Results of the Upper Sustut River Weir Steelhead Assessment Project 2006

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Executive Summary

In 2006, a floating PVC fish fence was in operation on the upper Sustut River from August 1 to September 30. The fish fence has been used in conjunction with a trap box, since 1992, as an annual indicator of upper Sustut River adult steelhead (*Oncorhynchus mykiss*) abundance. The fence has been in its current location since 1994. During site visits, general weather conditions, water level, air temperature and water temperature were recorded between 0800 hrs and 0900 hrs and 1900 hrs and 2100 hrs. Hourly water temperature was also collected via temperature data loggers located near the fence. Water levels ranged from 0.170 m to 0.308 m with a mean level of 0.211 m. Daily water temperatures ranged from 4.96°C to 14.26°C with a mean of 10.44°C.

One hundred and thirty three adult steelhead were enumerated between August 1 and September 30, 2006. This is the lowest recorded value for steelhead since the fence location and method was standardized in 1994. The mean number of steelhead from1994 to 2005 is 694. The previous low count was 268 in 2005. When the fence was dismantled on October 1 there were approximately 63 steelhead holding below the fence. One hundred and thirty three represents 12.8% of the estimated carrying capacity (1036) of the upper Sustut River adult steelhead population, and well below number of spawners (418) at MSY (*Maximum Sustainable* Y*ield*) (Tautz et al. 1992). Other species enumerated in 2006 include: rainbow trout (n=1), bull trout (*Salvelinus confluentus*) (n=19), Rocky Mountain whitefish (*Prosopium williamsoni*) (n=39), chinook salmon (*O. tshawytscha*) (n=472), sockeye salmon (*O. nerka*) (n=808) and coho salmon (*O. kisutch*) (n=121). The first steelhead was captured on August 9, and the last steelhead was captured on September 30.

Gillnet marks were observed on 2.5% of all steelhead enumerated during the 2006 project. The ratio of female to male steelhead that migrated past the fence was 1.50:1. In a typical year, approximately 20% of the steelhead migrating past the fence are handled to collect length data, genetic samples and scale samples for annual comparisons. Due to the low number of returning adult steelhead, biological parameters and steelhead scale samples for annual ageing analysis were not collected in 2006 to avoid the potential for handling stress.

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1.0 Introduction

Upper Sustut River steelhead are a unique population within the Skeena River watershed due to their early run timing into the lower Skeena River (Baxter 1997). Over-wintering, spawning and rearing occur at relatively high elevations: Sustut Lake (1306m); Johanson Lake (1448m). The short growth season in this 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).

Since 1994, adult upper Sustut River summer run steelhead (*Oncorhynchus mykiss*) index has been used as an annual indicator of stock status for all early run Skeena River summer steelhead. The early run Skeena River steelhead stocks are susceptible to intense marine commercial fisheries for sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon where they are vulnerable to capture in a mixed stock fishery (Ward *et al.* 1993; Cox-Rogers 1994). Due to their long freshwater migration Sustut River steelhead are also intercepted in First Nations fisheries and recreational fisheries on the Skeena River and lower Sustut River. Access to the fishable portion of the Sustut River is limited to helicopter, fixed wing aircraft or jet boat access from the two angling lodges on the lower river.

The Sustut River is designated as a Class 1 Classified Water from September 1 to October 31. The river is closed to angling from January 1 to May 31, and the portion of river upstream of the BC Railway Bridge, located at the confluence of the Bear and Sustut Rivers, is closed to angling throughout the year.

The objectives of the Sustut River enumeration program are:

1. to enumerate the upper Sustut River summer-run steelhead population.
2. to examine the sex ratio of steelhead throughout the run.
3. to examine the effect of water level and temperature on steelhead migration.
4. to examine the number of gillnet marked steelhead and the distribution of gillnet marked fish throughout the run.
5. to examine the relative run timing of male and female steelhead.
6. to enumerate salmon and resident trout populations.

Although the objectives of the project are related to steelhead, other species are captured during fence operation. Data for chinook, sockeye, coho salmon, bull trout, Rocky Mountain whitefish and rainbow trout are recorded

concurrently. Salmon data is forwarded to Fisheries and Oceans Canada for analysis and archiving.

2.0 Study Area

The Sustut River is located in north central British Columbia and is a tributary to the upper Skeena River (Figure 1). It originates in the Omineca Mountains approximately 220 km north of Smithers, B.C. The Sustut River flows for 8 km northwest from Sustut and Mud lakes where it joins Johanson Creek near the main spawning area for upper Sustut steelhead (Bustard 1993). The river then flows 3 km west to it's confluence with Moosevale Creek before turning southwest for approximately 100 km and flows into the Skeena River. The Sustut River drains approximately 3,574 km^2 and has seven main tributaries: Birdflat Creek, Bear River, Asitka River, Red Creek, Two Lake Creek, Moosevale Creek and Johanson Creek. Fish species known to inhabit the upper Sustut River include summer-run steelhead, chinook salmon, sockeye salmon, coho salmon, bull trout, Dolly Varden char, Rocky Mountain whitefish, and burbot [2] (Bustard 1993). The physical area that defines the upper Sustut River steelhead population is the Sustut River upstream of the Bear River confluence including Johanson Creek and Sustut and Johanson lakes (Spence *et al*. 1990) (Figure 2). The physical area that defines the lower Sustut River steelhead population is the Sustut River downstream of the Bear River confluence, including Bear River and Bear Lake (Spence *et al*. 1990) (Figure 2).

3.0 Methods

3.1 Steelhead Enumeration

A floating fish counting fence constructed from 3.8 cm PVC pipe was installed in the Sustut River 500 m upstream of the confluence with Moosevale Creek and 70 km upstream of the confluence with the Bear River (Figure 2). The fence was in operation between August 1 and September 30. Fish are directed into an aluminum trap box where they remained until a gate was opened allowing upstream migration to continue.

The total number of steelhead migrating past the fence between August 1 and September 30 is used as an estimate of adult upper Sustut River steelhead abundance. The Sustut River count is hypothesized to indicate steelhead abundance for upper Skeena River summer run steelhead stocks. Fish holding immediately downstream of the fence were visually counted on October 1 prior to fence removal. The pool downstream of the fence contains multiple species

[2] In August, 1999 a single juvenile burbot (<10 cm fork-length) was found in a beaver impoundment by Ministry staff on the Sustut River approximately 800 meters upstream of its confluence with Johanson Creek.

which makes an accurate visual count of steelhead difficult. Therefore, the visual count is considered an estimate.

The fence was inspected a minimum of three times a day. During site visits debris was removed and repairs made as necessary. The fence trap box was checked in the morning, afternoon and evening during low levels of fish migration. At peak migration the fence 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 fence often halts or delays migration. Therefore, the removal of debris and carcasses from the fence were conducted at the end of the day when fish migration has slowed. After chinook spawning is completed fence cleaning may only be required once every four or five days (Ron Steffy pers comm.).

