Data Summary Report for Chum Salmon Escapement Surveys in the Nass Area in 2015

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Nisga'a Fisheries Report #15-26

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EXECUTIVE SUMMARY

Beveridge, I. A., R. F. Alexander, S. C. Kingshott, C. A. J. Noble, and C. Braam. 2016. Data summary report for Chum Salmon escapement surveys in the Nass Area in 2015. Prepared by LGL Limited, Sidney, BC, for the Pacific Salmon Commission, Vancouver, BC, and the Nisga'a Lisims Government Fisheries and Wildlife Department, Gitlax̱t'aamiks, BC. Nisga'a Fisheries Report #15-26: v + 42 p.

Funding ($70,000) received from the Pacific Salmon Commission's Northern Fund in 2015 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 part of a multi-year research project started in 2014 (Beveridge and Alexander 2015).

A total of 14 systems, including six indicator (Ksemamaith, Kshwan, Stagoo, Kitsault, Illiance, Wilauks) and eight non-indicator (Donahue, Lizard, Crag, Perry Bay, Tseax, Pirate Cove, Zolzap, and Gitzyon) streams, were inspected between 27 July and 2 October 2015 in the Lower Nass (n = 4), Portland Inlet (n = 3), Portland Canal (n =1), and Observatory Inlet (n = 6). At least four surveys spanning the peak count were made in each indicator system with a total of 59 surveys conducted in the Nass Area in 2015.

High quality escapement estimates were produced for each indicator stream and for most non-indicator streams surveyed in 2015. The highest escapement was observed in the Kshwan River system (17,400) that accounted for 65% of the observed Nass Area escapement (26,963). The total escapement to the Nass Area in 2015 was estimated at 42,841 Chum Salmon, just below (5%) the escapement goal (45,000). This is the largest escapement documented to Nass Area streams since 2006 and is 1.7 to 13.8 times the escapement estimated from 2007 to 2014. The estimated total return of Nass Area Chum Salmon in 2015 was 54,120 which was the 15th best return since 1980.

INTRODUCTION

Chum Salmon (*Oncorhynchus keta*) stocks in the Nass Area (Figure 1) are depressed, with returns below the provisional escapement target (45,000) in recent years (Figure 2A; Beveridge and Alexander 2015; NJTC 2016). Since 2007, Nass Area Chum Salmon have: 1) returned on average 83% (85,000 fish) lower than the average return from 1980 to 2006 (18,000 vs. 70,000); 2) not met escapement goals; and 3) failed to show signs of recovery based on the assessment data currently collected (Beveridge and Alexander 2015; NJTC 2016). This trend is reflected in Chum Salmon catches at Gitwinksihlkw fishwheel test fishery in the lower Nass River from 1994 to 2015 (NFWD 2016). The number of Chum Salmon captured per hour of operation has declined since fishwheel operations began in 1994 (Figure 3). In response to poor returns of Nass Area Chum Salmon in recent years, Fisheries and Oceans Canada (DFO) fisheries managers have reduced Canadian commercial gillnet and seine exploitation rates to a mean of 3% (range: 2–5%) from 2007 to 2014 compared to the 1980 to 2006 mean of 22% (range: 5–43%; Figure 2B; NJTC 2016). However, recovery of Chum Salmon stocks has not occurred to date as evident in poor escapement to Nass Area streams since 2007, ranging from 3,000 (2008) to 26,000 (2014).

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 required 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 2016).

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 1). 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 (English et al. 2012).

Objectives

Escapement surveys in 2015 represent Year 2 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 2 (2015) 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 seven Chum Salmon indicator systems (Ksemamaith, Kshwan, Stagoo, Kitsault, Illiance, Wilauks, and Kwinamass) by conducting rigorous and repeatable surveys on the ground and by helicopter (where appropriate) during the complete migration of Chum Salmon to those systems with a minimum of four trips planned to each system;
2. Assess eight non-indicator Chum Salmon streams (Donahue, Lizard, Crag, Perry Bay, Tseax, Pirate Cove, Zolzap, and Gitzyon) where historical Chum Salmon escapement records are available. Assessment will be conducted using rigorous and repeatable ground based surveys; and
3. Estimate escapement to each of the streams surveyed and evaluate the escapement methods used (e.g., Peak Count, AUC, etc.).

METHODS

Surveyed Streams

Fourteen Nass Area streams were surveyed for Chum Salmon escapement in 2015 by NFWD and LGL, including six indicator and eight non-indicator streams (Figure 4). The seventh remaining indicator stream, Kwinamass River, was to be surveyed with DFO as part of DFO's Charter Patrol Program; but the stream surveys to the system were cancelled in 2015.

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 2015 were:

Lower Nass (Photo 1):

1. Ksemamaith Creek (Indicator Stream)
2. Zolzap Creek
3. Gitzyon Creek
4. Tseax side channel

Portland Inlet (Photo 2):

5. Lizard Creek
6. Crag Creek
7. Pirate Cove Creek

Portland Canal (Photo 3):

8. Donahue Creek

Observatory Inlet (Photos 4–7):

9. Illiance River (Indicator Stream)
10. Wilauks Creek (Indicator Stream)
11. Kitsault River (Indicator Stream; Figure 5). Surveys were conducted in:
    a. a mainstem side channel
    b. tributaries (Falls, Gwunya, La Rose, and Klayduc creeks)
12. Kshwan River (Indicator Stream; Figure 6). Surveys were conducted in:
    a. mainstem side channels
    b. unnamed tributaries
13. Stagoo Creek (Indicator Stream), and
14. Perry Bay Creek.

At least four ground surveys (stream walks) spanning the peak count were planned for each system. Surveys started with Stagoo Creek on 27 July and ended with Kshwan River on 2 October. Access methods included marine vessel, small boat, truck, and all-terrain vehicle (ATV) 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 conditions (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 7). 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 ≤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 were sampled for nose-fork length (NFL; cm) and identified by sex. To check for Alaskan hatchery origin, otoliths were collected where possible and stored dry 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 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 2015, 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

One to eight stream walks were conducted on each stream (Table 2) with at least four surveys conducted on indicator systems (Figure 4; Table 2). However, several issues limited the number of surveys on some streams to conduct effective counts. These included unsafe high flows (e.g., Lizard Creek), very low flows (e.g., Perry Bay Creek), poor weather and sea conditions preventing safe access (e.g., Pearse Island streams), and low counts indicating that peak spawning was missed (e.g., Donahue Creek).

Chum Salmon Escapement Estimates

Chum Salmon were observed in nearly every stream surveyed in 2015. Only Perry Bay Creek and Lizard Creek did not have Chum Salmon, although spawners have been previously observed (Beveridge and Alexander 2015). Six indicators were visited multiple times, producing high quality estimates for these streams.

The highest peak counts were observed in Stagoo Creek (3,379) on 9 August and Kshwan River side channels (8,700) on 10 September and the lowest counts were observed in Gitzyon Creek (2) and the Pearse Island streams (Lizard Creek = 0; Pirate Cove Creek = 3; and Crag Creek = 6). Of the six Indicator streams surveyed in 2015, Kshwan accounted for 64.5% of the total estimated observed escapement (26,963)to Nass Area streams, followed by Stagoo (25.1%), Illiance (6.7%), Kitsault and Wilauks (1.7%), and Ksemamaith (0.3%).

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 2016). The estimated Nass Area escapement (42,841) was just below the escapement goal (45,000; Figure 2) and was 1.7 to 13.8 times the estimates from 2007 to 2014 (Table 4). The increase in Chum Salmon escapement in 2015 was also reflected in an increase in Gitwinksihlkw fishwheel catches of Chum Salmon (Figure 8).

Pink, Sockeye, and Chinook Salmon Counts and Escapement Estimates

Counts of Pink (*O. gorbuscha*), Sockeye (*O. nerka*), and Chinook salmon (*O. tshawytscha*) are summarized in Appendix D. Pink Salmon were observed in all assessed streams (Table D - 1). In the lower Nass streams, no Chinook Salmon were counted and Sockeye Salmon were only observed in Gitzyon Creek and the Tseax side channel. In coastal systems of Area 3, Sockeye and Chinook salmon were only counted in the Kitsault River and its tributaries.

Sufficient data were collected to estimate escapement (AUC or peak count method) for Pink and Sockeye salmon for nine and two streams, respectively (Table D - 2). Chinook Salmon counts were too low to estimate escapement.

Bio Samples

Eighty-two Chum Salmon were bio-sampled in spawning streams in 2015. Of these, 29 (35%) were sampled in Lower Nass tributaries and the remainder were sampled in coastal streams. Nose-fork length was measured for 72 fish and the average NFL for male and female Chum Salmon from all streams was 75.2 cm (range: 48–95 cm) and 69.1 cm (range: 59−82 cm), respectively (Figure 9; Photo 8).

