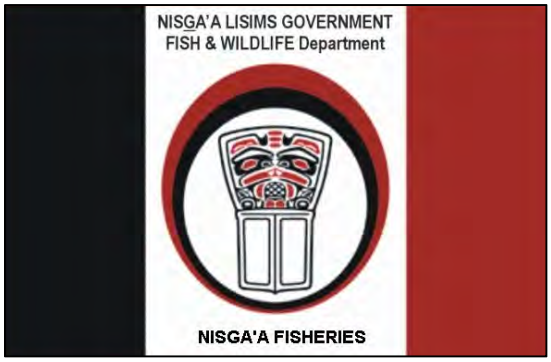

Coastal and Lower Nass Coho Salmon Escapement Surveys 2018

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Nisga'a Fisheries Report #18-23

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COASTAL AND LOWER NASS COHO SALMON ESCAPEMENT SURVEYS 2018

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LIST OF ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this Nisga'a Fisheries report:

AUC	area-under-the-curve
BC	British Columbia
CI	confidence interval
CU	Conservation Unit
CV	coefficient of variation
CWT	coded-wire tag
DFO	Fisheries and Oceans Canada
NFL	nose-fork length
NFWD	Nisga'a Fisheries and Wildlife Department
NJTC	Nisga'a-Canada-BC Joint Technical Committee
NuSEDS	[DFO's] New Salmon Escapement Database System
OE	observer efficiency
PSC	Pacific Salmon Commission
stdev	standard deviation
TRTC	total return to Canada
US	United States

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EXECUTIVE SUMMARY

Noble, C. A. J., R. F. Alexander, S. C. Kingshott, and I. A. Beveridge. 2019. Coastal and Lower Nass Coho Salmon escapement surveys 2018. Prepared for the Pacific Salmon Commission, and the Nisga'a Lisims Government Fisheries and Wildlife Department, Gitlaxt'aamiks, BC, by LGL Limited, Sidney, BC. Nisga'a Fisheries Report #18-23: vi + 34 p.

Funding ($26,000) received from the Pacific Salmon Commission (PSC) allowed the Nisga'a Fisheries and Wildlife Department (NFWD) to conduct coastal escapement ground surveys for Coho Salmon (*Oncorhynchus kisutch*) in the Nass Area (Fisheries and Ocean Canada [DFO]'s Pacific Fisheries Management Area 3) in 2018 as part of a multi-year research project. Five known Coho Salmon streams within the Nass Area were visited to assess spawner abundance in 2018; three creeks in the Lower Nass River (Ansedagan Creek, Diskangieq Creek, and Ksi Ts'oohl Ts'ap [Zolzap Creek]), and two creeks in the Coastal marine area of Area 3 (Dogfish Bay Creek and Salmon Cove Creek) that were specifically PSC funded surveys. In total, 22 field surveys were conducted on the five streams to count and estimate Coho Salmon returns to the Lower and Coastal Nass Area in 2018; 14 surveys in the lower Nass River and 8 surveys in the Coastal marine area. However, poor access (wind) or high flows (rains) restricted the ability to count on a number of surveys to many streams, resulting in escapement estimates being derived from a limited number of successful surveys.

Poor weather prevented NFWD from accessing any stream with sufficient frequency to generate an area-under-the-curve (AUC) estimate which is the preferred methodology of NFWD. Peak count x 2 methodology was used to estimate escapement to Diskangieq Creek (26) and Salmon Cove Creek (128). Coho Salmon escapement to Ksi Ts'oohl Ts'ap (414) is assessed annually 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 and if the fence was breached or not. Escapement estimates to Ansedagan Creek and Dogfish Bay Creek were not possible as there were either no fish observed (Ansedagan Creek) or all attempts to assess abundance were not possible due to poor weather and stream conditions. Based on annual escapement surveys, independent aggregate Coho Salmon escapement estimates for the Coastal and Lower Nass were generated using a habitat capacity model (Bocking and Peacock 2004). Despite the poor conditions and limited escapement data, we estimated aggregate escapement of Coho Salmon to the 2018 Coastal and Lower Nass as 6,147 and 8,498, respectively.

Previous Lower and Coastal Nass Coho Salmon escapement estimates were used to develop a linear regression to estimate Coastal escapement when no surveys were conducted (NFWD 2018). The regression was not updated with results from 2018 due to the few numbers of streams with an estimate, and where estimates were made, we were not confident in their quality to use in the regression.

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 (65.8% total; 51.3% US, 14.5% Canadian; Nisga'a-Canada-BC Joint Technical Committee [NJTC] 2018; Noble et al. 2017). Significant escapement estimates coupled with the highest exploitation rate since 1994 (72.7%) (resulted in very large estimates of harvest by US (760,000) and Canadian (190,000) fisheries, also unprecedented (Noble et al. 2017). Current methodology for estimating Coho Salmon aggregate abundance escapement to the Nass Area (Pacific Fisheries Management Area 3) relies on a mark-recapture program (Upper Nass Coho Salmon Aggregate) and a habitat-capacity model coupled with stream surveys (Lower Nass and Coastal Nass Coho Salmon aggregates; Bocking and Peacock 2004). Significant assumptions are applied to the habitat model to generate Coastal Nass Coho Salmon aggregate escapement estimates, especially in years when no escapement surveys have been conducted on coastal streams (2006 and 2009−2014). Specifically, it is assumed that the percent of habitat capacity utilized by the Coastal Nass Coho Salmon aggregate in a given year is identical to the percent of habitat capacity utilized by the Lower Nass Coho Salmon aggregate (Conservation Unit [CU]), as determined from escapement estimates from three or more tributaries in the Lower Nass (e.g., Ksi Ts'oohl Ts'ap[2] [Zolzap Creek], Ansedagan, Diskangieq, Ginlulak creeks, and Anudol River). The assumption of a 1:1 ratio was made despite having no supporting evidence.

