Puntledge River Headpond Gravel Placement

Post-Construction Monitoring

2006 - 2007

06.Pun.03

Prepared for:

Comox Valley Project Watershed Society
PO Box 3007
Courtenay, BC V9N 5N3

Prepared by:

E. Guimond
473 Leighton Ave.
Courtenay, BC V9N 2Z5
guimonde@telus.net

Prepared with financial support of:

BC Hydro Bridge Coastal Fish and Wildlife Restoration Program

April 2007

EXECUTIVE SUMMARY

The Puntledge River headpond, located between the Comox Lake impoundment dam and the diversion dam 3.7 km downstream, was historically the most important spawning area for summer-run chinook salmon and steelhead. Following expansion of the hydro facilities in the 1950's, this habitat was destroyed through a combination of flooding, reduced velocities and altered hydrology. As a result, annual escapements of summer chinook declined from an average of about 3000 to below 600 for a 20-year period post expansion.

With the assistance of financial support from BC Hydro Bridge Coastal Fish and Wildlife Restoration Program (BCRP), Fisheries and Oceans Canada and Ministry of Transportation, over 4700 square metres of high quality chinook spawning habitat was reconstructed in the Puntledge river headpond in 2004-2005 through gravel placement. It is estimated that the project provides spawning habitat for 1000 adult summer chinook salmon - a tripling in the number that could spawn in this reach previously. Monitoring and project evaluation, a key component of the BCRP program, was implemented in 2006/07 to determine the effectiveness of the gravel placement project in the headpond with respect to adult utilization, incubation survival and the influence of high river flows on gravel stability.

Spawning surveys conducted at the new spawning platform during October 2006 identified a maximum of 22 summer chinook utilizing the habitat. Over 50 chinook were observed spawning below the impoundment dam in a vestige area of the original spawning habitat. At least 100 adults were observed in the headpond at the commencement of the spawning period.

Egg-to-fry survival was assessed using eyed fall chinook eggs buried either in Jordan-Scotty incubation cassettes or in pipe incubators designed by DFO. Overall survival at the spawning platform was 95.6 % (range: 89 % - 98 %) for Jordan incubators and 32.5 % (range: 16% - 48%) for the pipe incubators. Shear force calculations from water level data show that the spawning gravel at this site was stable during the 2006-2007 incubation period at the maximum recorded discharge of 183.808 cms (from Comox Dam releases).

Biological monitoring should be continued annually to assess habitat utilization and at minimum, a total station survey should be completed periodically to assess changes in channel bed topography and determine the stability of the spawning gravel over time.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Puntledge River headpond reach was the main focus of a two-year habitat restoration project which saw the addition of 4756 square metres of spawning gravel in 2005. It is estimated that the project has provided spawning habitat for 1000 adult summer chinook salmon - a tripling in the number that could spawn in this reach previously since the reach was backflooded following expansion of BC Hydro's facilities. The spawning habitat will also be utilized by summer steelhead and coho salmon.

In order to determine the effectiveness of this spawning habitat restoration project, post-construction monitoring of the gravel platform was implemented in September 2006. Monitoring of habitat restoration projects is an integral and important component of Fisheries and Oceans Canada's (DFO) Puntledge River summer chinook recovery plan and the BC Hydro Bridge Coastal Fish and Wildlife Restoration Program (BCRP), the main funding source for this project, as well as for overall restoration in the watershed. Information gained from this monitoring program, in addition to results collected in 2005 (immediately following construction) will be useful for developing future habitat restoration activities in the Puntledge watershed. This type of monitoring is also critical in determining potential future maintenance requirements specific to this project, such as gravel replenishment.

1.1 Background

The Puntledge River headpond, located between the Comox Lake impoundment dam and the diversion dam 3.7 km downstream, was historically the most important spawning area for summer-run chinook salmon and steelhead. Following expansion of the hydro facilities in the 1950's, this reach was severely impacted by the two larger dams which increased flooding, reduced spawning habitat and obstructed gravel recruitment. This loss of habitat in addition to a high incidence of juvenile mortality from the turbine, over-fishing, and predation, caused a rapid decline of summer chinook stocks to critically low levels. DFO considers the Puntledge summer run chinook a unique endangered stock and therefore a potential priority for recovery under the Wild Salmon Policy. A long-term strategy to rebuild the summer run chinook stock to historical (pre-hydro expansion) production levels is currently underway. A limiting factor identified as key to the rebuilding of the summer chinooks is the restoration of the historic spawning habitat downstream of the lake outlet.

Completion of the spawning platform in 2005 has created spawning habitat for 475 pairs of chinook salmon, based on a spawning bio-standard of one pair for every 10 m^2 of spawning habitat, derived for the Campbell River Gravel Placement Project (Anderson et al., 2001 Draft Report). This represents a significant addition in summer chinook spawning habitat to the Puntledge system. It was estimated from earlier studies (Bengeyfield and McLaren 1994; M. Lough memo for WUP) that 5600 m^2 of spawning habitat was available for summer chinook, of which >70% was located in Reach C. This total represents only 37% of the required habitat area for a target escapement of 3,000 summer chinook adults (or 1,500 spawning pair). The completed spawning platform in the headpond increased this amount to 69% of the required spawning habitat area needed to support the target escapement of summer chinook (Guimond 2006).

1.2 Goals and Objectives

The objective of this post-construction monitoring program is to determine the effectiveness of the gravel placement project in the Puntledge River headpond with respect to adult utilization, incubation survival and the influence of high river flows on gravel stability.

2 STUDY AREA

The "Headpond" reach of the Puntledge River is bounded by the BC Hydro Impoundment Dam at the upstream end and the Diversion Dam approximately 3.7 km downstream. The location of restored spawning habitat in this reach is located at the confluence of Supply Creek, a small tributary on the north side, approximately 1 km upstream of the Puntledge Diversion Dam (Figure 1). Supply Creek was likely a historical source of gravel recruitment and a significant spawning area. A deep pool located 450 m upstream provides good adult holding habitat in proximity to the spawning platform.

Discharge through this reach is regulated by BC Hydro who targets a discharge of 33 m^3/sec in the fall-winter months in order to operate their generating station at 24 MW and to provide a minimum flow of 5.7 m^3/sec in the Puntledge River below the diversion dam.

