2016 Skagit River Snorkel Survey Report

Skagit Environmental Endowment Commission

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Executive Summary

Triton Environmental Consultants Ltd. was retained by the Skagit Environmental Endowment Commission (SEEC) to assess Rainbow Trout (*Oncorhynchus mykiss*) and Bull Trout (*Salvelinus confluentus*) stock populations in the Canadian portion of the Skagit River. The work builds on previous stock assessments conducted over the previous four decades.

A snorkel survey was conducted to enumerate individual Rainbow Trout and Bull Trout of four size classes (10-20 cm, 20-30 cm, 30-40 cm, and >40 cm) in 14 sections of the Canadian Skagit River. Results indicate that the trend of declining Rainbow Trout in the Skagit River observed in previous studies is continuing in 2016. This trend is broadly consistent across all size classes and river sections. Fewer Rainbow Trout of catchable size were seen in the Skagit River than any year since 1991. Bull Trout numbers have also begun to decline after a dramatic rise in population from 1998-2011. The factors driving the shifts in Rainbow Trout and Bull Trout populations are largely unknown.

Disclaimer

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- This report is based on facts and opinions contained within the referenced documents, including the results of any data collection programs carried out in relation to this report. We have attempted to identify and consider facts and documents relevant to the scope of work, accurate as of the time period during which we conducted this analysis. However, the results, our opinions, or recommendations may change if new information becomes available or if information we have relied on is altered.
- Triton assumes that historical data from prior reports was accurate.
- We applied accepted professional practices and standards in developing and interpreting data. While we used accepted professional practices in interpreting data provided by the Client or third party sources we did not verify the accuracy of any such data.
- This report must be considered as a whole; selecting only portions of this report may result in a misleading view of the results, our opinions, or recommendations.

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1.0 Introduction

Triton Environmental Consultants Ltd. was retained by the Skagit Environmental Endowment Commission (SEEC) to assess Rainbow Trout (*Oncorhynchus mykiss*) and Bull Trout (*Salvelinus confluentus*) stock populations in the Canadian Skagit River. The work builds on previous stock assessments conducted over the previous four decades.

1.1 Background

The Canadian Skagit River is located within the Skagit Valley provincial park in British Columbia, and flows southward into the Ross Lake Reservoir on the U.S/Canadian border. The lower portion of the river from the confluence of Klesilkwa River to the Chittenden Bridge is characterized by long runs, occasional riffles, and mostly cobble substrate. Upstream from the Klesilkwa River to the confluence with the Sumallo River, the Skagit River channel is narrower, and has a slightly greater gradient with boulder cascades amongst runs. The Skagit River is popular with sport fisherman, and is actively managed for populations of Rainbow Trout and Bull Trout. In order to make informed management decisions for the Skagit River fishery, current numbers of fish and species present in the river are required. Previous fish counts in the Canadian Skagit River occurred in 1982, 1994, and 1998, a three year stock assessment was conducted from 2009-2011, a partial assessment was conducted in 2012, and two additional years of study were undertaken in 2013 and 2014.

1.2 Objectives

The objectives of the 2016 fish count were identical to those objectives outlined in the 2011 fish count survey report and are listed below (Anaka et al. 2011).

1. Enumerate total Rainbow Trout and Bull Trout
2. Categorize Rainbow Trout and Bull Trout observed by size class
3. Compare distribution of Rainbow Trout and Bull Trout by species and location
4. Calculate abundance indices for Rainbow Trout and Bull Trout abundance and distribution
5. Provide observations and comments affecting Rainbow Trout/Bull Trout abundance and distribution
6. Analyze and compare results to previous surveys on the Canadian Skagit River

1.3 Rationale and Approach

In order to meet the objectives stated above, a snorkel survey was conducted to count individual fish present in the Skagit River. This approach was chosen to ensure consistency with previous annual fish counts and to cover a large spatial range with minimal disturbance to fish.

2.0 Methods

2.1 Survey Methods

2.1.1 Survey Timing

The 2016 Skagit River snorkel survey was conducted from September 19 to 23. The timing of the survey is generally consistent with the 2011 survey, which was conducted from September 6 to 10, 2011, and historical surveys which took place from late August to early September.

2.1.2 Survey Location

The Skagit River was divided into the same sections outlined in the Burrows and Neuman (1995) report and used in the 2009-2014 surveys (Anaka et al. 2011). Fourteen sections were identified, with the upstream extent of the surveyed section at the confluence of the Sumallo and Skagit rivers and the downstream extent at the Chittenden Bridge. The individual sections can be seen in Table 2-1 and Figure 2-1. Although the section descriptions are identical to previous surveys, section lengths have been recalculated to reflect corrected surveyed distances.

