Coastal and Lower Nass Coho Salmon Escapement Surveys 2015 and 2016 and Quantitative Evaluation of Relationship

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Nisga'a Fisheries Report #16-23

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COASTAL AND LOWER NASS COHO SALMON ESCAPEMENT SURVEYS 2015 AND 2016 AND QUANTITATIVE EVALUATION OF RELATIONSHIP

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EXECUTIVE SUMMARY

Noble, C. A. J., R. F. Alexander, S. C. Kingshott, and I. A. Beveridge. 2017. Coastal and Lower Nass Coho Salmon escapement surveys 2015 and 2016 and Quantitative Description of Relationship. Prepared by LGL Limited, Sidney, BC, for the Pacific Salmon Commission, Vancouver, BC, and the Nisga'a Lisims Government Fisheries and Wildlife Department, New Aiyansh, BC. Nisga'a Fisheries Report #16-23: v + 38 p.

Funding ($34,000) received from the Pacific Salmon Commission's Northern Fund allowed the Nisga'a Fisheries and Wildlife Department to successfully conduct escapement ground surveys for Coho Salmon (*Oncorhynchus kisutch*) in the Nass Area (DFO's Pacific Fisheries Management Area 3) in 2016 as part of a multi-year research project. Nine known Coho Salmon streams within the Nass Area were assessed for spawner abundance in both 2015 (Year 1) and 2016 (Year 2). Six (2015) and five (2016) streams were from the Coastal Nass Area and three (2015) and four (2016) were from the Lower Nass Conservation Unit (CU). Poor access (weather) or low (absent) flows restricted the number of surveys to many streams in both years. However, the total number of escapement surveys did increase in 2016 from 26 (12 in Lower and 14 in Coastal) conducted in 2015 to 45 (15 in Lower and 30 in Coastal) due primarily from the additional funding support provided in Year 2 of the project.

Salmon Cove Creek was the only coastal area stream to be assessed where an area-under-the-curve (AUC) estimate could be generated in both years. Peak count x 2 methodology was used to estimate escapement to other Coastal Nass Area streams that were inaccessible at various times, had multiple zero counts, and/or had fewer than four surveys. Streams in the Lower Nass CU were surveyed numerous times each year and AUC escapement estimates were generated annually. Coho escapement to Zolzap Creek, also in the Lower Nass CU, is annually assessed with a counting fence coupled with a mark-recapture program, where the latter estimate is preferred as more accurate depending on the number of mark recoveries. Based on escapement surveys conducted in Years 1 and 2, independent aggregate Coho escapement estimates were generated in 2015 (8,139 to the Coastal Nass vs. 6,090 to the Lower Nass) and 2016 (25,971 to the Coastal Nass vs. 23,700 to the Lower Nass). We used linear regression and empirical data from the aggregate escapement estimates from 2000 to 2005 and 2015 and 2016 to describe the relationship between the Lower Nass CU and Coastal Nass Area Coho escapements as $y = 0.5526*x + 10839$ with an R^2 of 0.6271. This result indicates that in years when no empirical data are available for Coastal Nass Area Coho escapement, assuming that the percent of seeded habitat in the Lower Nass is equal to that of the Coastal Nass CU, as is currently practiced by the Nisga'a-Canada-BC Joint Technical Committee (NJTC), is not appropriate for assessment purposes. Considering the moderate R^2 value, we recommend that annual escapement surveys be conducted in the Coastal Nass Area to generate a total aggregate escapement estimate and that the regression relationship be used in absence of surveys.

We also recommend that the NJTC consider updating the Coho Nass Coho aggregate escapement estimates from 2006 to 2013 with linear regression estimates. The replacement of the values in these years would reduce the aggregate Coastal Nass Area Coho Salmon escapements on average by 37,000 spawners (range: 2,000–143,000).

INTRODUCTION

Nass Area[1] Coho Salmon (*Oncorhynchus kisutch*) escapement in 2013 was unprecedented and stocks were exposed to the highest exploitation rates in almost 20 years (51.3% US, 13.9% Canadian; Nisga'a-Canada-BC Joint Technical Committee (NJTC 2017; Table 1). Significant escapement estimates coupled with the highest exploitation rate since 1996 resulted in very large estimates of harvest by US (770,000) and Canadian (190,000) fisheries, also unprecedented. Current methodology for estimating Coho Salmon aggregate abundance escapement to the Nass Area Pacific Management Area 3 relies on a mark-recapture program (Upper Nass Coho Aggregate) and a habitat-capacity model coupled with stream surveys (Lower Nass and Coastal Nass Coho aggregates; Bocking and Peacock 2004). Significant assumptions are applied to the habitat model to generate Coastal Nass Coho aggregate escapement estimates, especially in years when no escapement surveys have been conducted on coastal streams. Specifically, it is assumed that the percent of habitat capacity utilized by the Coastal Nass Coho aggregate in a given year is identical to the percent of habitat capacity utilized by the Lower Nass Coho aggregate (CU), as determined from escapement estimates from three or more tributaries (e.g., Ansedagan, Diskangieq, Ginlulak, Anudol, and Zolzap creeks) in the Lower Nass. This assumption of a 1:1 ratio is made despite having no evidence for support.

Escapement monitoring of the Lower Nass in 2013 found Coho Salmon in abundances at an average of 789% greater than the average expected from the habitat model for the systems monitored (Zolzap, Diskangieq, and Ansedagan; NFWD 2014). For the Coastal Nass Coho Aggregate, the NJTC assumes that the same adjustment factor applies to coastal streams when streams are not surveyed, despite having no data to support this assumption. This resulted in an estimated escapement of 235,000 Coho Salmon in 2013 to the Coastal Nass Area, four times more than the 2007–2015 mean (Table 1). Due to such a large escapement estimate, estimates of US and Canadian commercial harvests may be biased high. Commercial harvests are estimated from exploitation rate data provided from Zolzap Creek coded-wire tagging (CWT) recoveries in both US and Canadian fisheries (Zolzap Creek is a Wild Coho indicator stream for the Nass watershed and North Coast, BC; Nass 1997) combined with estimates of the total run size which is estimated through a combination of net escapement and total exploitation estimates. Consequently, any bias in escapement estimates has a direct effect on estimated harvests.

Since 2014, escapement monitoring of Coastal Nass Area streams were conducted by the Nisga'a Fish and Wildlife Department (NFWD) with stream surveys specifically funded by the Nisga'a Lisims Government (2014) and the PSC Northern Fund (2015 and 2016). Based on aggregate escapement estimates, Coho Salmon were found in lower abundances in Coastal Nass streams than in the Lower Nass streams in 2014 (25,000 vs. 89,000; 83% vs. 424% habitat capacity; NFWD 2015); but not in 2015 (26,000 vs. 24,000; 27% vs. 29% habitat capacity; Noble et al. 2016). However, in 2014, despite three surveys conducted in each stream, NFWD found few Coho Salmon spawning in the Coastal Nass streams surveyed (Dogfish, Donahue, and Belle

[1] The term "Nass Area" describes Coho Salmon stocks comprising the *Lower Nass* and *Upper Nass* conservation units (CUs) and the portion of the *Portland Sound-Observatory Inlet-Portland Canal* CU that falls within the area covered by the Nisga'a Final Agreement (NFA 2000). Conservation units are defined by Canada's Wild Salmon Policy (Holtby and Ciruna 2007).

Bay creeks) and the aggregate estimate was generated from escapement estimates from outside the Nass Area escapement estimates (Ensheshese, Kwinamass, and Khutzeymateen rivers) that were surveyed by Fisheries and Ocean Canada (DFO)'s Charter Patrol Program (NFWD 2015). This report describes the results from escapement monitoring by NFWD of Coho Salmon returning to Coastal Nass Area and Lower Nass streams in 2016, and recommendations for assessments and methodology to improving Nass Area Coho Salmon escapement estimates in the future.

Objectives

Escapement surveys conducted in 2016 represent Year 2 of a Pacific Salmon Commission (PSC) funded project to assess Coho Salmon escapements to Coastal Nass Area streams. The primary goals of the project were to identify which of these Nass Area Coastal streams support Coho Salmon populations significant enough to generate an escapement estimate, and are close enough to Kincolith (Gingolx) such that surveying them is feasible both financially and technically (i.e., accessible despite poor weather conditions in late fall).

There are four specific objectives of the Year 2 project:

1. Conduct ground surveys on at least five Coastal Nass streams (Salmon Cove, Lizard, Crag, Dogfish Bay, Scowban and/or others as recommended by the NJTC; Figure 1) in 2016 to identify systems that could generate reliable escapement estimates each year and become indicator streams for coastal escapement surveys in the future;
2. De-couple the aggregate escapement estimates for Coastal Nass and Lower Nass Coho Salmon streams, through the use of empirical data from coastal streams that were surveyed in the two project years (2015 and 2016);
3. Improve accuracy in estimates of commercial harvests by generating empirically based escapement estimates for the Coastal Coho Salmon Aggregate; and
4. Evaluate and possibly quantify how (if) Lower Nass and Coastal Nass Coho escapement abundances co vary (requires annual funding through 2017).

While funding for this project specifically supported Coastal Nass Coho surveys, this report also documents:

1. Survey results from Coho Salmon escapement surveys to Lower Nass tributaries;
2. Coho Salmon escapement estimates to each of the Lower Nass CU and the Coastal Nass Area; and
3. Quantitative description of the relationship in aggregate escapement abundance between the Lower Nass CU and the Coastal Nass Area.

METHODS

Stream Assessments

There are approximately 30 streams within the Coastal Nass Area known to support Coho Salmon annually. This area itself is nested within the Portland Sound-Observatory Inlet-Portland Canal CU, a unit more familiar to fisheries managers. While this CU officially has 33 streams listed in DFO's New Salmon Escapement Database (NuSEDS; Tompkins and Baxter 2015), an additional fifteen are considered to support Coho Salmon by local biologists (English 2016; Table 2).

