Assessment of the homing behaviour of 4 and 5 year old Puntledge summer Chinook adult returns from lake and river released juveniles

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Prepared for:

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Comox Valley Project Watershed Society

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EXECUTIVE SUMMARY

An investigation on the homing behaviour of summer Chinook in the Puntledge River was conducted over five years to determine whether Chinook smolts that have been released in Comox Lake will imprint and successfully migrate to the lake as adults and in greater abundance than those that are released directly in the river below the diversion dam. Results from past research and assessment projects on Puntledge River summer-run Chinook have clearly demonstrated that summer Chinook adults arriving before late June have the greatest success in reaching Comox Lake and surviving to spawn compared to later arrivals (i.e. >90% versus ≤50%). This report summarizes activities in year five of this multi-year study to assess the homing behaviour of the two groups of returning summer Chinook adults (from "lake released" and "river released" juveniles) in the Puntledge River, and provides an overview of the results from the three years of returns.

Four and five year old summer Chinook adults from 2011 and 2012 juvenile releases returning to the Puntledge River were captured at the lower Puntledge Hatchery, implanted with PIT (Passive Integrated Transponder) tags and released back to the river to continue their migration. Their migration behaviour was passively monitored using Radio Frequency Identification (RFID) monitoring systems installed at both the Puntledge diversion dam and Comox impoundment dam fishways. Unfortunately, due to warm river temperatures, a forecast of record drought conditions, and predicted low summer Chinook escapement, collection and PIT tagging of adults for the study was terminated early. Consequently, a total of 7 "lake released" and 1 "river released" adults were PIT tagged at the Puntledge Hatchery in 2015. None of these fish were detected at either the diversion dam or impoundment dam fishway antenna arrays.

An underwater video camera located at the diversion dam and the impoundment dam, were also used to determine the number of non-PIT tagged adults migrating into the upper river. A total of 20 and 19 Chinook were observed migrating through the diversion and impoundment dam fishways, respectively. Data collected from three years of tagging suggests that point of release of Chinook fry has no impact on migration behaviour in the lower Puntledge River and homing into Comox Lake.

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1 INTRODUCTION

In 2011, a homing behaviour study on Puntledge summer Chinook salmon was initiated with funding support from the Fish and Wildlife Compensation Program (FWCP). The study extended over several years in order to determine if releases of hatchery reared summer Chinook smolts in Comox Lake imprint and successfully return to the lake as adults. Specifically, the study addresses whether lake released summer Chinook juveniles migrate back to the lake as adults in greater proportion than adults that were released as juveniles directly in the river immediately below the diversion dam (Guimond 2012).

Activities in Year 1 (2011) and Year 2 (2012) of this project included the releases of coded wire tagged (CWT) summer Chinook juveniles in the river below the diversion dam, and in Comox Lake, and the installation of equipment to monitor adult returns. These activities are summarized in separate reports (Guimond 2012 and 2013). Monitoring of 3 and 4 year old summer Chinook adult returns originating from the juvenile Chinook releases in Comox Lake and the Puntledge River in 2011 and 2012 occurred in Year 3 (2013) and Year 4 (2014) as reported in Guimond 2014, and Guimond and Taylor 2015, respectively. This report summarizes activities conducted in Year 5, the final year of the project (2015) which involved capturing and PIT tagging 4 and 5 year old summer Chinook adult returns at the Puntledge River Hatchery that were identified as originating from lake and river juvenile releases. These adults, and those that were not captured at the hatchery were monitored migrating past the Puntledge diversion and Comox impoundment dams using PIT tag receivers and video cameras.

1.1 Background

The recovery of summer Chinook in the Puntledge River is contingent on successful migration and access into Comox Lake where adults can hold in deeper cool water during the summer before spawning in October. Past research and assessments have clearly demonstrated that this migration and holding behaviour results in a spawning survival rate greater than 95% compared to 30-50% for fish that hold in much higher water temperatures in the lower river (Guimond and Taylor 2009). Actions and efforts that improve adult access into Comox Lake are therefore viewed as a priority and critical to the recovery of the population. When the Puntledge summer Chinook enhancement program began in 1965 with the operation of the upper hatchery spawning channel, the majority of Puntledge hatchery summer Chinook smolts were released immediately downstream of the Puntledge diversion dam. Although poorly

documented, support biologists and hatchery managers in the DFO SEP program observed a strong tendency for hatchery fish to return to the site of release. Following the installation of Eicher fish screens in the penstock in 1993, which purportedly reduced turbine mortality to below 10% on outmigrating smolts, summer Chinook were then outplanted in the upper watershed (Upper Puntledge and Cruickshank rivers). In 2005, the first time adult returns were enumerated at the diversion and Comox impoundment dams, video cameras in the fishways found that 76% of the adults that migrated above the diversion dam into the headpond (i.e. 134 of 176 adults) successfully migrated into Comox Lake (Guimond 2006). This event corresponds to the last brood year a large hatchery release was made upstream of the Comox impoundment dam. DFO could not confirm if the 2005 adults migrating through the fishway were originally imprinted to the upper watershed. Since the last hatchery smolt releases above Comox Dam, the proportion of adults observed passing into Comox Lake for the 3 succeeding years has been a fraction of the 2005 observations.