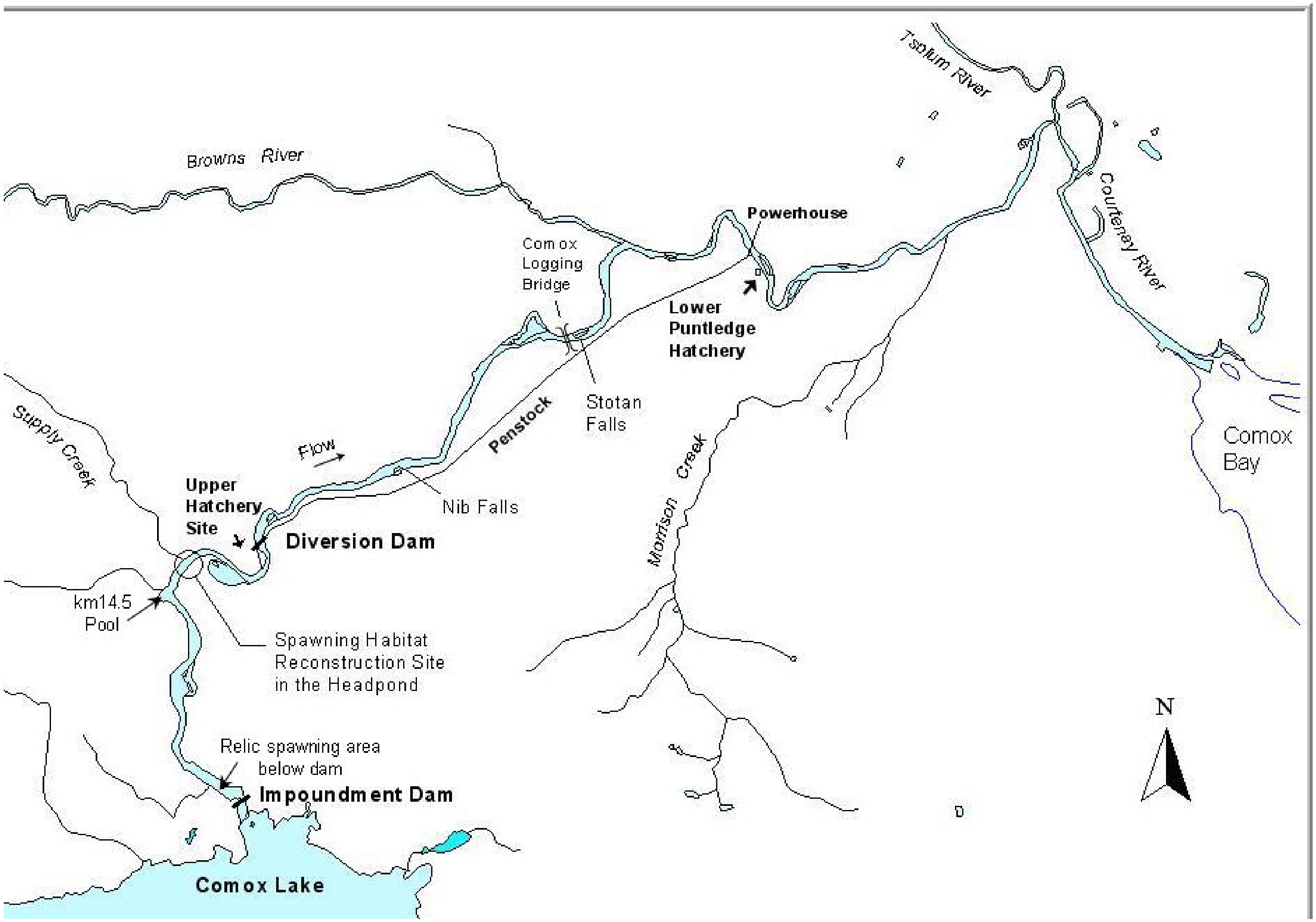


Figure 1. Puntledge River showing location of the Headpond Spawning Gravel Placement Project and other major features.

3 METHODS

3.1 Ambient Temperature

Water temperature was monitored throughout the incubation period using a built-in temperature sensor on one of two Solinst water level loggers installed at the spawning platform (see Section 3.2). The instrument was periodically downloaded in order to calculate the Accumulated Thermal Units (ATU - daily mean temperature multiplied by the number of days of incubation) which is used to estimate the rate of development of eggs for the incubation study. This ATU calculation was used for the rate of development of the control group incubated at Puntledge Hatchery since temperatures at the two sites were expected to be very similar. Incubation temperature at Puntledge Hatchery was recorded using a Tidbit® temperature logger.

3.2 Water Level and Discharge

Two Solinst water level data loggers installed at the spawning platform in October 2005, were used to monitor hydraulic grade over the gravel platform. These pressure transducers measured pressure changes produced from changes in water depth and atmospheric pressure. One recorder was placed at the upstream end of the platform and one 100 m downstream at the lower end of the platform. The instruments were placed underwater and suspended from cables in 2 inch perforated metal standpipes that were embedded in the streambed. A third recorder was located nearby and used to measure local barometric pressure. This data was used to compensate the water level recorder data. Discharge data was obtained from the BC Hydro Power Records office in order to correlate water level data at the spawning platform with discharge data for the headpond (Comox Dam releases) and turbine releases from the penstock.

3.3 Spawning Assessment

Prior to and throughout the summer-run chinook spawning season (September and early November), visual observations of summer chinook adult holding and spawning activity at the platform were recorded at four locations:

- at the Comox impoundment dam tailrace pool (holding);
- at km 14.5 pool upstream of the Supply Creek confluence (holding);
- at the new gravel platform (spawning); and
- at the gravel riffle ~150 m downstream of the impoundment dam (spawning).

For the most part, monitoring was conducted from a canoe which allowed completion of surveys over large areas of the gravel pads or holding pools with minimal disturbance to fish.

3.4 Incubation Assessment

On October 27, 2006, approximately 4450 fall-run chinook salmon eyed-eggs (i.e. 309 ATUs) from Puntledge Hatchery were loaded into incubators and transported to the gravel platform site. Fall chinook eggs were used instead of summer run due to the limited number of summer chinook eggs available. The eggs were placed in Jordan-Scotty incubation cassettes, 200 eggs per cassette and buried in three transects in the gravel (7 cassettes near the upstream end of the platform, 7 cassettes in the middle and 7 near the downstream end). In addition to Jordan cassettes, pipe incubators were also used to provide a comparison of incubation survival between the two apparatuses (Appendix III, Photo 1). The pipe incubators are 1.9 cm diameter (3/4 inch) perforated metal pipes, 38 cm in length and equipped with masonry drill bits at their tips so they could be driven into the substrate using a rechargeable drill. They were fabricated specifically for applications in deep water (Cowichan River) since they can easily be drilled into the substrate from the side of a boat. These pipe incubators were modified from those used at Bull Island in 2005. The pipe chamber which originally had 1/8 inch (3 mm) perforations was replaced with a pipe chamber with smaller diameter holes (1/16 inch or 1.6 mm). Field staff suspected that the alevins or fry could escape through the 3 mm holes. Each pipe incubator was loaded with eggs (25 eggs per incubator mixed with small beads as a substrate) and buried beside a Jordan cassette. Ten pipe incubators were installed at the platform – 4 at the upper transect, 3 in the middle transect and 3 at the lower transect. All incubators were marked with a piece of yellow poly rope and orange flagging for easier recovery at the end of the study. A control group of about 6000 eyed eggs remained at Puntledge Hatchery in 2 Heath trays and were assessed at the hatch and “button-up” stages.

One Jordan cassette from each transect and two pipe incubators from the upper and lower transect were removed on Dec 11, 2006 to assess survival to the hatching stage. All cassette and pipe incubators were removed on February 13, 2007 and contents were inspected to calculate percent survival to swim-up (fry) stage. Fry were transported in totes and released below the diversion dam.

3.5 Communications

A Communications Plan conducted by staff of Comox Valley Project Watershed Society informed the public and immediate community about the monitoring project through notices in local newspapers, displays at a BC Rivers Day Open House Event at Puntledge Hatchery, an article in the *Watershed News,* and during a guided Watershed tour of the habitat restoration site in the headpond (Appendix C). More detailed reporting of the Community Outreach Program associated with this and three other BCRP projects in the Puntledge River watershed is summarized in a separate report.

4 RESULTS

4.1 As-built Survey

On September 13, 2006, DFO (Resource Restoration Division) staff surveyed the footprint of the gravel pad with over 100 elevation shots over the entire area (Appendix E). Compared to the 2005 "as-built" survey, the platform elevation has not changed significantly.

4.2 Ambient Temperature

During the chinook spawning and incubation period, water temperatures at the spawning platform recorded by the water level loggers ranged from a maximum of 13.15 ^{o}C to a minimum of 1.56 ^{o}C between Oct 27, 2006 and Feb 13, 2007. Daily average incubation temperature at Puntledge Hatchery was slightly warmer than temperature measured in the headpond (Figure 2).