Otoliths were collected from 54 Chum Salmon from 10 streams (Table 5). Three of these fish, all from Crag Creek, had thermal markings indicating Alaska hatchery origin. Each thermally marked fish was released in 2011 from a different Alaskan hatchery: Kendrick, Nakat Inlet, and Neets Bay.

Scales were collected from 29 (16 female; 13 male) Chum Salmon in lower Nass tributaries (Table 5; Photo 8). One scale book (nine samples) was unfortunately lost. Of the 13 samples successfully aged (Gilbert Rich notation), 11 were aged 4_1, one was 3_1, and one was 2_1 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

No usual temperatures were measured, with average temperature ranging from 8.3°C in Kshwan River side channels to 12.4°C in Lizard Creek (Table 6). Average turbidity was low in all streams, ranging from 0.7 NTU in Perry Bay Creek to 7.3 NTU in Kshwan 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, Pirate Cove, and Crag creeks) were all tea coloured (Photo 2) 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 Pirate Cove Creek, was either moderate or good (Table 7). Due to extensive blow-down and logjams, Pirate Cove Creek had a low 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 Perry Bay Creek (poor; Table 7). Very low water levels severely limited any potential spawning in Perry Bay Creek in 2015. The highest quality spawning habitat was observed in the Tseax side channel, Lizard Creek, Wilauks Creek, Kitsault River tributaries, 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, and Belle Bay Creek) to determine if theses 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.
4. Discontinue Chum Salmon surveys in Gitzyon and Zolzap creeks based on the very few Chum Salmon observed in these systems.
5. Discontinue Chum Salmon surveys in Pirate Cove Creek based on the poor walk-ability score, limited spawning habitat, and low counts.
6. Start surveys in Donahue Creek and Kshwan River in early to mid-August in 2016. Over 4,000 Chum Salmon were observed in Kshwan River channels on the first 2015 survey

(31 August−1 September) and the first count in Donahue Creek (21 August) was the highest.

7. 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.
8. Evaluate survey life combined with observer efficiency for variation within and among streams surveyed.

REFERENCES

Beveridge, I. A., and R. F. Alexander. 2015. An evaluation of Nass Area Chum Salmon escapement data, 1980–2014. Prepared by LGL Limited, Sidney, BC, for the Pacific Salmon Commission, Vancouver, BC, and the Nisga'a Lisims Government Fisheries and Wildlife Department, New Aiyansh, BC. Nisga'a Fisheries Report #14-26. v + 35 p.

Cousens, N. B. F., G. A. Thomas, C. G. Swan, and M. C. Healy. 1982. A review of salmon escapement estimation techniques. Canadian Technical Report of Fisheries and Aquatic Sciences 1108: vi + 122 p.

DFO (Fisheries and Oceans Canada). 2009. Framework for implementation of the Wild Salmon Policy: initial lists of Conservation Units for British Columbia. DFO Canadian Science Advisory Secretariat Science Advisory Report 2009/055: 31 p.

English, K. K., R. C. Bocking, and J. R. Irvine. 1992. A robust procedure for estimating salmon escapement based on the area under the curve method. Canadian Journal of Fisheries and Aquatic Sciences 49: 1982–1989.

English, K. K., T. Mochizuki, and D. Robichaud. 2012. Review of North and Central Coast salmon indicator streams and estimating escapement, catch and run size for each salmon conservation unit. Prepared by LGL Limited, Sidney, BC, for the Pacific Salmon Foundation and Fisheries and Oceans Canada. iv + 68 p.

Holt, K. R., and S. P. Cox. 2008. Evaluation of visual survey methods for monitoring Pacific salmon (*Oncorhynchus* spp.) escapement in relation to conservation guidelines. Canadian Journal of Fisheries and Aquatic Sciences 65: 212–226.

Mathews, M. A., A. C. Blakley, R. C. Bocking, C. Y. Stephens, and N. S. Morven. 2012. Nisga'a Salmon and Steelhead Catch Monitoring Program 2006–2011. Prepared by LGL Limited, Sidney, BC, and Nisga'a Fisheries and Wildlife Department, New Aiyansh, BC, for Nisga'a Lisims Government, New Aiyansh, BC. Nisga'a Fisheries Report #11-03: vii + 115 p.

NFWD. 2016. Nisga'a Fisheries Program: final report of funded 2015 projects. Report prepared by the Nisga'a Fisheries and Wildlife Department, New Aiyansh, BC, for the Nisga'a-Canada-BC Joint Technical Committee. Nisga'a Fisheries Report #15-01: ii+ 46 p.

NJTC (Nisga'a-Canada-BC Joint Technical Committee). 2016. Nass Area salmon fisheries management tables as prepared by the Nisga'a-Canada-BC Joint Technical Committee in May 2016 for the Nisga'a-Canada-BC Joint Fisheries Management Committee.

Perrin, C. J., and J. R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Technical Reports in Fisheries and Aquatic Sciences 1733: vii + 49 p.

TABLES

Table 1. Access methods and travel time to Chum Salmon streams surveyed in 2015.

			Travel	
Area	Stream	Access method	Time (hours)	From
Lower Nass	Gitzyon Creek	Highway vehicle access to stream	0.20	Gitlax̲t'aamiks
	Ksemamaith Creek	Highway vehicle access to stream	0.50	Gitlax̲t'aamiks
	Zolzap Creek	Highway vehicle access to stream	0.40	Gitlax̲t'aamiks
	Tseax Side Channel	Highway to Tseax River parking area; hike from highway	1.00	Gitlax̲t'aamiks
Portland Inlet	Lizard Creek	Marine vessel; small zodiac to shore	1.50	Gingolx
	Pirate Cove Creek	Marine vessel; small zodiac to shore	1.75	Gingolx
	Crag Creek	Marine vessel; small zodiac to shore	2.00	Gingolx
Portland Canal	Donahue Creek	Marine vessel; small zodiac to shore	4.00	Gingolx
Observatory Inlet	Stagoo Creek	Marine vessel; small zodiac to shore	2.00	Gingolx
	Perry Bay Creek	Marine vessel; small zodiac to shore	3.00	Gingolx
	Kshwan River	Marine vessel; small zodiac to shore	4.50	Gingolx
	Illiance River	Gravel road vehicle access to Kitsault townsite; boat from townsite to stream	3.00	Gitlax̲t'aamiks
	Wilauks Creek	Gravel road vehicle access to Kitsault townsite; boat from townsite to stream	3.00	Gitlax̲t'aamiks
	Kitsault River tribuaries	Gravel road vehicle access to Kitsault townsite; boat to Alice Arm dock; ATV on old road to tributary streams	3.00	Gitlax̲t'aamiks

Table 2. Survey dates, water quality, habitat quality score, count-ability scores, and Chum Salmon counts for streams surveyed in 2015.

Survey				Water and habitat quality			Countability score		Chum counts				
Area	Stream name	Date	Length (m)	Temp (°C)	Turbidity (NTU)	Habitat score	Walk	Snorkel	Observer efficiency	Raw live	Expanded live	Carcass	Comments
Lower Nass	Ksemamaith Creek	06/08/2015	700	10.8	1.7	3	4	3	90%	11	12	1	
		15/08/2015	700	10.3	1.5	4	5	2	90%	16	18	0	
		24/08/2015	700	9.9	0.9	4	4	3	90%	33	37	4	
		01/09/2015	700	7.0		3	3	4	65%	7	10	1	
		14/09/2015	300	7.5	4.3	4	2	1	15%				Flow too high for safe survey
	Zolzap Creek	06/08/2015	470	11.7	2.3	3	3	3	90%	0	0	0	
		15/08/2015	470	11.1	2.1	2	4	2	60%	0	0	0	
		24/08/2015	470	10.3	2.4	3	4	3	90%	0	0	0	
		01/09/2015	470			3	4	4	80%	0	0	0	
		14/09/2015	470	8.8	2.6	2	5	3	90%	0	0	0	
	Tseax Side Channel	06/08/2015	360	11.3	1.1	5	4	3	90%	5	6	0	
		15/08/2015	360	11.5	1.1	2	3	2	90%	6	7	1	
		24/08/2015	360	11.4	0.9	4	4	3	90%	30	33	0	
		01/09/2015	360	7.0	NR	4	4	5	85%	54	64	0	
		14/09/2015	360	11.3	1.7	5	5	3	95%	76	80	0	
		23/09/2015	360						90%	24	27	0	
	Gitzyon Creek	07/08/2015	2,000	12.4	1.3	3	2	1	80%	2	2	0	
		16/08/2015	2,000	12.0		4	3	3	84%	0	0	1	
		25/08/2015	2,000	9.7	1.3	3	3	2	90%	0	0	0	
		02/09/2015	2,000			3	2	3	63%	0	0	0	
Portland Inlet	Lizard Creek	22/08/2015	2,600	14.1	1.5	4	4	1	67%	0	0	0	
		03/09/2015	2,600	10.6	1.6	3	3	1	72%	0	0	0	
		12/09/2015	0										Could not surveyed due to high water
	Pirate Cove Creek	22/08/2015	400	12.8	5.5	1	1	1	10%	0	0	0	Bankfull was >100%, limiting countability
		03/09/2015	500	10.3	0.8	NR	2	1	50%	0	0	0	
		12/09/2015	500	11.9	1.3	4	2	1	70%	2	3	0	
	Crag Creek	23/08/2015	3,000	12.9	1.0	3	4	1	65%	0	0	2	
		04/09/2015	3,000	9.5	1.0	4	3	1	79%	5	6	4	
		12/09/2015	3,000	12.2	0.9	4	4	2	77%	1	1	7	
Portland Canal	Donahue Creek	21/08/2015	800	9.9	1.2	3	3	2	90%	43	48	1	
		05/09/2015	800	8.3	1.0	3	3	1	80%	5	6	0	
		13/09/2015	800	8.8	2.4	3	5	3	50%	2	4	1	

Table 2 continued.

