Upper Sustut River Steelhead Enumeration 2018

Skeena Fisheries Branch
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
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Acknowledgments

This vital enumeration project would not be possible without the tireless dedication of the Steffey family of Moose Valley, BC; Ron, Wanda, Clayton, Leaf, Brome and Hawk install, staff, maintain, repair and remove the Sustut weir annually. Their commitment to excellence has maintained this project's integrity in spite of often difficult and technically challenging conditions. Their hard work and thoughtfulness is of great benefit to the Sustut River ecosystem, the Province of BC and all its citizens.

This project was funded by the Habitat Conservation Trust Foundation (HCTF). The HCTF was created by an act of the legislature to preserve, restore and enhance key areas of habitat for fish and wildlife throughout British Columbia. Anglers, hunters, trappers and guides contribute to HCTF enhancement projects through license surcharges.

Mark Beere coordinated funding and sample analysis for this study. This annual report has been built upon the efforts of previous authors who include Paddy Hirshfield, Dean Peard, Ron Diewert, Regina and Ron Saimoto, Cory Williamson, Chuck Parken and Krista Morten.

Executive Summary

From August 1 to September 30, 2018, a fish weir was operated on the upper Sustut River. This weir has been used for twenty five years to count migrating summer-run Steelhead (*Oncorhynchus mykiss*) and provides annual monitoring information for this species. Two hundred and ninety-nine (299) Steelhead were counted passing the weir in 2018. This total is 29% of the estimated carrying capacity (1036) and 39% of the average annual count for this project (n=762). These totals may not accurately represent the 2018 population size of upper Sustut River Steelhead. Extreme low water conditions in 2018 appear to have significantly delayed or blocked migration through the weir. Prior to weir removal on October 3rd, 2018, several hundred fish, mostly Steelhead, were observed in two holding pools immediately below the weir site. For management purposes, the population status for 2018 is below the Conservation Concern Threshold and is inside the Conservation Concern Zone. However, due to the aforementioned uncertainty in total population size, this designation should be interpreted with caution.

The first Steelhead migrated through the weir on August 1, which was 7 days earlier than the 25-year average. Overall run-timing of Steelhead was abstract, with 178 Steelhead (59.5%) crossing the weir on a single day, September 7th. Persistent low water levels negatively affected Steelhead movements in the upper Sustut River in 2018.

Of the 299 Steelhead that migrated past the weir, 199 (67%) were female and 100 (33%) were male resulting in a F:M sex ratio of 2:1. In 2018, only 51 Steelhead, 32 females and 19 males, were sampled for fork length and scale age. Females ranged from 670 to 860mm in length, with a mean of 745mm. Males were, on average, larger than females (range 705 to 905 mm, mean 806mm). In 2018, the dominant age class was 4.2. In total, seven different life histories were observed. Eight percent of Steelhead were repeat spawners.

All Steelhead crossing the weir were checked for the presence of gillnet scars or tags. No gillnet scars were observed in 2018. This is attributable to the lack of directed sockeye gillnet fisheries in the Skeena River approach waters in early-mid July when Sustut River Steelhead are significantly present. No tagged Steelhead were observed at the weir in 2018.

Mean daily air temperature at the weir ranged between -4.4°C and 15.6°C, averaging 6.9°C. Mean daily water temperature at the weir ranged between 2.4°C and 14.2°C, averaging 8.6°C. Water levels ranged from a low of 0.075 m to a high of 0.345 m and averaged 0.13 m. While comparison of current water levels to those observed prior to 2015 is not possible due to relocation of the staff gauge in 2015, the observed downward trend in water level is consistent pre and post-2015 relocation.

Recommendations of this report include suggestions to enhance management and conservation of the upper Sustut River Steelhead population and improvements to study design.

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1.0 Introduction

The Sustut River is a lake-headed tributary of the Skeena River located in north central British Columbia (Figure 1) which supports populations of more than a dozen species of fish, most notably including Steelhead and Rainbow Trout (*Oncorhynchus mykiss*), Chinook Salmon (*O. tshawytscha*), Sockeye Salmon (*O. nerka*), Coho Salmon (*O. kisutch*), Bull Trout (*Salvelinus confluentus*) and Mountain Whitefish (*Prosopium williamsoni*). The Sustut River originates in the Omineca Mountains approximately 200 km north of Smithers, B.C., drains approximately 3,574 km^2, and flows for approximately 108 km from the outlet of Sustut Lake to the Skeena River. It has seven main tributaries including the Bear and Asitka Rivers, as well as Birdflat, Red, Two Lake, Moosevale and Johanson Creeks. The mainstem sections of the upper Sustut River and Johanson Creek from their respective lake outlets to their confluence form the primary spawning areas for Steelhead in the upper Sustut River (Bustard, 1993).

Upper Sustut River Steelhead comprise a unique population within the Skeena River watershed. Overwintering, spawning and rearing occur at high elevations in the Sustut Lake (1306m) and Johanson Lake (1448m) watersheds. The short growth season in this high elevation, mountainous region prolongs the rearing component of their life-history. The mean smolt age for upper Sustut River Steelhead is 4.5 years (Tautz *et al.*, 1992). In comparison, most British Columbia Steelhead populations produce smolts that range from two to three years of age (McPhail, 2007). Populations which exist near the edges of their respective species' biological thresholds are known to be valuable indicators of population trend and ecosystem shift, as they are often the first to be impacted by and illuminate change on the landscape. As a result, upper Sustut River Steelhead are an ideal population to monitor in order to understand trends of abundance, life history, biology and ecosystem health over time.

Early research (Spence *et al.*, 1990) into Sustut River Steelhead shed light on a migration behaviour which provides a unique opportunity for weir-based stock assessment. Because the upper Sustut River and its major tributary Johanson Creek are both lake-headed, they provide hydrologically and thermally stable overwintering, spawning and rearing habitat for Steelhead. This stability lends itself well to enumeration by weir. Since 1994, the upper Sustut River Steelhead population has been monitored in a standardized manner at a counting weir located upstream of Moosevale Creek during the months of August and September. The information collected at the weir site provides insight into annual escapements of upper Sustut River Steelhead and is believed to demonstrate trends in abundance for other populations of upper Skeena River Steelhead.

Perpetual concerns exist regarding the conservation of summer-run Steelhead stocks in the Skeena watershed as their run timing coincides with mixed stock commercial gillnet and seine fisheries primarily targeting Chinook, Sockeye and Pink salmon. Steelhead are incidentally captured and suffer mortality in these fisheries (Ward *et al.*, 1993; Cox-Rogers, 1994). Sustut River Steelhead are also harvested by Indigenous fishers using various methods (gillnet, seine, rod, dip-net, gaff, etc.) during their migration through the Skeena watershed and at terminal locations near the weir site.

The Sustut River is managed as a Class 1 Classified Water from September 1 to October 31. Angling on the Sustut River is prohibited all year upstream of the BC Railway bridge at the Bear River/Sustut River confluence to protect the upper Sustut River Steelhead population and minimize possible effects of angling on migration of this reference population. In addition, angling is prohibited from January 1 to June 15 to protect overwintering, spawning and emigrating Steelhead. The use of bait while angling is also prohibited from Sept 1 to Dec 31 to minimize angling-related mortality. As per provincial policy, wild Steelhead may not be harvested by recreational anglers.

The objectives of the project are to:

- Enumerate the upper Sustut River Steelhead population
- Inform management of upper Skeena River Steelhead stocks
- Monitor the biological characteristics of upper Sustut River Steelhead
- Monitor environmental variables in critical Steelhead habitat
- Monitor the impact of gillnet fisheries by examining Steelhead for the presence of gillnet scars

Although the objectives of the project relate to Steelhead, other species are enumerated during weir operation. Data for Chinook, Sockeye, Coho, Bull Trout, Rocky Mountain Whitefish and Rainbow Trout are also recorded. Salmon data is forwarded to Fisheries and Oceans Canada.

2.0 Methods

2.1 Steelhead Enumeration

A floating fish weir constructed from 3.8 cm PVC pipe was installed in the upper Sustut River approximately 600m upstream of the Moosevale Creek confluence (Figures 2 and 3), approximately 97km upstream from the confluence of the Skeena and Sustut rivers. It is important to note that as a result of localized erosion, the weir was repositioned in 2015, to a new location approximately 100m upstream (Figures 3 and 4).

The weir was in operation between August 1 and September 30, 2018. Upon arriving at the weir, fish were directed into an aluminum trap box where they remained until a gate was opened allowing upstream migration to continue (Figures 5, 6 and 7). A count of Steelhead crossing the weir after September 30 (usually during de-construction of the weir) is periodically recorded, in addition to Steelhead holding downstream of the weir upon its removal. This information has not historically been added to total counts as it is not consistently measured. In some years, water clarity is limited and accurate visual counts are not possible.

During operation, the weir was inspected a minimum of three times a day. Debris was removed and repairs were made as necessary. The trap box was checked in the morning, afternoon and evening during low levels of fish migration. At peak migration, the weir was checked in the morning and a member of the project crew remained on site throughout the afternoon and evening. Experience indicates that human activity around the weir often delays or halts migration (Ron Steffey pers. comm.). Therefore, the removal of debris and salmon carcasses from the weir was limited to avoid affecting fish migration.