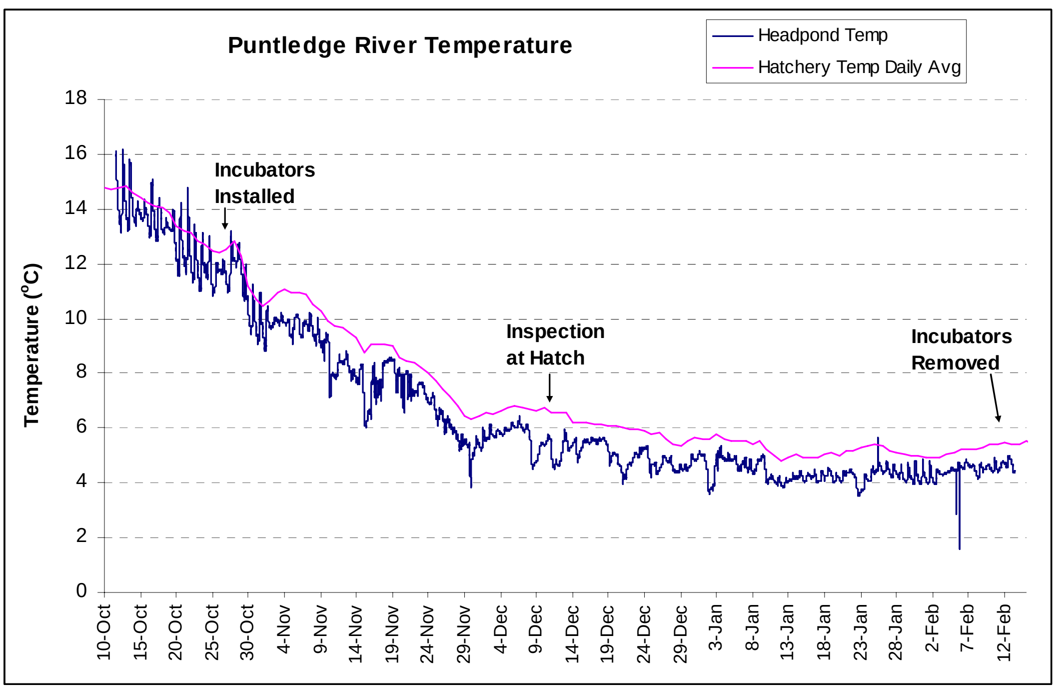


Figure 2. Ambient water temperature recorded at the Puntledge Headpond spawning platform and Puntledge Hatchery incubation temperature, October 2006 to February 2007.

4.3 Water Level and Discharge

Water levels were continuously measured at the upstream and downstream end of the spawning platform (100 meters apart) in the headpond from October 2006 to February 2007. Using the surveyed elevation of the recorders, water level data was corrected for elevation and the difference in elevation between the 2 water level recorders (hydraulic grade or slope) was calculated. The influence of turbine flow and river discharge in the headpond (sluice gate discharge) can be seen in Figure 3. When the turbine was not operating there was little drop over the platform. Once turbine and sluice gate flow increased, the hydraulic grade increased five-fold, but was not significantly influenced by flood events.

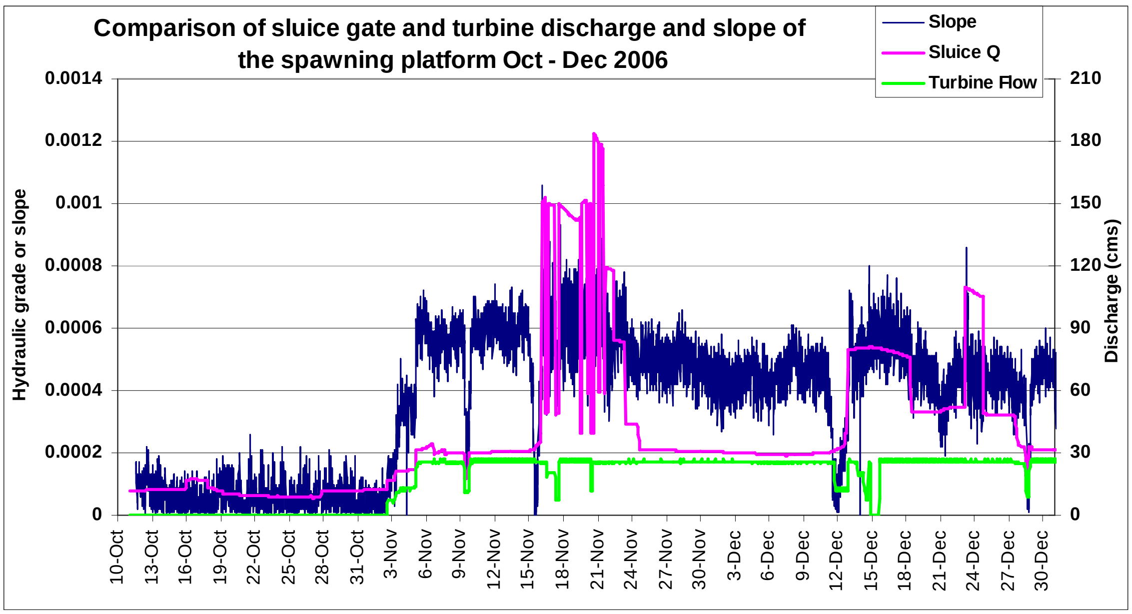


Figure 3. Hydraulic grade (slope) of the constructed spawning platform in the Puntledge Headpond, Comox dam sluice gate discharge and turbine flow, October to December 2006.

4.4 Spawning Gravel Platform Stability

The stability of the gravel at the spawning platform can be calculated using information collected from the staff gauge and by the two water level recorders. This information provides the average slope of the water surface and mean depth over the platform. The tractive force (kg/m^2) or shear stress (T) exerted by the flow on individual particles to the point at which they just begin to move (incipient motion) are calculated using the following relationship:

T = 1000 x depth (m) x slope (slope of water surface)

From the size composition of the placed spawning substrate (Table 2 in Guimond 2006), a (T) of 5 cm or lower would be considered acceptable at this site. The shear forces calculated are plotted with the discharge data provided by B.C. Hydro for November – December 2006 (Figure 4). The highest shear force calculated was 1.71 centimetres on November 18, 2006, at 05:45 hrs; the hydraulic grade (slope) was 0.00082 and water depth was 2.085 m. This does not correspond to the highest recorded water depth, nor the highest discharge in the headpond, but indicates the spawning gravel at this site was stable during the 2006-2007 incubation period. Maximum discharge from Comox Dam sluice gate releases was 183.808 m^3/s on November 20, 2006.

