

Coquitlam-Buntzen Water Use Plan Monitoring Program

Assessment of Pink Salmon Passage in Lower Coquitlam River

Implementation Year : 4

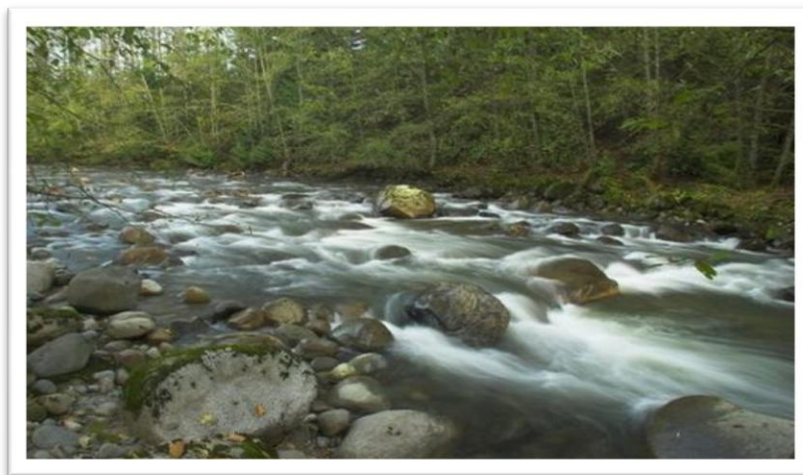
COQMON -4

Study Period: August 25 - September 30, 2013

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January 31, 2014

ASSESSMENT OF PINK SALMON PASSAGE IN LOWER COQUITLAM RIVER



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EXECUTIVE SUMMARY

The objectives of this study is to firstly conduct an assessment of adult Pink Salmon (*Oncorhynchus gorbuscha*) passage in the lower Coquitlam River by identifying index sites that may have the potential to restrict Pink Salmon migration during summer low flows. A secondary objective is to determine at what flows each barrier is eliminated or reduced. In 2013 it is the fourth study year of a five year assessment, which started in 2007 and will end in 2015, and is conducted in odd years only to coincide with south coast migrating Pink Salmon. This study represents a component of the monitoring program BC Hydro has undertaken as partial fulfillment of its commitments made during the Coquitlam-Buntzen Water Use Plan (WUP) process. A fisheries technical document was reviewed by the WUP Consultative Committee that indicated main stem passage was restricted at flows below 2.8cms (Jarvis 2001). The 2007 assessment identified seven index sites that had the potential of restricting passage during low summer flows. The 2013 survey year replaced two monitoring sites which included site 1, because re-assessment and previous surveys in 2009 and 2011 determined it no longer represented a fish passage obstruction. Site 3B was also discontinued after in stream habitat improvements were completed by the Department of Fisheries and Oceans (DFO) in the summer of 2012 to improve flow and stream depth to the right side channel. The addition of index sites that was identified for the 2013 assessment were incorporated into monitoring due to depth and flow constraints.

The treatment 2 flow regime from the Coquitlam Dam gate identified as low level outlet 3 (LLO3) contributed a consistent daily average discharge ranging from 2.28cms to 2.63cms (Fournier 2013) with an average daily discharge of 3.47cms recorded at the Water Survey Canada site from August 25th to September 25th. During the monitoring period the lowest discharge occurred on September 15th and was recorded at 2.59cms (WSC Port Coquitlam), at which time no migrating Pink Salmon were observed to be impeded or restricted at any of the index monitoring sites as indicated with fish distribution numbers in the upper reaches of the Coquitlam mainstem, specifically in the Swoboda channels. During the lowest discharge rate, a total of 255 Pink Salmon were observed throughout all reaches and of those, 63 were observed upstream of index site 4, indicating that velocity, depth and flow were adequate for migration. Precipitation induced flow events (288mm) occurred during late September (22nd to 30th) and in combination with an increase in the discharge from the Dam, significant

numbers of Pink Salmon migrated into the system and peaked by October 11th with 13,231 Pink Salmon enumerated in the mainstem Coquitlam and of those, 4,380 were observed upstream of index site 3C (Macnair 2013).

A concern during the 2013 study period is associated with elevated stream temperatures averaging 19°C daily throughout the assessment period, which is at the higher threshold temperature for Pink Salmon migration, however, the average residency time of 20 days was observed which is adequate for staging and spawning and similar to previous years observations. (Macnair 2013). Due to an extended hot and dry 2013 summer on the south coast, observations indicate that the treatment 2 flow regime target with consistent maximum discharge (2.7cms), improved the ease of passage at all the index sites by providing adequate depth and velocity for passage during minimal tributary contributions. The higher consistent base flows during the early summer season increased the availability of mainstem spawning habitat and the ability for early returning Pink Salmon to migrate without difficulty past all index sites. The 2013 survey observed the highest proportion (77%) of mainstem spawning habitat selection (Macnair 2013) as well as increased numbers and spawning activity in the upper reaches of the Coquitlam River since monitoring began in 2003.

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1.0 INTRODUCTION

This 2013 study represents the fourth assessment year of the a five odd-year monitoring study, commencing in 2007 and ending in 2015, of Pink Salmon migration in the lower Coquitlam River.

1.1 Background

A report prepared by Jarvis (2001) provided historical evidence that main stem salmon spawning migration had been restricted in the Coquitlam River during summer low flows when discharges were less than 100cfs (2.8cms). In 2003, Pink Salmon returns were primarily observed in late September to early October although it has been documented that Pink Salmon runs in the Fraser River can access tributaries as early as August (Macnair, Lewis, 2003). With the increased Pink Salmon escapements in recent years, there is potential access issues for migrating adults in late summer during low flows. Based on recommendation from the Coquitlam/Buntzen Water Use Plan (WUP) Consultative Committee and the approved WUP monitoring program, the purpose of this report is to monitor the migration of returning Coquitlam River adult Pink Salmon to determine if there are any flow related migration barriers and at what flows can they be mitigated. With the issue of the revised Coquitlam/Buntzen Water Licence in 2005 the monitoring and assessment study of Pink Salmon migration is to continue in odd year spawning cycles commencing in 2007 and extending through the end of the WUP review in 2015. As a component of the WUP monitoring program the initial 2007 assessment was conducted to monitor Pink Salmon passage and determine if there are flow related migration barriers, either partial or complete, in the lower Coquitlam River during the treatment 1 flow regime (0.8 to 1.4cms). This flow regime continued until the completion of the Coquitlam Dam seismic upgrade in January 2008 when BC Hydro's transition to the adjusted treatment 2 flow regime of between 1.1 to 2.7cms commenced on September 15, 2008 (Table 1).

The following table provides details on the annual treatment 1 and treatment 2 discharge flows from the Coquitlam Dam as targeted by BC Hydro.

Table 1 - Annual schedule for release amounts from Coquitlam Dam, note: August and September current and targeted discharge amounts (BC Hydro 2003).

Coquitlam Dam Release Schedule (CMS)				
Date	Treatment 1 Current Minimum	Treatment 2 (CMS) Target	Treatment 2 (CMS) Minimum	Species Driver and Priority for Coquitlam River releases
1-Jan	1.0	5.9	3.6	Chinook Spawning
15-Jan	1.0	2.9	2.9	Chinook Spawning
Feb	1.0	2.9	1.8	Chinook Spawning
Mar	0.8	4.3	1.1	Steelhead Spawning
Apr	0.8	3.5	1.1	Steelhead Spawning
May	1.1	2.9	1.1	Steelhead Spawning
June	1.4	1.1	1.1	Steelhead Parr
July	1.4	1.2	1.1	Steelhead Parr
Aug	1.1	2.7	1.1	Steelhead Parr
Sept	0.8	2.2	1.1	Steelhead Parr
Oct	0.8	6.1	3.6	Chinook Spawning
Nov	1.1	4.0	1.5	Chinook Spawning
Dec	1.1	5.0	2.5	Chinook Spawning

1.2 Objectives

The assessment will be conducted from late August to no later than October 1st each Pink Salmon migration year (odd year) starting in September 2007 and extended though to 2015.

The two primary objectives of this monitoring study is to:

- (1) Monitor the migration of early returning Pink Salmon in odd years (2007-2015) to determine if there are any flow related migration barriers in the lower Coquitlam River mainstem corridor.
- (2) To determine at what flows each barrier is eliminated or reduced.

In order to answer the primary objectives above there are two alternative hypotheses that are tested:

- (1) Early run Pink Salmon migration is not restricted during low inflows to the lower Coquitlam River.
- (2) Changes in flow do not influence the efficacy of Pink Salmon migration.

2.0 STUDY AREA

The study area on the Coquitlam River is 12.9km in length and consists of seven potential passage index sites being monitored, beginning upstream of the Pitt River Road Bridge and extending upstream to the Coquitlam Dam (Figures 1 & 2). Adult Pink Salmon are typically main stem spawners and generally made use of spawning areas in the upper reaches of the Coquitlam River, but it has also been reported that on average 36% of returning Pink Salmon access off channel habitat since monitoring began in 2003 (Decker 2009). This study primarily consists of main stem passage therefore tributaries or off channel habitat monitoring is not included which may limit the results of this report. The following seven index sites are identified as:

Index Site 1A -(49°15.941 N -122°46.902 W) New site for 2013. Located under the CPR rail bridge crossing at Kingsway Street in Port Coquitlam.

Index Site 2a - (49° 16.276 N – 122° 47.075 W) located at the foot of Prairie Avenue east and Shaughnessy Street in Port Coquitlam.

Index Site 2b -(49° 16.585 N – 122 46.620 W) extends upstream 30m and downstream 55m of Patricia Street pedestrian bridge in Port Coquitlam.

Index Site 2c - (49° 19.621 N – 122° 46.346 W) located 85m downstream of Galette Park access and Pipeline Road, Coquitlam.

Index Site 3A -(49° 19.632 N – 122° 46.344 W) located at Upper Coquitlam River Park, 120m upstream of the diving board hole pool.

Index Site 3C -(49° 20 .230 N – 122° 46.251 W) New Site for 2013. Located 60m downstream of the Al Grist Memorial Hatchery off Pipeline Road.

Index Site 4 -(49° 21. 041 N – 122° 46.452 W) located at the Coquitlam main stem and Swoboda channel confluence, access south of Grant's Tomb pond.