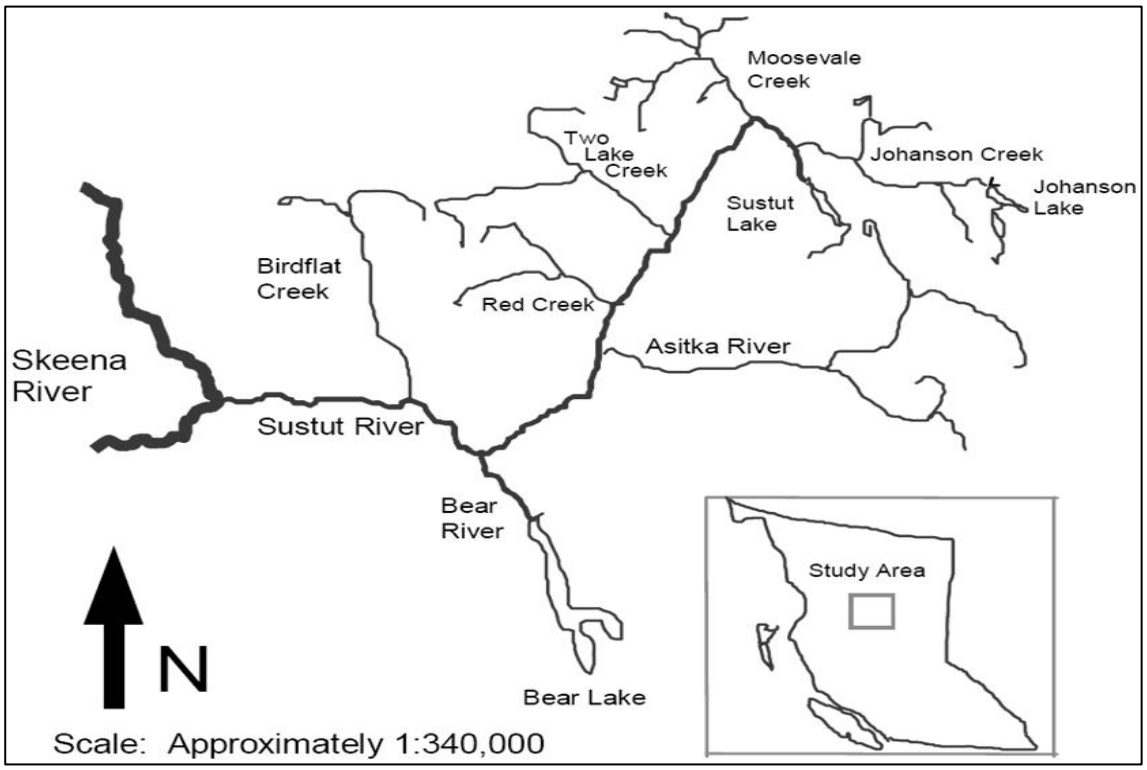

Figure 1. Sustut River and surrounding tributaries

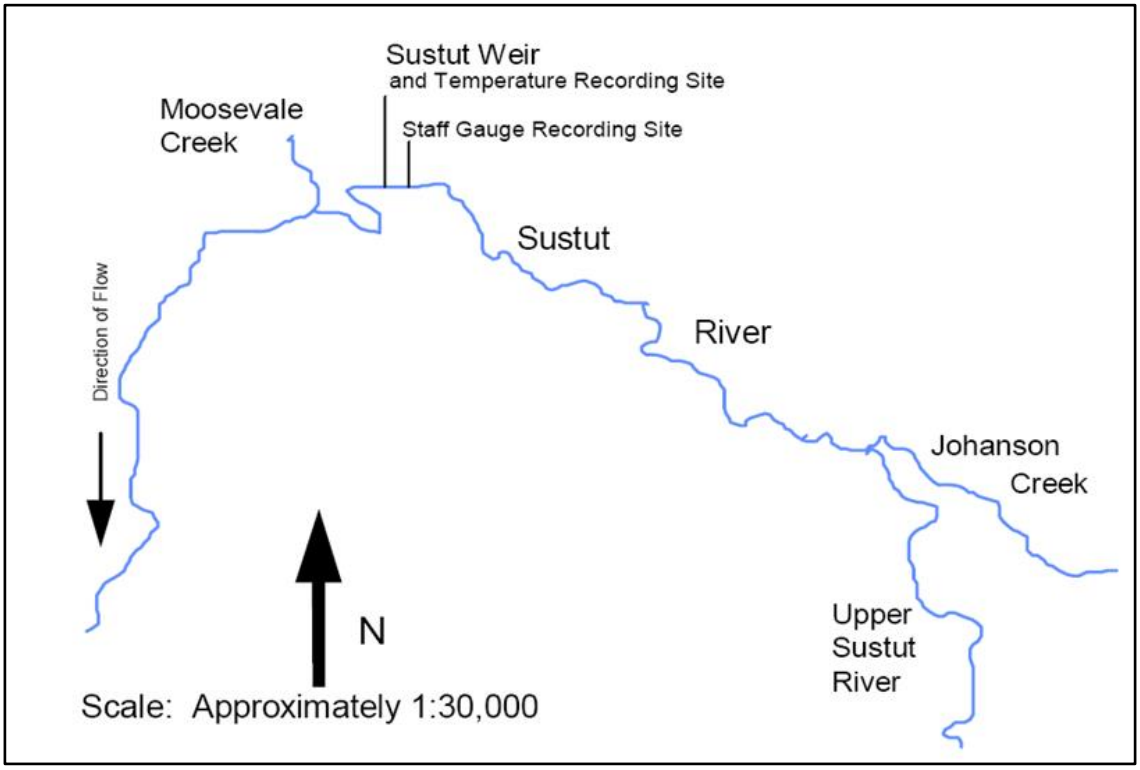

Figure 2. Sustut enumeration weir location on the upper Sustut River

Figure 3. Aerial view of Sustut enumeration weir relocation

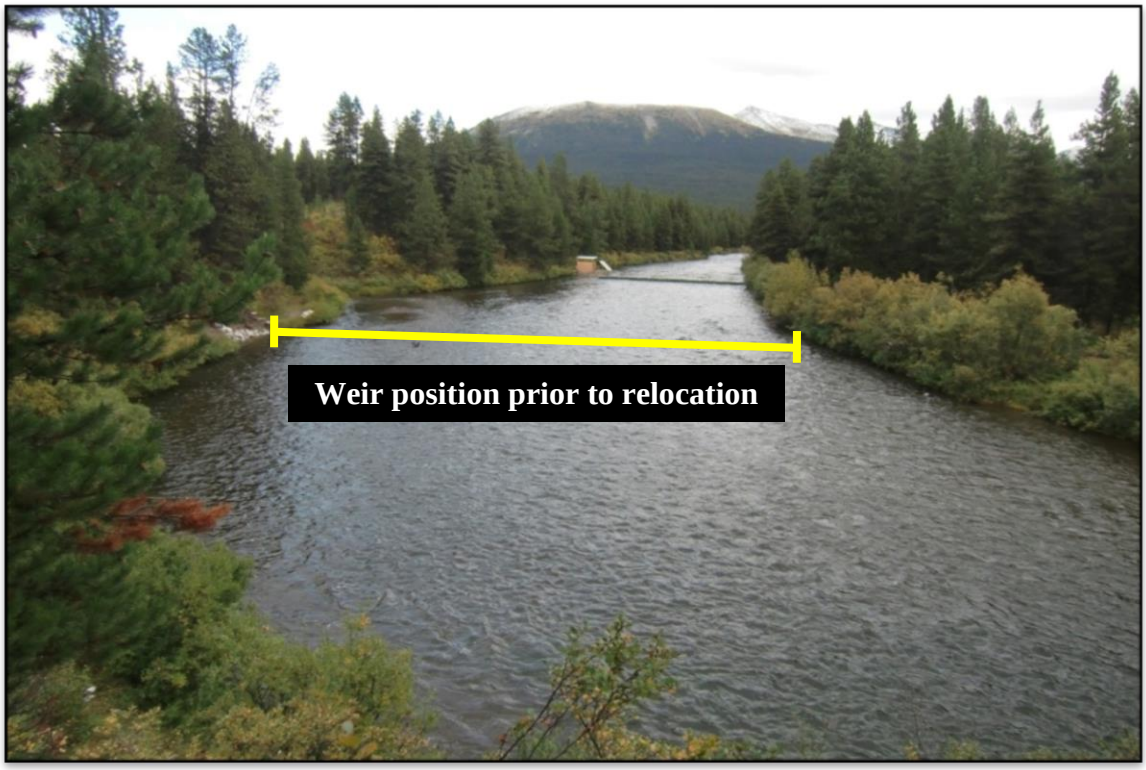

Figure 4. Ground view of Sustut enumeration weir relocation
Photo courtesy of Mark Beere

Figure 5. Sustut enumeration weir looking downstream
Photo courtesy of Mark Beere

Figure 6. Sustut enumeration weir looking upstream
Photo courtesy of Mark Beere

Figure 7. Sustut enumeration weir trap box entrance
Photo courtesy of Mark Beere

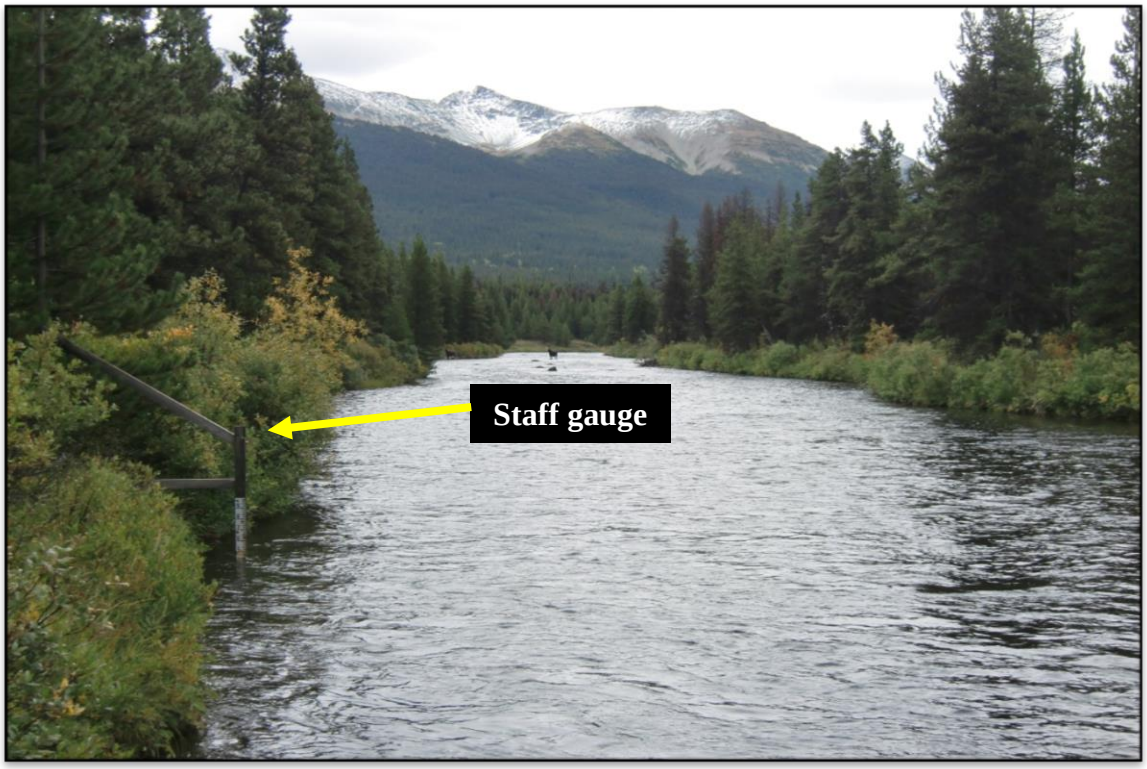

Figure 8. Staff gauge location upstream of the repositioned Sustut enumeration weir
Photo courtesy of Mark Beere

2.2 Management Framework

Sustut River Steelhead are managed according to the *Provincial Framework for Steelhead Management in British Columbia* (MFLNRO, 2016). This framework conceptualizes an abundance based management regime which relies on biological reference points to ensure conservation of stock and species (Figure 9). These biological reference points were proposed in Johnston *et al.* (2002) and adapted in MFLNRO (2016). Reference points are typically assigned using estimates of carrying capacity. Steelhead carrying capacities for streams in the Skeena watershed were determined using a habitat based productivity model developed by Tautz *et al.* (1992). This model indicates an adult production potential of 1036 Steelhead for the upper Sustut River. Default management thresholds are currently being reviewed to determine if they can effectively meet conservation objectives for upper Sustut River Steelhead.