Table 2-1. Canadian Skagit River section descriptions and lengths

Section number	Section Description	Length (m)	Number of Floaters
15	Sumallo River to Silverdaisy Creek	1619	2
14	Silverdaisy Creek to Skagit Hotel	2878	2
13	Skagit Hotel to 28 Mile Creek	4514	2
12	28 Mile Creek to Silvertipped Creek	3033	2
11	Silvertipped Creek to 26 Mile Bridge	2978	2
10	26 Mile Bridge to Klesilkwa River	745	2
9	Klesilkwa River to 45 km	1951	2
8	45 km to 46.4 km	1776	3
7	46.4 km to Shawatum Creek	1950	3
6	Shawatum Creek to Fuel Dump	1679	3
5	Fuel Dump to Roadside	1423	3
4	Roadside to Garbage Dump	1582	3
3	Garbage Dump to 56 km	3665	3
2	56 km to Chittenden Bridge	1476	3
	Total	**31269**	

Figure 2-1. Map displaying section breaks of the Canadian Skagit River, 2016

2.1.3 Field Procedures

Field data collection was consistent with the method employed by Burrows and Neuman (1995) and Scott Resources (Anaka et al. 2011) during previous surveys. The survey team comprised three experienced senior fisheries biologists. In the upstream sections (river sections 10 to 15) of the river, two floaters were in the water, and one shore tender recorded data; in the wider downstream sections (sections 2 to 9) of the river there were 3 floaters who were tended by data recorders in an inflatable boat. Prior to starting each day, wood dowels were used to recalibrate each floater's ability to recognize fish of differing size classes. Each floater was assigned a lane in the river, and only recorded fish within their lane in order to minimize duplication of fish. Sections were floated through once, unless large numbers of fish were observed. If large numbers of fish were observed, floaters would do a second pass to ensure accurate fish counts.

2.2 Data Analysis

2.2.1 Abundance Index

Data analysis was consistent with the methods employed by Burrows and Neuman (1995), Harper and Scott (1998), and Scott Resources (Anaka et al. 2011). All data prior to 2016 was drawn from the 1995 Burrows and Neuman Report, and the 2011, 2013, and 2015 reports prepared by Scott Resources.

Abundance indices were calculated for each section, using a metric of the number of fish observed per kilometer per floater. The abundance index was calculated according to the following formula.

$$Abundance\ Index\ (A) = \frac{Fish\ count\ by\ species\ per\ section}{(Section\ length\ in\ km)(Floater\ equivalent)}$$

The section lengths used for the survey were the updated section lengths reflecting field conditions rather than the values used by Burrows and Neuman (1995) and Scott Resources (Anaka et al. 2011). This represents a change in methods from 2009-2014. A floater equivalent of 2 was used for all sections, consistent with previous reports.

2.2.2 Statistical Analysis

A repeated measures ANOVA was conducted to determine statistically significant differences between each year. Repeated measures ANOVAs of total fish observed and abundance indices were calculated using Systat 11.

3.0 2016 Results

Through the period of the survey, weather conditions were predominantly rainy and river discharge levels were low. Water was clear, providing to good visibility for the snorkelers.

3.1 Total Fish Counts

Three fish species were observed across 14 sections, over a course of approximately 31.3 km of the Canadian Skagit River. During the survey, 758 Rainbow Trout, 1,063 Bull Trout and 17 Eastern Brook Trout (*Salvelinus fontinalis)* were observed. No other fish species were reported by the snorkelers. See Table 3-1 for the total counts of all fish species and size classes observed by section.

Table 3-1. Counts of all fish species observed, September 2016

Species	Size Class (cm)	Section														
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	Total
RB	10-20	11	31	0	0	1	0	1	0	3	1	0	0	2	0	50
	20-30	13	20	13	7	3	0	10	6	12	5	0	6	33	18	146
	30-40	5	12	39	10	28	0	13	29	32	24	13	55	109	91	460
	>40	0	0	0	4	7	0	2	5	15	3	11	15	20	20	102
	Total	29	63	52	21	39	0	26	40	62	33	24	76	164	129	758
BT	10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20-30	1	3	0	0	1	0	4	0	0	0	0	0	1	0	10
	30-40	24	10	73	40	3	1	71	75	24	19	23	30	115	5	513
	>40	32	16	77	53	11	0	58	39	16	28	33	59	104	14	540
	Total	57	29	150	93	15	1	133	114	40	47	56	89	220	19	1063
EB	20-30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	30-40	0	1	1	0	0	0	0	0	0	0	0	1	0	0	3
	>40	0	0	0	2	0	0	0	3	0	0	6	1	1	0	13
	Total	0	2	1	2	0	0	0	3	0	0	6	2	1	0	17

3.2 Size Class

3.2.1 Rainbow Trout

Rainbow Trout of all size classes were observed during the survey; however their distribution was not even between the upper sections (sections 10 to 15) and lower sections (2 to 9) of the river. The majority of the Rainbow Trout (60.7 %) were found in the 30-40 cm size class, and an additional 19.3% of fish were found in the 20-30 cm size class. 13.5% of fish were >40 cm, and 6.6% of fish were between 10-20 cm. The overall distribution of the size classes of Rainbow Trout changes between the upper and lower

sections of the Skagit River. In particular, the percentage of 10-20 cm size class fish dramatically increase in the upper section of the river when compared to the lower. Fish in the 10-20 cm size range make up 1.3 % of the Rainbow Trout in the lower Skagit River, but make up 18.7 % in the upper Skagit River. See Figure 3-1 for distributions of Rainbow Trout size classes in the upper and lower Skagit River.

