

Data Summary Report for Chum Salmon Escapement Surveys in the Nass Area, 2016

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Nisga'a Fisheries Report #16-26

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EXECUTIVE SUMMARY

Beveridge, I. A., R. F. Alexander, S. C. Kingshott, C. A. J. Noble and C. Braam. 2017. Data summary report for Chum Salmon escapement surveys in the Nass Area, 2016. Prepared by LGL Limited, Sidney, BC, for the Pacific Salmon Commission, Vancouver, BC, and the Nisga'a Lisims Government Fisheries and Wildlife Department, Gitlaxt'aamiks, BC. Nisga'a Fisheries Report #16-26: v + 48 p.

Funding (\$77,000) received from the Pacific Salmon Commission's Northern Fund in 2016 allowed the Nisga'a Fisheries and Wildlife Department to successfully conduct escapement ground surveys for Chum Salmon (*Oncorhynchus keta*) in the Nass Area (DFO's Pacific Fisheries Management Area 3) as Year 3 in a multi-year research project started in 2014 (Beveridge and Alexander 2015; Beveridge et al. 2016).

A total of 11 systems, including six indicator (Ksemamaith, Kshwan, Stagoo, Kitsault, Illiance, Wilauks) and five non-indicator (Donahue, Belle Bay, Lizard, Crag, and Tseax) streams, were inspected between 15 July and 21 September 2016 in the Lower Nass (n = 2), Portland Inlet (n = 2), Portland Canal (n = 2), and Observatory Inlet (n = 5). At least four surveys spanning the peak count were made in each indicator system with a total of 52 stream surveys conducted in 2016.

High quality escapement estimates were produced for each indicator and for most non-indicator streams surveyed in 2016. The highest escapement was observed in the Stagoo Creek system (8,139) that accounted for 62% of the observed Nass Area escapement (13,156). The total escapement to the Nass Area in 2016 was estimated at 20,903 Chum Salmon, 54% lower than the escapement goal (45,000). The total estimated return of Nass Area Chum Salmon in 2016 was 28,254 which was the 8th lowest return since 1980 and the 7th lowest return since 2006.

INTRODUCTION

Chum Salmon (*Oncorhynchus keta*) stocks in the Nass Area (Figure 1; Figure 2) are depressed, with returns below the provisional escapement target (45,000) in recent years (Figure 3A; Beveridge and Alexander 2015; Beveridge et al. 2016; NJTC 2017). From 2007 to 2015, Nass Area Chum salmon have returned on average 79% (81,000 fish) lower than the average return from 1980–2006 (22,000 vs. 103,000) and not met the escapement goal in all years. This declining trend is reflected in Chum Salmon catches at the Gitwinksihlkw fishwheel test fishery in the lower Nass River. The number of Chum Salmon captured per hour of operation has declined since fishwheel operations began in 1994 (Figure 4). In response to poor returns of Nass Area Chum Salmon in recent years, Fisheries and Oceans Canada (DFO) managers have reduced Canadian exploitation rates to a mean of 4% (range: 2–7%) from 2007 to 2015 compared to the 1980 to 2006 mean of 22% (range: 5–42%; Figure 3B). While recovery of Nass Area Chum Salmon stocks has not occurred to date, there are indications that stocks are improving. The 2015 Nass Area escapement was the highest observed since 2006 (Beveridge et al. 2016), and since 2013, the Chum Salmon catch per hour at the Nass River fishwheels has increased each year (Figure 4).

The data defining the Chum Salmon decline in the Nass Area are poor (Beveridge and Alexander 2015). Since 1980, the average number of eight indicator streams surveyed by DFO with sufficient effort to produce an escapement estimate has declined from seven (1980-1989) to four (2005-2014). In 2002, 2003, and 2011, only two indicator streams were surveyed by DFO (Kshwan River and Stagoo Creek).

Effective management of Nass Area Chum Salmon and development of a recovery plan, for DFO's Wild Salmon Policy (DFO 2009) and as a condition of the Marine Stewardship Council Certification Program for conducting sustainable commercial fisheries in Area 3, requires accurate escapement and run size data. Consistent survey effort and higher quality estimates are necessary. High quality estimates are essential to understand the current status of Nass Area Chum Salmon and to monitor population trends in the future. To achieve high quality estimates for all surveyed streams, escapement data should be collected using standardized methods. Recognizing the importance of accurate escapement estimates to defining the decline, the Nisga'a Fisheries and Wildlife Department (NFWD) has committed the necessary resources to produce high quality estimates in two lower Nass Chum Salmon systems (Ksemamaith Creek and a groundwater fed tributary of Tseax Slough known as the Tseax side channel). Since 2010, NFWD have annually conducted at least four stream surveys spanning the peak count in these systems and have generated confidence-bounded area-under-the-curve (AUC) estimates (Beveridge and Alexander 2015; NFWD 2017).

The Wild Salmon Policy has identified 36 Chum Salmon spawning streams from three conservation units (CUs; Lower Nass; Portland Inlet; Portland Canal-Observatory Inlet) that cover the Nass Area (Figure 2). Estimates of annual Chum Salmon escapement to the Nass Area are based on surveys of up to eight indicator systems (22% of identified Chum Salmon streams) from these CUs (Figure 2; English et al. 2012).

Objectives

Escapement surveys in 2016 represent Year 3 of a Pacific Salmon Commission (PSC) funded multi-year project to standardize Chum Salmon escapements to lower Nass and coastal streams and to develop a long-term, scientifically defensible, and cost-effective escapement program. The primary goal of Year 3 (2016) was to conduct stream surveys and collect escapement data following a standardized methodology to improve the quality of estimates. The applicability of AUC and other methods was also evaluated for both indicator and non-indicator streams.

Specific objectives for Year 2 were:

1. Assess six Chum Salmon indicator systems (Kshwan River, Stagoo Creek, Kitsault River, Illiance River, Wilauks Creek, and Ksemamaith Creek) by conducting rigorous and repeatable surveys on the ground during the complete migration of Chum Salmon to those systems with a minimum of four trips planned to each system;
2. Assess up to five non-indicator Chum Salmon streams (e.g., Donahue Creek, Crag Creek, Lizard Creek, Pirate Cove Creek, Belle Bay Creek and/or other streams recommended by the NJTC) and where Chum Salmon are found in abundance determine if they could be added to or replace existing indicator streams; and
3. Generate aggregate Nass Area Chum Salmon escapement estimates for 2016 that are scientifically defensible and recommend methods for long-term annual estimation of Chum Salmon escapements in the Nass Area.

METHODS

Surveyed Streams

Eleven Nass Area streams were surveyed for Chum Salmon escapement in 2016 by NFWD and LGL, including six indicator and five non-indicator streams (Figure 5). Although Kincolith River (~30 km stream length) and Kwinamass River (~39 km stream length) are both indicator systems for Nass Area Chum Salmon, they are not proposed for assessment in 2016 due to the challenges in counting low numbers of Chum Salmon that return each year to these large systems. Surveyed streams were from four regions of the Nass Area: 1) Lower Nass River; 2) Portland Inlet (Areas 3-7 and 3-12); 3) Portland Canal (Areas 3-13 to 3-15); and 4) Observatory Inlet (Area 3-14; Figure 1). Specific streams surveyed in 2016 were:

Lower Nass (Photo 1):

1. Ksemamaith Creek (Indicator Stream)
2. Tseax side channel

Portland Inlet (Photo 4):

3. Lizard Creek
4. Crag Creek

Portland Canal (Photo 2):

5. Donahue Creek
6. Belle Bay Creek

Observatory Inlet (Photos 4-7):

7. Illiance River (Indicator Stream)
8. Wilauks Creek (Indicator Stream)
9. Kitsault River (Indicator Stream; Figure 6). Surveys were conducted in:
 - a. a mainstem side channel
 - b. Falls Creek (Kitsault tributary)
10. Kshwan River (Indicator Stream; Figure 7). Surveys were conducted in:
 - c. mainstem side channels
 - d. unnamed tributaries ; and
11. Stagoo Creek (Indicator Stream).

At least four ground surveys (stream walks) spanning the peak count were planned for each system. Surveys started with Stagoo Creek on 15 July and ended with Kshwan River on 21 September. Access methods included marine vessel, small boat, zodiac, and truck and are summarized in Table 1. All fish count and habitat data were recorded on NFWD field forms (Appendix A).

During each stream walk, crews counted live Chum Salmon and carcasses on a per-reach basis (Table A-1). Live and dead counts of other salmon species were also recorded. The lead counter estimated their 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 percent bankfull data (Table A-2), assessed stream count-ability (Appendix B), and bio-sampled (i.e., measured length and identified by sex) fully intact carcasses (Table A-3).

Water Quality

Temperature (°C) and turbidity (NTU) were measured in each reach with a YSI ProDSS multimeter.

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 8). 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 sight 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

Chum Salmon typically spawn in lower stream reaches with gradients shallower than 3%, but preferred spawning areas have gradients $\leq 1\%$. 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.