Survey				Water and habitat quality			Countability score		Chum counts				
Area	Stream name	Date	Length (m)	Temp (°C)	Turbidity (NTU)	Habitat score	Walk	Snorkel	Observer efficiency	Raw live	Expanded live	Carcass	Comments
Observatory Inlet	Stagoo River	27/07/2015	1,600	7.3	4.2	4	4	4	83%	942	1,136	0	Partial survey
		09/08/2015	3,900	8.4	4.0	4	3	3	82%	2,760	3,379	174	Partial survey
		20/08/2015	4,200	9.0	12.9	4	3	3	50%	86	353	2	High turbid flow limited survey
		29/08/2015	4,200	8.8	4.7	NR	4	NR	78%	73	97	31	Full survey
	Perry Bay Creek	30/08/2015	600	9.9	0.7	1	3	1	95%	0	0	0	Very low water so dropped from further surveys
	Kitsault River Tributaries[a]	04/08/2015	1,770	10.8	4.0	3	3	3	80%	18	23	0	
		17/08/2015	1,770	10.2	2.7	3	4	2	87%	88	98	0	
		27/08/2015	1,770	10.3	2.5	3	4	2	90%	109	121	2	
		07/09/2015	1,770	9.5	2.3	3	4	2	84%	164	184	51	
		19/09/2015	0	7.9	21.4	1	2	1	20%	0	0	0	High turbid flows prevented surveys
	Illiance River	03/08/2015	1,800	12.2	2.0	3	4	3	77%	485	609	2	
		16/08/2015	1,800	12.6	2.3	3	4	2	73%	472	668	5	
		26/08/2015	1,800	11.2	1.5	4	4	3	80%	194	275	11	
		08/09/2015	1,800	9.6	4.0	3	4	1	45%	3	11	20	
		16/09/2015	1,800	8.9	1.6	3	4	2	59%	0	0	2	
	Wilauks Creek	03/08/2015	1,050	11.2	14.7	3	3	3	70%	1	1	0	
		26/08/2015	1,050	11.7	2.6	3	4	3	70%	149	213	2	
		08/09/2015	1,050	9.3	9.9	3	4		90%	45	50	53	
		16/09/2015	1,050	7.9	4.5	4	5	3	90%	11	12	31	
	Kshwan River	31/08/2015	1,100	9.6	0.7	2	4	2	90%	36	40	1	
		01/09/2015	3,800	7.9	4.3	4	4	2	85%	4,390	5,256	632	
		09/09/2015	1,100	10.9	1.0	4	4	1	100%	60	60	13	
		10/09/2015	3,800	7.9	3.2	5	4	1	80%	6,855	8,640	2,579	
		20/09/2015	1,100	9.6	2.3	3	3	1	90%	52	58	5	
		21/09/2015	1,910	6.6	15.0	4	4	2	55%	1,074	1,601	618	High turbidity limited counts in river left tributaries
		01/10/2015	0										High flows prevented access to river right tributaries
		02/10/2015	1,300	5.7	26.3	4	3	1	40%	39	100	80	High turbidity in most river left tributaries limited counts

NR = Not recorded

[a] Kitsault River surveys included a mainstem side channel and lower reaches of four tributaries: Falls Creek, Gwunya Creek, La Rose Creek, and Klayduc Creek.

Table 3. A comparison of Chum Salmon escapement estimates for each system surveyed in 2015. Bold estimates are considered the best estimate for each system. NA indicates insufficient data for calculating the escapement estimate.

					Chum Salmon escapement estimate					
Area	Stream name	Indicator	Funding source	Surveys	Peak count	Peak count + Cum. carcass	Peak count x 2[a]	Mean count	Total live	AUC[b,c]
Lower Nass	Ksemamaith Creek	Yes	NFWD	5	37	43	74	19	77	**91**
	Zolzap Creek	No	PSC	5	0	0	0	0	0	NA
	Tseax Side Channel	No	NFWD	6	80	81	160	36	216	**302**
	Gitzyon Creek	No	PSC	4	2	3	4	1	2	NA
Portland Inlet	Lizard Creek	No	PSC	2	0	0	0	NA	0	NA
	Pirate Cove Creek	No	PSC	3	3	3	6	1	3	NA
	Crag Creek	No	PSC	3	6	19	**12**	3	8	NA
Portland Canal	Donahue Creek	No	PSC	3	48	50	96	19	58	**71**
Observatory Inlet	Stagoo Creek	Yes	PSC	4	3,379	3,586	**6,758**	NA	4,965	NA
	Kitsault River	Yes	PSC	5	184	237	368	106	425	**445**
	Illiance River	Yes	PSC	5	668	708	1,336	313	1,563	**1,836**
	Wilauks Creek	Yes	PSC	4	213	299	426	69	277	**449**
	Kshwan River	Yes	PSC	4	8,700	12,628	**17,400**	NA	15,755	NA

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

[b] Residence time (RT) and standard deviation (SD) for lower Nass tributaries (Ksemamaith Creek, 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, 1980–2015 (NJTC 2016).

	Escapement to Nass Area indicator streams[a]								Nass Area escapement			Canadian harvests						Exploitation rates			
Year	Illiance River	Kitsault River	Ksemamaith Creek	Kshwan River	Kincolith River	Kwinamass River	Stagoo Creek	Wilauks 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	20		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%
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	604	273	53	4,254			6,064	217	10,401	1.9	19,043	258	967	1,225	20,267	2,991	23,258	1%	3%	13%	18%
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. Summary of 2015 Nass Area Chum Salmon otolith and scale samples.

Area	Stream	Number of samples	
		Otoliths	Scales
Lower Nass	Gitzyon Creek	1	3
	Ksemamaith Creek	3	18
	Tseax Side Channel	1	8
Pearse Island	Crag Creek	3	NC
Portland Canal	Donahue Creek	2	NC
Observatory Inlet	Stagoo River	6	NC
	Kshwan River	15	NC
Alice Arm	Illiance River	13	NC
	Kitsault River Side Channel	9	NC
	Falls Creek (Kitsault tributary)	1	NC
Total		54	29

NC = Not collected

Table 6. Summary of 2015 water temperature and turbidity measurements from surveyed streams.

Area	Stream	Temperature (°C)			Turbidity (NTU)		
		Average	Min	Max	Average	Min	Max
Lower Nass	Gitzyon Creek	11.4	9.6	12.5	1.3	1.0	2.1
	Tseax Side Channel	10.3	7.0	11.5	1.2	0.9	1.8
	Zolzap Creek	10.5	8.8	11.7	2.4	2.1	2.6
	Ksemamaith Creek	9.2	7.0	10.8	1.8	0.9	4.3
Portland Inlet	Lizard Creek	12.4	9.7	14.8	1.6	1.0	2.4
	Pirate Cove Creek	11.7	10.3	12.8	2.5	0.8	5.5
	Crag Creek	11.3	9.3	13.1	1.0	0.8	1.3
Portland Canal	Donahue Creek	9.1	8.3	10.0	1.5	0.9	2.6
Observatory Inlet	Stagoo Creek	8.5	7.3	11.8	6.5	1.2	25.1
	Perry Bay Creek	9.9	9.9	9.9	0.7	0.7	0.7
	Illiance River	10.8	8.0	14.5	2.2	1.0	5.9
	Wilauks Creek	9.5	7.8	11.7	7.7	1.6	15.8
	Kitsault River tributaries[a]	9.8	7.2	12.7	6.6	0.5	59.0
	Kshwan River side channels	8.3	4.8	12.2	7.3	0.6	58.0

[a] Kitsault River values are for Falls Creek, Gwuyna Creek, La Rose Creek, Klayduc Creek, and a mainstem side channel.

Table 7. Summary of 2015 walk-ability, snorkel-ability, and spawning habitat quality scores for Chum Salmon survey streams.