Figure 3-1. Size classes of Rainbow Trout in (a) the Canadian Skagit River, (b) the upper sections, and (c) the lower sections, 2016

3.2.2 Bull Trout

Bull Trout of the larger three size classes were observed during the survey. No Bull Trout of the 10-20 cm size class were observed in any of the sections of the river. 50.8% of the Bull Trout observed were of the >40 cm size class, and 48.3 % of the Bull Trout were of the 30-40 cm size class. Less than 1% of the Bull Trout observed were of the 20-30 cm size class. The proportions were relatively similar in the upper and lower sections of the river. See Figure 3-2 for distributions of Bull Trout size classes in the upper and lower Skagit River.

Figure 3-2. Size classes of Bull Trout in (a) the Canadian Skagit River, (b) the upper sections, and (c) the lower sections, 2016

3.3 Distribution

3.3.1 Rainbow Trout

The distribution of Rainbow Trout showed high variability between sections. The greatest overall numbers of Rainbow Trout were observed in the three most downstream sections, with almost half (48.6%) of all Rainbow Trout found in sections 2 to 4. Section 3 demonstrated the most Rainbow Trout, with 164 individuals observed. Section 2 had 129 individuals and section 4 had 73. The remaining Rainbow Trout were distributed among the remaining sections, excluding section 10 which exhibited no Rainbow Trout. Figure 3-3.

3.3.2 Bull Trout

The distribution of Bull Trout showed high variation by river section. The greatest overall observance of Bull Trout was in sections 3 and 13, where 220, and 130 Bull Trout were observed, respectively. The lowest catch was from section 10, where only 1 individual was observed (Figure 3-3).

Figure 3-3. Distribution by river section of Rainbow Trout (RB) and Bull Trout (BT) in the Canadian Skagit River, 2016

3.4 Abundance Indices

3.4.1 Rainbow Trout

The total abundance index for Rainbow Trout was 12.70 fish/km/floater. The distribution of abundancy index by river section broadly follows the same trends as the distribution by counts, with high abundance indices in sections 2 through 4, and most of the fish in the 30-40 cm size class. The 10-20 cm size class, while representing very few fish overall, had the highest abundance index in section 14, with an abundance index of 5.39. Figure 3-4, Table 3-2.

Figure 3-4. Abundance index of Rainbow Trout by river section and size class, 2016

3.4.2 Bull Trout

The total abundance index for Bull Trout was 16.61 fish/km/floater. The highest abundancy indices were observed in sections 9 and 8, with values of 34.09 and 32.09 respectively. The 30-40 cm size class has higher abundance indices in sections 8 and 9, and the >40 cm size class has a higher index than the smaller size classes in sections 5 and 4. Figure 3-5, Table 3-2.

Figure 3-5. Abundance index of Bull Trout by river section and size class, 2016

Table 3-2. Abundance Indices by species, size class, and river section, 2016

Species	Size Class (cm)	Section														
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	Average
RB	10-20	3.40	5.39	0.00	0.00	0.17	0.00	0.26	0.00	0.77	0.30	0.00	0.00	0.27	0.00	0.75
	20-30	4.01	3.47	1.44	1.15	0.50	0.00	2.56	1.69	3.08	1.49	0.00	1.90	4.50	6.10	2.28
	30-40	1.54	2.08	4.32	1.65	4.70	0.00	3.33	8.16	8.21	7.15	4.57	17.38	14.87	30.83	7.77
	>40	0.00	0.00	0.00	0.66	1.18	0.00	0.51	1.41	3.85	0.89	3.87	4.74	2.73	6.78	1.90
	Total	8.96	10.95	5.76	3.46	6.55	0.00	6.66	11.26	15.90	9.83	8.43	24.02	22.37	43.70	3.18
BT	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20-30	0.31	0.52	0.00	0.00	0.17	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.15
	30-40	7.41	1.74	8.09	6.59	0.50	0.67	18.20	21.11	6.15	5.66	8.08	9.48	15.69	1.69	7.03
	>40	9.88	2.78	8.53	8.74	1.85	0.00	14.86	10.98	4.10	8.34	11.60	18.65	14.19	4.74	8.52
	Total	17.60	5.04	16.61	15.33	2.52	0.67	34.09	32.09	10.26	14.00	19.68	28.13	30.01	6.44	4.15

3.5 Catchable Fish

The proportions of catchable (>20 cm) v. non-catchable (<20 cm) Rainbow Trout and Bull Trout in the Skagit River were calculated to be consistent with prior studies.

3.5.1 Rainbow Trout

Non-catchable fish were observed in 7 sections, and catchable fish were observed in 13 sections. The greatest abundance of non-catchable fish was is sections 14 and 15, and the greatest abundance of catchable fish was in section 2. The lowest abundance of both catchable and non-catchable fish was in section 10**.** To be consistent with prior reports, we calculated the upper and lower bounds of catchable fish using expansion coefficients from Burrows and Neuman (1995). There were 47 catchable Rainbow Trout per km using Burrows and Neuman's lower expansion coefficient of 2.09, and 104 catchable Rainbow Trout/km using Burrows and Neuman's upper expansion coefficient of 4.59.

3.5.2 Bull Trout

All Bull Trout observed during the 2016 survey were of catchable size classes (>20cm). Using the formula in Burrows and Neuman (1995), there were 71 catchable Bull Trout per km using a lower expansion coefficient of 2.09, and 156 catchable Bull Trout /km using an upper expansion coefficient of 4.59.

