Spring Run Chinook Escapement Study on the Upper Nanaimo River in 2012 and Historical Data Review

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Watson, N.M. 2015. Spring run chinook escapement study on the upper Nanaimo River in 2012 and historical data review. Can. Manuscr. Rep. Fish. Aquat. Sci. 3080: vi + 21 p.

In 2012, Fisheries and Oceans Canada in co-operation with Snuneymuxw First Nation and Nanaimo River hatchery conducted an escapement study of spring run chinook salmon (*Oncorhynchus tshawytscha*) in the upper Nanaimo River. Components of this study included:

i) Estimating the spawning population of spring run chinook in the upper Nanaimo River;
ii) Assessing potential spawning and holding habitat locations on the upper Nanaimo River;
iii) Collecting biological data from the spring run chinook natural spawners.

The estimated total return of spring run chinook to the Nanaimo River in 2012 used an addition/subtraction method where a total of five chinook were enumerated, including one adult male, one adult female and three jacks. The estimate classification was deemed to be a Type 4, indicating a moderate resolution, relative abundance estimate. The Nanaimo River Hatchery does not collect broodstock on this population. One adult female chinook was biologically sampled. The DNA results from this fish indicated a 58% probability of being a Nanaimo spring run chinook. The scale sample results indicated that this fish was a 3 year old, which did not overwinter in freshwater before smolting.

Spawner observational data was compiled from the Nanaimo River Hatchery records for return years 1979 to 2011. This data was reviewed and analysed, and the estimates from each year were used to create Stream Estimate Narratives (SENs) in the Salmon Escapement Database (NuSEDs). No data was available for 1991, 1994-1995, 1997-2000 and 2009-2011 so the SENs created were *Not Inspected*. For years 1979, 1982-1983, and 2003-2004 the estimate method used was *Addition/Subtraction* and for years 1980-1981, 1984-1990, 1992-1993, 1996, 2001-2002, and 2005-2008 the method used was *Peak Live plus Dead*. All of the estimates for these two groups were deemed to be Type 5, indicating a low resolution, relative abundance estimate. The estimates ranged from a low of 1 (2006) to a high of 264 (1979).

RÉSUMÉ

Watson, N.M. 2015. Spring run chinook escapement study on the upper Nanaimo River in 2012 and historical data review. Can. Manuscr. Rep. Fish. Aquat. Sci. 3080: vi + 21 p.

En 2012, Pêches et Océans Canada, en collaboration avec la Première Nation Snuneymuxw et l'écloserie de la rivière Nanaimo, a poursuivi son étude sur les échappées de saumon quinnat à remonte printanière (*Oncorhynchus tshawytscha*) dans la rivière Nanaimo. Les composantes de cette étude comprenaient :

i) L'estimation de la population reproductrice de saumon quinnat à remonte printanière dans le cours supérieur de la rivière Nanaimo;
ii) L'évaluation des sites potentiels de reproduction et de retenue dans le cours supérieur de la rivière Nanaimo;
iii) La collecte de données biologiques auprès des reproducteurs naturels de la population de saumons quinnat à remonte printanière.

La méthode addition-soustraction a servi au calcul de l'estimation de la montaison totale des saumons quinnat à remonte printanière en 2012 selon un échantillon de cinq individus composé d'un mâle adulte, d'une femelle adulte et de trois saumons mâles. L'estimation a été classée sous la catégorie 4, c'est-à-dire une estimation d'abondance relative à résolution moyenne. L'écloserie de la rivière Nanaimo ne recueille aucun géniteur pour cette population. Des données biologiques ont été prélevées sur une femelle adulte. Les résultats des tests d'ADN indiquaient une probabilité de 58 % que ce poisson appartienne à la population de saumons quinnat de la remonte du printemps. D'après l'analyse effectuée à partir d'un échantillon d'écaille, ce poisson serait âgé de trois ans et n'aurait donc pas passé l'hiver dans l'eau douce avant son adaptation à l'eau salée.

Les données d'observation sur les géniteurs ont été compilées d'après les données recueillies par l'écloserie de la rivière Nanaimo pour les années de montaison de 1979 à 2011. Ces données ont été révisées et analysées, et les estimations obtenues pour chaque année ont servi à créer des « Stream Estimate Narratives (SENs) » dans la base de données Salmon Escapement Database (NuSEDs). Puisqu'aucune donnée n'était disponible pour les années 1991, 1994-1995, 1997-2000 et 2009-2011, les SENS de ces années portaient la mention *non inspecté*. La méthode addition-soustraction a été employée afin d'obtenir les estimations pour les années 1979, 1982-1983 et 2003-2004, alors que pour les années 1980-1981, 1984-1990, 1992-1993, 1996, 2001-2002 et 2005-2008, l'estimation a été obtenue en comptant les poissons vivants et morts à la période de pointe. Toutes les estimations obtenues pour ces deux regroupements ont été classées sous la catégorie 5, estimation d'abondance relative à faible résolution. L'estimation la plus basse était de 1 (2006) alors que la plus haute était de 264 (1979).

INTRODUCTION

The Nanaimo River watershed is a unique system that combines a series of lakes and tributaries and hosts a variety of salmonid species, including different runs of the same species. Chinook (*Oncorhynchus tshawytscha*) in the Nanaimo River exhibit a variety of life history strategies, with at least three genetically distinct populations (Carl and Healey 1984).

The fall and summer run chinook populations have been monitored closely, especially since 1988 and much more information is known about these two populations. The fall run enters the lower river in late summer to early fall and spawns within the lower reaches, mainly from the Trans-Canada Highway Bridge to the Cedar Road Bridge (Carl and Healey 1984, Healey and Jordan 1982). The summer chinook run enters the river in the early summer months, they hold in First Lake and Southfork Junction, and spawn in a two kilometre stretch of the Nanaimo River from First Lake down to Wolf Creek (Healey and Jordan 1982). Both the fall and summer populations are mainly ocean-type chinook that do not overwinter in freshwater (a portion of the summer run population has been found to exhibit stream-type life history where fry spend the winter in freshwater) (Carl and Healey 1984).