Escapement surveys conducted in 2015 are reported in Noble et al. 2016. For 2016, nine streams were assessed for Coho Salmon escapement with representative images of streams presented from Photo 1 to Photo 5. Of the 9 stream surveyed in the Nass Area (Figure 1); four were in the Lower Nass (Ansedagan Creek, Diskangieq Creek, Anudol River, and Zolzap Creek; Photo 1); three in Portland Inlet including two on Pierce Island (Lizard and Crag creeks; Photo 2) and Dogfish Bay Creek (Photo 4); and two in Observatory Inlet including Scowban Creek (Photo 3) and Salmon Cove Creek (Photo 5). In 2015, Anudol Creek was not assessed; but Pirate Cove Creek was. Attempts to survey Perry Bay Creek were made in 2015; but it was found to be deficient in water supply so surveys were not continued.

At least four ground surveys (stream walks and/or snorkel surveys) spanning the peak count were planned for each system in 2016. Specific details with respect to survey dates, surveyed lengths as well as parameters for AUC estimation and habitat capacity are provided in Table 3 through Table 5. Access methods included marine vessel, small boat, and truck and are summarized in Table 6. Zolzap Creek was assessed using a counting weir operated from mid-September to mid-November in combination with a Peterson mark-recapture program (NFWD 2017).

During each stream walk or snorkel survey, crews counted live Coho Salmon and carcasses on a per-reach basis (Table A - 1). Live and dead counts of other salmon species were also recorded, when present. The lead counter estimated their reach specific observer efficiency (%), taking into account water depth, turbidity, glare, woody debris, undercut banks, and other factors potentially limiting visibility and fish counts.

In addition to salmon counts, crews collected water quality and bankfull data (Table A - 2) and assessed stream count-ability (Appendix B).

Escapement Estimation

Several escapement estimates were calculated for each stream, and where sufficient data were collected, included:

1. Area under the curve (AUC; e.g. English et al. 1992; Perrin and Irvine 1990)
2. Peak live count
3. Peak live plus cumulative carcass

4. Peak live count x 2 (e.g. Cousens et al. 1982)
5. Mean count (e.g. Holt and Cox 2008), and;
6. Total live count

The AUC methodology requires estimates of the number of live fish over the run timing period, observer efficiency and estimates of residence time (days) and a minimum of three complete surveys. Confidence bounded escapement estimates were calculated using NFWD's AUCmonteMASTER 2.04 Microsoft Excel program. This program uses Monte Carlo simulation of variation in observer efficiency and survey life (19 days, 2.5 days SD) to develop a frequency distribution of escapement values (the algorithms used were provided by Steve Cox-Rogers, DFO, Prince Rupert). Frequency distributions of escapement were generated in AUCmonteMASTER 2.04 using the parameters described above and running the model for 10,000 iterations. The midpoint of the frequency distribution was selected as the escapement point estimate. No direct estimates of survey life for Coho salmon in the Nass area are available, thus expert opinion was consulted, and the aforementioned estimate was agreed upon. We note that Perrin and Irvine (1990) provide an average survey life for Coho Salmon of 11.4 days (range of 3 – 15 d), thus we consider our estimate of both survey life and escapement estimate to be conservative.

Zolzap Adult Weir

Nisga'a Fisheries and Wildlife Department operated a counting weir on Zolzap Creek from mid-September to mid-November 2017 to determine escapement to this system (NFWD 2017; Photo 1). The weir remained fully operationally throughout the period it was in the creek and was not breeched by high-water events in 2016.

All Coho Salmon caught at the fence were marked with a primary left operculum hole-punch and secondarily marked with a numbered T-bar anchor tag applied to the base of the dorsal fin. All Coho Salmon were examined for presence of an adipose fin, measured for nose-fork length, and sex identified. Scales for aging were collected from 20% of the Coho Salmon captured per day. All captured fish were released upstream of the weir.

Coho Salmon are known to enter Zolzap Creek prior to fence installation and to continue to enter the system after fence removal. For these reasons, total fence counts have not been used as escapement estimates (Table 7). Instead, surveys were conducted upstream of the weir to recover tags from carcasses and from live fish via angling and a Petersen mark-recapture estimate was calculated. This estimate is presented here to compliment the stream surveys conducted in 2016 (NFWD 2017).

Regression of Escapement to Lower Nass CU to Coastal Nass Area

Coho-bearing streams in the Coastal Nass Area were not surveyed by the NFWD or DFO from 2006 to 2013 due to lack of funding for assessment surveys. From 2000 to 2005, Salmon Cove Creek was surveyed annually by NFWD (Baxter and Bocking 2001; Baxter et al. 2002–2004; Stewart et al. 2005; NFWD 2006); Lachmach River was surveyed by DFO from 2000 to 2003 (NJTC 2017); Lizard Creek was surveyed from 2000 to 2002 by NFWD (Baxter and Bocking 2001;

Baxter et al. 2002–2004); and a fence was operated at the Kincolith River in 2007 (Alexander and Stewart 2008) and 2008 (NFWD 2009) by NFWD. From 2000 to 2003, escapement to Salmon Cove Creek and Lachmach were used to estimate the aggregate percent of habitat capacity utilized in the Coastal Nass Area each year. Escapement in 2004 and 2005 was estimated using Salmon Cove Creek only and in 2007 and 2008, escapement was estimated using only Kincolith River data. Thirty eight fish were observed in Lizard Creek in 2000, were found to be 'present' in 2001 and none were observed in 2002, thus data for Lizard were deemed insufficient for generating an aggregate Coastal Nass Coho estimate.

Herein we develop two regressions: one uses data from 2000 to 2005 and 2015 and 2016 where escapement to Salmon Cove was available; the second uses the same data with the addition of data from the Kincolith weir. In both cases, paired empirical escapement data are available for both the Coastal Nass Area and the Lower Nass CU. Area-under-the-curve escapement estimates specific to each stream were used to populate the Nass Area Habitat Model (Bocking and Peacock 2004), thus generating an estimate of total escapement to both areas. Note that Coastal Nass Area aggregate escapements for 2004 and 2005 and 2007 and 2008 will not match those supported by the NJTC (Table 1). Estimates to the Coastal Nass Area for these years were modified from the NJTC estimates to standardize across years for this analysis. The official NJTC estimates for these years use escapement to the coastal stream(s) assessed in that year and assessed streams within the Lower Nass CU to estimate the average percent of habitat occupied in the Coastal Nass Area. Estimates in 2004 and 2005 and 2007 and 2008 used here simply use the percent of habitat occupied in Salmon Cove and Kincolith River, respectively.

Coho escapement data are also available for Lachmach River (2000–2003), Talahat Creek (2000), Ensheshese River (2014), and Khutzymateen River (2014). These streams are all within the Portland Sound-Observatory Inlet-Portland Canal CU; but outside of the Nass Area as defined by the Nisga'a Treaty. Methods used to estimate escapement are of either Type IV or V (relative abundance or unknown) in DFO's NuSEDs (Tomkins and Baxter 2015), which, in other assessment methods that have been developed are deemed insufficient for analysis (English 2016). Thus we have not attempted to describe the relationship between escapement to the Lower Nass CU and the Portland Sound-Observatory Inlet-Portland Canal CU.

Water Quality

Temperature (°C) and turbidity (NTU) were measured with both an alcohol thermometer an YSI ProDSS multimeter in each reach in 2016. The YSI Multimeter malfunctioned near the beginning of the Coho Salmon stream surveys and was not used for the majority of the surveys in 2016.

Percent Bankfull

The percent bankfull, defined as the portion (%) of a channel that is full (wetted or flowing), was used as an estimate of the water level in each reach. It was estimated by visualizing the cross-sectional area of the stream as if it was full and then estimating the percentage of the cross-sectional area that was actually full (Figure 2). Estimates of percent bankfull were grouped into five categories: < 25%, 25–50%, 50–75%, 75–100%, and > 100%.

Walk-ability, Snorkel-ability, and Spawning Habitat Quality Scores

Walk-ability Score

The ability to safely walk or wade each reach was assessed during each survey and assigned a score of 1 (Poor) to 5 (Excellent; Table B - 1). This assessment included several factors such as confinement, turbidity, gradient, barriers, logjams, substrate, over stream vegetation, blowdown, and visible distance. Appendix B provides a description of the criteria used to assign walk-ability scores to each reach.

Snorkel-ability Score

The ability to snorkel each reach was also assessed during each survey and scored on a scale of 1 (Poor) to 5 (Excellent; Table B - 2). Factors included in this assessment were depth, velocity, instream visibility, presence of logjams, substrate, aquatic vegetation, and access.

Spawning Habitat Quality Score

Coho Salmon are considered to be the least particular of all Pacific Salmon in selecting their spawning area (Groot and Margolis 1991). Redds may be located on gravel bars of smooth flowing rivers, on white water riffles of turbulent mountain streams, or anywhere in between. They are sometimes referred to as “ditch spawners” referring to the fact that they are also capable to spawning in slow flowing, muddy water common in lower mainland BC farming regions. Habitat spawning quality was scored from 1 (Poor) to 5 (Excellent; Table B - 3) following an assessment of gradient, substrate suitability, and frequency of suitable spawning areas.

RESULTS AND DISCUSSION

Stream Surveys

Stream survey results from 2015 are reported in Noble et al. 2016. For 2016, one to six escapement walks were conducted on each stream for a total of 45 surveys; 15 in the Lower Nass and 30 in the Coastal Nass Area (Table 3). Several issues limited the number of surveys on some streams. These included poor marine weather preventing safe access or unsafe stream conditions (e.g., Lizard Bay, Crag, Scowban, Dogfish Bay, and Salmon Cove creeks). *MV Xsgaagim Lisims* and *MV Lihlksim Lisims* also had mechanic issues which prevented surveys of Scowban and Salmon Cove Creeks from 13–14 November, respectively. However despite the logistical challenges of conducting some surveys, the total number of escapement surveys in 2016 did increase to 45 (15 in Lower and 30 in Coastal) from 26 (12 in Lower and 30 in Coastal) conducted in 2015, primarily due to additional funding support in Year 2 to conduct more surveys.