The fence monitors use the visual characteristics described in Scott and Crossman (1973) and McPhail and Carveth (1994), to identify the species of all fish captured during the project. For data collection purposes, a plexiglass viewing box was used to identify and record fish by species, sex, presence of gill net marks, tags, wounds and general condition.

Figure 1. Location of Sustut River.

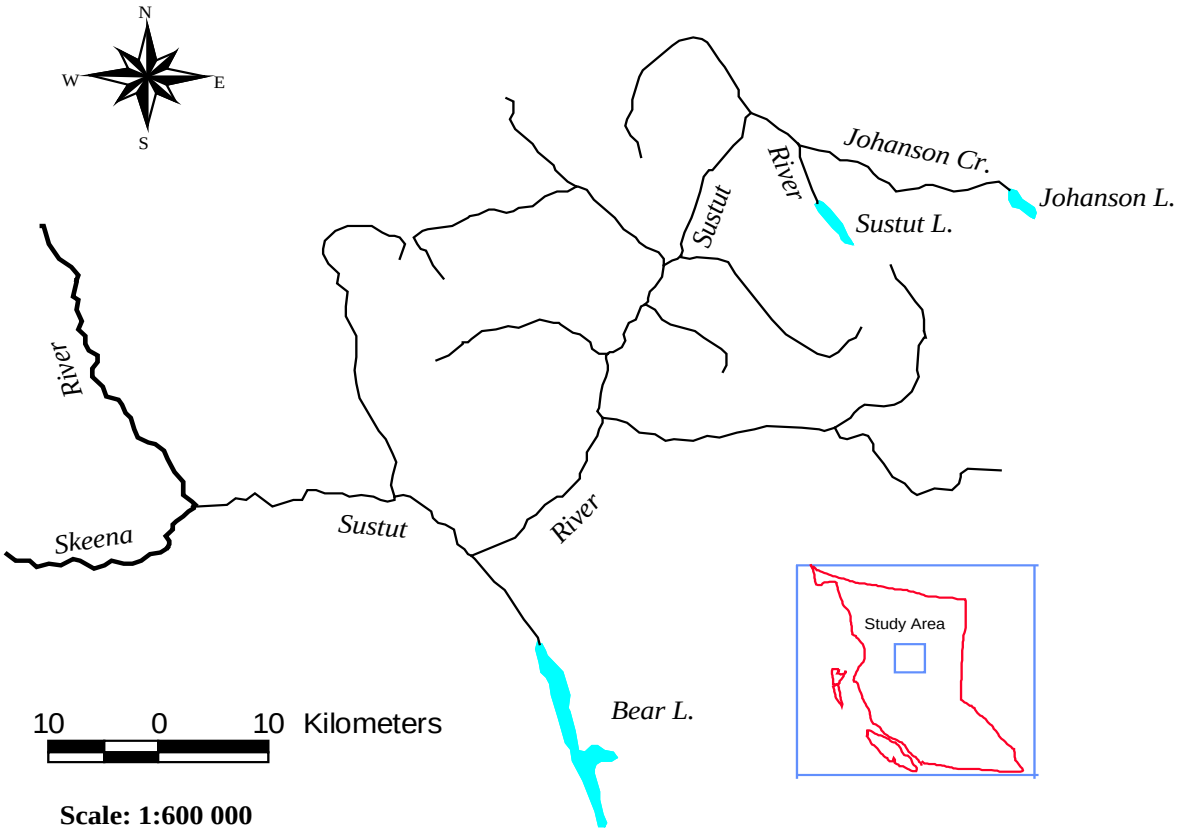

Figure 2. Map of Sustut River and tributaries.

Figure 3. Photograph steelhead enumeration fence assembly (a) and fence in operation. (b), 2008. Courtesy of Brome and Leaf Steffey.

3.2 Steelhead Migration and Physical Data

Stream water temperatures were recorded daily using a minimum-maximum thermometer (Brannon Ltd). Also, Optic Stowaway temperature data loggers (Onset Computer Corporation, Pocasset, MA) were deployed in the river and in a tree near the fence site to record hourly temperatures. Water levels were recorded in the morning and the evening using a metric staff gauge. Weather conditions were also recorded daily. Mean daily water temperature and level were compared against steelhead migration to measure potential links between the two variables and daily steelhead migration. Annual steelhead abundance was also compared to mean annual water level and mean annual temperature to investigate potential relationships between steelhead abundance and the two environmental variables.

3.3 Gillnet Marks

Sustut River steelhead migrate with other species of anadromous salmonids that are captured in tidal and non-tidal gillnet fisheries. The presence or absence of gillnet marks was noted for all steelhead as they migrated past the fence. This was facilitated by the use of a viewing box, avoiding the need to handle fish. Steelhead that exhibited wounds from a gillnet encounter were identified using this method.

3.4 Male and Female Steelhead Run Timing

The run timing of male and female steelhead was examined by plotting cumulative percent male and female steelhead by date over the duration of fence operation. The date of first arrival and median migration date past the fence for male and female steelhead was also compared.

4.0 Results

4.1 Steelhead Results

Between August 1 and September 30, 2006, 133 steelhead migrated through the upper Sustut River enumeration weir (Table 1; Appendix Table 1). Approximately 63 steelhead were counted in the pool immediately downstream of the fence, prior to removal, resulting in a total count of 196 steelhead. The standardized count of 133 represents the lowest recorded value since the current fence

location was established in 1994. One hundred and thirty three represents 13% of the estimated carrying capacity (1036) for the upper Sustut River steelhead population, and 32% of maximum sustainable yield (418) (Tautz *et al.* 1992). Prior to 2006, the lowest recorded fence count was 268 in 2005 (Fig 4). The 12 year mean fence count (1994-2005) is 694.