The Upper Nanaimo River also hosts a spring timed chinook run but little is known about this population. Fish have been found to enter the river during the spring months (as early as March) and hold from First Lake and up to the deep canyon pools below Fourth Lake until they are ready to spawn in September and October. Most of the spring run spawning has been found to occur between Second and Fourth Lakes but it is possible that some spawning occurs in tributaries (including Green Creek). The majority of fry are stream-type which rear for up to one year before out-migrating to the estuary (Healey 1980, Blackman 1981, Nagtegaal and Carter 2000).

This spring run has been defined in its own unique Wild Salmon Policy Conservation Unit (CU); East Coast Vancouver Island- Nanaimo spring timing, (Holtby and Ciruna 2007; Figure 2). The spring run is historically a small population, and has been assessed intermittently from 1979 to 2008 but assessments have not been well documented and no estimates were previously entered into DFO's Salmon Escapement Database (NuSEDs).

Due to the lack of assessment on this single stock chinook CU, Fisheries and Oceans Canada (DFO), with assistance from the Snuneymuxw First Nation (SFN), conducted escapement surveys within the Upper Nanaimo River during 2012 in order to assess the spawning population.

The purpose of this report is to document the efforts to locate and enumerate spring run chinook in the Upper Nanaimo River in 2012, assess chinook habitat in the upper river through locations of fish observed, biologically sample spring run carcasses and compile all historical and current data regarding the spring run chinook population into DFO's salmon escapement database (NuSEDs). Recommendations on future enumeration surveys and biological sampling are outlined.

METHODS

In the summer and fall of 2012 DFO and SFN took part in an escapement study to assess the spawning population of spring run chinook. The main type of assessment was through swim surveys. The first survey was also assisted by Nanaimo River hatchery staff, who in the past had conducted minimal spot checks in 3 locations on the upper river between Second and Fourth Lake. Subsequent surveys expanded the survey area, especially further up the river as well as adjoining sections in between to increase the likelihood of locating spawning chinook and assess the river for spawning locations.

DFO and SFN conducted one day of carcass sampling in the section of the river above Second Lake. This assessment consisted of floating the section of the river in an inflatable boat with gas powered engine and searching for chinook carcasses, live chinook and redds. Carcass samples included scales for age analysis, DNA for run timing identification, sex, length and pre-spawn mortality condition.

Historical data provided by the Nanaimo River Hatchery was compiled and reviewed. These data were recorded and kept by hatchery staff but Summary Estimate Narratives (SENs) were never created in NuSEDs. The data was reviewed and SEN reports were created for all years from 1979 to present. For years where there were no records of surveys occurring the SEN specified that the spring run chinook population was deemed to be *Not Inspected*. For the years where data does exist, SENs were created with the escapement estimate. An escapement estimate method was selected as either *Peak Live plus Dead* when a sum of chinook observed on a single survey day was selected as the total estimated natural spawners, or an *Addition/Subtraction* method when observations from different days were added together to obtain the total estimated natural spawners. An escapement estimate for 2012 was produced using the same methods as was used for historical data. See Appendix 1 for estimate method definitions used in NuSEDs.

Estimates for each year are also given an estimate classification based on the definitions of these classifications in NuSEDs (see Appendix 2 for classification descriptions). These classifications are termed Type 1 to Type 6 and describe the resolution of the estimate with the highest resolution as a Type 1 and the lowest as a Type 6. Type 1 and 2 are used when the estimate is a True Abundance, Type 3, 4 and 5 are used when the estimate is a Relative

Abundance, and Type 6 is used when the estimate is solely a presence or absence.

RESULTS

Swim Surveys

Swim surveys began in mid-August, and continued approximately every 2 weeks until the end of October. The results of each survey are outlined below and summarized in Tables 1, 2 and 3. Figure 1 shows the survey area map with common segment locations.

On 14 August, four swimmers (2 from NRH, 1 from DFO and 1 from SFN) conducted spot checks in three locations; Green Creek junction pool, old bridge to canyon, below 3rd Lake to TP Bridge (Table 1 and 2). On this survey only one jack chinook was observed in the Green Creek junction pool and the survey area covered 1491 meters of the river (Table 3). The Nanaimo River Hatchery staff were included to convey information to DFO and SFN about locations in the river where previous swim counts have been conducted and to indicate the access points to the upper river survey locations. The subsequent surveys included only DFO and SFN members.

On 27 August, three swimmers (two from DFO and one from SFN) conducted the swim survey, and for this swim count the survey area was expanded to include additional areas (Table 2). The observers surveyed the entire section from the Green Creek pool down to the canyon (from the first spot check to the second spot check location on 14 August survey) and started the last section about 360m above the start point of the first survey. Three jacks and one adult female were observed during this survey and coverage was 4001 meters of the river (Table 3).

An additional swim survey on 10 September was conducted but no fish were observed. This survey included the exact same sections as on 27 August, which included 4001 meters of the river (Table 2).

On 24 September the survey area was expanded once again where the surveyors commenced the survey almost two kilometres further up the river at an elevation of 268 meters and the entire survey covered 6114 meters of the river (Table 2). In this additional upper section of the river, an adult male chinook was observed near a log pile in the centre of the river upstream of the Green Creek junction at 257 meters elevation (Table 3). No other chinook were observed during this survey. Surveyors also checked a 150 meter portion of the lower spawning area above Second Lake but no chinook were observed in this area either.