Escapement monitoring of the Lower Nass in 2013 found Coho Salmon at abundances that were on average 789% greater than the average expected from the habitat model for Ksi Ts'oohl Ts'ap, Diskangieq Creek, and Ansedagan Creek (Nisga'a Fisheries and Wildlife Department [NFWD] 2014). For the Coastal Nass Coho Salmon Aggregate, the NJTC assumes that the same adjustment factor applies to coastal streams when streams are not surveyed. 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 (Noble et al. 2017). Due to this large escapement estimate, estimates of US and Canadian commercial harvests may be biased high.

Commercial harvests are estimated from estimates of total run size (escapement + harvests) and exploitation rate data provided from Ksi Ts'oohl Ts'ap coded-wire tag (CWT) recoveries in both US and Canadian fisheries. Ksi Ts'oohl Ts'ap is a Wild Coho Salmon indicator stream for the Nass watershed and BC North Coast (Nass 1997) that has operated from 1993 to 2005 and 2011 to 2018 (adult return year). Consequently, any bias in escapement estimates has a direct effect on estimated harvests.

[1] The term "Nass Area" describes Coho Salmon stocks comprising the "Portland Canal – Observatory Inlet" and "Lower Nass" Conservation Units (CUs) as defined by Canada's Wild Salmon Policy, as well as the portion of the "Portland Inlet" CU that falls within the area covered by the Nisga'a Treaty (Nisga'a Final Agreement 2000).

Since 2014, escapement monitoring of Coastal Nass Area streams has been conducted by NFWD with stream surveys specifically funded by the Nisga'a Lisims Government (2014), the PSC Northern Fund (2015, 2016, and 2018), and Coast Funds (2017). Surveys in 2014 did not find Coho Salmon in sufficient abundance within the Coastal Area to be used in the habitat model. Based on aggregate escapement estimates, Coho Salmon were found in lower abundances in Coastal Nass streams than in the Lower Nass streams in 2016 and 2017, but not in 2015 (NFWD 2015; Noble et al. 2016, 2017). 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 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 2018 and provides recommendations for assessments and methodology to improving Nass Area Coho Salmon escapement estimates in the future.

Objectives

Escapement surveys conducted in 2018 represent the fourth year of a multi-year project to assess Coho Salmon escapements to Coastal Nass Area streams. There are three specific objectives of this year's PSC funded project:

1. Assess abundance of spawning Coho Salmon in up to two Coastal Nass streams (Figure 1);
2. Update the regression with 2018 empirical data from coastal and Lower Nass streams, and;
3. Improve accuracy in estimates of commercial harvests by generating data driven escapement estimates for the Coastal Coho aggregate.

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

1. Survey results from Coho Salmon escapement surveys to Lower Nass tributaries in 2018; and
2. Coho Salmon escapement estimates to 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 (Table 2; Figure 1). This area itself is nested within the Portland Sound-Observatory Inlet-Portland Canal CU (Fisheries and Oceans Canada 2009), a unit more familiar to fisheries managers. While this CU officially has 33 streams listed in DFO's New Salmon Escapement Database System (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 through 2017 are reported in Noble et al. (2016, 2017, and 2018, respectively). In 2018, five streams were assessed for Coho Salmon escapement with representative images of streams presented from Photo 1 to Photo 3. Of the five streams surveyed in the Nass Area (Figure 1), three were in the Lower Nass (Ansedagan Creek, Diskangieq Creek, and Ksi Ts'oohl Ts'ap; Photo 1) and one in each of Portland Inlet (Dogfish Bay Creek; Photo 2) and Observatory Inlet (Salmon Cove Creek; Photo 3).

At least four ground surveys (stream walks and/or snorkel surveys) spanning the peak count were attempted for each system in 2018. Specific details with respect to survey dates, surveyed lengths, as well as parameters for escapement 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. Ksi Ts'oohl Ts'ap was assessed using a counting weir operated from mid-September to mid-November in combination with a Peterson mark-recapture program (NFWD 2017, 2018).

During each stream walk, 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 (OE; %), taking into account water depth, turbidity, glare, woody debris, undercut banks, and other factors potentially limiting visibility and fish counts.

Escapement Estimation

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

1. Peak live count;
2. Peak live plus cumulative carcass; and
3. Peak live count x 2 (e.g., Cousens et al. 1982).

Nisga'a Fisheries and Wildlife Department generally prefers area-under-the-curve (AUC) escapement estimates for modelling residence times and observer efficiency; however all escapement estimates in 2018 were compromised by bad weather to the point that the minimum number of assessments required for AUC estimation (n = 3) was not achieved. Thus, all 2018 escapement estimates for Coho Salmon are peak count x 2, with the exception of Ksi Ts'oohl Ts'ap.

Minimum Data Quality Requirements

Prior to any stream escapement being estimated, survey data are reviewed and where observer efficiency is estimated to be less than 50%, the data are excluded regardless of the number of fish seen. All surveys that were completed in 2018 had observer efficiencies greater than 50%, thus none were excluded. Furthermore, if the quality of escapement estimates are of poorer quality, Type 4 or greater (Table C - 1), they are excluded from the regression analyses.

Ksi Ts'oohl Ts'ap (Zolzap Creek) Adult Weir

Nisga'a Fisheries and Wildlife Department operated a counting weir on Ksi Ts'oohl Ts'ap from late-September to mid-November 2018 to determine escapement to this system (Photo 1). The weir was compromised once on 4 November due to a high-water event but was 'fish tight' the following morning.