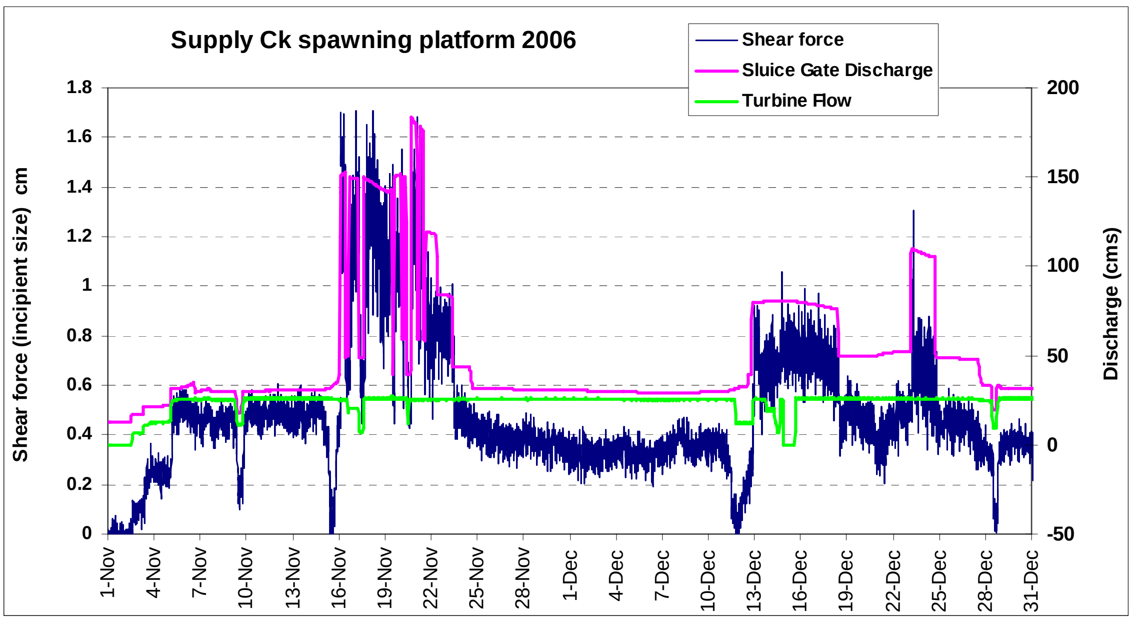


Figure 4. Correlation of shear force (incipient size in centimetres) and discharge (Comox Dam sluice gate discharge) at the spawning platform for the period November to December 2006.

The calculated discharge at Comox Dam is likely moderated by the 2 hour delay it takes to reach the Supply Creek spawning platform (Guimond 2006), and therefore does not likely experience the same instantaneous or hourly discharge. However, the product of mean hydraulic grade and depth at the spawning platform provides a representative estimate of shear force or incipient particle size at this site. This 2-hour delay has been factored into Figure 5 below which illustrates the relationship between shear force and headpond discharge at the spawning platform in 2006.

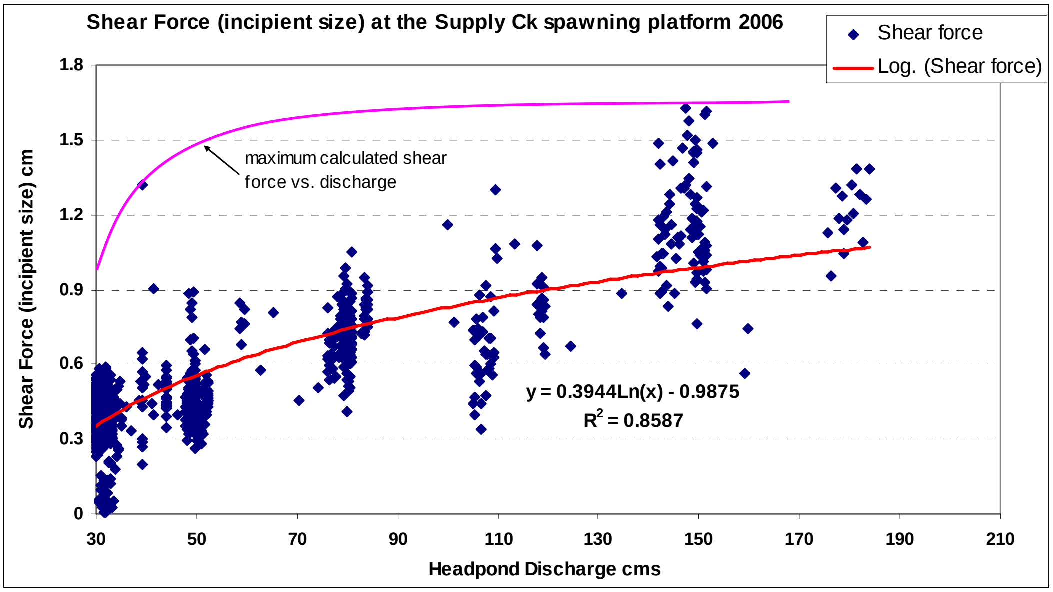


Figure 5. Shear force (incipient size) for the spawning platform calculated from water level recorder data and water depths over the platform from November to December 2006.

Records of discharge for the headpond (Comox Dam sluice gate discharge) were provided by BC Hydro. Peak hourly discharges for October – December 2006 were slightly lower than those recorded in 2005 (Figure 6).

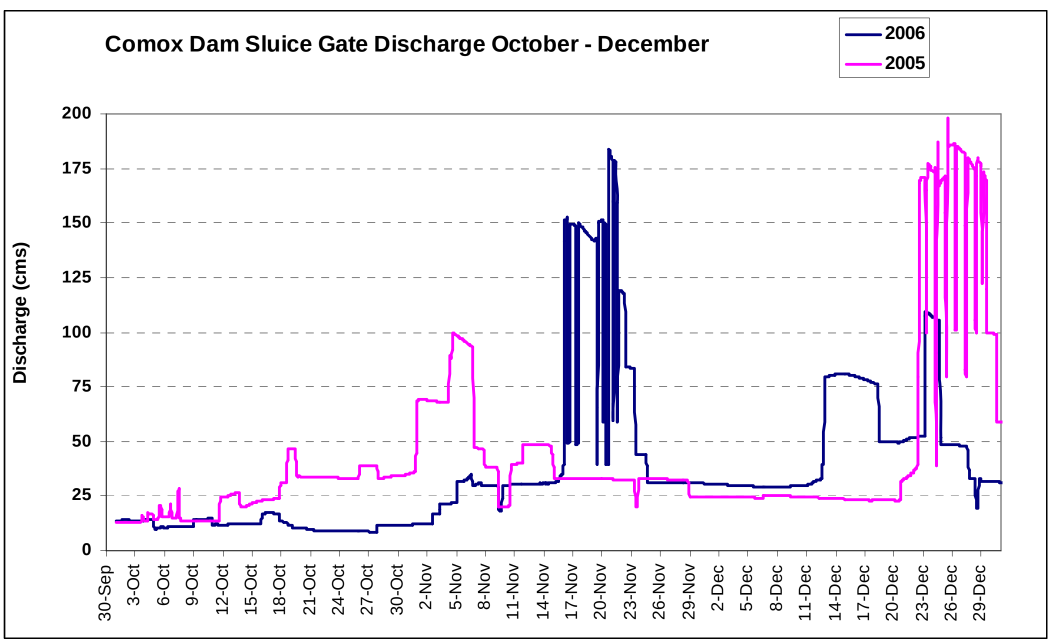


Figure 6. Comparison of Puntledge River headpond discharge (Comox dam sluice gate discharge) for October – December 2005 and 2006.

4.5 Spawning Success

From June 16 to September 7, 2006, approximately 237 summer chinook adults were counted passing through the fishway at the Puntledge Diversion Dam into the headpond (Guimond 2007 in print). At least 100 adults were observed holding in the headpond at one of only a few deep pools, located 1.5 km upstream of the diversion dam and only 500 m upstream of the spawning platform. This is also referred to as the 'Km 14.5 pool'. Spawning surveys conducted between October 2 and 29 found the majority of spawners utilizing historic gravel just below the Comox Dam, but over 20 adults were counted at the spawning platform (Table 1). Highest numbers of spawners were observed on October 11th with 22 adults located mostly near the upper half of the platform (Appendix D; Photo 1)

Table 1. Summary of spawning surveys conducted at the Puntledge Headpond spawning platform October 2006.