On 9 October the survey area was expanded for the last time to include an additional 900 meters upstream of the rock pool with the start location at the confluence of an unnamed tributary at 275 meters elevation and the entire survey covered 6864 meters of the river (Table 2). One jack chinook was observed in the additional section (Table 3). A second jack was observed in the Green Creek junction pool. One adult male was also observed in the upper pool along the road above TP Bridge, very close to the location where an adult female was observed on 27 August.

The survey on 19 October was cancelled due to high water. Swimmers commenced the swim at the same location as the 9 October survey but the water was too high and fast moving and the visibility was very low. The survey was terminated early at the 'Rock Pool' shown on Figure 1 due to dangerous conditions and the total surveyed area was only 985 meters of the river (Table 1).

The final swim survey was conducted on 26 October and began at the confluence of the unnamed tributary below Fourth Lake and this survey was terminated above the old bridge pool at 251 meters elevation (Table 2). Only one jack chinook was observed above the confluence of Rockyrun Creek at 272 meters elevation (Table 3). No other sections of the river were surveyed on this date due to water conditions and time constraints.

During all swim surveys observers also searched for signs of spawning including redds or test digging. No redds or gravel disturbances by fish were observed. Many signs of elk (*Cervus canadensis*) were observed within the survey area during most surveys, including hoof tracks on the banks and crossing the river as well as elk droppings. During the 26 October swim survey elk were observed crossing the river and along the river bank 350m upstream of the end of the survey. Black bears (*Ursus americanus*) were spotted occasionally along the roadside during travel to and from segment locations but none were observed along the river bank. Blacktail deer (*Odocoileus hemionus columbianus*) were also observed along the roadside during travel.

Carcass sampling

DFO and SFN conducted one survey day searching for carcasses in the lower spawning section of the spring timing chinook on 6 November. Surveyors floated downstream in an inflatable boat and 15 horsepower engine from TP Bridge to Second Lake, an area that was not surveyed during the swims. The purpose of this survey was to inspect this section of the river for spawned out chinook to collect biosamples, locate and document any existing chinook redds, observe spawning and holding areas for future swim survey sections. The area surveyed included 5820 meters of river length beginning at 212 meters elevation and ending where the river enters Second Lake at 194 meters.

During this survey only one female chinook carcass was found. The carcass was on the river left bank over half way to Second Lake at 199 meters elevation (49.086144 N, 124.253394 W). The chinook was 741 mm POH length, not adipose clipped and had spawned naturally. Upon opening the egg sack, approximately 200 eggs were found in the cavity. Scale and DNA samples were also taken for analysis. Scale results indicated the chinook was age 3 (2009BY) and did not exhibit signs of overwintering in freshwater (no freshwater annuli) indicating the fish was an ocean-type life history. DNA results indicated that this chinook was 58% probability of being a Nanaimo River spring chinook (with 28% probability Nanaimo River summer chinook and 14% probability Nanaimo River fall chinook) and 100% probability of being an east coast Vancouver Island chinook.

Observers did not observe any other signs of spawning chinook in this section of the river, but it was noted that this section contained extensive spawning habitat with substantial sized gravel and riffles appropriate for successful spawning. The area contained less bedrock and more medium to smaller sized gravel with little gradient. No predators were observed.

Historical Data and Escapement Estimation

Nanaimo River Hatchery provided historical survey records from 1979 to 2008. Most of the surveys were swim counts in spot check and short segment locations within the upper river. Additional paper copies of Stream Inspection Logs (SILs) and information were found in Nanaimo River archives at the DFO South Coast Area office, including additional surveys and years that were not found in the Hatchery records. Table 4, the historical data summary table, outlines the results from each survey conducted throughout the upper Nanaimo River spring run chinook spawning grounds (all surveys between Fourth and Second Lake).

The estimate methods that fit the historical data were limited to *Peak Live plus Dead* and *Addition/Subtraction*. Very little information regarding the surveys and how they were conducted was available. The surveys did not appear to have covered the entire spawning area in the upper river it was not possible to expand the counts to the entire habitat therefore these two methods were the only suitable methods for the data. Also, due to the limited data, low effort and vaguely defined methods, all estimates from 1979 to 2008 were classified as Type 5, Relative Abundance with low resolution.

For all years from 1979 to 2012, SEN reports were created. For years 1979, 1982, 1983, 2003 and 2004 estimates were produced using *Addition/Subtraction* as the estimate method due to the use of two surveys date observations added together to obtain an estimate, which maximized the spawning area surveyed and utilized the data to its full extent. For years 1980 – 1981, 1984 – 1990, 1992 – 1993, 1996, 2001 – 2003 and 2005 - 2008 *Peak Live plus Dead* was used as the estimate method because only data from a single survey day was used for the estimate (Table 5).

The escapement estimate for 2012 was the final result of the swim surveys. A SEN report was created with *Addition/Subtraction* as the estimate method with three jack and two adult natural spawners (three jacks and one adult female were observed on 27 August and these counts were added to the survey on 9 October; adult observation of one male).

For years where no data were available, SEN reports were created as *Not Inspected*. This included ten years from 1979 to 2012; 1991, 1994 - 1995, 1997 – 2000 and 2009 – 2011 (Table 5).

DISCUSSION

Swim Surveys

Despite efforts to locate spawning chinook we can only be certain that at least five chinook (two adults and three jacks) have contributed to the spawning population in 2012. It was found that the common short sections and spot check locations from more recent historical swim surveys were not sufficient coverage of the spawning grounds. In order to obtain a more thorough survey in the future, it is recommended that the reach from TP Bridge down to Second Lake is surveyed, in addition to the areas swam in 2012. The 2012 estimate was classified as a Type 4, Relative Abundance, medium resolution. This Type was selected because although effort was moderate to high over the survey period and more than 4 surveys were conducted, these surveys did not ever cover the entire spawning habitat (especially the area between TP Bridge and Second Lake where the female carcass was found) and the observation data only allowed for a simple analysis for the estimate.

