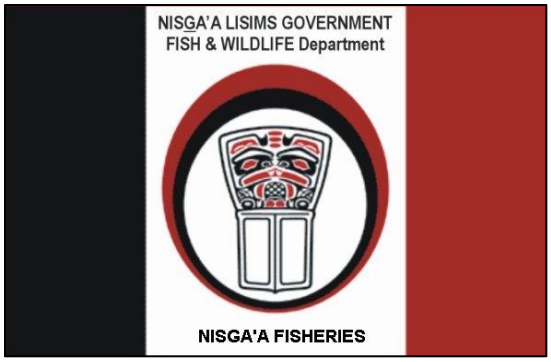

Chum Salmon (*Oncorhynchus keta*) Escapement Surveys in the Nass Area, 2019

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Nisga'a Fisheries Report #19-26

December 31, 2020

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CHUM SALMON (*Oncorhynchus keta*) ESCAPEMENT SURVEYS IN THE NASS AREA, 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

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

AUC	area-under-the-curve
BC	British Columbia
DFO	Fisheries and Oceans Canada
EF	Expansion factor
ER	Exploitation rate
EUR	European age notation
NFL	nose-fork length
NFWD	Nisg̲a'a Fisheries and Wildlife Department
NJTC	Nisg̲a'a-Canada-BC Joint Technical Committee
NuSEDS	New Salmon Escapement Database System
OE	observer efficiency
PFMA	Pacific Fishery Management Area
PSC	Pacific Salmon Commission
RT	residence time
SD	standard deviation
SIL	stream inspection log
TRTC	total return to Canada
US	United States

EXECUTIVE SUMMARY

Beveridge, I. A., R. F. Alexander, S. C. Kingshott, and C. A. J. Noble. 2020. Chum Salmon (*Oncorhynchus keta*) escapement surveys in the Nass Area, 2019. Prepared for the Pacific Salmon Commission, Vancouver, BC, and the Nisga'a Lisims Government Fisheries and Wildlife Department, Gitlaxt'aamiks, BC, by LGL Limited, Sidney, BC. Nisga'a Fisheries Report #19-26: v + 46 p.

Funding ($46,000) received from the Pacific Salmon Commission's Northern Fund in 2019 allowed the Nisga'a Fisheries and Wildlife Department to successfully conduct escapement ground surveys for Chum Salmon (*Oncorhynchus keta*) in the Nass Area (PFMA 3) as Year 6 of a multi-year research project started in 2014 (Beveridge and Alexander 2015; Beveridge et al. 2016−2019).

A total of eight systems, including six indicator (Ksemamaith, Kshwan, Stagoo, Kitsault, Illiance, Wilauks) and two non-indicator (Gitzyon and Tseax side-channel) streams, were inspected between 22 July and 25 September 2019 in the Lower Nass (two streams) and Observatory Inlet (five streams). At least four surveys spanning the peak count were planned for each indicator system. In 2019, we conducted a total of 24 stream surveys for Chum Salmon (and Pink Salmon [*O. gorbuscha*]), including streams that were visited but could not be counted due to high flows and/or turbidity.

High quality escapement estimates were produced for most indicator streams in 2019. The highest Chum Salmon escapement was observed in Kshwan River (7,506) and accounted for 49% of the observed Nass Area indicator escapement (15,393). The next highest escapement was in Stagoo Creek (6,367; 42% of observed escapement). The total estimated escapement for the Nass Area in 2019 was only 24,767 Chum Salmon, 54% of the escapement goal (45,000). The estimated total return to Canada and total run size of Nass Area Chum Salmon in 2019 was 24,853 and 28,766, respectively. The estimated exploitation rate was 13.9% (1.0% Canadian and 12.9% US).

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 (Table 1; Figure 3A; Beveridge and Alexander 2015; Beveridge et al. 2016−2019; Nisga'a-Canada-BC Joint Technical Committee [NJTC] 2019). From 2007 to 2018, the estimated total run for Nass Area Chum Salmon returned on average 76% (76,300 fish) lower than the average return from 1980 to 2006 (25,700 vs. 102,000) and only met the escapement goal in 2018. In response to these poor returns, Fisheries and Oceans Canada (DFO) resource managers have reduced Canadian marine exploitation rates to a mean of 3.1% (range: 0.2−7.4%) from 2007 to 2018 compared to the 1980 to 2006 mean of 22.3% (range: 5.8−43.2%; Table 2; Figure 3B). Exploitation rates of Nass Area Chum Salmon in Alaskan fisheries are estimated to have also substantially declined since 2007 to a mean of 15.8% (range: 7.5−39.4%) from a mean of 28.8% (range: 8.9−56.0%) from 1980 to 2006 (NJTC 2019). As a result, on average the US fishery is harvesting 29,000 fewer Nass Area Chum Salmon each year since 2007.

While recovery of Nass Area Chum Salmon stocks has not occurred to date, there are indications that stocks may be improving. The 2015 and 2018 Nass Area escapements were the highest observed since 2006. Starting in 2015, the Nisga'a Lisims Government Fisheries and Wildlife Department (NFWD) commenced standardized surveys on coastal Chum Salmon indicator streams to improve the data defining the decline in these stocks. Effective management of Nass Area Chum Salmon and development of a recovery plan, for DFO's Wild Salmon Policy (DFO 2009), requires accurate escapement and run size data. Consistent survey effort and higher quality estimates are necessary and are the focus of NFWD surveys. 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, our goal is to continue collecting escapement data using standardized methods.

Objectives

The Wild Salmon Policy has identified 36 Chum Salmon spawning streams from three conservation units (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 (7 coastal, 1 lower Nass) indicator systems (22% of identified Chum Salmon streams) from these conservation units (Figure 2; English et al. 2012).

Escapement surveys in 2019 represent Year 6 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 6 was to conduct stream surveys and collect escapement data following a standardized methodology to improve the quality of estimates. The applicability of area-under-the-curve (AUC) and other methods (e.g., peak count) were also evaluated for both indicator and non-indicator streams.

Specific objectives for 2019 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; and

2. Generate aggregate Nass Area Chum Salmon escapement estimates for 2019 that are scientifically defensible and recommend methods for long-term annual estimation of Chum Salmon escapements in the Nass Area.

This report summarises our 2019 data collection and provides recommendations for future Nass Area Chum surveys.

METHODS

Surveyed Streams

Eight Nass Area streams were surveyed for Chum Salmon escapement in 2019 by NFWD, including six indicator and two non-indicator streams (Figure 4).

Although Ksi Gingolx (Kincolith River; ~30 km stream length) and Ksi X'anmas (Kwinamass River; ~39 km stream length) are both indicator systems for Nass Area Chum Salmon, they were not assessed due to the challenges in counting the low numbers of Chum Salmon that return each year to these large systems. Surveyed streams were from two regions of the Nass Area: 1) Lower Nass River and; 2) Observatory Inlet (Pacific Fisheries Management Area 3-14; Figure 1).

Specific streams surveyed in 2019 were:

Lower Nass:

1. Ksemamaith Creek (Indicator Stream; Figure 5; Photo 1)
2. Tseax side-channel (Figure 6; Photo 2)
3. Gitzyon Creek (Figure 7; Photo 3)

Observatory Inlet:

4. Stagoo Creek (Indicator Stream; Figure 8; Photo 4).
5. Kshwan River (Indicator Stream; Figure 9; Photo 5). Surveys were conducted in:
    a. mainstem side-channels
    b. unnamed tributaries
6. Kitsault River (Indicator Stream; Figure 10; Photo 6). Surveys were conducted in:
    a. a mainstem side-channel
    b. Dak River (Kitsault tributary)
7. Illiance River (Indicator Stream; Figure 11; Photo 7)
8. Wilauks Creek (Indicator Stream; Figure 12)

At least four ground surveys (stream walks) spanning the peak count were planned for each system. Surveys started with Stagoo Creek on 22 July and ended with Tseax side-channel on 18 September. The primary access method for coastal systems in 2019 was helicopter. Lower Nass streams were accessed via truck and hiking (Table 3) 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 (%), considering water depth, turbidity, glare, woody debris, undercut banks, and other factors potentially limiting visibility and fish counts. In addition to salmon counts, crews collected temperature and percent bankfull data (Table A-2), and bio-sampled (i.e., measured length; identified sex; collected otoliths) select intact carcasses (Table A-3).

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 were full and then estimating the percentage of the cross-sectional area that was actually full (Figure 13). Estimates of percent bankfull were grouped into five categories: <25%, 25−50%, 50−75%, 75−100%, and >100%.

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 dry in numbered vials. Alaskan hatcheries thermally mark Chum Salmon otoliths and the releasing hatchery can be determined by examining the otoliths. Scale collection was planned for live and dead Chum Salmon in the lower Nass tributaries for aging. Not all carcasses were bio-sampled due to time constraints.

Escapement Estimation

Escapement was estimated using area-under-the-curve (AUC; English et al. 1992; Perrin and Irvine 1990) and peak count times two (Cousens et al. 1982)

The AUC method 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). Area under the curve estimates were planned for streams with live counts from three or more complete surveys spanning the peak count. Only Stagoo Creek had sufficient data to generate an AUC estimate in 2019 (Table 4).

RESULTS AND DISCUSSION

Streams Surveys

Access

Two to five stream walks were conducted on each Nass Area stream to count Chum Salmon and other salmon species present (Table 4; Figure 4). Marine vessels were not available this year, so to meet our project objectives, we utilized a helicopter to access coastal streams. Helicopter access offered several advantages over marine vessels and improved our sampling program in several ways. First, it allowed crews to survey streams more efficiently and to survey more streams in a single day. Where our surveys of Stagoo Creek and Alice Arm streams (Illiance, Wilauks, Kitsault) typically took three days via marine vessel, we could survey these systems in

a single day via helicopter. Second, we gained access to Dak River, an important Chum Salmon spawning tributary of Kitsault River. In previous years, we were unable to safely access this stream. Finally, the flexibility of scheduling the helicopter allowed us to respond to poor weather and/or sampling conditions (e.g., prolonged rain) by adjusting survey days to more appropriate times.

Chum Salmon Escapement Estimates

Chum Salmon were observed in nearly every stream surveyed in 2019. In the lower Nass, Chum Salmon counts were best in the Tseax side-channel (76; Table 5) but were still below average (132). Counts in Gitzyon and Ksemamaith creeks were poor, with only a few adults observed in each stream. This was the third consecutive year that counts were negligible in Ksemamaith Creek, the lower Nass indicator stream. Prior to 2017, escapement to Ksemamaith Creek averaged 54 Chum Salmon (Table 6). In 2018, signs of significant bedload movement and channel changes were observed and in 2019, the large logjam had changed. The lack of Chum Salmon could be related to the observed instability of the channel.

In the coastal systems, the highest escapements were observed in Stagoo Creek (4,826; 4,676 live plus 150 carcasses; Table 7) on 8 August and Kshwan River side-channels (3,655; 3,456 live plus 199 carcasses; Table 8) on 11 September. Of the indicator streams surveyed in 2019, Stagoo Creek and Kshwan River accounted for nearly all (42% and 48%, respectively) of the total estimated observed escapement (15,110) to Nass Area streams. In contrast, no salmon were observed in Wilauks Creek. From 2015 to 2017, flow from the Dak River (slightly turbid) entered Wilauks Creek and returns were within the historical range (Table 9). This Dak flow was absent in both 2018 and 2019 during surveys and returns in both years were negligible.

This was the first year we could access Dak River and it had the highest Chum Salmon count (532) since NFWD began surveying Kitsault tributaries and a side-channel in 2015 (Table 10). Our Dak River observations are the first since at least 2006 and indicate that this is still an important Chum Salmon spawning system. Escapement to Illiance River was average (1,356; Table 11).

The best escapement estimates for each surveyed indicator system (Table 12) were input into the English et al. (2012) method to estimate the total Chum Salmon return to the Nass Area (Table 1; NJTC 2019). The estimated Nass Area escapement (24,767) was only 54% of the escapement goal (45,000; Figure 3; Table 1).