1.2 Goals and Objectives

The goal of this study is to determine whether juvenile summer Chinook that are released in Comox Lake migrate back to the lake as adults in greater abundance than adults that originate from juveniles released in the river (below the diversion dam). The objectives of this final year of the study are as follows:

1. **Monitor 4 and 5-yr old adult returns -** The migration and homing behaviour of 4 and 5 year old adult returns originating from juveniles released in the river and Comox Lake in 2011 and 2012 will be monitored using antennas and RFID (Radio Frequency Identification) receivers installed at the Puntledge diversion and Comox Lake impoundment dam fishways.

2. **Monitor all summer Chinook access into Comox Lake -** operate an underwater video camera and digital recorder at the Comox impoundment dam and diversion dam fishways during the summer Chinook migration period to monitor all Chinook migration into Reach B (headpond) and Comox Lake. This will provide a greater understanding of migration behaviour and Chinook access into the upper watershed throughout the migration period.

3. **Provide an overall summary of results from the three years of monitoring adult returns.**

2 STUDY AREA

The Puntledge River Watershed encompasses a 600 km^2 area west of the city of Courtenay (Figure 1). The lower Puntledge River flows from Comox Lake in a north-easterly direction for 14 km where it joins with the Tsolum River. From this point downstream the river is called the Courtenay River, and flows for another 2.9 km into the Strait of Georgia. The lower river below Comox Lake is divided into 3 major reaches (Bengeyfield and McLaren 1994).

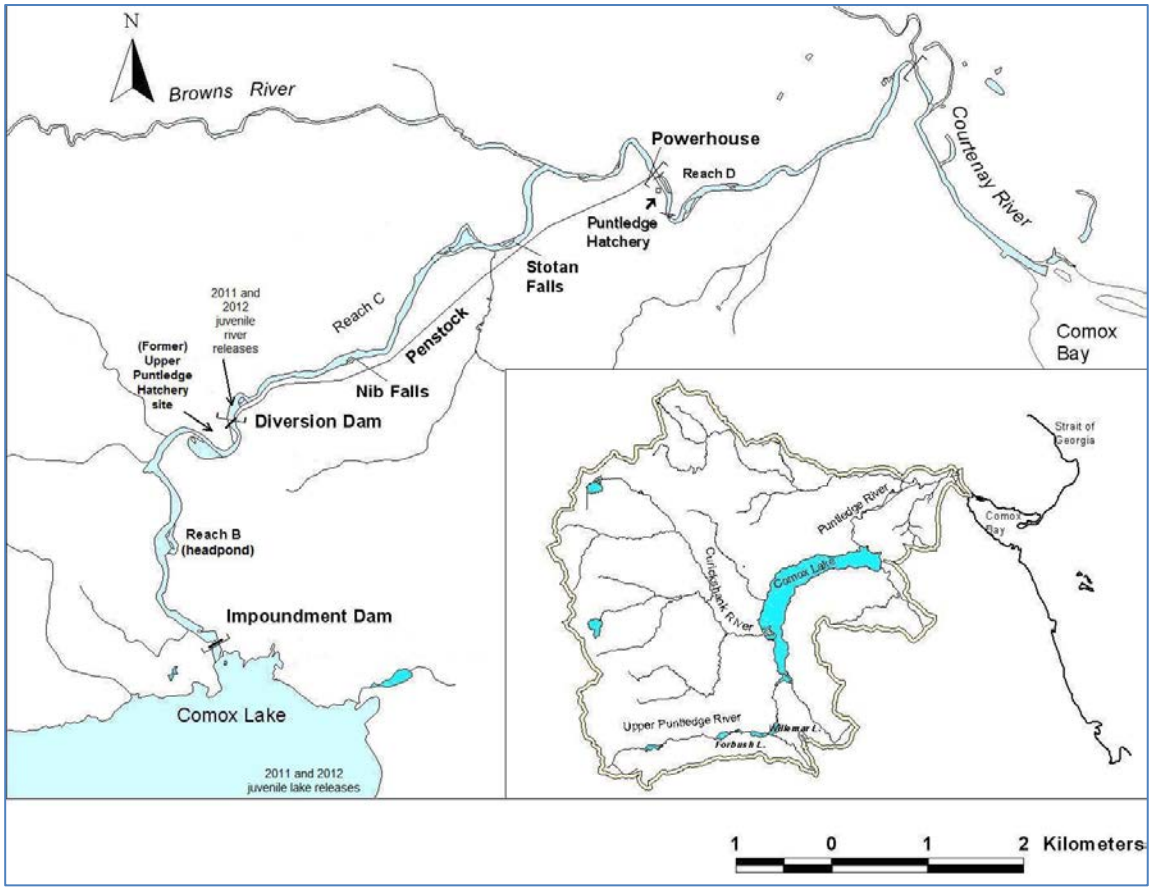

Figure 1. Location map of the Puntledge River watershed including lower river features and location of juvenile Chinook releases in 2011 and 2012.

Reach B, the headpond reach, is located between the Comox impoundment dam at the outlet of Comox Lake, and the Puntledge diversion dam approximately 3.7 km downstream. Both of these structures have concrete fishways to provide fish access. Reach C, the diversion reach, extends downstream of the diversion dam for 6.3 km to the BC Hydro Puntledge Generating Station or "Powerhouse". Reach D encompasses the remaining 4 km of the Puntledge River from the Powerhouse to the Tsolum River

confluence. Puntledge River Hatchery is located 400 m downstream of the Powerhouse. A barrier fence across the river directs migrating fish into a fishway that can either direct fish into concrete raceways at the facility, or redirect fish upstream of the fence and back to the river, depending on the hatchery's broodstock collection requirements.