Date	Time	Staff Gauge	Total Count on Platform	Total Count in km14.5 Pool	Total Count below Dam	Total Count in Tailrace Pool	Comments
6-Sep	13:00		0	~100		0	Survey of standpipes; US - WL 29 cm below top of pipe; DS - WL 67 cm below top of pipe
2-Oct	14:00	0.685	0	~100		0	Staff gauge tilted; measured on d/s side; 17 ^{o}C
11-Oct	10:40	0.695	22	15		0	Bert Smit saw a few fish on platfiorm on Oct 5th but had moved back into pool on the 6th. Download loggers. ~11 redds
12-Oct	13:30				55		
14-Oct	14:00		12				Viewed from bank only; 2 spawners on new redd d/s boat launch
16-Oct	9:30		12				Viewed from bank only
23-Oct	10:00	0.635	10		20		15 redds in upper 2/3 of platform
29-Oct	14:00		3				Viewed from bank only

4.6 Incubation Success

On December 11, 2006 one Jordan cassette incubator was removed from each of the 3 transects and two pipe incubators were removed from the upper and lower transect to assess the stage of development and survival at ~626 ATUs (Appendix D-Photos 3 & 4). Survival to this stage in the Jordan cassettes was 98.3% (range 97% - 100 %). Survival in the pipe incubators was 68% (range 64% - 72 %). All incubators were removed from the spawning platform on February 13, 2007 at ~944 ATUs (Appendix D-Photo 6 & 7).

Survival to the fry stage in the Jordan-Scotty cassette incubators was high at all three transects (Table 2). Overall egg-to-fry survival in Jordan cassettes at the Puntledge Headpond (Supply Creek) spawning platform was 95.6 % (range: 89 % - 98 %). Egg-to-fry survival was significantly lower in the pipe incubators (mean = 32.5 %; range: 16% - 48%). Egg-to-fry survival for the control group at Puntledge Hatchery was 97.8 %.

Table 2. Summary of egg-to-fry survival for chinook eggs in the Puntledge Headpond spawning platform using Jordan cassette and pipe incubators Oct 2006 - Feb 2007.

Installation Date:	27-Oct-06	**Check at Hatch:**		11-Dec-06		**Removal Date:**		13-Feb-07
Site	**Incubator #**	**# Eggs**	**Dead Eggs**	**Dead Alevins**	**Dead Fry**	**% Survival to Hatch**	**Live Fry**	**% Survival to Emergence**
Transect 1 (top)	J1	200	2	4	0	97	-	-
LB to RB	J2	200	3	2	0	-	195	97.5
	J3	200	3	1	2	-	194	97
	J4	200	3	3	0	-	194	97
	J5	200	1	6	2	-	191	95.5
	J6	200	5	2	0	-	193	96.5
	J7	200	3	4	0	-	193	96.5
Mean								**96.7**
	P2	25	1	8	0	64	-	-
	P3	25				-	10	40
	P4	25				-	12	48
	P5	25				-	10	40
Mean								**42.7**
Transect 2 (middle)	J1	200	3	1	0	98	-	-
LB to RB	J2	200	1	3	0	-	196	98
	J3	200	4	4	2	-	190	95
	J4	200	5	4	0	-	191	95.5
	J5	200	2	13	0	-	185	92.5
	J6	200	4	2	0	-	194	97
	J7	200	3	0	1	-	196	98
Mean								**96.0**
	P2	25				-	5	20
	P3	25				-	11	44
	P4	25				-	6	24
Mean								**29.3**
Transect 3 (lower)	J1	200	2	18	2	-	178	89
LB to RB	J2	200	0	0	0	100	-	-
	J3	200	3	8	0	-	189	94.5
	J4	200	4	4	0	-	192	96
	J5	200	4	4	0	-	192	96
	J6	200	2	10	5	-	183	91.5
	J7	200	2	4	0	-	194	97
Mean								**94.0**
	P2	25	2	5	0	72	-	-
	P3	25				-	4	16
	P4	25				-	7	28
Mean								**22.0**

Control Group at Puntledge Hatchery - 97.8% survival to emergence

5 DISCUSSION

5.1 Physical Performance

The diversion dam and operation of the turbine does not appear have any negative effects on spawning platform stability. The backwatering effects from the diversion dam would be better understood by recording water level elevations at the diversion dam in addition to turbine flow (only the latter was obtained in 2006).

Maximum discharges recorded in the headpond since the project was completed in 2005 have been below the 1:25 year flood event discharge (254 cms). The River 2D model developed for the headpond (Chilibeck 2004) indicated that based on the composition of the substrate at the spawning platform, a D50 of 75 mm (median particle diameter) will remain immobile up to flows of approximately 250 cms (1:25 year flood) and a 35 mm diameter substrate will remain stable for flows in excess of 180 cms (1:2 year flood). The calculated shear force (incipient size) from observed depths and hydraulic grades at the site was less than the model predictions for a 1:2 yr flood (maximum shear force of 1.9 in 2005 and 1.7 in 2006). The Puntledge River 2D model also found that the greatest stresses were located at the downstream edge of the downstream pad. A comparison of the 2005 (as-built) and the 2006 total station surveys of the gravel platform (Appendix E) shows subtle changes in the gravel pad topography. The deliberate mounding of the platform when the gravel was placed in 2005 has levelled out, particularly at the lower end of the platform, but the overall elevation of the platform has remained unchanged. No areas of scouring were identified and all incubators that were buried at the platform in October 2006 were recovered at roughly the same depth that they were installed, unlike some of those recovered from the 2005 incubation study. Several incubators near the top of the platform in 2005 were exposed, while some near the lower end were buried deeper suggesting local scour had caused re-distributions of the substrates, as predicted in the River 2D model (Chilibeck 2004).

5.2 Biological Performance

5.2.1 Spawning

The low number of spawners at the gravel platform was surprising given that over 200 summer chinook were counted through the diversion dam fishway and at least 100 fish were observed schooling in the holding pool upstream of the gravel platform prior to the spawning period. The quality of spawning habitat below the Comox Dam tailrace appears poor with moderate compaction a high proportion of fines.

5.2.2 Incubation

The high egg-to-fry survival of chinook in Jordan cassettes is not unexpected given the quality of the gravel and the low suspended sediment transport in this reach. Mean egg-to-fry survival in 2006 (95.6 %) is similar to results obtained in 2005 (96.4 %). It should also be noted that Jordan incubators provide ideal conditions for incubation and therefore likely overestimate natural spawning conditions. While pipe incubators may more closely reflect natural conditions (i.e. eggs are not separated in individual cells like Jordan cassettes), the poor egg-to-fry survival observed in the pipe incubators may have resulted from the design. The smaller perforations may have reduced oxygen delivery to the eggs. Also, significantly more corrosion of the metal drill bit of the incubators was noted this year than in previous years (Appendix D; Photo 8; rusting likely worsens each year that the same bit is used). This may have adversely affected the water quality for those eggs resting close to the top of the bit (i.e. bottom end of the incubator). The live fry released from the pipe incubators in February were all at the top while the bottom of the pipe contained a clump of dead eggs/alevins and fungus (Appendix D; Photo 8).

Sedimentation events in Supply Creek during the winter storms in Nov/Dec 2006 did not appear to affect eggs or alevins at the spawning platform downstream of the confluence. Incubation survival appeared to be as good in the Jordan cassettes within the Supply Creek sediment plume as those that were not exposed to the plume. The siltation may have negatively impacted redds in Supply Creek itself but this was not assessed. Siltation in Supply Creek was significant enough to cause elevated turbidity levels in the Puntledge River causing a “boil water advisory” to be issued by the Comox-Strathcona Regional District on one occasion (Appendix D; Photo 5).

6 RECOMMENDATIONS

Continuation of a condensed version of this monitoring program can provide critical information about the physical and biological performance of the project over time. The following recommendations are proposed:

1. Continue to maintain water level recorders at the upstream and downstream limits of the spawning platform, and collect discharge records (Comox Dam sluice gate discharge) from BC Hydro in order to estimate shear forces at the site and verify River 2D calculations for bed stability.