Carcass sampling

Carcass sampling in 2012 took place quite late in the season and occurred following a peak in water levels due to rain storms which can wash carcasses downstream from the spawning grounds. Ideally in the future, carcass sampling should take place just after the peak spawn timing, and before any high water flows to maximize the chances of locating carcasses for sampling.

Very few samples, especially DNA samples, have been acquired from this population in the past. Previous records from the DNA lab at the Pacific Biological Station show samples from 1998 only. It is recommended to increase sampling efforts of carcasses in the future to increase the sample size of DNA to better understand the differences between the three distinct chinook populations that spawn throughout the Nanaimo River watershed.

Healey and Jordan (1982) sampled all three chinook populations to determine the proportions of ocean type and stream type chinook from years 1977 to 1980. Unfortunately only data from 1979 and 1980 were available for the spring run. As in other reports, the data indicated that a higher proportion of stream type (1+) downstream migrants were evident in the spring run population compared to the fall and summer populations. The fall run population contained little to no stream type fish (0 - 5%) over the years, where the summer run population was 2 - 33% stream type and the spring run was 39 - 83%. The scale sample from the 2012 carcass indicated that the fish was a 3 year old and did not exhibit overwintering in freshwater (was not a stream type). In the future it is recommended to continue to increase the sampling efforts for the spring run chinook to better understand the life history patterns of this unique population.

Historical Data and Escapement Estimation

Since 1979, when the first known data was available on spring run chinook enumeration, the average escapement up to 2012 is 44 fish. Healey and Jordan (1982) note that the traditional expected escapement of the spring run has always been lower than the fall and summer numbers and averages less than 100 natural spawners. The average escapement estimate over the past 10 years (2003 - 2008 and 2012) is only 11 chinook. With such low escapement estimates and the minimal data that is available for this population, it is recommended to increase the survey efforts on this population in the future years to come to obtain a better understanding of the dynamics of this population's fluctuations in return numbers as well as the it's health and future sustainability.

In the historic surveys the available spring run spawning area has not been fully covered so most of the estimates should be considered as minimum estimates and there were likely more fish than were observed. The raw swim counts were not expanded for observer efficiency and percent population coverage as is done in the present. Since these factors were not estimated in the past and therefore are unknown it is impossible to expand the estimates in these ways. In the future it is recommended to gather more data and knowledge on the locations of preferred spawning and holding areas for spring run chinook.

Due to the limited data and low effort and coverage of the historical Nanaimo spring run chinook data, the estimates were classified as Type 5 in all years where data were available. Type 5 estimate classifications are used when the estimate is a relative abundance with low resolution and unknown or vague survey methods and the data from these years were best fit to the description of Type 5 estimate classification.

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TABLES

Table 1: Swim survey results summary

Date	Fish visibility	Cloud cover	Precipitation	Precip amount	Light Level	Water Clarity	Water Level	Water Temp.	Total Area Surveyed (m)	Adults observed	Jacks observed
14-Aug-12	High		None	NA	-	3-5m or to bottom	below normal	6.5°C	1491	0	1
27-Aug-12	High	>50%	None	NA	Med bright	>5m	below normal	9.0°C (M)	4001	1	3
10-Sep-12	High	<50%	None	NA	Bright	3-5m	below normal	9.0°C (est)	4001	0	0
24-Sep-12	High	<50%	None	NA	Med bright	>5m	below normal	9.0°C (est)	6114	1	0
9-Oct-12	High	0%	None	NA	Bright	3-5m	extremely low	8.0°C (est)	6864	1	2
19-Oct-12	Low	aborted due to high water, fast flows and very low visibility				<1m	flood	8.0°C (est)	985	0	0
26-Oct-12	High	100%	Rain	Medium	Medium	3-5m	normal	7.0°C (est)	5230	0	1

Table 2: Survey dates and segment location details

Date	Section of river	Start location		End location		Start elevation (m)	End elevation (m)	Section distance (m)	Total distance surveyed (m)
		Latitude	Longitude	Latitude	Longitude				
14-Aug-12	green creek pool	49.090678 N	124.370036 W	49.090925 N	124.368694 W	254	254	100	
14-Aug-12	old bridge to canyon	49.084517 N	124.344917 W	49.084386 N	124.3387 W	251	247	566	
14-Aug-12	road below 3rd to TP bridge	49.0849 N	124.305481 W	49.0849 N	124.296356 W	218	212	825	**1491**
27-Aug-12	green creek pool to canyon	49.090678 N	124.370036 W	49.083806 N	124.339331 W	254	248	2817	
27-Aug-12	pool below 3rd lake to TP bridge	49.083719 N	124.309706 W	49.0849 N	124.296356 W	220	212	1184	**4001**
10-Sep-12	green creek pool to canyon	49.090678 N	124.370036 W	49.083806 N	124.339331 W	254	248	2817	
10-Sep-12	pool below 3rd lake to TP bridge	49.083719 N	124.309706 W	49.0849 N	124.296356 W	220	212	1184	**4001**
24-Sep-12	rock pool to canyon	49.087 N	124.393031 W	49.083806 N	124.339331 W	268	248	4780	
24-Sep-12	pool below 3rd lake to TP bridge	49.083719 N	124.309706 W	49.0849 N	124.296356 W	220	212	1184	
24-Sep-12	pool at access road above 2nd	49.086811 N	124.260936 W	49.087031 N	124.258722 W	200	200	150	**6114**
9-Oct-12	confluence of unnamed to canyon	49.083281 N	124.4027 W	49.083806 N	124.339331 W	275	248	5680	
9-Oct-12	pool below 3rd lake to TP bridge	49.083719 N	124.309706 W	49.0849 N	124.296356 W	220	212	1184	**6864**
26-Oct-12	confluence of unnamed to above old bridge	49.083281 N	124.4027 W	49.084578 N	124.345022 W	275	251	5230	**5230**