Other Salmon Counts and Escapement Estimates

In addition to Chum Salmon, Pink (*O. gorbuscha*), Sockeye (*O. nerka*), and Chinook (*O. tshawytscha*) salmon were observed during our surveys (Table C-1). Except for Wilauks Creek, Pink Salmon were observed in all surveyed streams, although their numbers varied greatly from 46 fish (Tseax side-channel) to over 13,000 fish (Illiance River). Stagoo Creek also had a strong Pink Salmon return (10,445).

Compared with previous years, conditions in Wilauks Creek had changed considerably. Dak River water (cold, turbid, glacial) was no longer flowing into Wilauks Creek. No fish were observed in Wilauks Creek in 2019, suggesting the spawners to this system used Illiance River

instead; the mouths of both streams are at the same location (Figure 4). This could explain the high count in Illiance River relative to other systems.

Pink Salmon counts were sufficient to generate escapement estimates to Ksemamaith Creek, Tseax side-channel, Stagoo Creek, and Illiance River using AUC and peak count methods (Table C-2). Peak count estimates were also calculated for Kitsault and Kshwan rivers.

Due to low numbers, no estimates were made for Sockeye or Chinook salmon. Sockeye Salmon were observed in low numbers (<5) in Dak River (Kitsault tributary) and Kshwan River. The lack of lakes in these systems suggests that these are sea-type sockeye. A single Chinook Salmon was observed in Dak River.

Bio Samples

Twenty Chum Salmon were bio-sampled from Kshwan River and Tseax side-channel. The average nose-fork length was 78.5 cm (range: 66 to 90 cm) and most were male (60%; 12 fish). The remaining eight fish were female. Scales were collected from 19 Chum Salmon carcasses (17 from Kshwan; 2 from Tseax) and 16 were age 4_1 (EUR 0.3), two were age 5_1 (EUR 0.4) and one was age 3_1 (EUR 0.2).

Otoliths were collected from each of these fish to assess Alaskan hatchery origin and results should be available in 2021.

Water Quality

No unusual temperatures were measured, with temperature ranging from 13°C in Gitzyon Creek in August to 6°C in Kshwan River side-channels in September (Table 13).

RECOMMENDATIONS

1. Continue to conduct rigorous and repeatable ground surveys of at least six Nass Area Chum Salmon indicator systems (Kshwan River, Stagoo Creek, Kitsault River, Illiance River, Wilauks Creek, and Ksemamaith Creek) with priority to marine areas of Area 3;
2. Conduct a minimum of three surveys per system to count Chum Salmon and other salmon present, with surveys spanning the peak spawning period;
3. Explore options to replace Ksemamaith Creek as a lower Nass indicator stream if counts and/or habitat conditions remain poor;
4. Start Stagoo Creek and Alice Arm streams (Illiance River, Kitsault River, and Wilauks Creek) surveys in mid to late July;
5. Evaluate survey life combined with observer efficiency for variation within and among streams surveyed; and
6. Install water level gauges in Nass Area indicator streams to assess flow conditions over the migration period and effect on Chum Salmon entry and timing into the Nass streams that are surveyed.

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TABLES

Table 1. Nass Area Chum Salmon escapement, 1980−2019 (NJTC 2019). Peak count escapement estimates between 2015 and 2019 for some indicator streams have been updated from previous reporting to account for carcass counts.

	Escapement to Nass Area indicator streams[a]								Nass Area escapement		
Year	Illiance River	Kitsault River	Ksemamaith Creek	Kshwan River	Kincolith River	Kwinamass River	Stagoo Creek	Wilauks Creek	Obs.[b]	EF[c]	Est.[d]
1980	3,000	8,600		20,000	100	800	1,500	1,000	35,000	1.6	55,070
1981	500	3,700	10	4,000	200	500	1,500	100	10,510	1.6	16,514
1982	400	800	25	10,000		100	500	100	11,925	1.6	18,808
1983	2,500	5,300	20	10,000	25	100	12,000	550	30,495	1.6	47,916
1984	5,000	6,500		8,000	200	500	15,000	1,000	36,200	1.6	56,958
1985	1,500	1,000		20,000	1	500	2,000	250	25,251	1.6	39,731
1986	1,200	3,000		20,000		150	2,500	75	26,925	1.6	42,524
1987	1,300	2,250	25	15,000		50	3,600		22,225	1.6	35,664
1988	350	1,500	100	15,000		100	1,000	250	18,300	1.6	28,862
1989	2,000	3,000	20	10,000	20		10,000		25,040	1.6	40,555
1990	10,000	1,000	20	6,500			8,000	500	26,020	1.6	41,108
1991	1,000	1,000	20	10,000		100			12,120	2.2	26,934
1992	1,506	3,000				100	3,500	700	8,806	3.2	28,325
1993	2,000	5,000		50,000		100	5,000	300	62,400	1.6	98,438
1994	4,000	8,500				10	10,000	400	22,910	3.2	73,692
1995	4,000	6,000		10,000	200	50	10,000	1,000	31,250	1.6	49,129
1996	400	1,320		10,000	50	100	4,000	450	16,320	1.6	25,657
1997	350			10,000		100	2,000	150	12,600	1.8	22,627
1998	3,000	12,530		50,000		50	30,000	2,000	97,580	1.6	153,936
1999	1,500	1,500		2,000		50	17,000	300	22,350	1.6	35,258
2000	1,200	1,696		2,000			6,500	300	11,696	1.6	18,561
2001	1,000	870		2,000	104	50	15,000	250	19,274	1.6	30,383
2002				3,000			5,000		8,000	1.8	14,753
2003				5,000			30,000		35,000	1.8	64,545
2004	1,500			15,000			12,000	400	28,900	1.7	49,276
2005	300		70	2,000	126		15,000	260	17,756	1.7	30,041
2006	1,800			15,000	20		13,000		29,820	1.7	51,382
2007				1,000	95		4,900		5,995	1.8	11,005
2008				1,000	24		640		1,664	1.8	3,055
2009	475		51	1,500			9,800	60	11,886	1.7	20,195
2010	170		68	500			4,200		4,938	1.7	8,515
2011			80	1,170			2,200		3,450	1.8	6,338
2012	113		32	1,100			7,925	56	9,226	1.7	15,676
2013	500	100	20	1,100	NI	AP	7,100	300	9,120	1.6	14,426
2014	419	AP	25	NI	NI	NO	8,200	63	8,707	2.3	20,396
2015	1,820	445	91	23,730	NI	NI	7,106	449	33,641	1.6	53,212
2016	902	351	51	3,265	NI	NI	8,139	418	13,126	1.6	20,762
2017	220	74	AP	7,492	NI	NI	6,804	62	14,652	1.6	23,252
2018	1,828	457	NO	18,742	NI	AP	9,164	AP	30,191	1.6	48,577
2019	932	588	AP	7,506	NI	AP	6,367	NO	15,393	1.6	24,767
Averages:											
1980−1989	1,775	3,565	33	13,200	91	311	4,960	416	24,187	1.6	38,260
1990−1999	2,776	4,428	20	18,563	125	73	9,944	644	31,236	2.0	55,511
2000−2009	1,046	1,283	61	4,750	74	50	11,184	254	16,999	1.7	29,320
2010−2019	767	336	52	7,178			6,721	225	14,244	1.7	23,592

[a] Data are from the DFO New Salmon Escapement Database (NuSEDs). AP = adults present; NI = not inspected; NO = none observed.

[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).

Table 2. Nass Area Chum Salmon harvest and exploitation rates, 1980−2019 (NJTC 2019).

	Canadian harvests						Exploitation rates (%)			
Year	Nisga'a[a]	Other[b]	Total	Total return to Canada	US harvest[c]	Total run	Nisga'a	Other Can.	US	Total
1980		55,777	55,777	110,847	141,011	251,858		22	56	78
1981		7,891	7,891	24,406	23,891	48,297		16	49	66
1982		10,581	10,581	29,389	6,082	35,470		30	17	47
1983		40,513	40,513	88,429	33,071	121,500		33	27	61
1984		62,955	62,955	119,914	42,679	162,593		39	26	65
1985		18,274	18,274	58,005	15,971	73,976		25	22	46
1986		24,323	24,323	66,847	49,602	116,448		21	43	63
1987		23,470	23,470	59,134	21,543	80,677		29	27	56
1988		8,755	8,755	37,618	20,601	58,218		15	35	50
1989		22,764	22,764	63,320	39,051	102,371		22	38	60
1990		19,398	19,398	60,506	36,677	97,183		20	38	58
1991		19,563	19,563	46,498	14,869	61,367		32	24	56
1992	200	25,291	25,491	53,817	13,223	67,040	0	38	20	58
1993	416	139,756	140,172	238,610	84,873	323,483	0	43	26	70
1994	579	31,181	31,760	105,452	43,990	149,443	0	21	29	51
1995	402	33,470	33,872	83,001	30,366	113,367	0	30	27	57
1996	269	14,483	14,752	40,410	20,848	61,258	0	24	34	58
1997	227	7,933	8,160	30,787	22,408	53,195	0	15	42	57
1998	983	27,088	28,071	182,007	107,688	289,695	0	9	37	47
1999	846	31,938	32,784	68,042	20,560	88,602	1	36	23	60
2000	1,067	6,525	7,592	26,153	4,022	30,175	4	22	13	38
2001	1,617	3,897	5,514	35,897	18,255	54,152	3	7	34	44
2002	132	2,859	2,991	17,744	1,727	19,472	1	15	9	24
2003	318	11,097	11,415	75,960	11,054	87,014	0	13	13	26
2004	1,115	7,338	8,453	57,729	23,878	81,608	1	9	29	40
2005	728	2,429	3,157	33,198	8,678	41,876	2	6	21	28
2006	1,214	7,882	9,095	60,478	12,353	72,830	2	11	17	29
2007	932	975	1,907	12,911	8,397	21,308	4	5	39	48
2008	511	185	697	3,751	436	4,187	12	4	10	27
2009	447	1,139	1,586	21,781	7,405	29,186	2	4	25	31
2010	386	242	628	9,143	1,002	10,146	4	2	10	16
2011	245	446	691	7,030	1,387	8,416	3	5	16	25
2012	394	415	809	16,485	2,180	18,664	2	2	12	16
2013	243	604	847	15,272	2,262	17,534	1	3	13	18
2014	711	422	1,133	21,529	2,789	24,318	3	2	11	16
2015	1,382	5,047	6,429	59,641	8,674	68,315	2	7	13	22
2016	2,923	193	3,117	23,879	4,645	28,524	10	1	16	27
2017	744	52	797	24,048	1,942	25,990	3	0	7	11
2018	535	567	1,102	49,679	3,118	52,798	1	1	6	8
2019	206	87	294	25,061	3,705	28,766	1	0	13	14
Averages:										
1980−1989		27,530	27,530	65,791	39,350	105,141		25	34	59
1990−1999	490	35,010	35,402	90,913	39,550	130,463	0	27	30	57
2000−2009	808	4,433	5,241	34,560	9,621	44,181	3	9	21	34
2010−2019	777	807	1,585	25,177	3,170	28,347	3	2	12	17

[a] Nisga'a catch from annual reports by Nisga'a Fisheries and Wildlife Department (see Mathews et al. 2012) and include release mortality estimates from NJTC (2019).

[b] 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. For 1980 and 1981, the Nass component was estimated using the average % Nass in the commercial catch.

[c] US commercial catch is estimated from methods developed by the Pacific Salmon Foundation (English et al. 2012). For 1980 and 1981, values were estimated using a 25% US ER (1982−1986 average).

Table 3. Access methods and travel time to Nass Area Chum Salmon streams surveyed in 2019.