3 METHODS

3.1 PIT tagging adults at Puntledge Hatchery

Summer Chinook adults migrating up the lower Puntledge River were diverted at the barrier fence into raceways at the Puntledge River Hatchery beginning May 21, 2015. Every few days the adults were crowded for sorting and inspected for coded wire tags (CWTs). Unmarked adults (i.e. those that possessed an adipose fin) were netted from the hatchery raceway and scanned with a handheld T-Wand Detector (Northwest Marine Technology Inc., WA) in order to detect CWT'd adults that were part of the study (CWT but not clipped lake released juveniles) and to differentiate them from other wild or hatchery adults that were not CWT'd. Coded wire tagged adults selected for PIT tagging were transferred to a sampling trough, and tagged with a uniquely coded 23 mm X 3.65 mm half duplex (HDX) PIT Tag (Oregon RFID, Portland, OR). The tag was injected subcutaneously into the dorsal cavity/sinus which surrounds the pterygiophores (or interneural rays of the dorsal fin) using a 7-gauge hypodermic needle and metal injector[1]. PIT tag code numbers were recorded along with study group code ("Unmarked" or "Adipose Clipped" for lake and river releases respectively), sex, fork length and overall condition (scale loss, injury, etc.). A tissue sample (hole punch of the caudal fin) was also collected from each adult for DNA analysis. PIT tagged fish were then placed in a holding/recovery tank before release back to the river. All adults were tagged at the lower Puntledge River Hatchery and released back to the river upstream of the hatchery barrier fence.

Summer Chinook that were not required for the homing study were either loaded into a transport truck and held at Rosewall Creek Hatchery for hatchery broodstock, or transported and released directly into Comox Lake where fish could safely hold and spawn naturally in October, in either the Lower Puntledge River or the Comox Lake tributaries.

[1] PIT tags were injected as per methods described in http://www.biomark.com/Documents%20and%20Settings/67/Site%20Documents/PDFs/Fish%20Tagging%20Methods.pdf

3.2 Monitoring migration of PIT tagged summer Chinook adults

Radio-frequency identification (**RFID**) receivers and antenna arrays installed at the Puntledge diversion and Comox impoundment dam fishways were used to monitor the movement of the PIT tagged adults into the Puntledge River (headpond) and Comox Lake. Each fishway was equipped with two antennas - one at the downstream end (entrance), the other near the upstream end (exit). The two antennas at each fishway provided information on rate of travel and migration success rate through the fishway and served as a backup in the event that one antenna failed. At the beginning of the 2015 monitoring program, the upper antenna at the Comox Dam fishway was found to be malfunctioning, and could not be repaired/replaced without scheduling a lock-out with BC Hydro. Therefore only one antenna was used to monitor migration into Comox Lake. A multiplex HDX reader (Oregon RFID, Portland, OR) located at each site, automatically detected and recorded PIT tagged fish as they passed the antennas. The receivers were monitored and downloaded 3-4 times per week.

3.3 Monitoring migration of all summer Chinook adults into the headpond and Comox Lake

Puntledge Hatchery has monitored migration at the diversion dam fishway since 2005 with an underwater colour video camera (SplashCam Deep Blue, Ocean Systems Inc, WA) and digital video recorder (Duplex 1600/800 manufactured by Silent Witness®) referred to as a Digital Video Monitoring System (DVMS) in this report. The data from this installation was used to verify any RFID detected adults and provided an overall estimate of the total number of summer Chinook adults that accessed habitat above the diversion dam.

In 2015, we decided to abandon the use of a DIDSON sonar camera deployed in the previous two years of monitoring adult migration at the Comox impoundment dam. The difficulties associated with capturing optimum images, the time required to review and analyse DIDSON video recordings, and the limitations in the software settings and export formats to enable motion detection at this location made the equipment disadvantageous for our requirements. These issues were detailed in the previous year's reports (Guimond and Taylor 2014 and 2015). Instead we employed only the DVMS equipment (used at this location last year), to capture video recordings of fish passage through the fishway. The video recording camera and LED light (Aquascape® 6W) were installed downstream of the existing camera tunnel in the fishway and could easily be positioned, readjusted or removed for cleaning during the project. The digital

recorder and TV monitor were housed in the weather-proof metal cabinet on the dam. This DVMS installation could only collect timelapse video footage. Motion event recordings could not be captured due to the amount of camera vibration in the fishway. The equipment provided continuous recording for the duration of Chinook migration between 23 May and 30 Sept 2015 except for a few brief interruptions when the DMVS digital recorder temporarily stopped working or the LED light failed.

4 RESULTS AND DISCUSSION

4.1 Environmental Conditions

Mean hourly discharge and reservoir elevation data for the Puntledge River and Comox Lake during the 2015 summer Chinook migration period was obtained from BC Hydro Power Records and is illustrated in Figure 2. Data includes flows in Reach C recorded at BC Hydro's Gauge 6 below the diversion dam (WSC Gauge No. 08HB084), Comox impoundment dam sluice gate releases (Reach B discharge), penstock discharge (turbine flow), and Comox Lake reservoir elevation.