Coho Salmon Escapement Estimates

Several measures of escapement were calculated for Coho Salmon in 2016 for each stream in the Lower Nass (Table 4) and Coastal Nass (Table 5) areas. These included peak live count, peak live count plus cumulative dead, peak count x 2 (e.g., Cousens et al. 1982), mean count (e.g., Holt and Cox 2008), and total live count. Each method of estimating escapement has its own advantages and disadvantages, and different institutions and agencies may prefer alternative methods. Here we present escapement estimates using a variety of methods, so groups interested in this information can select that estimate which best adheres to their internal policies and practices. Where sufficient data were collected, AUC estimates were produced. AUC estimates are a preferred method of estimation by both the NFWD and the DFO assuming that the observer efficiency and residence time estimates are reasonable and that a minimum of three surveys are conducted for generating the estimate.

Lower Nass Streams

Coho Salmon were observed between 3 October and 25 November in each of the four Lower Nass streams (Ansedagan Creek, Diskangieq Creek, Zolzap Creek, and Anudol River) surveyed in 2016. Observer efficiency expanded peak counts (Table 4) and high resolution AUC escapement estimates (Table 4) were generated for Ansedagan Creek (357 expanded, 533 AUC), Diskangieq Creek (1,584 expanded, 1,634 AUC), and Anudol River (1,096 expanded, 1,065 AUC).

Zolzap Creek Adult Weir

A total of 392 adult Coho Salmon were captured at the weir from 13 September to 11 November and 36% were missing an adipose fin (i.e., indicates the presence of a coded-wire tag; NFWD 2017). A total of 231 adults were recaptured and examined for marks and 121 marks were recovered. The Peterson mark-recapture escapement estimate for Zolzap Creek was 731 adult Coho Salmon (95% CI: 614–873; 9% CV; Table 4, Table 7). Three anchor tagged, post-spawn Coho carcasses were collected for measuring residency times. Two tagged carcasses

were collected off the upstream side of the Zolzap weir and one from the spawning grounds of Goat Creek; a tributary to Zolzap Creek. Residency times for the fence recoveries were 24 and 22 days, respectively. Residency time for the spawning ground recovery was 51 days. Although a small sample size of only two fish, the residency times observed generally support our mean residency time estimate (19 d) used for generating AUC escapement estimates in 2016 and no adjustments were made to AUC methods.

Nisga'a Fisheries and Wildlife Department recommends the escapement estimate from the mark recapture program be used for estimating the Zolzap Creek return of Coho Salmon rather than the weir count (NFWD 2017). In any given year, NFWD regularly finds un-marked Coho Salmon above the weir, even in years when it has not been breached by a high water event. Evidently, fish enter the system prior to weir installation. Access is also possible (but unlikely) via a culvert which, under very high water conditions (flooding) make it possible for Coho Salmon to enter Zolzap Creek via a culvert that is otherwise "hanging", thus obstructing access. Typically, during conditions which would permit access via the culvert, the weir would be breached anyway.

Coastal Streams

Coho Salmon were observed between 24 September and 26 November in all five coastal streams (Lizard, Dogfish, Salmon Cove, Scowban, and Crag creeks) surveyed in 2016 (Table 3). Counts ranged from one fish (Dogfish Bay Creek) to 360 fish (Salmon Cove Creek). Sufficient counts and surveys were only available from Salmon Cove Creek to generate a high resolution AUC escapement estimate (736; Table 5). Escapement to Crag (147), Lizard (226), and Scowban (50) creeks was estimated using peak count x 2.

Of the coastal streams surveyed in 2015 and 2016, Salmon Cove Creek was assessed previously (ground surveys from 2000 to 2005 (Baxter and Bocking 2001; Baxter et al. 2002–2004; Stewart et al. 2005; NFWD 2006). During those years, escapement was estimated using AUC and ranged from 219 to 1,074 with an average of 500. Lizard Creek was surveyed from 2000 to 2002, and the maximum number of Coho Salmon observed in each year was 28, 20, and 11 (Baxter and Bocking 2001; Baxter et al. 2002–2003). Scowban Creek was surveyed in 2000 and one Coho Salmon was observed (Baxter and Bocking 2001).

Aggregate Escapement Estimates

Bocking and Peacock (2004) present a Coho Salmon habitat capacity model that estimates that the accessible habitat in the Coastal Nass Area (n = 26 streams) and Lower Nass CU (n = 23 streams) can support an average of 29,794 and 21,033 spawners, respectively. This model estimates the average number of Coho Salmon spawners that each known Coho-bearing stream can support in each area based on a number of variables, namely accessible stream length, literature supported estimates of the number of smolts produced per spawner, and survival parameters from egg to smolt.

To generate an escapement estimate to the Lower Nass CU, escapement estimates to Ansedagan, Diskangieq, Zolzap creeks, and others, when available, are used to populate the

habitat model. The percent of habitat occupied by spawners to each of these three systems was 32%, 41%, and 14% in 2015 (Noble et al. 2016) and 112%, 142% and 71% in 2016, respectively. These estimates are combined as a weighted average and assumed to be representative of all other streams within the Lower Nass area. In 2015, escapement to these three Lower Nass tributaries was estimated to occupy 29% of available habitat and 113% in 2016 (when including Anudol Creek). Therefore, we estimate that a total of 6,090 and 23,700 Coho Salmon escaped to the Lower Nass CU (or 29% and 113% of 21,033) in 2015 and 2016, respectively (Table 8). Using an identical approach but with results from Coastal Nass Area surveys, we estimate that 8,139 and 25,971 (or 27% and 87% of 29,794) Coho Salmon escaped to the Coastal Nass Area in 2015 and 2016, respectively (Table 8). Escapement in both years is below the recent 10 year average, however estimates are within the historical range of escapement estimates.

Regression of Lower Nass CU Escapement to Coastal Nass Area Escapement

Two regressions were developed and herein assessed. The first regression analysis of data in Table 8, exclusive of 2007 and 2008 produces a line of best fit described as: $Y = 0.5526x + 10839$; where y = escapement to the Coastal Nass Area and x = escapement to the Lower Nass CU; R^2 is 0.627 (Figure 3).

When data from 2007 and 2008 are included from Kincolith weir operated years (Alexander and Stewart 2008; NFWD 2009), the second regression relationship changes to: $Y = 0.5090x + 7765$ with an R^2 of 0.429 (Figure 4). We propose that the first model using data which excludes Kincolith Coho Salmon escapement data is preferred due to the better R^2 value; but also because Salmon Cove data are used in all years to populate the Coastal Coho aggregate escapement, thus providing a standardized basis for our assessment.

Results from the regression analyses suggest that escapement does not co-vary on a 1:1 relationship as has been assumed by the NJTC in the past. Typically the Coastal Nass Area aggregate habitat-capacity proportions for Coho Salmon are considerably lower (on average 64%; range: 2%–161%) than the Lower Nass CU estimates (Table 8). This has significant implications for management of the Coastal Nass Coho aggregate, and by extension, the Portland Sound-Observatory Inlet-Portland Canal CU. For example, using the above, preferred, formula to estimate Coho escapement to the Coastal Nass Area in 2013 would have generated an aggregate escapement estimate of only 91,750 (Table 9); or 143,000 fewer Coho Salmon than currently reported by the NJTC (Table 1) that was generated assuming the 1:1 habitat capacity relationship previously discussed. Using the first regression method estimate would reduce the estimated marine harvests of Nass Area Coho from 770,000 to 563,000; or 201,000 (26% reduction) fewer Nass Coho Salmon harvested in the Alaskan fisheries. For Canadian fisheries, the reduced harvests in 2013 from the regression method would be from 187,000 to 138,000; or 49,000 fewer Nass Coho Salmon harvested in the marine fisheries (Table 1 vs. Table 10). Using the regression for years where no coastal streams were surveyed (i.e., 2006–2013) in the Nass marine area, the Coastal Nass Coho aggregate escapement would be on average 37,000 fewer spawners (range: 2,000–143,000); 89,000 fewer marine harvests (range: 250,000 less to 6,000 more); and 70,000 fewer (range: 394,000 less to 1,000 more) Coho Salmon in total Nass return estimates (Table 10; Figure 5).

Other Salmon Counts

Other adult salmon species were absent from all lower and coastal Nass streams surveyed in 2016. Other species captured in the Zolzap adult fence in 2016 (NFWD 2017) included 18 adult Sockeye Salmon (*O. nerka*).

Water Quality

No unusual water temperature values were measured in 2016, with average temperature ranging from 4.5°C in Anudol River (2 November) to 11.2°C in Salmon Cove Creek (24 September; Table 11. Turbidity was not measured in 2016; but in general streams had adequate visibility for counts and no additional adjustments were made to observer efficiency estimates than standard.

Walk-ability, Snorkel-ability, and Spawning Habitat Quality Scores

The average walk-ability in all streams in 2016, was either moderate or good (Table 12). Most of the streams surveyed had low or moderate snorkel-ability (Table 12). Few good snorkel areas were observed; but snorkel counts were conducted in sections of Ansedigan Creek, Diskangieq Creek, Anudol River, and Salmon Cove Creek (Table 12).

Average spawning habitat quality in 2016 was moderate or good in most streams (Table 12). Scowban Creek had the lowest habitat quality. The highest quality spawning habitat was observed in Ansedagan, Diskangieq, Anudol River, Lizard, Dogfish Bay, Crag, and Salmon Cove creeks. No modifications were made to methods used (e.g., adjustments to observer efficiency or residence time estimates) for estimating Coho Salmon abundance in 2016 to account for stream walk-ability, snorkel-ability, and spawning habitat quality.