Bio Sampling

Select carcasses that were fully intact were sampled for nose-fork length (NFL; cm) and identified by sex. To check for Alaskan hatchery-origin Chum Salmon, otoliths were collected where possible and stored in ethanol in numbered vials. Alaskan hatcheries thermally mark Chum Salmon otoliths and the releasing hatchery can be determined by examining the otoliths. Scales were collected from both live and dead Chum Salmon in the lower Nass tributaries for aging. Not all carcasses were bio-sampled due to time constraints.

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 times two (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 (expanded from raw counts using observer efficiency) and estimates of residence time (days). For 2016, AUC estimates were generated for streams with live counts from three or more

complete surveys. Streams with incomplete surveys (e.g., due to poor visibility or safety considerations) were excluded from AUC estimates. 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 to develop a frequency distribution of escapement values (the algorithms used were provided by Steve Cox-Rogers, DFO, Prince Rupert). For coastal systems, we used a 10 day survey life based on the findings of Perrin and Irvine (1990) and for lower Nass streams, we used a 7 day survey life based on the much smaller stream size. 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 (Figure C-1).

RESULTS AND DISCUSSION

Streams Surveys

Four to six stream walks were conducted on each stream (Table 2) with at least four surveys conducted on indicator systems (Figure 5; Table 2). However, high and/or turbid flow conditions and wildlife encounters limited the number of surveys on some streams to conduct counts. High flows resulted in cancelled or rescheduled surveys in Lizard Creek, Crag Creek, Stago Creek, Illiance River, and Kitsault River. Encounters with sow grizzly bears with cubs cancelled or limited surveys in Wilauks Creek and Kshwan River and a nearby wolf pack limited the final survey in Ksemamaith Creek.

Chum Salmon Escapement Estimates

Chum Salmon were observed in nearly every stream surveyed in 2016. Only Belle Bay Creek did not have Chum Salmon. Six indicator systems were visited multiple times, producing high quality estimates for these streams.

The highest peak counts were observed in Stago Creek (2,756) on 6 August and Kshwan River side channels (1,381) on 22 August and the lowest peak counts were observed in Ksemamaith Creek (13) and the Pearse Island streams (Lizard Creek = 4; Crag Creek = 17). Of the indicator streams surveyed in 2016, Stago accounted for 61.9% of the total estimated observed escapement (13,156) to Nass Area streams, followed by Kshwan (24.8%), Illiance (6.9%), Wilauks (3.2%), Kitsault (2.7%), and Ksemamaith (0.6%).

The best escapement estimates for each surveyed indicator system (Table 3) were input into the English et al. (2012) method to estimate the total Chum Salmon return to the Nass Area (Table 4; NJTC 2017). While the estimated Nass Area escapement (20,903) was less than half of the escapement goal (45,000; Figure 3), 2016 was the second largest Nass Area return since 2010 (Table 4).

Other Salmon Counts and Escapement Estimates

In addition to Chum Salmon, only Pink (*O. gorbuscha*) and Sockeye (*O. nerka*) salmon were observed during our surveys (Appendix D). Pink Salmon were observed in all assessed streams (Table D-1). Pink Salmon counts were sufficient to generate escapement estimates to each

stream (AUC and peak count methods). In contrast, Sockeye Salmon were only observed in four streams and typically only one or two fish were observed (Ksemamaith Creek; Tseax Side Channel; Kitsault River side channel; and Illiance River). Only the Tseax Side Channel had more than two Sockeye Salmon observed.

Bio Samples

Twenty-two Chum Salmon were bio-sampled in spawning streams in 2016. Of these, five (23%) were sampled in lower Nass tributaries and the remainder were sampled in coastal streams. Nose-fork length was measured for 22 fish and the average NFL for male and female Chum Salmon from all streams was 67.7 cm (range: 64.0-74.0 cm) and 81.5 cm (range: 72.0-91.0 cm), respectively (Figure 9; Photo 10).

Otoliths were collected from 20 fish from seven streams (Table 5) and were sent to the Alaska Department of Fish and Game for thermal mark analysis in late 2017.

Scales were collected from eight (5 female; 3 male) Chum Salmon (Photo 10) from five streams (Table 5) and five were successfully aged. Age results were one fish aged 3₁, three fish aged 4₁, and one fish aged 5₁ using Gilbert Rich notation where the first digit represents total age and the second digit denotes the number of winters the fish resided in fresh water after egg deposition.

Water Quality

Excluding Lizard Creek, no unusual temperatures were measured, with average temperature ranging from 8.3°C in Kshwan River side channels to 12.7°C in Crag Creek (Table 6). The highest temperatures (16°C) were recorded in Lizard Creek on 23 August and 3 September and were accompanied by thick filamentous green algae (Photo 4).

Average turbidity was low in all streams, ranging from 1.3 NTU in Belle Bay Creek to 10.6 NTU in Kitsault River side channels. The highest turbidity values were measured following rain events in glacial systems (e.g. Stagoo Creek; Kitsault River; Kshwan River; Table 6). Most systems assessed were stable with maximum turbidity values of less than 6.0 NTU (Figure 10).

Streams on Pearse Island (Lizard and Crag creeks) were tannin stained (tea coloured; Photo 4) with limited instream visibility, despite having low turbidity values (Table 6).

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

The average walk-ability in all streams, except Belle Bay Creek, was either good or excellent (Table 7). Due to the blown-out nature of the streambed and logjams, Belle Bay had a moderate average walk-ability score. Most of the streams surveyed had poor, low, or moderate snorkel-ability (Table 7). Few good snorkel areas were observed.

Average spawning habitat quality was moderate or good in all streams, except Belle Bay Creek (poor; Table 7). The highest quality spawning habitat was observed in the Tseax side channel, Lizard Creek, Crag Creek, Stagoo Creek, Illiance River, Kitsault River side channel, and the Kshwan River side channels and tributaries.

RECOMMENDATIONS

1. Conduct rigorous and repeatable ground surveys of six Chum Salmon indicator systems (Kshwan River, Stagoo Creek, Kitsault River, Illiance River, Wilauks Creek, and Ksemamaith Creek)
 - a. Conduct at least four surveys per system, with surveys spanning the peak spawning period.
2. Continue ground surveys in non-indicator systems (e.g., Donahue Creek, Crag Creek, Lizard Creek, Tseax side channel, and Ohl Creek) to determine if these stream could be included or replace existing indicators.
 - a. Conduct at least four surveys per system, with surveys spanning the peak spawning period.
3. Continue to assess the Tseax side channel as a possible indicator system to be added to the Lower Nass streams and be included in the NJTC annual method to estimate Nass Area Chum Salmon escapement for the lower Nass CU.
4. Discontinue surveys on Belle Bay Creek based on the lack of suitable Chum Salmon spawning habitat.
5. Start Stagoo Creek and Alice Arm streams (Illiance River, Kitsault River, and Wilauks Creek) surveys in mid-July.
6. Continue to evaluate count-ability conditions for estimating observer efficiency based on water quality measurements, walk-ability and snorkel-ability for determining future indicator streams for escapement surveys or potential adjustments to escapement estimates.

Evaluate survey life combined with observer efficiency for variation within and among streams surveyed.

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TABLES

Table 1. Access methods and travel time to Chum Salmon streams surveyed in 2016.

Area	Stream	Access method	Travel	
			Time (hours)	From
Lower Nass	Ksemamaith Creek	Highway vehicle access to stream	0.5	Gitlaxt'aamiks
	Tseax Side Channel	Highway to Tseax River parking area; hike from highway	1.0	Gitlaxt'aamiks
Portland Inlet	Lizard Creek	Marine vessel; small zodiac to shore	1.5	Gingolx
	Crag Creek	Marine vessel; small zodiac to shore	2.0	Gingolx
Portland Canal	Donahue Creek	Marine vessel; small zodiac to shore	4.0	Gingolx
	Belle Bay Creek	Marine vessel; small zodiac to shore	3.0	Gingolx
Observatory Inlet	Stagoo Creek	Marine vessel; small zodiac to shore	2.0	Gingolx
	Kshwan River	Marine vessel; small zodiac to shore	4.5	Gingolx
	Illiance River	Marine vessel; small zodiac to shore	4.0	Gingolx
	Wilauks Creek	Marine vessel; small zodiac to shore	4.0	Gingolx
	Kitsault River tribuary (Falls Creek) and side channel	Marine vessel; foot or vehicle access from Alice Arm dock	5.0	Gingolx

Table 2. Survey dates, water quality, habitat quality score, countability scores and Chum Salmon counts for streams surveyed in 2016.