4.0 Inter-year results

4.1 *Fish Counts*

4.1.1 Rainbow Trout

2016 had a statistically significant ($p<0.05$) decrease in Rainbow Trout observed compared to the 1998, 2009, 2010, 2011, and 2013 surveys. There was a statistically significant decrease in Rainbow Trout yearly from 1998-2014, with the exception of 2009 to 2010 when there was a statistically significant increase in fish. There was also no significant decrease from the 2014 to the 2016 survey, though the downward trend continued in those years. Figure 4-1, Appendix 1.

4.1.2 Bull Trout

There was a significant increase ($p<0.05$) in the number of Bull Trout from 1998 to 2011, but a significant decrease in the number from 2011 to 2016. The general trend from 1998 to 2011 has been a monotonic increase in Bull Trout observations, followed by a decline from 2011 to 2016. Although 2016 was the lowest number of observation since 2009, the total observations of Bull Trout was still greater than the number observed in 2009 and 1998. Figure 4-1, Appendix 1.

Figure 4-1. Count of Rainbow Trout (RB) and Bull Trout (BT) observed in the Canadian Skagit River, 1998-2016

4.2 Size Classes

4.2.1 Rainbow Trout

The general trend for fish in each size class is similar across all years. In each year that surveys were conducted, the 30-40 cm size class accounts for the largest component of the observed individuals, and this is consistent through the downward trend with the overall observations—from 918 fish in 1998 to 460 fish in 2016. The 20-30 cm size class makes up the next largest size class for each year of the survey, and follows the same pattern as the overall trend with a decrease from 795 to 143 fish. In 1998, 2009, and 2010, the 10-20 cm fish make up the third largest size class, but in 2011 and 2016 the >40 cm size class is the third largest. The number of 10-20 cm fish observed after 2011 is lower than in 1998, 2009, and 2010. See Figure 4-2.

Figure 4-2. Count of Rainbow Trout by size class in the Canadian Skagit River, 1998-2016

4.2.2 Bull Trout

In all surveys prior 2016, the >40 cm size class of Bull Trout makes up the greatest number of individuals observed. In 2016 the number of observations of 30-40 cm fish and >40 cm fish are close to equal, representing an increase in 30-40 cm fish and a decrease in >40 cm fish observed in 2016. The smaller two size classes, 10-20 cm and 20-30 cm do not make up more than 1 percent of observations in any year of the survey. See Figure 4-3.

Figure 4-3. Count of Bull Trout by size class in the Canadian Skagit River, 1998-2016

4.4 Distribution

4.4.1 Rainbow Trout

In 2016, as in previous surveys from 1998 to 2014, the greatest number of Rainbow Trout were found in the lower sections of the river (river sections 2 to 8). The lowest number of Rainbow Trout were found in section 10, also consistent with previous studies. Unlike previous studies, which had numerous fish observations in sections 11 to 13, in 2016 those sections had relatively few fish observations when compared with previous years. However, the overall pattern of Rainbow Trout distribution was broadly consistent with previous years**.** See Figure 4-4.

Figure 4-4. Distribution of Rainbow Trout by section in the Skagit River, 1998-2016

4.4.2 Bull Trout

As in previous surveys, Bull Trout in 2016 were most common in section 3 of the Skagit River. This matches previous surveys from 2009 to 2014. As in all other years, Bull Trout were observed least frequently in section 10. The overall pattern of distribution in 2016 is broadly similar to previous studies, with high concentrations in the lower sections of the river, and a second region of high concentration near sections 8 and 9. See Figure 4-5.

Figure 4-5. Distribution of Bull Trout by river section in the Canadian Skagit River, 1998-2016

4.5 Abundance Indices

4.5.1 Rainbow Trout

There was a statistically significant ($p<0.05$) drop in the abundance index of rainbow trout from 1998 to 2016, and the abundance index for Rainbow Trout is lower than observed in all previous surveys with the exception of 2014. The abundance index rose from 11.27 to 12.7 from 2014-2016 despite lower count numbers (Figure 4-6 and 4-7). From 2011 to 2016, the abundancy index of the middle two size classes (20-30 cm and 30-40 cm) increased while the abundancy index of the upper and lower size classes (>40 cm and 10-20 cm) decreased.

Figure 4-6. Abundance index of Rainbow Trout in the Canadian Skagit River by river section, 1998-2016

Figure 4-7. Average abundance index of Rainbow Trout in the Canadian Skagit River by size class, 1998-2016

*Note: Abundance indices by size class weren't available in 2013.

4.5.2 Bull Trout

The abundancy index for 2016 (16.61) is lower than it has been since 2009 (12.82; Figure 4-8 and 4-9). The abundancy index has been broadly increasing for all size classes of Bull Trout, with the exception being a decrease in the abundancy index of the largest size class (>40 cm) form 2011 to 2016.

Figure 4-8. Abundance index of Bull Trout in the Canadian Skagit River by river section, 1998-2016

Figure 4-9. Average abundance index of Bull Trout in the Canadian Skagit River by size class, 1998-2016

4.6 Catchable Fish

4.6.1 Rainbow Trout

The greatest number of catchable Rainbow Trout per kilometer was in 1994 when it peaked at 266/585 fish/km (expansion coefficients 2.09/4.59), and has been trending downwards from 1994 to 2016. Figure 4-10, Appendix 3.