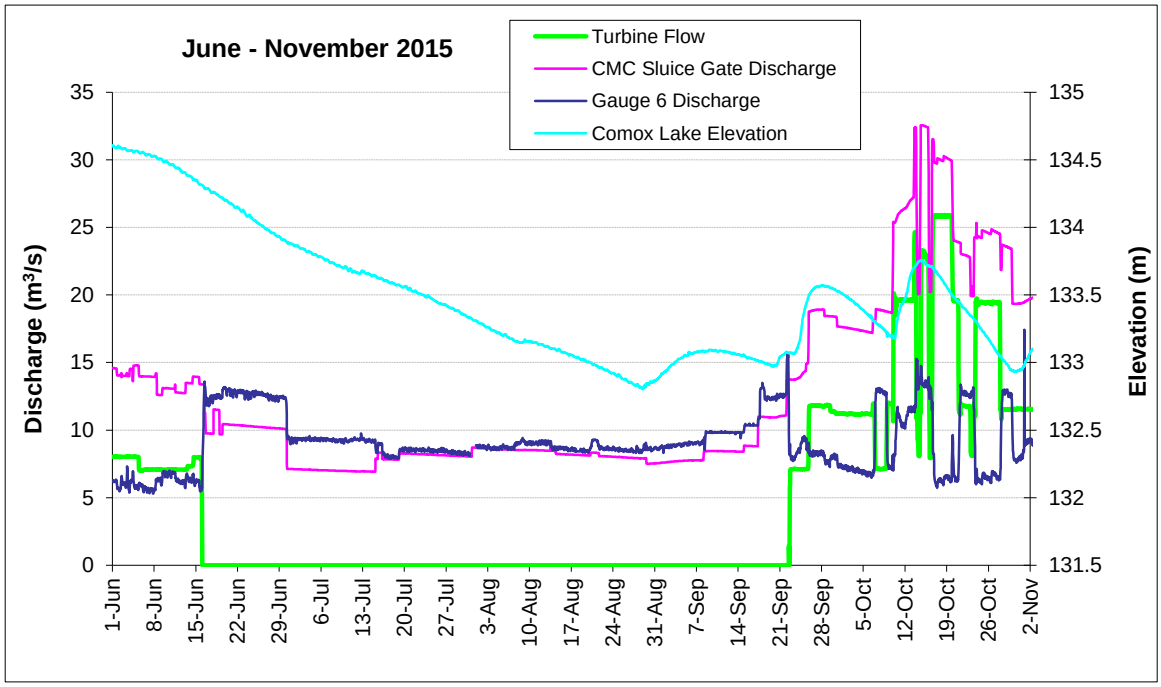

Figure 2. Puntledge River mean hourly discharge for Gauge 6 below the diversion dam (WSC Gauge No. 08HB084), Reach B (Comox dam sluice gate discharge), and penstock discharge, and Comox lake reservoir elevations during the summer Chinook migration period (June-October).

The Puntledge Generating Station was shut down for maintenance on June 16, 2015, and was not returned to service until September 23, 2015 due to low inflows and BC Hydro's need to conserve water during the summer to meet downstream fish flow requirements. As a result, discharge in Reach C was higher than the normal minimum fish flow (i.e. 5.7 m^3/s) during the summer Chinook migration period, ranging between 7.9 m^3/s and 15.6 m^3/s during the generator shutdown period.

A comparison of mean daily river temperature during the 2013-2015 summer Chinook migration period, collected from temperature data loggers (Onset Tidbit v2; Solinst Levelogger Model 3001) located upstream of the diversion dam, is illustrated in Figure 3. For the most part, river temperature in 2015 was warmer during the first half of the summer Chinook migration than in 2013 and 2014. Between 1 May and 31 August, mean daily river temperature in 2015 was above 18 °C for 87 days (71%) versus 55 and 57 days (45% and 46%) in 2013 and 2014 respectively. At temperatures above this threshold, handling summer Chinook adults increases stress and may result in a higher risk of pre-spawn mortality.