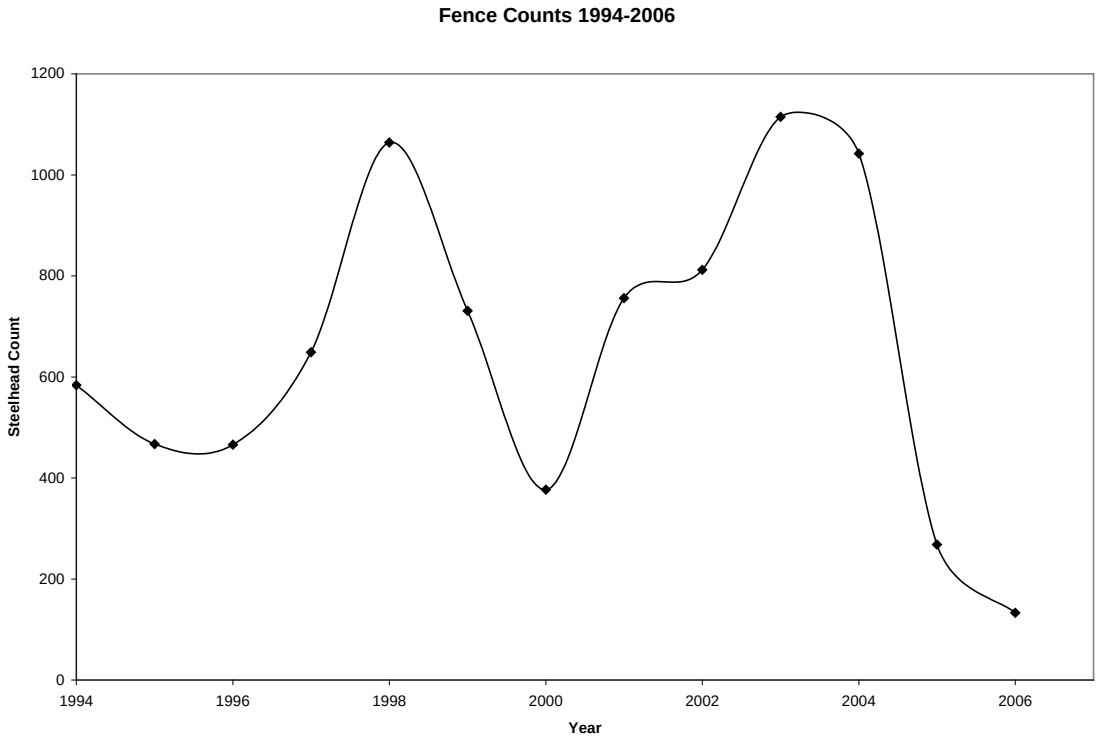

Figure 4. Annual steelhead fence count 1994-2006.

The first steelhead migrated through the fence on August 9 and by September 4, 50% of the steelhead enumerated in 2006 had passed the fence (n=66) (Fig 5). For annual comparison, the previous dates by which 50% of the migration had occurred along with the corresponding total fence counts to September 30 are recorded in Table 1 for the years 1994 to 2006. Information collected prior to 1994 was not included due to the variation in fence design and location.

Since 1994, the mean date at which 50% of the steelhead run had passed the fence is September 7 (SD=5.47). In comparison, since 2002, the 50% migration date has been relatively consistent. The mean 50% migration date during this time period is September 3 (SD=1) (Table 1).

Table 1. Dates when 50% of the steelhead migrated through the fence and the total count to September 30, for the years 1994 to 2006.

Year	Date of 50% Migration	50% Fence Count	Aggregate Fence Count	Rank
1994	Aug-29	292	584	8
1995	Sep-08	234	467	9
1996	Sep-07	233	466	10
1997	Sep-13	325	649	7
1998	Sep-07	532	1064	2
1999	Sep-17	366	731	6
2000	Sep-07	186	377	11
2001	Sep-16	378	756	5
2002	Sep-02	406	812	4
2003	Sep-02	558	1115	1
2004	Sep-03	521	1042	3
2005	Sep-03	134	268	12
2006	Sep-04	66	133	13
Earliest 50% Migration Date	Aug-29	Minimum Count	133	
Latest 50% Migration Date	Sep-17	Maximum Count	1115	
		Mean Count	651	

Graphical analysis of the cumulative proportional distribution of steelhead over time shows that, in 2006, almost half of the steelhead migration occurred in a two day period (Fig 5). On August 23 (n=35) and September 27 (n=24) a total of 59 or 44% of the total index were counted. The daily steelhead count ranged from 0 to 35, and steelhead were counted on 23 days of the 61 day project. In comparison, from 2002 through 2005, the mean number of days steelhead were counted during the 61 day project was 43.7 (SD=5.3). During this time period the fence count ranged from 268 to 1115 (Table 1).

On October 1 the fence crew conducted a visual count in the fence pool located downstream of the fence. Their observations indicated that there were between 100 and 150 fish in the pool. Approximately half were coho and the other half were steelhead (Ron Steffy pers comm.).

Estimating the number of steelhead in the fence pool prior to fence removal was calculated by dividing the mid point between 100 and 150 (125) by two, since

half were estimated to be steelhead and the other half coho. This calculation results in a rough estimate of 63 steelhead.

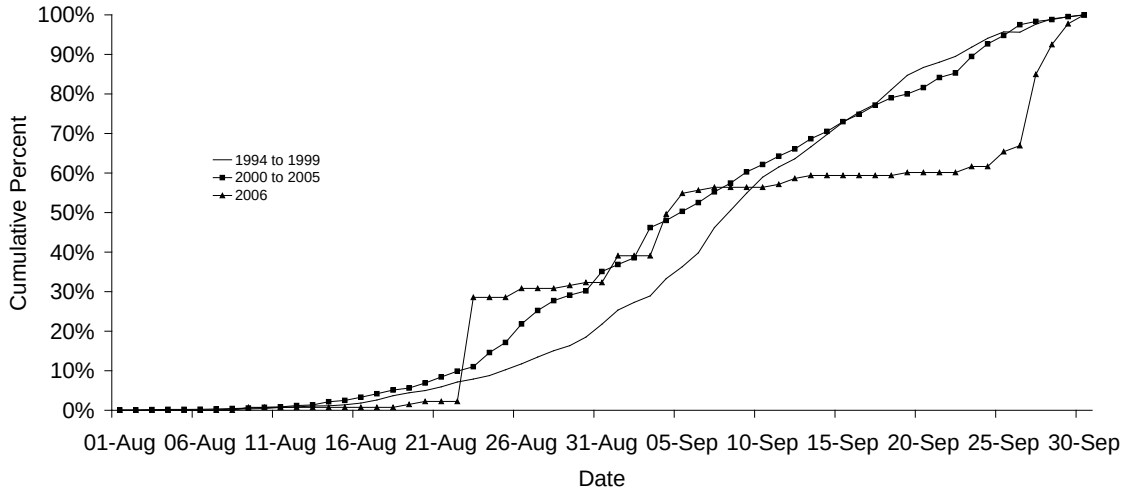

Figure 5. Daily cumulative percentage of upper Sustut River steelhead migrating past the fence for the years 1994 to 2006.

4.2 Steelhead Ageing and Tagging Information

Prior to 2002, all steelhead captured in the trap box were marked via Anchor-T tag (Floy Seattle WA.) before being released upstream of the fence. Since 2002, the tagging component of the program has been discontinued. Steelhead captured and released in Alaskan commercial fisheries, Canadian commercial fisheries, First Nation fisheries programs and the Tyee Test Fishery are sometimes tagged or marked prior to release. Steelhead enumerated at the fence are checked for marks or tags. There were no tagged or marked fish observed at the fence in 2006.