Table 3: Fish observation location details

Date	Observation	Location common name	Latitude	Longitude	Elevation (m)
14-Aug-12	Jack	Green Creek junction	49.090781 N	124.368997 W	254
27-Aug-12	Jack	Green Creek junction	49.090781 N	124.369 W	254
27-Aug-12	Jack	below Green Creek junction	49.090789 N	124.366983 W	254
27-Aug-12	Jack	below Green Creek junction	49.090789 N	124.366983 W	254
27-Aug-12	Adult female	pool along road above tp bridge	49.084528 N	124.304011 W	215
24-Sep-12	Adult male	log pile above green creek	49.090228 N	124.382375 W	257
9-Oct-12	Jack	between unnamed creek and rock pool	49.084028 N	124.399414 W	272
9-Oct-12	Jack	Green Creek junction	49.090781 N	124.368997 W	254
9-Oct-12	Adult male	pool along road above tp bridge	49.084553 N	124.30485 W	217
26-Oct-12	Jack	above confluence of Rockyrun Creek	49.084953 N	124.398504 W	272

Table 4: Historical survey data (F= female, M=male, J=jack, A= adult total)

DATE	SECTION	F	M	J	A	Daily subtotal	Comments
18-Jul-79	T P Bridge				40	40	in 2 canyon like pools
23-Jul-79	Sadie to TP bridge				71	71	predominantly jacks, adults 8lbs+, distributec
17-Aug-79	T P Bridge				40	40	in bridge pool, to 18lbs, 50% less than 10lbs.
7-Sep-79	Sadie Creek				13	13	in pool 100m below dam
14-Sep-79	Sadie to Green					48	60% jacks, adults to 25lbs, mostly dark, 30%
14-Sep-79	Green Creek to upper Bridge (2)					49	60% jacks, adults to 25lbs, mostly dark, 30%
14-Sep-79	Upper bridge to TP bridge					121	60% jacks, adults to 25lbs, mostly dark, 30%
24-Sep-79	Sadie creek to TP bridge			80	116	196	20% on redds, 50% on riffles or flats, 30% in
26-Sep-79	tp bridge to 2nd Lake			18	50	68	10% on redds, 50% riffles or flats, 40% in po
22-Apr-80	Green Creek to TP bridge					0	
27-May-80	4th Lake outlet to TP bridge					0	only parr observed
3-Jun-80	Canyon to tP Bridge				9	9	3-20 lbs. 14lb ave.
4-Jun-80	tp bridge to 2nd Lake					0	<300 fry observed, low number
9-Jul-80	Falls to TP Bridge				29	29	6 above bridge and 33 below ?? Survey from
18-Aug-80	Falls to Canyon				50	50	primarily in one pool, few jack, all in good sha
2-Sep-80	Canyon bridge to bridge 1 (TP)			7	1	8	no fry observed
6-Oct-80	Falls (4th lake outlet) to 2nd Lake			4	62	66	12 in canyon, 16 below, 34 and 4 jack above
22-Jun-81	Green Creek to confluence			1	0	1	
22-Jun-81	Green to Bridge 2			0	1	1	
22-Jun-81	Bridge 2 to TP Bridge			0	0	0	
31-Aug-81	1st bridge to 2nd Lake			0	0	0	
3-Sep-81	2nd bridge to 1st bridge above 2nd lake			36	17	53	8 at 2nd bridge, 8 at canyon and 33 at pool 1
4-Sep-81	4th lake outlet to bridge 2			1	5	6	3-4m vis, cooler above green creek
4-Sep-81	tp Bridge to 2nd Lake				6	6	
25-Sep-81	upstream of green creek confluence			2	0	2	vis high, 8-8.5 deg C
25-Sep-81	Green Creek to Bridge 2			2	1	3	vis high, 8-8.5 deg C
25-Sep-81	Bridge 2 Pool			4	3	7	vis high, 8-8.5 deg C
25-Sep-81	Canyon			30	5	35	vis high, 8-8.5 deg C
25-Sep-81	Canyon to Bridge 1			2	5	7	vis high, 8-8.5 deg C
25-Sep-81	Bridge 1 pool			2	1	3	vis high, 8-8.5 deg C
29-Jul-82	4th lake outlet to TP bridge			11	12	23	adults in pool 1km above green/ 3 jack in poo
17-Sep-82	4th lake outlet to green ck. Jct.			3	11	14	
20-Sep-82	Canyon to tP Bridge			10	10	20	12 above canyon bridge
2-Jun-83	4th lake outlet to Green			0	0	0	
2-Jun-83	Bridge 2 to top pool in canyon					8	
29-Aug-83	below 4th lake to bridge 2			2	0	2	
7-Sep-83	Above Green creek to bridge 2			14	0	14	
8-Sep-83	Bridge 2 to TP Bridge			30	20	50	all in canyon
21-Sep-83	4th lake to Bridge #2	3	11	7	14	21	2 redds
4-Jul-84	Bridge 2 to TP Bridge			33	18	51	
21-Aug-84	Rocky Run			20	15	35	
21-Aug-84	1st pool above #2 bridge			30	0	30	
21-Aug-84	Canyon			12	10	22	
27-Aug-85	Green Creek Jct Pool			0	1	1	
27-Aug-85	pool above bridge 2			2	0	2	
27-Aug-85	Canyon below bridge 2			13	11	24	
27-Aug-85	TP Bridge			2	0	2	