RECOMMENDATIONS

We recommend the following:

1. The Nisga'a-Canada-BC Joint Technical Committee consider the replacement of the Coastal Nass Area Coho Salmon aggregate escapement estimates from 2006 to 2013 with estimates generated from our regression analyses (Table 9). These estimates would then be based on the relationship between Coastal Nass Area and Lower Nass Coho Salmon aggregate escapement estimates versus using only the average Lower Nass habitat capacity estimate in years when no Coastal Nass Area Coho escapement surveys were conducted. Our current findings indicate that habitat capacity estimates generated annually for Coho Salmon returns in the Lower Nass do not co-vary on a 1:1 relationship with the Coastal Nass Area Coho Salmon returns.
2. Obtain funding to conduct escapement stream surveys in the Coastal Nass Area in 2017 and 2018 to estimate aggregate escapement of Coho Salmon that would then represent 10 years of independent assessment of the Nass marine area and contribute return data for the Portland Sound-Observatory Inlet-Portland Canal Coho CU.
3. Continue to develop the regression relationship between Coastal Nass Area and Lower Nass aggregate escapement estimates to better estimate Coastal Nass Area Coho Salmon escapement in years where Coastal Nass streams are not monitored for escapement;
4. Continue existing assessment programs on the Lower Nass River to generate an aggregate escapement estimate for the Lower Nass Coho CU by conducting stream surveys on Ansedagan, Diskangieq, and Zolzap creeks in 2017 and 2018;
5. Start conducting rigorous and repeatable ground and snorkel surveys on the lower Nass River tributary, Anudol River, to produce additional data for estimating the Lower Nass CU habitat capacity estimate. This estimate is not only used to generate the Lower Nass Coho aggregate escapement; but in years where no coastal stream surveys are conducted, the Lower Nass estimate is used to generate the Coastal Nass Coho aggregate escapement estimate;
6. When empirical stream survey data are available for Coastal Nass Area Coho Salmon, estimate total escapement via habitat capacity model for Coastal Nass streams. When no empirical data are available from Coastal Nass streams, we recommend the use of the regression relationship between the Lower Nass CU and Coastal Nass Area from our analyses;
7. Update the habitat model to incorporate additional streams and updated information (i.e., remove barrier on Scowban at 1.5 km as it does not exist); and
8. Update the list of streams in the Portland Sound-Observatory Inlet-Portland Canal CU to include the fifteen additional streams (Table 2) known by local biologists.

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TABLES

Table 1. Estimates of catch, escapement, stock size, and harvest rates for Nass River Coho Salmon stocks, 1992–2015 (NJTC 2017).

	Catch						Net escapement						Exploitation rates		
	Marine		In-river												
Year	Alaska	Canadian	Nisga'a	Other FN	Sport	Total	Coastal	Lower	Mid-to-Upper	Total	Total return to Canada	Total run size	US	Can	Total
1992	144,953	47,300	3,393	160	173	195,979	27,248	18,527	63,409	109,184	160,211	305,164	47.5%	16.7%	64.2%
1993	56,530	18,447	595	48	52	75,672	11,954	12,438	18,947	43,340	62,481	119,012	47.5%	16.1%	63.6%
1994	407,357	141,096	2,530	362	390	551,735	33,719	30,099	143,026	206,844	351,222	758,579	53.7%	19.0%	72.7%
1995	82,483	19,417	1,402	56	61	103,418	13,949	10,930	22,219	47,098	68,034	150,516	54.8%	13.9%	68.7%
1996	81,392	44,433	2,178	110	119	128,232	23,205	12,553	43,642	79,400	126,240	207,632	39.2%	22.6%	61.8%
1997	27,591	5,348	293	31	34	33,297	9,342	5,714	12,420	27,476	33,182	60,773	45.4%	9.4%	54.8%
1998	61,663	0	2,075	95	102	63,936	20,833	11,717	37,565	70,115	72,387	134,051	46.0%	1.7%	47.7%
1999	99,990	2,484	1,122	144	155	103,896	29,601	16,533	56,988	103,123	107,028	207,018	48.3%	1.9%	50.2%
2000	92,413	25,080	1,950	98	271	119,812	29,115	5,885	71,137	106,136	133,535	225,949	40.9%	12.1%	53.0%
2001	176,002	32,686	14,706	399	498	224,291	47,639	67,395	79,726	194,761	243,050	419,051	42.0%	11.5%	53.5%
2002	62,532	12,431	9,016	26	369	84,374	63,016	68,045	161,262	292,323	314,165	376,697	16.6%	5.8%	22.4%
2003	88,563	15,889	14,882	68	176	119,578	23,508	49,829	67,564	140,901	171,916	260,480	34.0%	11.9%	45.9%
2004	90,983	11,317	20,336	44	232	122,912	30,501	22,542	45,955	98,998	130,927	221,910	41.0%	14.4%	55.4%
2005	163,381	34,717	14,969	718	502	214,287	40,488	32,219	87,153	159,861	210,767	374,148	43.7%	13.6%	57.3%
2006	68,624	14,582	8,425	392	91	92,114	31,394	22,162	48,137	101,693	125,183	193,806	35.4%	12.1%	47.5%
2007	106,795	22,693	9,515	127	637	139,767	41,205	51,738	48,987	141,930	174,902	281,697	37.9%	11.7%	49.6%
2008	61,471	13,062	3,450	54	97	78,134	12,526	18,847	84,105	115,477	132,141	193,611	31.7%	8.6%	40.4%
2009	124,546	26,465	13,794	327	2,021	167,153	112,537	79,443	188,903	380,882	423,489	548,036	22.7%	7.8%	30.5%
2010	96,545	20,515	10,292	193	294	127,839	49,902	35,227	83,786	168,914	200,209	296,754	32.5%	10.5%	43.1%
2011	75,244	12,466	2,635	18	228	90,591	7,648	5,399	72,864	85,910	101,257	176,501	42.6%	8.7%	51.3%
2012	107,979	33,156	12,082	187	164	153,568	37,182	26,248	62,326	125,756	171,344	279,324	38.7%	16.3%	55.0%
2013	763,416	187,237	19,370	46	448	970,517	235,193	166,029	117,263	518,485	725,585	1,489,001	51.3%	13.9%	65.2%
2014	137,656	23,608	8,452	60	298	170,074	24,774	89,279	117,657	231,710	264,128	401,784	34.3%	8.1%	42.3%
2015	278,819	110,775	7,905	38	448	397,985	8,139	6,090	41,725	55,954	175,119	453,938	61.4%	26.3%	87.7%
Mean: 1992–1999	120,245	34,816	1,699	126	136	157,021	21,231	14,814	49,777	85,822	122,598	242,843	47.8%	12.7%	60.5%
Mean: 2000–curr.	155,936	37,292	10,736	175	423	204,562	49,673	46,648	86,159	182,481	231,107	387,043	37.9%	12.1%	50.0%

Table 2. Coho Salmon bearing streams in Area 3 as known to DFO's Salmon Escapement Database (nuSEDS) and NFWD, and recommended streams to add.

No.	NFWD	nuSEDS	In nuSEDS?	In Habitat Model?
1	Crow Lagoon Creek	Crow Lagoon Creek	y	y
2	Bear River	Bear River	y	y
3	Belle Bay Creek	Belle Bay Creek	y	y
4	Bonanza Creek	n/a	n	y
5	Cascade Creek	n/a	n	y
6	Cedar Creek	Cedar Creek	y	n
7	Chambers Creek	n/a	n	y
8	Crag Creek	n/a	n	n
9	Dogfish Creek	Dogfish Bay Creek	y	y
10	Donahue Creek	n/a	n	y
11	Ensheshese River	Ensheshese River	y	y
12	Fortune Creek	n/a	n	y
13	Georgie River	Georgie River	y	y
14	Illiance River	Illiance River	y	y
15	Isaac Creek	n/a	n	y
16	Khutzeymateen River	Khutzeymateen River	y	y
17	Ksi Gingolx (Kincolith) River	Ksi Gingolx	y	y
18	Kitsault River	Kitsault River	y	y
19	Kshwan River	Kshwan River	y	y
20	Ksi X"anmas (Kwinamass) River	Ksi X"anmas	y	y
21	Lachmach River	Lachmach River	y	y
22	Larch Creek	Larch Creek	y	n
23	Leverson Creek	Leverson Creek	y	y
24	Lime Creek	n/a	n	y
25	Lizard Creek	Lizard Creek	y	y
26	Manzanita Cove Creek	Manzanita Cove Creek	y	y
27	Marion Creek	n/a	n	n
28	Mouse Creek	Mouse Creek	y	n
29	Olh Creek	Olh Creek	y	y
30	Pearce Island No1	n/a	n	y
31	Pirate Cove Creek	Pirate Cove Creek	y	y
32	Rainy Creek	Rainy Creek	y	n
33	Roberson Creek	Roberson Creek	y	n
34	Rodgers Creek	n/a	n	y
35	Roundy Creek	n/a	n	y
36	Salmon Cove Creek	Salmon Cove Creek	y	y
37	Sam Bay Creek	Sam Bay Creek	y	y
38	Ksi Sgawban (Scowban) Creek	Ksi Sgawban	y	y
39	Stagoo Creek	Stagoo Creek	y	y
40	Talahaat Creek	Talahaat Creek	y	n
41	Tauw Creek	n/a	n	y
42	Toon River	Toon River	y	y
43	Tracy Bay Creek	Tracy Bay Creek	y	y
44	Tracy Bay Creek #2	Tracy Bay Creek #2	y	n
45	Tsampanaknok Bay Creek	n/a	n	y
46	Turk Creek	Turk Creek	y	y
47	Whitley Point Creek	n/a	n	y
48	Wilauks Creek	Wilauks Creek	y	y
	Number of streams to add		15	9

Table 3. Survey dates, water quality, habitat quality score, count-ability scores, and Coho Salmon counts for streams surveyed in 2016.