The following watershed information further describes the Coquitlam River basin below the Dam:

- Watershed code: 100-024500-00000-00000-000
- Geo-data BC Trim Map reference: 092G037, 092G027, 092G026
- Watershed size : 237 km²
- River length from mouth to Coquitlam dam: 17 km
- Study area: 12.9 km
- Coquitlam River mean annual discharge: 4.6cms (McPhee 2003)
- Major Tributaries: Or Creek MAD=2.9cms, Scott/Hoy Creek MAD=1.0cm (McPhee 2003)

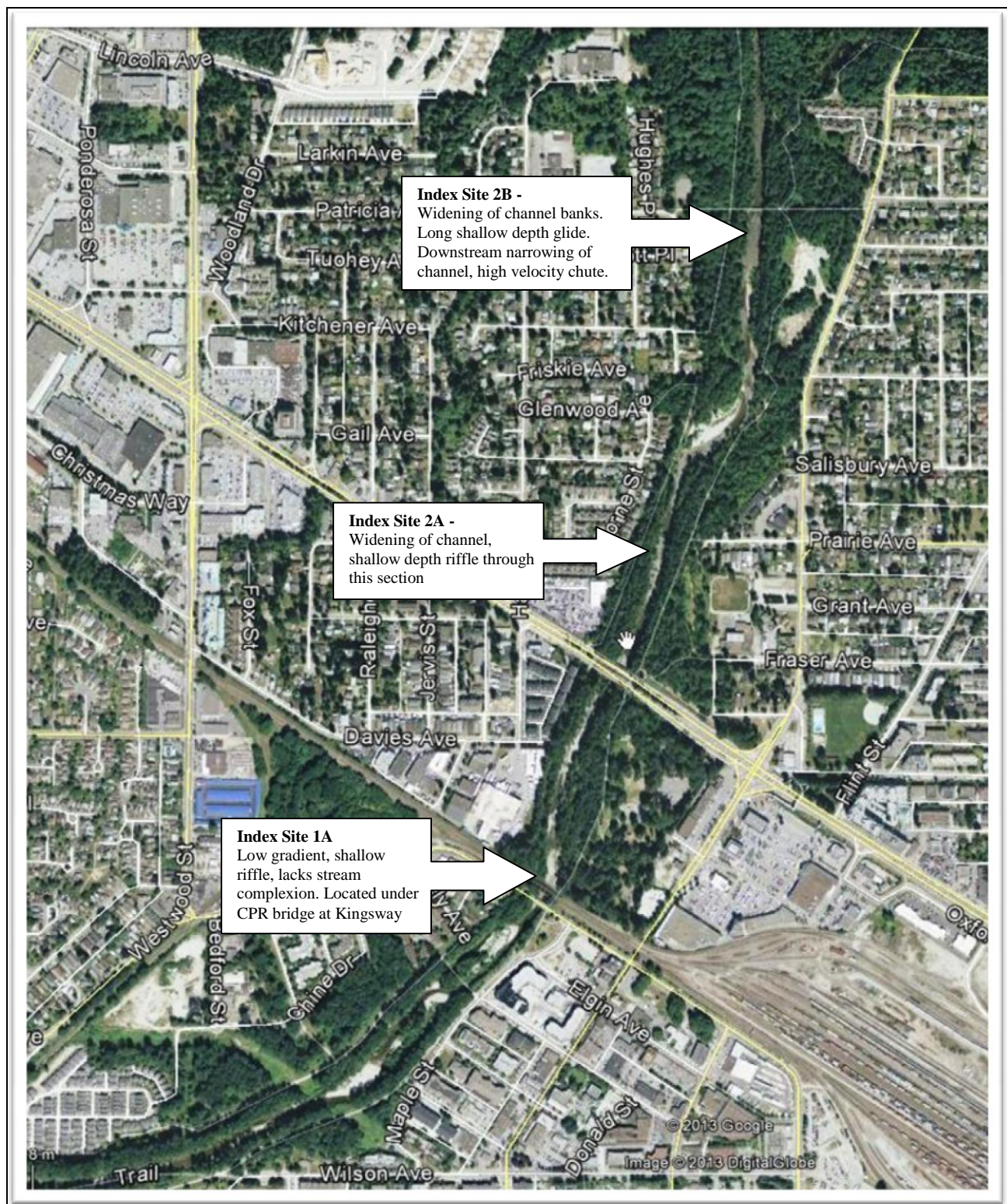


Figure 1 – Passage index site locations 1A, 2A and 2B located in the lower portion of the Coquitlam River. (source: Google Earth)

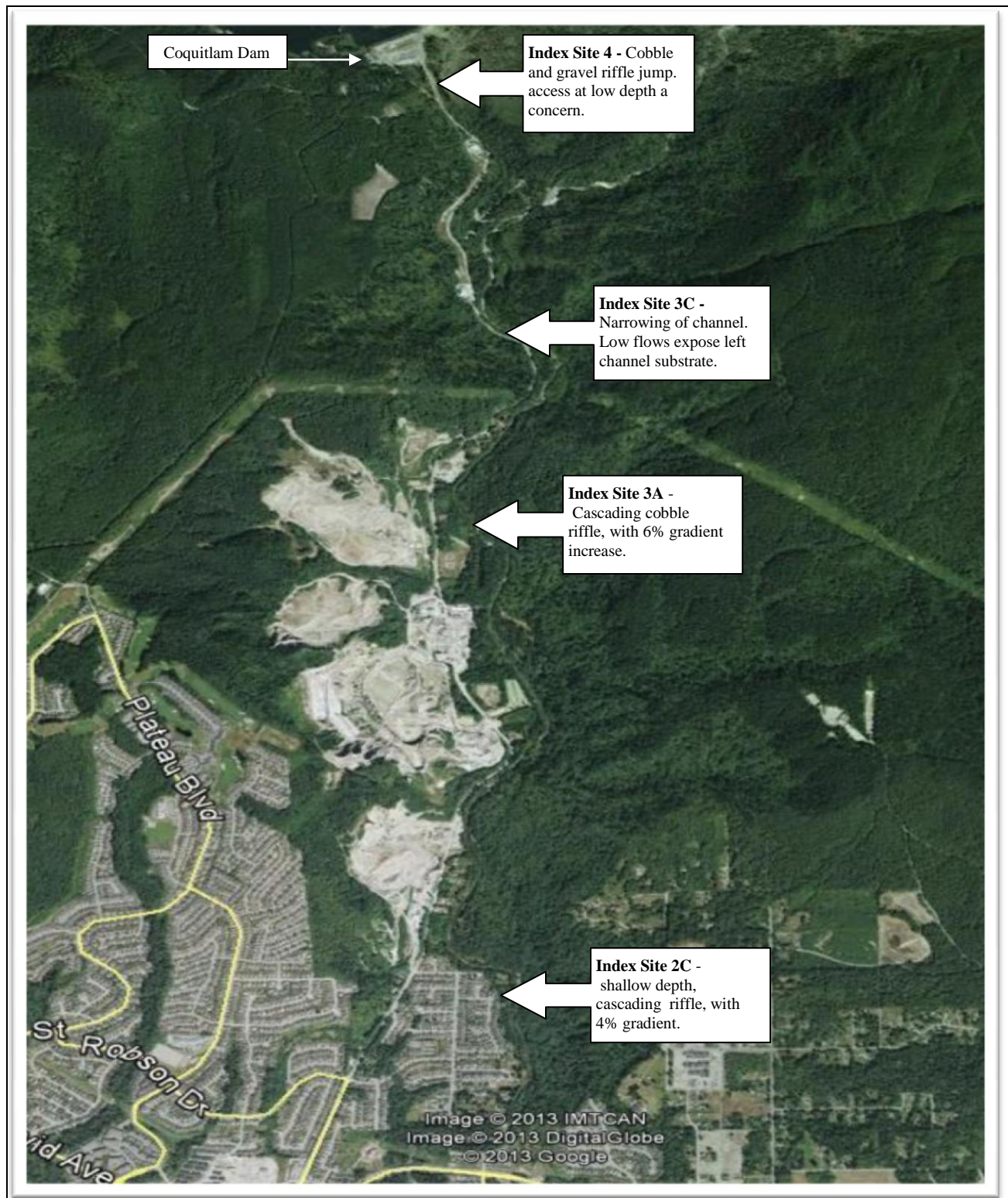


Figure 2 –Passage index site locations 2C, 3A, 3C and 4 located in the upper portion of the Coquitlam River. (source: Google Earth)

3.0 METHODS

The objective undertaken for the 2013 assessment was to monitor previously identified index sites that had the potential to constrict salmon passage in the mainstem Coquitlam River and to identify any new index sites that could potentially be a passage barrier to migrating Pink Salmon. In 2007 seven sites were identified and GPS located as monitoring sites as indicated in the study area section of this report. For any new sites the entire river was surveyed at summer low flows, prior to the arrival of the first observed migrating Pink Salmon, and added to the index site list according to the physical parameters indicating passage could be an issue. The 2013 preliminary assessment identified two new monitoring sites, 1A and 3C, the first site is located under the Kingsway CPR bridge and the second site is located downstream of Al Grist memorial hatchery. Site 1 was discontinued because re-assessment of this site and previous assessments in 2009 / 2011 determined that it no longer represented a fish passage obstruction. Site 3B located upstream of the Al Grist memorial hatchery was also discontinued after in stream habitat improvements were completed by the Department of Fisheries and Oceans (DFO) in the summer of 2012 to improve flow to the right side channel. The sites were monitored from August 25th to September 30th, 2013 with a maximum of six surveys conducted to determine if low flows impeded or restricted Pink Salmon passage. For safety reasons site surveys were performed during daylight hours and visual observations were considered adequate from the stream bank. A variety of techniques have been used to assess adult stream passage usually at critical stream reaches such as shallow riffles and low depth glides (Bjornn and Reiser 1991). A site assessment card which provides an overview of each index site on observation days is filled out and kept on record, a blank assessment card can be reviewed in appendix III. Field assessment data collected primarily focused on water depth and velocity which is collected using a Swoffer model 2100 series current velocity meter. Maximum and minimum depths and velocity is collected at intervals dictated by the wetted width of the channel and for this study a wetted width <10m, dictated that collection points were taken every meter and wetted widths greater than 10m, depth and velocity data was collected every 2 to 3 meters to obtain a representative value and as a result, a target of between 5 and 10 depth and velocity measurements were recorded for each transect.

Velocity measurements were collected at 60% of the total depth and presented as meters per second. Depth measurements were collected perpendicular to the width of the channel and is represented as an average and maximum stream depth. Air and creek temperature data was collected once per index site at a mid depth water level in the center of the channel using a handheld mercury thermometer. Additional data parameters were also collected such as wetted width of the stream channel, measured distance across the wetted portion of the stream channel. Gradient data was collected using a Suunto clinometer and represented as a percent value. Substrate composition (Table 2) and weather conditions as well as photo documentation was also collected.