Figure 4-10. Catchable Rainbow Trout in the Canadian Skagit River, 1998-2016

4.6.2 Bull Trout

The number of catchable Bull Trout increased from 1998 to 2011, where it peaked at 110/241 catchable fish/km (expansion coefficients 2.09/4.59), and has declined every year from 2011 to 2016. Figure 4-11, Appendix 3.

Figure 4-11. Catchable Bull Trout in the Canadian Skagit River, 1998-2016

e is the expansion coefficient

5.0 Discussion

The 2016 snorkel survey of fish species in the Skagit River continues work begun in 1982. It directly follows from a series of surveys done by Scott Resources in 2009-2014, with a partial survey conducted in 2012. Data from 2012 was not included in the analysis. Up to date information on fish present in the Skagit River system is required to make sound management decisions. As identified in the 2011 report, the Skagit River has transitioned from a Rainbow Trout dominated system (1982-2010), to a Bull Trout dominated system (2011-2016). It is important for this change to be highlighted to resource managers since the Skagit River is managed as a Rainbow Trout fishery, and the transition in species composition may indicate a need to revisit Rainbow Trout conservation efforts. The Skagit River is well known among anglers, and a change in fish composition may affect fishing tourism.

5.1 Rainbow Trout

The catchable number of rainbow trout in the Skagit River in 2016 was the lowest since 1991. The abundance index represented a rise from 2014, but the rise is due to the change in calculation to reflect the updated section lengths rather than a rise in the number of fish observed.

The declining numbers of Rainbow Trout have a variety of potential causes. Competition and predation from the increasing number of Bull Trout in the system may be causing lower rates of survival of juvenile Rainbow Trout. Evidence of predation was described by Anaka et al. (2011), who observed bite scars and ripped fins on many Rainbow Trout in the Skagit River. Anaka et al. (2011) also hypothesized that competition from Redside Shiners (*Richardsonius balteatus*) may cause further strain on juvenile Rainbow Trout. No incidental Redside Shiners were observed during the 2016 survey, but further study is necessary to determine the presence/ absence and potential influence of Redside Shiners on the juvenile Rainbow Trout populations.

Another potential explanation for the decline in observed numbers of Rainbow Trout may be that Rainbow Trout had already begun migrating into the Ross Reservoir at the time of the 2016 survey. Harper and Scott (1998) observed that the Skagit River Rainbow Trout are highly migratory and that by late October very few Rainbow Trout remain in the Skagit River (Anaka et al. 2011). Although the 2016 survey took place in late September, it is possible that a greater number of Rainbow Trout had migrated into the Ross Reservoir than in previous years. For example, the 2011 survey took place 2 weeks earlier in September, so the delay in the 2016 survey timing could have influenced the numbers of Rainbow Trout observed.

Additionally, 2016 water levels were low at the time of the survey (Duane Jesson, pers. communication). While this aided surveyors' ability to see the fish, it may have caused Rainbow Trout to seek sanctuary in the deeper water of Ross Reservoir.

Numbers of Rainbow Trout of the smallest size class (10-20 cm) decreased from 2010 to 2011, and have remained low from 2011-2016. Although the overall numbers are low, the number of observations has fluctuated from 22 to 55 individuals in the 2011 to 2016 surveys. As Anaka et al. (2011) suggested, the steep decline in 10-20 cm individuals from 2010 to 2011 may be contributing to the lowered adult population numbers. There have been no drastic changes in the number of 10-20 cm individuals since 2011, suggesting that the population may be restabilising at a smaller size.

5.2 Bull Trout

Bull Trout increased in numbers in the Skagit River from their inclusion in the float counts in 1998 to 2011 but, based on the data from 2011 to 2016, the numbers have declined since 2011. In 2011, Anaka et al. expressed concern that an influx of Redside Shiners could have a detrimental effect on Bull Trout populations as well as Rainbow Trout populations, but no Redside Shiners were observed in 2016, therefore it is questionable that competition from Redside Shiners has driven the decline in Bull Trout population since 2011. Further study on the population and competitive pressures on Bull Trout in the Skagit River would help clarify the changes in population size since 1998.

In all previous years of Bull Trout observations, the majority of individuals have been of the >40 cm size class. In 2016, the number of individuals was very similar between the >40 cm and the 30-40 cm size classes. This shift towards smaller fish could be due to the low water levels observed during the survey. Salmonid species, including trout need a minimum water depth between 10 and 24 cm (Bjornn and Reiser 1991, Bottom et al. 2005).

6.0 Conclusions and Recommendations

6.1 Conclusions

- The trend of declining Rainbow Trout in the Skagit River observed in previous studies continued in 2016. This trend is observed across all size classes and river sections. Fewer Rainbow Trout of catchable size were seen in the Skagit River than any year since 1991. The causes of the decline are unknown.
- After a dramatic rise in population from 1998-2011, the number of Bull Trout in the Skagit River has slowly begun to decline. The factors driving the shifts in Bull Trout population also remain unknown.

6.2 Recommendations

Given the decline in both Rainbow Trout and Bull Trout populations in the Canadian Skagit River and the importance of the river to local anglers, monitoring of the respective stocks is recommended. Migration studies between Ross Lake and the Skagit River is also suggested to inform migration timing of all size classes and species. Such information may be beneficial in determining the proportions of adfluvial fish and potamadromy within the Skagit system. It is also recommended that the historic data be updated to reflect the accurate section lengths in the Skagit River.