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 Ksi Ts'oohl Ts'ap prior to fence installation, continue to enter the system after fence removal, and swim over the weir when it is topped due to high flows. For these reasons, total fence counts have not been used as escapement estimates to the system (Table 7). Instead, surveys are conducted upstream of the weir to recover tags from carcasses and from live fish via angling. These data are used to calculate a Petersen mark-recapture estimate. The mark-recapture estimate is presented here to compliment the stream surveys conducted in 2018.

Water Quality

Temperature (°C) was measured with either an alcohol thermometer or a YSI ProDSS multimeter in each reach in 2018. The YSI Multimeter turbidity meter malfunctioned near the beginning of the Coho Salmon stream surveys and was not used for surveys in 2018, thus only temperature is reported.

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

In 2018, 22 stream surveys were conducted or attempted across five streams to count Coho Salmon returns (Table 3). Counting surveys included 14 stream surveys in three creeks of the Lower Nass River Coho CU and 8 stream surveys in two creeks of the Coastal Nass Area Coho CU. Several issues limited the number and quality of surveys on all streams. These included poor weather preventing safe access or creating unsafe stream conditions (e.g., Dogfish Bay and Salmon Cove creeks), extremely high-water levels prevented safe access (all streams), and either no water or extremely low water levels, particularly for the early attempts for all streams. Low water level conditions in 2018 during later summer, fall and winter months, were one of the most extreme on record that may have contributed to more spawning occurring in mainstem areas of the Nass River (NFWD 2019).

Coho Salmon Escapement Estimates

Several measures of escapement were calculated for Coho Salmon in 2018 for each stream in the Lower Nass (Table 4) and Coastal Nass (Table 5) areas. These include expanded peak live

count, carcasses counted, habitat expanded peak count, and the final preferred method, peak x 2. 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.

Despite many attempts, Coho Salmon were only observed once in each of Salmon Cove Creek (31 October, n = 45) and Diskangieq Creek (6 November, n = 9). Observer efficiency expanded peak counts were generated, and were multiplied by two to generate the recommended peak count x 2 escapement estimates of 128 and 26, respectively (Table 4 and Table 5).

Ksi Ts'oohl Ts'ap (Zolzap Creek) Adult Weir

A total of 139 adult Coho Salmon were captured at the weir from 24 September to 13 November and 30% were missing an adipose fin (i.e., indicates the presence of a coded-wire tag that was applied during juvenile out-migrating from the system three to four years earlier). Twenty-one adults were recaptured and examined for marks and six marks were recovered. The Peterson mark-recapture escapement estimate for Zolzap Creek was 414 adult Coho Salmon (95% confidence interval [CI]: 206−778; 41% CV; Table 4, Table 7).

Nisga'a Fisheries and Wildlife Department recommends the escapement estimate from the mark recapture program be used for estimating the Ksi Ts'oohl Ts'ap return of Coho Salmon rather than the weir count (NFWD 2018). 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 and after weir operations. Access is also possible (but unlikely) via a hanging culvert which, under very high-water conditions (flooding) make it possible for Coho Salmon to enter Ksi Ts'oohl Ts'ap through this culvert. Under normal flow conditions, this culvert is impassable. However, during conditions which would permit fish access through the culvert, the weir would be breached, allowing for easy access past the fence.

<u>Aggregate Escapement Estimates</u>

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 aggregate Coho Salmon escapement estimate to the Lower Nass CU, escapement estimates to Ansedagan, Diskangieq, Ksi Ts'oohl Ts'ap, and other creeks when available (e.g., Anudol River) are used to populate the habitat model. In 2018, the percent of habitat occupied by Coho spawners was 40%, as estimated by escapement to Ksi Ts'oohl Ts'ap only. Therefore, we estimate that a total of 8,498 Coho Salmon escaped to the Lower Nass

(Table 8). Using an identical approach with escapement to Salmon Cove only the Coastal Nass Area, we estimate that the habitat capacity occupied by Coho spawners was only 21% for a total of 6,147 Coho Salmon spawners in 2018 (Table 1 andTable 8).

Lower Nass CU to Coastal Nass Area Escapement Regression

Coho-bearing streams in the Coastal Nass Area were not surveyed by the NFWD or DFO in 2006 or 2009−2014 due to either a lack of funding or the surveys conducted did not provide estimates of sufficient quality (2014, for example) for assessment purposes. From 2000 to 2005, Salmon Cove Creek was surveyed annually by NFWD (Baxter and Bocking 2001; Baxter and Bocking 2002; Baxter et al. 2003, 2004; Stewart et al. 2005; NFWD 2006); Lachmach River was surveyed by DFO from 2000 to 2003 (NJTC 2018); Lizard Creek was surveyed from 2000 to 2002 by NFWD (Baxter and Bocking 2001; Baxter and Bocking 2002; Baxter et al. 2003, 2004); and a fence was operated on Ksi Gingolx (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 River 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 Ksi Gingolx weir data. Thirty-eight fish were observed in Lizard Creek in 2000, were found to be 'present' in 2001, and none were observed in 2002. Consequently, escapement data quality for Lizard Creek were deemed insufficient for including in generating an aggregate Coastal Nass Coho Salmon estimate in those years.

Herein, we abstain from updating the regression with 2018 escapement data, as estimates do not meet the minimum quality standard to be used in the regression (i.e., are of Type 4 or greater [Table C - 1]). However, we present the regression for reference (Figure 3).

Other Salmon Counts

Other adult salmon species were absent from all Lower and Coastal Nass streams surveyed in 2018. The only other species captured in the Ksi Ts'oohl Ts'ap adult fence in 2018 were three adult Sockeye Salmon (*O. nerka*).