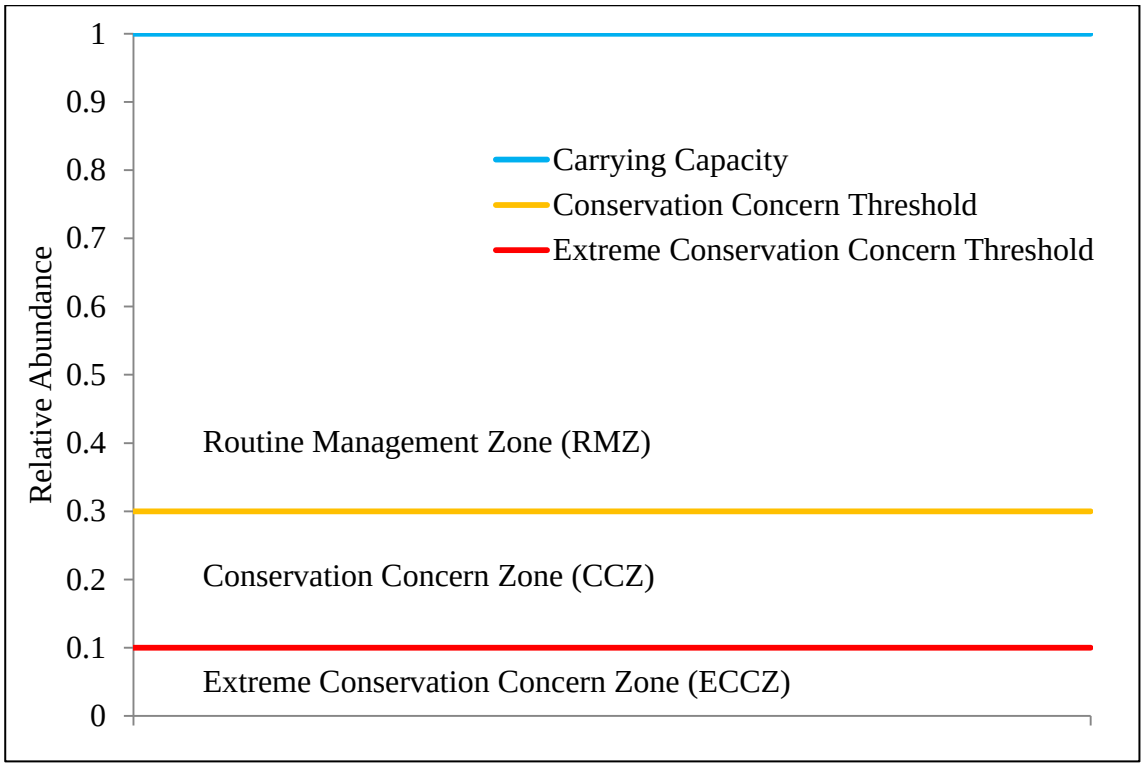

Figure 9. Default management framework for upper Sustut River Steelhead

2.3 Steelhead Biological Information

Experienced personnel using the visual characteristics described in Scott & Crossman (1973) and McPhail & Carveth (1994) identified all fish passing the weir by species. This information was recorded and summarized daily. A plexiglass viewing box was used to identify fish by species and sex and to observe scars, wounds and general condition. Approximately 17% of all Steelhead passing through the weir were sub-sampled for fork length and scale ageing. Steelhead were sampled by dip netting from the trap box (Figure 7). Fork length was measured to the nearest half-centimeter and five scales were removed mid-laterally between the dorsal and anal fins. Any mortalities recovered from the weir are also sampled for fork length and age structures.

Scale samples were analyzed by Birkenhead Scale Analyses who determined length of freshwater (FW) and saltwater (SW) residency and incidence of spawning events.

FLNRO staff then filtered the scale ages by condition. All scales coded as 1, 5, 5a and 9 were included in the analysis. For scales identified as condition code 2 (poor condition, n=2), both had useable ages. For scales identified as condition code 6 (regenerated, n=8), all SW ages except one (regenerated) were included in the analysis. No scale samples were assigned codes 3, 4, 7, 8 or 10 in 2018. See Appendix Table 2 for full scale condition code descriptors. Total useable scale ages from 2018 sampling were FW n= 43 and SW n=50 and combined n=43. Fish age was determined by adding FW and SW residency periods and spawning checks. For example, a Steelhead reported as 4.2S1 was deemed to have been spawned as an egg in May 2010, hatched in August 2010, lived for four years in freshwater, smolted in May 2014, spent until August 2016 in the ocean, migrated to freshwater and subsequently spawned in May of 2017, migrated back to the ocean immediately after spawning, remained there until August of 2018 and migrated back to their weir site and was sampled in September 2018. This individual is then reported as a repeat spawner in its 9th year of life.

2.4 Steelhead Tagging

Steelhead intercepted in commercial or Indigenous fisheries, the Tyee Test Fishery or other biological monitoring programs may be tagged or marked prior to release. Steelhead enumerated at the weir were checked for the presence of these tags and marks. This information allows fisheries managers to assess migration rates, interception in domestic and international fisheries and survival following capture in these fisheries.

2.5 Steelhead Gillnet Scars

The presence of gillnet scars was noted for all Steelhead that migrated through the weir to the extent possible. The plexiglass viewing box allowed this information to be collected and avoided the need to handle fish. In some cases, not all fish with net scars may have been recorded due to turbid water conditions or limited observation time during high rates of migration.

2.6 Environmental Variables

Two Onset Hobo Pro v2® temperature loggers were used to record water and air temperatures at the weir site. These loggers have been secured in consistent locations annually. Hourly data was averaged to generate mean daily air and water temperatures. For redundancy, stream water and air temperatures were recorded each day using a hand-held minimum-maximum thermometer.

Water level measurements were recorded from a metric staff gauge located immediately upstream of the weir (Figure 8). Levels were recorded by weir staff twice a day, typically in the morning (~0900H) and evening (~2000H). Weir staff also recorded air temperature and weather conditions daily. For comparison purposes, the two daily water level measurements were averaged to determine the mean daily water level. As previously noted, the weir was repositioned in 2015, to a location approximately 100m upstream of the previous location. The staff gauge used for measuring water level was also moved and fixed upstream of the new weir site (Figure 8).

3.0 Results

3.1 Steelhead Enumeration

Between August 1 and September 30, 299 Steelhead migrated past the Sustut enumeration weir (Figure 10). This count is 39% of the long term average (*n*=781; Table 1) and 29% of the estimated carrying capacity (1036, Figure 12). The first Steelhead migrated past the weir on August 1. Since 1994, the date on which the first Steelhead passed weir has ranged between July 28 (2004) and August 18 (1999), averaging August 7. As indicated in Figure 11, Steelhead migration beyond the weir in 2018 was abstract, and peaked when 178 Steelhead crossed on a single day, Sept 7. Approximately 60% of the total enumeration crossed the weir on this day. Several hundred (300-600+) Steelhead were observed holding downstream in several locations in the days prior to weir removal (Ron Steffey pers. comm.). This places significant uncertainty around the enumeration of the 2018 Steelhead population.

3.2 Management Framework

The upper Sustut Steelhead population had previously been in the Routine Management Zone for the past nine years (Figure 12). Excluding the several hundred fish observed below the weir prior to removal, the enumeration of upper Sustut River Steelhead in 2018 falls inside the Conservation Concern Zone (threshold n = 311). However, given that migration was delayed and the total enumeration through the weir is a minimum estimate, this designation should be treated cautiously.