7.0 References

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APPENDIX 1

ALL COUNT DATA

Species	Year	Size class (cm)	Section														
			15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**Total**
RB	**1998**	10-20	2	43	20	15	16	6	0	9	15	1	5	2	132	30	296
		20-30	13	72	68	41	30	6	9	47	43	8	59	92	123	148	759
		30-40	6	32	77	43	45	10	32	84	28	23	69	176	140	153	918
		>40	0	1	12	5	13	6	13	40	10	4	11	23	18	20	176
		Total	21	148	177	104	104	28	54	180	96	36	144	293	413	351	2149
	2009	10-20	13	31	13	18	4	3	3	0	23	2	1	0	36	6	153
		20-30	28	44	100	50	38	8	32	23	42	18	8	23	77	51	542
		30-40	18	26	128	46	82	5	30	65	36	36	24	23	110	84	713
		>40	2	0	5	0	2	1	0	1	1	2	0	1	9	10	34
		Total	61	101	246	114	126	17	65	89	102	58	33	47	232	151	1442
	2010	10-20	33	53	6	9	3	1	0	15	13	1	0	0	12	20	166
		20-30	18	22	59	60	56	11	27	60	38	18	39	37	115	80	640
		30-40	24	36	145	58	99	13	56	45	39	26	95	123	151	88	998
		>40	1	5	8	2	9	0	0	7	3	0	1	3	5	1	45
		Total	76	116	218	129	167	25	83	127	93	45	135	163	283	189	1849
	2011	10-20	0	3	0	2	0	0	0	0	0	0	1	0	17	1	24
		20-30	4	8	23	29	20	5	15	7	27	4	24	23	74	42	305
		30-40	33	25	95	68	94	19	53	18	45	26	57	74	135	109	851
		>40	0	1	3	4	5	1	1	3	2	2	0	7	3	3	35
		Total	37	37	121	103	119	25	69	28	74	32	82	104	229	155	1215
	2013	10-20	0	0	0	1	0	0	0	0	1	1	0	0	47	5	55
		20-30	0	1	31	9	36	0	13	7	35	11	25	25	60	78	331
		30-40	18	12	111	40	48	12	32	20	57	11	43	45	87	84	620
		>40	3	1	25	8	3	3	2	1	1	3	4	3	14	4	75
		Total	21	14	167	58	87	15	47	28	94	26	72	73	208	171	1081
	2014	10-20	1	7	7	2	0	0	0	0	0	0	0	0	0	5	22
		20-30	14	16	55	15	17	1	9	12	16	7	12	17	38	36	265

Species	Year	Size class (cm)	Section														
			15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**Total**
RB	**2014**	30-40	24	7	74	30	36	16	32	9	26	17	30	39	86	76	502
		>40	3	0	15	7	5	0	1	1	2	1	2	6	1	6	50
		Total	42	30	151	54	58	17	42	22	44	25	44	62	125	123	839
	2016	10-20	11	31			1		1		3	1			2		50
		20-30	13	20	13	7	3		10	6	12	5		6	33	18	146
		30-40	5	12	39	10	28		13	29	32	24	13	55	109	91	460
		>40				4	7		2	5	15	3	11	15	20	20	102
		Total	29	63	52	21	39		26	40	62	33	24	76	164	129	758
BT	**1998**	10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		20-30	0	0	0	0	1	0	0	0	0	0	0	0	4	0	5
		30-40	0	1	1	3	1	0	1	1	2	0	0	3	16	4	33
		>40	0	20	32	35	1	1	1	19	0	0	5	14	17	3	148
		Total	0	21	33	38	3	1	2	20	2	0	5	17	37	7	186
	2009	10-20	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
		20-30	0	0	0	2	0	0	2	0	0	0	0	0	3	1	8
		30-40	0	0	17	16	2	0	9	7	6	8	2	14	95	46	222
		>40	7	8	91	54	4	0	71	80	7	23	58	30	137	155	725
		Total	7	8	108	72	6	0	82	87	13	31	60	44	237	202	957
	2010	10-20	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
		20-30	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
		30-40	0	0	17	16	2	0	9	7	6	8	2	14	95	46	222
		>40	57	4	40	44	51	2	124	222	50	14	180	177	491	127	1583
		Total	62	4	57	61	53	2	133	229	56	22	182	191	586	173	1811
	2011	10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		20-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		30-40	0	1	2	0	3	0	9	14	22	7	13	30	41	31	173
		>40	116	23	107	105	56	23	284	76	114	48	103	181	358	171	1765
		Total	116	24	109	105	59	23	293	90	136	55	116	211	399	202	1938

Species	Year	Size class (cm)	Section														
			15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**Total**
BT	**2013**	10-20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		20-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		30-40	0	0	0	1	0	0	0	0	0	1	0	0	2	0	4
		>40	59	22	200	93	54	5	314	35	138	32	82	105	249	157	1545
		Total	60	22	200	94	54	5	314	35	138	33	82	105	251	157	1550
	2014	10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		20-30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
		30-40	2	2	12	2	1	0	0	3	10	2	5	1	9	1	50
		>40	93	25	250	102	43	17	260	49	76	44	56	70	131	71	1287
		Total	95	27	263	104	44	17	260	52	86	46	61	71	140	72	1338
	2016	10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		20-30	1	3	0	0	1	0	4	0	0	0	0	0	1	0	10
		30-40	24	10	73	40	3	1	71	75	24	19	23	30	115	5	513
		>40	32	16	77	53	11		58	39	16	28	33	59	104	14	540
		Total	57	29	150	93	15	1	133	114	40	47	56	89	220	19	1063
EB	**2016**	20-30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
		30-40	0	1	1	0	0	0	0	0	0	0	0	1	0	0	3
		>40	0	0	0	2	0	0	0	3	0	0	6	1	1	0	13
		Total	0	2	1	2	0	0	0	3	0	0	6	2	1	0	17