Table 2- Bed Material (substrate) Size Distribution

Class	Size
Fines	<2mm
Gravels	2 - 64mm
Cobbles	64 - 256mm
Boulders	>256
Rock	>4000mm
(Kaufmann and Robinson(1993))	

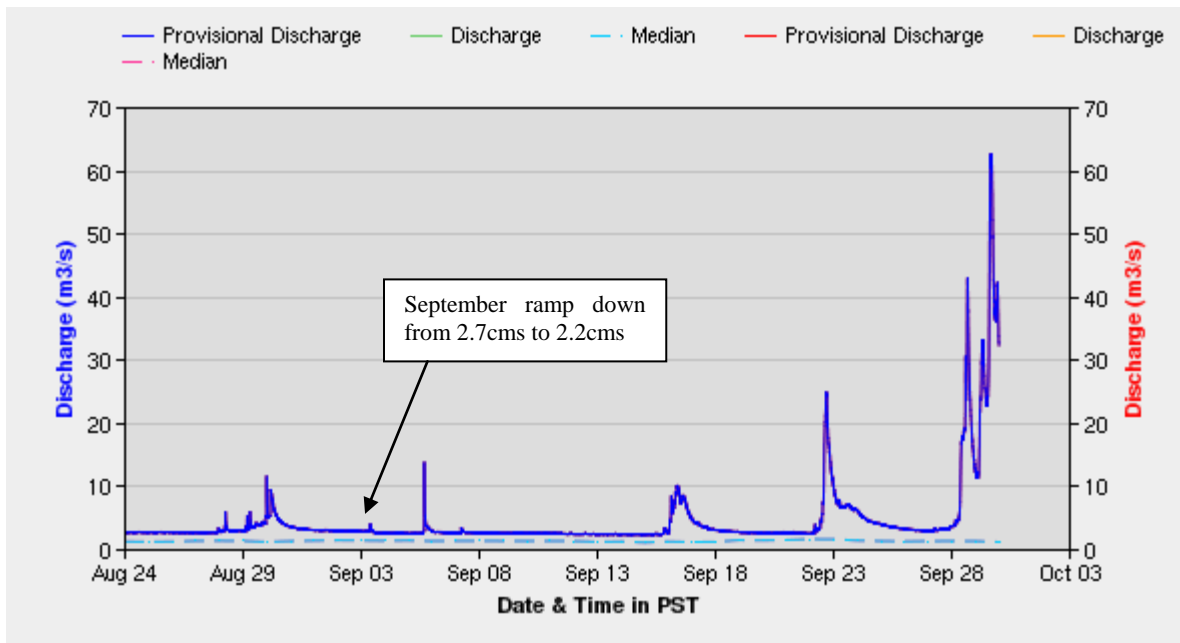
Other physical conditions monitored at the index sites included description of the barrier type, length, width, plunge pool depth and jump height. Observations of holding (sedentary) and or migrating (active) Pink spawners were enumerated downstream and upstream of the index site locations and their overall physical condition and health was documented. Visual monitoring of migration attempts were conducted by two trained technicians from the stream bank for a maximum of 30 minute observation period when fish were present.

Daily minimum, mean and maximum discharge data information was provided from Water Survey Canada, site 08MH002 hydrometric data station located at Kingsway Road bridge in Port Coquitlam and operated by Environment Canada. Precipitation data was provided by Metro Vancouver weather station located at the base of Coquitlam Dam. Communication and data exchange with other BC Hydro monitoring crews conducting adult salmon assessments of the Coquitlam River were ongoing to determine Pink Salmon numbers, distribution and other potential monitoring sites that may restrict or impede passage.

4.0 RESULTS

The treatment 2 flow regime from the Coquitlam Dam gate, identified as low level outlet 3 (LLO3), provided a consistent contribution to stream flow of 2.39cms from August 25th to September 30th with a average daily discharge of 2.83cms recorded at the WSC monitoring site. The arrival of the first Pink Salmon was observed August 7th and located upstream of index site 4 during a discharge of 3.16cms (WSC Port Coquitlam). Six survey days were conducted, which began on August 25th when 21 Pink Salmon were observed upstream of Index site 4 in the Swoboda channels. The last field survey was conducted September 30th with high flows preventing visual observation and collection of quantitative data. Precipitation induced flow events occurred September 27th to October 5th providing high stream flows averaging a daily discharge of 17.5cms (WSC Port Coquitlam) (Figure 3) and at which time significant numbers of Pink Salmon migrated into the Coquitlam River and distributed throughout the system. During the monitoring period the lowest stream discharge recorded was on September 15th during a discharge of 2.59cms (Figure 3) in which 255 Pink Salmon were observed throughout the mainstem and of those 63 were enumerated upstream of index site 4 indicating that depth and velocity for passage was adequate to reach the upper habitat of the Coquitlam mainstem (WSC Port Coquitlam) (Macnair 2013). Although low numbers of Pink Salmon were migrating in late August to mid September, observations indicate passage was not impeded or restricted at any of the index monitoring sites during the lowest stream discharge as indicated by visual observations and the maximum depth and velocity recorded at each index site (Figure 28). Stream temperatures are a potential concern and were unseasonably high averaging 19° to 20°C in August to mid September, resulting from an extended period of hot, dry conditions throughout the south coast region. Observations from the BC Hydro adult enumeration crew indicated that the higher flows in late September coincided with a precipitation induced flow event that instigated migration with 9,023 into the Coquitlam system and as a result, significant numbers (2,755) of Pink Salmon were observed upstream of index site 3a. During the early migration period the treatment 2 flow regime provided adequate passage flows when migration is most critical due to the lack of precipitation, low summer flows and the reduced September target release from 2.7 cms to 2.2cms from the Coquitlam Dam (Figure 3). The following figure (Figure 3) is based on the Water Survey Canada (WSC) hydrometric station 08MH002 data operated by Environment Canada and graphically illustrates the discharge and raw water level at Port Coquitlam station during the pink migration monitoring period. On average, the treatment 2 discharge regime from the Coquitlam Dam was significant in keeping water levels and velocities adequate for passage as tributary contributions fluctuated to the mainstem and ranged from 0.20cms to 1.38cms during the monitoring period.

Assessment of Pink Salmon Passage in Lower Coquitlam River



Unapproved data - subject to revision		WSC - 08Mh 002 Port Coquitlam, BC					
Date	Daily Mean flowrate (CMS)						
25-Aug-11	2.79	4-Sep-11	2.65	14-Sep-11	2.48	24-Sep-11	4.77
26-Aug-11	2.77	5-Sep-11	3.14	15-Sep-11	2.59	25-Sep-11	3.65
27-Aug-11	2.77	6-Sep-11	2.77	16-Sep-11	7.09	26-Sep-11	3.14
28-Aug-11	3.15	7-Sep-11	2.77	17-Sep-11	3.75	27-Sep-11	3.22
29-Aug-11	4.01	8-Sep-11	2.68	18-Sep-11	2.97	28-Sep-11	15.44
30-Aug-11	5.26	9-Sep-11	2.65	19-Sep-11	2.76	29-Sep-11	32.20
31-Aug-11	3.36	10-Sep-11	2.64	20-Sep-11	2.67	30-Sep-11	21.40
1-Sep-11	3.09	11-Sep-11	2.58	21-Sep-11	2.65	1-Oct-11	15.30
2-Sep-11	2.99	12-Sep-11	2.52	22-Sep-11	9.08	2-Oct-11	20.40
3-Sep-11	2.88	13-Sep-11	2.50	23-Sep-11	7.11	3-Oct-11	12.30

Figure 3 – WSC Port Coquitlam gage graphical and tabular data, August 25th - October 3rd, 2013. The highlighted data indicates survey days. (source: Environment Canada 2013)

Sixteen days of precipitation were recorded during the monitoring period for a total of 383mm recorded at the Coquitlam Dam weather station which represents the upper and mid river area (3a to index site 4) and during the same period 250mm was recorded at the Como Lake weather station (Environment Canada, 2013) representing the lower river, 1A to 2C index sites. The peak of the Pink Salmon migration was observed after the ramp down from spill

activities due to significant precipitation beginning September 28 and ending on October 5th at which time discharge from LLO3 ranged from 2.5cms to 6.45cms. It is probable that the majority of Pink Salmon entering the system migrated during the ramp down of flows starting October 5th and did not spend a significant amount of time staging in the mainstem. The estimated daily flow contribution from Coquitlam watershed tributaries into Coquitlam main stem during the monitoring period from August 25th to September 25, 2013 ranged from 0.17cms to 1.38cms.(Table 3). The following graph (Figure 4) illustrates the average daily discharge contribution from the Coquitlam dam, tributaries and precipitation amounts. The circled numbers indicate total number of Pink Salmon enumerated in all monitored reaches and not by index sites by the BC Hydro adult enumeration assessment staff.

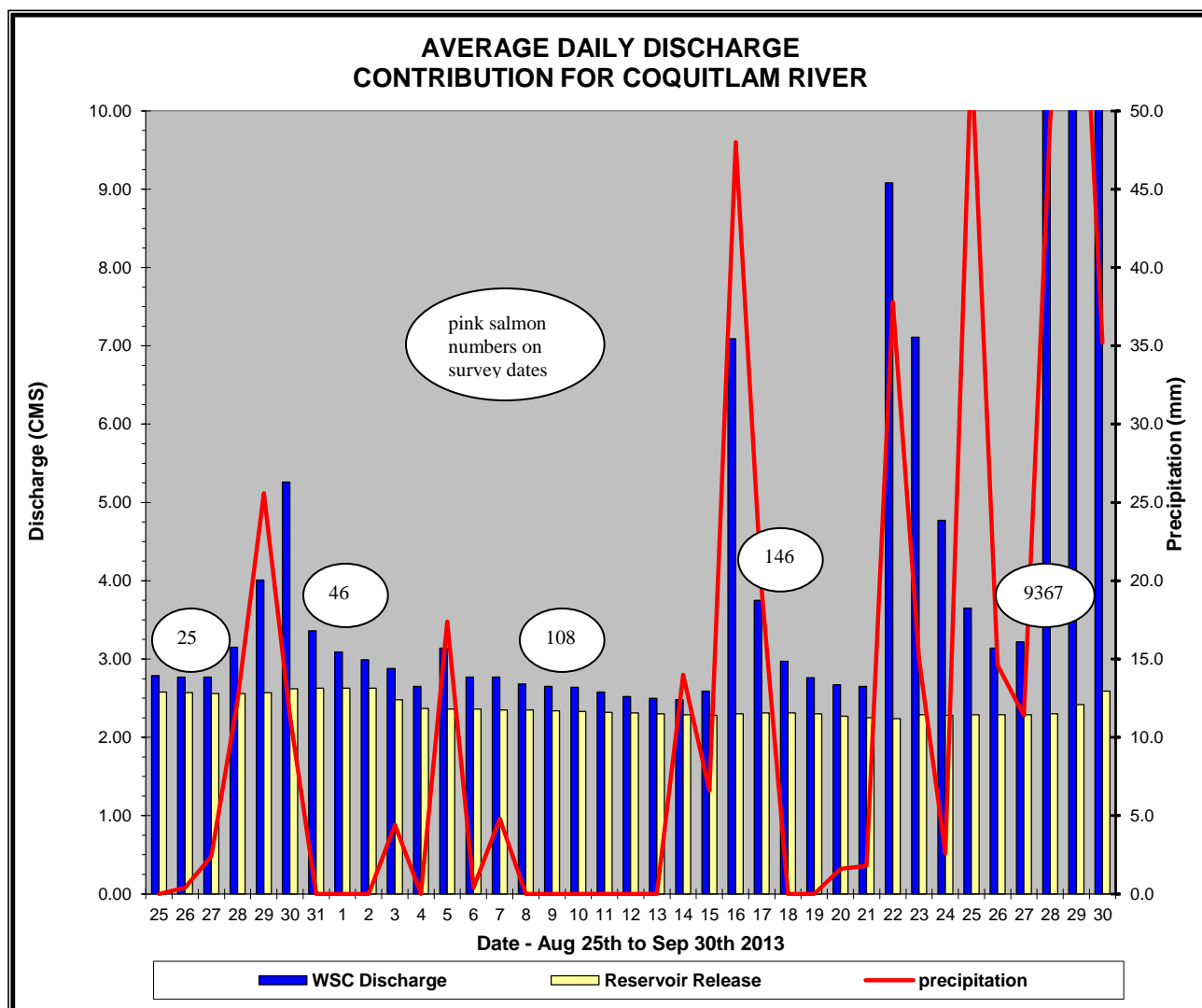


Figure 4 – Coquitlam Dam valve release, precipitation and average daily river discharge, Aug 25th to Sept 30th, (source: WSC Port Coquitlam, Dunkley 2013, Macnair 2013)

Assessment of Pink Salmon Passage in Lower Coquitlam River

The following table provides a summary of field observations at the seven index sites during the assessment period.