		Walk-ability[a]			Snorkel-ability[a]			Spawning Habitat Quality[a]		
Area	Stream	Average	Min	Max	Average	Min	Max	Average	Min	Max
Lower Nass	Gitzyon Creek	3	2	4	2	1	3	3	3	4
	Tseax Side Channel	4	3	5	3	2	5	4	2	5
	Zolzap Creek	4	3	5	3	2	4	3	2	3
	Ksemamaith Creek	4	2	5	3	1	4	3	3	4
Portland Inlet	Lizard Creek	3	1	5	1	1	1	4	2	5
	Pirate Cove Creek	2	1	2	1	1	1	3	1	4
	Crag Creek	4	2	5	1	1	2	4	1	4
Portland Canal	Donahue Creek	3	3	5	2	1	3	3	2	4
Observatory Inlet	Stagoo Creek	3	1	5	3	2	4	4	3	4
	Perry Bay Creek	3	3	3	1	1	1	1	1	1
	Illiance River	4	2	5	2	1	4	3	2	4
	Wilauks Creek	4	3	5	3	3	3	3	1	5
	Kitsault River tributaries[b]	3	2	5	2	1	4	3	1	5
	Kshwan River side channels	4	3	5	1	1	3	4	2	5

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

[b] Kitsault River values are for Falls Creek, Gwuyna Creek, La Rose Creek, Klayduc Creek, and a mainstem side channel.

FIGURES

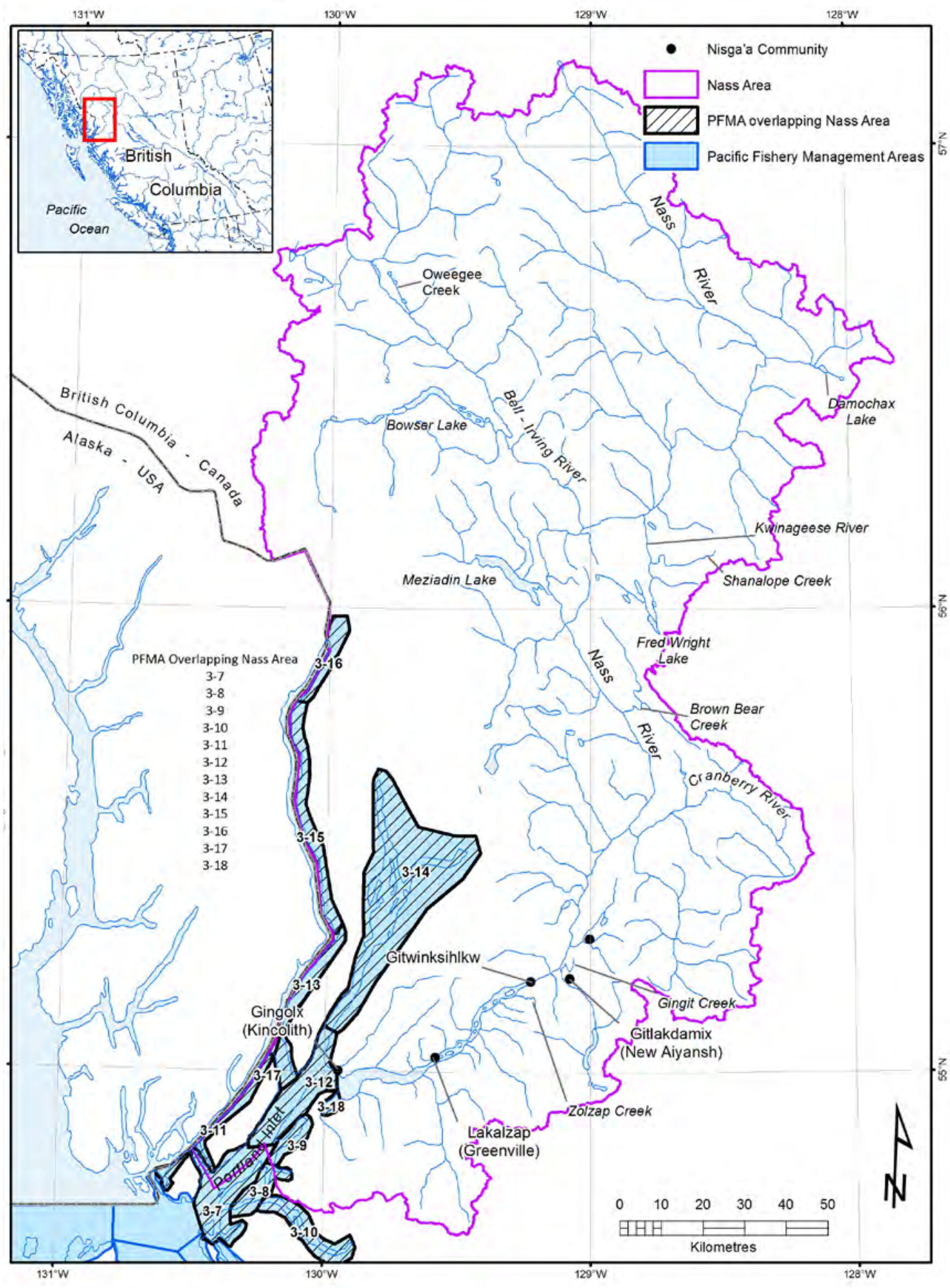


Figure 1. Pacific Fishery Management Area 3 and the Nass Area as defined by the Nisga'a Treaty.

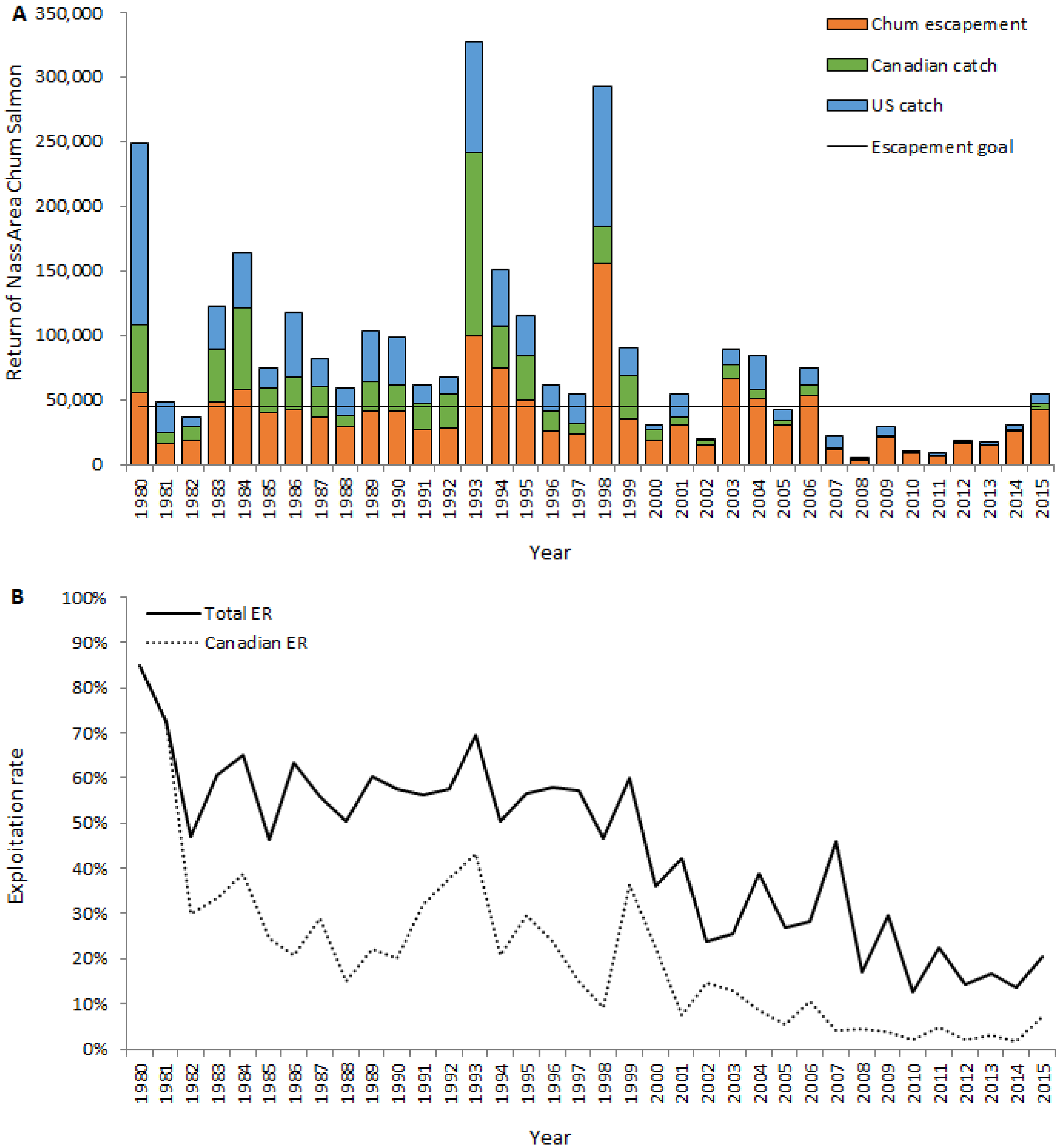


Figure 2. Nass Area Chum Salmon (A) escapement and (B) exploitation rates from 1980 to 2015.