Survey			Average water and habitat quality				Countability score		Chum counts				Comments	
Area	Stream name	Date	Length (m)	Temp (°C)	Turbidity (NTU)	Habitat score	Walk	Snorkel	Observer efficiency	Raw live	Expanded live	Carcass		
Lower Nass	Ksemamaith Creek	2016-07-27	1250	11.0	NR	4	4	3	93%	0	0	0		
		2016-08-16	1250	NR	NR	NR	NR	NR	90%	8	9	0		
		2016-08-25	1250	9.0	NR	4	5	3	90%	10	11	2		
		2016-09-05	1250	11.5	NR	2	3	2	90%	12	13	0		
		2016-09-15	235	NR	NR	4	4	3	75%	0	0	0	Incomplete survey due to wolf encounter.	
	Tseax Side Channel	2016-07-27	380	NR	NR	NR	NR	NR	NR	95%	0	0	0	
		2016-08-16	380	12.0	NR	NR	NR	NR	NR	90%	5	6	0	
		2016-08-25	380	11.0	NR	5	4	3	90%	19	21	0		
		2016-09-05	380	11.4	NR	3	4	2	80%	33	41	0		
		2016-09-15	380	NR	NR	5	4	3	90%	10	11	6		
Portland Inlet	Crag Creek	2016-08-23	3000	12.8	1.7	4	4	2	65%	11	17	1		
		2016-09-03	3000	12.8	2.6	4	4	2	70%	11	16	3		
		2016-09-14	1000	12.3	4.4	4	3	1	40%	0	0	0	High turbid flow prevented safe access beyond first reach.	
	Lizard Creek	2016-09-25	0										Flood conditions; high turbid flow prevented safe access.	
		2016-08-23	2000	15.6	1.9	4	4	1	70%	0	0	0	High flows prevented access to stream.	
		2016-09-03	2000	16.0	1.7	4	4	2	73%	3	4	3	High flows prevented access to stream.	
Portland Canal	Donahue Creek	2016-09-14	0										High flows prevented access to stream.	
		2016-09-25	0										High flows prevented access to stream.	
		2016-08-12	800	12.1	3.1	3	5	2	70%	12	17	0		
		2016-08-22	800	12.2	3.4	4	4	2	70%	35	50	6		
	Belle Bay Creek	2016-09-02	800	10.7	5.2	3	3	2	50%	17	34	3		
		2016-09-13	800	9.0	NR	3	4	2	90%	1	1	0		
		2016-08-12	830	12.5	1.3	1	3	2	100%	0	0	0		
		2016-08-22	830	12.4	1.2	1	3	1	82%	0	0	0		
Belle Bay Creek	2016-09-02	430	11.3	1.3	2	3	2	80%	0	0	0			
	2016-09-13	430	NR	NR	1	3	1	90%	0	0	0			

Table 2 continued.

Survey			Average water and habitat quality			Countability score		Chum counts				Comments		
Area	Stream name	Date	Length (m)	Temp (°C)	Turbidity (NTU)	Habitat score	Walk	Snorkel	Observer efficiency	Raw live	Expanded live		Carcass	
Observatory Inlet	Stagoo Creek	2016-07-15	4500	9.4	4.7	4	4	3	70%	1,140	1,629	0	Survey incomplete due to high turbid flow.	
		2016-07-25	1000	7.8	16.9	4	4	1	28%	24	87	1		
		2016-08-06	4500	10.8	6.2	4	4	3	70%	1,929	2,756	358		
		2016-08-16	4500	8.4	14.6	3	3	1	30%	314	1,047	133		Poor instream visibility.
		2016-08-26	0	8.2										No survey due to high turbid flow.
	2016-09-06	4500	7.7	15.7	NR	NR	NR	66%	11	17	13			
	Kitsault River ^a	2016-07-26	900	9.4	4.2	5	5	2	96%	24	25	0		
		2016-08-07	900	12.7	10.5	3	4	2	74%	98	132	3		
		2016-08-18	900	10.6	3.4	NR	NR	NR	80%	74	93	26		
		2016-08-26	0										River flooding. No survey due to high turbid flow.	
	2016-09-07	900	9.8	20.9	2	5	1	30%	13	43	11			
	Illiance River	2016-07-26	1800	12.6	2.4	4	4	2	60%	162	268	0		
		2016-08-07	1800	13.3	4.2	4	4	3	80%	117	146	35		
		2016-08-17	1800	11.3	4.4	3	4	1	77%	117	152	17		
		2016-08-26	0	12.7	22.9								River flooding. No survey due to high turbid flow.	
		2016-09-07	1800	10.7	7.6	NR	4	1	30%	3	10	3		
	Wilauks Creek	2016-07-27	50										Survey cancelled due to grizzly bear with cubs in stream.	
		2016-08-08	1900	12.6	6.9				70%	90	129	43	Small tributary near mouth not counted.	
2016-08-17		2220	10.9	8.0	4	4	1	66%	136	206	11	Includes small tributary near mouth.		
2016-08-26		1900	13.1	8.2	3	3	2	65%	64	99	36	Small tributary near mouth not counted.		
2016-09-07	550	10.2	21.3	NR	NR	NR	30%	1	3	5	Reaches 3 & 4 not counted due to turbid flow.			
Kshwan River	2016-08-19	3800	7.2	9.8	NR	NR	NR	72%	305	425	50	River left (reaches 1-3) inaccessible and not surveyed.		
	2016-08-27	3800	9.4	NR	4	3	2	63%	868	1,381	124	River left inaccessible and not surveyed.		
	2016-09-08	3800	7.7	16.9	4	4	1	80%	732	920	153	River left inaccessible and not surveyed.		
	2016-09-20	1100	10.0	5.2	4	4	1	93%	8	8	3	River left reaches accessed and counted.		
	2016-09-21	1300	6.7	6.9	5	4	2	80%	177	221	41	Counts are for river left reaches. Survey cut short by encounter with sow grizzly and 3 cubs near top of reach 5. Reaches 6 and 7 not counted.		

^a Kitsault River surveys included a mainstem sidechannel and the first 100m of Falls Creek.

NR= Not recorded

Table 3. A comparison of Chum Salmon escapement estimates for each system surveyed in 2016. Bold estimates are considered the best estimate for each system. NA indicates insufficient data for calculating the escapement estimate.

Area	Stream name	Indicator	Funding source	Surveys	Chum Salmon escapement estimate					
					Peak live	Peak live + cum. dead	Peak count x 2 ^a	Mean count	Total live	AUC ^{b,c}
Lower Nass	Ksemamaith Creek	Yes	NFWD	5	13	13	26	8	33	51
	Tseax Side Channel	No	NFWD	5	41	41	82	16	79	116
Portland Inlet	Lizard Creek	No	PSC	2	4	7	14	2	4	NA
	Crag Creek	No	PSC	2	17	18	36	16	33	NA
Portland Canal	Donahue Creek	No	PSC	4	50	56	112	26	102	110
	Belle Bay Creek	No	PSC	4	0	0	0	0	0	NA
Observatory Inlet	Stagoo Creek	Yes	PSC	5	2,756	3,114	6,228	1,107	5,534	8,139
	Illiance River	Yes	PSC	4	268	268	536	124	619	902
	Wilauks Creek	Yes	PSC	4	206	217	434	109	437	418
	Kitsault River	Yes	PSC	4	132	135	270	73	293	351
	Kshwan River	Yes	PSC	4	1,381	1,505	3,010	739	2,955	3,006

^a Estimate is based on the observation that peak counts can underestimate weir counts by 30 to 50% (Cousens et al. 1982).

^b Residence time (RT) and standard deviation (SD) for lower Nass tributaries (Ksemamaith Ck, Tseax Side Channel): RT = 7 days; SD = 3 days.

^c For coastal streams: RT = 10 days; SD = 5.4 days (Perrin and Irvine 1990).

Table 4. Nass Area Chum Salmon escapement, harvest, and exploitation rates, 1980–2016 (NJTC 2017).