Survey				Water and Habitat Quality			Countability Score		Coho Counts				
Area	Stream Name	Date	Length (m)	Temp (°C)	Turbidity (NTU)	Habitat Score	Walk	Snorkel	Observer	Raw Live	Expanded Live	Carcass	Comment
Lower Nass	Ansedagan Creek	10/4/2016	830	7.0	4.5	3	3	3	42%	34	84	0	
		10/11/2016		7.0	NR	3	3	3	100%	30	30	1	
		10/21/2016		6.0	NR	3	3	3	80%	25	31	0	
		11/1/2016		5.4	NR	3	3	3	80%	25	31	0	
		11/10/2016		7.0	NR	3	3	3	72%	230	357	0	
		11/23/2016		5.5	NR	3	4	2	80%	17	20	3	
	Diskangieq Creek	10/3/2016	2,900	8.8	5.7	3	3	3	66%	471	764	3	
		10/11/2016		7.3	NR	3	4	2	91%	81	108	0	
		10/21/2016		7.5	0.0	4	4	2	80%	30	38	0	
		10/31/2016		7.5	NR	4	4	2	95%	28	35	0	
		11/9/2016		7.8	NR	3	4	2	74%	1123	1584	1	
		11/25/2016		5.0	NR	3	4	2	66%	26	39	24	
	Anudol River	10/26/2016		7.4	NR	3	4	3	70%	411	587	1	Survey conducted over 2 days; 26-27 Oct
		11/2/2016		4.6	NR	3	4	3	80%	877	1096	0	Survey conducted over 2 days; 2-3 Nov
		11/14/2016		5.8	NR	3	4	3	80%	326	408	3	
	Zolzap Creek	See Comments	843	Zolzap Creek is not surveyed as others are, thus this information is not applicable to Zolzap									29 Recovery surveyes above the weir occurred between 14 September - 22 November 2016.
Portland Inlet	Lizard Creek	9/25/2016	2600	NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Creek to high
		10/5/2016		10.3	4.9	4	3	3	50%	11	22	0	
		10/20/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
		10/30/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
		11/11/2016		6.5	NR	3	4	2	10%	11	110	3	
		11/21/2016		5.5	NR	3	4	2	62%	4	9	0	
	Crag Creek	9/25/2016	3000	NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Creek to high
		10/5/2016		9.0	4.7	3	3	3	68%	31	47	0	
		10/20/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
		10/30/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
		11/11/2016		4.8	NR	3	4	2	30%	22	73	0	
		11/21/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
	Dogfish Bay Creek	9/26/2016	1400	NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Creek to high
		10/8/2016		7.5	4.4	3.0	3.5	2.0	90%	0	0	0	
		10/19/2016		6.0	NR	3.5	3.5	3.0	73%	0	0	0	
		10/28/2016		6.0	NR	3.5	3.5	2.0	80%	0	0	0	
		11/12/2016		5.0	NR	3.5	3.5	2.0	80%	1	1	0	
		11/26/2016		5.5	NR	4.0	4.0	2.0	90%	0	0	0	
Observatory Inlet	Salmon Cove Creek	9/24/2016	5000	10.3	NR	3	3	3	73%	252	360	0	
		10/7/2016		8.8	3.5	3	3	3	63%	175	246	0	
		10/18/2016		7.5	0.0	3	3	3	90%	184	204	0	
		10/28/2016		6.0	NR	3	3	3	80%	157	196	0	
		11/14/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Boat mechanical issues.
		11/22/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
	Scowban Creek	9/27/2016	3000	NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Creek to high
		10/6/2016		8.1	3.6	2	3	2	60%	15	25	0	
		10/17/2016		6.1	5.3	2	3	2	83%	14	18	0	
		10/29/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w
		11/13/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Boat mechanical issues.
		11/22/2016		NS	NS	NS	NS	NS	NS	NS	NS	NS	Not surveyed. Could not access creek, too w

NR= Not recorded NS= Not surveyed.

Table 4. Lower Nass stream specific survey and estimation details, 2016.

Survey Parameters and Escapement Estimate	Stream			
	Ansedagan Creek	Diskangieq Creek	Anudol Creek	Zolzap Creek
Survey Dates 2016	4, 11, 21 Oct; 1, 10, 23 Nov	3, 11, 21, 31 Oct; 9, 25 Nov	26 Oct; 2, 14 Nov	14 Sept - 22 Nov
Counting Method	Stream Walk/Snorkel	Stream Walk/Snorkel	Stream Walk/Snorkel	Adult Fence/Stream Walk
No. of reaches	3	4	2	5
Count lengths (m)	1164	2900	4421	1356
Available habitat (m)[a]	3110	8960	9794	7810
Expanded peak count[b]	357	1,584	1,096	n/a
Date of Peak Count	10-Nov	9-Nov	2-Nov	5-Oct
Carcasses	4	28	4	18
Survey Live (stdev) (days)	15 (2.5)	15 (2.5)	15 (2.5)	n/a
Habitat Expansion Factor	2.67	3.09	2.22	5.76
Habitat Expanded Peak Count[c]	954	4,894	2,428	n/a
Final Escapment Method	AUC	AUC	AUC	Mark-Recapture
Final Escapement	**533**	**1,634**	**1,065**	**731**
95% Confidence Intervals	472 - 718	1,339 - 2,080	947 - 1,328	614 - 873
Habitat Capacity Model Est.	474	1,150	868	1,025
% of Habitat Capacity Model	112%	142%	123%	71%

[a] Nass Coho Habitat Model (Bocking and Peacock 2004).

[b] Peak live count after raw counts have been expanded for estimated observer efficiency.

[c] The expanded peak live count corrected for available habitat, added to the carcass coun for the same day.

Table 5. Coastal Nass Area stream specific survey and estimation details, 2016.

Survey Parameters and Escapement Estimates	Stream				
	Lizard Creek	Dogfish Creek	Salmon Cove Creek	Scowban Creek	Crag Creek
Survey Dates 2016	5 Oct; 11, 21 Nov	12-Nov	24 Sep; 7, 18, 28 Oct; 14, 22 Nov	6, 17 Oct	5 Oct; 11 Nov
Counting Method	Stream Walk	Stream Walk	Stream Walk	Stream Walk	Stream Walk
Reaches Surveyed	3	2	4	2	4
Count lengths (m)	n/a	n/a	n/a	n/a	n/a
Available habitat (m)[a]	2650	5440	5340	1320	n/a
Expanded peak count[b]	22	1	360	25	47
Date of Peak Count	5-Oct	12-Nov	24-Sep	6-Oct	5-Oct
Carcasses	3	0	0	0	0
Survey Life (stdev) (days)	n/a	n/a	15 (2.5)	n/a	n/a
Habitat Expansion Factor	n/a	n/a	n/a	n/a	n/a
Habitat Expanded Peak Count[c]	n/a	n/a	n/a	n/a	n/a
Final Escapment Method	Peak x 2	Peak x 2	AUC	Peak x 2	Peak x 2
Final Escapement	**226**	**3**	**736**	**50**	**147**
95% Confidence Intervals	n/a	n/a	637 - 874	n/a	n/a
Habitat Capacity Model Est.	830	1000	620	195	n/a
% of Habitat Capacity Model	27%	0%	119%	26%	n/a

[a] Nass Coho Habitat Model (Bocking and Peacock 2004).

[b] Peak live count after raw counts have been expanded for estimated observer efficiency.

[c] The expanded peak live count corrected for available habitat, added to the carcass coun for the same day.

Table 6. Access methods and travel time to Coho Salmon streams surveyed in the Lower Nass and Coastal Nass Area, 2016.

			Travel	
Area	Stream	Access Method	Time (hours)	From
Lower Nass	Ansedagan Creek	Hwy vehicle access to stream	0.5	Gitlaxt'aamiks
	Diskangieq Creek	Hwy vehicle access to stream	0.8	Gitlaxt'aamiks
	Anudol Creek	Hwy vehicle access to stream	1.0	Gitlaxt'aamiks
	Zolzap Creek	Hwy vehicle access to stream	0.4	Gitlaxt'aamiks
Portland Inlet	Lizard Creek	Marine vessel; small zodiac to shore	1.5	Gingolx
	Dogfish Bay Creek	Marine vessel; small zodiac to shore	1.8	Gingolx
	Crag Creek	Marine vessel; small zodiac to shore	2.0	Gingolx
Observatory Inlet	Scowban Creek	Marine vessel; small zodiac to shore	0.5	Gingolx
	Salmon Cove Creek	Marine vessel; small zodiac to shore	2.0	Gingolx

Table 7. Zolzap Creek juvenile and adult Coho Salmon summary, 1992–2016 (NFWD 2017).

Smolt out-migration				Resulting escapement		
Smolt year	Total count	AFC estimate[a]	CWT[b]	**Return year**	Fence count	Estimate
1992	40,601	53,000	33,150	**1993**	794	1,048
1993	26,334	51,000	22,649	**1994**	2,438	2,536
1994	34,419	41,000	29,319	**1995**	908	908
1995	12,369	13,000	10,156	**1996**	1,039	1,039
1996	20,745	23,000	20,519	**1997**	470	470
1997	15,099	18,000	13,566	**1998**	967	967
1998	15,937	19,000	13,900	**1999**	1,302	1,393
1999	15,153	16,000	14,572	**2000**	409	456
2000	33,934	34,500	30,132	**2001**	1,897	1,897
2001	27,948	28,000	22,216	**2002**	1,918	3,233
2002	15,001	15,000	12,318	**2003**	1,444	2,855
2003	30,005	30,005	26,305	**2004**	393	1,631
2004	27,799	27,799	25,742	**2005**	-	-
2010	35,322	34,692	33,099	**2011**	238	421
2011	15,077	14,859	14,382	**2012**	840	886
2012	46,746	46,313	45,142	**2013**	996	2,419
2013	31,649	31,352	30,393	**2014**	2,105	2,280
2014	26,182	25,918	24,747	**2015**	90	140
2015	35,249	34,881	33,985	**2016**	392	731
2016	34,729	34,213	32,998			
Average	27,015	29,577	24,464		1,036	1,406

[a] Best estimate of total smolt outmigration based on fence counts and migration patterns.

[b] Number of smolts that were coded-wire tagged during their outmigration, adjusted for tag loss.

[c] Adjusted to account for Coho that were not CWT. Uses adjusted catch using total adipose clip rate at recovery and the total estimated catch for all tag codes.

[d] Estimated catch and escapement of Zolzap Creek CWT coho by tag code, including commercial, sport, native, fishwheel recoveries.

Table 8. Independent aggregate escapement estimates for Nass Coho Salmon generated from Coastal Nass Area stream surveys compared to estimates from Lower Nass CU surveys from 2000 to 2016.

	Aggregate escapement		% Habitat capacity estimate		
Year	Coastal Nass	Lower Nass CU	% Coastal	% Lower	% Diff. (Coastal vs. Lower)
2000	29,115	5,885	98%	28%	70%
2001	47,639	67,395	160%	320%	-161%
2002	63,016	68,045	212%	324%	-112%
2003	23,508	49,829	79%	237%	-158%
2004*	22,283	22,542	75%	107%	-32%
2005*	19,401	32,219	65%	153%	-88%
2015	8,139	6,090	27%	29%	-2%
2016	25,971	23,700	87%	113%	-26%
Average	30,000	34,000	100%	164%	-64%

*Coastal Nass estimates differ from official records and only include escapement data from Coastal Nass Area streams that were surveyed in those years.