Area	Stream	Access method	Travel	
			Time (hours)	From
Lower Nass	Ksemamaith Creek	Highway vehicle access to stream	0.5	Gitlaxt'aamiks
	Gitzyon Creek	Highway vehicle access to stream	0.1	Gitlaxt'aamiks
	Tseax side-channel	Highway vehicle to Ksi Sii Aks parking area; hike from highway	1.0	Gitlaxt'aamiks
Observatory Inlet	Stagoo Creek	Helicopter	0.5	Nass Camp
	Kshwan River	Helicopter	0.7	Nass Camp
	Illiance River	Helicopter	0.5	Nass Camp
	Wilauks Creek	Helicopter	0.5	Nass Camp
	Kitsault River tributary (Dak River) and side-channel	Helicopter	0.5	Nass Camp

Table 4. Survey dates, water temperature, and Chum Salmon counts for Nass Area streams surveyed in 2019.

Survey					Chum counts				
Area	Stream name	Date	Length (m)	Average water temp. (°C)	Average observer efficiency (%)	Raw live	Expanded live	Carcass	Comments
Lower Nass	Ksemamaith Creek	31-Jul-2019	700	8.0	90	0	0	0	Large logjam breached by high flows
		06-Aug-2019	700	11.0	90	0	0	0	
		15-Aug-2019	700	12.0	90	0	0	0	
		24-Aug-2019	700	10.0	65	4	6	0	
		15-Sep-2019	700	8.0	95	0	0	0	
	Tseax side-channel	31-Jul-2019	380	10.0	95	0	0	0	
		06-Aug-2019	380	10.0	95	0	0	0	
		15-Aug-2019	380	12.0	90	5	6	0	
		24-Aug-2019	380	11.0	80	11	14	0	
		15-Sep-2019	380	10.0	70	14	20	0	
		18-Sep-2019	380	10.0	90	3	3	1	
	Gitzyon Creek	31-Jul-2019	1,500	10.0	87	0	0	0	
		06-Aug-2019	1,500	13.0	83	0	0	0	
		15-Aug-2019	1,500	12.0	90	0	0	5	
		24-Aug-2019	1,500	11.0	60	0	0	0	
Observatory Inlet	Stagoo Creek	22-Jul-2019	3,500	8.3	48	18	44	0	
		30-Jul-2019	4,500	9.0	82	702	876	6	
		08-Aug-2019	4,500	8.5	80	3,741	4,676	150	
		16-Aug-2019	4,200	8.0	68	1,499	2,064	62	
	Kitsault River	31-Jul-2019	800	7.5	100	0	0	0	Side-channel only
		08-Aug-2019	2,500	NR	80	51	64	2	Side-channel and Dak River
		16-Aug-2019	1,700	12.0	60	175	292	0	Dak River only
	Illiance River	31-Jul-2019	1,800	9.5	78	14	18	0	
		08-Aug-2019	1,800	NR	80	155	194	0	
		16-Aug-2019	1,800	12.5	57	242	425	42	
	Wilauks Creek	31-Jul-2019	1,000	NR	80	0	0	0	Stagnant; no flow
		08-Aug-2019	1,900	NR	80	0	0	0	Stagnant; no flow
	Kshwan River	04-Sep-2019	4,600	6.5	74	2,051	3,174	98	
		11-Sep-2019	4,600	8.0	90	2,887	3,456	199	

NR = not recorded

[a] Kitsault River surveys included a mainstem side-channel and Dak River (8 & 16 August).

Table 5. Summary of Tseax side-channel Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[a]	
Year	No. surveys	First	Last	Survey	Escapement estimate	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS[b]	Quality
1994	0	-	-	Not surveyed	No estimate	-						-	NI	6
1995	0	-	-	Not surveyed	No estimate	-						-	NI	6
1996	0	-	-	Not surveyed	No estimate	-						-	NI	6
1997	0	-	-	Not surveyed	No estimate	-						-	NI	6
1998	0	-	-	Not surveyed	No estimate	-						-	NI	6
1999	0	-	-	Not surveyed	No estimate	-						-	NI	6
2000	0	-	-	Not surveyed	No estimate	-						-	NI	6
2001	0	-	-	Not surveyed	No estimate	-						-	NI	6
2002	0	-	-	Not surveyed	No estimate	-						-	NI	6
2003	0	-	-	Not surveyed	No estimate	-						-	NI	6
2004	0	-	-	Not surveyed	No estimate	-						-	blank	6
2005	0	-	-	Not surveyed	No estimate	-						-	blank	6
2006	0	-	-	Not surveyed	No estimate	-						-	blank	6
2007	0	-	-	Not surveyed	No estimate	-						-	blank	6
2008	0	-	-	Not surveyed	No estimate	-						-	blank	6
2009	0	-	-	Not surveyed	No estimate	-						-	blank	6
2010	5	25-Aug	09-Sep	Walk	AUC	25-Aug	16		93	7	3	48	66	4
2011	7	31-Jul	15-Sep	Walk	AUC	28-Aug	32		92	7	7	152	152	3
2012	7	13-Aug	25-Sep	Walk	AUC	18-Sep	53		90	7	7	143	143	3
2013	7	01-Aug	23-Sep	Walk	AUC	12-Sep	25		93	7	7	97	97	3
2014	6	07-Aug	13-Sep	Walk	AUC	27-Aug	21		87	7	6	47	47	3
2015	5	15-Aug	23-Sep	Walk	AUC	14-Sep	80		90	7	5	302	302	3
2016	5	27-Jul	15-Sep	Walk	AUC	05-Sep	41		90	7	5	116	116	3
2017	0	-	-	Not surveyed	No estimate	-							NI	6
2018	0	-	-	Not surveyed	No estimate	-							NI	6
2019	6	31-Jul	18-Sep	Walk	AUC	15-Sep	20		87	7	6	76	76	3
Min	2	27-Jul	09-Sep			25-Aug	16		87	7	3	47	47	3
Max	5	25-Aug	25-Sep			18-Sep	80		93	7	7	302	302	6
Avg	4	07-Aug	17-Sep			06-Sep	36		91	7	6	129	132	5

[a] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[b] AP = adults present; NI = not inspected; blank = no entry in NuSEDS.

Table 6. Summary of Ksemamaith Creek Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[a]	
Year	No. surveys	First	Last	Survey	Escapement estimate	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS[b]	Quality
1994	0	-	-	Not surveyed	No estimate	-						-	NI	6
1995	0	-	-	Not surveyed	No estimate	-						-	NI	6
1996	0	-	-	Not surveyed	No estimate	-						-	NI	6
1997	0	-	-	Not surveyed	No estimate	-						-	NI	6
1998	0	-	-	Not surveyed	No estimate	-						-	NI	6
1999	0	-	-	Not surveyed	No estimate	-						-	NI	6
2000	0	-	-	Not surveyed	No estimate	-						-	NI	6
2001	0	-	-	Not surveyed	No estimate	-						-	NI	6
2002	0	-	-	Not surveyed	No estimate	-						-	NI	6
2003	0	-	-	Not surveyed	No estimate	-						-	NI	6
2004	0	-	-	Not surveyed	No estimate	-						-	blank	6
2005	4	31-Jul	10-Sep	Walk	AUC	19-Aug	19		98	7	4	83	70	4
2006	0	-	-	Not surveyed	No estimate	-						-	blank	6
2007	0	-	-	Not surveyed	No estimate	-						-	blank	6
2008	0	-	-	Not surveyed	No estimate	-						-	blank	6
2009	2	31-Aug	10-Sep	Walk	Peak live + dead	31-Aug	23	2.2				-	51	3
2010	5	23-Aug	22-Sep	Walk	AUC	26-Aug	29		92	7	5	82	68	4
2011	4	31-Jul	22-Sep	Walk	AUC	28-Aug	18		78	7	4	80	80	3
2012	8	06-Aug	21-Sep	Walk	AUC	13-Aug	11		88	7	4	32	32	3
2013	6	01-Aug	12-Sep	Walk	AUC	27-Aug	8		92	7	5	20	20	3
2014	6	07-Aug	13-Sep	Walk	AUC	14-Aug	11		87	7	6	25	25	3
2015	5	06-Aug	14-Sep	Walk	AUC	24-Aug	41		85	7	4	91	91	3
2016	5	27-Jul	15-Sep	Walk	AUC	05-Sep	13		90	7	4	51	51	3
2017	6	27-Jul	26-Sep	Walk	No estimate	31-Aug	2					-	AP	6
2018	4	04-Aug	07-Sep	Walk	No estimate	n/a						-	NO	6
2019	5	31-Jul	15-Sep	Walk	No estimate	24-Aug	4					-	AP	6
Min	2	27-Jul	07-Sep			13-Aug	2	2.2	78	7	4	20	20	3
Max	8	31-Aug	26-Sep			05-Sep	41	2.2	98	7	6	91	91	6
Avg	5	05-Aug	15-Sep			24-Aug	16	2	89	7	5	58	54	4

[a] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[b] AP = adults present; NI = not inspected; NO = none observed; blank = no entry in NuSEDS.

Table 7. Summary of Stagoo Creek Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[b]	
Year	No. surveys	First	Last	Survey	Escapement estimate[a]	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS	Quality
1994	8	30-Jun	08-Sep	Walk; Plane	Not specified	03-Aug	3,500	2.9				-	10,000	4
1995	8	06-Aug	07-Oct	Walk; Plane	Not specified	06-Aug	6,500	1.5				-	10,000	3
1996	9	24-Jul	29-Aug	Walk; Plane	Not specified	18-Aug	1,275	3.1				-	4,000	5
1997	5	06-Aug	04-Sep	Walk; Plane	Not specified	09-Aug	500	4.0				-	2,000	5
1998	13	16-Jul	22-Oct	Walk; Plane; Heli	Not specified	01-Aug	20,000	1.5				-	30,000	3
1999	7	01-Aug	15-Sep	Walk; Plane; Heli	Not specified	07-Aug	8,706	2.0				-	17,000	3
2000	7	02-Aug	13-Sep	Walk; Plane; Heli	Not specified	14-Aug	4,140	1.6				-	6,500	3
2001	6	29-Jul	10-Sep	Walk; Plane; Heli	Not specified	11-Aug	9,511	1.6				-	15,000	4
2002	3	11-Aug	10-Sep	Walk; Heli	Not specified	21-Aug	3,100	1.6				-	5,000	4
2003	6	25-Jul	25-Aug	Walk; Heli	Not specified	11-Aug	18,050	1.7				-	30,000	4
2004	6	02-Jul	31-Aug	Walk; Heli	Expert opinion	13-Aug	8,520	1.4				-	12,000	3
2005	6	13-Jul	03-Sep	Walk (5); Heli (1)	Expert opinion	08-Aug	7,500	2.0	80	10	3	16,506	15,000	3
2006	6	25-Jul	02-Sep	Walk	AUC	04-Aug	6,140		100	13	4	13,162	13,000	3
2007	5	27-Jul	13-Sep	Walk	AUC	27-Jul	2,740		100	15	5	4,894	4,900	3
2008	4	29-Jul	08-Sep	Walk	AUC	22-Aug	172		100	10	4	633	640	3
2009	5	18-Jul	07-Sep	Walk	AUC	08-Aug	5,559		100	12	5	9,800	9,800	3
2010	4	15-Jul	05-Sep	Walk	AUC	11-Aug	2,000		85	10	4	4,193	4,200	4
2011	3	27-Jul	16-Sep	Walk	Peak live + cum. dead	-	1,868	1.2				-	2,200	4
2012	6	25-Jul	16-Sep	Walk	AUC	-			100	14	3	7,925	7,925	3
2013	3	31-Jul	02-Sep	Walk	Expert opinion	31-Jul	6,500	1.1					7,100	4
2014	3	27-Jul	12-Sep	Walk	AUC	-			60	10	3	8,117	8,200	4
2015	4	27-Jul	29-Aug	Walk	Peak count x 2	09-Aug	3,553	2.0				-	7,106	4
2016	5	15-Jul	06-Sep	Walk	AUC	06-Aug	3,115		62	10	4	8,139	8,139	3
2017[c]	2	16-Jul	06-Sep	Walk	Peak count x 2	06-Aug	3,402	2.0				-	6,804	4
2018	4	15-Jul	20-Aug	Walk	AUC	08-Aug	3,913		75	10	4	9,164	9,164	3
2019	4	22-Jul	16-Aug	Walk	AUC	08-Aug	4,832		71	10	4	6,367	6,367	3
Min	2	30-Jun	16-Aug			27-Jul	172	1.1	60	10	3	633	640	3
Max	13	11-Aug	22-Oct			22-Aug	20,000	4.0	100	15	5	16,506	30,000	5
Avg	5	23-Jul	08-Sep			08-Aug	5,629	1.9	85	11	4	8,082	9,694	4

[a] From DFO BC16 records and Stream Estimate Narrative data.