Table 3 – Summary of field monitoring observations at the seven index sites during the August 25th to September 30th, 2013 assessment period.

Survey Date	Index Site	WSC Reading Mean(cms)	Coq Dam LLO#3 (cms)	Tributary Contribution (cms)	Days since last RIFE*	Mean Depth (cm)	Mean Velocity (m/s)	Max depth (cm)	Velocity at Max depth(m/s)	COQ.R. Temp (C)	# Pink Holding	# Pink Migrating	# Pink upstream of Site
25-Aug	1a	2.82	2.58	0.24	11	25	0.62	75	0.05	22	0	0	0
25-Aug	2a	2.85	2.58	0.27	11	20.1	0.44	31	1.05	22	0	0	0
25-Aug	2b	2.82	2.58	0.24	11	31.1	0.35	44	0.39	22	0	0	0
25-Aug	2c	2.80	2.58	0.22	11	35.9	0.62	72	0.49	21	0	0	0
25-Aug	3A	2.78	2.58	0.2	11	24.2	0.75	40	1.83	21	0	0	0
25-Aug	3c	2.74	2.58	0.16	11	39.5	0.38	45	0.77	20	0	0	0
25-Aug	4	2.80	2.58	0.22	11	22.5	0.47	32	0.79	22	0	0	21
31-Aug	1a	3.37	2.63	0.74	1	30.8	0.63	86	0.94	16	0	0	0
31-Aug	2a	3.35	2.63	0.72	1	22.2	0.53	35	0.65	16	0	0	0
31-Aug	2b	3.34	2.63	0.71	1	36	0.34	42	0.44	16.5	0	0	0
31-Aug	2c	3.41	2.63	0.78	1	37.8	0.66	75	0.91	18	0	0	0
31-Aug	3A	3.32	2.63	0.69	1	24.1	0.62	37	0.88	20	0	0	0
31-Aug	3c	3.30	2.63	0.67	1	20.4	0.45	45	0.8	20	0	0	0
31-Aug	4	3.26	2.63	0.63	1	18.2	0.59	26	0.66	20.5	0	0	2
09-Sep	1a	2.63	2.34	0.29	4	31	0.52	84	0.02	18	1	0	5*
09-Sep	2a	2.65	2.34	0.31	4	19.7	0.46	29	0.7	18.5	0	0	5*
09-Sep	2b	2.76	2.34	0.42	4	28	0.28	42	0.12	19	0	0	34*
09-Sep	2c	2.68	2.34	0.34	4	31	0.41	77	0.69	20	10*	0	0
09-Sep	3A	2.68	2.34	0.34	4	26.4	1.05	39	0.31	20	6	0	0
09-Sep	3c	2.68	2.34	0.34	4	23.4	0.47	55	0.78	20	0	0	12*
09-Sep	4	2.67	2.34	0.33	4	17.5	0.48	27	0.53	20	0	0	40*
15-Sep	1a	2.45	2.28	0.17	8	27.5	0.48	85	0.01	19	0	0	50*
15-Sep	2a	2.45	2.28	0.17	8	20.1	0.42	33	0.82	19	0	0	42*
15-Sep	2b	2.45	2.28	0.17	8	27.9	0.27	44	0.23	18.5	0	0	23*
15-Sep	2c	2.45	2.28	0.17	8	39.3	0.50	74	0.18	19.5	6	1	9
15-Sep	3A	2.50	2.28	0.22	8	23.8	0.59	38	0.77	19.5	25	2	26*
15-Sep	3c	2.57	2.28	0.29	8	22.5	0.43	48	0.91	19.5	1	4	3
15-Sep	4	2.56	2.28	0.28	8	16.3	0.52	27	0.55	20	0	0	63
25-Sep	1a	3.56	2.29	1.27	3	29	0.62	80	0.05	15	20	0	511*
25-Sep	2a	3.54	2.29	1.25	3	24.4	0.56	36	0.5	15	0	0	450*
25-Sep	2b	3.52	2.29	1.23	3	33.3	0.36	49	0.2	15	450*	0	3215*
25-Sep	2c	3.60	2.29	1.31	3	35.5	0.56	80	0.27	15	14	5	2274*
25-Sep	3A	3.63	2.29	1.34	3	37.1	0.78	46	0.68	14	20	2	1555*
25-Sep	3c	3.65	2.29	1.36	3	27	0.51	53	0.84	14	3	1	1200*
25-Sep	4	3.67	2.29	1.38	3	11.5	0.49	26	0.48	17	4	2	33
30-Sep	1a	22.00	2.59	20.28	1	55	1.29	55	1.29	10	0	0	1010*
30-Sep	2a	19.60	2.59	20.28	1	66	0.99	67	1.04	10	4	3	1012*
30-Sep	2b	20.60	2.59	20.28	1	82	1.46	82	1.46	9.5	0	0	1475*
30-Sep	2c	19.60	2.59	20.28	1	29	1.15	n/a	n/a	9.5	887*	0	1774*
30-Sep	3A	19.70	2.59	20.28	1	55.1	1.33	53	1.61	10	708*	0	555*
30-Sep	3c	21.20	2.59	20.28	1	n/a	1.17	n/a	1.17	10	354*	0	7
30-Sep	4	22.70	2.59	20.28	1	19.7	0.74	30	1.32	10	500*	0	700*

*RIFE ~ rain induced flow event.

* indicates enumeration data from BC Hydro adult enumeration program

Note: September 30, unable to survey index sites due to high flow event.

4.1 Reach 1 ~ Index site 1a

Index site 1A (**49°15.941 N -122°46.902 W**) is a new monitoring site for the 2013 assessment. Access is located under the CPR bridge and can be reached off Kingsway Street in Port Coquitlam (Figure 1). The area is characterized as shallow depth riffle habitat with low velocity and a 2% gradient that lacks in any stream complexity. The substrate is a mix of gravel and small to medium size cobble. This site has the potential to restrict Pink Salmon passage at low stream flows from the center of the channel to the right bank (Figure 5 & 7). Passage through this section likely occurs in a 4 meter wide slot locate on the left bank side of the mainstem channel as this area provides sufficient velocity and depth for Pink Salmon migration at various flow rates (Figure 6 & 28). The assessment identified an average wetted width of 29m and the average depth in the main channel at 0.27m. The maximum depth in the left bank slot provided a depth of 0.85m during the lowest monitored discharge of 2.59cms (WSC, Port Coquitlam) and most likely migrating Pink Salmon choose this route during lower flows. This area was observed not to be a migration barrier in the current year during the lowest discharge flow of 2.59cms (WSC, Port Coquitlam). The following table summarizes observations for the monitoring period:

Table 4 – Index site 1A data summary

Monitoring date	WSC Mean daily discharge (cms)	Wetted width (m)	Avg. wetted Depth (cm)	Avg. velocity (m/sec)	Max depth (cm)	Velocity at max depth (m/s)	Stream temp (C)
25-Aug-13	2.79	29	25	0.62	75	0.05	22
31-Aug-13	3.36	29	30.8	0.63	86	1.05	16
9-Sep-13	2.65	29	28.6	0.52	84	0.39	18
15-Sep-13	2.59	28.7	21	0.48	85	0.49	19
25-Sep-13	3.65	29	29	0.62	80	1.83	15
30-Sep-13	21.4	n/a	55	1.29	55	0.77	10

Pink Salmon were not observed migrating however, 20 were holding at index site 1A on September 25th during a discharge of 3.56cms. During the lowest discharge of 2.59cms, 202 Pink Salmon were enumerated upstream of this index site on September 17, 2013 by the BC Hydro adult monitoring crew and indicated that depth and velocity were adequate for passage through this index site (Table 3) (WSC, Port Coquitlam).



Figure 5 – Index site 1a- upstream view, Sept.09.13
Discharge rate = 2.65cms (WSC Port Coquitlam)



Figure 6 – Index site 1a – downstream view of shallow depth, Sept.15.13
Discharge rate = 2.59cms (WSC Port Coquitlam). The arrow indicates probable migration route in a left channel deep slot.



Figure 7 – Index site 1a – upstream view, Aug.31.13
Discharge = 3.36cms (WSC Port Coquitlam)

4.2 Reach 2 ~ Index site 2a

Access to index site 2a is 120m downstream from Prairie Avenue, east of Shaughnessy Street in Port Coquitlam (**49° 16.276 N – 122° 47.075 W**). This index site was chosen for monitoring due to its low gradient (0.5%) and shallow depth riffle characteristics that have the potential to impact migration at low flows and secondly, annual human interference with the construction of a cobble weir across the mainstem has the potential to block passage during low flows if not breached (Figure 10). The substrate is a mix of small to medium size cobble that is compacted and the mainstem channel lacks habitat complexity (Figure 8 & 9). The assessment of Index site 2 identified an overall average wetted width of 29m and a depth range from 0.20m to 0.67m during the lowest discharge flow of 2.59cms (WSC, Port Coquitlam). It is probable that any migration during lower discharge rates occurred in the right side channel of the mainstem where depth and velocities were sufficient providing a maximum depth of 0.31m to 0.36m for passage at the range of discharge rates observed (Table 5). Although no fish were observed migrating, 4 pink Salmon were observed holding at this index site on the September 30th during a discharge of 20cms. This area was assessed not to be a migration barrier when stream flows were recorded at the lowest discharge of 2.59cms which provided sufficient depth and velocity for passage (Figure 28) (WSC, Port Coquitlam). In support of this assessment, 160 Pink Salmon spawners were observed upstream of this index site on September 17th by the BC Hydro adult enumeration crew (Table 3). Given the available substrate and degree of compaction at this location, migrating Pink Salmon would likely navigate through this index site and would not use it as a staging or spawning area.