Table 4 continued

DATE	SECTION	F	M	J	A	Daily subtotal	Comments
9-Jul-86	Above green creek	5	5	8	10	18	
9-Jul-86	Bridge #2			9	10	19	
9-Jul-86	TP Bridge			3	12	15	includes 1 dead
26-Sep-86	Green creek jct. to bridge 2					16	
26-Sep-86	Canyon below					8	
26-Sep-86	TP Bridge					0	
2-Oct-86	Above green creek					8	
19-Aug-87	Above green creek			0	0	0	8.5 deg c
19-Aug-87	pool above bridge 2			6	5	11	
19-Aug-87	canyon	4	2	11	6	17	
19-Aug-87	TP bridge			0	0	0	
29-Sep-87	Canyon	2	0	9	0	11	
13-Sep-88	Bridge #2	3	3	28	0	34	
13-Sep-88	Canyon	6	6	3	0	15	
3-Aug-89	Green Creek Pool	0	0	0	0	0	
3-Aug-89	Bridge #2	0	0	5	0	5	
3-Aug-89	Canyon	0	0	0	4	4	
6-Sep-89	Recon Flight up to Bridge #2	0	0	0	0	0	
17-Aug-90	Bridge #2	0	15	12	0	27	
17-Aug-90	Canyon	5	5	4	0	14	
25-Jun-92	Pool above Green Ck. Jct.	0	0	1	0	1	
15-Sep-92	Pool above Green Ck. Jct.	1	0	3	0	4	
15-Jul-93	Canyon	0	0	10	3	13	
29-Jul-93	Green Creek	0	0	0	0	0	
29-Jul-93	Canyon	0	0	5	1	6	
25-Aug-93	Canyon	0	0	3	1	4	
12-Sep-96	Canyon	0	0	5	0	5	
29-May-01	4th lake to T-pee Bridge	0	0	0	0	0	
7-Jun-01	Tee Pee Bridge	0	0	0	1	1	
29-Jun-01	4th lake to T-pee Bridge	0	0	3	2	5	
18-Jul-01	Canyon to Third Lake	0	0	1	0	1	
21-Sep-01	Green Creek Pool	0	0	2	2	4	
28-Sep-01	4th lake to Bridge #2	4	6	0	5	15	
13-Oct-01	Green Creek to Canyon	0	1	0	1	2	
26-Sep-02	Above Second Lake				6	6	includes live chinook only, adults and jacks
7-Oct-02	Above Second Lake				173	173	combined
1-Nov-02	Above Second Lake				7	7	
6-Aug-03	Green Creek Junction				6	6	
4-Sep-03	Below Fourth Lake to TP Bridge				6	6	
10-Sep-03	Green Creek Junction				4	4	
24-Sep-03	Green Creek Junction to Old Bridge #2				8	8	
25-Sep-03	Green Creek Junction to Pool above Old Bridge #2				9	9	
30-Sep-03	TP Bridge to Second Lake				24	24	
3-Oct-03	TP Bridge to just above Dash Creek				17	17	
24-Sep-04	Green Creek to Old Bridge #2			4	6	10	2 redds at Green Creek junction
5-Oct-04	TP Bridge to Second Lake			0	12	13	1 adult mortality, add to total
14-Jul-05	Green Creek			0	0	0	
14-Jul-05	Canyon			2	7	9	
14-Jul-05	TP bridge			0	0	0	
17-Jul-06	Green Crk			1	0	1	
17-Jul-06	Old Bridge to Canyon			0	0	0	
17-Jul-06	TP Bridge			0	0	0	
24-Aug-06	Green Crk			0	0	0	
9-Jul-07	Green Crk			0	0	0	
9-Jul-07	Canyon			4	3	7	
9-Jul-07	TP Bridge			0	1	1	
15-Jul-08	Green Crk			0	0	0	
15-Jul-08	Old bridge to Canyon			1	1	2	
15-Jul-08	TP Bridge			2	0	2	

Table 5: Nanaimo spring run chinook escapement estimates

Estimate Type	Adult Natural Spawners	Jack Natural Spawners	Total Natural Spawners	Total Return To River	Estimate Method	Estimate Classification
1979	166	98	264	264	Addition/Subtraction	Type 5
1980			66	66	Peak Live plus Dead	Type 5
1981	15	42	57	57	Peak Live plus Dead	Type 5
1982	21	13	34	34	Addition/Subtraction	Type 5
1983	20	44	64	64	Addition/Subtraction	Type 5
1984	25	62	87	87	Peak Live plus Dead	Type 5
1985	12	17	29	29	Peak Live plus Dead	Type 5
1986	32	20	52	52	Peak Live plus Dead	Type 5
1987	11	17	28	28	Peak Live plus Dead	Type 5
1988	18	31	49	49	Peak Live plus Dead	Type 5
1989	4	5	9	9	Peak Live plus Dead	Type 5
1990	25	16	41	41	Peak Live plus Dead	Type 5
1991						
1992	1	3	4	4	Peak Live plus Dead	Type 5
1993	3	10	13	13	Peak Live plus Dead	Type 5
1994						
1995						
1996	0	5	5	5	Peak Live plus Dead	Type 5
1997						
1998						
1999						
2000						
2001	15		15	15	Peak Live plus Dead	Type 5
2002			173	173	Peak Live plus Dead	Type 5
2003			33	33	Addition/Subtraction	Type 5
2004	13	4	17	17	Addition/Subtraction	Type 5
2005	7	2	9	9	Peak Live plus Dead	Type 5
2006		1	1	1	Peak Live plus Dead	Type 5
2007	4	4	8	8	Peak Live plus Dead	Type 5
2008	1	3	4	4	Peak Live plus Dead	Type 5
2009						
2010						
2011						
2012	2	3	5	5	Addition/Subtraction	Type 4