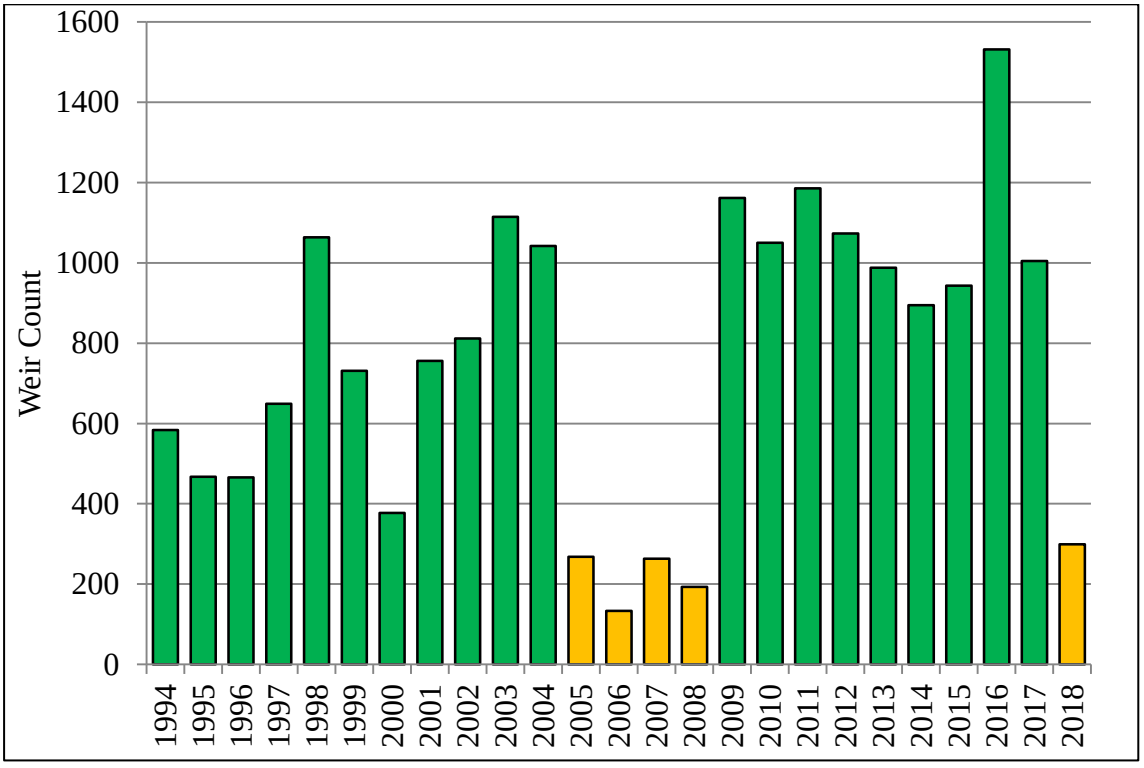

Figure 10. Upper Sustut River Steelhead enumeration, 1994-2018

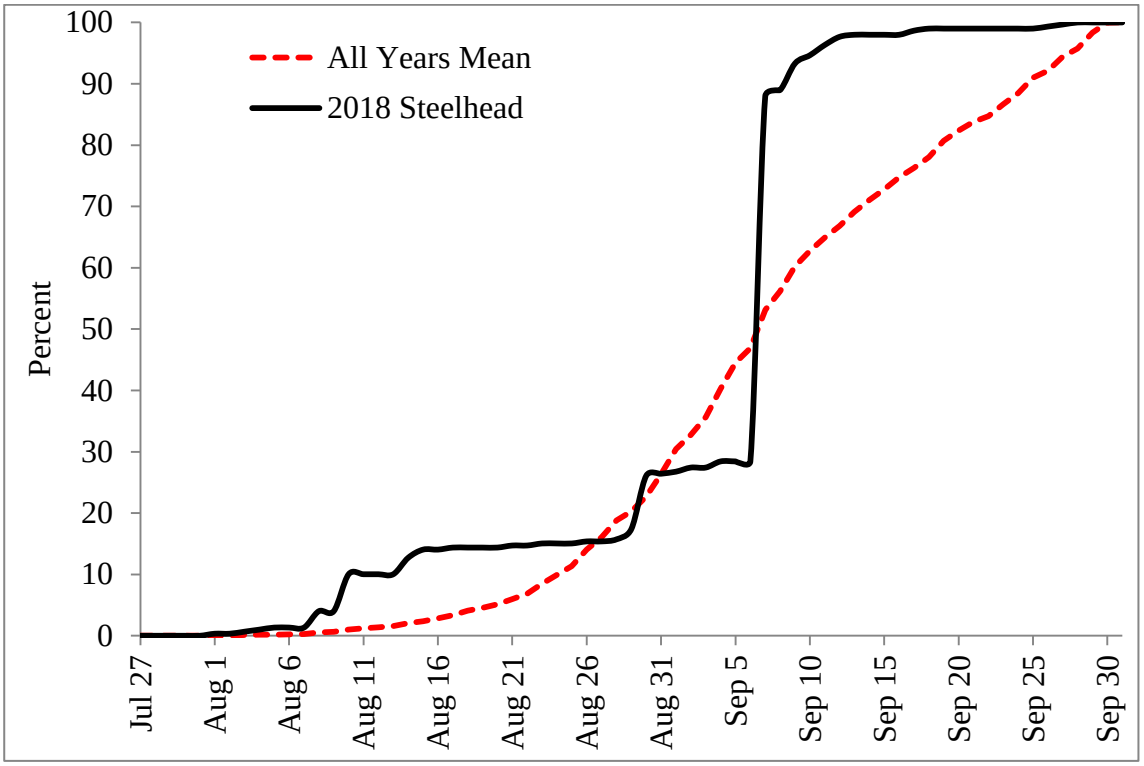

Figure 11. Upper Sustut River Steelhead migration timing

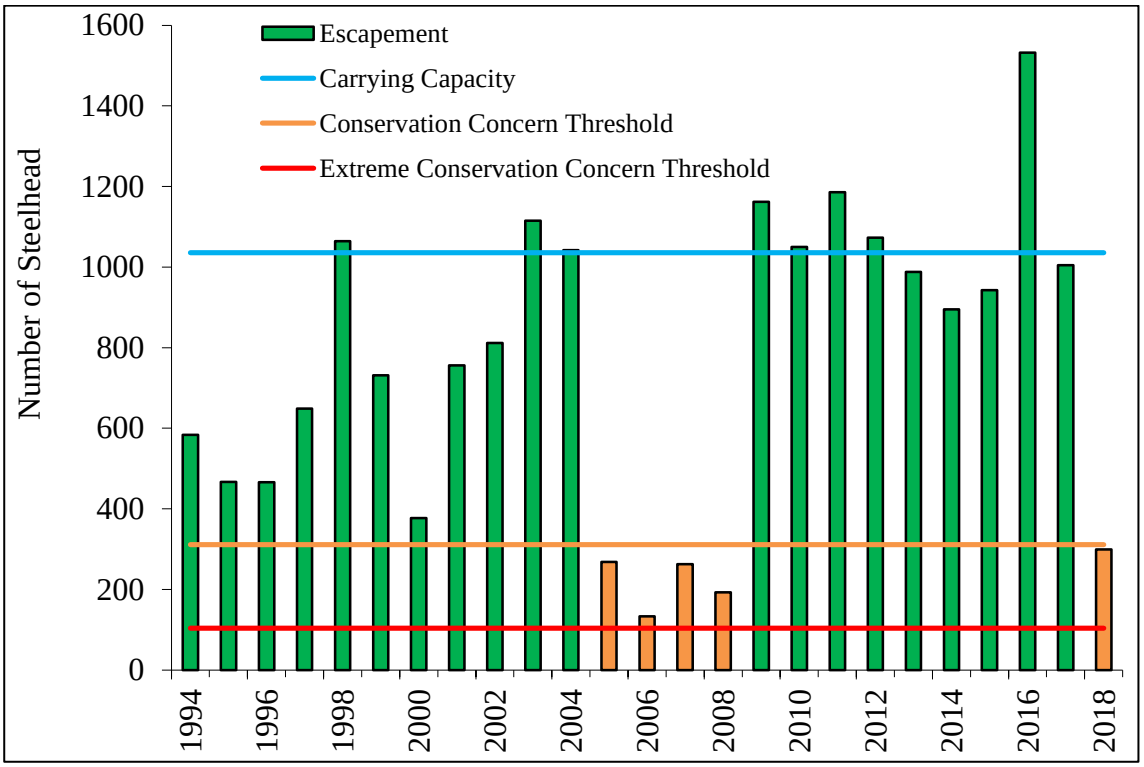

Figure 12. Annual enumeration showing management thresholds

Year	First ST Date	Total Weir Count	Average Length (mm)		Repeat Spawners (%)	Sex Ratio (F:1M)	Gillnet Scarring (%)			Mean Water Temp (°C) Aug1 - Sep30	Mean Water Level (m) Aug1 - Sep30
			M	F			M	F	Combined		
1994	08-Aug	584	824	737		1.55			2.0		
1995	08-Aug	467	826	746	1.2	1.23			6.0		
1996	17-Aug	466	829	739	1.3	1.58			14.0		
1997	09-Aug	649	814	733	0.6	1.43	9.2	17.8	15.4		
1998	03-Aug	1064	827	749		1.73	13.4	13.8	13.7		0.27
1999	18-Aug	731	848	756	2.5	1.64	6.1	9.9	8.5		0.28
2000	08-Aug	377	827	741	0.4	1.64	10.6	16.2	14.1		0.30
2001	15-Aug	756	864	771	2.5	1.63	10.1	14.5	12.8		
2002	09-Aug	812			1.9	1.27	3.6	8.4	6.3		0.23
2003	03-Aug	1115	780	730	1.2	1.39	8.3	14.2	11.8		0.31
2004	28-Jul	1042	818	745		1.48	6.0	8.8	7.7		0.34
2005	31-Jul	268	859	741	19.0	2.01	3.3	5.5	4.8	8.81	0.32
2006	09-Aug	133				1.50	0.5	1.6	2.3	8.71	0.21
2007	09-Aug	263				1.39	2.7	4.6	3.8	8.81	0.16
2008	08-Aug	193				1.92	4.5	2.4	3.1	9.11	0.23
2009	06-Aug	1162				1.66	0.7	1.5	1.2	9.61	0.20
2010	03-Aug	1050	793	746	1.0	1.48	0.9	2.6	1.9	8.91	0.12
2011	13-Aug	1186	824	756	10.3	1.73	3.7	8.0	6.4	8.65	0.27
2012	11-Aug	1073	801	728	5.3	1.65	2.7	2.4	2.5	9.29	0.15
2013	03-Aug	988	816	752	9.2	1.96	0.5	0.5	1.0	10.1	0.10
2014	03-Aug	895	773	724	6.4	1.69	6.3	4.8	5.4	9.31	0.11
2015	06-Aug	943	804	743	8.2	2.13	0.2	1.3	1.5	8.38	0.30
2016	08-Aug	1532	778	732	8.9	1.99	2.9	3.6	3.4	9.47	0.25
2017	09-Aug	1005	820	751	5.95	1.98	0.4	1.0	1.4	9.56	0.19
2018	**01-Aug**	**299**	**806**	**745**	**8**	**2**	**0.0**	**0.0**	**0.0**	**8.6**	**0.13**
Min	28-Jul	133	773	724	0.4	1.23	0.0	0.0	0.0	8.38	0.10
Max	18-Aug	1532	864	771	19.0	2.13	13.4	17.8	15.4	10.10	0.34
Mean	07-Aug	762	817	743	5.1	1.67	4.4	6.5	6.0	9.09	0.22

Table 1. Summary data collected at the Sustut enumeration weir, 1994 – 2018.
Note: Steelhead biological samples were not collected from 2006 to 2009 to eliminate handling stress while Steelhead abundance was in the Conservation Concern Zone.

3.3 Steelhead Biological Information

3.3.1 Length

A total of 51 Steelhead were sampled for fork length in 2018, 19 males and 32 females. Male lengths ranged from 705 to 905mm, averaging 806mm. Female lengths ranged from 670 to 860mm, averaging 745mm. Since monitoring began, the difference in fork lengths between male and female Steelhead has been statistically significant. Males are, on average, larger than females. Males are, however, demonstrating a downward trend in length over time (Figure 13). Figure 14 shows length frequency of upper Sustut River Steelhead.

3.3.2 Scale analysis and age determination
The predominant FW age (Figure 15) observed was four (62.8%) and ranged from three (27.9%) to five (9.3%). The predominant maiden SW age (Figure 16) observed was two (72%), the remainder were three-ocean migrants (20%). Maiden Steelhead represented 92% of the sample and 8% of Steelhead sampled showed evidence at least of one previous spawning event. The full suite of upper Sustut River Steelhead life history strategies observed in 2018 is illustrated in Figure 17.

3.3.3 Sex ratio
Of the 299 Steelhead that migrated past the weir, 199 (67%) were female and 100 (33%) were male resulting in a female to male ratio of 2:1.

3.3.4 Mortalities
There were no Steelhead mortalities observed at the weir during 2018.

3.4 Steelhead Tagging
No tagged Steelhead were observed at the weir in 2018.

3.5 Steelhead Gillnet Scars
Gillnet scars were not observed in 2018

3.6 Environmental Variables

3.6.1 Water Temperature
The lowest water temperature, 0.6°C, was recorded on September 30 at 0800H. The highest water temperature, 16.8°C, was recorded on August 5 at 1700H (Figure 18). Since 2005, the mean daily water temperature between August 1 and Sept 30 has ranged between 8.4°C and 10.1°C, averaging 9.1°C (Table 1).