The following table summarizes observations for the monitoring period:

Table 5 – Index site 2a data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max depth (cm)	Velocity at max depth(m/s)	Stream temp (C)
25-Aug-13	2.79	29	21	0.351	31	1.05	22
31-Aug-13	3.36	29	22.2	0.529	35	0.65	16
9-Sep-13	2.65	28.7	19.7	0.456	29	0.7	18.5
15-Sep-13	2.59	29	21	0.418	33	0.82	19
25-Sep-13	3.65	29	28.9	0.612	36	0.5	15
30-Sep-13	21.4	n/a	n/a	0.985	67	1.04	10

Human interference occurred in 2009, 2011 and 2013 with the construction of a cobble weir that could result in a potential migration barrier at low flows, however it was not considered to be a barrier to migration if breached (Figure 10) as observed during the 2013 assessment period. During the lowest monitored discharge of 2.59cms (WSC, Port Coquitlam) the average plunge pool depth at the weir was 0.27m and the average jump height over the weir was 0.19m indicating that the weir was adequate for passage

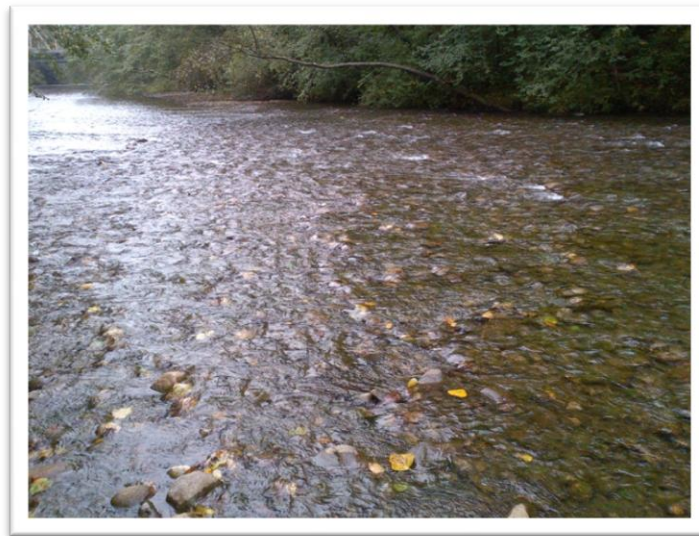


Figure 8 - Index site 2a - downstream view of shallow riffle, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam)

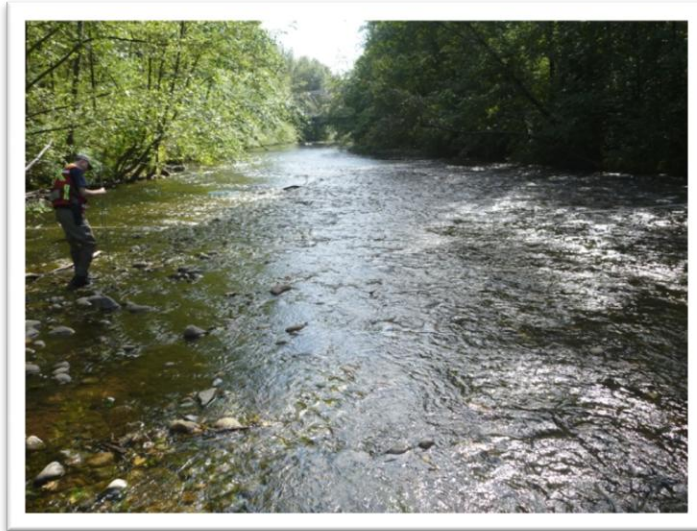


Figure 9 - Index site 2a - downstream view, Aug.25.13
Discharge = 3.65cms (WSC Port Coquitlam)



Figure 10 - Index site 2a - upstream view of weir, Sept.09.13
Discharge = 2.65cms (WSC Port Coquitlam)
The arrow identifies breached access point over weir.

4.3 Reach 2 ~ Index site 2b

Access to index site 2b is from the pedestrian trail on Patricia Avenue east of Shaughnessy Street in Port Coquitlam. This index site extends upstream 45m and downstream 60m of the Patricia Ave pedestrian bridge (**49° 16.585 N – 122 46.620 W**). This site is characterised as a long, shallow depth glide as the mainstem channel wetted width increases with a widening of the channel banks (Figure 11 & 12). Downstream, the wetted width narrows into a shallow riffle and into a high velocity chute on the right channel side (Figure 13). This substrate consists of a mix of compacted gravel and small to medium sized cobble. The habitat at this location is likely not suitable for Pink Salmon staging or spawning due to the shallow depth, compacted substrate and lack of habitat complexity. During higher discharge rates, greater than 40cms (WSC, Port Coquitlam), it is possible that passage may be impeded due to stream velocity through the narrow chute (Figure 13) and may be greater than the recommended threshold criteria of 2.13m/sec (Bjornn and Reiser 1991), however there is enough high velocity refuge areas downstream for Pink Salmon to hold. The 2013 assessment identified the low depth glide area with an average wetted width of 32m and the average depth of 0.27m across the channel and a maximum depth of 0.44m during the lowest monitored discharge rate of 2.59cms (WSC, Port Coquitlam). This index site was observed not to be a migration barrier in the current year as 23 (Table 3) Pink Salmon spawners were enumerated upstream of this index site during the lowest monitored flow which provided adequate depth and velocity for migration. The following table summarizes observations of the glide and riffle area located upstream of the chute for the monitoring period:

Table 6 – Index site 2b data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max depth (cm)	Velocity at max depth(m/s)	Stream temp (C)
25-Aug-13	2.79	32.8	31.1	0.351	44	0.39	22
31-Aug-13	3.36	33	36	0.34	42	0.44	16.5
9-Sep-13	2.65	32	28	0.282	42	0.12	19
15-Sep-13	2.59	32	27.9	0.27	44	0.23	18.5
25-Sep-13	3.65	32.8	33.3	0.363	49	1.39	15
30-Sep-13	21.4	n/a	66	0.985	82	1.46	10

Thirty Four Pink Salmon were first observed holding upstream of this index site after September 9th by the BC Hydro adult enumeration crew during a discharge rate of 2.65cms and decreasing (Table 6) (WSC, Port Coquitlam) (Table 3). During a higher discharge rate of 3.65 cms on September 25th, twenty Pink Salmon (Table 3) were observed holding downstream of this index site and although none were observed to be migrating on this survey day, velocity was recorded at 1.39 m/s mid channel of the chute and was below the critical threshold of 2.13m/s for Pink Salmon migration. (Bjornn and Reiser 1991) (WSC, Port Coquitlam).



Figure 11 - Index site 2b - upstream view of shallow glide, Sept.9.13. Discharge = 2.76cms (WSC Port Coquitlam)

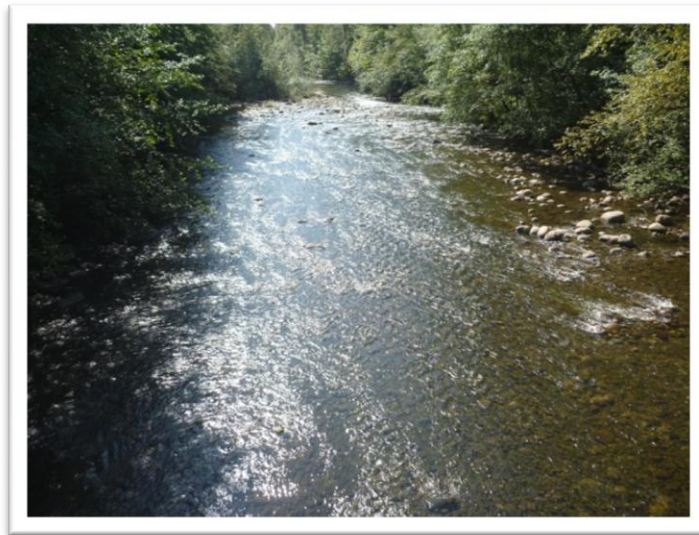


Figure 12 - Index site 2b - downstream view, Sept.09.13
Discharge = 2.76cms (WSC Port Coquitlam)



Figure 13 - Index site 2b - upstream view of the high velocity chute, Aug.31.13. Discharge = 3.36cms (WSC Port Coquitlam)

4.4 Reach 2 ~ Index site 2c

Access to index site 2c is located off Pipeline Road and east on Galette Ave in Coquitlam. Access to this index site is located 65m downstream of the Galette Park entrance (**49° 19.621 N – 122° 46.346 W**). This site was identified to potentially constrict migration due to the main channel narrowing around a gravel bar located mid channel on the left bank side (Figure 14). A shallow riffle with a slight gradient increase on the right channel side of the gravel bar may have the potential to impede access at lower flows. The left channel likely provides the main access route as it provides a deep slot providing an depth range of 0.56m to a maximum depth of 0.77m during the lowest discharge rate. Six Pink Salmon were observed holding below this index site and one observed migrating on September 15th, additionally 9 were enumerated upstream during the lowest discharge of 2.59cms (Table 3) (WSC, Port Coquitlam). The substrate is characterized as a mix of small to medium size gravel, cobble and large scattered boulders that form a scour pool and provide pool habitat at the tail out of the left channel slot (Figure 14). Pink salmon spawners were observed migrating primarily through the left channel slot during the lowest monitored discharge rate of 2.59cms which provided sufficient depth and velocity for passage (WSC, Port Coquitlam). During the lowest flow the average wetted width of the right channel stem was 24m and although the right channel riffle provided an average depth of 0.16m and a maximum depth of 0.25m which was adequate for upstream passage, the left channel deep slot was the route being primarily utilized.

The following table summarizes observations for the monitoring period:

Table 7 – Index site 2c data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max Depth (cm)	Velocity at max depth(m/s)	Stream temp (C)
25-Aug-13	2.79	24	35.9	0.62	72	0.49	21
31-Aug-13	3.36	24	37.8	0.66	75	0.91	18
9-Sep-13	2.65	24	31	0.41	77	0.69	20
15-Sep-13	2.59	24	35.9	0.5	77	0.69	19.5
25-Sep-13	3.65	24.1	35.5	0.56	80	0.27	15
30-Sep-13	21.4	n/a	n/a	1.15	n/a	n/a	10

The first observation of Pink Salmon at this site was on September 9th, as 10 Pink salmon were holding in the pool below the left channel slot (Table 3). Observations during the monitoring period indicated that there were no impediments to migration during the lowest discharge rate of 2.59cms with adequate depth, velocity and also the sighting of 9 Pink Salmon holding upstream of the index site(WSC, Port Coquitlam) indicate passage was unimpeded. The general health and condition of holding or migrating Pink Salmon was observed to be good. A significant increase in numbers of 900 Pink Salmon holding and migrating upstream of this index site were enumerated by BC Hydro adult enumeration crew after the rain induced flow event on September 22nd, during a discharge flow of 9.1cms (WSC, Port Coquitlam). The majority of Pink Salmon migrated through this index during late September and were heavily pressured by recreational anglers.