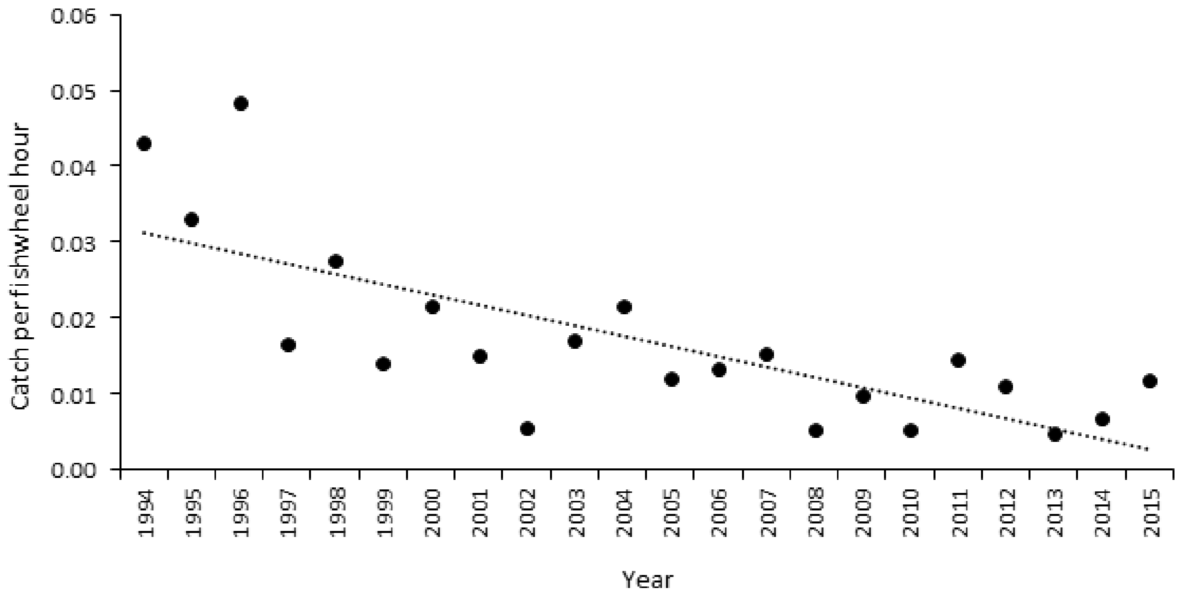


Figure 3. Declining trend in Chum Salmon catch per hour at the Lower Nass River fishwheels from 1994 to 2015.

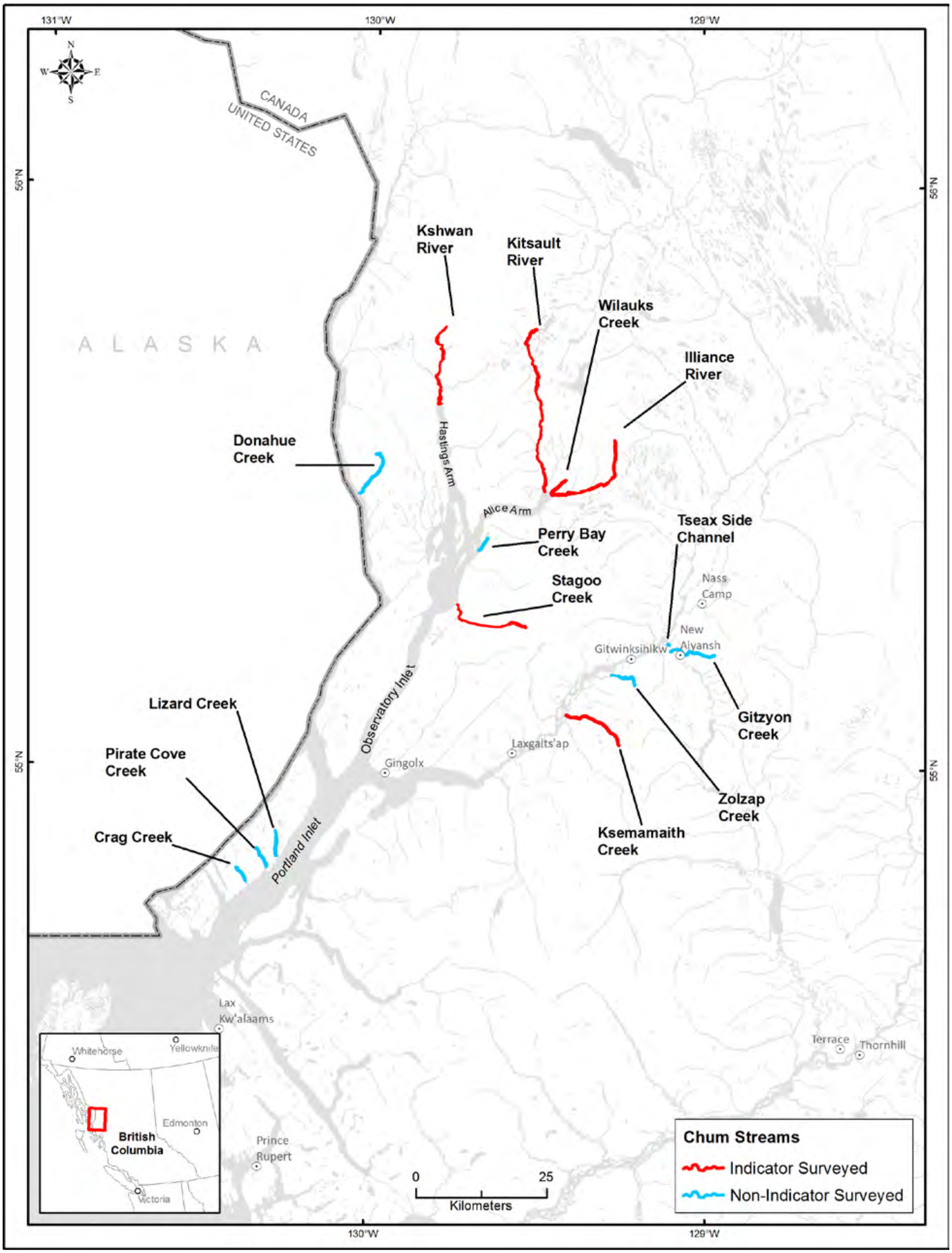


Figure 4. Nass Area Chum Salmon indicator and non-indicator streams surveyed in 2015.

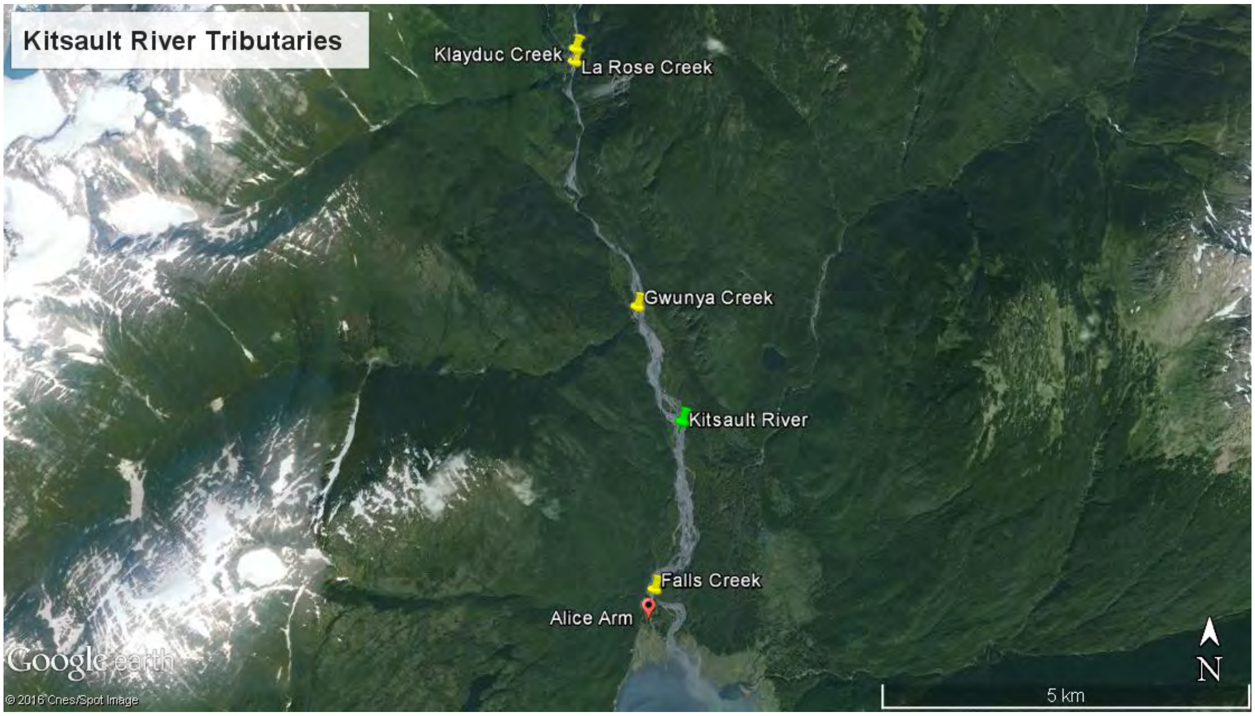


Figure 5. Tributaries of the Kitsault River that were surveyed for Chum Salmon in 2015. Tributary surveys were limited to the lower reaches due to impassable barriers or steep gradients.