Typically, the fence staff attempts to collect scale samples, for ageing purposes, from approximately 20% of the steelhead captured at the fence. Since steelhead abundance levels in 2006 were very poor the decision was made to suspend scale collection to preclude handling stress. Therefore, there is no ageing information available for the 2006 season.

4.3 Steelhead Migration and Physical Data

Daily environmental data recorded by the fence monitors are presented in Appendix Table 4. For purposes of analysis, water temperatures collected via Stowaway data loggers were utilized. The data logger recorded water

temperatures from August 1 to September 30, 2006. Water temperature was recorded hourly providing 1,464 data points for analysis. Overall, the highest temperature was recorded on August 17 (14.26°C) and the lowest was recorded on September 15 (2.13°C). The mean temperature during the 2006 project was 8.64°C. The lowest mean daily water temperature recorded when a steelhead was captured was 5.74 °C on September 19. Daily minimum and maximum water temperatures are shown graphically in Appendix Figure 1. Mean water temperatures in 2004, 2005 and 2006 were 9.81°C, 8.81°C and 8.71°C respectively (mean 8.90°C) (SD=0.24). In this time period the fence count ranged from 1042 in 2004 to 133 in 2006.

Stratified by hour, the warmest water temperatures were recorded between 17:00:00 and 18:00:00 (Fig 6). During the study period 71% (n=94) of the steelhead entering the trap box did so after the morning site visit. The remainder, 29% (n=39), entered the trap box after the crew left in the evening and before the morning site visit the following day. Since the fence staff are not at the site on a continual basis the exact hour steelhead entered the trapbox cannot be determined. However, the data indicates that the majority of steelhead that entered the trapbox did so in the afternoon and evening hours. This coincides with the daily time period when water temperatures are increasing or have reached their daily maximum (Fig 6). Accumulated thermal units are defined as the cumulative daily water temperature (degrees Celsius) stratified by hour from August 1 to September 30.

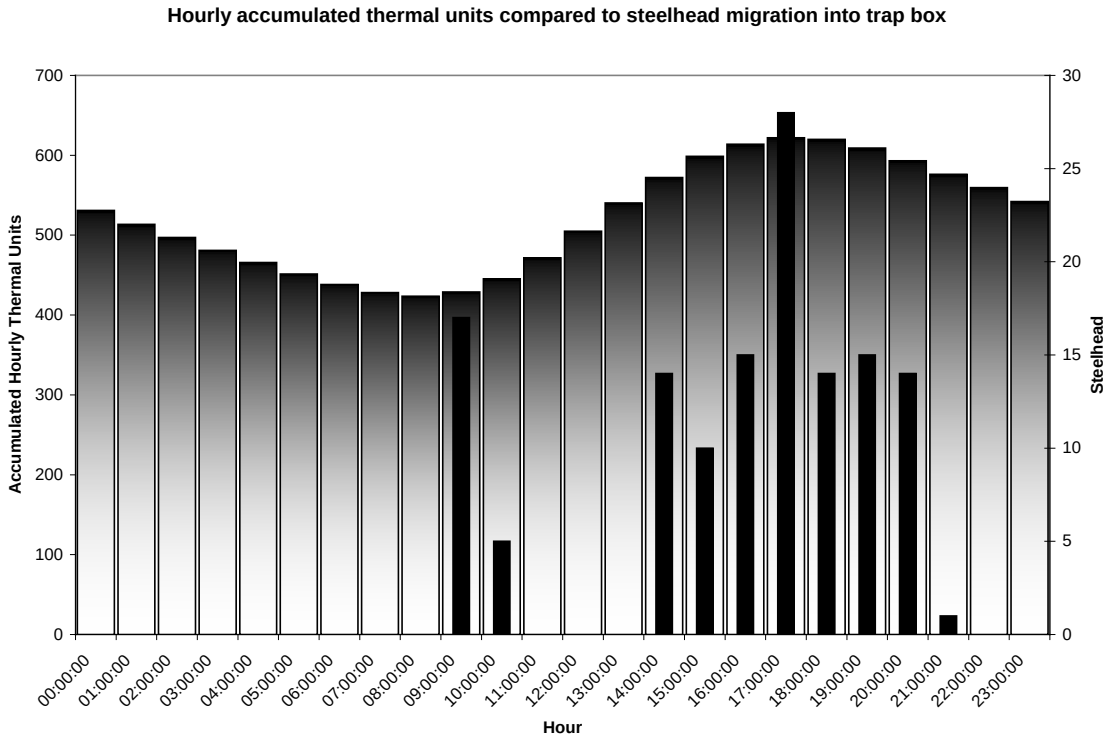

Figure 6. Water temperatures and steelhead migration stratified by hour August 1- October 1, 2006.

Water levels were recorded by fence staff twice a day. The two measurements were averaged to determine a daily level (Fig 7). Measurements were recorded from a metric staff gauge located immediately upstream of the fence. In 2006, water levels ranged between 0.17 m and 0.31 m. Steelhead entered the trap box when water levels ranged between 0.17 m and 0.28 m. The mean level was 0.21 m and the standard deviation was 0.05. The highest water level was 0.31 m measured on August 1, and the lowest level was 0.17 m measured on September 13,15,16,17,18,19,20,21. Figure 7 shows the combined 2006 daily water levels and steelhead migration at the fence from August 1 to September 30.

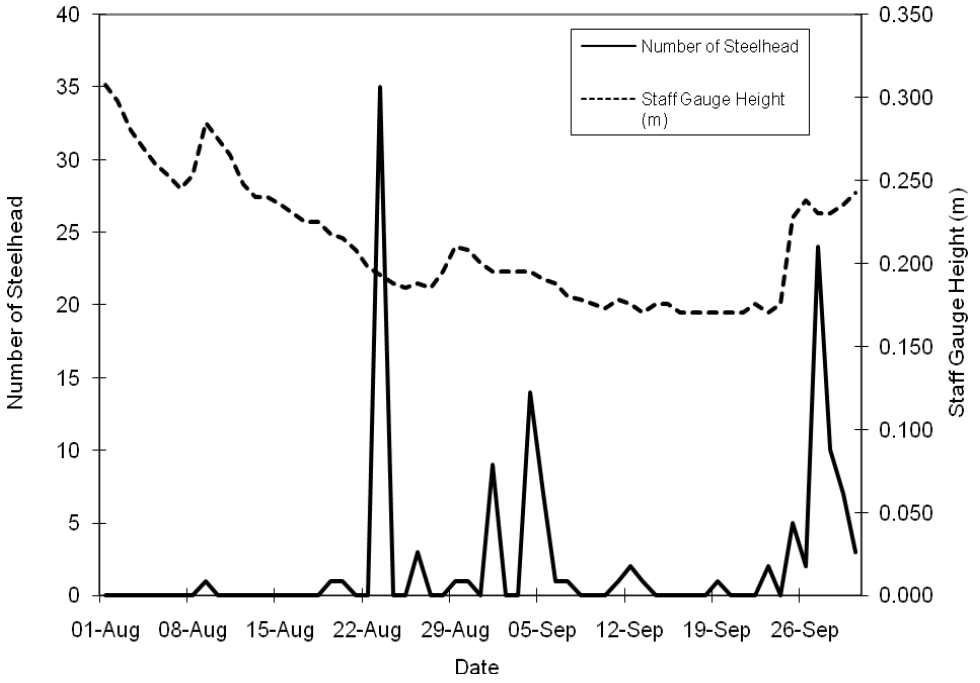

Figure 7. Daily staff gauge height and the daily number of steelhead migrating past the fence in 2006.