Figure 14 – Index site 2c - upstream view, Sept.9.13
Discharge = 2.45cms (WSC Port Coquitlam)
The arrow identifies the access channel



Figure 15 – Index site 2c - downstream view, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam)
Arrow identifies main access route



Figure 16 - Index site 2c - downstream view, Sept.9.13
Discharge = 2.68cms (WSC Port Coquitlam)
View of gravel bar and the red arrow indicates the left channel migration route

4.5 Reach 3 ~ Index site 3a

Index site 3a is located on Pipeline Road at the Upper Coquitlam River Park gate. Access to this site is 80m upstream of the diving board hole pool (**49° 19.632 N – 122° 46.344 W**). This index site is characterised as a shallow cascading riffle with a 4% grade over 19m (Figure 17). Adjacent to the index site the mainstem flow is split around a mid channel island with the dominant flow in the left bank side of the channel and spread across the cobble riffle. During lower discharge flows the cobble and rock is unstable and becomes exposed splitting the channel flow between the right channel riffle and the left channel chute. Discharge flows below 2.59 cms can potentially impact migration due to the shallow water depth across the cobble riffle and the moderate gradient increase although, the flow and depth graph indicates that depth did not fall below the critical level to impede passage. Twenty-one Pink were observed upstream of this index site in late August during the preliminary reconnaissance (Table 3). Two migrating Pink Salmon were observed through this site on September 15th during the lowest discharge of 2.59cms and indicated that the left bank slot provided sufficient depth for passage ranging from 0.24m to 0.38m which is above the critical depth threshold for passage (Figure 28) (WSC Port Coquitlam). The wetted width of the right channel riffle is 16m and provides an average depth of 0.24m and a maximum depth of 0.38m which also provides adequate flow and depth for passage during various flows. The highest velocity recorded was 1.33m/s during a discharge of 21.4cms and did not impede passage as the velocity falls within the threshold criteria for Pink migration (Bjornn and Reiser 1991). A downstream pool provides holding habitat suitable as a staging area with 25 Pink Salmon observed holding below the index site September 15th and an additional 150 were observed holding upstream during the increasing flow on September 25th (Figure 18). Holding and migrating Pink Salmon were observed to be in good physical condition and no pre spawn mortalities noted during the study. The substrate primarily consists of medium to large size cobble and gravel that was being utilized by Pink spawners. A significant number of Pink Salmon (5,320) were enumerated upstream of this site after the rain induced flow and spill event that took place beginning September 30th. The following table summarizes observations for the monitoring period:

Table 8 – Index site 3a data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max Depth (cm)	Velocity at max depth (m/s)	Stream temp (C)
25-Aug-13	2.79	17	24.2	0.75	40	1.83	21
31-Aug-13	3.36	17.8	24.1	0.62	37	0.88	20
9-Sep-13	2.65	16	26.4	1.05	39	0.31	20
15-Sep-13	2.59	16	23.8	0.59	38	0.77	19.5
25-Sep-13	3.65	16.1	37.1	0.78	46	0.68	14
30-Sep-13	21.4	n/a	55.1	1.33	53	1.61	10

Observed fish distribution upstream of this index site indicates that depth and velocity for passage was adequate during the lowest discharge value of 2.59cms (Figure 28) (WSC, Port Coquitlam). Although not an impediment to migration, lower discharge rates can present a challenge to the Pink Salmon as they migrate upstream through the cascading cobble riffle (Figure 18).



Figure 17 - Index site 3a - cross sectional view, Aug.31.13
Discharge = 3.36cms (WSC Port Coquitlam)
The arrows indicate the slot used for passage



Figure 18 - Index site 3a - passage attempt, Sept 25.13

Discharge = 3.65cms (WSC Port Coquitlam)

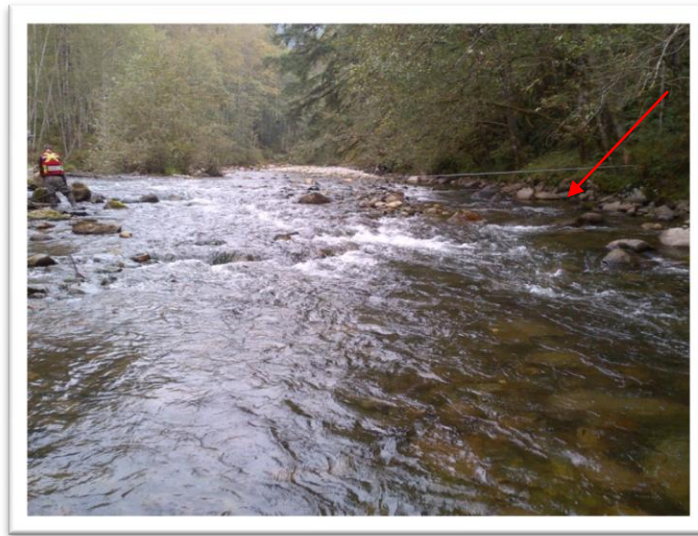


Figure 19 - Index site 3a - upstream view, Sept 15.13
Discharge = 2.59cms (WSC Port Coquitlam)
The arrow indicates the chute which is accessible at present flow



Figure 20 - Index site 3a - downstream view, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam)
The arrow identifies observed migration route

4.6 Reach 3 ~ Index site 3C

Index site 3b is located north on Pipeline Road and 80m downstream of the Al Grist Memorial Hatchery (**49° 20' .230 N – 122° 46.344 W**) and is a new monitoring site for the 2013 survey. This index site was originally identified in 2001 as having the potential to constrict passage as the channel narrows exposing larger cobble and shallow depth from the mid center channel to the left bank. Migration observations indicated that the Pink Salmon were accessing the right bank side of the channel as there are a series of large woody debris placements that provide adequate water depth, velocity and cover for passage. The lowest discharge recorded was 2.59cms (WSC, Port Coquitlam) providing an average depth and a maximum depth range of 0.22m to 0.48m which is sufficient for Pink Salmon passage as observed during the September 15th field survey. During this time 4 Pink Salmon were observed migrating through this site and were observed to be in good physical condition. The substrate is compacted and comprised of gravel and medium to large size cobble that may be utilized for spawning.

The following table summarizes observations for the monitoring period:

Table 9 – Index site 3C data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max depth (cm)	Velocity at max depth(m/s)	Stream temp (C)
25-Aug-13	2.79	24.8	39.5	0.38	45	0.77	20
31-Aug-13	3.36	24.3	20.4	0.45	45	0.8	20
9-Sep-13	2.65	24.8	23.4	0.47	55	0.78	20
15-Sep-13	2.59	24	22.5	0.43	48	0.91	19.5
25-Sep-13	3.65	24.8	27	0.51	53	0.84	14
30-Sep-13	21.4	n/a	n/a	1.17	n/a	1.17	9.5

21 Pink Salmon were observed upstream of the index site on August 25th during a discharge rate of 2.79cms indicating depth and velocity was adequate for passage through this index site (WSC, Port Coquitlam). The first Pink Salmon carcass was observed upstream of this site September 15th and physical characteristics indicated that it had been in the system for a few weeks with discoloration and scale loss (Figure 23). The BC Hydro adult enumeration crew first observed 12 Pink Salmon upstream of this index site during the September 9th survey when minimal precipitation and a lower discharge rate of 2.65cms occurred (WSC, Port Coquitlam). Fish observations and distribution upstream of this index site throughout the monitoring period indicated that at the lowest discharge flow of 2.59cms migration was not impeded and depth levels were sufficient for migration (Figure 28) (WSC, Port Coquitlam).



Figure 21 – Index site 3c - upstream view, Sept.25.13
Discharge = 3.65cms (WSC Port Coquitlam)
The arrow indicates the main access with adequate depth and velocity



Figure 22 – Index site 3c - downstream view, Aug.31.13
Discharge = 3.36cms (WSC Port Coquitlam)
The arrow identifies the migration route



Figure 23 - Index site 3c - salmon carcass, Sept.25.13
Discharge = 3.65cms(WSC Port Coquitlam)

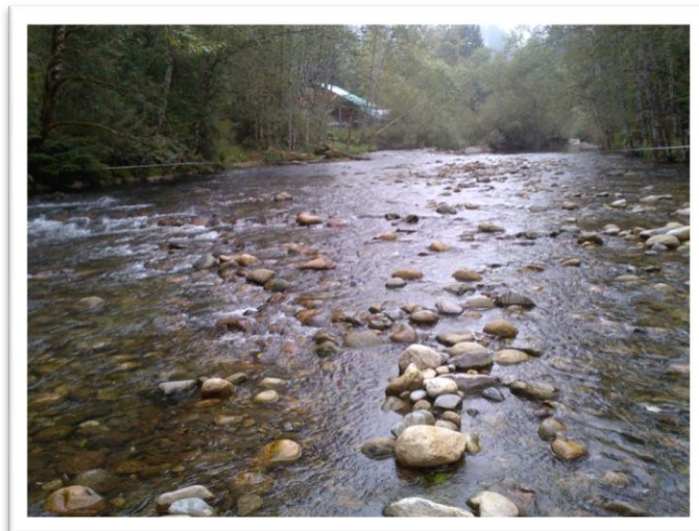


Figure 24 - Index site 3c - upstream view, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam).