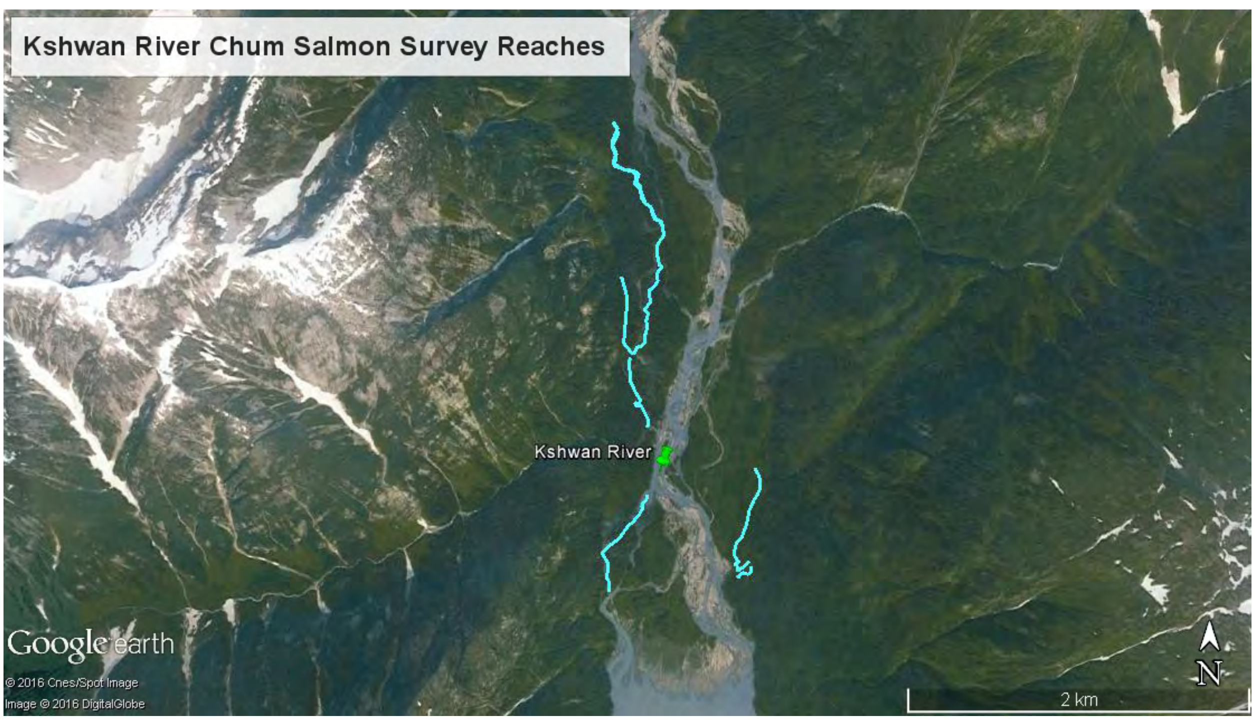


Figure 6. Kshwan River side channels and tributaries surveyed for Chum Salmon spawning in 2015.

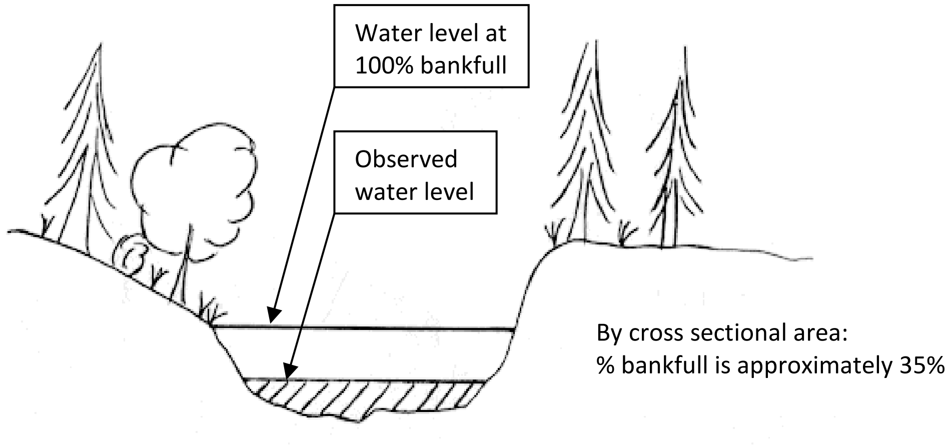


Figure 7. Estimating percent bankfull based on the portion of the channel that is wetted. Figure was copied from DFO Stream Inspection Log definitions.

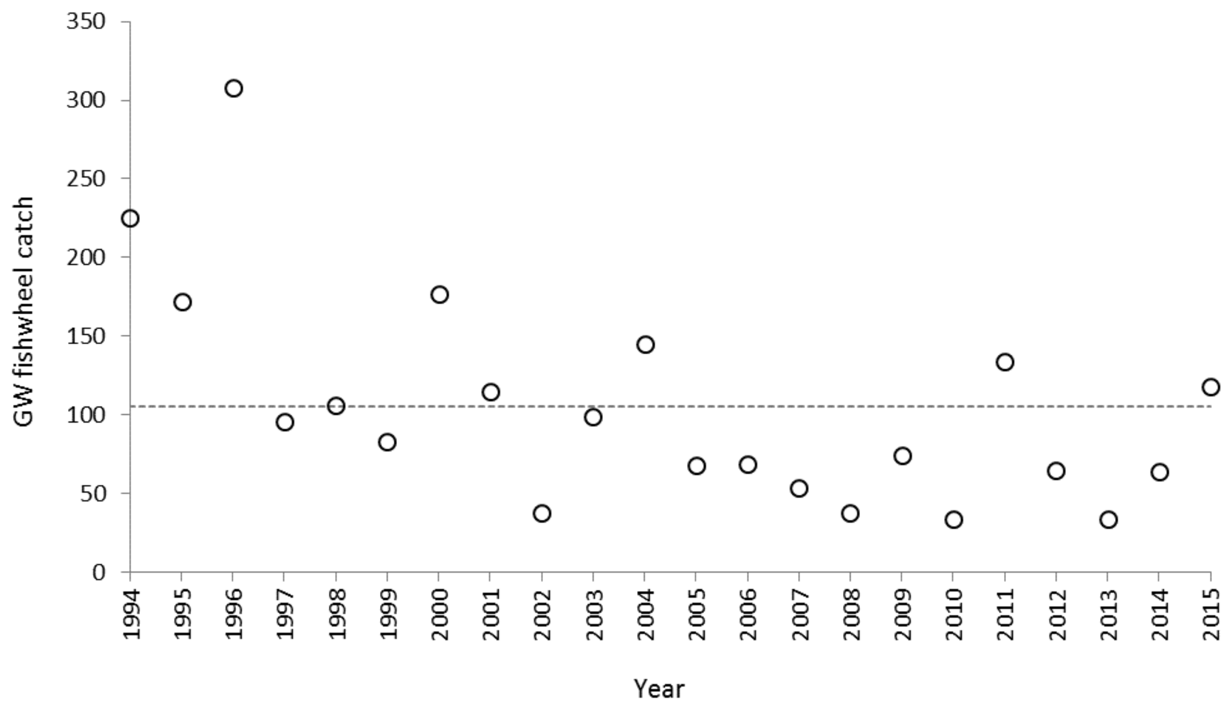


Figure 8. Total Chum Salmon catch at the Gitwinksihlkw (GW) fishwheels, 1994–2015. The dashed line is the 1994–2015 average fishwheel catch at the GW fishwheels.