Water Quality

No unusual water temperature values were measured in 2018, with average temperature in all streams never being more than one degree above or below 7°C (Table 9).

RECOMMENDATIONS

We recommend the following:

1. Obtain annual funding to conduct Coho Salmon escapement stream surveys in the Coastal Nass Area that are significantly different (on average 94% less; Table 8) in annual habitat-capacity estimates between years when compared to the Lower Nass Coho Salmon habitat-capacity estimates;
2. Priority streams to assess escapement of Coastal Coho Salmon are (in decreasing priority):
    a. Salmon Cove Creek;
    b. Dogfish Bay Creek;
    c. Crag Creek; and
    d. Scowban Creek.
3. Update the regression relationship when new data are collected in order 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 Ksi Ts'oohl Ts'ap (Zolzap Creek) creeks;
5. When empirical stream survey data are available for Coastal Nass Area Coho Salmon, estimate total escapement via the habitat capacity model for Coastal Nass streams. When no empirical data are available from Coastal Nass streams, we recommend professional opinion be sought or consideration of the Lower Nass regression once a stronger relationship is developed with the Coastal Nass returns;
6. 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 add Crag Creek to the model); and
7. 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 using new regression results to estimate Coastal Nass Coho aggregate escapement (shaded values) for 2006 and 2009 to 2014. (NJTC 2018). Estimates shaded grey indicate those affected by the regression

	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	144,948	47,299	3,393	160	169	195,969	27,248	18,527	63,409	109,184	160,206	305,154	47.5%	16.7%	64.2%
1993	56,529	18,446	595	48	51	75,668	11,954	12,438	18,947	43,340	62,479	119,008	47.5%	16.1%	63.6%
1994	407,340	141,090	2,530	362	381	551,703	33,719	30,099	143,026	206,844	351,208	758,547	53.7%	19.0%	72.7%
1995	82,480	19,416	1,402	56	59	103,414	13,949	10,930	22,219	47,098	68,031	150,511	54.8%	13.9%	68.7%
1996	81,389	44,432	2,178	110	116	128,226	23,205	12,553	43,642	79,400	126,236	207,626	39.2%	22.6%	61.8%
1997	27,590	5,348	293	31	33	33,296	9,342	5,714	12,420	27,476	33,181	60,771	45.4%	9.4%	54.8%
1998	61,661	0	2,075	95	100	63,932	20,833	11,717	37,565	70,115	72,385	134,046	46.0%	1.7%	47.7%
1999	99,987	2,484	1,122	144	152	103,889	29,601	16,533	56,988	103,123	107,025	207,011	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	176,003	32,686	14,706	399	500	224,294	47,639	67,395	79,726	194,761	243,052	419,055	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	88,564	15,889	14,882	68	178	119,581	23,508	49,829	67,564	140,901	171,918	260,483	34.0%	11.9%	45.9%
2004	90,984	11,317	20,336	44	232	122,912	30,501	22,542	45,955	98,998	130,927	221,911	41.0%	14.4%	55.4%
2005	163,381	34,717	14,969	718	505	214,290	40,488	32,219	87,153	159,861	210,770	374,150	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	193,807	35.4%	12.1%	47.5%
2007	106,795	22,693	9,515	127	638	139,768	41,205	51,738	48,987	141,930	174,903	281,698	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	1,718	166,850	112,537	79,443	188,903	380,882	423,186	547,732	22.7%	7.7%	30.5%
2010	96,545	20,515	10,292	193	266	127,810	49,902	35,227	83,786	168,914	200,180	296,725	32.5%	10.5%	43.1%
2011	75,244	12,466	2,635	18	245	90,608	7,648	5,399	72,864	85,910	101,274	176,518	42.6%	8.7%	51.3%
2012	107,979	33,156	12,082	187	151	153,555	37,182	26,248	62,326	125,756	171,331	279,311	38.7%	16.3%	55.0%
2013	763,416	187,237	19,370	46	336	970,405	235,193	166,029	117,263	518,485	725,473	1,488,889	51.3%	13.9%	65.2%
2014	137,653	23,607	8,452	60	294	170,066	24,774	89,279	117,657	231,710	264,123	401,776	34.3%	8.1%	42.3%
2015	278,805	110,769	7,905	38	444	397,961	9,434	6,090	41,725	57,248	176,404	455,209	61.2%	26.2%	87.4%
2016	341,111	80,256	8,234	82	141	429,825	21,300	23,700	133,562	178,563	267,276	608,388	56.1%	14.6%	70.6%
2017	238,039	62,785	10,300	336	1,491	312,951	9,286	71,388	109,481	190,155	265,067	503,106	47.3%	14.9%	62.2%
2018	58,433	24,379	2,682	49	392	85,936	6,147	8,498	57,903	72,548	100,051	158,484	36.9%	17.4%	54.2%
Mean: 1992–1999	120,241	34,814	1,699	126	133	157,012	21,231	14,814	49,777	85,822	122,594	242,834	47.8%	12.7%	60.5%
Mean: 2000–curr.	164,870	40,215	10,158	172	440	215,855	43,831	44,735	88,394	176,961	227,945	392,816	39.3%	12.6%	51.9%

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. Shading indicates streams that are not in both NuSEDS and the Habitat Model.