APPENDIX 2

ALL ABUNDANCE INDEX DATA

Species	Year	Size class (cm)	Section														
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	Average
RB	1998	10-20	0.53	8.37	1.66	2.16	2.42	4.05	0.00	2.27	2.99	0.52	1.00	0.35	22.60	5.70	3.90
		20-30	3.42	14.01	5.66	5.89	4.53	4.05	1.81	11.87	8.57	4.17	11.85	16.08	21.06	28.14	10.08
		30-40	1.58	6.23	6.41	6.18	6.80	6.76	6.43	21.21	5.58	11.98	13.86	30.77	23.97	29.09	12.63
		>40	0.00	0.19	1.00	0.72	1.96	4.05	2.61	10.10	1.99	2.08	2.21	4.02	3.08	3.80	2.70
		Total	5.53	28.80	14.73	14.95	15.71	18.91	10.85	45.45	19.13	18.75	28.92	51.22	70.71	66.73	29.31
	2009	10-20	3.42	6.03	1.08	2.59	0.60	2.03	0.60	0.00	4.58	1.04	0.20	0.00	6.16	1.14	2.11
		20-30	7.37	8.56	8.32	7.18	5.74	5.41	6.43	5.81	8.37	9.38	1.61	4.02	13.18	9.70	7.22
		30-40	4.74	5.06	10.65	6.61	12.39	3.38	6.02	16.41	7.17	18.75	4.82	4.02	18.84	15.97	9.63
		>40	0.53	0.00	0.42	0.00	0.30	0.68	0.00	0.25	0.20	1.04	0.00	0.17	1.54	1.90	0.50
		Total	16.06	19.65	20.47	16.38	19.03	11.50	13.05	22.47	20.32	30.21	6.63	8.21	39.72	28.71	19.46
	2010	10-20	8.68	10.31	0.50	1.29	0.45	0.68	0.00	3.79	2.59	0.52	0.00	0.00	2.05	3.80	2.48
		20-30	4.74	4.28	4.91	8.62	8.46	7.43	5.42	15.15	7.57	9.38	7.83	6.47	19.69	15.21	8.94
		30-40	6.32	7.00	12.06	8.33	14.95	8.78	11.24	11.36	7.77	13.54	19.08	21.50	25.86	16.73	13.18
		>40	0.26	0.97	0.67	0.29	1.36	0.00	0.00	1.77	0.60	0.00	0.20	0.52	0.86	0.19	0.55
		Total	20.00	22.56	18.14	18.53	25.22	16.89	16.66	32.07	18.53	23.44	27.11	28.49	48.46	35.93	25.15
	2011	10-20	0.00	0.58	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	2.91	0.19	0.30
		20-30	1.05	1.56	1.91	4.17	3.02	3.38	3.01	1.77	5.38	2.08	4.82	4.02	12.67	7.98	4.06
		30-40	8.68	4.86	7.90	9.77	14.20	12.84	10.64	4.55	8.96	13.54	11.45	12.94	23.12	20.72	11.73
		>40	0.00	0.19	0.25	0.57	0.76	0.68	0.20	0.76	0.40	1.04	0.00	1.22	0.51	0.57	0.51
		Total	9.73	7.19	10.06	14.80	17.98	16.90	13.85	7.08	14.74	16.66	16.47	18.18	39.21	29.46	16.59
	2013	Total	5.53	2.72	13.89	8.33	13.14	10.14	9.44	7.07	18.73	13.54	14.46	12.76	35.62	32.51	14.13
	2014	10-20	0.26	1.36	0.58	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.25
		20-30	3.68	3.11	4.58	2.16	2.57	0.68	1.81	3.03	3.19	3.65	2.41	2.97	6.51	6.84	3.37
		30-40	6.32	1.36	6.16	4.31	5.44	10.81	6.43	2.27	5.18	8.85	6.02	6.82	14.73	14.45	7.08
		>40	0.79	0.00	1.25	1.01	0.76	0.00	0.20	0.25	0.40	0.52	0.40	1.05	0.17	1.14	0.57
		Total	11.05	5.83	12.57	7.77	8.77	11.49	8.44	5.55	8.77	13.02	8.83	10.84	21.41	23.38	11.27
	2016	10-20	3.40	5.39	0.00	0.00	0.17	0.00	0.26	0.00	0.77	0.30	0.00	0.00	0.27	0.00	0.75
		20-30	4.01	3.47	1.44	1.15	0.50	0.00	2.56	1.69	3.08	1.49	0.00	1.90	4.50	6.10	2.28
		30-40	1.54	2.08	4.32	1.65	4.70	0.00	3.33	8.16	8.21	7.15	4.57	17.38	14.87	30.83	7.77
		>40	0.00	0.00	0.00	0.66	1.18	0.00	0.51	1.41	3.85	0.89	3.87	4.74	2.73	6.78	1.90
		Total	8.96	10.95	5.76	3.46	6.55	0.00	6.66	11.26	15.90	9.83	8.43	24.02	22.37	43.70	12.70
BT	1998	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		20-30	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.06
		30-40	0.00	0.19	0.08	0.43	0.15	0.00	0.20	0.25	0.40	0.00	0.00	0.52	2.74	0.76	0.41
		>40	0.00	3.89	2.66	5.03	0.15	0.68	0.20	4.80	0.00	0.00	1.00	2.45	2.91	0.57	1.74
		Total	0.00	4.08	2.74	5.46	0.45	0.68	0.40	5.05	0.40	0.00	1.00	2.97	6.33	1.33	2.21
	2009	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.02
		20-30	0.00	0.00	0.00	0.29	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.51	0.19	0.10