FIGURES

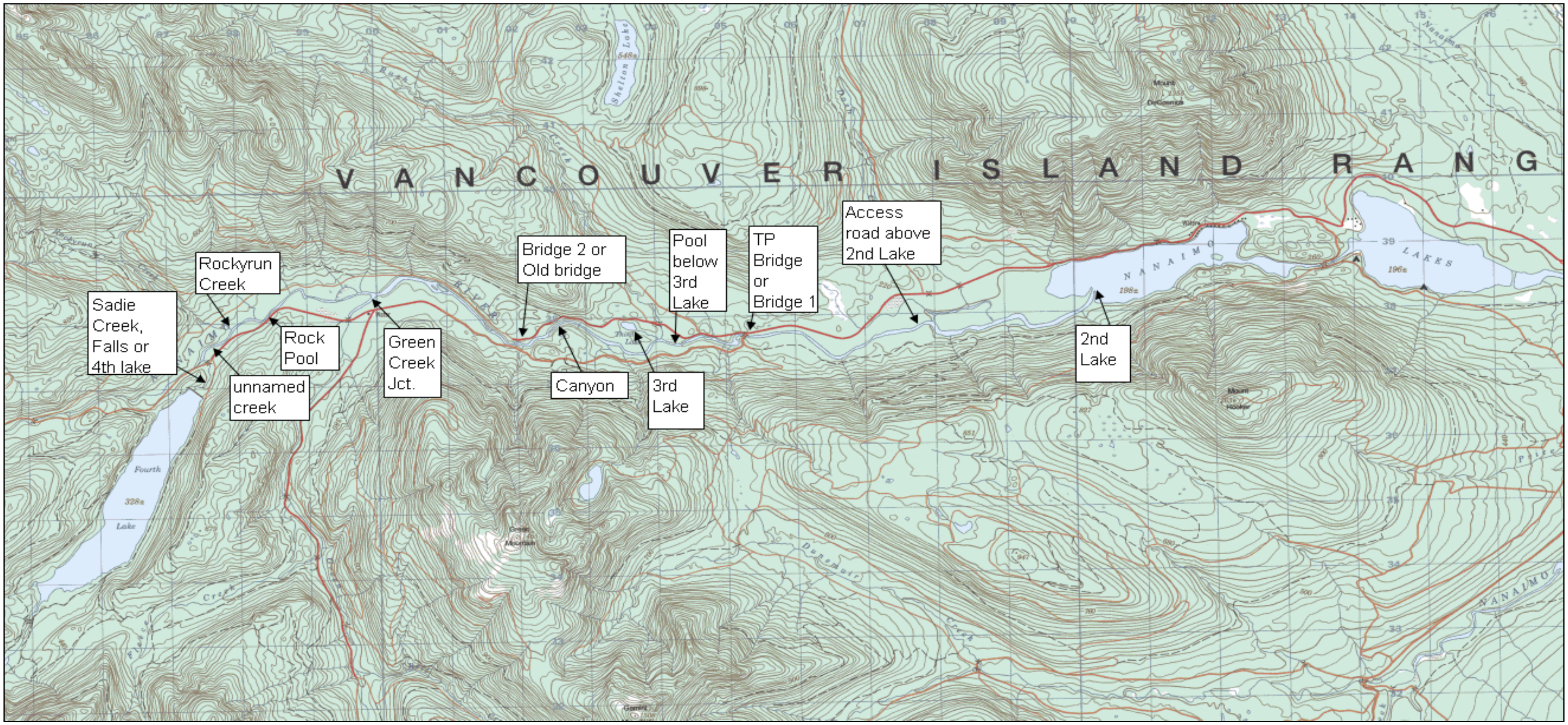

Figure 1: Survey area map with major locations

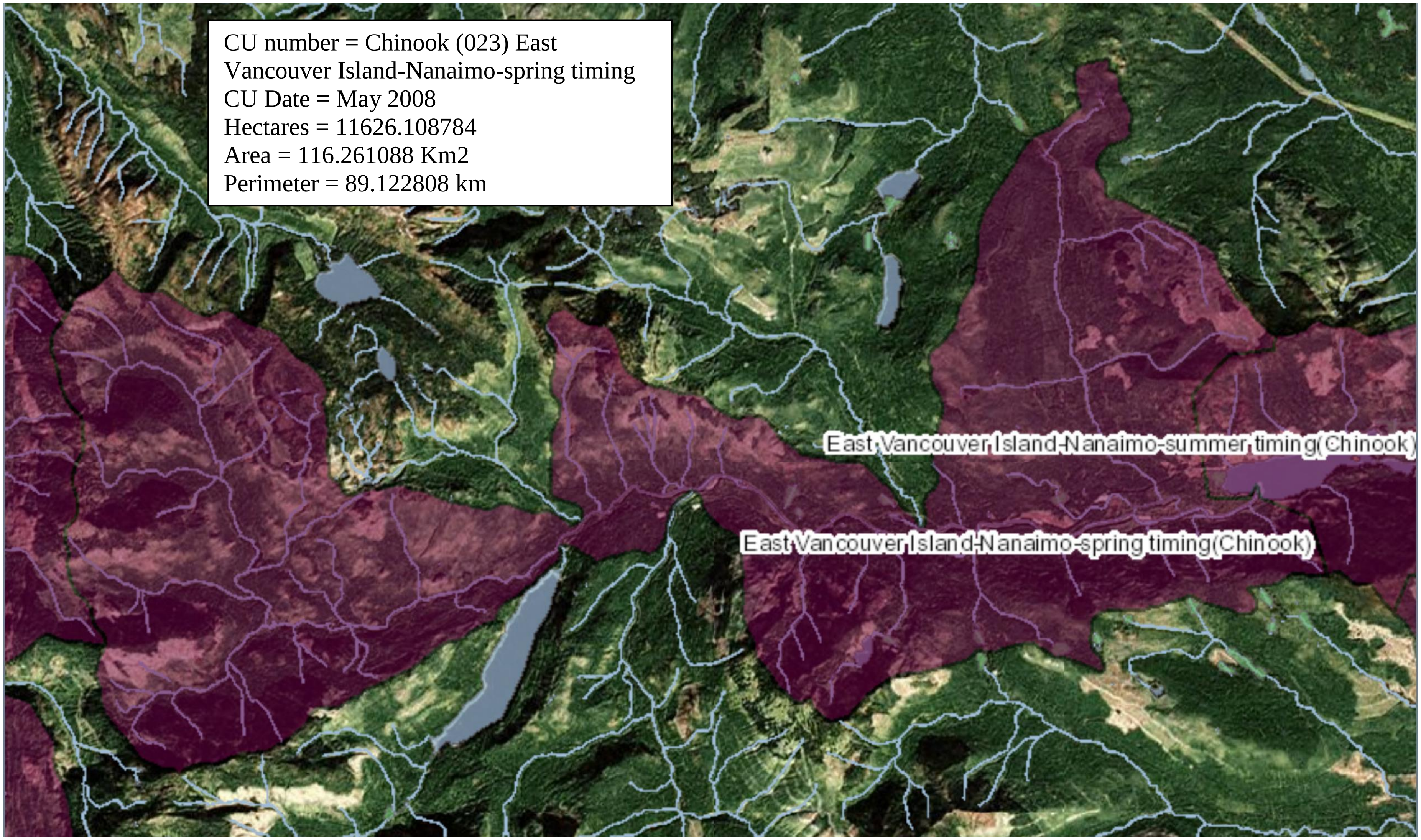

Figure 2: East Vancouver Island-Nanaimo-spring timing (Chinook) Conservation Unit map

APPENDICIES

DFO Salmon Escapement Database definitions (accessed 31-July-2015)

Appendix 1: Estimate Method

Addition/Subtraction	Simple addition or subtraction to provide an estimate. Should be used in conjunction with activity types Adjustment/Calibration and Summary observations. E.g. a population aggregate, the sum of two or more populations, would require the linking of two or more SENs and straight summation of the estimates.
Multiplication/Division	Simple multiplication or division to summary estimates. This method should be used in conjunction with activity type Adjustment/Calibration. E.g. E.g. An annual estimate that was arrived at by Peak Live Plus Dead analysis can be adjusted by some factor to make it equivalent to a Time Series estimate that uses AUC calculations.
Area Under the Curve	Combining a series of point estimates for abundance to create an estimate for the annual abundance. This is done by determining the total area under a curve of abundance by time then dividing by the survey life (the average length of time that an individual is available to be observed alive i.e. is still within the survey area and is not dead).
Peak Live Plus Dead	Examine point estimates for abundance, determine the survey when the maximum live count observed; sum the live and dead counts for that survey to create the annual estimate.
Peak Live Plus Cumulative Dead	Examine point estimates for abundance, determine the survey when the maximum live count observed. Sum the live count for that survey with the cumulative total of the dead counts prior to and including that survey to create the annual estimate.
Fixed Site Census	Combining one or more raw observations into a single estimate (e.g. add all daily fence observation SIL to create a single annual estimate).
Mark and Recapture - Petersen	Use capture and re-capture SIL data to determine an abundance estimate with the Petersen calculation.
Mark and Recapture - Jolly-Seber	Use capture and re-capture SIL data to determine an abundance estimate with the Jolly-Seber calculation.
Redd Count	Using counts of redds from SILs and multiplied by a factor such as 2.
Lake Expansion	expanding the dead recoveries by the recovery effort

Appendix 2: Estimate Classification