No.	NFWD	NuSEDS	In NuSEDS?	In Habitat Model?
1	Bear River	Bear River	y	y
2	Belle Bay Creek	Belle Bay Creek	y	y
3	Bonanza Creek	n/a	n	y
4	Cascade Creek	n/a	n	y
5	Cedar Creek	Cedar Creek	y	n
6	Chambers Creek	n/a	n	y
7	Crag Creek	n/a	n	n
8	Crow Lagoon Creek	Crow Lagoon Creek	y	y
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	Kitsault River	Kitsault River	y	y
18	Kshwan River	Kshwan River	y	y
19	Ksi Gingolx (Kincolith) River	Ksi Gingolx	y	y
20	Ksi Sgawban (Scowban) Creek	Ksi Sgawban	y	y
21	Ksi X'anmas (Kwinamass) River	Ksi X'anmas	y	y
22	Lachmach River	Lachmach River	y	y
23	Larch Creek	Larch Creek	y	n
24	Leverson Creek	Leverson Creek	y	y
25	Lime Creek	n/a	n	y
26	Lizard Creek	Lizard Creek	y	y
27	Manzanita Cove Creek	Manzanita Cove Creek	y	y
28	Marion Creek	n/a	n	n
29	Mouse Creek	Mouse Creek	y	n
30	Olh Creek	Olh Creek	y	y
31	Pearce Island No1	n/a	n	y
32	Pirate Cove Creek	Pirate Cove Creek	y	y
33	Rainy Creek	Rainy Creek	y	n
34	Roberson Creek	Roberson Creek	y	n
35	Rodgers Creek	n/a	n	y
36	Roundy Creek	n/a	n	y
37	Salmon Cove Creek	Salmon Cove Creek	y	y
38	Sam Bay Creek	Sam Bay Creek	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 specific water quality and Coho Salmon counts in the Lower and Coastal Nass Area, 2018.

Survey				Coho counts					
Area	Stream name	Scheduled date	Length (m)	Temp (°C)	Observer efficiency	Raw live	Expanded live	Carcass count	Comments
Lower Nass	Ansedagan Creek	2018-09-30	830	-	100%	0	0	0	
		2018-10-09		-	100%	0	0	0	
		2018-10-24		7.0	95%	0	0	0	Zero Coho Salmon in all reaches
		2018-10-30		7.0	90%	0	0	0	Zero Coho Salmon in all reaches
		2018-11-18		7.0	90%	0	0	0	
	Diskangieq Creek	2018-09-29	2,900	-	100%	0	0	0	No water, no fish
		2018-10-08		-	100%	0	0	0	Very low water, no fish
		2018-10-23		7.0	100%	0	0	0	No Coho Salmon
		2018-11-05		7.5	70%	0	0	0	Water too high and dirty
		2018-11-06		7.0	70%	9	13	0	9 Coho Salmon, bankfull
		2018-11-14		7.0	80%	0	0	0	Piece of carcass, no signs of fish holding or spawning
	Anudol River	2018-10-25	6,410	-	-	-	-	-	Not surveyed due to weather/access/high flows
		2018-11-07		-	-	-	-	-	Not surveyed due to weather/access/high flows
		2018-11-19		-	-	-	-	-	Not surveyed due to weather/access/high flows
	Zolzap Creek	See comments	843	Zolzap Creek is not surveyed as others are, thus this information is not applicable to Zolzap					Weir operated from 24 Sep through 13 Nov
Portland Inlet	Dogfish Bay Creek	2018-10-10	1,400	-	100%	0	0	0	No water, no fish
		2018-11-01		-	-	-	-	-	DNS - Winds prevented access
		2018-11-15		-	-	-	-	-	Water too high and dirty
		2018-11-21		6.0	-	-	-	-	Water too high and dirty, lots of eagles and seals at mouth
	Salmon Cove Creek	2018-10-11	5,000	-	100%	-	-	-	No water, no fish
		2018-10-31		7.5	70%	45	64	-	Fish are fresh and holding in deep pools
		2018-11-16		-	-	-	-	-	Water high
		2018-11-29		-	-	-	-	-	Seal activity at mouth

DNS = Did not survey

Table 4. Lower Nass stream specific survey and estimation details for Coho Salmon, 2018.

Survey parameters and escapement estimates	Stream		
	Ansedagan Creek	Diskangieq Creek	Zolzap Creek
Survey dates 2018	30 Sep; 09, 24, 30 Oct; 18 Nov	29 Sep; 08, 23 Oct; 05, 06, 14 Nov	n/a
Counting method	Stream walk/Snorkel	Stream walk/Snorkel	Adult fence/Stream walk
No. of reaches	3	4	5
Count lengths (m)	1,164	2,900	1,356
Available habitat (m)[a]	3,110	8,960	7,810
Expanded peak count[b]	n/a	13	n/a
Date of peak count	n/a	06 Nov	03 Nov
Carcasses	0	0	0
Survey life (stdev) (days)	n/a	n/a	n/a
Habitat expansion factor	2.67	3.09	5.76
Habitat expanded peak count[c]	0	40	n/a
Final escapement method	n/a	Peak x 2	Mark-recapture
Final escapement	**0**	**26**	**414**
95% confidence intervals	n/a	n/a	206–778
Habitat capacity model est.	474	1,150	1,025
% of habitat capacity model	n/a	2%	40%

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

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

[c] Where OE > 50%, the expanded peak live count corrected for available habitat, added to the carcass count for the same day.

Table 5. Coastal Nass Area stream specific survey and estimation details for Coho Salmon, 2018.