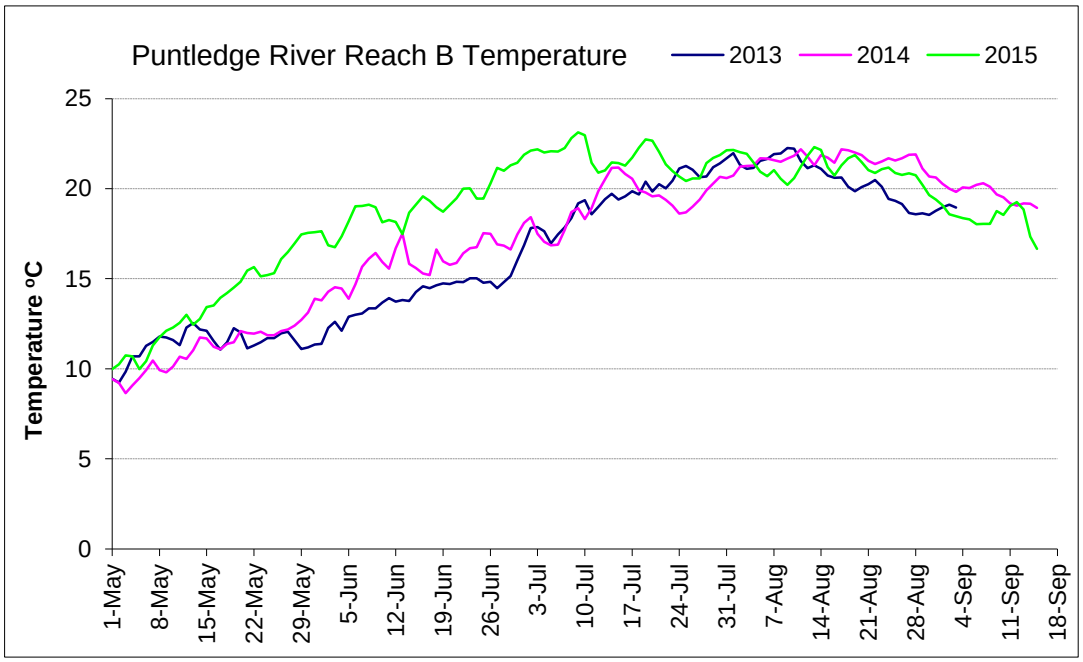

Figure 3. Mean daily river temperature from data collected in the Puntledge River Reach B, May – September, 2013-2015.

4.2 PIT Tagging Adult Returns

The total number of summer Chinook adult returns that were PIT tagged in 2015 is summarized in Table 1. Unfortunately, with river temperatures already approaching 21°C by June 22, and a predicted low summer Chinook escapement, the study was terminated early with only 8 adults PIT tagged (7 from lake released juveniles, and 1 river released juvenile). The decision to suspend the study was also influenced by BC Hydro's forecast for a record dry summer and low water conditions, a likely increase in recreational activity in the river, and concern over the success rate of PIT tagged 'Homing study' adults to reach the diversion dam, (and the potential bias this could have on the final results). The 2015 Puntledge River summer Chinook escapement was 603, or roughly half of the previous year's escapement of 1,176.

Table 1. PIT tagging summary of summer Chinook adult returns to Puntledge Hatchery in 2015.

	No. Chinook PIT tagged				
Application Date	Unclipped (Lake releases)	Adipose Clipped (River releases)	Water Temp (°C)	Total No. Inspected	% PIT tagged
21-May	0	0	15.5	1	0
26-May	0	0	16	2	0
27-May	0	0	16	1	0
2-Jun	0	0	16.5	4	0
5-Jun	1	0	17	3	33
8-Jun	2	1	17	35	8.6
10-Jun	0	0	18	5	0
12-Jun	0	0	18	1	0
15-Jun	0	0	19	9	0
17-Jun	0	0	19	3	0
19-Jun	0	0	19	3	0
22-Jun	4	0	20.5	27	14.8
Total	**7**	**1**		**94**	**8.5**

4.3 Monitoring 2015 Adult Returns

The fishway at the diversion dam was opened for Chinook migration on May 19, 2015, much earlier than usual due to the low river flows and cancellation of the annual kayak pulse flow which typically facilitates many early arriving summer Chinook adults to by-pass the hatchery barrier fence in the lower river. It was suspected that very few early arriving adults accessed Reach C above the barrier fence as a result of the

infrequent spill events. The fishway remained opened until September 14, 2015 to prevent fall Chinook from accessing the headpond. During this period, none of the 8 PIT tagged Chinook that were released in the lower river were detected by the antennas in the diversion dam fishway, or the Comox Dam fishway. Although these 8 adults did not succeed in migrating into the headpond, their success to the upper river (i.e. diversion dam pool) cannot be verified.

In 2015, a total of 20 summer Chinook adults were counted by the underwater video camera in the diversion dam passing into the headpond, and 19 adults were counted by the Comox impoundment dam fishway camera, passing into Comox Lake (Figure 4).

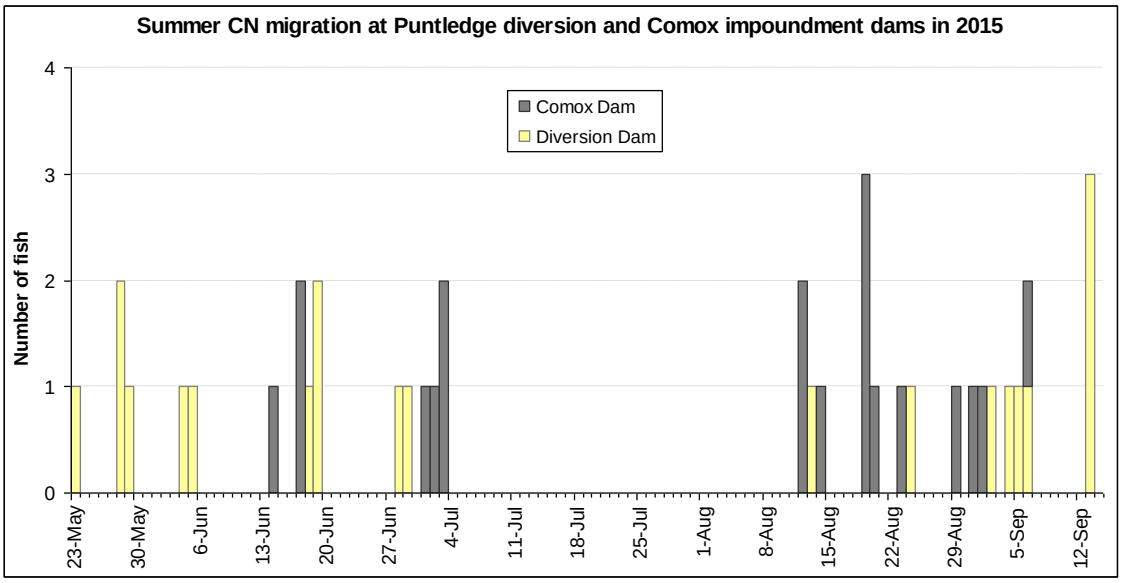

Figure 4. Movement of summer Chinook salmon through the diversion dam and impoundment dam fishways as recorded by underwater video surveillance, May – September 2015.