4.7 Reach 4 ~ Index site 4

This index site is located in the Coquitlam watershed at the Coquitlam River main stem and Swoboda channel confluence (**49° 21. 041 N – 122° 46.452 W**). Access to this site is located at the base of the dam, downstream of Grant's tomb rearing pond and Swoboda channel confluence. This index site is primarily influenced by Coquitlam Dam releases (Figure 4) and discharge from Swoboda channel as there is minimal tributary contribution. This monitoring site is characterized by a cobble and gravel cascading riffle that is 10m wide and shallow with the cobble becoming exposed and splitting around a mid channel vegetated island. During the lowest discharge rate of 2.59cms the average wetted depth across the channel area is 0.16m and a maximum depth of 0.52m. The jump height over the exposed cobble in the left channel riffle is 0.22m with an adequate plunge pool depth of 0.31m and a maximum depth of 0.56m (Figure 25) (WSC, Port Coquitlam). The substrate is a mix of loose gravel and small to medium size cobble. As this site is primarily influenced by Dam spill the lowest flow observed in the main stem channel was 2.30cms (Fournier 2013) limiting depth and flow distribution across the riffle (Figure 25 & 27) however, the depth and velocity were sufficient for passage as illustrated in the critical depth graph. Coquitlam Dam release data is included in table 10 as it offers more of a representative discharge rate for this index site. The following table summarizes observations for the monitoring period:

Table 10 – Index site 4 data summary

Monitoring Date	WSC Mean daily Discharge (cms)	Dam Release	Wetted Width (m)	Avg. Wetted Depth (cm)	Velocity (m/sec)	Max Depth (cm)	Velocity at max depth(m/s)	Stream temp (C)
25-Aug-13	2.79	2.58	14.4	17.8	0.47	32	0.79	22
31-Aug-13	3.36	2.63	14.6	18.2	0.59	26	0.66	20.5
9-Sep-13	2.65	2.34	14.6	14.9	0.48	27	0.53	20
15-Sep-13	2.59	2.28	14.6	14	0.52	27	0.55	20
25-Sep-13	3.65	2.29	14.7	17.5	0.49	26	0.48	17
30-Sep-13	21.4	2.59	14.4	19.7	0.74	30	1.32	10

21 Pink Salmon were observed upstream of this index site on August 25th with a discharge rate of 2.8cms (Fournier 2013). During the lowest discharge of 2.28 cms on September 15th, 63 Pink Salmon were observed upstream of index site 4, indicating that stream flow, water depth and velocity was adequate for passage (Figure 28) (Fournier, 2013). The last survey day occurred September 30 with fifty four Pink Salmon observed staging and spawning in the mainstem channel and 17 enumerated in the Swoboda channel which indicated that the mainstem access was preferred for staging and spawning during this survey day.



Figure 25 - Index site 4 - upstream view, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam)
The arrows indicate access points

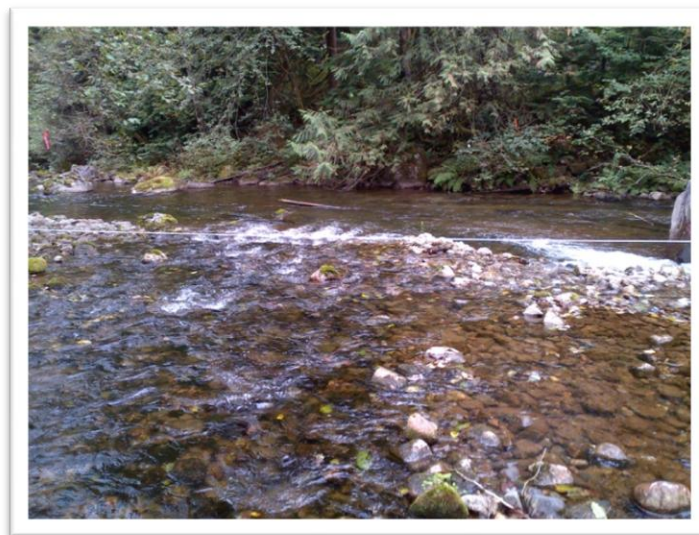


Figure 26 - Index site 4 - downstream view, Sept.15.13
Discharge = 2.59cms (WSC Port Coquitlam)



Figure 27 – Index site 4 - upstream view, Sept.25.13
Discharge = 3.65cms (WSC Port Coquitlam)
The black arrow indicates the mainstem Coquitlam,
the red arrow indicates Swoboda channel access.

5.0 DISCUSSION

The first objective of this study is to conduct an assessment of adult Pink Salmon passage in the lower Coquitlam River by identifying index sites that may have the potential to restrict Pink Salmon migration during summer low flows. The second objective is to determine at what flow each barrier is eliminated or reduced.

The 2013 survey adjusted the monitoring sites with the relocation of index site 1 and 3B. Site 1 was discontinued because re-assessment of this site and previous assessments in 2009 / 2011 determined that it no longer represented a fish passage obstruction. Site 3B located upstream of the Al Grist memorial hatchery was also discontinued after in-stream habitat improvements were completed by the Department of Fisheries and Oceans (DFO) in the summer of 2012 to improve flow to the right side channel. The two new monitoring sites were identified for the 2013 assessment and were incorporated into survey activities as index site 1A and 3C.

5.1 Objective 1 - low flow passage issues

The first objective is to assess if there were any Pink Salmon passage issues during low flows due to migration barriers in the lower Coquitlam River mainstem corridor. To test this objective, surveys were performed to analyse various flows, depths, velocities and visual observations of migration passage to determine if early returning Pink Salmon were restricted at any of the index sites that were identified as having the potential to cause passage barriers. Monitoring of the index sites began on August 25th, although the first Pink Salmon was observed in the system upstream of index 4 on August 7th during preliminary survey reconnaissance. The study was completed on September 30th and unfortunately high stream flows hampered visual observations and the ability to safely obtain quantitative measurements during the final survey date.

The results show that throughout the 2013 study period the lowest minimum daily discharge recorded was 2.59cms (WSC, Port Coquitlam) which occurred on September 15th and was early into the migration run with combined observations from BC Hydro adult enumeration crew and Pink survey resulted in a total of 255 Pink Salmon observed in the system (MacNair 2013). Of the 255 Pink Salmon, 63 were observed upstream of index site 4 indicating that flow, velocity and stream depth was adequate for passage through all index sites to the upper reaches of the Coquitlam mainstem (Figure 28). Pink Salmon were observed to be in good physical condition with minimal pre-spawn mortalities observed although, the stream temperature averaged 19° Celsius and is at the upper threshold criteria for Pink Salmon passage (Appendix 1). Late August to mid September temperatures fluctuated during the survey period and overall the stream temperatures ranged between 17° to 22°C, most likely due to infrequent precipitation and warmer than average reservoir temperatures caused by an extended hot, dry period throughout the South Coast region.

Stream depth (Table 4 to 10) at all index sites were identified to be adequate for Pink Salmon passage and was above the threshold limit for Pink Salmon migration requirements (Appendix 1) (Figure 28) (Bjornn and Reiser 1991). Observations of migrating Pink Salmon did indicate some challenges at Index site 3A and index site 4 during the lowest flow of 2.59cms (WSC, Port Coquitlam) however, these index sites were not an impediment to passage as indicated with the maximum depth and velocity being adequate for passage (Figure 28). Index site 4 data indicates that passage could potentially become an issue with flows below 2.59cms (WSC Port Coquitlam) as this site is primarily influenced by Dam discharge and minimal tributary contribution.

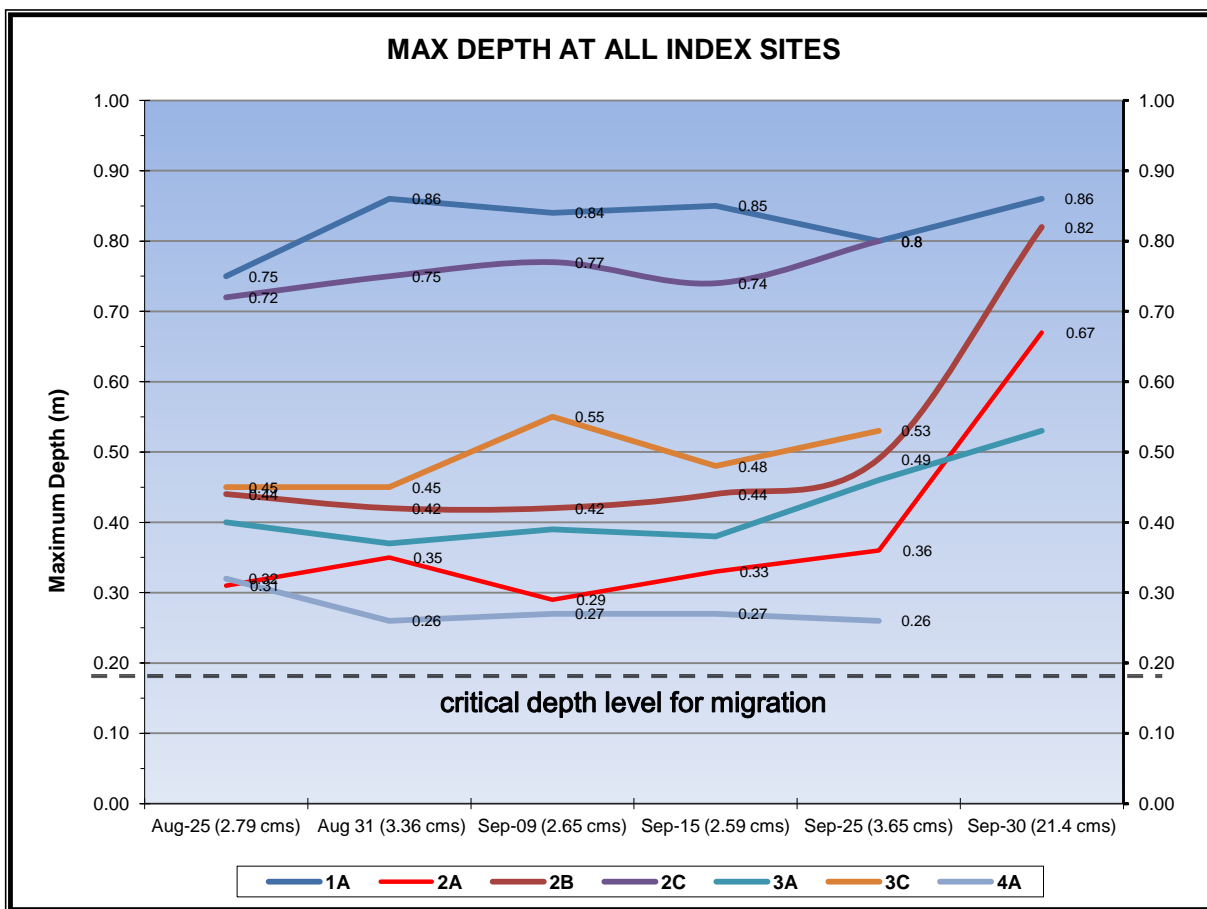


Figure 28 - Illustrates the maximum depth at each index site over the survey period.

During the field assessment the highest recorded velocity was measured at 1.61m/sec (Table 3) on September 30th at index site 3A during a mean daily discharge of 21.4cms (WSC, Port Coquitlam). This event coincided with 233mm of precipitation between September 25th and September 30th and coincided with spilling from the Coquitlam Dam to October 5, 2013. Although no Pink Salmon were observed migrating at this velocity on the survey day, 1.61m/s was below the threshold for passage criteria (Bjornn and Reiser 1991) and indicates that

velocities were passable during that period, based on the assumption, that there is enough available high velocity refuge for Pink Salmon to hold (Table 3) (WSC, Port Coquitlam).

The DFO Habitat Management Unit has adopted a flow velocity value of 1.0 m/sec as a guideline for defining maximum discharge flow suitable for upstream salmon migration (Levy and Slaney 1993). In contrast, other publications indicated that a maximum velocity of 2.13 m/sec is the threshold limit for successful Pink Salmon migration (Bjornn and Reiser 1991).