Survey parameters and escapement estimates	Stream	
	Dogfish Creek	Salmon Cove Creek
Survey dates 2018	10 Oct; 01, 15, 21 Nov	11, 31 Oct; 16, 29 Nov
Counting method	Stream walk	Stream walk
No. of reaches	4	5
Count lengths (m)	n/a	n/a
Available habitat (m)[a]	7,550	5,340
Expanded peak count[b]	n/a	64
Date of peak count	n/a	31 Oct
Carcasses	0	0
Survey life (stdev) (days)	n/a	n/a
Habitat expansion factor	n/a	n/a
Habitat expanded peak count[c]	n/a	n/a
Final escapement method	n/a	Peak x 2
Final escapement	**0**	**128**
95% confidence intervals	n/a	n/a
Habitat capacity model est.	830	620
% of habitat capacity model	0%	32%

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

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

[c] Where OE > 50%, the expanded peak live count corrected for available habitat, added to the carcass count for the same day.

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

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

Table 7. Ksi Ts'oohl Ts'ap (Zolzap Creek) juvenile and adult Coho Salmon summary, 1992−2018 (NFWD 2019).

Smolt out-migration				Resulting escapement		
Smolt year	Total count	Adipose fin clip 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	**2017**	457	1,235
2017	12,906	12,163	12,163	**2018**	139	414
2018	21,395	20,728	19,512			
Average	26,118	28,383	23,680		962	1,348

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

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

Table 8. Aggregate escapement estimates for Nass Coho Salmon generated from Coastal Nass Area stream surveys compared to estimates from Lower Nass CU surveys in years where stream surveys were conducted in both areas.

	Aggregate escapement		% Habitat saturation		
Year	Coastal Nass CU*	Lower Nass CU	% Coastal	% Lower	% difference (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%
2007*	10,970	51,738	37%	246%	-209%
2008*	3,871	18,847	13%	90%	-77%
2015	8,139	6,090	27%	29%	-2%
2016	25,971	23,700	87%	113%	-26%
2017	9,265	71,388	31%	339%	-308%
2018	6,147	8,498	21%	40%	-20%
Average	22,000	36,000	75%	169%	-94%

*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. Summary of 2018 water temperature in surveyed streams in the Lower and Coastal Nass Area.

		Temperature (°C)		
Area	Stream	Average	Min	Max
Lower Nass	Ansedagan Creek	7.0	7.0	7.0
	Diskangieq Creek	7.0	7.0	7.5
	Zolzap Creek	5.5	3.0	10.0
Portland Inlet	Dogfish Bay Creek	7.0	6.0	7.0
Observatory Inlet	Salmon Cove Creek	7.0	4.0	12.0

FIGURES

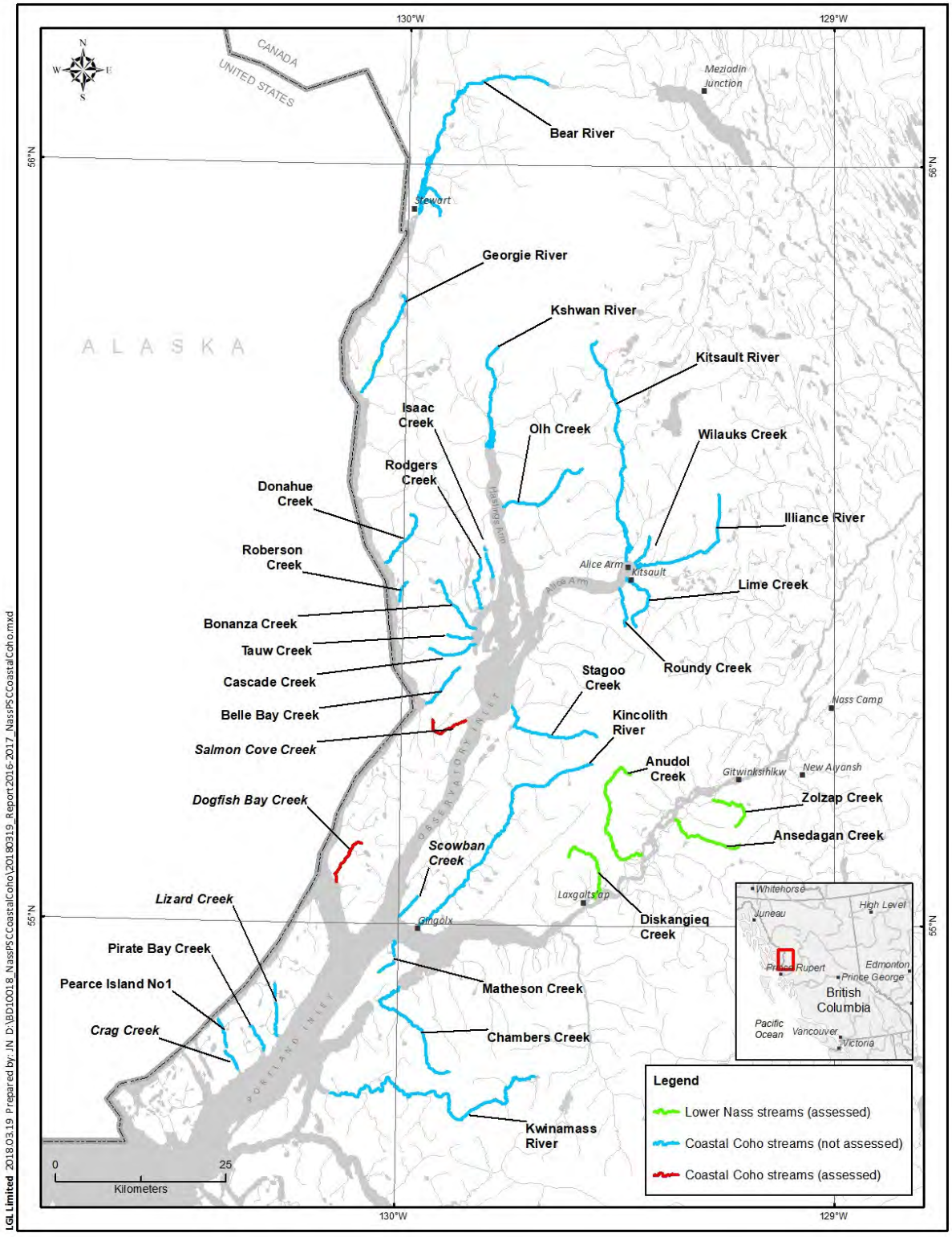


Figure 1. Coho Salmon escapement indicator streams in the Lower Nass River and Coastal Nass Area, 2018.