3.6.2 Air Temperature
The lowest air temperature, -12.9°C, was recorded on September 30 at 0700H. The highest air temperature, 26.9°C, was recorded on August 21 at 1300H (Figure 18). Mean daily air temperature ranged from -4.4°C to 15.5°C and averaged 6.9°C.

3.6.3 Water Level
The lowest water levels, 0.075m, were recorded on Sept 30. The highest water level, 0.345m, was recorded on August 1, the first day of the project (Figure 19). Mean water level over the course of the project was 0.13 (Table 1). Water level measurements recorded for this project after 2015 cannot be compared to historical values as the staff gauge was relocated in 2015. The new staff gauge location is narrower and lower in gradient than the previous site.

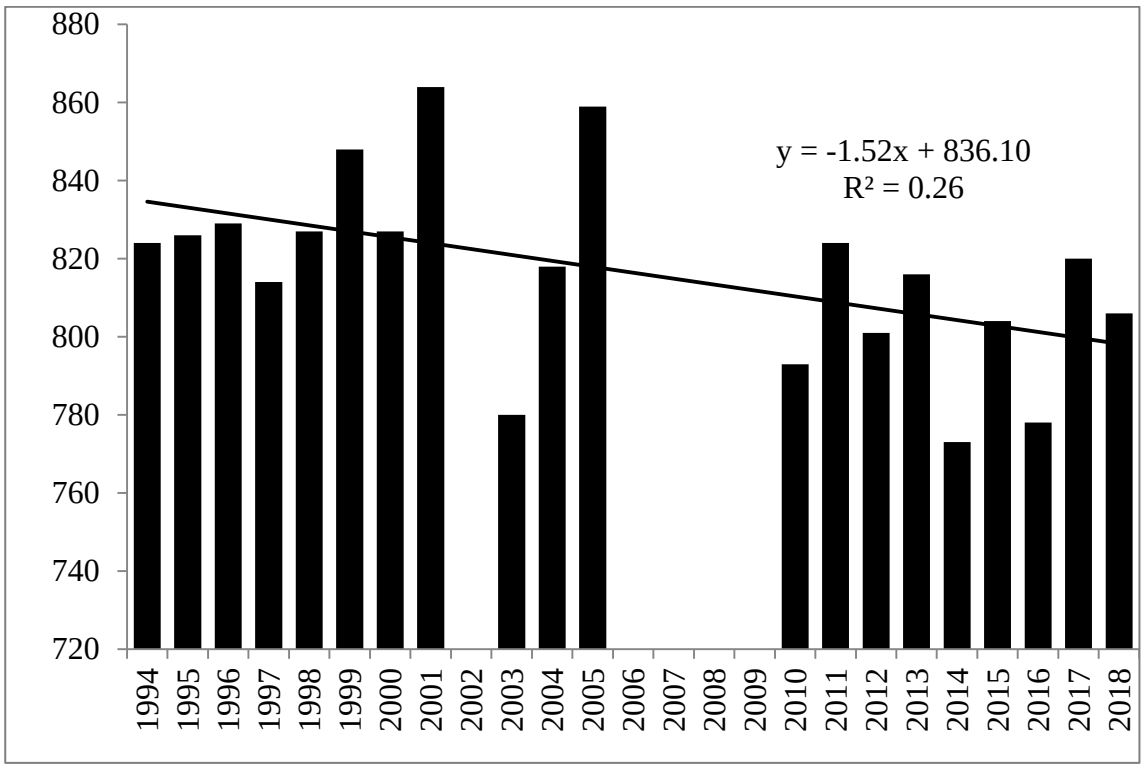

Figure 133. Mean upper Sustut River Steelhead fork length, 1994-2018

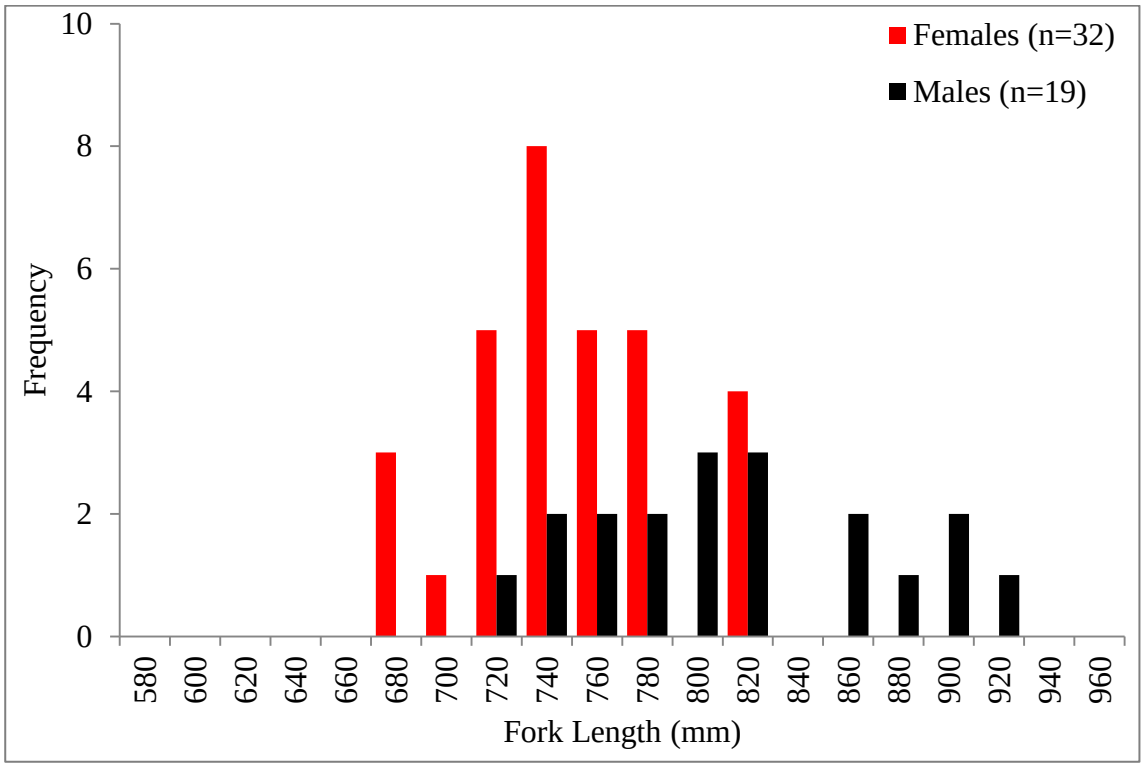

Figure 144. Upper Sustut River Steelhead length frequency, 2018

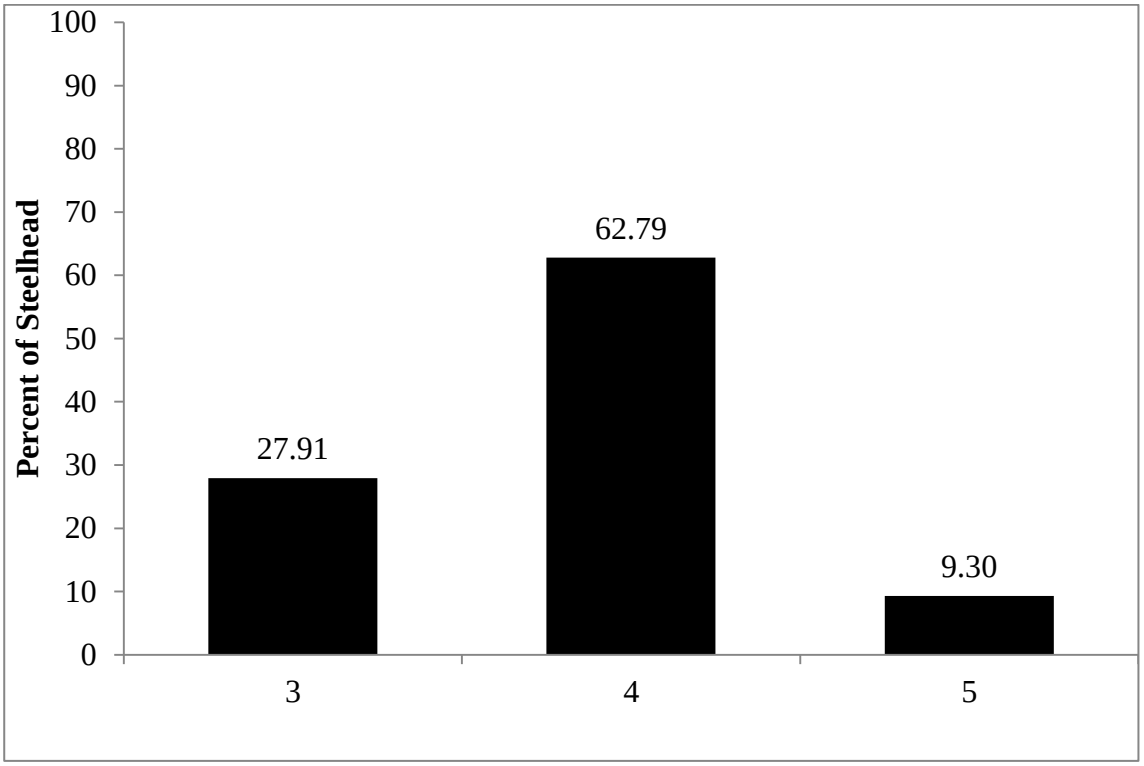

Figure 15. Freshwater ages of upper Sustut River Steelhead, 2018

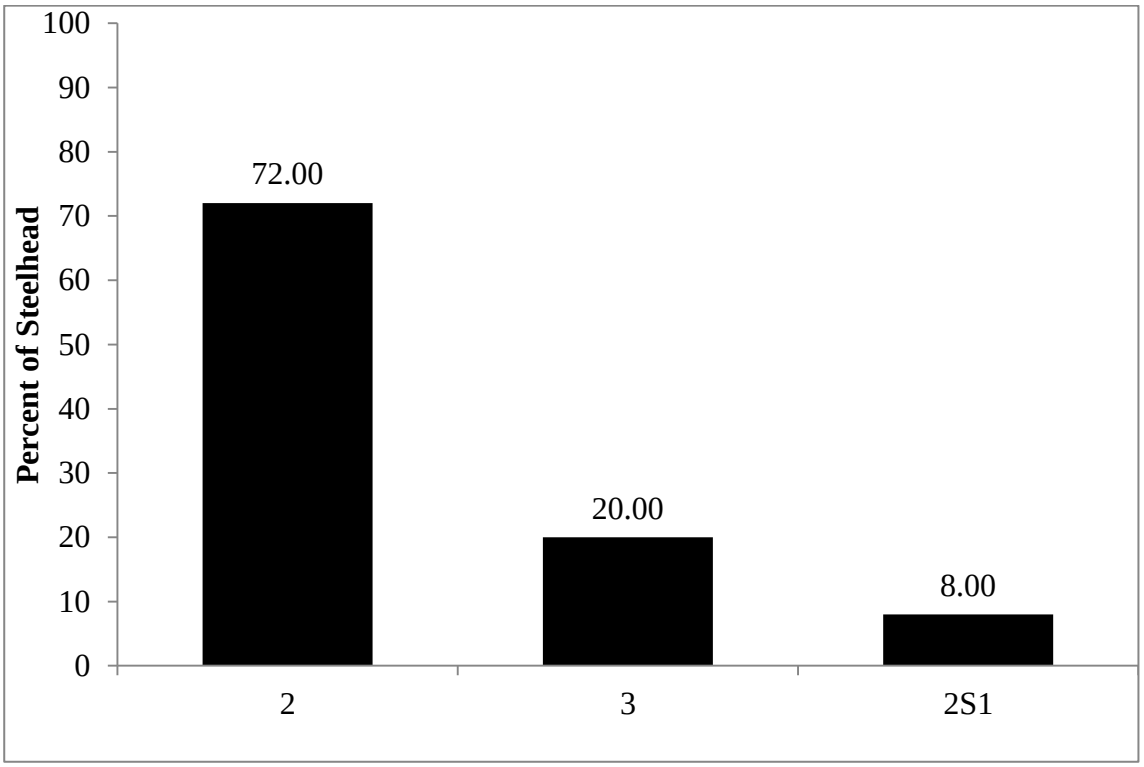

Figure 16. Marine ages of upper Sustut River Steelhead, 2018

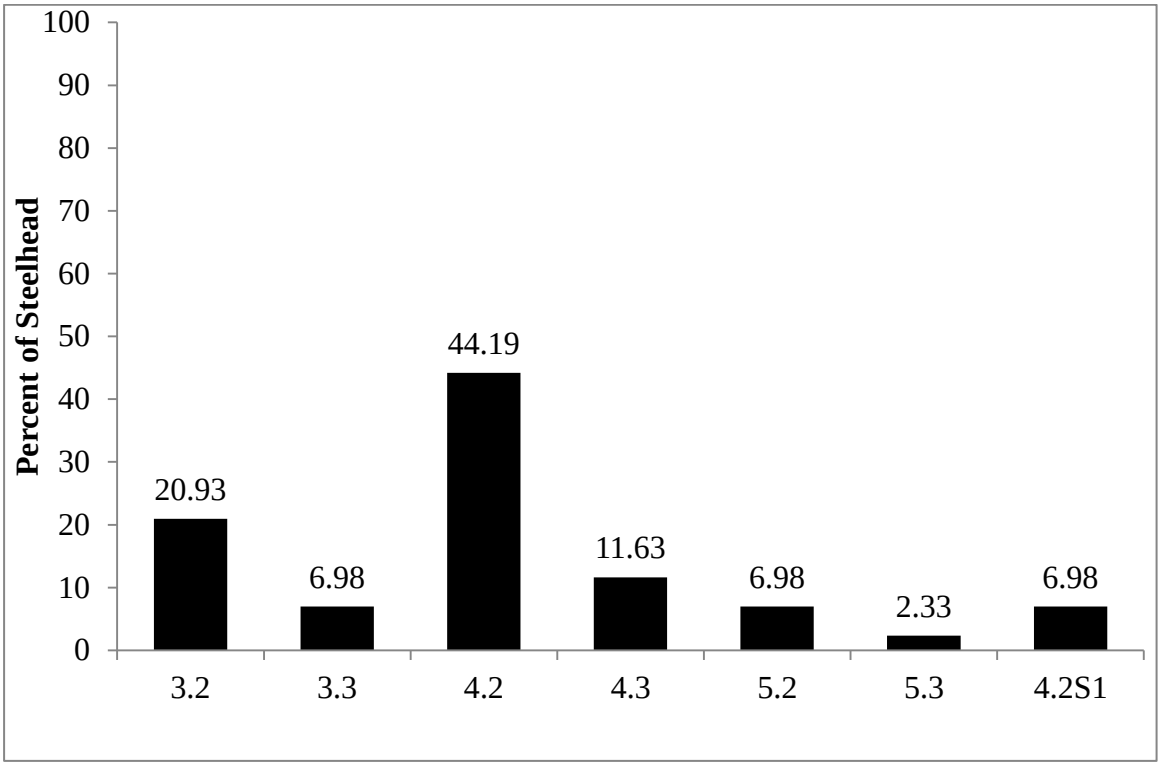

Figure 17. Age classes of upper Sustut River Steelhead, 2018

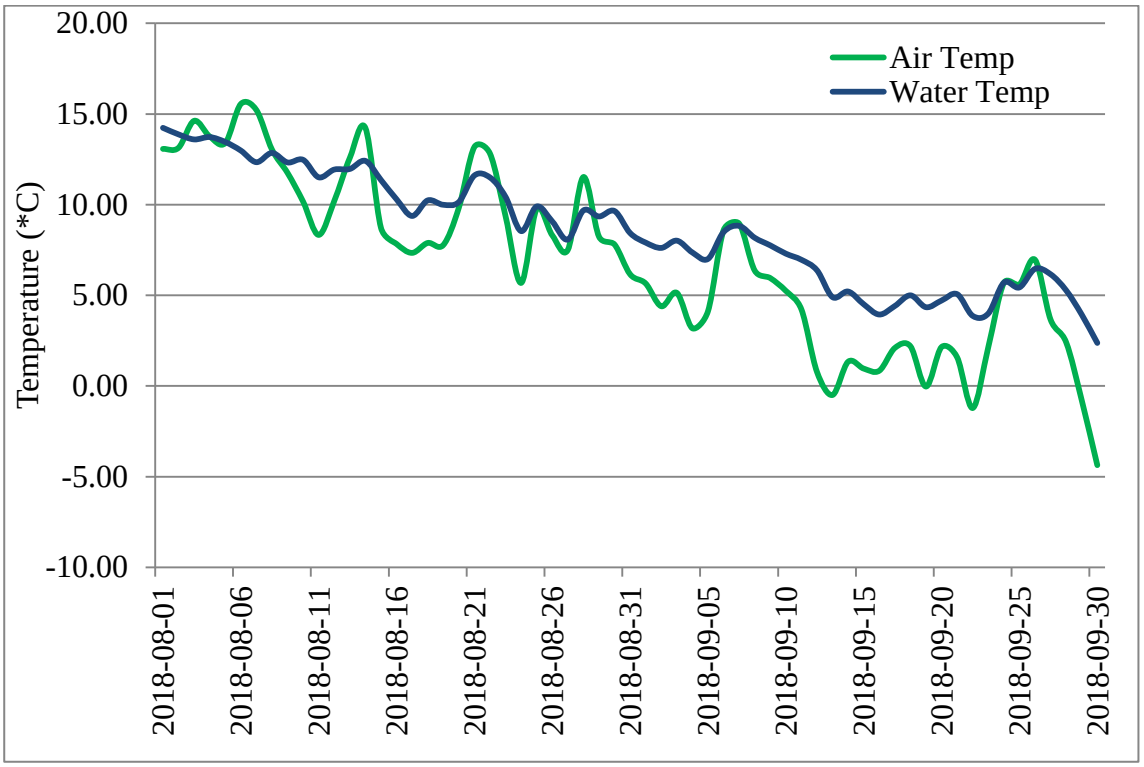

Figure 15. Mean daily air and water temperature

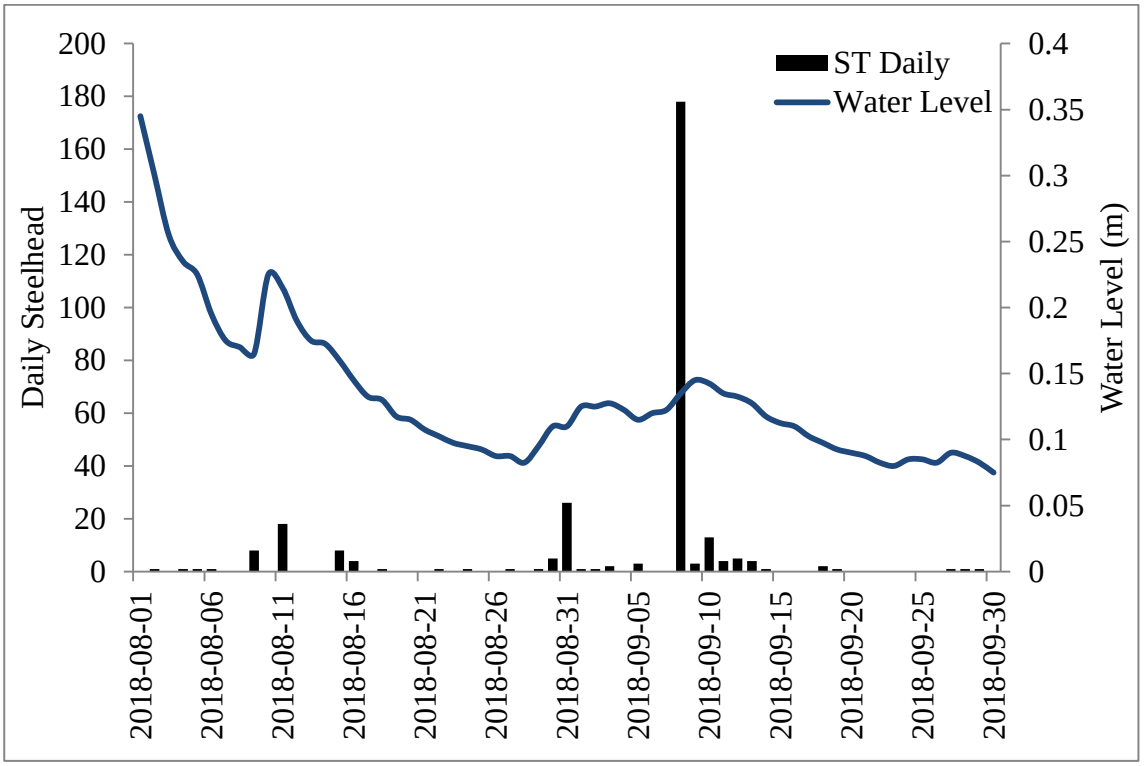

Figure 16. Mean daily water level plotted against daily Steelhead count

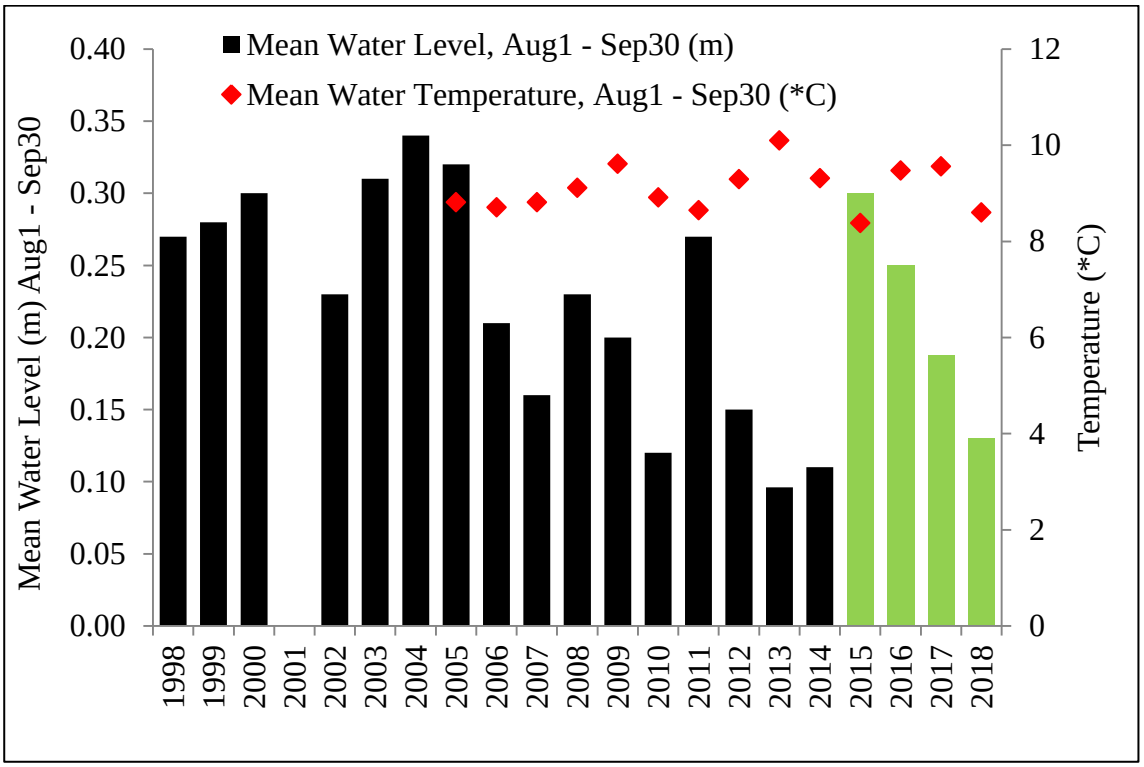

Figure 20. Mean water level and temperature, 1998-2018
Green bars denote new staff gauge location

4.0 Discussion

4.1 Steelhead Enumeration

Normally, the total count of Steelhead migrating past the weir between August 1 and September 30 is believed to reflect the majority of the upper Sustut River Steelhead population. The 2018 enumeration, however, must be interpreted with caution. Low water levels likely halted migration of Steelhead through the weir site. Staff observed several hundred (300-600) fish holding in several locations immediately downstream of the weir the day before weir removal. The majority of fish were believed to be Steelhead with some Coho and a few Sockeye.

Observations of Steelhead crossing the weir site or holding downstream during and after weir removal are not included in the enumeration total. These observations are not made reliably from year to year and as such are not standardized for observer error and conditions. The use of this non-standard information could lead to improper management actions and as such is provided only as an anecdote.

4.2 Management Framework

According to a habitat based productivity model developed for the Skeena drainage (Tautz *et al.,* 1992) the 299 Steelhead that migrated past the weir in 2018 was 29% of the estimated adult production at capacity for the system (1036). Comparisons made between annual weir counts and adult production capacity estimates rely on the assumption that weir counts represent total escapement through the weir. As noted above, steelhead enumeration for 2018 remains uncertain. This has significant implications for potential conservation actions and should be considered carefully by decision makers.

4.3 Environmental Variables

The average water level observed at the project site has been on a general downward trend since 1998. Observed increases in 2015 and 2016 (Figure 20) are likely attributable to the relocation of the staff gauge. Given this change, it is not possible to directly compare water levels pre and post-2015. However, the continued downward trend since 2015 is cause for concern.

