, greatly improving night vision.

BCRP funding for fishway monitoring in 2007 has been approved and will complement a radio telemetry study of chinook migration through Reach C and B of the Puntledge River and the Comox Lake tributaries. The 2007 study will incorporate the following key recommendations:

1. Commence operation of the lower hatchery camera earlier in the spring to ensure greater confidence in the summer chinook migration timing and the number of adults that successfully reach the diversion dam.

2. Assess the possibility of fish access around the left end of the barrier fence across the river at the lower hatchery during higher river discharges.

3. Monitor recreational fishing activity in the headpond, particularly at two main holding pools (impoundment dam tailrace and Km14.5).

4. Further investigate the potential for adults to access the lake through the sluice gates.

5. Inspect the fishway at the Comox Dam during low lake elevations (Sept-Oct) to determine whether the fishway is functioning adequately. At low fishway flows, the "submerged orifices" may be no longer operating properly, and access through each cell of the fishway may be impaired.

6. 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 at all fishway cameras.

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 donation and installation of a separate environmental enclosure for the video equipment at the Comox Dam, and provision of lake elevation, discharge and gate height records; Laurent Frisson (DFO Puntledge Hatchery) for modification and installation of the tunnels, equipment installation, maintenance and monitoring; and all Puntledge Hatchery staff at who have been involved with various components of the project.

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Personal Communication

Mel Sheng	Fisheries and Oceans Canada, Resource Restoration
R. Bailey	Fisheries and Oceans Canada, Stock Assessment

Appendix A - Financial Statement Form **Project #: 06.Pun.05**

	BUDGET			ACTUAL		
INCOME	**BCRP**	**Other (Cash)**	**Other (in-kind)**	**BCRP**	**Other (cash)**	**Other (in-kind)**
Total by Source	$21,455.00		$8,380.00	$21,455.00		$7,788.00
Grand Total Income (BCRP + Other)	**$29,835.00**			**$29,243.00**		
EXPENSES						
Project Personnel						
Biologist (contractor)	$3,440.00			$3,488.00		
Technician (contractor)	$5,000.00			$3,561.66		
Communications Technician	$2,250.00			$2,250.50		
Statistician	$1,560.00			$1,536.89		
DFO Biologist			$2,400.00			$2,400.00
DFO Technicians			$4,500.00			$4,500.00
Volunteers			$320.00			
Honoraria			$100.00			
Material and Equipment						
Small Tools/supplies & equipment rental	$2,805.00			$1,530.17		
Underwater cameras	$3,000.00			$2,474.67		
Newsletter	$1,000.00			$983.10		
Travel	$450.00		$180.00	$93.60		$180.00
Adiministration						
Office Supplies	$50.00					
10%	$1,900.00		$880.00	$1,592.12		$708.00
Total Expenses	**$21,455.00**	**$0.00**	**$8,380.00**	**$17,510.71**	**$0.00**	**$7,788.00**
Grand Total Expenses (BCRP + others)	**$29,835.00**			**$25,298.71**		
Balance (Grand Total Income - Grand Total Expenses	**$0.00**			**$3,944.29**		
BCRP Balance (surplus)	**($3,944.29)**					

* 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 # 06.Pun.05

Performance Measures – Target Outcomes												
			Habitat (m^2)									
Project Type	**Primary Habitat Benefit Targeted of Project (m^2)**	**Primary Target Species**	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											

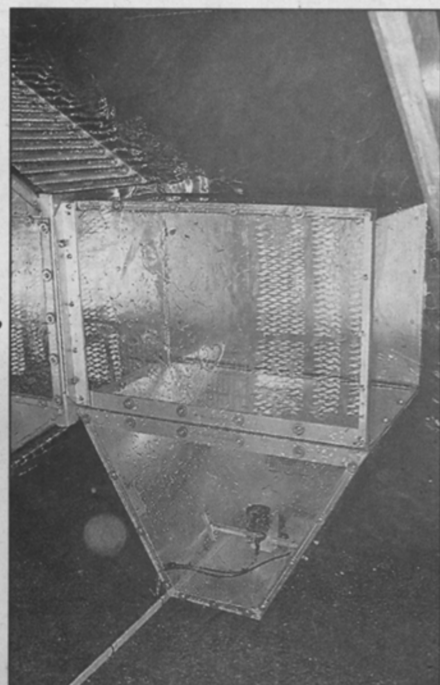
Appendix C – Confirmation of BCRP Recognition

Article in the Comox Valley Record announcing the Puntledge River Fishway Assessment Project, August 25, 2006.