Table 9. Comparison of habitat and regression based aggregate escapement estimates for Coastal Nass Area Coho Salmon from 2006 to 2013 in years where no escapement surveys were conducted in the Coastal Nass Area.

	Habitat Model Escapement		Regression	Regression vs. Habitat	
Year	Lower Nass	Coastal Coho	Coastal Coho	Difference	% Difference
2006	22,162	31,394	23,086	-8,308	-26%
2007	51,738	41,205	28,591	-12,613	-31%
2008	18,847	12,526	10,415	-2,111	-17%
2009	79,443	112,537	43,901	-68,636	-61%
2010	35,227	49,902	19,467	-30,435	-61%
2011	5,399	7,648	2,983	-4,664	-61%
2012	26,248	37,182	14,505	-22,677	-61%
2013	166,029	235,193	91,750	-143,443	-61%
Average	**50,636**	**65,948**	**29,337**	**-36,611**	**-47%**

Table 10. Estimates of catch, escapement, stock size, and harvest rates from 1992 to 2016 for Nass River Coho Salmon stocks using new regression results to estimate Coastal Nass Coho aggregate escapement (shaded values) from 2006 to 2013.

	Catch						Net escapement						Exploitation rates		
	Marine		In-river												
Year	Alaska	Canadian	Nisga'a	Other FN	Sport	Total	Coastal	Lower	Mid-to-Upper	Total	Total return to Canada	Total run size	US	Can	Total
1992	144,953	47,300	3,393	160	173	195,979	27,248	18,527	63,409	109,184	160,211	305,164	47.5%	16.7%	64.2%
1993	56,530	18,447	595	48	52	75,672	11,954	12,438	18,947	43,340	62,481	119,012	47.5%	16.1%	63.6%
1994	407,357	141,096	2,530	362	390	551,735	33,719	30,099	143,026	206,844	351,222	758,579	53.7%	19.0%	72.7%
1995	82,483	19,417	1,402	56	61	103,418	13,949	10,930	22,219	47,098	68,034	150,516	54.8%	13.9%	68.7%
1996	81,392	44,433	2,178	110	119	128,232	23,205	12,553	43,642	79,400	126,240	207,632	39.2%	22.6%	61.8%
1997	27,591	5,348	293	31	34	33,297	9,342	5,714	12,420	27,476	33,182	60,773	45.4%	9.4%	54.8%
1998	61,663	0	2,075	95	102	63,936	20,833	11,717	37,565	70,115	72,387	134,051	46.0%	1.7%	47.7%
1999	99,990	2,484	1,122	144	155	103,896	29,601	16,533	56,988	103,123	107,028	207,018	48.3%	1.9%	50.2%
2000	92,413	25,080	1,950	98	271	119,812	29,115	5,885	71,137	106,136	133,535	225,949	40.9%	12.1%	53.0%
2001	176,002	32,686	14,706	399	498	224,291	47,639	67,395	79,726	194,761	243,050	419,051	42.0%	11.5%	53.5%
2002	62,532	12,431	9,016	26	369	84,374	63,016	68,045	161,262	292,323	314,165	376,697	16.6%	5.8%	22.4%
2003	88,563	15,889	14,882	68	176	119,578	23,508	49,829	67,564	140,901	171,916	260,480	34.0%	11.9%	45.9%
2004	90,983	11,317	20,336	44	232	122,912	30,501	22,542	45,955	98,998	130,927	221,910	41.0%	14.4%	55.4%
2005	163,381	34,717	14,969	718	502	214,287	40,488	32,219	87,153	159,861	210,767	374,148	43.7%	13.6%	57.3%
2006	68,624	14,582	8,425	392	91	92,114	23,086	22,162	48,137	93,385	116,875	185,499	37.0%	12.7%	49.7%
2007	106,795	22,693	9,515	127	637	139,767	28,591	51,738	48,987	129,317	162,289	269,083	39.7%	12.3%	51.9%
2008	61,471	13,062	3,450	54	97	78,134	10,415	18,847	84,105	113,367	130,030	191,501	32.1%	8.7%	40.8%
2009	124,546	26,465	13,794	327	2,021	167,153	43,901	79,443	188,903	312,247	354,854	479,400	26.0%	8.9%	34.9%
2010	96,545	20,515	10,292	193	294	127,839	19,467	35,227	83,786	138,480	169,774	266,319	36.3%	11.8%	48.0%
2011	72,610	21,067	2,635	18	228	96,558	2,983	5,399	72,864	81,246	105,193	177,804	40.8%	13.5%	54.3%
2012	90,259	27,715	12,082	187	164	130,407	14,505	26,248	62,326	103,079	143,226	233,486	38.7%	17.2%	55.9%
2013	562,620	137,839	19,370	46	448	720,322	91,750	166,029	117,263	375,041	532,744	1,095,364	51.4%	14.4%	65.8%
2014	137,656	23,608	8,452	60	298	170,074	24,774	89,279	117,657	231,710	264,128	401,784	34.3%	8.1%	42.3%
2015	278,819	110,775	7,905	38	448	397,985	8,139	6,090	41,725	55,954	175,119	453,938	61.4%	26.3%	87.7%
2016	341,129	80,261	8,234	82	151	429,858	25,971	23,700	133,562	183,234	271,962	613,092	55.6%	14.5%	70.1%
Mean: 1992–1999	120,245	34,816	1,699	126	136	157,021	21,231	14,814	49,777	85,822	122,598	242,843	47.8%	12.7%	60.5%
Mean: 2000–curr.	153,820	37,100	10,589	169	407	202,086	31,050	45,299	88,948	165,296	213,562	367,383	39.5%	12.8%	52.3%

Table 11. Summary of 2016 water temperature and turbidity measurements surveyed streams.

		Temperature (°C)			Turbidity (NTU)		
Area	Stream	Average	Min	Max	Average	Min	Max
Lower Nass	Ansedagan Creek	6.4	3.4	9.0	Turbidity meter was		
	Diskangieq Creek	7.3	5.0	8.8	malfunctioning in 2016. It was		
	Anudol Creek	5.9	4.5	7.5	not used on many of the		
	Zolzap Creek	7.2	4.8	10.4	surveys.		
Portland Inlet	Lizard Creek	7.4	5.5	10.8			
	Dogfish Bay Creek	6.0	5.0	8.0			
	Crag Creek	6.9	4.8	9.1			
Observatory Inlet	Scowban Creek	7.1	6.1	8.2			
	Salmon Cove Creek	8.2	6.0	11.2			

Table 12. Summary of 2016 walk-ability, snorkel-ability, and spawning habitat quality scores for Chum Salmon survey streams.

		[a] Walk-ability			[a] Snorkel-ability			[a] Spawning Habitat Quality		
Area	Stream	Average	Min	Max	Average	Min	Max	Average	Min	Max
Lower Nass	Ansedagan Creek	3	3	4	3	1	4	3	3	4
	Diskangieq Creek	4	2	5	2	1	3	3	2	4
	Anudol Creek	4	3	4	3	2	4	3	2	4
	Zolzap Creek	Walk-ability, snorkel-ability and habitat quality scores not recorded								
Portland Inlet	Lizard Creek	4	2	4	2	2	3	3	3	4
	Dogfish Bay Creek	4	3	4	2	2	3	4	3	4
	Crag Creek	4	3	4	2	1	3	3	2	4
Observatory Inlet	Scowban Creek	3	3	3	2	1	2	2	1	3
	Salmon Cove Creek	3	1	4	3	2	4	3	2	4

[a] 1 = Poor; 2 = Low; 3 = Moderate; 4 = Good; 5 = Excellent.

FIGURES

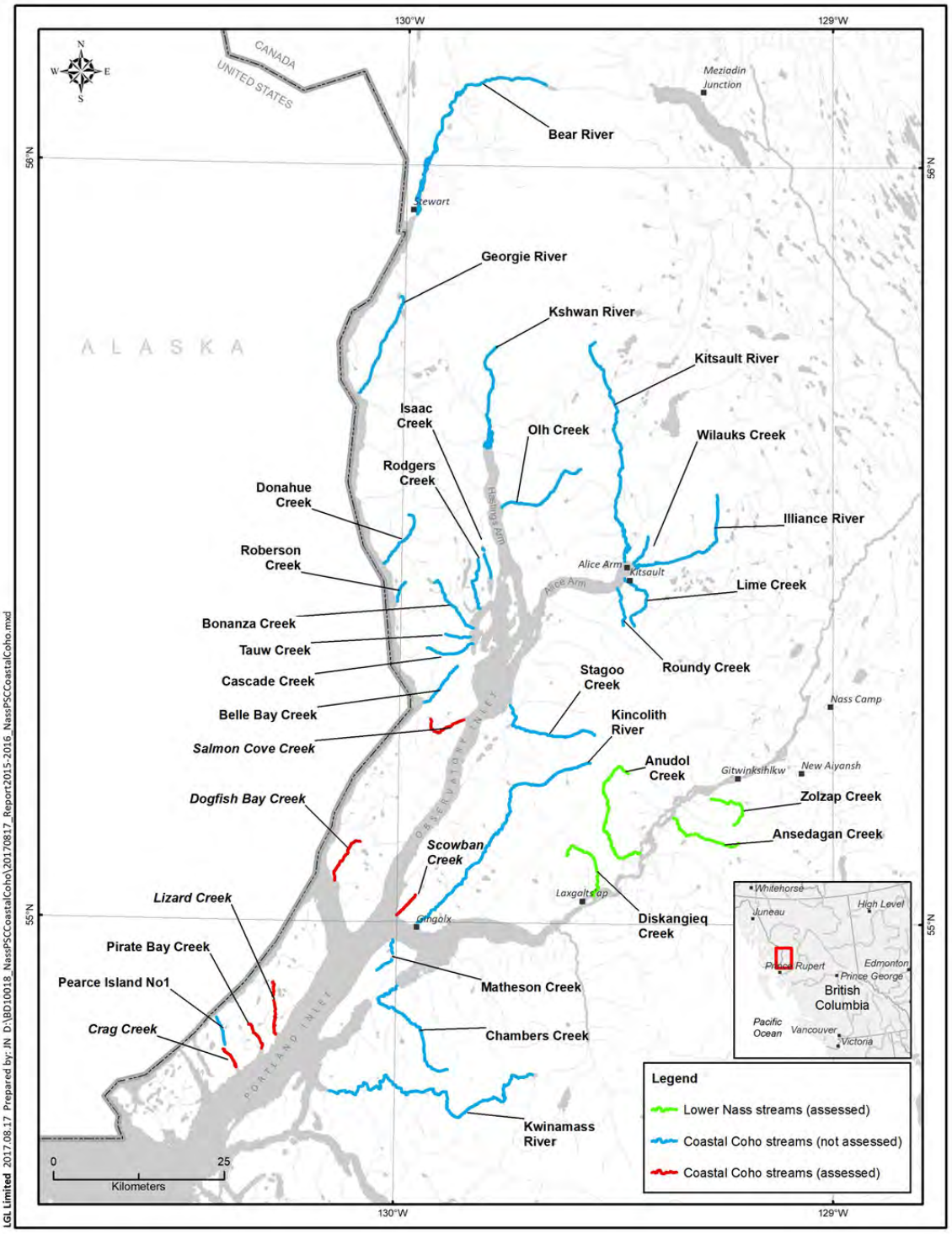


Figure 1. Coho Salmon escapement indicator streams in the Lower Nass River and Coastal Nass Area that were assessed in 2016.