Species	Year	Size class (cm)	Section														
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	Average
BT	2009	30-40	0.00	0.00	1.41	2.30	0.30	0.00	1.81	1.77	1.20	4.17	0.40	2.45	16.27	8.75	2.92
		>40	1.84	1.56	7.57	7.76	0.60	0.00	14.26	20.20	1.39	11.98	11.65	5.24	23.46	29.47	9.78
		Total	1.84	1.56	8.98	10.35	0.90	0.00	16.47	21.97	2.59	16.15	12.05	7.69	40.58	38.41	12.82
	2010	10-20	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
		20-30	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		30-40	1.05	0.39	0.00	0.43	0.60	0.00	0.40	4.80	0.40	0.00	0.60	0.00	0.00	4.18	0.92
		>40	15.00	0.78	3.33	6.32	7.70	1.35	24.90	56.06	9.96	7.29	36.14	30.94	84.08	24.14	22.00
		Total	17.37	1.17	3.33	6.89	8.30	1.35	25.30	60.86	10.36	7.29	36.74	30.94	84.08	28.32	23.02
	2011	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		20-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		30-40	0.00	0.19	0.17	0.00	0.45	0.00	1.81	3.54	4.38	3.65	2.61	5.24	7.02	5.89	2.50
		>40	30.53	4.47	8.90	15.09	8.46	15.54	57.03	19.19	22.71	25.00	20.68	31.64	61.30	32.51	25.22
		Total	15.79	4.28	16.64	13.51	8.16	3.38	63.05	8.84	27.49	17.19	16.47	18.36	42.98	29.85	20.43
	2013	Total	30.53	4.66	9.07	15.09	8.91	15.54	58.84	22.73	27.09	28.65	23.29	36.88	68.32	38.40	27.71
	2014	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		20-30	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		30-40	0.53	0.39	1.00	0.29	0.15	0.00	0.00	0.76	1.99	1.04	1.00	0.17	1.54	0.19	0.65
		>40	24.47	4.86	20.80	14.66	6.50	11.49	52.21	12.37	15.14	22.92	11.24	12.24	22.43	13.50	17.49
		Total	25.00	5.25	21.88	14.95	6.65	11.49	52.21	13.13	17.13	23.96	12.24	12.41	23.97	13.69	18.14
	2016	10-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		20-30	0.31	0.52	0.00	0.00	0.17	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.16
		30-40	7.41	1.74	8.09	6.59	0.50	0.67	18.20	21.11	6.15	5.66	8.08	9.48	15.69	1.69	7.93
		>40	9.88	2.78	8.53	8.74	1.85	0.00	14.86	10.98	4.10	8.34	11.60	18.65	14.19	4.74	8.52
		Total	17.60	5.04	16.61	15.33	2.52	0.67	34.09	32.09	10.26	14.00	19.68	28.13	30.01	6.44	16.61

APPENDIX 3

CATCHABLE FISH HISTORIC DATA

Species	Year	No. Sections	Length Surveyed	No. of Fish <20 cm	No. of Fish >20 cm	Catchables/km (e=2.09)	Catchables/km (e=4.59)
RB	1982	6	21.6	240	203	20	43
	1983	3	9.3	18	187	42	92
	1984	9	33.2	198	595	37	82
	1985	11	33.3	189	433	27	60
	1986	4	13.6	74	767	118	258
	1987	8	27.2	187	1168	90	197
	1988	8	27.2	138	915	70	154
	1989	14	36.9	113	926	53	115
	1990	16	42.4	303	720	35	78
	1991	12	33	153	349	22	49
	1992	13	34	836	1909	117	258
	1993	11	36.9	184	1247	71	155
	1994	14	36.9	1027	4696	266	585
	1998	14	36.9	296	1853	105	230
	2009	14	36.9	153	1289	73	160
	2010	14	36.9	166	1683	95	209
	2011	14	36.9	24	1191	67	148
	2013	14	36.9	386	695	39	86
	2014	14	36.9	55	1026	58	128
	2016	14	31.3	50	708	47	104
BT	1998	14	36.9	0	186	11	23
	2009	14	36.9	2	955	54	119
	2010	14	36.9	5	1806	102	225
	2011	14	36.9	0	1938	110	241
	2013	14	36.9	1	1549	88	193
	2014	14	36.9	0	1338	76	166
	2016	14	31.3	0	1063	71	156