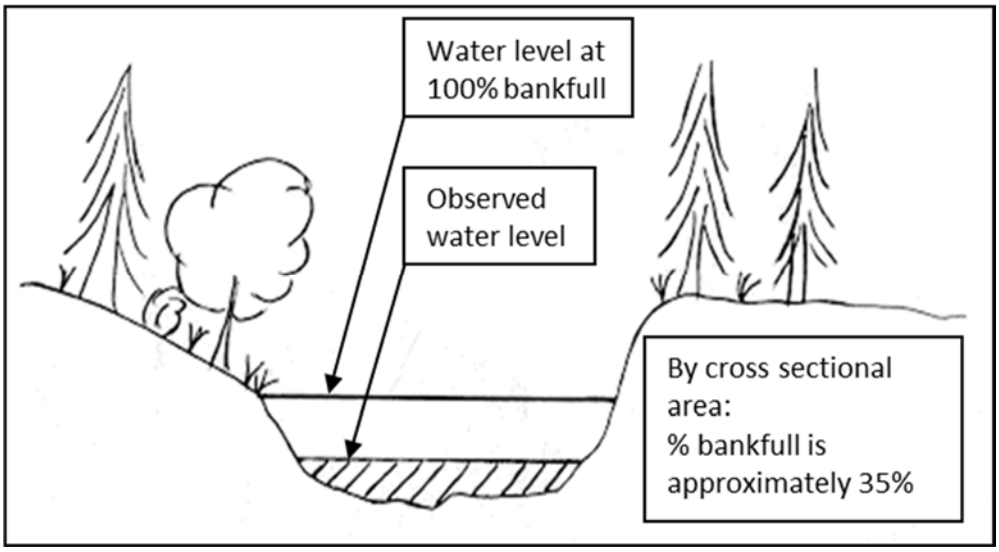


Figure 2. Estimating percent bankfull based on the portion of the channel that is wetted. Figure was copied from DFO Stream Inspection Log definitions.

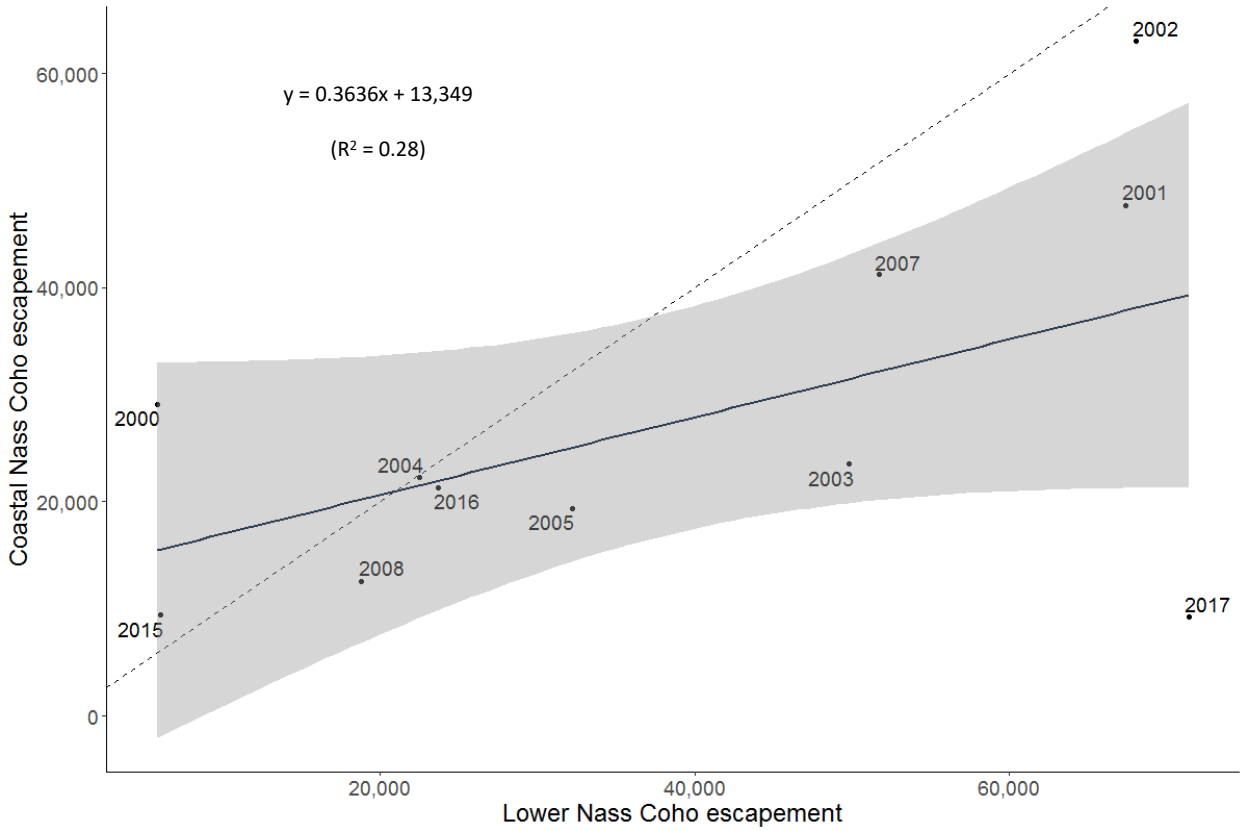


Figure 3. Regression of Coho Salmon aggregate escapements to the Lower Nass CU and the Coastal Nass Area, 2000−2018. The 1:1 dashed line shown for comparison purposes. Shaded area indicates 95% CIs.