A20 Friday, August 25, 2006 COMOX VALLEY RECORD

Smile, Mr. Chinook, you're on Candid Camera

Motion sensor helps to record accurate numbers of fish in river



AN UNDERWATER CAMERA at left photographs fish moving up the Puntledge River.

The first 18 chinook that made their way up the Puntledge River and into Comox Lake this year were caught on camera.

To monitor the summer run chinook, underwater cameras have been installed inside fish ladders at three separate locations along the Puntledge River. The project was led by Fisheries and Oceans, with funding provided by BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program and DFO.

"The project is going very well," says Laurent Frisson, fish culturist at the Puntledge Hatchery. "Before, we had to view hours of tape, and even then the likelihood of missing a fish was pretty high."

Rather than cameras running 24/7, the new system incorporates a motion sensor that activates a digital camera and sends the photo directly to a hard drive.

"Now, we're getting a picture of everything that moves through the fish ladders," says Frisson. "We even have an image of a seal going through the lower hatchery fish ladder! I'm surprised it didn't get stuck in there!"

Overall, the fish ladders are quite wide, but narrow to a square opening of about two and a half feet where the camera is stationed. The camera is completely waterproof and sits behind a plexiglass window in a compartment to the side of the enclosure.

As of Aug. 14, 229 summer chinook had moved through the Puntledge Diversion Dam fish ladder and into the section of river between the diversion dam and the Comox Dam, 3.7 kilometres upstream. Another 18 fish had moved through the fish ladder at Comox Dam and into Comox Lake.

"This is the most fish we've had above the diversion dam since I've been here at the hatchery," says operations manager Brian Munro, who began his career at the hatchery over 20 years ago. "All of this is done in an attempt to restore the natural salmon runs in the river."

Historically, before human intervention on the river, summer run chinook took advantage of high river periods to make their way up to the cooler waters of Comox Lake. After spending the summer in the lake, the chinook either move further up into the Cruickshank watershed or drop back down into the headpond area of the upper Puntledge.

BC Hydro recently completed three chinook migration pulse flows over a three-week period to provide a better opportunity for fish to move above river obstacles such as waterfalls. The pulses increase the river flow between twofold and threefold.

With this new monitoring equipment in the tunnels, Fisheries and Oceans now has a much better idea of how the pulse flows are helping with fish migration as well as how the fishways around the dams are functioning. BC Hydro, Fisheries and Oceans Canada, Project Watershed Society and other local community groups are committed to the ongoing improvement of chinook numbers on the Puntledge River.

Appendix D – Photos

Photo 1. Modified tunnel assembly in the Comox Lake impoundment dam fishway showing separate chamber on left side of tunnel with camera installed

Photo 2. Tunnel assembly in the Comox Lake impoundment dam fishway showing new lighting system (top of tunnel) for improved night recording. Photo looking downstream at (submerged) fishway orifices.

Photo 3. Installation of new protective shelter for DVMS digital recording equipment at Comox Dam, July 2006.

Photo 4. Comox impoundment dam sluice gates and tailrace pool, and fishway entrance, October 24, 2006. Sluice gate Q = 9.1 cms; fishway Q = 0.15 cms.

Photo 5. Comox Dam fishway entrance, October 24, 2006. Water level logger located in black PVC pipe on left of fishway outlet. Fishway Q = 0.15 cms (13 cm water flowing over weir).

Photo 6. Entrance to fishway showing approximately 35 cms discharge over outlet weir.

Photo 7. Image of summer chinook passing through the tunnel at the Lower Puntledge Hatchery, May 25, 2006 @ 1800 hrs.

Photo 8. Image of seal passing through the tunnel at the Lower Puntledge Hatchery, June 1, 2006 @ 0300 hrs.