4.4 Monitoring 2015 summer Chinook migration into Comox Lake

For each hour that the DVMS was operational, 1 hour of timelapse video from the underwater camera was recorded by the DVMS software at 5 frames per second (fps) and each hour was saved automatically as a separate file (~500 Mb each) to one of the removable hard drives. These files were reviewed at up to 10x speed (minimum of 6 min/hr of footage).

An open source video surveillance software, called iSpy, was used to review the DVMS timelapse recordings via the DVMS s-video output connected to a 'USB analog

to digital video signal converter' (Dazzle DVC) on a 64 bit Win 7 laptop. The iSpy software has varied 'motion detection' recording settings which can produce a series of video clips of the motion triggered events and simultaneously creates thumbnails of the detected 'object'. Folders of the created thumbnails (640x480) were reviewed to verify the events and acquire timestamps of when fish passed through the tunnel. iSpy can be setup to monitor a series of cameras that are connected using IP, USB, or it can review folders of existing video files. An example of a motion detected event thumbnail captured by the iSpy software is presented in Figure 5. This software significantly reduced the amount of time needed to review the DVMS timelapse video files, essentially operating as a substitute for the DVMS internal motion detection feature.

Figure 5. Image of adult passage through the Comox dam fishway captured by the DVMS surveillance system and filtered with iSpy software.

4.5 Analysis of 2013 to 2015 migration

The two years of "study group" juvenile releases in 2011 and 2012 (i.e. ~90,000 smolts released each year into Comox Lake with a CWT and adipose fin; and 180,000 CWT-adipose clipped smolts into the river) provided a 3 year period where the adult returns could be PIT tagged and their migration behaviour monitored at the dams. This ensured that a sufficient sample size could be examined. The multi-year assessment was also designed to reduce the bias a poor river escapement year (due to low marine survival, higher pre-spawn mortality from predation, warm water conditions, etc.) could have on the study results. The majority of Puntledge summer Chinook females return at

4 years old (range 3-5 yrs) while the greatest proportion of males are 3 and 4 years old (range 2-5 yrs; Trites et al. 1996). Pooling homing results over the three years of study would increase the sample size in each group, improve the statistical power of the study design and average out the physical and biological conditions that can vary year-to-year.

Over the three tagging years, 2013 to 2015, totals of 56 adipose clipped Chinook (River group) and 64 un-clipped fish (Lake group) were tagged. These totals included 2 jacks in the river study group and 5 jacks in the lake group, all of which were tagged in 2013 (Table 2). In two of the three years, summer Chinook escapement was <1,000 and river discharge in Reach C was higher than usual throughout the upstream migration period. Furthermore, in 2015, river temperatures were higher during upstream migration than in 2013 and 2014.

Genetic analysis of 2014 summer Chinook adults and 2015 juveniles (offspring of adults that spawned in Reach B) conducted as part of a FWCP/DFO parentage-based tagging study on Puntledge River summer Chinook salmon, discovered that some of the adults had been mis-identified with respect to sex on initial sampling during the adult PIT tagging phase (Withler and Guimond 2016 *in prep.*). For PIT tagged adults, 12 of the 20 adults that were identified as females were males (60%) while 6 of the 63 adults that were identified as males were females (9.5%). This does not affect the migration results. The values in Table 2 have been corrected for sex using the sex ID genetic marker. Furthermore, the assignment of 2015 juvenile summer Chinook fry (progeny) to genotyped parents identified 3 additional PIT tagged adults that had successfully accessed and spawned in the headpond without being detected by the antennas in the diversion dam fishway.

Table 2. Total number of Chinook tagged by study group and sex, over the three years of the study (2014 sex corrected through genetic testing).

	2013				2014			2015			Three Yrs Combined			
Study	Sex				Sex			Sex			Sex			Total over 3
Group	M	F	J	Total	M	F	Total	M	F	Total	M	F	J	Yrs
River (Ad-Clip)	9	5	2	**16**	35	4	**39**	1	0	**1**	45	9	2	**56**
Lake (No mark)	5	3	5	**13**	34	10	**44**	5	2	**7**	44	15	5	**64**

The number of Chinook in each study group that reached the diversion dam and the Comox dam tracking sites over the three years of monitoring adult returns, are listed in Table 3. In 2014, 3 Chinook were detected by the antennas at the Comox dam, but not by the antennas at the diversion dam 3.7 km downstream. These were likely fish that passed through the diversion fishway RFID antennas during a brief period when the antennas' sensitivity required readjustment. Since other PIT tagged Chinook may have passed through the fishway during this time, but did not proceed into Comox Lake, these fish are not included in Table 3. For the same reason, the 3 additional PIT tagged adults confirmed in the headpond through genetic testing of progeny are also not included. These fish may have passed by the antennas undetected as above, or they may have been adults that rejected their PIT tag during migration. Therefore, there is a degree of error associated with detection rates and unfortunately this error cannot be quantified from our data, as explained below.

Table 3. Number of Chinook recorded at the Diversion and Comox dams by year and study group. P1 and P2 identify the proportions of releases that migrated to the respective areas.