Comparing 2006 daily water level to steelhead migration into the trap box indicated little or no relationship between the variables (Fig.8). In 2006, the median water level was 0.198 m. Slightly more (58% n=77) steelhead entered the trap box when water levels were below 0.198m than when they were above 0.198m (42% n=56).

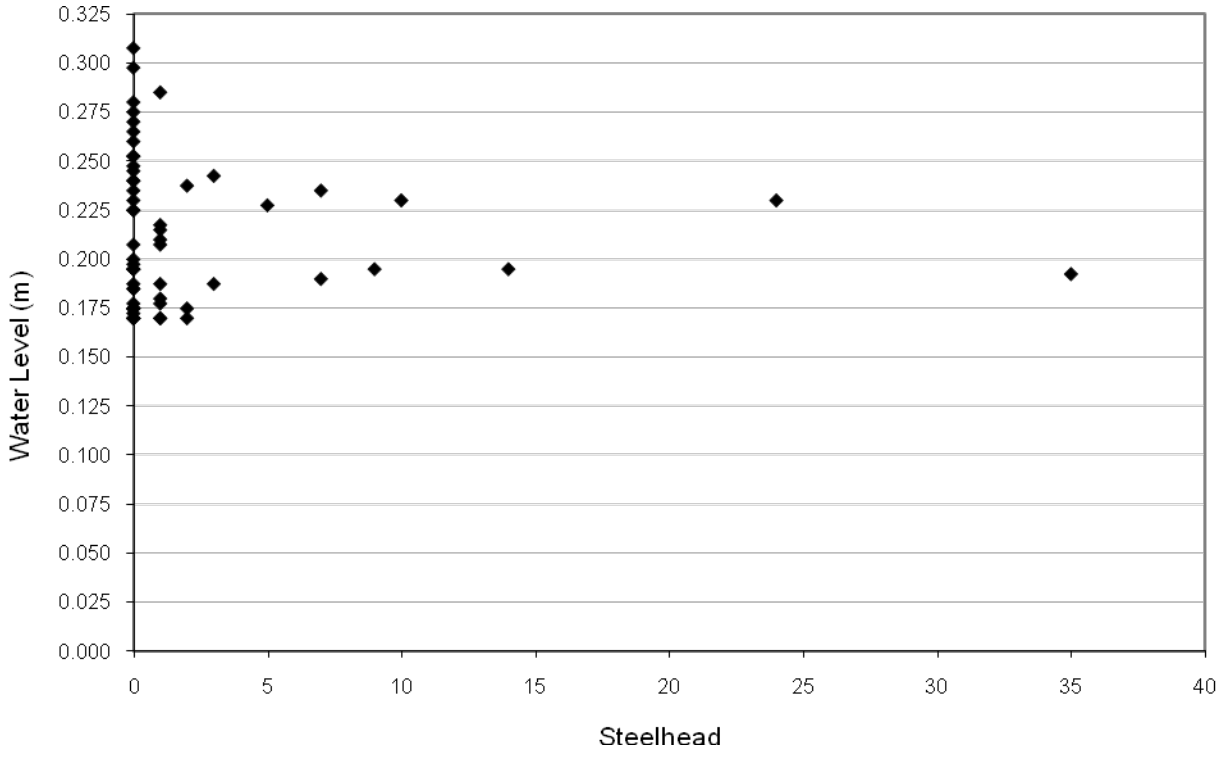

Figure 8. Water level vs. steelhead migration past the upper Sustut River enumeration weir 2006.

Since 1998, the annual mean level from August 1 to September 30 has ranged between 0.34 m (2004) and 0.21m (2006). The mean water level in this eight year period is 0.28 m (SD=0.04). Figure 9 compares the mean annual water level and fence count. The R^2 value (0.1362) indicates that there is not a relationship between mean annual water level and fence count.

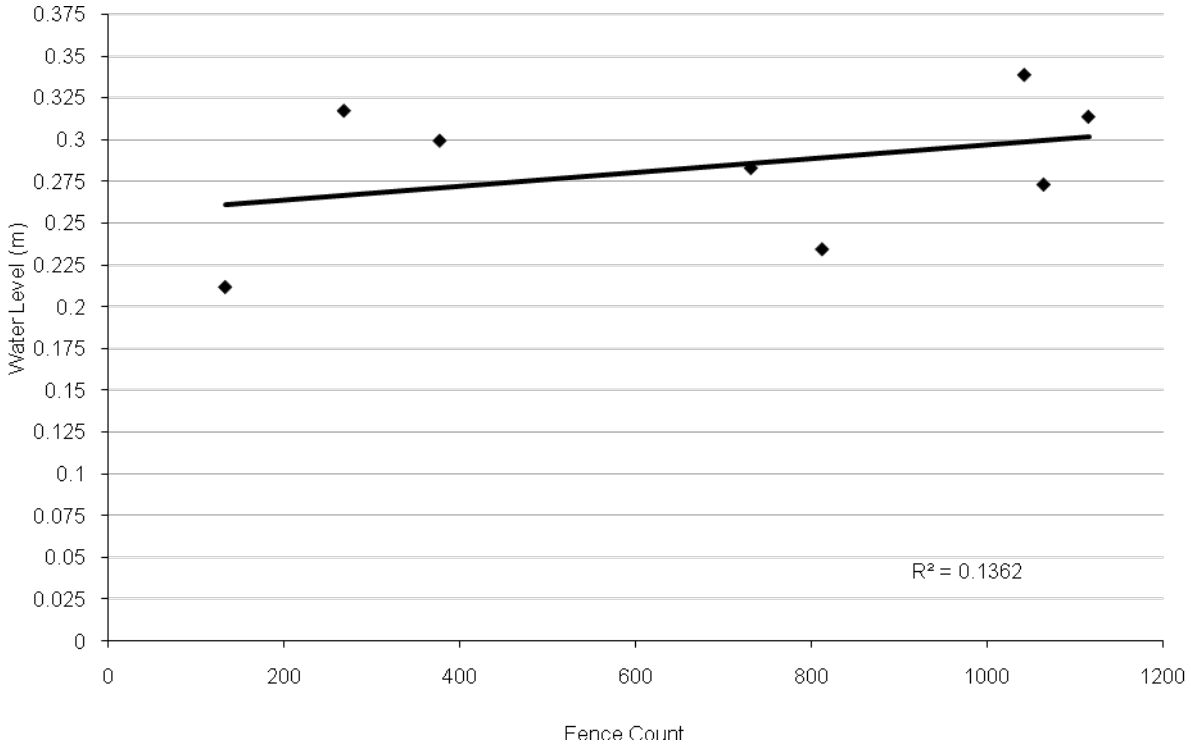

Figure 9. Water level vs. steelhead fence count 1998-2006.