[b] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[c] Six surveys were attempted but high turbid flows limited (29 July) or prevented (16, 26 August; 6 September) four surveys.

Table 8. Summary of Kshwan River Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[b]	
Year	No. surveys	First	Last	Survey	Escapement estimate[a]	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS[c]	Quality
1994	1	23-Jul	-	Walk	No estimate	-							NI	6
1995	2	27-Aug	21-Sep	Walk	Not specified	-	5,265	1.9				-	10,000	4
1996	2	22-Aug	07-Sep	Walk	Not specified	-	6,575	1.5				-	10,000	5
1997	1	07-Sep	-	Walk	Not specified	-	4,849	2.1				-	10,000	5
1998	3	01-Aug	07-Oct	Walk	Not specified	09-Sep	36,090	1.4				-	50,000	4
1999	1	15-Sep	-	Walk	Expert opinion	-	147	13.6				-	2,000	5
2000	1	22-Sep	-	Walk	Expert opinion	-	211	9.5				-	2,000	5
2001	1	17-Sep	19-Oct	Walk	Expert opinion	-	724	2.8				-	2,000	5
2002	1	21-Sep	-	Walk	Expert opinion	-	1,261	2.4				-	3,000	5
2003	1	23-Sep	24-Sep	Walk	Expert opinion	-	1,988	2.5				-	5,000	5
2004	1	06-Sep	-	Walk	Expert opinion	-	7,772	1.9				-	15,000	5
2005	2	17-Aug	11-Sep	Walk	Expert opinion	-	1,043	1.9				-	2,000	5
2006	3	13-Aug	12-Sep	Walk	Expert opinion	12-Sep	9,920	1.5				-	15,000	5
2007	2	31-Aug	12-Sep	Walk	Expert opinion	-	519	1.9				-	1,000	5
2008	1	15-Sep	-	Walk	Expert opinion	-	977	1.0				-	1,000	6
2009	3	13-Sep	25-Sep	Walk	Expert opinion	14-Sep	769	2.0				-	1,500	4
2010	1	16-Sep	-	Walk	Expert opinion	-	381	1.3				-	500	5
2011	1	15-Sep	-	Walk	Expert opinion	-	1,162	1.0				-	1,170	5
2012	2	15-Sep	16-Sep	Walk	Expert opinion	16-Sep	873	1.3				-	1,100	4
2013	-	-	-		Unknown	-							1,100	
2014	-	-	-	Not surveyed	-	-	-					-	NI	6
2015[d]	4	31-Aug	02-Oct	Walk	Peak count x 2	10-Sep	11,865	2.0				-	23,730	3
2016[e]	5	19-Aug	21-Sep	Walk	AUC	27-Aug	1,555		70	10	3	3,265	3,265	3
2017[f]	4	17-Aug	20-Sep	Walk	Peak count x 2	20-Sep	3,746	2.0				-	7,492	4
2018[g]	5	18-Aug	11-Sep	Walk	Peak count x 2	11-Sep	9,371	2.0				-	18,742	4
2019	2	04-Sep	11-Sep	Walk	Peak count x 2	11-Sep	3,753	2.0				-	7,506	4
Min	1	23-Jul	07-Sep			27-Aug	147	1.0	70	10	3	3,265	500	3
Max	8	23-Sep	19-Oct			20-Sep	36,090	13.6	70	10	3	3,265	50,000	6
Avg	2	01-Sep	20-Sep			11-Sep	4,818	2.7	70	10	3	3,265	8,088	5

[a] For 1994−2011, from DFO BC16 records and Stream Estimate Narrative data.

[b] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[c] NI = not inspected.

[d] Flood conditions (high turbid flow) prevented or limited surveys on 21 September and 1, 2 October.

[e] High flows prevented access to river left tributaries on 19, 27 August, and 8 September. A grizzly encounter limited a survey on 21 September.

[f] Flood conditions prevented surveys on 17, 26 August, and 8 September.

[g] Flood conditions and poor marine weather prevented final survey planned for 27−28 September 2018.

Table 9. Summary of Wilauks Creek Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[b]	
Year	No. surveys	First	Last	Survey	Escapement estimate[a]	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS[c]	Quality
1994	3	20-Jul	12-Sep	Walk	Not Specified	20-Aug	236	1.7					400	5
1995	9	20-Jul	09-Oct	Walk	Not Specified	01-Aug	532	1.9					1,000	5
1996	10	20-Jul	05-Oct	Walk	Not Specified	13-Aug	115	3.9					450	4
1997	5	09-Aug	07-Sep	Walk	Not specified	07-Sep	85	1.8					150	4
1998	13	16-Jul	23-Oct	Plane; Walk	Not specified	11-Aug	413	4.8					2,000	3
1999	9	05-Aug	05-Oct	Walk	Not specified	20-Aug	132	2.3					300	4
2000	10	03-Aug	31-Oct	Walk	Not specified	17-Aug	95	3.2					300	4
2001	12	31-Jul	29-Oct	Walk	Not specified	30-Aug	139	1.8					250	3
2002	1	20-Aug	-	Walk	No estimate	20-Aug	149	-					AP	6
2003	1	-	-	Volunteer	No estimate	-	86	-					AP	6
2004	3	09-Aug	08-Sep	Walk	Expert opinion	20-Aug	191	2.1					400	4
2005	7	23-Jul	09-Sep	Walk	AUC	17-Aug	108	-	70	10	5	263	260	4
2006	3	08-Aug	11-Sep	Walk	No estimate	08-Aug	13	-					AP	6
2007	-	-	-	Not surveyed	No estimate	-							NO	6
2008	2	07-Aug	09-Sep	Walk	No estimate	-	2	-					AP	6
2009	4	10-Aug	24-Sep	Walk	Expert opinion	10-Aug	26	2.3					60	4
2010	3	17-Jul	15-Sep	Walk	No estimate	10-Aug	3	-					AP	6
2011	-	-	-	Not surveyed	No estimate	-							NI	6
2012	5	23-Jul	06-Sep	Walk	Expert opinion	16-Aug	51					-	56	5
2013	2	29-Jul	21-Aug	Walk	No estimate	-						-	NO	6
2014	3	08-Aug	14-Sep	Walk	AUC	-			75	10	3	63	63	4
2015	4	03-Aug	16-Sep	Walk	AUC	26-Aug	215		80	10	4	449	449	3
2016	5	27-Jul	07-Sep	Walk	AUC	17-Aug	260		67	10	4	418	418	3
2017[d]	2	30-Jul	07-Sep	Walk	Maximum count x 2	-[e]	31	2.0				-	62	5
2018[f]	3	30-Jul	17-Aug	Walk	No estimate	-						-	NO	6
2019[f]	2	31-Jul	08-Aug	Walk; Heli	No estimate	-						-	NO	6
Min	1	16-Jul	08-Aug			01-Aug	2	1.7	67	10	3	63	56	3
Max	13	20-Aug	31-Oct			07-Sep	532	4.8	80	10	5	449	2,000	6
Avg	6	31-Jul	17-Sep			17-Aug	145	2.5	73	10	4	298	414	5

[a] From DFO BC16 records and Stream Estimate Narrative data for 1994 to 2014.

[b] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[c] AP = adults present; NI = not inspected; NO = none observed.

[d] Five surveys were attempted but three surveys were prevented by high turbid flows (16, 26 August) and marine vessel mechanical issues (7 August).

[e] The peak count was missed due to weather. The count shown is the maximum Chum Salmon count for 2017.

[f] No Dak River water in Wilauks Creek in 2018 or 2019.

Table 10. Summary of Kitsault River Chum Salmon escapement estimates, 1994−2019.

		Survey dates				Method		Peak			AUC				Escapement[c]	
Year	No. surveys[a]	First	Last	Tributaries surveyed[b]	Dak River surveyed	Survey	Escapement estimate	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS[d]	Quality
1994	1–7	01-Jul	13-Sep	6	Y	Boat; Walk	Not specified	28-Aug	4,098	2.1				-	8,500	4
1995	2–9	14-Jul	18-Sep	7	Y	Walk	Not specified	02-Aug	4,278	1.4				-	6,000	4
1996	5–10	15-Jul	22-Sep	7	Y	Walk	Not specified	18-Aug	506	2.6				-	1,320	4
1997	1–3	01-Aug	04-Sep	5	N	Walk	No estimate	04-Sep	69	-				-	AP	6
1998	2–13	16-Jul	31-Oct	7	Y	Plane; Walk	Not specified	20-Aug[f]	3,630	3.5				-	12,530	4
1999	1–5	25-Jul	05-Oct	7	Y	Walk	Not specified	17-Aug	503	3.0				-	1,500	4
2000	2–9	02-Aug	09-Oct	6	Y	Walk	Not specified	31-Aug	197	8.6				-	1,696	4
2001	3–13	21-Jul	21-Oct	7	Y	Walk	Not specified	21-Aug	609	1.4				-	870	4
2002	-	-	-			Not surveyed	No estimate	-						-	AP	6
2003[e]	1	28-Aug	-	1	Y	Walk	No estimate	-	333	-				-	AP	6
2004	1–5	02-Aug	08-Oct	7	Y	Walk	No estimate	05-Aug	555	-				-	AP	6
2005	1–7	25-Jul	01-Oct	7	N	Walk	No estimate	12-Aug	116	-				-	AP	6
2006	1–3	19-Jul	16-Sep	7	Y	Walk; Heli (Dak)	No estimate	16-Sep	352	-				-	AP	6
2007	-	-	-			Not surveyed	No estimate	-						-	NI	6
2008	1	07-Aug	-	3	N	Walk	No estimate	-		-				-	AP	6
2009	-	-	-			Not surveyed	No estimate	-						-	NI	6
2010	1	31-Aug	-	2	N	Walk	No estimate	-	122	-				-	AP	6
2011	5	09-Aug	14-Sep	3	N	Walk	No estimate	-	14	-				-	AP	6
2012	4	25-Jul	06-Sep	-	N	Walk	Expert opinion	20-Aug	69					-	AP	6
2013	4	29-Jul	05-Sep	4	N	Walk	No estimate	-						-	AP	6
2014	-			-		Not surveyed		-						-	NI	6
2015[g]	5	04-Aug	19-Sep	5	N	Walk	AUC	07-Sep	237		87	10	4	445	445	3
2016[h]	6	26-Jul	07-Sep	2	N	Walk	AUC	07-Aug	149		71	10	4	351	351	3
2017[h]	5	30-Jul	07-Sep	2	N	Walk	Maximum count x 2	-[i]	37	2.0				-	74	5
2018	4	31-Jul	12-Sep	2	N	Walk	AUC	12-Sep	320		86	10	4	457	457	3
2019	3	31-Jul	16-Aug	2	Y	Walk	Peak count x 2	16-Aug	294	2.0				-	588	3
Min	0	01-Jul	16-Aug	1				02-Aug	14	1.4	71	10	4	351	74	3
Max	13	31-Aug	31-Oct	7				16-Sep	4,278	8.6	87	10	4	457	12,530	6
Avg[j]	4	27-Jul	20-Sep	5				22-Aug	1,241	3.0	81	10	4	418	2,861	5

[a] Several Kitsault River tributaries are assessed as part of the Kitsault surveys. The number of surveys conducted in each tributary varied each year.

[b] Prior to 2015, tributaries assessed in a given year can include: Kitsault River side-channels, Dak River, Falls Creek, Gwunya Creek, La Rose Creek, Klayduc Creek, Layall Creek, and Stark Creek.

[c] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate.

[d] AP = adults present; NI = not inspected.

[e] Volunteer counts of Falls, Gwunya, and Klayduc creeks were also made (before 8 August) but no SILs records.