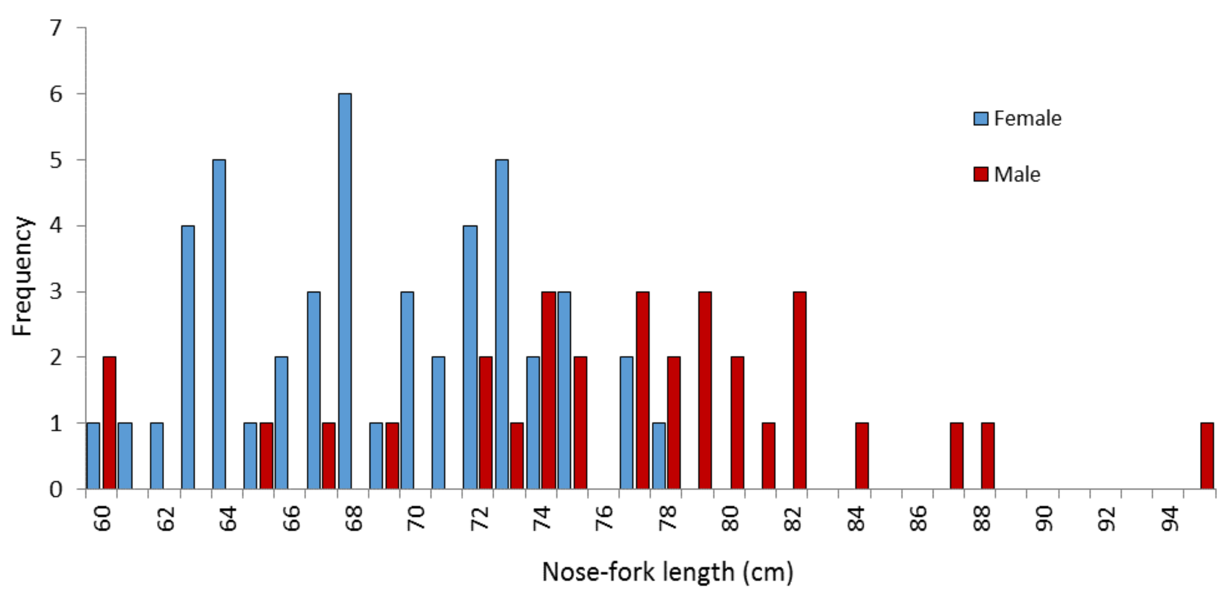


Figure 9. Length frequency histograms for male and female Chum Salmon sampled in Nass Area streams in 2015.

0.7 NTU; Kshwan River Side Channel

2.6 NTU; Donahue Creek

4.0 NTU; Stagoo Creek

8.8 NTU; Kshwan River Side Channel

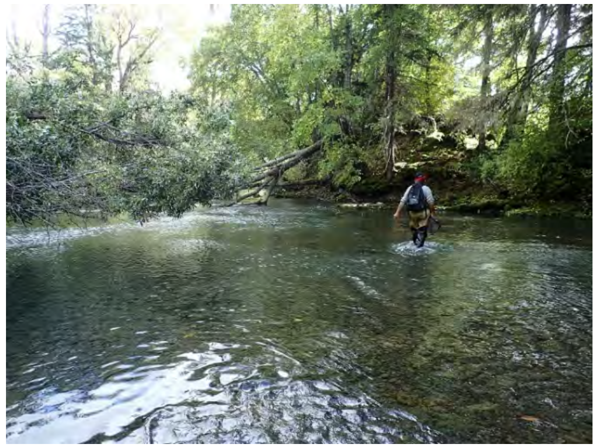
14.7 NTU; Wilauks Creek

25.1 NTU; Stagoo Creek

Figure 10. Examples of different turbidity levels measured in 2015, ranging from 0.7 to 25.1 NTU.

PHOTOS

Gitzyon Creek



Tseax Side Channel

Zolzap Creek

Ksemamaith Creek

Photo 1. Representative images of lower Nass Chum Salmon streams: Gitzyon Creek, Tseax Side Channel, Zolzap Creek, and Ksemamaith Creek.

Lizard Creek

Pirate Cove Creek

Crag Creek

Photo 2. Representative images of Pearse Island streams: Lizard Creek, Pirate Cove Creek, and Crag Creek. Water in each Pearse Island stream was tannin stained and tea coloured.

Photo 3. Representative images of Donahue Creek in 2015.

Photo 4. Representative images of Stagoo Creek in 2015.

Kshwan River west side channel

Kshwan River east tributary

Photo 5. Representative images of a Kshwan River side channel (west side of the river) and an east side tributary.

Falls Creek

Gwunya Creek

La Rose Creek

Klayduc Creek

Kitsault River Side Channel

Kitsault River Side Channel

Photo 6. Representative images of Kitsault River tributaries and a mainstem side channel surveyed in 2015.

Illiance River

Wilauks Creek

Photo 7. Representative images of Illiance River and Wilauks Creek in 2015.

Collecting scales

Measuring nose-fork length

Photo 8. Examples of Chum Salmon biosampling.

APPENDICES

Appendix A – Field forms.

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

PSC Nass Chum 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	
		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 count-ability scoring form.

PSC Nass Chum 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:															

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

PSC Nass Stream Survey 2015 - BIOSAMPLE													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		
			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.

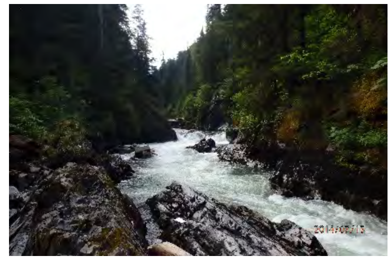
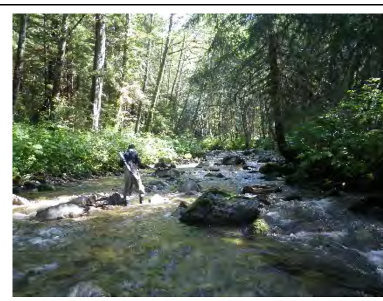
Score	Classification	Description	Example
1	Poor	Extremely difficult or not walkable due to safety concerns (log jams; high flows) or poor accessibility coupled with high flows or turbidity, debris, limited visibility, high confinement or other factors.	
2	Low	Difficult walking due to steep, fast, or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

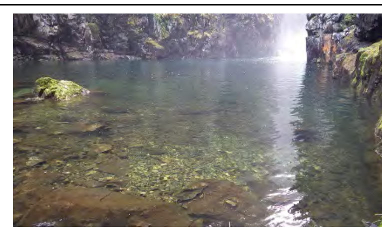
Score	Classification	Description	Example
1	Poor	Snorkelling not possible due to lack of deep pools or glides; extensive debris jams, lack of safe egress; high turbidity or velocity prevent safe or effective snorkelling.	
2	Low	Snorkelling difficult due to lack of suitable habitat. Pools and glides are 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 off channel areas. Some potential hazards (e.g., woody debris; boulders). Good visibility.	
5	Excellent	Slow, clear pools, glides, or off channel 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.