Year	Escapement to Nass Area indicator streams ^a								Nass Area escapement			Canadian harvests			Exploitation rates						
	Illiance River	Kitsault River	Ksemamaith Creek	Kshwan River	Kincolith River	Kwinamass River	Stagoo Creek	Willauks Creek	Obs. ^b	EF ^c	Est. ^d	Nisga'a ^e	Other ^f	Total	Total return to Canada	US Harvest ^g	Total Run	Nisga'a	Other Can.	US	Total
1980	3,000	8,600		20,000	100	800	1,500	1,000	35,000	1.6	55,646		52,304	52,304	107,950	141,011	248,960	21%	57%	78%	
1981	500	3,700	10	4,000	200	500	1,500	100	10,510	1.6	16,687		7,400	7,400	24,087	23,891	47,978	15%	50%	65%	
1982	400	800	25	10,000		100	500	100	11,925	1.6	19,005		10,691	10,691	29,696	6,145	35,841	30%	17%	47%	
1983	2,500	5,300	20	10,000	25	100	12,000	550	30,495	1.6	48,417		40,937	40,937	89,354	33,417	122,771	33%	27%	61%	
1984	5,000	6,500		8,000	200	500	15,000	1,000	36,200	1.6	57,554		63,614	63,614	121,168	43,126	164,294	39%	26%	65%	
1985	1,500	1,000		20,000	1	500	2,000	250	25,251	1.6	40,146		18,465	18,465	58,612	16,138	74,749	25%	22%	46%	
1986	1,200	3,000		20,000		150	2,500	75	26,925	1.6	42,969		24,577	24,577	67,546	50,120	117,666	21%	43%	63%	
1987	1,300	2,250	25	15,000		50	3,600		22,225	1.6	36,037		23,716	23,716	59,752	21,769	81,521	29%	27%	56%	
1988	350	1,500	100	15,000		100	1,000	250	18,300	1.6	29,164		8,847	8,847	38,011	20,816	58,827	15%	35%	50%	
1989	2,000	3,000		20	10,000		10,000		25,040	1.6	40,979		23,002	23,002	63,982	39,459	103,441	22%	38%	60%	
1990	10,000	1,000	20	6,500			8,000	500	26,020	1.6	41,538		19,601	19,601	61,139	37,061	98,199	20%	38%	58%	
1991	1,000	1,000	20	10,000			100		12,120	2.2	27,216		19,768	19,768	46,984	15,025	62,008	32%	24%	56%	
1992	1,506	3,000				100	3,500	700	8,806	3.3	28,622	200	25,556	25,756	54,378	13,361	67,739	0%	38%	20%	58%
1993	2,000	5,000		50,000		100	5,000	300	62,400	1.6	99,468	416	141,217	141,633	241,101	85,761	326,862	0%	43%	26%	70%
1994	4,000	8,500				10	10,000	400	22,910	3.3	74,463	579	31,507	32,086	106,549	44,451	151,000	0%	21%	29%	51%
1995	4,000	6,000		10,000	200	50	10,000	1,000	31,250	1.6	49,643	402	33,820	34,222	83,865	30,684	114,549	0%	30%	27%	57%
1996	400	1,320		10,000	50	100	4,000	450	16,320	1.6	25,926	269	14,635	14,904	40,829	21,066	61,896	0%	24%	34%	58%
1997	350			10,000		100	2,000	150	12,600	1.8	22,864	227	8,016	8,243	31,107	22,643	53,749	0%	15%	42%	57%
1998	3,000	12,530		50,000		50	30,000	2,000	97,580	1.6	155,546	983	27,371	28,354	183,900	108,814	292,715	0%	9%	37%	47%
1999	1,500	1,500		2,000		50	17,000	300	22,350	1.6	35,627	846	32,272	33,118	68,745	20,775	89,520	1%	36%	23%	60%
2000	1,200	1,696		2,000			6,500	300	11,696	1.6	18,793	1,067	6,607	7,674	26,467	4,072	30,539	3%	22%	13%	38%
2001	1,000	870		2,000	104	50	15,000	250	19,274	1.6	30,730	1,617	3,942	5,559	36,289	18,463	54,752	3%	7%	34%	44%
2002				3,000			5,000		8,000	1.9	15,055	132	2,917	3,049	18,105	1,763	19,867	1%	15%	9%	24%
2003				5,000			30,000		35,000	1.9	65,867	318	11,324	11,642	77,509	11,280	88,789	0%	13%	13%	26%
2004	1,500			15,000			12,000	400	28,900	1.7	50,514	1,030	6,906	7,936	58,449	25,095	83,544	1%	8%	30%	40%
2005	300		70	2,000	126		15,000	260	17,756	1.7	30,739	698	2,241	2,939	33,677	9,124	42,802	2%	5%	21%	28%
2006	1,800			15,000	20		13,000		29,820	1.8	52,652	1,110	7,637	8,747	61,399	13,098	74,497	1%	10%	18%	29%
2007				1,000	95		4,900		5,995	1.9	11,221	932	884	1,816	13,037	8,672	21,709	4%	4%	40%	48%
2008				1,000	24		640		1,664	1.9	3,115	506	168	674	3,789	465	4,254	12%	4%	11%	27%
2009	475		51	1,500			9,800	60	11,886	1.7	20,680	139	1,064	1,203	21,883	7,685	29,568	0%	4%	26%	30%
2010	170		68	500			4,200		4,938	1.8	8,723	102	202	304	9,026	1,073	10,099	1%	2%	11%	14%
2011			80	1,170			2,200		3,450	1.9	6,461	210	392	602	7,062	1,477	8,539	2%	5%	17%	24%
2012	113		32	1,100			7,925	56	9,226	1.7	16,070	316	393	709	16,779	2,266	19,046	2%	2%	12%	16%
2013	500	100	20	1,100	N/I	A/P	7,100	300	9,120	1.6	14,480	111	563	674	15,154	2,314	17,468	1%	3%	13%	17%
2014	419	A/P	25	N/I	N/I	N/O	8,200	63	8,707	2.9	25,681	553	475	1,028	26,709	3,567	30,276	2%	2%	12%	15%
2015	1,820	445	91	17,400	N/I	A/P	6,758	449	26,963	1.6	42,841	255	3,776	4,031	46,872	7,248	54,120	0%	7%	13%	21%
2016	902	351	81	3,265	N/I	N/I	8,139	418	13,156	1.6	20,903	2,486	187	2,673	23,576	4,678	28,254	9%	1%	17%	26%
Averages:																					
1980–1989	1,775	3,565	33	13,200	91	311	4,960	416	24,187	1.6	38,660		27,355	27,355	66,016	39,589	105,605	25%	34%	59%	
1990–1999	2,776	4,428	20	18,563	125	73	9,944	644	31,236	2.0	56,091	490	35,376	35,769	91,860	39,964	131,824	0%	27%	30%	57%
2000–2009	1,046	1,283	61	4,750	74	50	11,184	254	16,999	1.8	29,937	755	4,369	5,124	35,060	9,972	45,032	3%	9%	21%	33%
2010–2019	654	299	57	4,089			6,360	257	10,794	1.9	19,308	576	855	1,432	20,740	3,232	23,972	2%	3%	14%	19%
2007–2014	335	100	46	1,053	60		5,621	120	6,873	1.9	13,304	359	518	876	14,180	3,440	17,620	3%	3%	18%	24%

A/P = Adults present; N/I = Not inspected; N/O = None observed

^a Data are from the DFO New Salmon Escapement Database (NuSEDs).^b Sum of the annual surveyed indicator stream escapements as documented in NuSEDs.^c Expansion factor to account for non-surveyed indicator systems, escapement to non-indicator systems, and observer efficiency (1.5) for each year. Method was developed by the Pacific Salmon Foundation (English et al. 2012).^d Estimated Nass Area escapement (product of observed escapement and expansion factor).^e Nisga'a catch from annual reports by Nisga'a Fisheries Wildlife Department (see Mathews et al. 2012).^f Canadian marine commercial catch is estimated from methods developed by the Pacific Salmon Foundation (English et al. 2012) and include commercial harvests in net fisheries only.^g US commercial catch is estimated from methods developed by the Pacific Salmon Foundation (English et al. 2012).

Table 5. Chum Salmon otolith and scale samples collected from Nass Area streams in 2016.

Area	Stream	Number of Samples	
		Otoliths	Scales
Lower Nass	Ksemamaith Creek	1	1
	Tseax Side Channel	2	4
Portland Inlet	Crag Creek	2	1
Portland Canal	Donahue Creek	2	2
Observatory Inlet	Stagoo Creek	7	NC
	Kshwan River	3	NC
	Illiance River	3	NC
Total		20	8

NC = Not collected

Table 6. Summary of 2016 water temperature and turbidity measurements surveyed streams.

Area	Stream	Temperature (°C)			Turbidity (NTU)		
		Average	Min	Max	Average	Min	Max
Lower Nass	Ksemamaith Creek	10.5	9.0	11.5	NR	Clear	Clear
	Tseax Side Channel	11.2	11.0	11.4	NR	Clear	Clear
Portland Inlet	Lizard Creek	15.7	14.2	16.5	1.9	1.7	2.1
	Crag Creek	12.7	12.3	13.0	2.5	1.7	4.4
Portland Canal	Donahue Creek	10.8	9.0	12.2	3.7	2.9	5.2
	Belle Bay Creek	12.2	11.3	12.5	1.3	1.2	1.3
Observatory Inlet	Stagoo Creek	8.9	7.1	18.1	11.1	2.0	21.0
	Kitsault River ^a	10.5	8.5	15.2	10.6	1.4	37.5
	Illiance River	11.9	9.6	15.6	6.0	1.7	22.9
	Wilauks Creek	11.6	9.1	13.2	10.0	4.7	22.0
	Kshwan River ^b	8.3	6.1	11.4	10.5	1.5	40.0

NR = not recorded.

^a Kitsault River values are for Falls Creek and a mainstem side channel.

^b Kshwan River values are for the surveyed side channels and unnamed tributaries of Kshwan River.

Table 7. Summary of 2016 walk-ability, snorkel-ability, and spawning habitat quality scores for Chum Salmon survey streams.