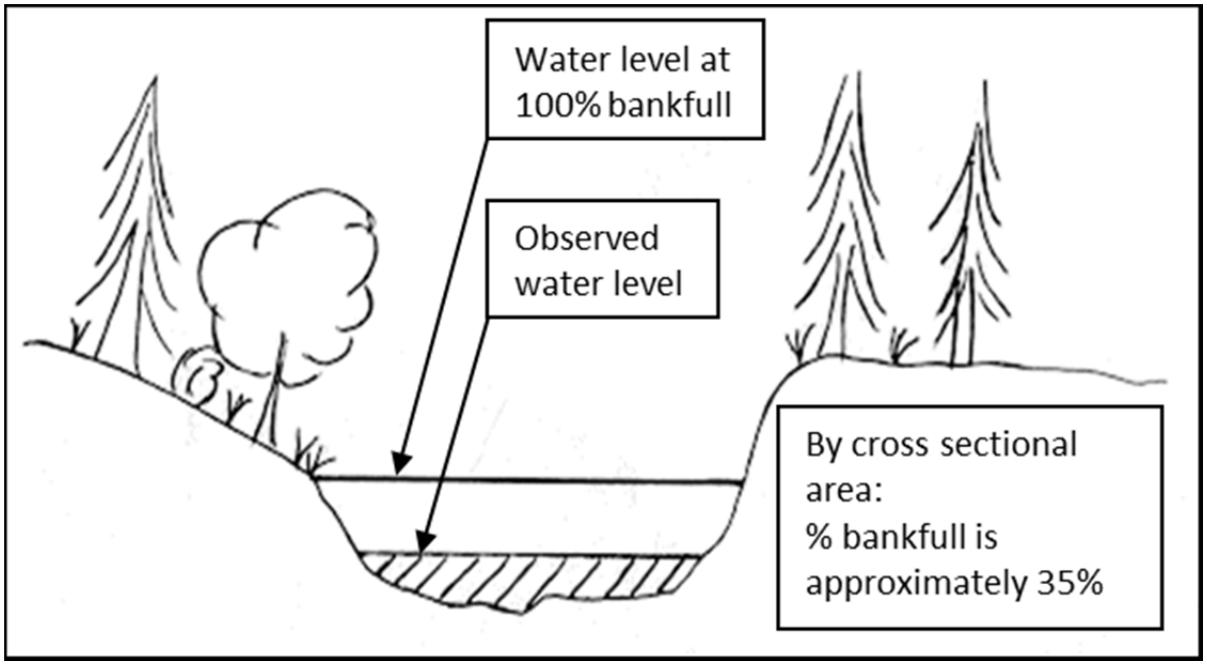


Figure 2. Estimating % bankfull based on the portion of the channel that is wetted. Figure was copied from DFO Stream Inspection Log definitions

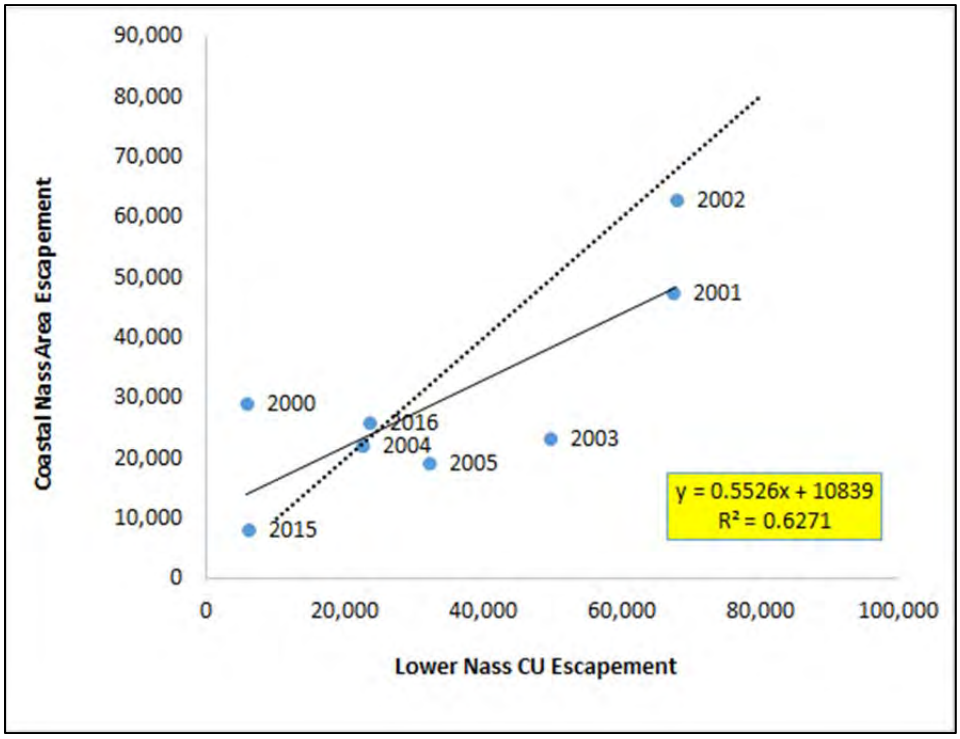


Figure 3. Regression plot1 of Coho Salmon aggregate escapements to the Lower Nass CU and the Coastal Nass Area from 2000 to 2016, excluding Kincolith weir data in 2007 and 2008.

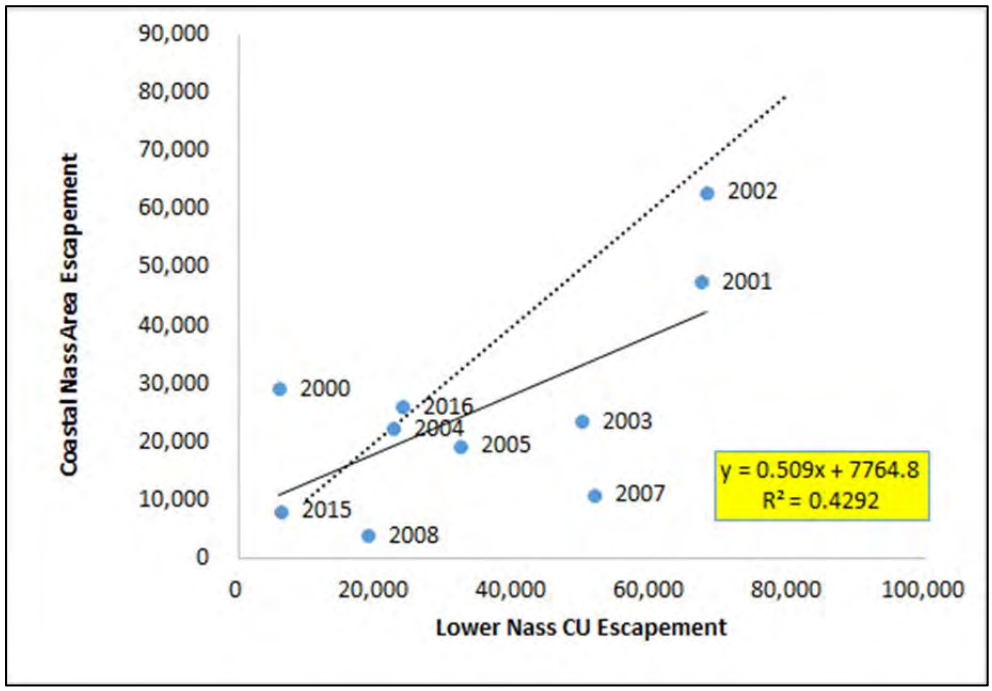


Figure 4. Regression plot2 of Coho Salmon aggregate escapements to the Lower Nass CU and the Coastal Nass Area from 2000 to 2016, including Kincolith weir data in 2007 and 2008.