[f] Peak date is for Dak River.

[g] Tributaries assessed by NFWD in 2015 were Falls, Gwunya, La Rose, and Klayduc creeks and a mainstem side channel. The final survey on 19 September was prevented by flood conditions.

[h] Tributaries assessed by NFWD in 2016 and 2017 were Falls Creek and a mainstem side channel. Flood conditions prevented surveys on 26 August 2016. Floods also prevented surveys on 30 July and 16, 26 August 2017. A vessel mechanical issue prevented a survey planned for 7 August 2017.

[i] Peak not surveyed in 2017 due to flooding and access issues. Count shown in for the only complete 2017 survey conducted on 7 September.

[j] Average dates exclude 2008 (single volunteer count); average number of surveys from 2010 to 2017.

Table 11. Summary of Illiance River Chum Salmon escapement estimates, 1994−2019.

		Survey dates		Method		Peak			AUC				Escapement[b]	
Year	No. surveys	First	Last	Survey	Escapement estimate[a]	Date	Count	Expansion	OE (%)	RT (days)	No. surveys	Estimate	NuSEDS	Quality
1994	4	20-Jul	12-Sep	Walk	Not specified	27-Aug	1,650	2.4				-	4,000	3
1995	10	20-Jul	09-Oct	Walk	Not specified	01-Aug	2,377	1.7				-	4,000	3
1996	10	20-Jul	05-Oct	Walk	Not specified	13-Aug	184	2.2				-	400	3
1997	9	09-Aug	10-Oct	Walk; Heli	Not specified	07-Sep	227	1.5				-	350	3
1998	13	16-Jul	11-Oct	Walk; Heli	Not specified	11-Aug	1,044	2.9				-	3,000	3
1999	10	26-Jul	05-Oct	Walk	Not specified	20-Aug	401	3.7				-	1,500	4
2000	10	03-Aug	12-Oct	Walk	Not specified	09-Sep	678	1.8				-	1,200	3
2001	12	31-Jul	12-Oct	Walk	Not specified	30-Aug	290	3.4				-	1,000	3
2002	1	20-Aug	-	Walk	No estimate	-	520					-	AP	6
2003	1	28-Aug	-	Walk	No estimate	-	568					-	AP	6
2004	3	09-Aug	08-Sep	Walk	Expert opinion	09-Aug	437	3.4				-	1,500	5
2005	9	08-Jul	19-Sep	Walk	Expert opinion	17-Aug	178	1.7				-	300	4
2006[c]	3	08-Aug	11-Sep	Walk	AUC	27-Aug	884		80	10	3	1,806	1,800	4
2007	1	-	-	Not recorded	No estimate	-	12					-	AP	6
2008	2	07-Aug	09-Sep	Walk	No estimate	-	8					-	AP	6
2009	4	10-Aug	24-Sep	Walk	AUC	24-Aug	209		100	10	3	472	475	3
2010	4	17-Jul	15-Sep	Walk	Expert opinion	10-Aug	116	1.5				-	170	4
2011	7	26-Jul	15-Sep	Walk	No estimate	-	19					-	AP	6
2012	5	23-Jul	06-Sep	Walk	Expert opinion	-						-	113	3
2013	2	29-Jul	21-Aug	Walk	No estimate	-						-	AP	6
2014	4	31-Jul	14-Sep	Walk	AUC	08-Aug	299		90	10	3	419	419	3
2015	5	03-Aug	16-Sep	Walk	AUC	16-Aug	675		61	10	5	1,820	1,820	3
2016	5	26-Jul	07-Sep	Walk	AUC	26-Jul	268		69	10	4	902	902	3
2017[d]	2	30-Jul	07-Sep	Walk	Maximum count x 2	-[e]	110	2.0				-	220	5
2018	5	30-Jul	12-Sep	Walk	AUC	17-Aug	628		80	10	4	1,828	1,828	3
2019	3	31-Jul	16-Aug	Walk	Peak count x 2	16-Aug	466	2.0				-	932	3
Min	1	08-Jul	16-Aug			26-Jul	8	1	61	10	3	419	113	3
Max	13	28-Aug	12-Oct			09-Sep	2,377	4	100	10	5	1,828	4,000	6
Avg	6	30-Jul	18-Sep			17-Aug	510	2	80	10	4	1,208	1,296	4

[a] For 1994 to 2014, from DFO BC16 records and Stream Estimate Narrative data. Estimates for 2015−2019 are from PSC funded NFWD surveys.

[b] Escapement estimate quality (see Appendix Table B-1 for full description): 1, 2, & 3 = High; 4 = Medium; 5 = Low; 6 = No estimate. AP = adults present.

[c] Two AUC estimates were produced in 2006 using different values for survey life (10 d & 15 d). Using 15 d survey life, the escapement estimate was 1,204. The estimate using 10 d survey life was used for NuSEDS (1,806).

[d] Five surveys were attempted but three surveys were prevented by high turbid flows (16, 26 August) and marine vessel mechanical issues.

[e] The peak count was missed due to weather. The count shown is the maximum Chum Salmon count for 2017.

Table 12. Nass Area Chum Salmon escapement summary, 2019. Bold font indicates the best estimate.

					Escapement estimate	
Area	Stream name	Indicator	Funding source	Surveys	Peak count x 2[a,b]	AUC[c]
Lower Nass	Ksemamaith Creek	Yes	NFWD	5	AP	NA
	Gitzyon Creek	No	NFWD	4	AP	NA
	Tseax side-channel	No	NFWD	6	40	**76**
Observatory Inlet	Stagoo Creek	Yes	PSC	4	9,664	**6,367**
	Illiance River	Yes	PSC	3	**932**	NA
	Wilauks Creek	Yes	PSC	2	NO	NA
	Kitsault River (Dak River)	Yes	PSC	3	**588**	NA
	Kshwan River	Yes	PSC	2	**7,506**	NA

[a] Estimate is based on the observation that peak counts can underestimate weir counts by 30 to 50% (Cousens et al. 1982). The peak count is the highest live count plus cumulative carcasses observed to that day.

[b] AP = adults present; NO = none observed.

[c] NA = insufficient number of complete surveys or fish counted to calculate an AUC estimate.

Table 13. Summary of 2019 water temperature from surveyed Nass Area streams.

		Temperature (°C)			
Area	Stream name	n	Average	Min	Max
Lower Nass	Ksemamaith Creek	5	9.8	8.0	12.0
	Gitzyon Creek	4	11.5	10.0	13.0
	Tseax side-channel	6	10.5	10.0	12.0
Observatory Inlet	Stagoo Creek	11	9.4	7.5	12.0
	Kitsault River[a]	2	9.8	7.5	12.0
	Illiance River	3	10.8	9.0	12.5
	Wilauks Creek	0	-		
	Kshwan River[b]	8	8.0	6.0	9.5

[a] Kitsault River values are for Dak River (12°C) and a mainstem side-channel (7.5°C).

[b] Kshwan River values are for the surveyed side-channels and unnamed tributaries of Kshwan River.

FIGURES

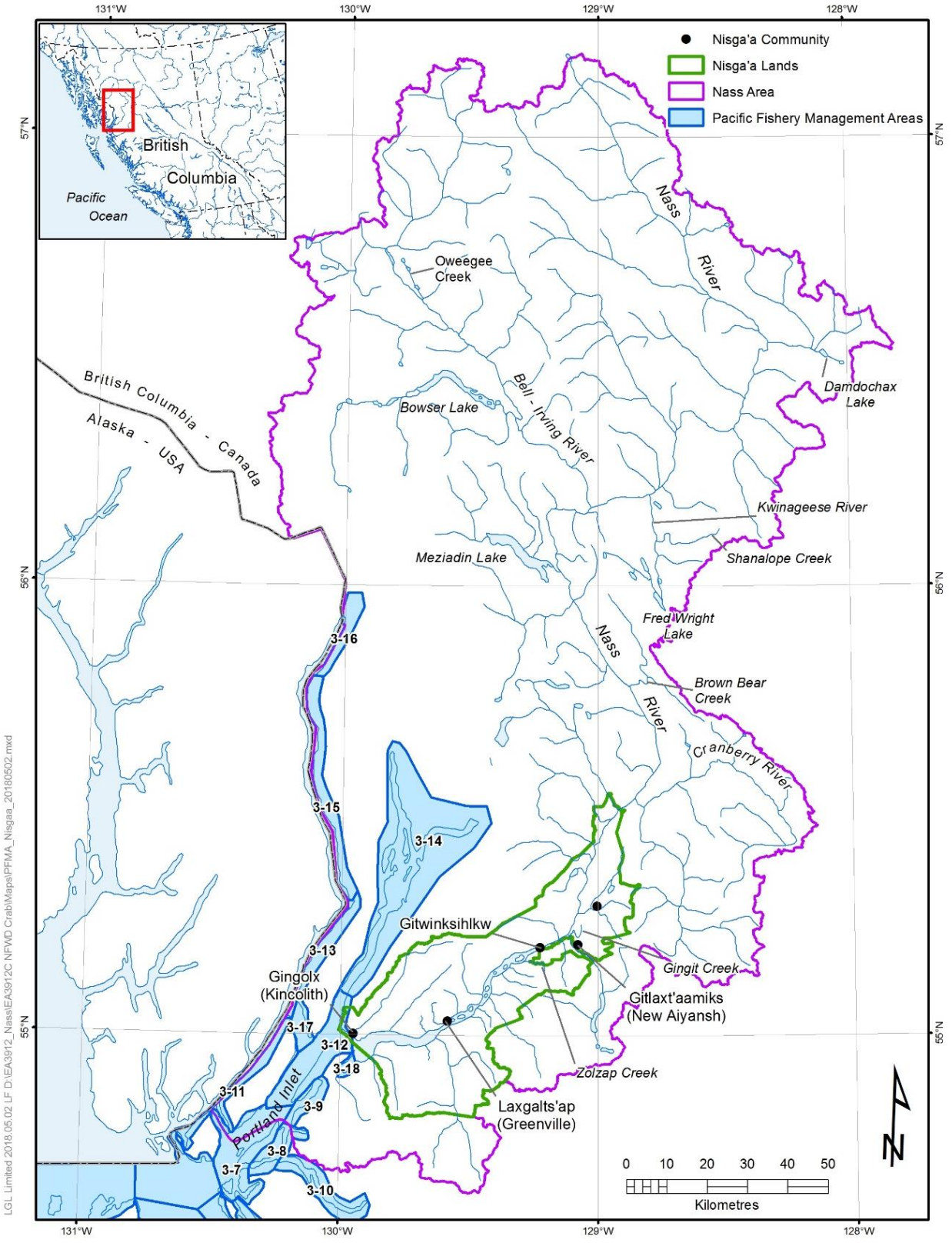

Figure 1. Pacific Fishery Management Area 3 and the Nass Area as defined by the Nisga'a Treaty.