2. Complete a total station survey at the site every 3-5 years or after significant flood events (i.e. 1:25 year event) to identify changes in channel bed topography and determine overall pad stability.

3. Conduct periodic spawning surveys at the site during the chinook spawning period (October) to assess adult utilization.

4. Continue to experiment with variations of the pipe incubators. Perfecting an incubator that can be more easily utilized in deeper or faster spawning areas will be beneficial (both from an economic and safety perspective) for assessing natural and restored spawning habitats.

7 ACKNOWLEDGEMENTS

This project was made possible through the financial support of the B.C. Hydro Bridge Coastal Fish and Wildlife Restoration Program, and the technical and supervisory support of Fisheries and Oceans Canada/Oceans and Habitat Enhancement Branch (Nanaimo). Special thanks is given to Bert Smit for permission to access the river through his property to conduct surveys; Malaspina University-College students in the Fisheries and Aquaculture program for assistance with installation of incubators; and Puntledge Hatchery for providing chinook eggs for the study.

8 REFERENCES

Anderson, S., M. Sheng, R. Norgan and L. DeGroot. 2001. Campbell River Gravel Placement: Utilization and Stability 1997-2000. Dept. Fish. and Oceans. DRAFT report.

Bengeyfield, W. and W. A. McLaren. 1994. Puntledge River gravel placement feasibility study. Global Fisheries Consultants Ltd. White Rock, B.C. and McLaren Hydrotechnical Engineering, Coquitlam, B.C. for: Environmental Resources, B.C. Hydro, Burnaby.

Chilibeck, B.M. 2004. Puntledge River Summer Chinook Spawning Habitat Restoration Design and Numerical Modelling. Final Report. Northwest hydraulic consultants, North Vancouver, B.C. for: Fisheries and Oceans Canada, Habitat and Enhancement Branch, Nanaimo, B.C.

Guimond, E. 2006. Summer Chinook Spawning Habitat Restoration in the Puntledge River Headpond 2004-2005. BCRP Project # 04.Pu.01. 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. BCRP Project # 06.Pun.05. *In Print.* Prepared for BC Hydro BCRP, Burnaby, BC.

Lough, M. 2003. Re: Status of Puntledge River Reach C Gravel Investigations. Memo to Adam Lewis for the Puntledge River WUP, April 7, 2003.

Appendix A - Financial Statement Form

Project #: 06.Pun.03

	BUDGET			ACTUAL		
INCOME	**BCRP**	**Other (Cash)**	**Other (in-kind)**	**BCRP**	**Other (cash)**	**Other (in-kind)**
Total by Source	$13,607.00		$11,361.00	$13,607.00		$8,633.00
Grand Total Income (BCRP + Other)	**$24,968.00**			**$22,240.00**		
EXPENSES						
Project Personnel						
Biologist (contractor)	$6,450.00			$6,466.00		
Technician (contractor)	$2,400.00			$1,663.05		
Communications Technician	$2,250.00			$2,250.00		
DFO Biologist			$2,000.00			$2,000.00
DFO Technicians)			$4,800.00			$4,800.00
Volunteers			$2,400.00			
Material and Equipment						
Small Tools/supplies & equipment rental	$670.00		$768.00	$24.69		$668.00
Travel	$600.00		$300.00	$352.80		$380.00
Adiministration						
10%	$1,237.00		$1,093.00	$1,075.65		$785.00
Total Expenses	**$13,607.00**	**$0.00**	**$11,361.00**	**$11,832.19**	**$0.00**	**$8,633.00**
Grand Total Expenses (BCRP + others)	**$24,968.00**			**$20,465.19**		
Balance (Grand Total Income - Grand Total Expenses	**$0.00**			**$1,774.81**		
BCRP Balance (surplus)	**($1,774.81)**					

* 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.03

Using the performance measures applicable to your project, please indicate the amount of habitat actually restored/enhanced for each of the specified areas (e.g. riparian, tributary, mainstream).

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											
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.	**Sum CN Sum ST**		**4,700**								
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 during the Puntledge River Gravel Placement Post-Construction Monitoring Project, October 25, 2006.

COMOX VALLEY RECORD Wednesday, October 25, 2006 A9

Summer-run chinook spawning in Puntledge

Watershed walk Sunday at river with biologist Esther Guimond

Despite this fall's low river levels, two dozen summer-run chinook are now spawning at a new habitat restoration project on the Puntledge River, Project Watershed says in a news release.

The project is approximately three kilometres downstream from BC Hydro's impoundment dam at Comox Lake in a section of the river known as the Headpond.

In 2005, 6,700 tonnes of gravel was added in an area of the Headpond, creating a new spawning bed measuring approximately 4,750 square metres, says Project Watershed. This year the site is being closely monitored and assessed for its ability to provide effective habitat for spawning and incubation.

"We seem to be off to a good start," says project biologist Esther Guimond. "The gravel was spread out over a 100-metre stretch, and spans across the entire river. Although we have only seen 12 pairs spawning this year, there is enough habitat there to eventually support over 400 pairs."

The Headpond section was historically the most important spawning area for summer-runs of chinook salmon and steelhead, notes Project Watershed. Following expansion of the hydro facilities in the 1950s, this habitat was severely impacted through a combination of flooding, reduced velocities and altered hydrology, the group adds.

The Puntledge River Hatchery, built in 1977, has been instrumental in conserving and maintaining the summer-run chinook stock over the past four decades.

According to Chris Beggs, manager at Puntledge Hatchery, "A key element in the successful re-establishment of the summer-run chinook salmon stock will be restoration of the historical spawning habitats.

"Since 2001 the hatchery has enabled a greater portion of the returning summer chinooks access above the Puntledge Diversion Dam into the Headpond and Comox Lake, after we acquire broodstock. This year, over 200 passed through the fish ladder at the Diversion Dam," he adds.

> *Since 2001 the hatchery has enabled a greater portion of the returning summer chinooks access above the Puntledge Diversion Dam into the Headpond and Comox Lake, after we acquire broodstock. This year, over 200 passed through the fish ladder at the Diversion Dam.*
> Chris Beggs

Running simultaneously to the Headpond project is a genetic analysis study of summer and fall-run chinook. This information will help researchers and hatchery staff better understand the migration timing of these two distinct species in order to safeguard and rebuild the summer-run stock, says Project Watershed.

Both projects are funded through BC Hydro Bridge Coastal Fish and Wildlife Restoration Program (BCRP) and Fisheries and Oceans Canada.

The Puntledge River system is one of a few rivers on the east coast of Vancouver Island to support both a summer and a fall run of chinook salmon, states Project Watershed.

The Comox Valley Project Watershed Society says it is a non-profit society established in 1993 and run by a volunteer board of directors.

***

Project Watershed is having a Watershed Walk in the upper Puntledge River from the upper hatchery to a new spawning site in the Headpond.

You can join biologist Esther Guimond on Sunday, Oct. 29 at 1 p.m. to learn more about the history of the BC Hydro dam and the importance of a healthy stream habitat for the survival of salmon populations. The walk will require good walking shoes and last for one to two hours. People will meet at the entrance to Barber's Pool on Forbidden Plateau Road.

For more information call Heather Beckett of Comox Valley Project Watershed at 703-2871.

APPENDIX D: PHOTOS

Photo 1. Summer chinook spawning at the Puntledge River headpond spawning platform (at Supply Creek), October 2006, viewed from the upper end of the platform.

Photo 2. One of ten pipe incubators used to assess incubation survival of chinook eggs in the spawning platform in the Puntledge River Headpond 2006/07.