		Diversion Dam	Comox Dam	P1	P2
River	2013	7	6	43.8%	37.5%
	2014	18	14	46.2%	35.9%
	2015	0	0	0.0%	0.0%
Lake	2013	6	5	46.2%	38.5%
	2014	15	14	34.1%	31.8%
	2015	0	0	0.0%	0.0%
Total River		25	20	44.6%	35.7%
Total Lake		21	19	32.8%	29.7%

Over the 3 years, the overall success rate of tagged fish that migrated to the detection array at the diversion dam was 44.6% for the River group and 32.8% for the Lake group. The equivalent proportions that were detected at the Comox Lake array were 35.7% and 29.7%, respectively. The first hypothesis to be tested, H_1, states that more of the Lake release group would likely migrate to Comox dam, given their release in the upper system. The alternative hypotheses, H_0 states that the probabilities are equal and neither group shows a preference for a specific migration destination. Comparing the overall probabilities for these groups, there is no significant difference between them ($Z = 0.337$ $p = 0.736$). Similarly, we can test the assumption that more River fish were attracted to the diversion dam. Again there was no significant difference between the probabilities ($Z = 0.927$ $p = 0.354$). Finally, we examined the possibility that, of the fish reaching the diversion dam, Chinook in the Lake group

would be more likely to continue to Comox dam. These probabilities derived from the differences in counts from the first array to the second upstream, and p1 is 0.80, while p2 is 0.905. Once more, there was no significant difference between the proportions in each study group that continued upstream ($Z = -1.013$ $p = 0.267$). Even if we were to include the 3 additional undetected PIT tagged fish which were confirmed in the headpond (by virtue of their offspring genes), the data would only strengthen the result of no significant difference between the probabilities.

Connolly (2010) discusses factors that affect passive integrated transponder (PIT) tag detection in terms of array orientation and antenna placement. These are both biological and physical and include tag orientation as well as lateral and vertical coverage by the array. Using more than one antenna allows for the estimation of detection efficiency which is useful where differential detection of the PIT tags is encountered. However, this method is applicable to studies of unidirectional movement, where it is assumed the subjects will continue to move past both arrays.

Unfortunately, in our study, there is the expectation that some fish will not continue their migration due to imprinting on a release location. Therefore, the probability of re-sighting a fish at the second array cannot be assessed. The movement of Chinook to the second array while undetected at the first suggests that the number of fish moving to the diversion dam is underestimated. This creates uncertainty in the detection rates, but may apply equally to both arrays. We have no ability to check on undetected movement past the Comox dam array. (Although a video surveillance system may provide information on fish passage, there are no clearly visible external identifying features to distinguish PIT tagged adults from untagged adults). However, the error from this factor is likely to be small and in terms of underestimation of diversion dam fish it would tend to reduce the difference between the study groups, resulting in lower statistical significance for the comparison. Consequently, we can confirm that the data collected from three years of tagging suggests that point of release of Chinook fry in 2011 and 2012 (east end of Comox Lake) has no impact on homing behaviour in the Puntledge River.

The point of release of the “lake” group was approximately 4.5 km upstream of the “river” release group. In both years of lake releases, observations of CWT hatchery pre smolts were observed passing through the Puntledge Eicher screen evaluation facility within one to two days of release. These fish were easily recognized, at least initially, by their larger size compared to wild Chinook juveniles (Figure 6), and were periodically verified using a coded wire tag V-detector (Northwest Marine Technology Inc., WA) during the migration period. Thus unsuccessful imprinting due to the proximity to the lower river release point, and/or, short duration in the lake, may also

account to some degree for the comparable results in the "lake" and "river" adult groups.

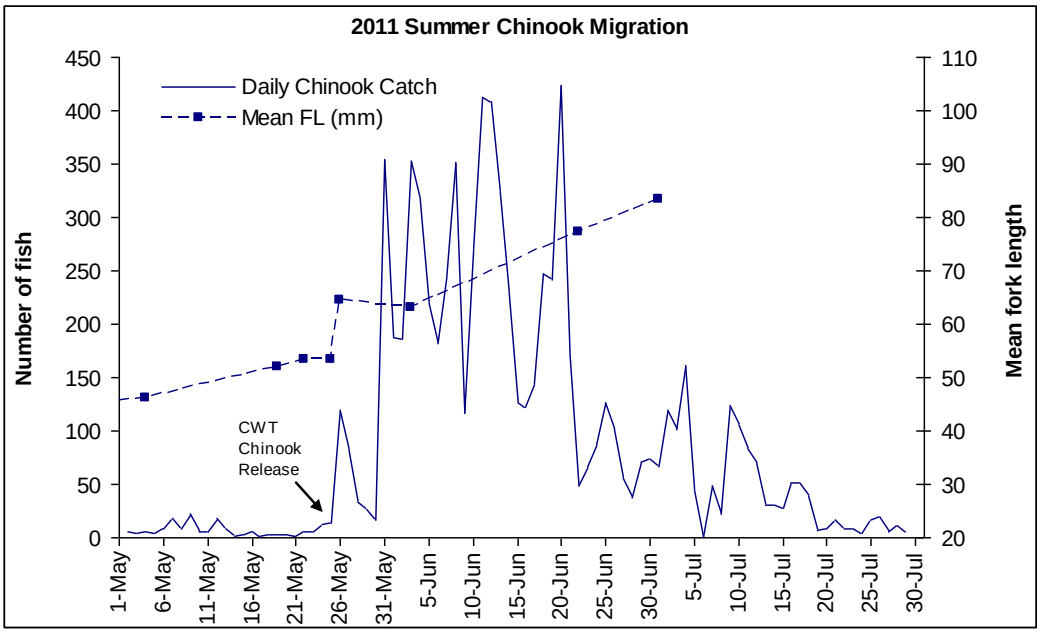

Figure 6. Brood year 2010 juvenile summer Chinook migration at the Puntledge diversion dam from May – August 2011. Hatchery reared CWD'd juveniles were released in Comox Lake on May 24, 2011 for imprinting.