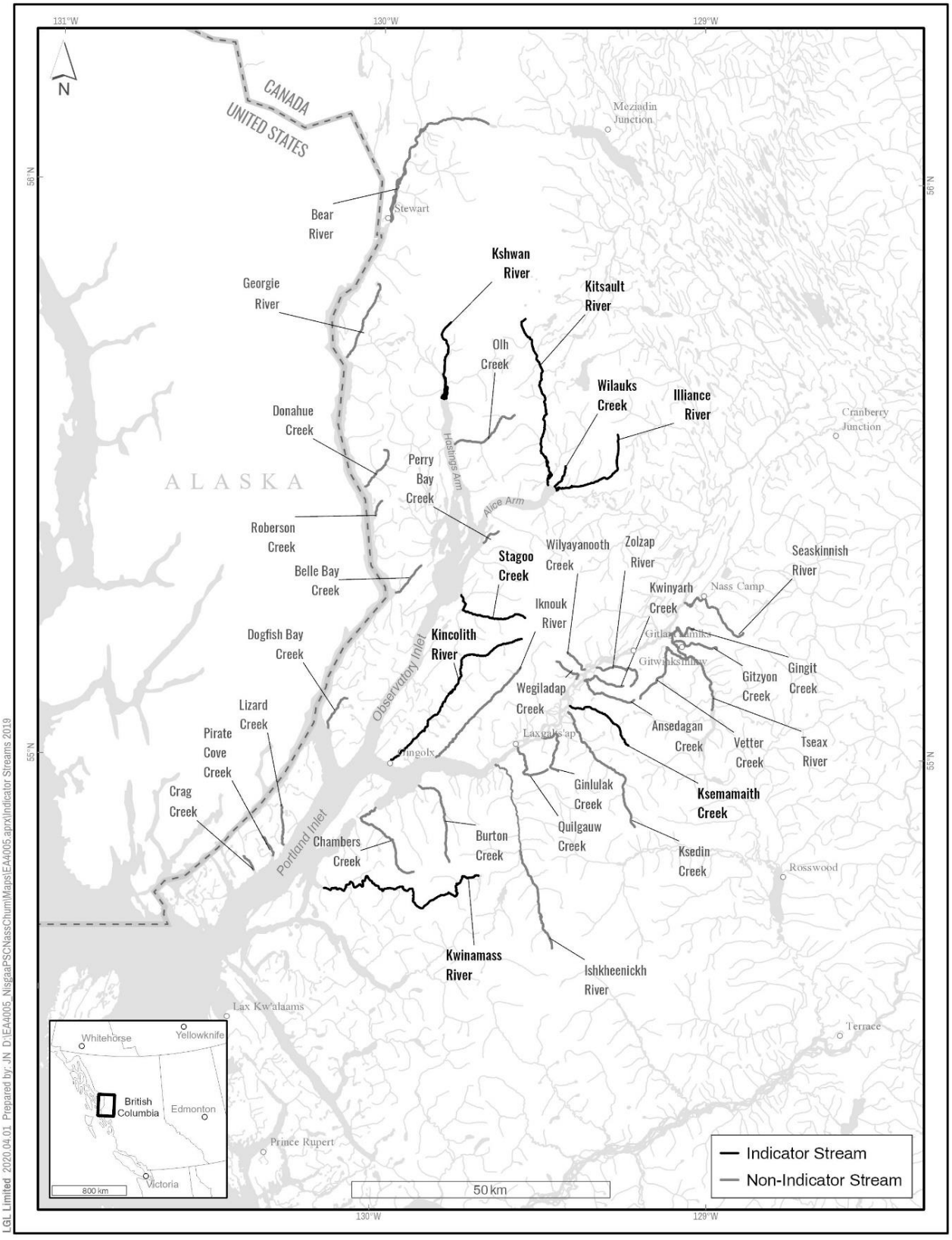

Figure 2. Nass Area Chum Salmon indicator and non-indicator streams.

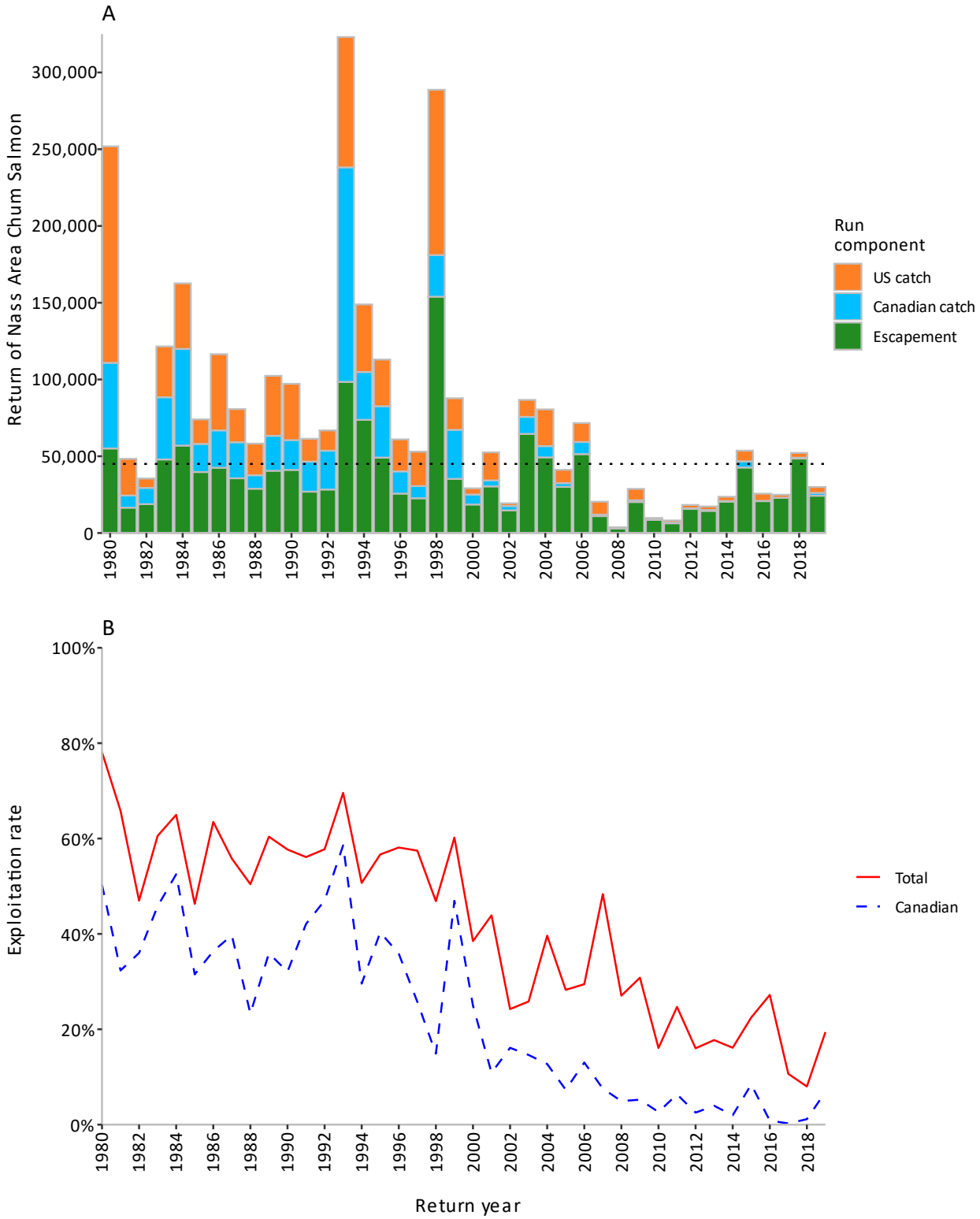

Figure 3. Nass Area Chum Salmon A) escapement and catch, and B) exploitation rates from 1980 to 2019. In panel A, the dashed line is the escapement goal (45,000).

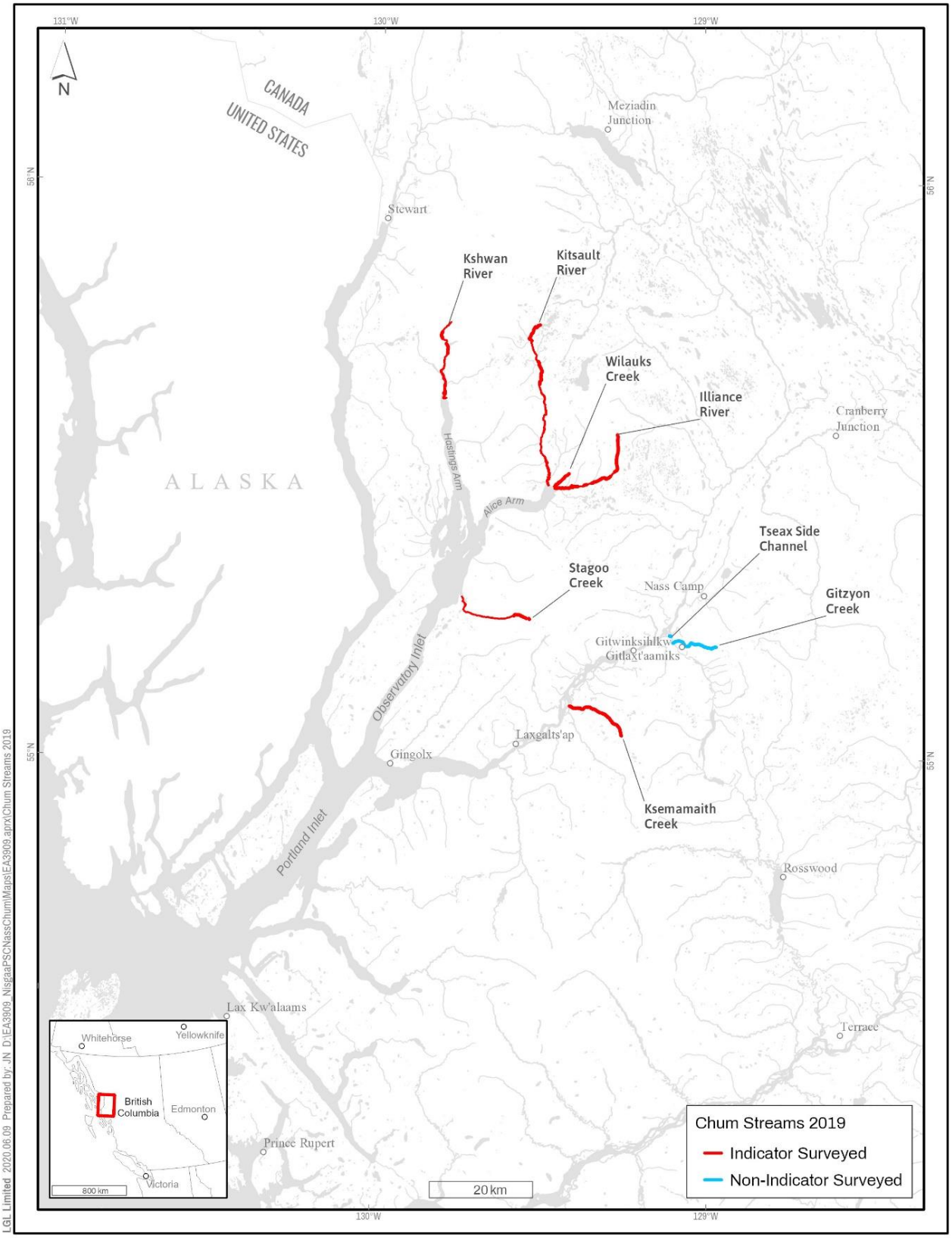

Figure 4. Nass Area Chum Salmon indicator and non-indicator streams surveyed in 2019.