4.4 Steelhead Sex Ratio

Of the 133 steelhead counted migrating through the fence, 53 (40%) were male and 80 (60%) were female resulting in a female to male ratio of 1.50:1. This is comparable to the value of 2.01:1 reported in 2005.

4.5 Steelhead Gillnet Marks

Fence observers recorded the presence of gillnet marks on steelhead that were observed during the project. Gillnet marks were present on 2.25% (n=3) of all steelhead that migrated past the fence; two of the steelhead observed with net marks were female and one was male.

4.6 Male and Female Steelhead Run Timing

The first male steelhead passed through the fence on August 9 while the first female steelhead migrated upstream on August 20 (Fig 10). The median migration date for males was September 4 and the median date for females was September 5. The plot of daily cumulative percentage of male and female steelhead arriving at the fence revealed a similar migration pattern for both sexes (Fig 10).

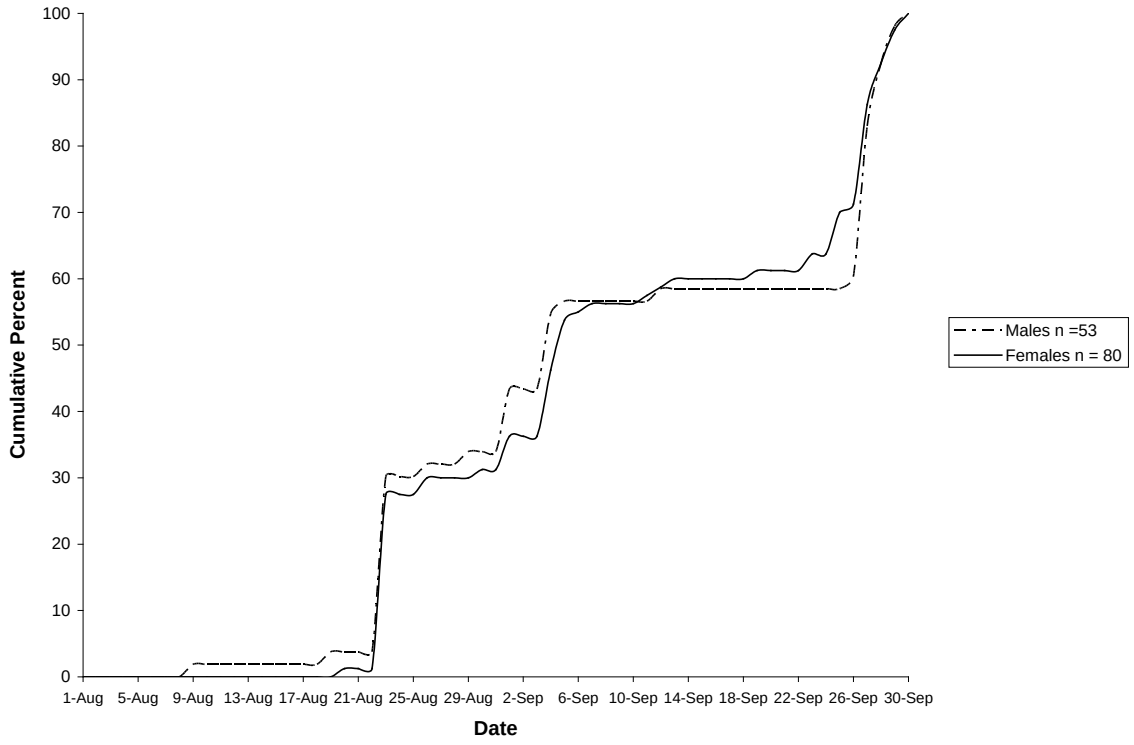

Figure 10. Daily cumulative percent of male and female steelhead migrating past the fence 2006.

5.0 Discussion

The 2006 upper Sustut River steelhead fence count to September 30 was 133. Halfway through the project it appeared that the steelhead index could be very poor. As a result of the low numbers, ageing and length data were not collected to reduce potential handling stresses. One hundred and thirty three represents the lowest recorded since methods were standardized in 1994 (Table 3). Approximately 63 steelhead were observed downstream of the fence prior to its removal. The sum of the 2006 fence count and steelhead observed downstream

of the fence prior to removal, results in an abundance estimate of 196. Since 1994, annual standardized fence counts have ranged from a high of 1,115 in 2003 to a low of 133 in 2006 (Table 3).

Table 2. Historical upper Sustut River steelhead data for the years 1994 to 2006[3].

Year	Date of First Steelhead	Date of 50% Migration	Count	Average Length (cm) M	Average Length (cm) F	Repeat Repeat Spawner	% Handling Mortalities	% Gillnet Marked M	% Gillnet Marked F	% Gillnet Marked Total
1994	8-Aug	29-Aug	584	824	737					2.0
1995	8-Aug	8-Sep	467	826	746	1.2	4.0			6.0
1996	17-Aug	7-Sep	466	829	739	1.3	2.8			14.0
1997	9-Aug	13-Sep	649	814	733	0.6	1.5	9.2	17.8	15.4
1998	3-Aug	7-Sep	1064	827	749		0.8	13.4	13.8	13.7
1999	17-Aug	17-Sep	731	848	756	2.5	0.3	6.1	9.9	8.5
2000	8-Aug	7-Sep	377	827	741	0.4	0.5	10.6	16.2	14.1
2001	15-Aug	16-Sep	756	864	771	2.5	1.9	10.1	14.5	12.8
2002	9-Aug	2-Sep	812			1.9	0.5	3.6	8.4	6.3
2003	3-Aug	2-Sep	1115	780	730	1.2	0.3	8.3	14.2	11.8
2004	28-Jul	3-Sep	1042	818	745		0.3	6.0	8.8	7.7
2005	31-Jul	3-Sep	269	859	741	19	0	3.3	5.5	4.8
2006	9-Aug	4-Sep	133	N/A*	N/A*	N/A*	0	0.53	1.6	2.25
Minimum			133	780	730	0.4	0.0	0.53	1.6	2.0
Maximum			1115	864	771	19.0	4.0	13.4	17.8	15.4
Average			651	829	744	N/A*				

No steelhead mortalities were found on the upstream side of the fish fence in 2006.