Declining flow rates in the upper Sustut River may have serious consequences for not only habitat and fish, but the ability of the project to accurately enumerate upper Sustut River Steelhead over time. If water levels continue to decline, migration can be temporarily or permanently delayed. If upper Sustut River Steelhead are forced to overwinter in sub-optimal locations in the mainstem Sustut River or tributaries, the implications for both the project's efficacy and the population's conservation outlook are severe.

The average water temperature during the project in 2018 was 8.6°C. Given the observed downward trend in flow, it is a positive sign that annual temperature records indicate no significant change in the thermal regime of the upper Sustut River. However, this variable is only measured for the duration of the weir operation during the months of August and September. Temperature monitoring should be expanded to include the entire calendar year so that changes to the thermal regime of the Upper Sustut River are not misunderstood.

4.6 The Importance of Continued Monitoring

The upper Sustut River enumeration weir is one of two long term indexes used to estimate summer run Steelhead abundance in the Skeena River watershed. It is also the only index available to monitor the abundance of upper Skeena River Steelhead stocks. This long term data set is invaluable. The data provided to fisheries managers provides critical insight into a multitude of variables that affect Steelhead. The ability to detect changes in these parameters and establish linkages to natural and anthropogenic impacts is vital to sustaining the ecological, social and economic benefits Skeena Steelhead provide now and into the future.

5.0 Recommendations

1. Continue to enumerate the upper Sustut River Steelhead population annually. The long term monitoring data from this project provides fisheries managers with critical information on abundance trends for all early run / upper Skeena Steelhead populations.
2. Year-round monitoring of environmental variables should commence immediately.
3. Conservation thresholds should be evaluated to determine their efficacy at ensuring the long-term sustainability of the upper Sustut River Steelhead population.
4. An upper Skeena River Steelhead conservation plan should be developed to inform management actions to be taken if the indicator population described in this report falls below management objectives. This plan should draw heavily from the results of Recommendation #3, and be based on the framework outlined in Johnston *et al.* (2002) and MFLNRO (2016).
5. The conservation plan and associated actions developed in Recommendation #4 should be incorporated into the North Coast Integrated Fisheries Management Planning (IFMP) process conducted by DFO.
6. Visual observations of Steelhead at or near the weir site during deconstruction should continue. In years when large numbers of Steelhead are suspected to be holding below the weir during removal, standardized snorkel surveys may be useful to compare and validate visual observations.

6.0 Literature Cited

Beere, M.C. (1999). Sustut River Steelhead overwinter mortality study (Skeena Steelhead Chevron Compensation). Prepared for the Habitat Conservation Trust Fund, Victoria, B.C.

Bustard, D. (1993). Adult Steelhead studies in the upper Sustut River 1992. Unpublished manuscript prepared for British Columbia Ministry of Environment, Lands and Parks, Smithers, B.C.