Prior to the high flows, that occurred from precipitation and spilling from the dam on September 25th to September 30th, a total of 9,023 Pink Salmon were observed in the system and of which 31% of the population were enumerated upstream of index site 3A during a mean daily flowrate of 13.1cms (WSC, Port Coquitlam) (MacNair, 2013).

Early season fish distribution numbers (Table 3) indicated that migration was achieved upstream of all index sites demonstrating that at the lowest discharge value of 2.59cms provided adequate depth, velocity and flow for early migrating Pink Salmon (Figure 28) (WSC, Port Coquitlam). In addition to flow, stream temperatures can also be a concern at the index sites due to areas where stream depth is reduced during summer low flows and higher air temperatures. Water depth at five of the six monitoring sites provided sufficient depth for passage during the field assessment with the lowest monitored flow of 2.59cms and falls within the acceptable range of minimum depth requirements of 0.18m for Pink Salmon passage (WSC, Port Coquitlam) (Bjornn and Reiser 1991). The exception is at index site 4 which recorded the lowest average depth of 0.12m and a maximum depth of 0.27m however, observations indicate that Pink Salmon were not impeded from upstream migration.

The 2013 Pink Salmon assessment observed the flow regime from the Coquitlam Dam gate identified as low level outlet 3 (LLO3) averaged a daily discharge value 2.39cms, (Fournier, 2013) consistent with targeted releases anticipated by BC Hydro during the assessment period and recorded an average daily mean flow rate of 3.48cms at the Water Survey Canada data collection site.

Overall, early migrating Pink Salmon were not restricted at any of the index sites during the lowest discharge of 2.59cms in the Coquitlam River during the 2013 study year. Treatment 2 flows (1.1 - 2.2 cms) provided adequate depth and velocities for passage for early migrating Pink Salmon however, with the increased numbers of Pink Salmon returning, maximizing dam discharge contribution during the early run of the migration would be beneficial with the increased available habitat, lower stream temperatures and the ability of Pink Salmon to have a longer residency time to spawn successfully.

5.2 Objective 2 - at what flows are passage issues resolved or improved?

The second objective of this report was to assess at what flows the potential passage restrictions would be improved for migrating Pink Salmon. To test this objective information was obtained to determine the range of flow that did not influence the efficacy of migrating Pink Salmon and to determine what the minimum and maximum flows would be for successful migration.

During the 2013 adult enumeration survey, peak Pink Salmon migration occurred on October 11th with over 10,000 enumerated throughout the mainstem system during an average daily discharge of 7.4cms (WSC, Port Coquitlam). The 2013 field assessment observed an increase in mainstem habitat use (Table 11) with 77% of holding Pink Salmon spawning in the mainstem reaches of the Coquitlam River which is the highest percentage since adult enumeration began in 2003. It should also be noted that during treatment 2 flow regime a proportion of adults spawning in reach 4 increased significantly to 43% of the population compared to treatment 1 flow regime of 28% of the population spawning in the upper reaches of Coquitlam River mainstem (Macnair, 2013). The following table summarizes the Pink Salmon numbers and distribution by reach for the 2013 study year.

Table 11 - 2013 Coquitlam Pink Salmon Distribution by Reach						
Date	Reach 1	Reach2a	Reach 2b	Reach 3	Reach 4	Total
09-Sep	5	34	10	6	52	107
17-Sep	50	42	23	5	26	146
26-Sep	961	3033	2274	1555	1200	9,023
06-Oct	2024	1475	2661	1440	3880	11,480
11-Oct	4075	582	2818	1376	4380	13,231
18-Oct	2679	198	2164	867	2211	8,119
23-Oct	243	12	235	167	880	1,537
29-Oct	7	0	0	0	27	34
TOTALS	10,044	5,376	10,185	5,416	12,656	

Source: Pink adult spawning enumeration by reach (Macnair 2013)

The increased numbers (Appendix 2) coincided with the significant numbers of returning Fraser River Pink Salmon which can be attributed to strong marine survivals and a low fishery interception (Foy 2013). The 2012 Pink Salmon fry out migration can be attributed the successful spawning and increased survival in the freshwater environment which could be attributed to increased survival of off channel and mainstem progeny during the treatment 2 flow regime from treatment 1.

The 2013 study period observed the lowest percentage of off-channel use since 2003 and of all the off channel sites, an increase of 43% of the Pink Salmon population were observed in the Swoboda channels upstream of index site 3C (Macnair 2013) indicating that the present treatment 2 flow regime was adequate for passage to the upstream habitat. It is probable that the off channel sites were fully populated and the available habitat was limited in 2013 due to the significant numbers of returning Pink Salmon to the Coquitlam River (Table 12, Macnair, 2013).

The 2013 flow regime improved migration and continued that trend providing greater access to the upper watershed habitat, specifically in the Swoboda channels located upstream of Index site 4, which presented a greater area of quality spawning habitat (Table 12). The following table summarizes the percentage of enumerated Pink Salmon in off channel habitat since 2003.

Table 12 - Coquitlam River Pink Salmon Off Channel Habitat Use				
Date	Mainstem	Natural Off channel Sites (%)	Off Channel Restoration Sites (%)	Off Channel Sites Combined (%)
2003	55.2	18.8	26	44.8
2005	64.8	21.8	13.4	35.2
2007	71.2	20.3	8.5	28.8
2009	71.5	13.4	15.1	28.5
2011	57	23	20	43
2013	77.3	11.7	10.2	21.9

Source: (Macnair 2013)

Summer low flows may influence the efficacy of early returning Pink Salmon migration however, observations indicate the treatment 2 flow regime with a consistent and maximized contribution from LLO 3 (2.25 to 2.63 cms) throughout the 2013 study improved passage at all the index sites as indicated by the early season fish distribution numbers in the upper reaches of the Coquitlam mainstem. The higher base flows provided by the treatment 2 flow regime provided sufficient depth and velocity at all index sites, which resulted in Pink spawners being in better physical condition to migrate, hold and spawn successfully. During the lowest discharge of 2.59cms (WSC, Port Coquitlam) a significant concern is the increased stream temperatures that occurred early in the migration (late August to mid September) run and were recorded at the upper threshold limit (Appendix 1) for Pink Salmon migration, however, the average residency time of 20 days was consistent with past observations (Macnair, 2013) which is adequate for staging and spawning activities to occur. The treatment 2 flow regime from LLO3 is critical when tributary contributions are minimal during hot and dry

summers and if utilized at the upper maximum target requirement of 2.2cms which, provides greater accessibility to upper reaches where there is quality spawning and rearing habitat.

It is recommended that a continuation of the August treatment 2 target flow of 2.7cms into September would benefit migrating Pink Salmon with increased availability of spawning habitat as well, possibly decreasing the stream temperatures which could improve residency time and the ability to successfully spawn. Continued monitoring through 2015 will provide additional information for testing the hypothesis that flows affect the overall efficacy of the early returning Pink Salmon population.

ACKNOWLEDGEMENTS

Jason Macnair, Living Resources Environmental.

Julie Fournier, BC Hydro.

Jeffery Sneep, BC Hydro.

Dave Dunkley and Ken Juvik - Metro Vancouver.

Isaac Nelson and Ric Locke - Fisheries Technicians.

Lynn Campo, Environment Canada.

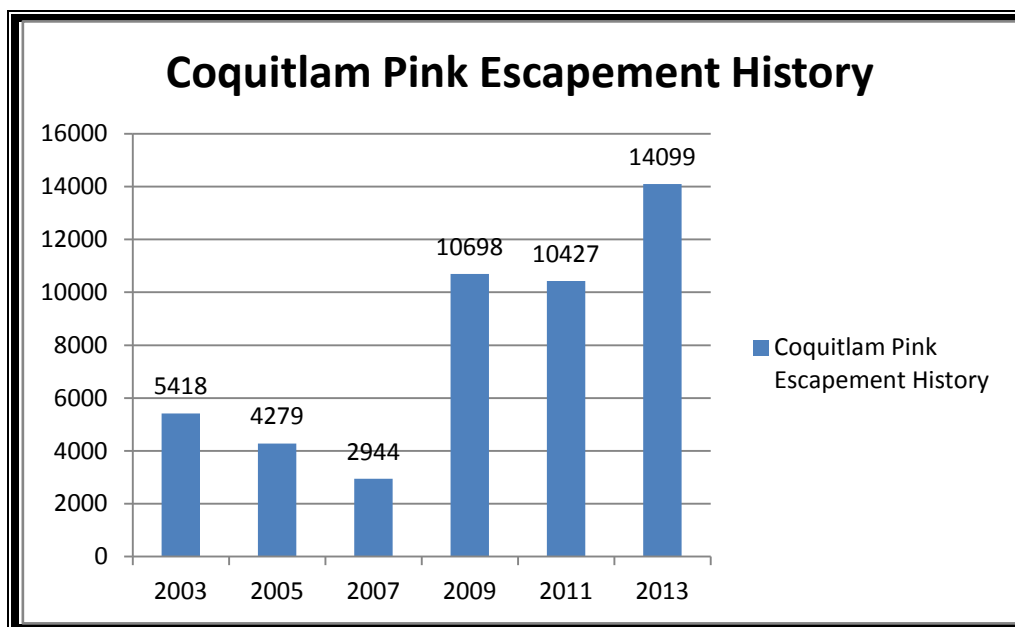
Matt Foy - Fisheries and Oceans Canada, Biologist.

APPENDICES

APPENDIX I [Salmon Passage Criteria Table]

Species	Temperature range (C)	Min. depth (m)	Max Velocity (m/s)
Chinook Salmon	10.6 - 19.4	0.24	2.44
Chum Salmon	8.3 - 15.6	0.18	2.44
Coho Salmon	7.2 - 15.6	0.18	2.44
Pink Salmon	7.2 - 15.6	0.18	2.13
Sockeye Salmon	7.2 - 15.6	0.18	2.13
Steelhead	7.2 - 15.6	0.18	2.44

APPENDIX II



*(2013 enumeration data is a post season estimate)

APPENDIX III
[Site Assessment Card]

Pink Salmon Migration Assessment Data Form															
Crew:											Photo #				
Date:															
Air temp:			C												
Start Time:															
End time:															
Survey #				Index Site :											
WSC			m ³ /sec						Stream Temperature				C		
# Pink observed:			at index site												
			upstream of index site												
			downstream of index site												
			migrating (30minute observation limit)												
Over all condition / appearance:															
Comments:															
Assesment Data:															
Barrier type															
wetted width (R-L):					m	Length					m				
wetted depth (cm):	meter														
	depth														
	velocity														
Pool depth max =					pool depth min=										
Dominate substrate:			Type	sands	gravels	cobbles	boulder	bedrock							
			%												
Gradient:					%	length surveyed:					m				
Comments:															

APPENDIX IV

[Precipitation Data Table]

[illegible]

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