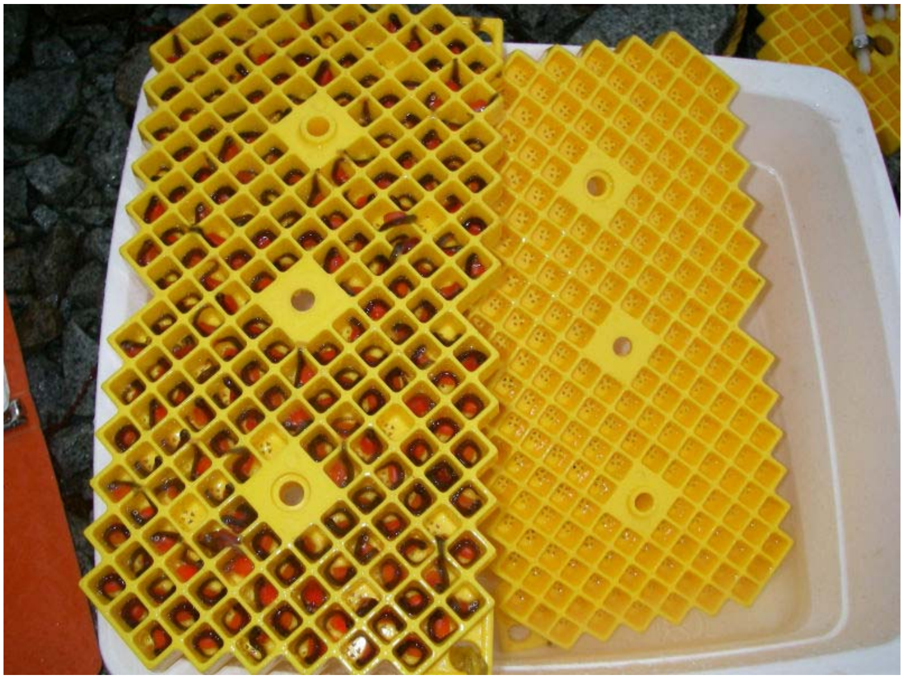


Photo 3. Jordan-Scotty cassette incubator removed from the spawning platform December 11, 2006 to check survival to the hatching stage. Survival was >98% for cassettes.

Photo 4. Contents from a pipe incubator at the gravel platform in the headpond checked at the hatching stage December 11, 2006. Survival to hatch in pipe incubators was 68%.

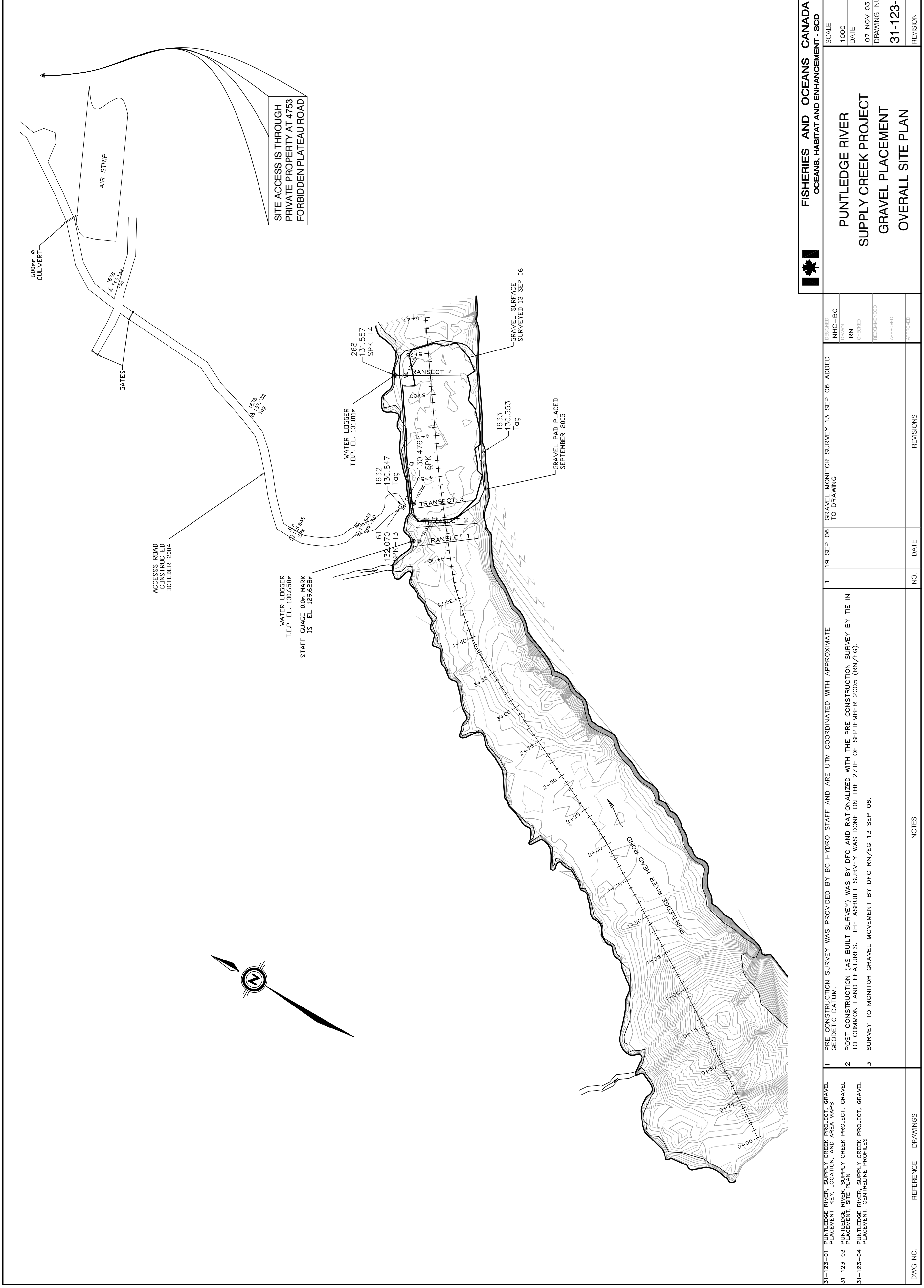
Photo 5. Plume of turbid water from Supply Creek entering the headpond on the left bank at the upstream end of the gravel platform December 11, 2006 (looking upstream).

Photo 6. One of 18 Jordan-Scotty incubation cassettes removed from the spawning platform February 13, 2007. Note very few dead and no silt in cassette.