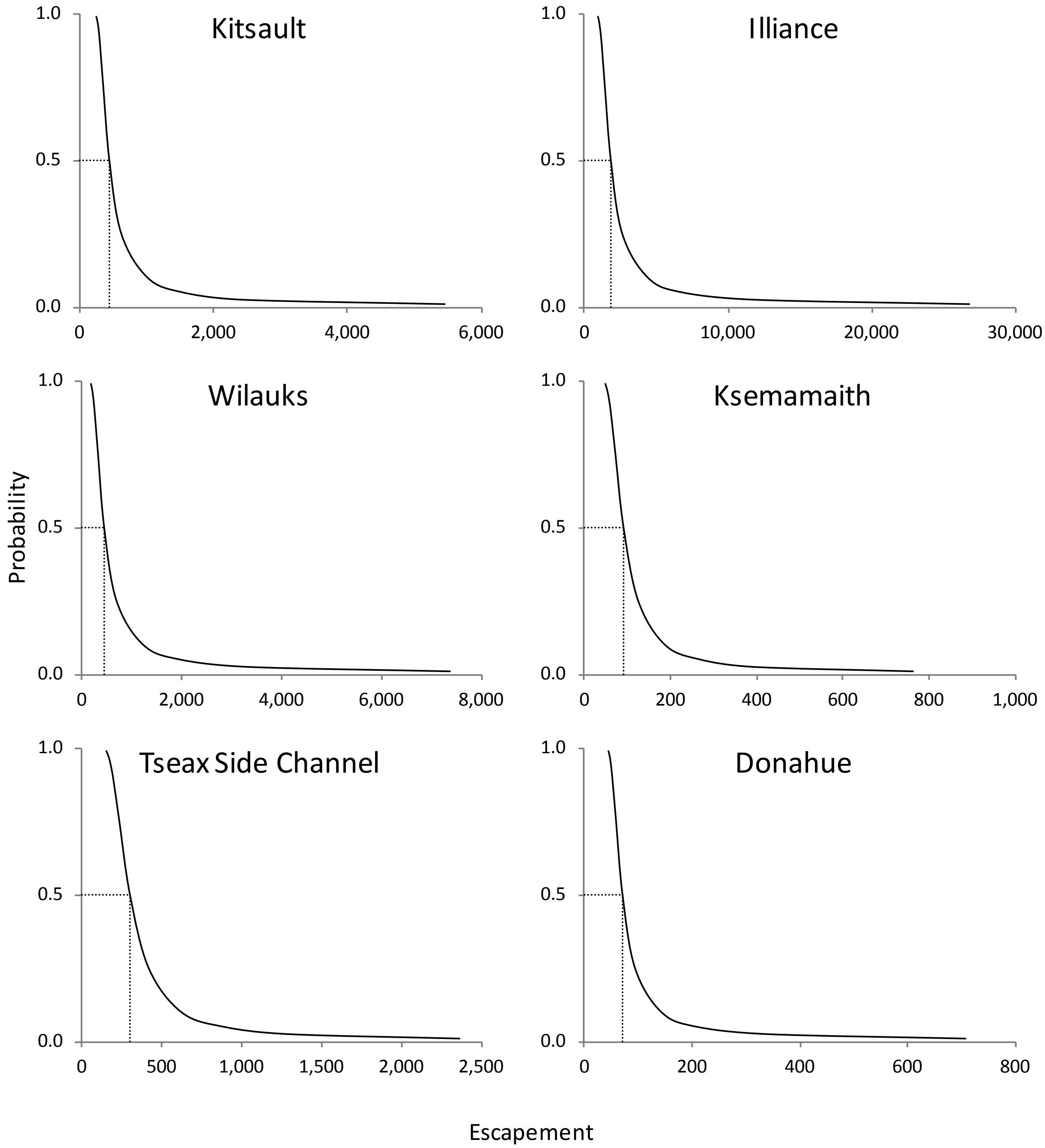


Figure C - 1. Probability distributions of AUC escapement estimates for Nass Area Chum Salmon streams surveyed in 2015. Probability distributions were generated using AUCmonteMASTER 2.04 and the dashed lines show the escapement estimate for each year.

Appendix D – Counts and escapement estimates for Pink, Sockeye, and Chinook salmon.

Table D - 1. Pink, Sockeye, and Chinook salmon counts for each stream surveyed in 2015.

Survey					Pink			Sockeye			Chinook			
Area	Stream name	Date	Length (m)	Observer efficiency	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Comments
Lower Nass	Ksemamaith Creek	06-08-2015	700	90%	174	193	0	0	0	0	0	0	0	
		15-08-2015	700	90%	718	798	5	0	0	0	0	0	0	
		24-08-2015	700	90%	883	981	23	0	0	0	0	0	0	
		01-09-2015	700	65%	212	387	16	0	0	0	0	0	0	
		14-09-2015	300	15%										Flow too high for safe survey
	Zolzap Creek	06-08-2015	470	76%	0	0	0	0	0	0	0	0	0	
		15-08-2015	470	90%	0	0	0	0	0	0	0	0	0	
		24-08-2015	470	90%	13	14	0	0	0	0	0	0	0	
		01-09-2015	470	90%	38	48	0	0	0	0	0	0	0	
		14-09-2015	470	85%	0	0	0	0	0	0	0	0	0	
	Tseax Side Channel	06-08-2015	360	90%	0	0	0	122	136	2	0	0	0	
		15-08-2015	360	90%	0	0	0	149	166	0	0	0	0	
		24-08-2015	360	90%	2	2	0	13	14	0	0	0	0	
		01-09-2015	360	85%	50	58	2	15	18	0	0	0	0	
		14-09-2015	360	95%	18	19	0	17	18	0	0	0	0	
		23-09-2015	360	90%	0	0	0	11	12	0	0	0	0	
	Gitzyon Creek	07-08-2015	2,000	80%	282	353	0	470	588	187	0	0	0	
		16-08-2015	2,000	84%	749	907	63	0	0	0	0	0	0	
		25-08-2015	2,000	90%	534	593	155	0	0	0	0	0	0	
		02-09-2015	2,000	63%	167	334	45	0	0	0	0	0	0	
Portland Inlet	Lizard Creek	22-08-2015	2,600	67%	94	165	0	0	0	0	0	0	0	
		03-09-2015	2,600	72%	970	1,288	4	0	0	0	0	0	0	
		12-09-2015	0											Could not surveyed due to high water
	Pirate Cove Creek	22-08-2015	400	10%	0	0	0	0	0	0	0	0	0	Bankfull was >100%, limiting countability
		03-09-2015	500	50%	121	242	2	0	0	0	0	0	0	
		12-09-2015	500	70%	279	399	15	0	0	0	0	0	0	
	Crag Creek	23-08-2015	3,000	65%	279	413	6	0	0	0	0	0	0	
		04-09-2015	3,000	79%	1,178	1,566	68	0	0	0	0	0	0	
		12-09-2015	3,000	77%	1,702	2,213	33	0	0	0	0	0	0	
Portland Canal	Donahue Creek	21-08-2015	800	90%	83	92	1	0	0	0	0	0	0	
		05-09-2015	800	80%	18	23	9	0	0	0	0	0	0	
		13-09-2015	800	50%	2	4	1	0	0	0	0	0	0	

Table D - 1 continued.

Survey					Pink			Sockeye			Chinook			
Area	Stream name	Date	Length (m)	Observer efficiency	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Comments
Observatory Inlet	Stagoo River	27-07-2015	1,600	83%	0	0	0	0	0	0	0	0	0	Partial survey
		09-08-2015	3,900	82%	10	13	0	0	0	0	0	0	0	Partial survey
		20-08-2015	4,200	50%	42	189	18	0	0	0	0	0	0	High turbid flow limited survey
		29-08-2015	4,200	78%	191	244	21	0	0	0	0	0	0	Full survey
	Perry Bay Creek	30-08-2015	600	95%	0	0	0	0	0	0	0	0	0	Very low water so dropped from further surveys
	Kitsault River Tributaries[a]	04-08-2015	1,770	80%	10	13	0	0	0	0	53	66	1	
		17-08-2015	1,770	87%	0	0	1	0	0	6	54	61	0	
		27-08-2015	1,770	90%	0	0	1	0	0	0	11	12	1	
		07-09-2015	1,770	84%	7	9	5	0	0	0	0	0	0	
		19-09-2015	0	20%	0	0	0	0	0	0	0	0	0	High turbid flows prevented surveys
	Illiance River	03-08-2015	1,800	77%	78	98	0	0	0	0	0	0	0	
		16-08-2015	1,800	73%	68	97	0	0	0	0	0	0	0	
		26-08-2015	1,800	80%	26	36	3	0	0	0	0	0	0	
		08-09-2015	1,800	45%	4	15	2	0	0	0	0	0	0	
		16-09-2015	1,800	59%	0	0	0	0	0	0	0	0	0	
	Wilauks Creek	03-08-2015	1,050	70%	0	0	0	0	0	0	0	0	0	
		26-08-2015	1,050	70%	28	40	0	0	0	0	0	0	0	
		08-09-2015	1,050	90%	0	0	0	0	0	0	0	0	0	
		16-09-2015	1,050	90%	0	0	0	0	0	0	0	0	0	
	Kshwan River	31-08-2015	1,100	90%	0	0	0	0	0	0	0	0	0	
		01-09-2015	3,800	85%	16	18	0	0	0	0	0	0	0	
		09-09-2015	1,100	100%	0	0	0	0	0	0	0	0	0	
		10-09-2015	3,800	80%	0	0	0	0	0	0	0	0	0	
		20-09-2015	1,100	90%	0	0	0	0	0	0	0	0	0	
		21-09-2015	1,910	55%	1	1	0	0	0	0	0	0	0	High turbidity limited counts in river left tributaries
		02-10-2015	1,300	40%	0	0	0	0	0	0	0	0	0	High flows prevented access to river right tributaries on 1 October High turbidity in most river left tributaries limited counts

[a] Kitsault River surveys included a mainstem side channel and lower reaches of four tributaries: Falls Creek, Gwunya Creek, La Rose Creek, and Klayduc Creek.

Table D - 2. Best escapement estimates for Pink and Sockeye salmon runs observed during Chum Salmon surveys in the Nass Area, 2015. Counts were insufficient to generate escapement estimates for Chinook Salmon.

		Escapement estimates			
		Pink		Sockeye	
Area	Stream name	AUC[a]	Peak count x 2[b]	AUC[c]	Peak count x 2[b]
Lower Nass	Ksemamaith Creek	1,495		N/O	
	Zolzap Creek	A/P		N/O	
	Tseax Side Channel	70		289	
	Gitzyon Creek	1,563			1,550
Portland Inlet	Lizard Creek		2,576	N/O	
	Pirate Cove Creek	572		N/O	
	Crag Creek	3,367		N/O	
Portland Canal	Donahue Creek	124		N/O	
Observatory Inlet	Stagoo Creek		488	N/O	
	Kitsault River	A/P		A/P	
	Illiance River	251		N/O	
	Wilauks Creek	A/P		N/O	
	Kshwan River	A/P		N/O	

A/P = Adults present; N/O = 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 30–50% (Cousens et al. 1982).

[c] RT and SD are the 2000–2015 averages for Gingit Creek (RT = 14.7 days; SD = 2.2 days).