In 2006, 60% of the steelhead migrating past the fence were female and 40% were male. These results suggested a sex ratio of 1.50:1 females to males. The sex ratio in favour of females is similar to that found in previous years (Parken *et al.* 1997; Williamson 1998, 1999a, 2000; Diewert 2001, 2002, 2003, 2004; Peard 2005). The mean ratio during this time period is 1.58: 1 SD=0.21

In 2006, 2.25% of all steelhead migrating past the fence exhibited gillnet marks. This falls in the lowest end of previously recorded values which have ranged from 2.0% to 15.4% (Table 2).

[3] Due to the low numbers of steelhead in 2006 length, ageing and genetic information was not collected.

5.1 The Importance of Continued Monitoring.

The upper Sustut River fence 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. The long term data set collected at the site allows fisheries managers to compare annual abundance, run timing, sex ratios and age composition of adult steelhead in the upper Sustut. The ability of fisheries managers to monitor steelhead stock abundance and other important biological parameters would be severely affected if this project were to discontinue. The social, economic and ecological benefits created by the Skeena summer run steelhead stocks make this project both cost efficient and important component of the long term viability of these stocks.

6.0 Recommendations

1. Enumeration of the upper Sustut River steelhead population should continue to be carried out annually. The valuable time series of data that results from this project provides fisheries managers with information on abundance trends for all early run Skeena steelhead populations and provides feedback on the impact of fisheries on these stocks.

2. Efforts to visually enumerate steelhead below the fence prior to fence removal should continue. These counts provide the basis for estimating total steelhead spawning escapement to the upper Sustut River allowing for an evaluation of stock status relative to carrying capacity. Surveys should take place bi weekly for the last two weeks of September to ensure that a count of steelhead below the fence is always available. A final count should be carried immediately prior to fence removal. How the count occurs should be standardized to maintain the long term consistency of the data.

3. Over the last two years, the values recorded at the upper Sustut River index have been poor. If 2006 fence counts are representative of the 2007 upper Sustut River steelhead spawning escapements the population may be below the routine management zone described by Johnston et al. 2002. A secondary method to estimate spawning escapement in the spring and compare to run abundance in the fall needs to be developed. In particular for the years when index counts are poor.

7.0 Acknowledgments

Ron, Wanda, Clayton, Heather, Leaf, Brome and Hawk Steffey repaired, installed and maintained the fence. Their dedication to the project was above and beyond what is asked of them; both fish and fisheries managers benefited from their hard work and thoughtful approach.

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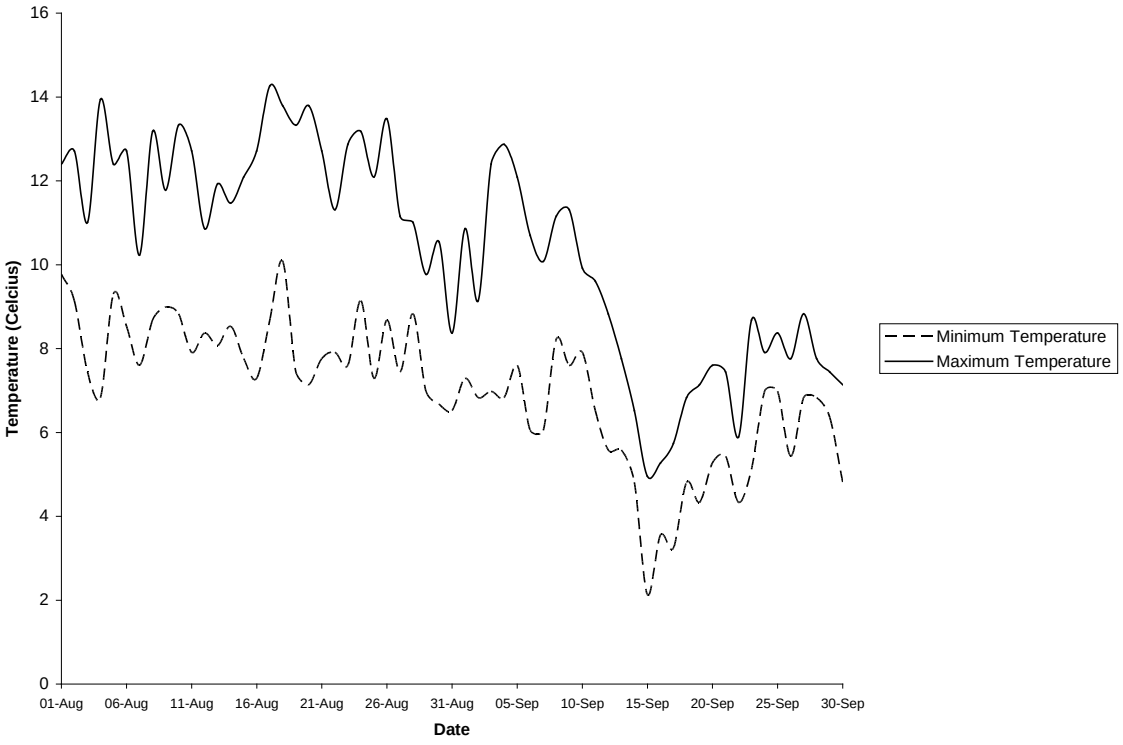
Appendix Figures



Appendix Figure 1. Daily minimum and maximum water temperatures at the upper Sustut River enumeration weir, August 1 to September 30, 2006.

Appendix Tables

Appendix Table 1. Daily and cumulative totals for non salmon species, 2006.

Date	ST Daily	ST Cumulative	RB Daily	RB Cumulative	BT Daily	BT Cumulative	WF Daily	WF Cumulative
1-Aug	0	0	0	0	0	0	1	1
2-Aug	0	0	0	0	2	2	3	4
3-Aug	0	0	0	0	0	2	2	6
4-Aug	0	0	0	0	0	2	1	7
5-Aug	0	0	0	0	0	2	4	11
6-Aug	0	0	0	0	0	2	3	14
7-Aug	0	0	0	0	0	2	0	14
8-Aug	0	0	0	0	0	2	1	15
9-Aug	1	1	0	0	0	2	0	15
10-Aug	0	1	0	0	0	2	0	15
11-Aug	0	1	0	0	0	2	0	15
12-Aug	0	1	0	0	1	3	0	15
13-Aug	0	1	0	0	0	3	0	15
14-Aug	0	1	0	0	0	3	0	15
15-Aug	0	1	0	0	0	3	0	15
16-Aug	0	1	0	0	0	3	2	17
17-Aug	0	1	0	0	0	3	0	17
18-Aug	0	1	0	0	0	3	2	19
19-Aug	1	2	0	0	0	3	0	19
20-Aug	1	3	0	0	1	4	2	21
21-Aug	0	3	0	0	0	4	1	22
22-Aug	0	3	0	0	0	4	1	23
23-Aug	35	38	0	0	1	5	3	26
24-Aug	0	38	0	0	0	5	0	26
25-Aug	0	38	0	0	0	5	0	26
26-Aug	3	41	0	0	1	6	1	27
27-Aug	0	41	0	0	0	6	0	27
28-Aug	0	41	1	1	1	7	0	27
29-Aug	1	42	0	1	0	7	2	29
30-Aug	1	43	0	1	0	7	2	31
31-Aug	0	43	0	1	0	7	0	31
1-Sep	9	52	0	1	0	7	0	31
2-Sep	0	52	0	1	0	7	2	33
3-Sep	0	52	0	1	0	7	0	33
4-Sep	14	66	0	1	0	7	0	33
5-Sep	7	73	0	1	0	7	0	33
6-Sep	1	74	0	1	0	7	0	33
7-Sep	1	75	0	1	0	7	0	33
8-Sep	0	75	0	1	0	7	0	33
9-Sep	0	75	0	1	1	8	0	33