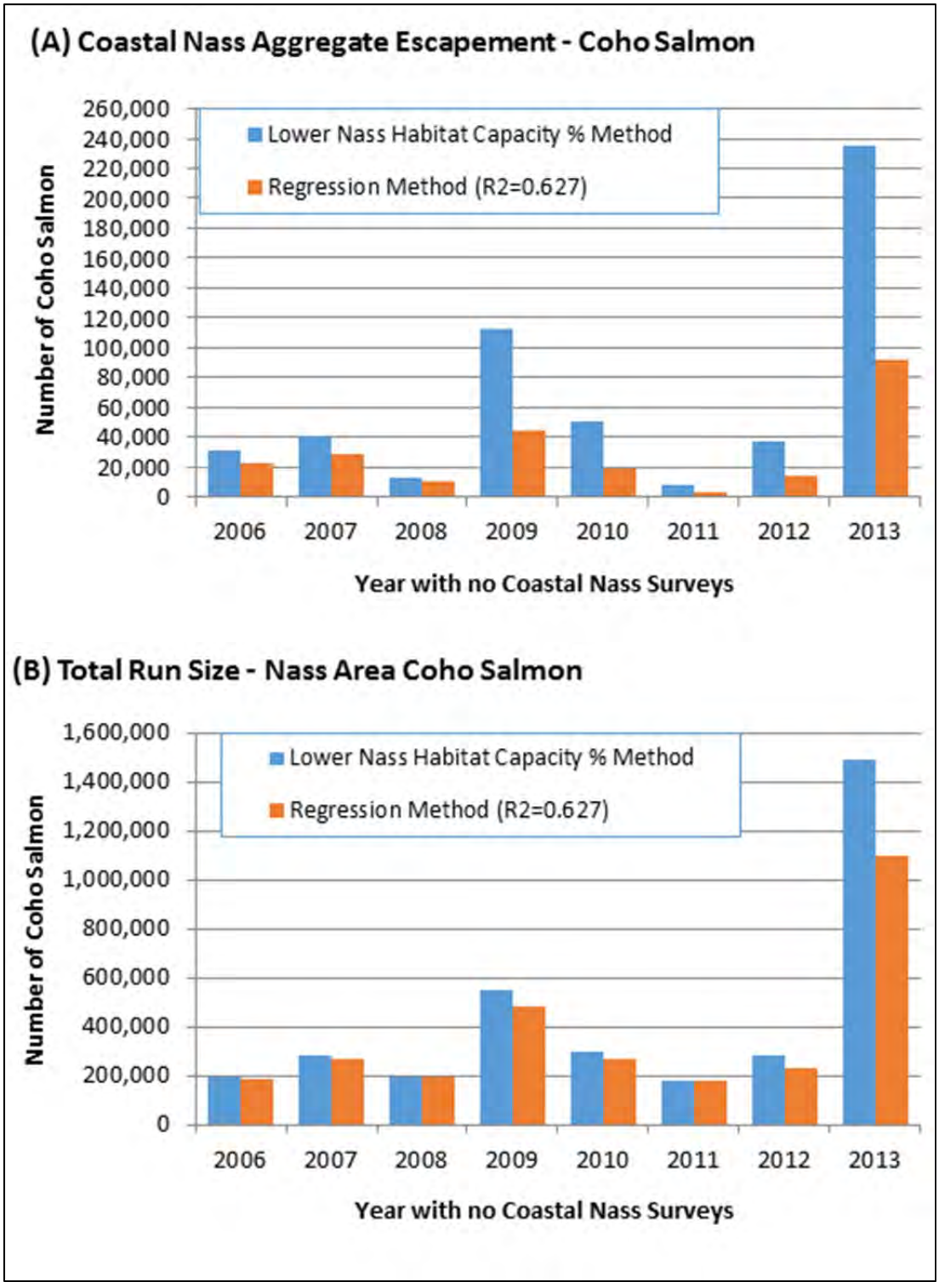


Figure 5. Comparison of two methods to estimate Coho Salmon Coastal Nass Area aggregate escapement (A) and Total Run Size (B) from 2006 to 2013 in absence of Coastal Nass Area escapement survey data.

PHOTOS


Ansedagan Creek


Diskangieq Creek


Zolzap Creek


Anudol River

Photo 1. Representative images of lower Nass Coho Salmon streams: Ansedagan Creek, Diskangieq Creek, Zolzap Creek and Anudol River.

Lizard Creek

Crag Creek

Photo 2. Representative images of Pearse Island streams: Lizard and Crag creeks.


Photo 3. Representative images of Scowban Creek.

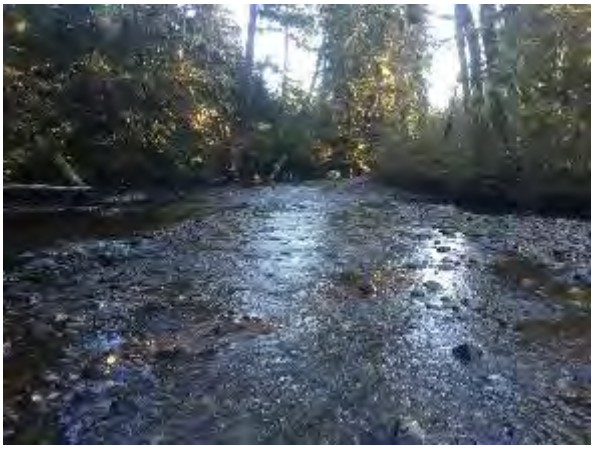



Photo 4. Representative images of Dogfish Bay Creek

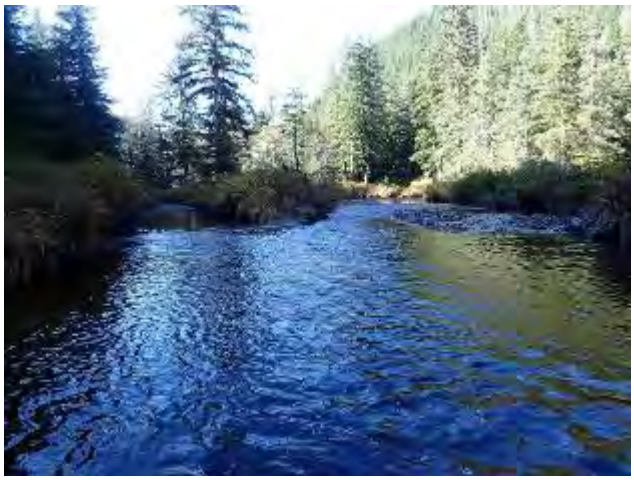



Photo 5. Typical habitat in the upper reaches of Salmon Cove Creek and the falls barrier limit to upstream migration.

APPENDICES

Appendix A – Field forms.

Table A - 1.Nisga'a Fisheries and Wildlife Department Coho Salmon stream survey fish count form, 2015–2016.

PSC Nass Coho Stream Survey Form 2015				Stream Name:					Crew:		Date (dd-mmm):	
Method:		Dead Pitch Stream Walk Snorkel Heli Other					Air (°C):					
Reach	Start/End Times	Live Count						Carcass Count			Photo Number(s)	Comments
		Coho Tag/NoTag	Pink	Sockeye Tag/NoTag	Chinook Tag/NoTag	Chum Tag/NoTag	Obs. Eff. (%)	Coho No Tag	Coho Tagged	Pink		
Totals												
Comments:												

Table A - 2. Nisga'a Fisheries and Wildlife Department water quality, habitat, and countability scoring form, 2015–2016.

PSC Nass Coho Stream Countability - 2015						Stream Name:					Crew:			Date (dd-mmm):	
Reach	Time	% Overcast	Wind	Precip.	Clarity	% Bankfull	Depth (m)	Instream Visibility (m)	Water (°C)	Turbidity (NTU)	Walk Score (1-5)	Snorkel Score (1-5)	Habitat Score (1-5)	Photo Number(s)	Comments (barriers, waypoint, lat lon, etc.)
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slightly Turbid Muddy Glacial Iced	<25 25-50 50-75 75-100 >100									
Comments:															

Appendix B – Score criteria for assessing the walk-ability, snorkel-ability, and spawning habitat quality for Coho Salmon survey streams.

Table B - 1. Walk-ability score descriptions.

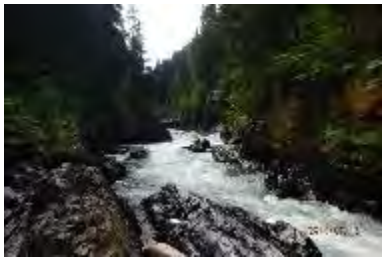
Score	Classification	Description	Example
1	Poor	Extremely difficult or not walkable due to safety concerns (log jams; high flows) or poor accessibility coupled with high flows or turbidity, debris, limited visibility, high confinement or other factors.	
2	Low	Difficult walking due to steep, fast, or deep flow (>1 m); narrow channel with thick vegetation; slippery boulder or bedrock substrate; lots of blowdown; extensive debris jams; poor upstream visibility (<10 m).	
3	Moderate	Average walkability. Mixture of large and small substrate; low-moderate velocity; moderate to good instream visibility; limited blowdown or debris jams; low gradient; safe depth (<1 m); upstream visibility 10–25 m.	
4	Good	Easily walked. Low velocity; good instream visibility; shallow (<50 cm); good traction; limited blowdown or debris jams; stream wide or with little over stream vegetation; good upstream visibility (i.e., 25–50 m).	
5	Excellent	Easily walked. Low velocity; good visibility; good traction; shallow (<50 cm); few hazards; very good upstream visibility (i.e., >50 m).	

Table B - 2. Snorkel-ability score descriptions.

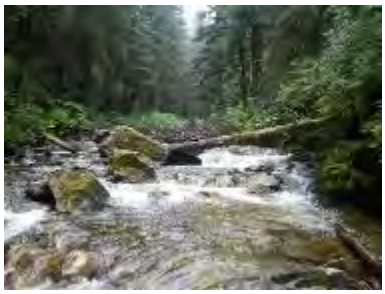
Score	Classification	Description	Example
1	Poor	Snorkelling not possible due to lack of deep pools or glides; extensive debris jams, lack of safe egress; high turbidity or velocity prevent safe or effective snorkelling.	
2	Low	Snorkelling difficult due to lack of suitable habitat. Pools and glides are infrequent and small; limited visibility; moderate-high velocity. Difficult to identify potential hazards such as extensive debris jams, turbulent water, lack of egress.	
3	Moderate	Sufficient depth for snorkelling. Flow velocity is safe and manageable. Hazards easily identified before snorkelling. Moderate to good visibility.	
4	Good	Slow and clear pools, glides, or offchannel areas. Some potential hazards (e.g., woody debris; boulders). Good visibility.	
5	Excellent	Slow, clear pools, glides, or offchannel habitat with no hazards. Visibility is very high.	

Table B - 3. Salmon spawning habitat quality score description.

Score	Classification	Description	Example
1	Poor	Gradient (>3%); cobbles and boulders dominate substrate; flows dominated by cascades; no pools.	
2	Low	Gradient (about 3%); few patches of suitable spawning gravel; few pools or riffles; shallow flow.	
3	Moderate	Gradient (<3%); good patches of suitable gravel; frequent pools and riffles; good flow and depth (>10 cm).	
4	Good	Gradient (≤1%); depth (>10 cm); frequent suitable gravels; frequent pools and riffles.	
5	Excellent	Gradient (≤1%); depth (>10 cm); abundant suitable gravels and flow conditions.