Area	Stream	Walk-ability ^a			Snorkel-ability ^a			Spawning Habitat Quality ^a		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
Lower Nass	Ksemamaith Creek	4	2	5	2	1	3	3	2	5
	Tseax Side Channel	4	3	4	3	2	3	4	2	5
Portland Inlet	Lizard Creek	4	3	5	2	1	2	4	3	4
	Crag Creek	4	3	4	2	1	2	4	4	5
Portland Canal	Donahue Creek	4	3	5	2	1	3	3	2	4
	Belle Bay Creek	3	2	3	2	1	2	1	1	2
Observatory Inlet	Stagoo Creek	4	1	5	2	1	3	4	3	5
	Illiance River	4	1	5	2	1	3	4	2	5
	Wilauks Creek	4	3	4	2	1	2	3	2	4
	Kitsault River ^b	5	4	5	2	1	2	4	2	5
	Kshwan River ^c	4	1	5	2	1	2	4	2	5

^a 1 = Poor; 2 = Low; 3 = Moderate; 4 = Good; 5 = Excellent

^b Kitsault River values are for Falls Creek and a mainstem side channel.

^c Kshwan River values are for surveyed side channels and unnamed tributaries.

FIGURES

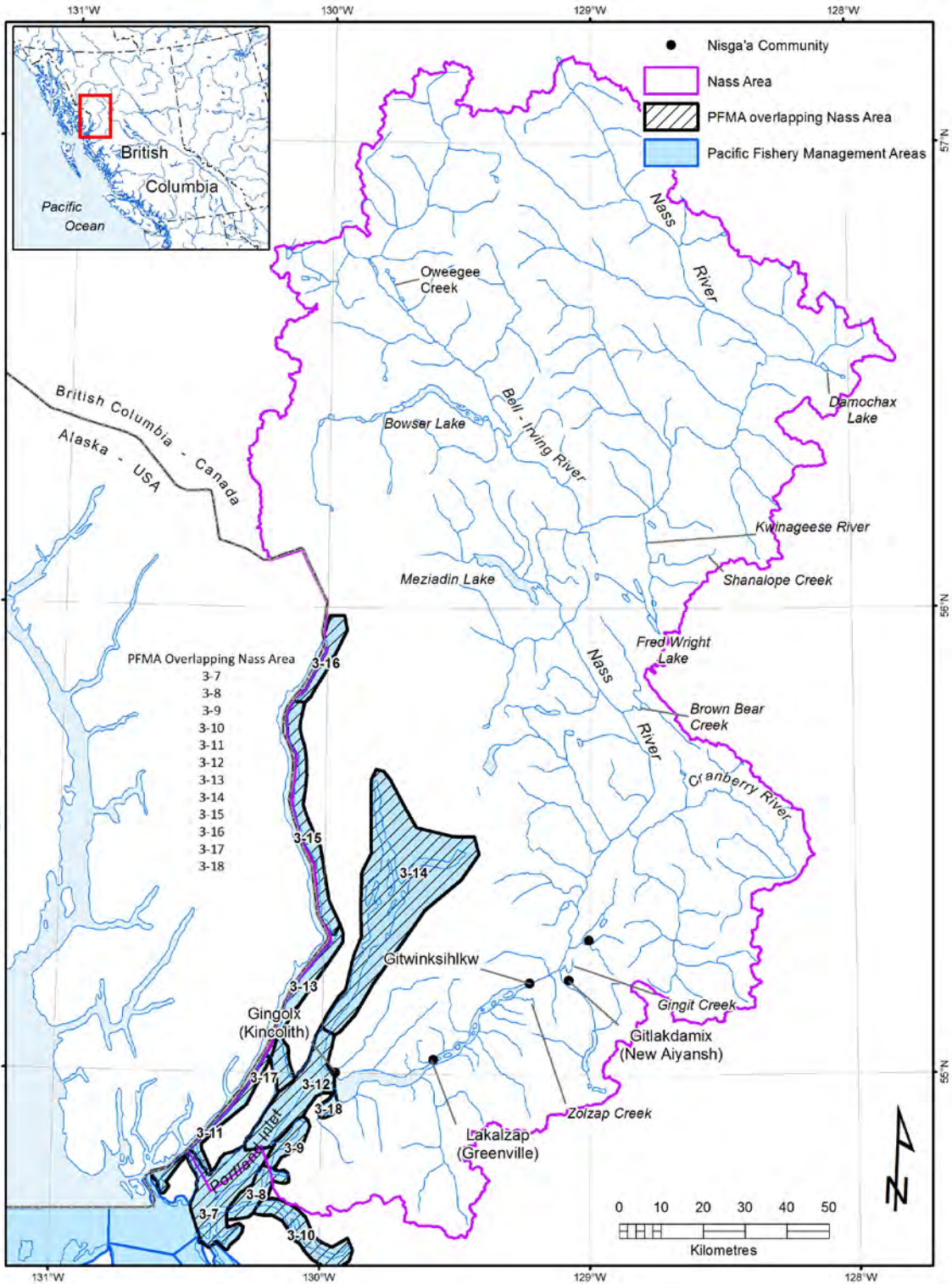


Figure 1. Pacific Fishery Management Area 3 and the Nass Area as defined by the Nisga'a Treaty.

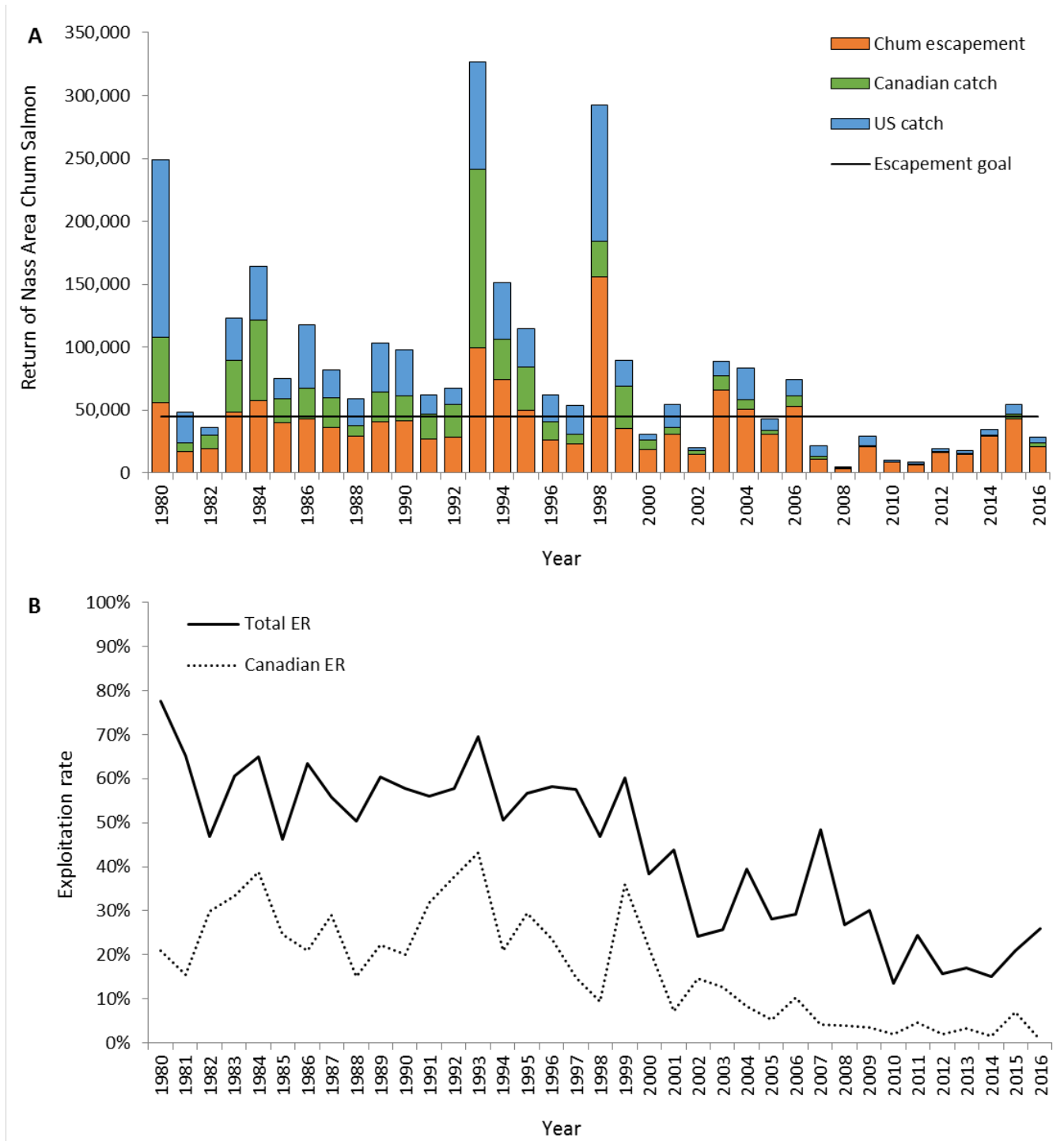


Figure 3. Nass Area Chum Salmon (A) escapement and catch, and (B) exploitation rates from 1980 to 2016.