PHOTOS


Ansedagan Creek


Diskangieq Creek


Ksi Ts’oohl Ts’ap (Zolzap Creek)

Photo 1. Representative images of Lower Nass Coho Salmon streams: Ansedagan and Diskangieq creeks, and Ksi Ts’oohl Ts’ap.

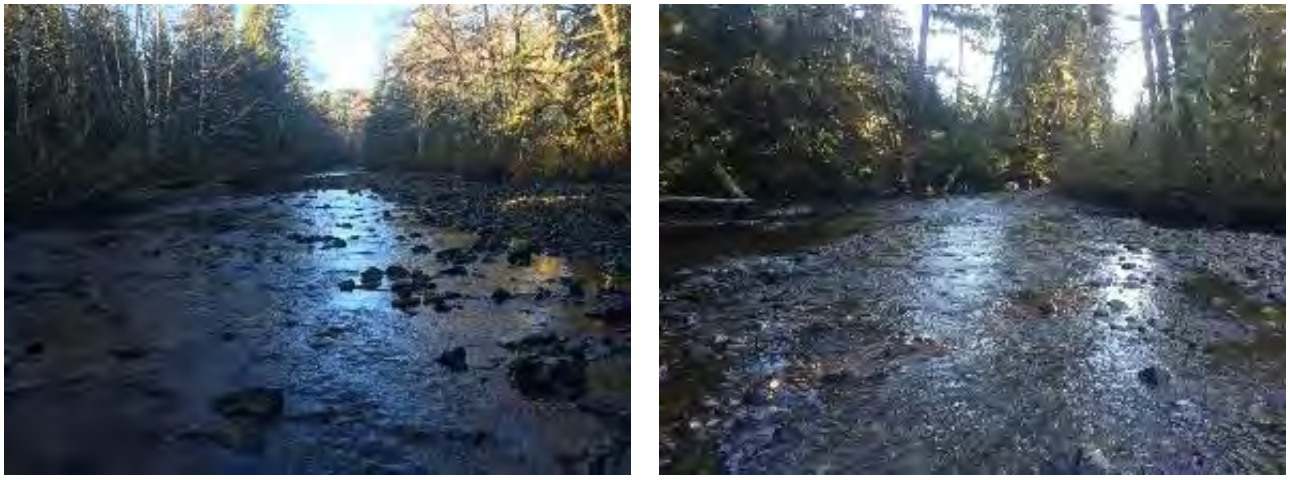


Photo 2. Representative images of Dogfish Bay Creek.

Photo 3. 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, 2015−2018.

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, 2015−2018.

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.

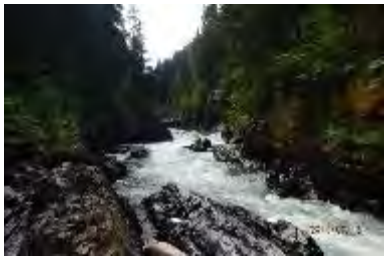
Score	Classification	Description	Example
1	Poor	Extremely difficult or not walkable due to safety concerns (log jams; high flows) or poor accessibility coupled with high flows or turbidity, debris, limited visibility, high confinement or other factors.	
2	Low	Difficult walking due to steep, fast, or 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.

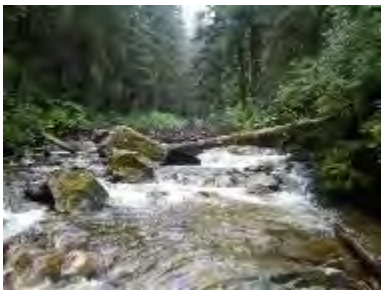
Score	Classification	Description	Example
1	Poor	Snorkelling not possible due to lack of deep pools or glides; extensive debris jams, lack of safe egress; high turbidity or velocity prevent safe or effective snorkelling.	
2	Low	Snorkelling difficult due to lack of suitable habitat. Pools and glides are 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.	

Appendix C – Fisheries and Oceans Canada escapement data classification system.

Table C - 1. Fisheries and Oceans Canada classification system for quality of Pacific salmon escapement estimates.

Escapement estimate class	Estimate quality	Description
1	High	An estimate of high resolution from an unbreached fence count. The estimate uncertainty is believed to be less than plus or minus 10% of the actual estimate.
2	High	An estimate of high resolution based on documented measured data.
3	High	An estimate of high resolution based on three or more documented inspections of walking, floating, or flying which clearly define the peak of spawning and contain high adult live estimates with high fish countabilities; Or an estimate of medium resolution based on documented data from a Mark & Recapture, Fixed Site method, or medium to high AUC calculation. The estimate uncertainty is believed to be less than plus or minus 25% of the actual estimate.
4	Medium	An estimate of medium resolution based on the documentation of two or more walking, floating, or flying inspections around the peak of spawning containing high adult live estimates with high fish countabilities; Or possibly low reliable fence count records, Mark & Recapture data or low to medium AUC calculation. The estimate uncertainty is believed to be no better than plus or minus 25% of the actual estimate.
5	Low	Low Resolution.
6	No Estimate	None Observed (NO); Adults Present (AP); Not Inspected (NI); Do Not Spawn (DNS); Fry Present (FP).