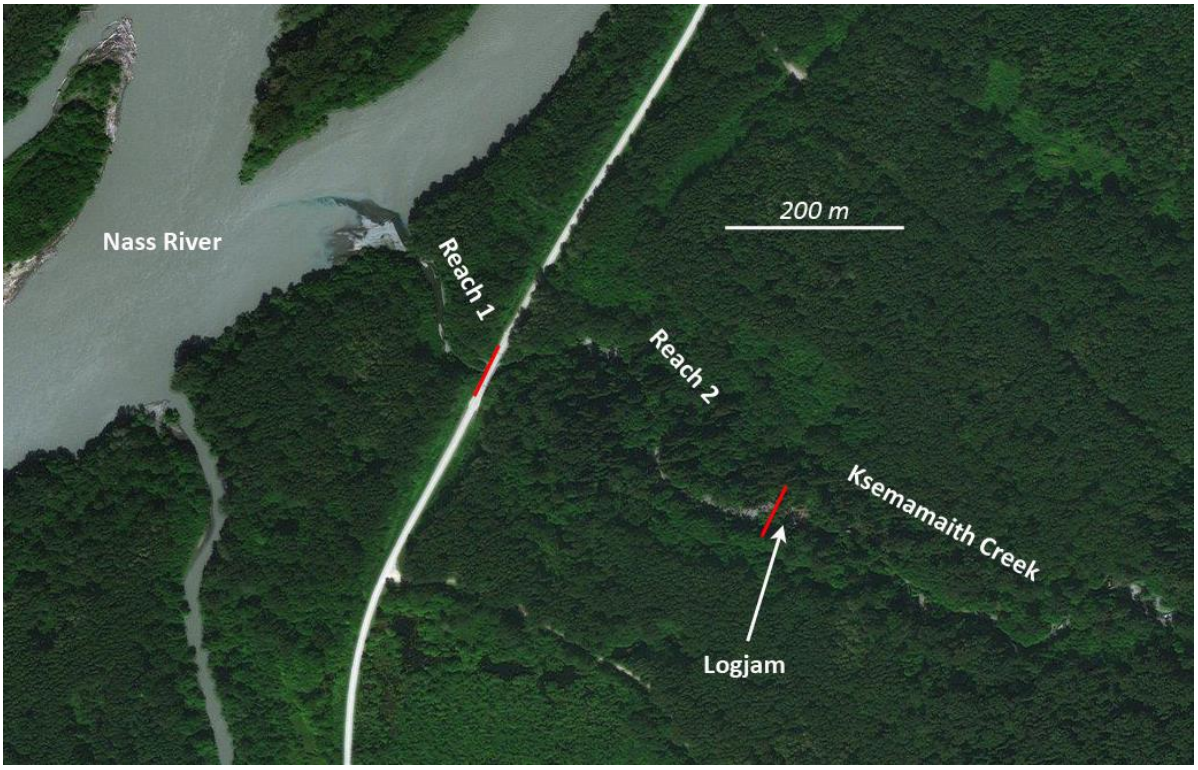

Figure 5. Ksemamaith Creek Chum Salmon survey reaches. Surveys end at the logjam.

Figure 6. Tseax side-channel survey reach. The side-channel is groundwater fed and the reach boundary marks the end of spawning habitat.

Figure 7. Gitzyon Creek Chum Salmon survey reaches, 2019.

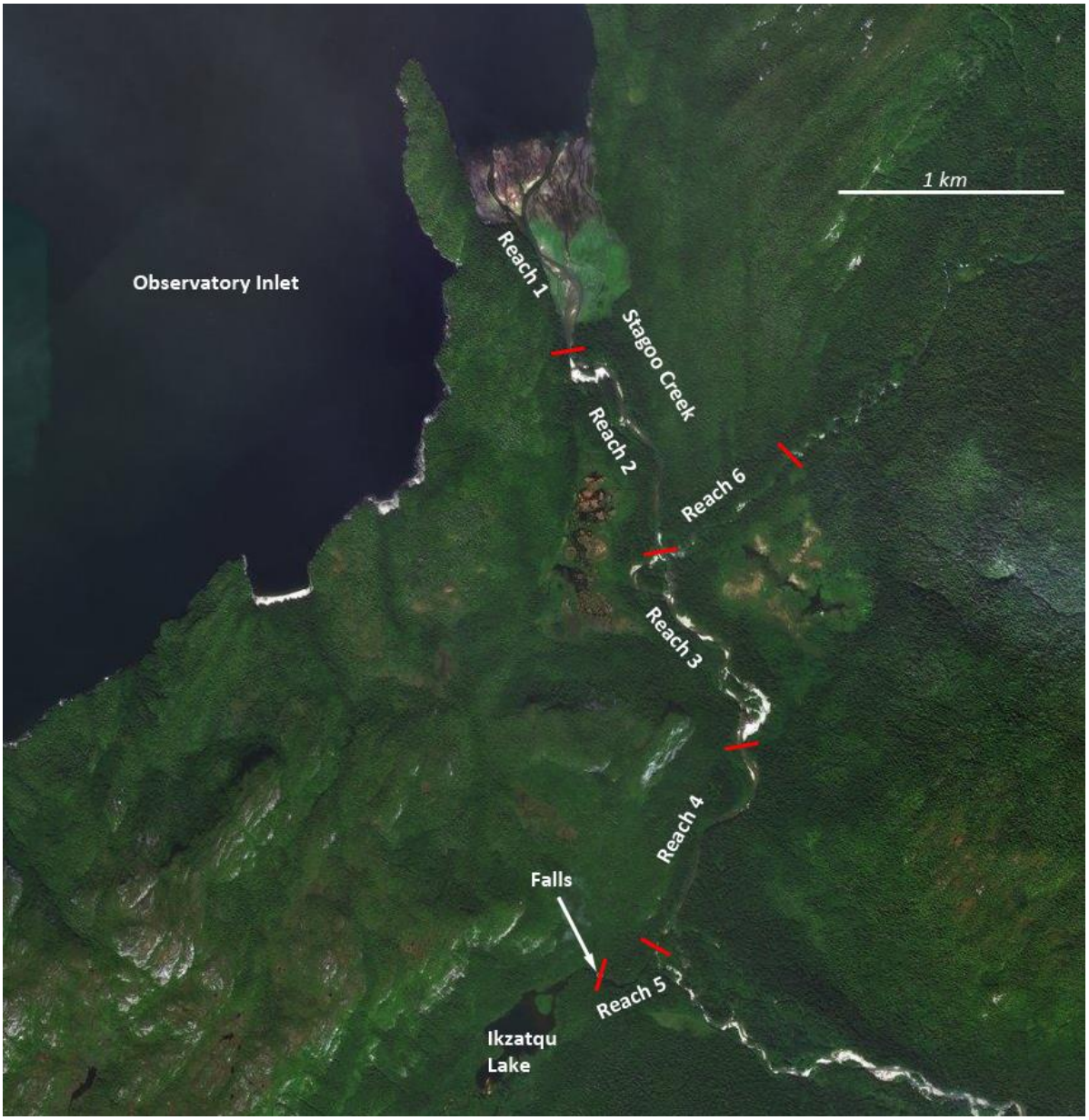

Figure 8. Stagoo Creek Chum Salmon survey reaches. Most spawning is observed in Reach 3.

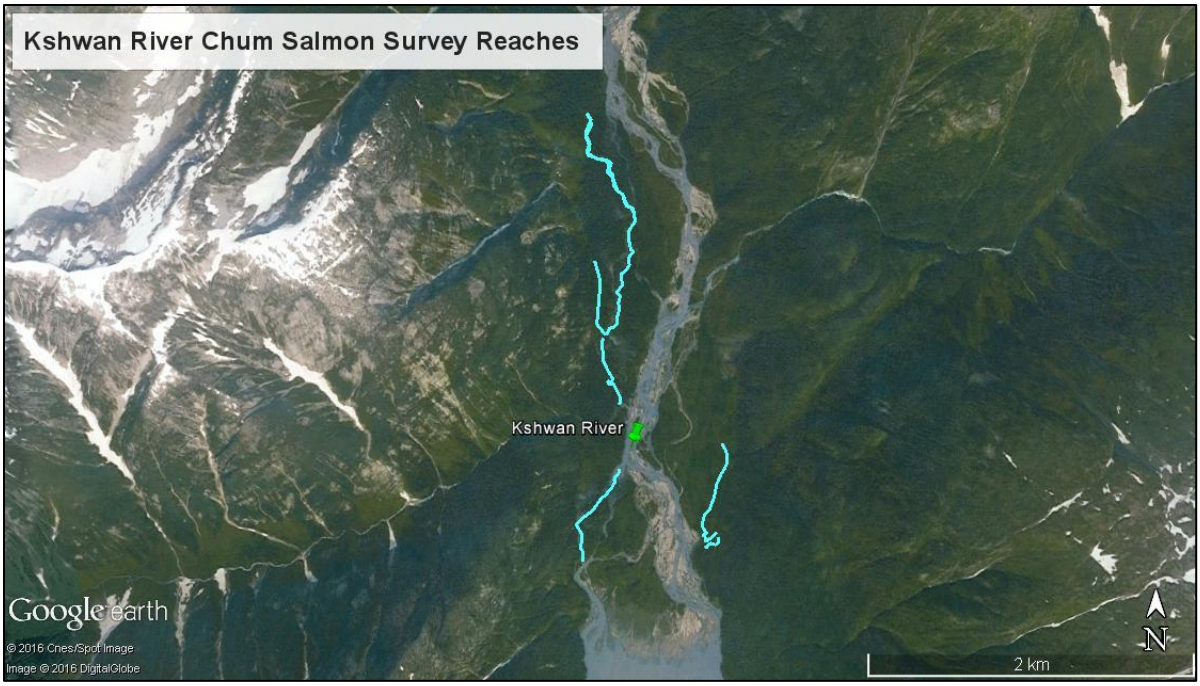

Figure 9. Kshwan River Chum Salmon side-channel and tributary survey reaches.

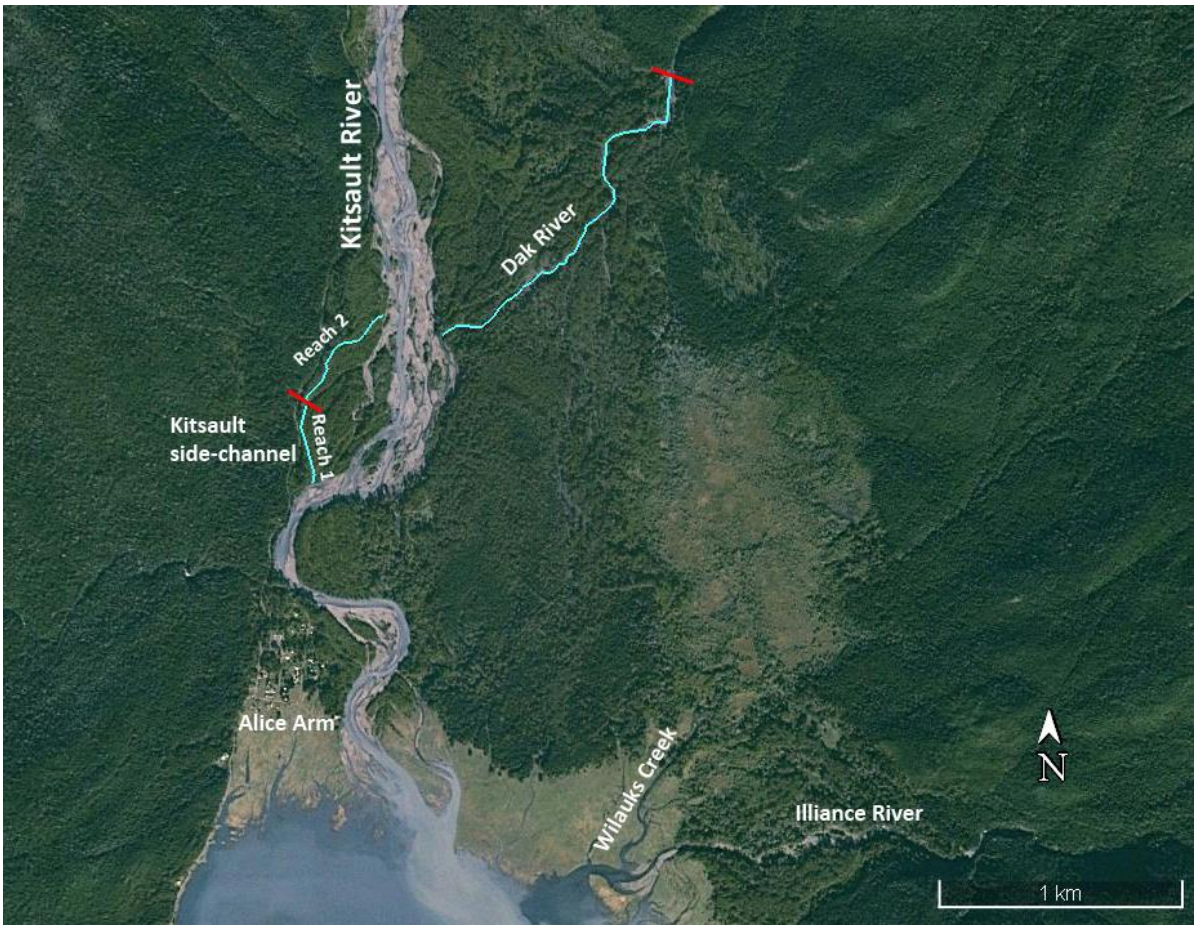

Figure 10. Kitsault River Chum Salmon survey reaches, 2019. Dak River was accessed via helicopter.