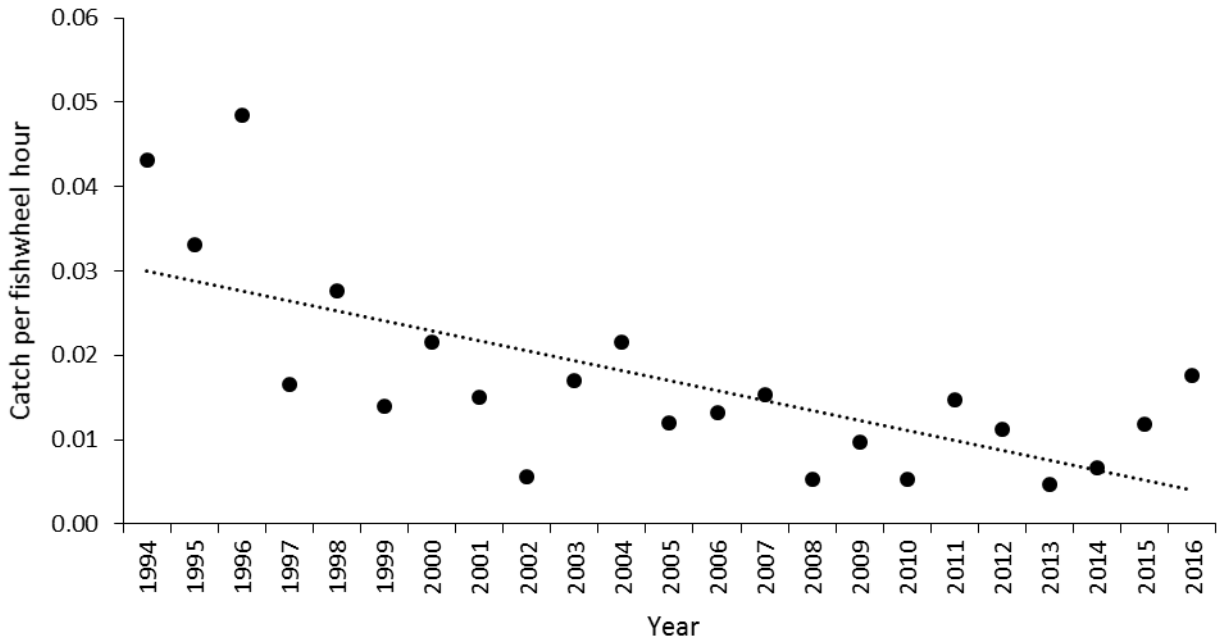


Figure 4. Declining trend in Chum Salmon catch per hour at the lower Nass River fishwheels since 1994. The fishwheel catch rate has increased annually from 2013 to 2016.

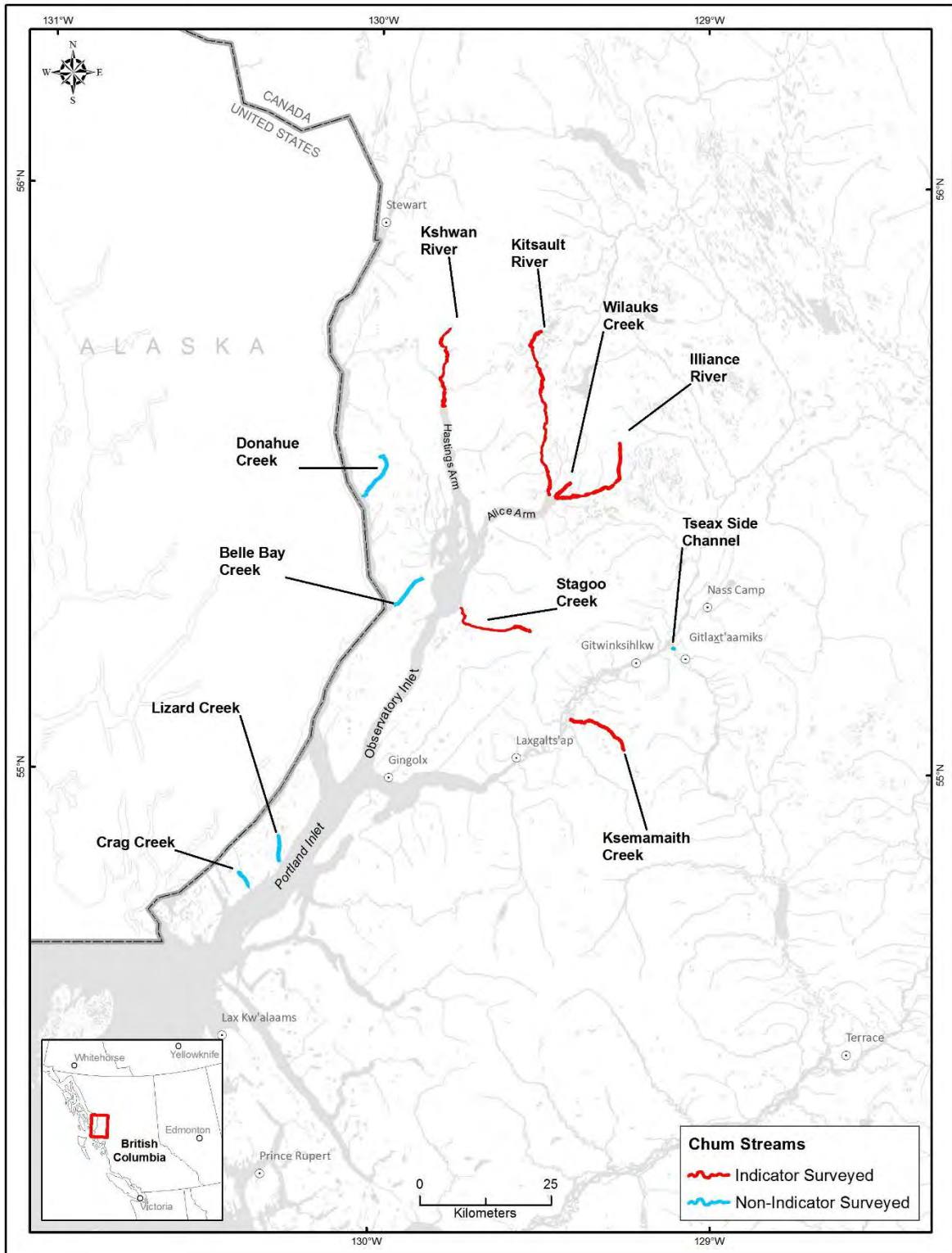


Figure 5. Nass Area Chum Salmon indicator and non-indicator streams surveyed in 2016.



Figure 6. Kitsault River Chum Salmon survey locations in 2016. Due to access constraints, surveys were limited to Falls Creek and a mainstem side channel.



Figure 7. Kshwan River side channels and tributaries surveyed for Chum Salmon spawners in 2016.

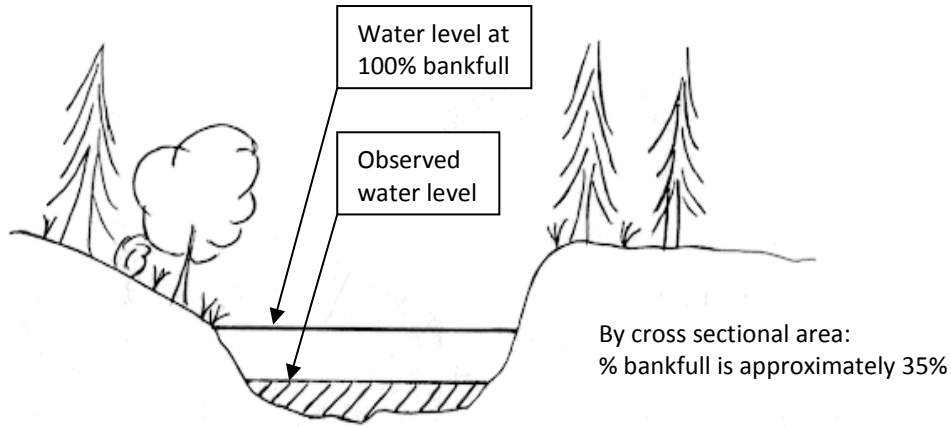


Figure 8. Estimating percent bankfull based on the portion of the channel that is wetted. Figure was copied from DFO Stream Inspection Log definitions.