Cox-Rogers, S. (1994). Description of daily simulation model for the Area 4 (Skeena) commercial gillnet fishery. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2256.

Johnston N.T., Parkinson., E.A., Tautz., A.F. & Ward, B.R. (2002). A Conceptual Framework for the Management of Steelhead, *Oncorhynchus mykiss*. Ministry of Water, Land and Air Protection. BC Fisheries Branch Report No. RD101.

Martinez, J.L., Moran, P., Perez, J., De Gaudemar, B., Beall, E., Garcia-Vasquez, E. (2000). Multiple paternity increases effective size of southern Atlantic salmon populations. Molecular Ecology. 9:3: 293-298.

Matala, A.P., Hatch, D.R., Everett, S., Ackerman, M.W., Bowersox, B., Campbell, M. and Narum, S. (2016). What goes up does not come down: the stock composition and demographic characteristics of upstream migrating Steelhead differ from post-spawn emigrating kelts. ICES Journal of Marine Science, doi: 10.1093/icesjms/fsw109.

McPhail, J.D. (2007). The freshwater fishes of British Columbia. The University of Alberta Press. Edmonton, Alberta, Canada.

McPhail, J.D. & Carveth, R. (1994). Field key. The freshwater fishes of British Columbia. British Columbia Resource Inventory Committee Publication #44.

MFLNRO. (2016) Provincial Framework for Steelhead Management in British Columbia.

Moore, J.W., Yeakel, J.D., Peard, D., Lough, J. and Beere, M.C. (2014). Life history diversity and its importance to population stability and persistence of a migratory fish: steelhead in two large North American watersheds. Journal of Animal Ecology, doi: 10.1111/1365-2656.12212.

Narum, S.R., Hatch, D., Talbot, A.J., Moran, P., and Powell, M.S. (2008). Iteroparity in complex mating systems of Steelhead *Oncorhynchus mykiss* (Walbaum). Journal of Fish Biology. 72: 45-60. Available from https://doi.org/10.1111/j.1095-8649.2007.01649.x.

Ohms, H.A., Sloat, M.R., Reeves, G.H., Jordan, C.E. and Dunham, J.B. (2013). Influence of sex, migration distance, and latitude on the life history expression in Steelhead and rainbow trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences. 71: 70-80. doi: dx.doi.org/10.1139/cjfas-2013-0274.

Parken, C.K. & Morten, KL. (1996). Enumeration of adult Steelhead in the upper Sustut River 1995. Ministry of Environment, Lands and Parks, Fisheries Branch. Skeena Fisheries Report #94.

Saimoto, R.K. (1995). Enumeration of adult Steelhead in the upper Sustut River 1994. Unpublished Manuscript prepared for British Columbia Ministry of Environment, Lands and Parks. Smithers, B.C.

Seamons, T.R. (2005). The mating system of Steelhead and the effect of length and arrival date on Steelhead reproductive success (Doctoral dissertation). University of Washington.

Scott, W.B. & E.J. Crossman. (1973). Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin No. 184, Ottawa, Ontario.

Spence, C.R., Beere, M.C. & Lough, M.J. (1990). Sustut River Steelhead Investigations 1986. British Columbia Ministry of Environment, Lands and Parks. Smithers, B.C., Skeena Fisheries Report SK#64.

Tautz, A.F., Ward, B.R., & Ptolemy, R.A. (1992). Steelhead trout productivity and stream carrying capacity for rivers of the Skeena drainage. PSARC Working Paper S92-6 and 8.

Ward, B.R., Tautz, A.F., Cox-Rogers, S. & Hooton, R.S. (1993). Migration timing and harvest rates of the Steelhead trout populations of the Skeena River system. PSARC Working Paper S93-06.

7.0 Appendices

Appendix 1. Daily and cumulative totals for all fish species counted at the Sustut enumeration weir in 2018.