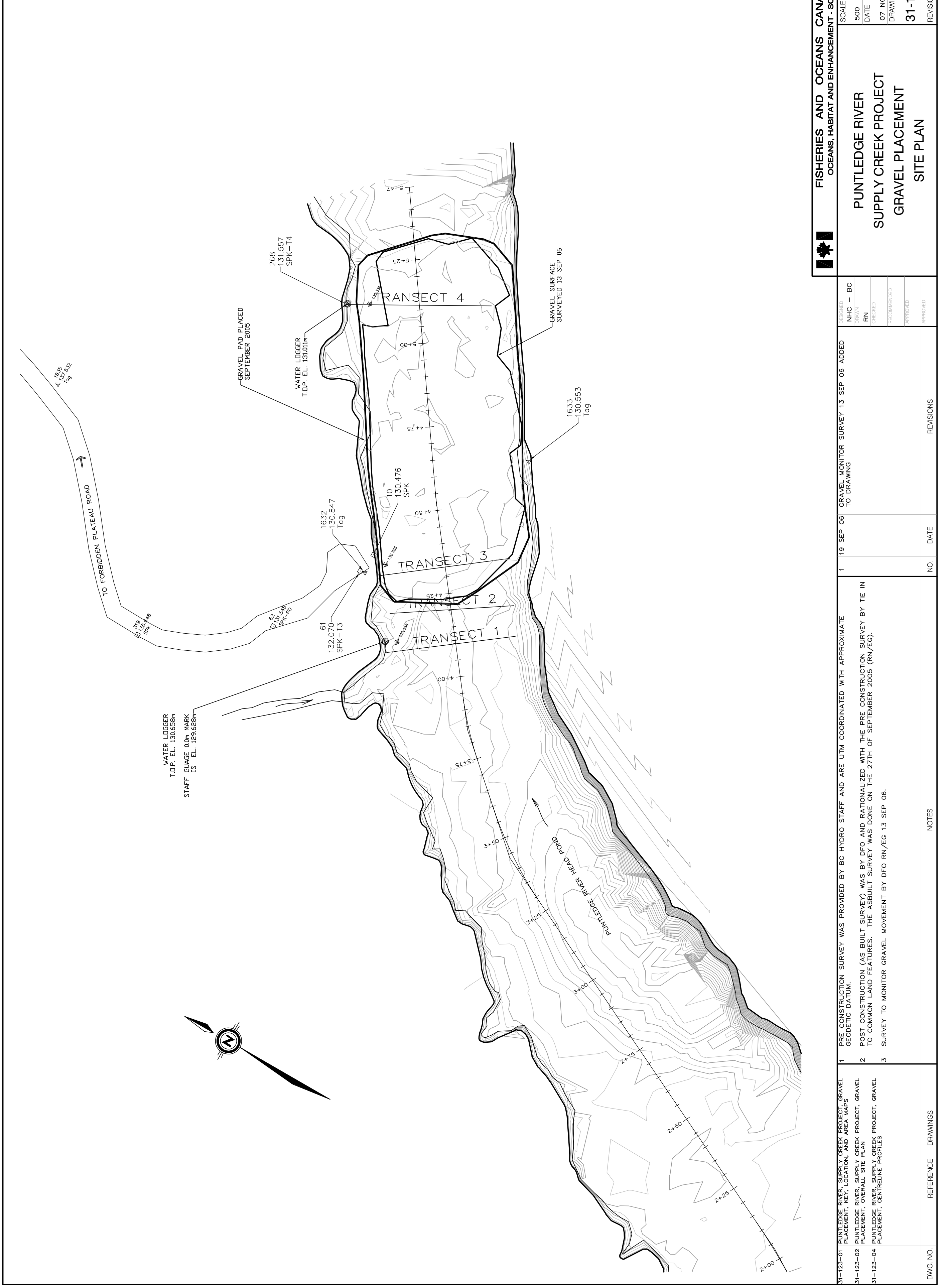
Photo 7. Contents from one of 8 pipe incubators removed form the spawning platform, February 13, 2007. Note clumps of dead material, and few live fry.

Photo 8. Accummulation of dead eggs and alevins on bottom of pipe incubator.

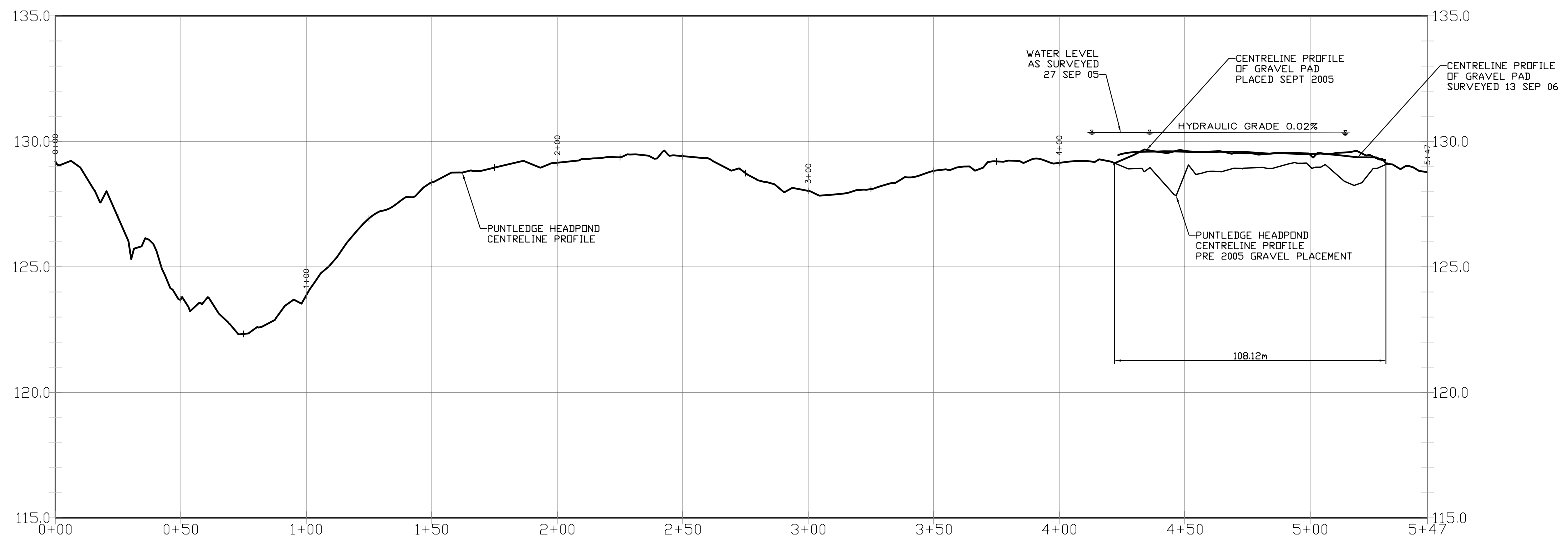
APPENDIX E - 2006 SURVEY OF THE PUNTLEDGE RIVER HEADPOND SPAWNING PLATFORM



APPENDIX E - 2006 SURVEY OF THE PUNTLEDGE RIVER HEADPOND SPAWNING PLATFORM



APPENDIX E - 2006 SURVEY OF THE PUNTLEDGE RIVER HEADPOND SPAWNING PLATFORM



DWG. NO.	REFERENCE DRAWINGS
31-123-01	PUNTLEDGE RIVER, SUPPLY CREEK PROJECT, GRAVEL PLACEMENT, KEY, LOCATION, AND AREA MAPS
31-123-02	PUNTLEDGE RIVER, SUPPLY CREEK PROJECT, GRAVEL PLACEMENT, OVERALL SITE PLAN
31-123-03	PUNTLEDGE RIVER, SUPPLY CREEK PROJECT, GRAVEL PLACEMENT, SITE PLAN

NOTES

1. PRE CONSTRUCTION SURVEY WAS PROVIDED BY BC HYDRO STAFF AND ARE UTM COORDINATED WITH APPROXIMATE GEODETIC DATUM.
2. POST CONSTRUCTION (AS BUILT SURVEY) WAS BY DFO AND RATIONALIZED WITH THE PRE CONSTRUCTION SURVEY BY TIE IN TO COMMON LAND FEATURES. THE ASBUILT SURVEY WAS DONE ON THE 27TH OF SEPTEMBER 2005 (RN/EG).
3. SURVEY TO MONITOR GRAVEL MOVEMENT BY DFO RN/EG 13 SEP 06.

NO.	DATE	REVISIONS
1	19 SEP 06	GRAVEL MONITOR SURVEY 13 SEP 06 ADDED TO DRAWING

DESIGNED: NHC – BC
DRAWN: RN
CHECKED
RECOMMENDED
APPROVED
APPROVED

FISHERIES AND OCEANS CANADA
OCEANS, HABITAT AND ENHANCEMENT - SCD

PUNTLEDGE RIVER
SUPPLY CREEK PROJECT
GRAVEL PLACEMENT
CENTRELINE PROFILES

SCALE: H: 1000 V: 100
DATE: 07 NOV 05
DRAWING NUMBER: 31-123-04
REVISION: -