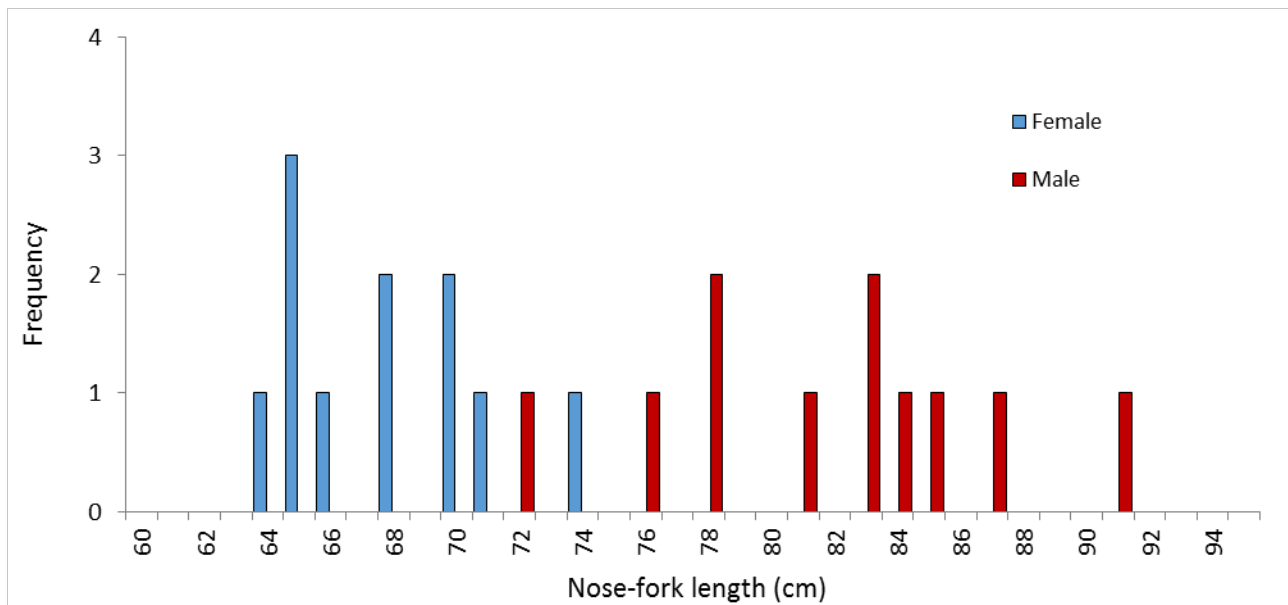


Figure 9. Length frequency histograms for male and female Chum Salmon sampled in Nass Area streams in 2016.



0.7 NTU; Kshwan River Side Channel



2.6 NTU; Donahue Creek



4.0 NTU; Stago Creek



8.8 NTU; Kshwan River Side Channel



14.7 NTU; Wilauks Creek



25.1 NTU; Stago Creek

Figure 10. Examples of different turbidity levels measured in 2015, ranging from 0.7 to 25.1 NTU. Similar values and turbidity conditions were observed in 2016.

PHOTOS



A) Ksemamaith Creek



B) Tseax Side Channel

Photo 1. Typical counting conditions in A) Ksemamaith Creek and B) Tseax Side Channel in the lower Nass.



A) Typical counting conditions.



B) Unstable and cobble-boulder dominated substrate observed throughout the lower reaches.

Photo 2. Representative images of Belle Bay Creek showing A) typical counting conditions and B) unstable channel conditions.



Photo 3. Representative images of Donahue Creek.



A) Lizard Creek – typical habitat.



B) Lizard Creek – typical habitat.



C) Lizard Creek – filamentous algae.



D) Lizard Creek – cascade at mouth of stream

Photo 4. Representative images of Lizard Creek on Pearse Island in Portland Inlet. Water in Lizard Creek was tannin stained and tea coloured.



Crag Creek

Photo 5. Representative images of typical counting conditions observed in Crag Creek on Pearse Island in 2016. Water in Crag Creek was tannin stained and tea coloured.



A) Typical counting conditions with several Chum.

B) High turbidity and water levels encountered on 25 July.

Photo 6. Stago Creek images showing A) typical counting conditions and Chum Salmon spawners, and B) poor counting conditions related to high turbid flows.



A) Kshwan River west side channel (reach 5)

B) Kshwan River east tributary (reach 3)

Photo 7. Representative images of A) a Kshwan River side channel (west side of the river) and B) an east side tributary. Note that reach 5 had high turbidity during most surveys but was clear on 21 September.



A) Falls Creek

B) Kitsault River side channel

Photo 8. Representative images of A) Falls Creek (Kitsault River tributary) and B) a mainstem Kitsault River side channel.



A) Illiance River



B) Clary Creek



C) Illiance River waterfall.



D) Clary Creek waterfall.

Photo 9. Representative images of A) Illiance River and B) Clary Creek (Illiance tributary). Surveys in both streams end at waterfalls (C & D).

Wilauks Creek

Photo 10. Representative images of Wilauks Creek



Collecting scales



Measuring nose-fork length

Photo 11. Examples of Chum Salmon bio-sampling.

APPENDICES

Appendix A. Field Forms

Table A-1. Nisga'a Fisheries and Wildlife Department Chum Salmon stream survey fish count form.

NFWD Chum Stream Survey Form - 2016							Stream Name:				Crew:		Date (dd-mmm):	
Method:							Air (°C):							
Reach	Start/End Times	Live Count					Carcass Count			Photo Number(s)	Comments			
		Chum Tag/NoTag	Pink	Sockeye Tag/NoTag	Chinook Tag/NoTag	Coho Tag/NoTag	Obs. Eff. (%)	Chum No Tag	Chum Tagged			Pink		
Totals														
Comments:														

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

NFWD Stream Countability - 2016											Stream Name:					Crew:			Date (dd-mmm):	
Reach	Time	% Overcast	Wind	Precip.	Clarity	% Bankfull	Depth (m)	Instream Visibility (m)	Water (°C)	Turbidity (NTU)	DO %	DO mg/L	Walk Score (1-5)	Snorkel Score (1-5)	Habitat Score (1-5)	Photo #	Comments			
			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:																				

Table A-3. Nisga'a Fisheries and Wildlife Department salmon biosample form.

NFWD Stream Survey - BIOSAMPLE FORM						Year:					Crew:		
Stream Name	Reach	Date (dd-mmm)	Species (circle)	Sex	NF Length (cm)	Tag Type (circle)	Tag # & Colour	Secondary Mark (circle)	Otolith Vial #	Scalebook #	Scale #	Condition	Comments
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
Comments:													

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

Table B-1. Walk-ability score descriptions.



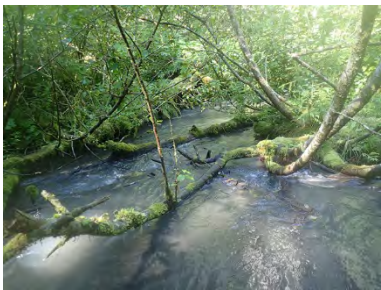
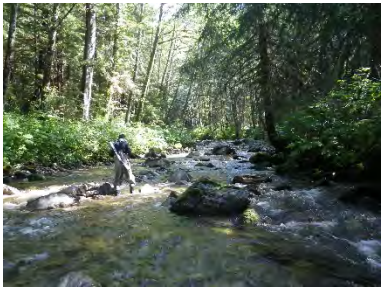

Score	Classification	Description	Example
1	Poor	Extremely difficult or not walkable due to safety concerns (log jams; high flows) or poor accessibility coupled with high flows or turbidity, debris, limited visibility, high confinement or other factors.	
2	Low	Difficult walking due to steep, fast, or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





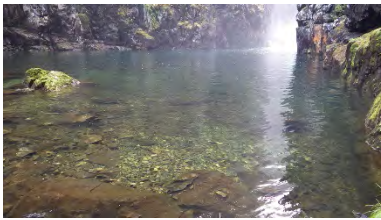





Score	Classification	Description	Example
1	Poor	Snorkelling not possible due to lack of deep pools or glides; extensive debris jams, lack of safe egress; high turbidity or velocity prevent safe or effective snorkelling.	
2	Low	Snorkelling difficult due to lack of suitable habitat. Pools and glides are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