Date	Chinook		Sockeye		Steelhead		Coho		Bull Trout		Whitefish		Rainbow Trout	
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
01-Aug-18	74	74	0	0	1	1	0	0	0	0	7	7	0	0
02-Aug-18	1	75	1	1	0	1	0	0	0	0	2	9	0	0
03-Aug-18	0	75	0	1	1	2	0	0	0	0	0	9	0	0
04-Aug-18	2	77	0	1	1	3	0	0	0	0	2	11	0	0
05-Aug-18	5	82	3	4	1	4	0	0	0	0	2	13	0	0
06-Aug-18	2	84	46	50	0	4	0	0	0	0	3	16	0	0
07-Aug-18	4	88	77	127	0	4	0	0	0	0	1	17	0	0
08-Aug-18	18	106	271	398	8	12	1	1	1	1	5	22	0	0
09-Aug-18	49	155	37	435	0	12	0	1	0	1	1	23	0	0
10-Aug-18	66	221	256	691	18	30	1	2	0	1	2	25	1	1
11-Aug-18	7	228	54	745	0	30	0	2	0	1	0	25	1	2
12-Aug-18	0	228	53	798	0	30	0	2	0	1	0	25	0	2
13-Aug-18	19	247	57	855	0	30	0	2	0	1	0	25	0	2
14-Aug-18	32	279	245	1100	8	38	5	7	0	1	0	25	0	2
15-Aug-18	16	295	168	1268	4	42	1	8	0	1	0	25	0	2
16-Aug-18	4	299	0	1268	0	42	0	8	0	1	0	25	0	2
17-Aug-18	6	305	0	1268	1	43	0	8	0	1	1	26	0	2
18-Aug-18	0	305	40	1308	0	43	1	9	0	1	1	27	0	2
19-Aug-18	6	311	21	1329	0	43	0	9	0	1	0	27	0	2
20-Aug-18	4	315	0	1329	0	43	0	9	1	2	1	28	0	2
21-Aug-18	18	333	23	1352	1	44	1	10	0	2	0	28	0	2
22-Aug-18	5	338	1	1353	0	44	0	10	0	2	0	28	0	2
23-Aug-18	2	340	3	1356	1	45	0	10	1	3	1	29	0	2
24-Aug-18	0	340	0	1356	0	45	1	11	0	3	0	29	0	2
25-Aug-18	1	341	0	1356	0	45	0	11	0	3	1	30	0	2
26-Aug-18	2	343	1	1357	1	46	0	11	0	3	2	32	0	2
27-Aug-18	1	344	1	1358	0	46	0	11	0	3	0	32	0	2
28-Aug-18	1	345	3	1361	1	47	0	11	0	3	0	32	1	3
29-Aug-18	1	346	87	1448	5	52	2	13	0	3	0	32	0	3
30-Aug-18	0	346	147	1595	26	78	20	33	5	8	0	32	0	3
31-Aug-18	0	346	1	1596	1	79	0	33	0	8	1	33	0	3
01-Sep-18	0	346	0	1596	1	80	0	33	0	8	0	33	0	3
02-Sep-18	0	346	0	1596	2	82	0	33	0	8	1	34	0	3
03-Sep-18	0	346	0	1596	0	82	0	33	0	8	0	34	0	3
04-Sep-18	0	346	3	1599	3	85	0	33	0	8	8	42	0	3
05-Sep-18	0	346	0	1599	0	85	0	33	0	8	0	42	0	3
06-Sep-18	0	346	1	1600	0	85	0	33	1	9	0	42	0	3
07-Sep-18	0	346	102	1702	178	263	13	46	0	9	5	47	0	3
08-Sep-18	0	346	29	1731	3	266	0	46	0	9	0	47	0	3
09-Sep-18	0	346	39	1770	13	279	0	46	1	10	0	47	0	3
10-Sep-18	0	346	8	1778	4	283	0	46	1	11	0	47	0	3
11-Sep-18	0	346	2	1780	5	288	0	46	0	11	0	47	0	3
12-Sep-18	0	346	12	1792	4	292	0	46	0	11	2	49	0	3
13-Sep-18	0	346	0	1792	1	293	0	46	0	11	1	50	0	3
14-Sep-18	0	346	1	1793	0	293	0	46	1	12	0	50	0	3

15-Sep-18	0	346	1	1794	0	293	0	46	0	12	2	52	0	3
16-Sep-18	0	346	1	1795	0	293	0	46	0	12	2	54	1	4
17-Sep-18	0	346	2	1797	2	295	0	46	0	12	0	54	0	4
18-Sep-18	0	346	5	1802	1	296	0	46	0	12	0	54	0	4
19-Sep-18	0	346	2	1804	0	296	0	46	0	12	1	55	0	4
20-Sep-18	0	346	0	1804	0	296	0	46	0	12	0	55	0	4
21-Sep-18	0	346	5	1809	0	296	0	46	1	13	1	56	0	4
22-Sep-18	0	346	2	1811	0	296	0	46	1	14	9	65	0	4
23-Sep-18	0	346	0	1811	0	296	0	46	0	14	10	75	0	4
24-Sep-18	0	346	12	1823	0	296	0	46	0	14	1	76	0	4
25-Sep-18	0	346	23	1846	0	296	0	46	0	14	0	76	0	4
26-Sep-18	0	346	11	1857	1	297	0	46	0	14	0	76	0	4
27-Sep-18	0	346	5	1862	1	298	3	49	0	14	0	76	0	4
28-Sep-18	0	346	3	1865	1	299	0	49	1	15	0	76	0	4
29-Sep-18	0	346	0	1865	0	299	0	49	0	15	0	76	0	4
30-Sep-18	0	346	0	1865	0	299	0	49	0	15	2	78	0	4

Appendix 2. Scale condition code definitions.

Condition Code	Definition
1	Good condition
2	Poor condition or questionable age
3	Freshwater age unreadable (eg. U.2)
4	Unreadable (eg. U.U)
5	Starting to regenerate (freshwater age may be under-estimated)
5a	Starting to regenerate, wide focus (freshwater age not under-estimated)
6	Regenerated (eg. R.2)
7	Missing
8	Resorption (eg. last marine annulus on edge of scale)
9	First freshwater annulus very vague, but must be present due to high circuli count and spacing relative to other freshwater annuli
10	Other species, not a Steelhead

Appendix 3. Steelhead scale ages from the Sustut enumeration weir in 2018.

Date	Sex	FL (mm)	Book #	Scales	Scale #	Code	Age	FW Age	SW Age	Comment
03-Aug-18	F	675	70036	1-21a	1	5	3.2	3	2	
05-Aug-18	M	850	70036	1-21b	2	9	4.2S1	4	2S1	
05-Aug-18	F	715	70036	2-22a	3	1	3.2	3	2	
05-Aug-18	F	710	70036	2-22b	4	1	4.2	4	2	
15-Aug-18	F	740	70036	3-23a	5	6	R.2	R	2	**FW excluded**
17-Aug-18	F	860	70036	3-23b	6	5a	3.3	3	3	
21-Aug-18	M	905	70036	4-24a	7	1	4.3	4	3	
23-Aug-18	F	670	70036	4-24b	8	9	4.2	4	2	
26-Aug-18	F	775	70036	5-25a	9	6	R.R	R	R	**FW & SW excluded**
28-Aug-18	F	700	70036	5-25b	10	6	R.2	R	2	**FW excluded**
29-Aug-18	M	740	70037	1-21a	1	1	3.2	3	2	
30-Aug-18	F	765	70037	2-22a	3	1	4.2	4	2	
30-Aug-18	F	735	70037	1-21b	2	9	4.2	4	2	
31-Aug-18	M	820	70037	2-22b	4	5	4.2	4	2	
01-Sep-18	F	775	70037	3-23a	5	1	3.3	3	3	
02-Sep-18	M	810	70037	3-23b	6	9	4.2	4	2	
02-Sep-18	F	730	70037	4-24a	7	9	4.2	4	2	
04-Sep-18	M	770	70037	5-25a	9	6	R.2	R	2	**FW excluded**
04-Sep-18	M	770	70037	5-25b	10	6	R.2	R	2	**FW excluded**

04-Sep-18	F	810	70037	4-24b	8	9	5.3	5	3	
04-Sep-18	F	730	70038	1-21a	1	5	4.2	4	2	
04-Sep-18	F	760	70038	2-22a	3	5	3.2	3	2	
04-Sep-18	M	705	70038	2-22b	4	9	4.2	4	2	
04-Sep-18	F	770	70038	1-21b	2	5a	3.3	3	3	
04-Sep-18	F	725	70038	3-23a	5	9	4.2	4	2	
04-Sep-18	F	745	70038	4-24b	8	1	4.2	4	2	
04-Sep-18	F	710	70038	4-24a	7	5	3.2	3	2	
04-Sep-18	F	805	70038	3-23b	6	9	4.2S1	4	2S1	
04-Sep-18	M	730	70038	5-25a	9	9	5.2	5	2	
08-Sep-18	F	750	70038	5-25b	10	1	5.2	5	2	
08-Sep-18	F	805	70039	1-21b	2	1	4.2S1	4	2S1	
08-Sep-18	F	725	70039	2-22a	3	5a	4.2	4	2	
08-Sep-18	F	750	70039	1-21a	1	9	4.2	4	2	
10-Sep-18	M	785	70039	3-23a	5	2	3.2	3	2	
10-Sep-18	F	810	70039	2-22b	4	9	4.3	4	3	
11-Sep-18	F	705	70039	4-24a	7	5	3.2	3	2	
11-Sep-18	M	860	70039	3-23b	6	6	R.3	R	3	**FW excluded**
11-Sep-18	M	890	70039	4-24b	8	1	4.3	4	3	
11-Sep-18	F	735	70039	5-25a	9	1	4.2	4	2	
11-Sep-18	M	790	70039	5-25b	10	5	4.2	4	2	
12-Sep-18	M	895	70040	1-21a	1	1	4.3	4	3	
12-Sep-18	F	770	70040	1-21b	2	1	4.2	4	2	
12-Sep-18	F	675	70040	2-22a	3	1	4.2	4	2	
12-Sep-18	M	760	70040	2-22b	4	2	5.2	5	2	
13-Sep-18	F	740	70040	3-23a	5	1	4.2	4	2	
17-Sep-18	M	795	70040	3-23b	6	6	R.2S1	R	2S1	**FW excluded**
17-Sep-18	M	750	70040	4-24a	7	9	4.2	4	2	
18-Sep-18	M	880	70040	4-24b	8	9	4.3	4	3	
26-Sep-18	M	815	70040	5-25a	9	5	3.2	3	2	
27-Sep-18	F	760	70040	5-25b	10	6	R.2	R	2	**FW excluded**
28-Sep-18	F	720	70041	1-21a	1	1	3.2	3	2	