4.6 Puntledge Chinook adult survival

While the results from the study suggest no difference in the homing behaviour to Comox Lake, adult survival data provided by DFO for the two study groups show a significantly lower survival for adults originating from lake releases (C. Lynch, DFO unpublished data). Using the estimated age class distributions for Puntledge summer Chinook, the total expanded escapement plus total catch for brood years 2010/2011 over 4 return years (2012 – 2015), the survival estimates (smolt to adult) for the two study groups are presented in Table 4.

Table 4. Survival of summer Chinook (SCN) from release to adult return for the two study groups in the Puntledge Homing study ("lake" and "river" release groups) calculated from total catch plus escapement data (DFO unpublished report).

	2010 Brood Year		2011 Brood Year	
SCN Treatment	# tagged	fry-to-adult Survival	# tagged	fry-to-adult Survival
River release	179,425	0.35%	179,184	0.75%
Lake release	88,513	0.19%	80,322	0.12%

The significantly lower adult survival of the "lake release" group compared to those released in the river below the diversion dam for the two brood years is notable. Exposure of the "lake" released juveniles to a potentially greater number of predators, and impacts from passage at the diversion dam Eicher screens may account in part for the lower survival rates overall on this group. Migration of CWT Chinook smolts was monitored at the Puntledge Eicher screen evaluation facility and verified using the V-detector (Northwest Marine Technology Inc., WA) which was employed intermittently to detect the proportion of CWT'd Chinook in the daily catch. Population estimates were then calculated from an analysis of CWT incidence in the total Chinook smolt population (i.e. wild Chinook production and CWT hatchery releases). For the 2011 release, a population estimate of 44,669 CWT Chinook smolts (95% CI 36,560 – 52,778) was calculated (Guimond and Taylor 2012), whereas, an estimate of 63,591 (95% CI 47,789 – 79,392) was calculated for the 2012 CWT only releases (Guimond and Taylor, 2013). However, since the proportions of CWT fish detected in the catch varied quite substantially over the sampling period (range 41% to 85% for the two sampling years), and the data was not collected systematically, these represent a crude approximation of the total population estimate.

A third year of juvenile releases into Comox Lake and the river was planned for 2013 to provide a more accurate population estimate of the lake released juveniles (i.e. CWT only), to the diversion dam. This would also provide an opportunity for an additional year of PIT tag assessments on adults at the diversion and impoundment dams. However, due to poor summer Chinook river escapement in 2012, and a high incidence of bacterial kidney disease in hatchery broodstock, there were not enough fry available for a lake release group.

5 RECOMMENDATIONS

Although the results from the homing behaviour study and the survival of adults from lake released juveniles do not support the argument for a juvenile summer Chinook lake release strategy at this time, it is critical that we continue to assess the future success of hatchery adults and the rebuilding of the overall summer Chinook population.

Following the closure and decommissioning of the Upper Hatchery in 2012, all summer Chinook production was moved to the lower Puntledge Hatchery site. Summer Chinook smolts are now released in the lower river, approximately 6.5 km further downstream from the river release site below the diversion dam used in the homing study. Although this lower river release strategy may reduce smolt downstream migration mortality and result in higher overall adult survival and returns, this release site could potentially influence imprinting/homing behaviour and migration success rates to Comox lake compared to our current study results. The returning adults may be less inclined to migrate past the lower hatchery or to Comox Lake. For hatchery adults to be able to successfully re-integrate into the wild spawning population, we believe that a key behavioural component to achieving this goal is the need for the returning adults (hatchery and wild) to migrate into Comox Lake and hold in the cooler depths during the summer to be able to survive and successfully spawn in October.

Under current hatchery practices, and even more so if only lower hatchery releases are implemented, it will be imperative that we ensure adult returns are able to migrate to Comox Lake and hold and spawn successfully. In order to assess this we will need to continue to monitor and assess hatchery adult returns to the lower Puntledge Hatchery, diversion dam and impoundment dam. Differential marking of hatchery smolt releases to assess new hatchery strategies and parentage-based (DNA) tagging of returning adults will also need to continue to assess the success of hatchery contribution into the wild population. Finally, continued modifications to the Eicher screen operations and assessment of the Eicher screen performance will be required to ensure that biodiversity is maintained and an acceptable survival rate of wild fry is achieved to support summer Chinook stock rebuilding.

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APPENDIX A - Confirmation of FWCP Recognition

Project Watershed participated in the annual Puntledge Hatchery Open House, October 2015.

Photo 1. Hundreds of local citizens had an opportunity to view returning adult salmon and journey behind the scenes at the popular Puntledge River Hatchery annual Open House event.

Photo 2. Among a variety of community organizations on-site, Project Watershed provided the public with information on the Summer Chinook Homing Behaviour Study, and other FWCP projects, past and present.