Estimate Type	Survey Method(s)	Analytical Method(s)	Reliability (within stock comparisons)	Units	Accuracy	Precision	Documentation
Type-1, True Abundance, high resolution	total, seasonal counts through fence or fishway; virtually no bypass	simple, often single step	reliable resolution of between year differences >10% (in absolute units)	absolute abundance	actual, very high	infinite i.e.+ or - zero%	detailed SIL(s), SEN, field notes or diaries, published report on methods
Type-2, True Abundance, medium resolution	high effort (5 or more trips), standard methods (e.g. mark-recapture, serial counts for area under curve, etc...)	simple to complex multi-step, but always rigorous	reliable resolution of between year differences >25% (in absolute units)	absolute abundance	actual or assigned estimate and high	actual estimate, high to moderate	detailed SIL(s), SEN, field notes or diaries, published report on methods
Type-3, Relative Abundance, high resolution	high effort (5 or more trips), standard methods (e.g. equal effort surveys executed by walk, swim, overflight, etc.)	simple to complex multi-step, but always rigorous	reliable resolution of between year differences >25% (in absolute units)	relative abundance linked to method	assigned range and medium to high	assigned estimate, medium to high	detailed SIL(s), SEN, field notes or diaries, published report on methods
Type-4, Relative Abundance, medium resolution	low to moderate effort (1-4 trips), known survey method	simple analysis by known methods	reliable resolution of between year differences >200% (in relative units)	relative abundance linked to method	unknown assumed fairly constant	unknown assumed fairly constant	complete SEN or equivalent with sufficient detail to verify both survey and analytical procedures
Type-5, Relative Abundance, low resolution	low effort (e.g. 1 trip), use of vaguely defined, inconsistent or poorly executed methods	unknown to ill defined; inconsistent or poorly executed	uncertain numeric comparisons, but high reliability for presence or absence	relative abundance, but vague or no i.d. on method	unknown assumed highly variable	unknown assumed highly variable	incomplete SEN, only reliable to confirm estimate is from an actual survey
Type-6, Presence or Absence	any of above	not required	moderate to high reliability for presence/absence	(+) or (-)	medium to high	unknown	any of above sufficient to confirm survey and reliable species i.d.