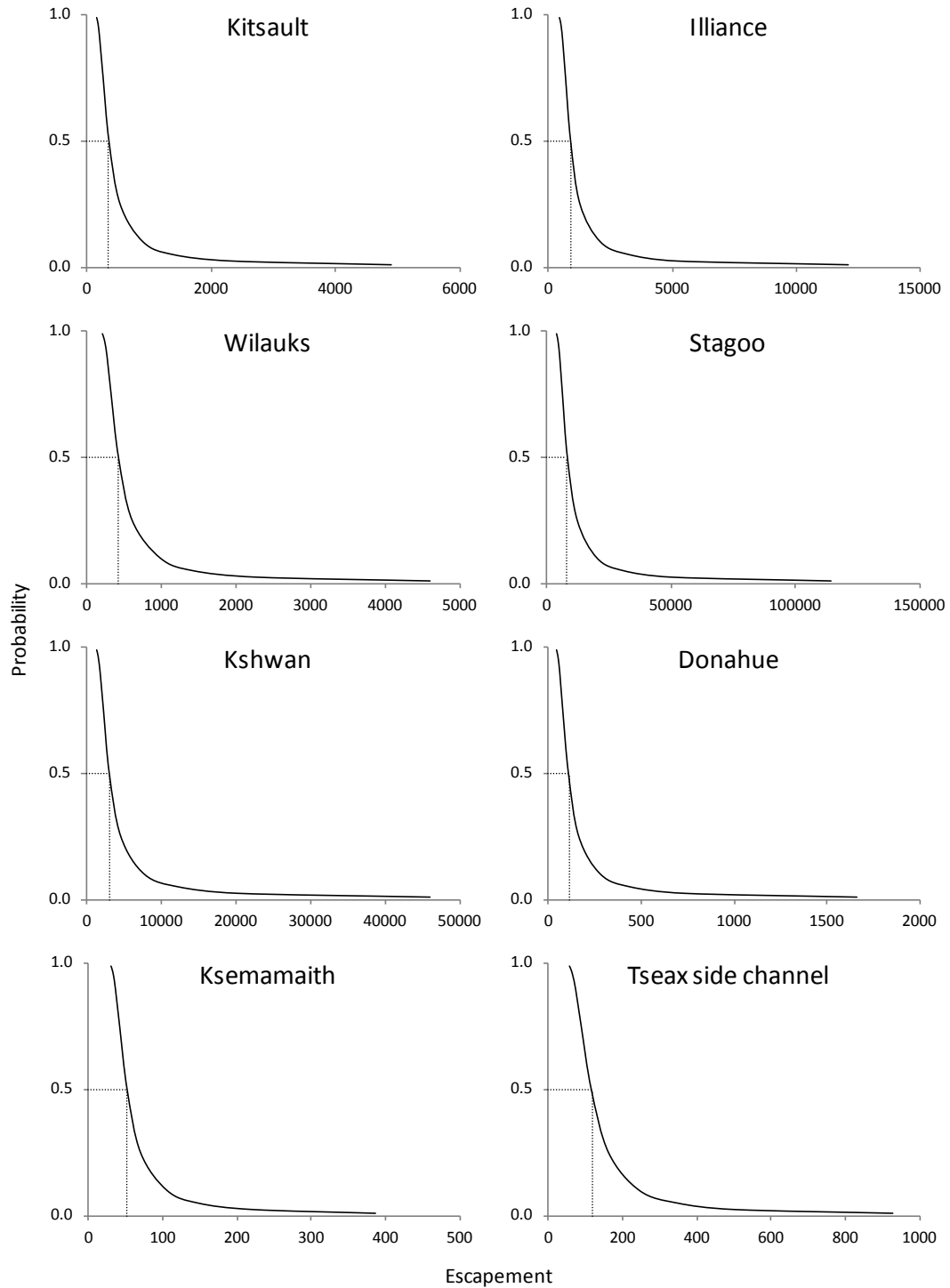


Figure C-1. Probability distributions of AUC escapement estimates for Nass Area Chum Salmon streams surveyed in 2016. Probability distributions were generated using AUCmonteMASTER 2.04 and the dashed lines show the escapement estimate for each year.

Appendix D. Counts and escapement estimates for Pink and Sockeye salmon.

Table D-1. Pink and Sockeye salmon counts for each stream surveyed in 2016.

Survey		Pink			Sockeye			Comment			
Area	Stream name	Date	Length (m)	Observer efficiency	Raw live	Expanded live	Carcass		Raw live	Expanded live	Carcass
Lower Nass	Ksemamaith Creek	2016-07-27	1250	93%	0	0	0	0	0	0	
		2016-08-16	1250	90%	460	547	6	0	0	0	
		2016-08-25	1250	90%	1,328	1,476	44	0	0	0	
		2016-09-05	1250	90%	300	333	0	1	1	0	
		2016-09-15	235	75%	36	48	10	0	0	0	
	Tseax Side Channel	2016-07-27	380	95%	0	0	0	0	0	0	
		2016-08-16	380	90%	0	0	0	15	17	0	
		2016-08-25	380	90%	2	2	0	0	0	0	
		2016-09-05	380	80%	7	9	0	0	0	0	
		2016-09-15	380	90%	48	53	7	1	1	0	
Portland Inlet	Lizard Creek	2016-08-23	2000	70%	162	249	1	0	0	0	
		2016-09-03	2000	73%	286	381	31	0	0	0	
		2016-09-14	0								High flows prevented access to stream.
	2016-09-23	0								High flows prevented access to stream.	
	Crag Creek	2016-08-23	3000	65%	559	860	1	0	0	0	
		2016-09-03	3000	70%	2,379	3,209	72	0	0	0	
		2016-09-14	1000	40%	352	880	28	0	0	0	
2016-09-23		0								Flood conditions; high turbid flow prevented safe access.	
Portland Canal	Donahue Creek	2016-08-12	800	70%	39	56	0	0	0	0	
		2016-08-22	800	70%	179	256	3	0	0	0	
		2016-09-02	800	50%	76	152	8	0	0	0	
		2016-09-13	800	90%	16	18	1	0	0	0	
	Belle Bay Creek	2016-08-12	830	100%	0	0	0	0	0	0	
		2016-08-22	830	82%	0	0	1	0	0	0	
		2016-09-02	430	80%	4	5	0	0	0	0	
2016-09-13	430	90%	0	0	0	0	0	0			
Observatory Inlet	Stagoo Creek	2016-07-15	4500	70%	0	0	0	0	0	0	
		2016-07-25	1000	28%	0	0	0	0	0	0	Survey incomplete due to high turbid flow.
		2016-08-06	4500	70%	1,380	1,971	0	0	0	0	
		2016-08-16	4500	30%	870	2,900	3	0	0	0	Poor instream visibility.
		2016-08-26	0								No survey due to high turbid flow.
		2016-09-06	4500	66%	1,520	2,536	505	0	0	0	

Table D-1 continued.

Survey		Pink			Sockeye						
Area	Stream name	Date	Length (m)	Observer efficiency	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Comment
		2016-07-26	900	96%	0	0	0	0	0	0	
		2016-08-07	900	74%	15	19	0	0	0	0	
	Kitsault River ^a	2016-08-18	900	80%	251	313	19	2	3	0	
		2016-08-26	0								River flooding. No survey due to high turbid flow.
		2016-09-07	900	30%	192	2,927	140	0	0	0	
		2016-07-26	1800	60%	2,745	4,522	0	0	0	0	
	Illiance River	2016-08-07	1800	80%	9,000	11,250	0	1	1	0	
		2016-08-17	1800	77%	5,500	6,933	33	1	1	0	
		2016-08-26	0								River flooding. No survey due to high turbid flow.
		2016-09-07	1800	30%	1,244	3,830	1,029	0	0	0	
Observatory Inlet		2016-07-27	50								Survey cancelled due to grizzly bear with cubs in stream.
		2016-08-08	1900	70%	182	251	0	0	0	0	Survey did not include unnamed tributary near mouth.
	Wilauks Creek	2016-08-17	2260	66%	752	1,086	0	0	0	0	Survey included unnamed tributary near mouth.
		2016-08-26	2260	65%	633	910	282	0	0	0	Survey included unnamed tributary near mouth.
		2016-09-07	1050	30%	56	297	166	0	0	0	Reaches 3 & 4 not counted due to turbid flow.
		2016-08-19	3800	72%	109	215	4	0	0	0	River left (reaches 1-3) inaccessible and not surveyed.
		2016-08-27	3800	63%	348	434	23	0	0	0	River left inaccessible and not surveyed.
		2016-09-08	3800	80%	165	404	28	0	0	0	River left inaccessible and not surveyed.
	Kshwan River	2016-09-20	1100	93%	13	14	0	0	0	0	River left reaches accessed and counted.
		2016-09-21	1250	80%	99	124	19	0	0	0	Counts are for river left reaches. Survey cut short by encounter with sow grizzly and 3 cubs near top of reach 5. Reaches 6 and 7 not counted.

^aKitsault River surveys included a mainstem sidechannel and the first 100m of Falls Creek.

Table D-2. Best escapement estimates for Pink and Sockeye Salmon runs observed during Chum Salmon surveys in the Nass Area, 2016. Counts were insufficient to generate escapement estimates for Chinook Salmon.

Area	Stream name	Escapement estimates			
		Pink		Sockeye	
		AUC ^a	Peak count x 2 ^b	AUC ^c	Peak count x 2 ^b
Lower Nass	Ksemamaith Creek	1,959	2,952	A/P	
	Tseax Side Channel	58	106	NA	34
Portland Inlet	Lizard Creek	NA	762	NO	
	Crag Creek	NA	6,418	NO	
Portland Canal	Donahue Creek	407	512	NO	
	Belle Bay Creek	NA	10	NO	
Observatory Inlet	Stagoo Creek	8,033	5,800	NO	
	Kitsault River ^d	764	626	A/P	
	Illiance River	26,457	22,500	A/P	
	Wilauks Creek	1,919	2,172	NO	
	Kshwan River ^e	812	868	NO	

A/P = Adults present; NO = None observed.

^a Residence time (RT) and standard deviation (SD) for Pink Salmon estimates: RT = 12.6 days; SD = 4.0 days.

^b Estimate is based on the observation that peak counts can underestimate weir counts by 30 to 50% (Cousens et al. 1982).

^c Insufficient counts for Sockeye Salmon AUC estimates.

^d Kitsault River estimates are based on counts from Falls Creek and a mainstem side channel.

^e Kshwan River estimates are based on counts from side channels and unnamed tributaries of Kshwan River.