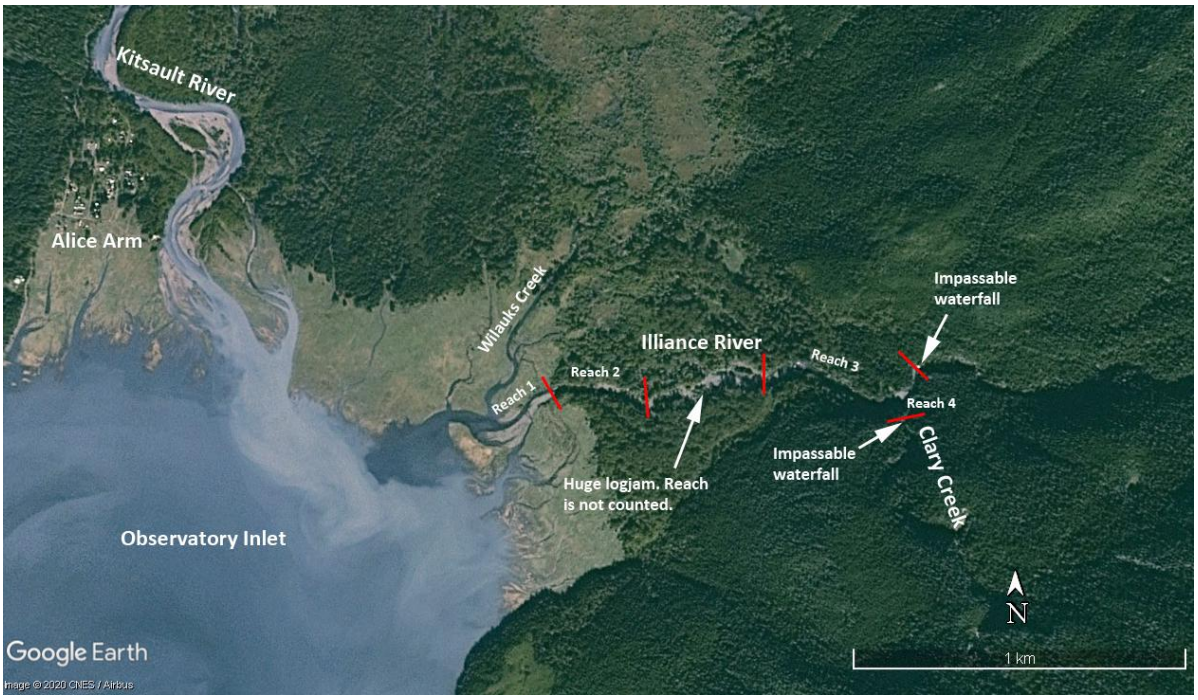

Figure 11. Illiance River Chum Salmon survey reaches. Illiance Creek has large log jam and for safety reasons, this reach not counted. Reaches 3 and 4 both end at waterfalls.

Figure 12. Wilauks Creek Chum Salmon survey reaches. Wilauks Creek was stagnant when assessed and no fish were observed.

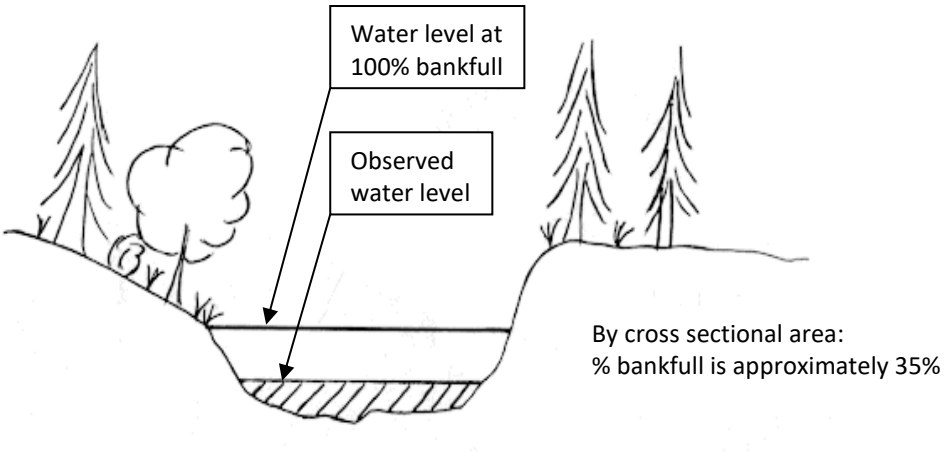

Figure 13. Estimating percent bankfull based on the portion of the channel that is wetted. Figure was copied from DFO Stream Inspection Log definitions.

PHOTOS

A) Reach 1 B) Reach 2

Photo 1. Typical counting conditions in Ksemamaith Creek in the lower Nass.

Photo 2. Representative images of Tseax side-channel.

Photo 3. Typical counting conditions in Gitzyon Creek in the lower Nass.

Photo 4. Representative images of Stagoo Creek.

Kshwan River side-channel

Side-channel

Chum and pink salmon carcasses

Kshwan mainstem and estuary.

Photo 5. Representative images of Kshwan River side-channel survey areas, carcasses, and the Kshwan River mainstem and estuary.

Photo 6. Representative images of Dak River, a major Chum Salmon spawning tributary of Kitsault River.

A) Illiance River

B) Clary Creek

C) Illiance River waterfall

D) Clary Creek waterfall

Photo 7. Representative images of A) Illiance River and B) Clary Creek (Illiance tributary). Surveys in both streams end at waterfalls (C & D).

APPENDICES

Appendix A – Field forms.

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

NFWD Stream Escapement Count Form - 2019	**Stream Name:**	**Crew:**	**Date (dd-mmm):**
	Method: Dead Pitch Stream Walk Snorkel Heli Other:		

Reach	**Start/End Times**	**Live Count**						**Carcass Count**				**Comments (SK tag colours; wildlife; etc)**
		Chum Tag/NoTag	**Pink**	**Sockeye Tag/NoTag**	**Chinook Tag/NoTag**	**Coho Tag/NoTag**	**Obs. Eff. (%)**	**Chum No Tag**	**Chum Tagged**	**Pink**	**Sockeye**	
Totals												

Comments:

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

NFWD Stream Countability					**Stream Name:**						
					Date (yyyy-mm-dd):						**Crew:**
Reach	**Start Time**	**% Overcast**	**Wind**	**Precip.**	**Clarity**	**Instream Visibility (m)**	**% Bankfull**	**Water (°C)**	**Air (°C)**	**Photo(s) #**	**Comments (unusual stream conditions, etc)**
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<25 25-50 50-75 75-100 >100				
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<25 25-50 50-75 75-100 >100				
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<25 25-50 50-75 75-100 >100				
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<25 25-50 50-75 75-100 >100				
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<25 25-50 50-75 75-100 >100				
			None Light Moderate Strong	None Light Moderate Heavy Very Heavy	Clear Tea Slight Muddy Glacial Iced	<0.3 0.3-0.5 0.5-1.0 1.0-2.0 >2.0	<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	
			CM SK CH CO			None Oper. Spag. Anch.		None Punch V-Clip				Live Fresh Old Rotten	
Comments:													

Appendix B – Fisheries and Oceans Canada escapement estimate classification.

Table B-1. Fisheries and Oceans Canada classification system for Pacific salmon escapement estimate quality.

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

Appendix C – Counts and escapement estimates for Pink and Sockeye salmon.

Table C-1. Pink, Sockeye, and Chinook salmon counts for each Nass Area stream surveyed in 2019.

Survey				Pink			Sockeye			Chinook		
Stream name	Date	Length (m)	Observer efficiency (%)	Raw live	Expanded live	Carcass	Raw live	Expanded live	Carcass	Raw Live	Expanded Live	Carcass
Ksemamaith Creek	31-Jul-2019	700	90	0	0	0	0	0	0	0	0	0
	06-Aug-2019	700	95	30	32	0	0	0	0	0	0	0
	15-Aug-2019	700	90	65	72	6	0	0	0	0	0	0
	24-Aug-2019	700	65	179	275	0	0	0	0	0	0	0
	15-Sep-2019	700	95	6	6	2	0	0	0	0	0	0
Gitzyon Creek	31-Jul-2019	1,500	87	0	0	1	751	868	75	0	0	0
	06-Aug-2019	1,500	83	1	1	0	430	510	245	0	0	0
	15-Aug-2019	1,500	90	31	34	35	94	104	156	0	0	0
	24-Aug-2019	1,500	60	558	930	34	8	8	13	0	0	0
Tseax side-channel	31-Jul-2019	380	95	0	0	0	0	0	0	0	0	0
	06-Aug-2019	380	95	0	0	0	34	36	0	0	0	0
	15-Aug-2019	380	90	1	1	0	11	12	1	0	0	0
	24-Aug-2019	380	80	13	16	0	8	10	0	0	0	0
	15-Sep-2019	380	70	15	21	5	6	9	2	0	0	0
	18-Sep-2019	380	90	9	10	0	4	4	1	0	0	0
Stagoo Creek	22-Jul-2019	3,200	68	1	2	0	0	0	0	0	0	0
	30-Jul-2019	4,500	82	2,015	2,422	0	0	0	0	0	0	0
	08-Aug-2019	4,500	80	7,700	9,625	0	0	0	0	0	0	0
	16-Aug-2019	4,300	68	302	455	49	0	0	0	0	0	0
Kitsault River[a]	31-Jul-2019	900	100	0	0	0	0	0	0	0	0	0
	08-Aug-2019	2,400	80	501	626	1	0	0	0	2	2	0
	16-Aug-2019	1,500	60	248	413	2	4	7	0	1	0	0
Illiance River	31-Jul-2019	1,800	78	4,600	5,750	0	0	0	0	0	0	0
	08-Aug-2019	1,800	80	5,850	7,313	0	0	0	0	0	0	0
	16-Aug-2019	1,800	62	2,718	4,573	81	0	0	0	0	0	0
Wilauks Creek	08-Aug-2019	1,000	80	0	0	0	0	0	0	0	0	0
	16-Aug-2019	1,000	80	0	0	0	0	0	0	0	0	0
Kshwan River	04-Sep-2019	4,900	85	280	328	106	1	0	0	0	0	0
	11-Sep-2019	4,900	83	271	324	0	0	0	0	0	0	0

[a]Kitsault River surveys included Dak River (8, 16 August) and a mainstem side-channel (31 July; 8 August).

Table C-2. Best escapement estimates for Pink and Sockeye salmon runs observed during surveys in the Nass Area, 2019.

		Escapement estimates[a]			
		Pink		Sockeye	
Area	**Stream name**	**AUC[b]**	**Peak count x 2[c]**	**AUC[d]**	**Peak count x 2[c]**
Lower Nass	Ksemamaith Creek	**430**	551	-	NO
	Gitzyon Creek	-	NO	**1,231**	1,886
	Tseax side-channel	**46**	53	**53**	72
Observatory Inlet	Stagoo Creek	**10,445**	19,250	-	NO
	Kitsault River[e]	-	**1,222**	-	AP
	Illiance River	**13,343**	14,625	-	NO
	Wilauks Creek	-	NO	-	NO
	Kshwan River[f]	-	**868**	-	AP

[a] AP = adults present; NO = none observed.

[b] Residence time (RT) and standard deviation (SD) for Pink Salmon estimates: RT = 12.6 d; SD = 4.0 d.

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

[d] Residence time calculated for Gingit Creek Sockeye Salmon was used for Gitzyon Creek and Tseax side-channel Creek (sea-type stocks): RT = 12.6 d, SD = 2.0 d (NFWD 2019).

[e] Kitsault River estimates are based on counts from Dak River and a mainstem side-channel.

[f] Kshwan River estimates are based on counts from side-channels and unnamed tributaries of Kshwan River.

Photo C-1. Sockeye Salmon observed in Dak River on 16 August 2019. These are likely a sea-type population given the proximity of Observatory Inlet and the absence of a rearing lake.