Date	ST Daily	ST Cumulative	RB Daily	RB Cumulative	BT Daily	BT Cumulative	WF Daily	WF Cumulative
10-Sep	0	75	0	1	0	8	0	33
11-Sep	1	76	0	1	3	11	0	33
12-Sep	2	78	0	1	0	11	1	34
13-Sep	1	79	0	1	2	13	1	35
14-Sep	0	79	0	1	0	13	0	35
15-Sep	0	79	0	1	0	13	0	35
16-Sep	0	79	0	1	1	14	0	35
17-Sep	0	79	0	1	1	15	0	35
18-Sep	0	79	0	1	2	17	2	37
19-Sep	1	80	0	1	1	18	1	38
20-Sep	0	80	0	1	0	18	0	38
21-Sep	0	80	0	1	0	18	0	38
22-Sep	0	80	0	1	0	18	0	38
23-Sep	2	82	0	1	0	18	0	38
24-Sep	0	82	0	1	0	18	0	38
25-Sep	5	87	0	1	0	18	1	39
26-Sep	2	89	0	1	1	19	0	39
27-Sep	24	113	0	1	0	19	0	39
28-Sep	10	123	0	1	0	19	0	39
29-Sep	7	130	0	1	0	19	0	39
30-Sep	3	133	0	1	0	19	0	39

Appendix Table 2. Steelhead sampling data from the Sustut River fence, 2006.

Date	Time	Sex	GN Mark	Comments
08-Aug	15:30	M	no	
19-Aug	19:30	M	no	
20-Aug	09:00	F	no	
23-Aug	17:00	M	no	
		M	no	
		M	no	
		M	no	
		M	no	
		M	no	
		F	no	
		F	no	
		F	no	
		F	no	
		F	no	
		F	no	
	17:30	M	no	
		M	no	
		M	no	
		F	no	
		F	no	
		F	no	
		F	no	
	18:00	M	no	
		M	no	
		M	no	
		F	no	
	18:30	M	no	
		F	no	
		F	no	
		F	no	
		F	no	
	19:00	F	no	
		F	no	
		F	no	
	19:30	M	no	
		F	no	
		F	no	
		F	no	
26-Aug	16:30	F	no	
		F	no	
29-Aug	14:00	M	no	
30-Aug	21:00	F	no	
01-Sept	09:30	F	no	
	20:30	M	no	
		M	no	

		M	no	
Continued				
Date	**Time**	**Sex**	**GN**	**Comments**
01-Sept	20:30	M	no	
		M	no	
		F	no	
		F	no	
		F	no	
04-Sept	18:00	M	no	
		F	no	
		F	no	
	19:00	M	no	
		M	no	
		F	no	
	20:00	M	no	
		M	no	
		F	no	
		F	no	
05-Sept	09:00	F	no	
	16:00	F	no	
	16:30	M	no	
		F	no	
	16:45	F	no	
		F	no	
		F	no	
06-Sept	16:00	F	no	
07-Sept	09:15	F	no	
11-Sept	15:00	F	no	
12-Sept	17:15	M	no	
		F	no	
13-Sept	20:30	F	no	
19-Sept	17:30	F	no	
23-Sept	16:00	F	no	
		F	no	
25-Sept	09:00	F	no	
		F	no	
		F	no	
	19:00	F	no	
		F	no	
26-Sept	10:00	M	yes	
	15:00	F	no	
27-Sept	10:30	M	no	
		M	no	
		M	no	
		F	no	
	14:30	M	no	
		M	no	
		M	no	
		M	no	
		M	no	

Continued	Time	Sex	GN	Comments
Date		F	no	
27-Sept	14:30	F	no	
		F	no	
		M	no	
		M	no	
	15:15	M	no	
		F	no	
	17:30	F	no	
		F	no	
		F	no	
		F	no	
		F	no	
	18:30	M	no	
		F	no	
28-Sept	09:30	M	no	
		M	no	
		F	no	
		F	no	
		F	no	
	15:00	M	no	
		M	no	
		M	no	
		F	no	
		F	no	
29-Sept	09:00	M	no	
		M	no	
		F	no	
		F	no	
	14:00	F	no	
		F	yes	
	16:15	M	no	
30-Sept	09:00	M	no	
		F	no	
		F	yes	

.

Appendix Table 3. Daily and cumulative total of chinook, sockeye and coho salmon migrating past the Sustut River fence, 2006.

Date	Chinook		Sockeye		Coho	
	Daily	Cum	Daily	Cum	Daily	Cum
01-Aug-06	32	32	0	0	0	0
02-Aug-06	32	64	0	0	0	0
03-Aug-06	21	85	0	0	0	0
04-Aug-06	37	122	0	0	0	0
05-Aug-06	58	180	0	0	0	0
06-Aug-06	43	223	0	0	0	0
07-Aug-06	32	255	0	0	0	0
08-Aug-06	31	286	2	2	0	0
09-Aug-06	57	343	0	2	0	0
10-Aug-06	27	370	14	16	0	0
11-Aug-06	11	381	0	16	0	0
12-Aug-06	21	402	0	16	0	0
13-Aug-06	24	426	0	16	0	0
14-Aug-06	13	439	3	19	0	0
15-Aug-06	5	444	0	19	0	0
16-Aug-06	5	449	0	19	1	1
17-Aug-06	0	449	0	19	0	1
18-Aug-06	4	453	0	19	0	1
19-Aug-06	5	458	8	27	0	1
20-Aug-06	1	459	13	40	0	1
21-Aug-06	2	461	1	41	0	1
22-Aug-06	3	464	3	44	0	1
23-Aug-06	4	468	233	277	0	1
24-Aug-06	0	468	7	284	0	1
25-Aug-06	1	469	0	284	0	1
26-Aug-06	0	469	4	288	1	2
27-Aug-06	0	469	0	288	0	2
28-Aug-06	2	471	0	288	0	2
29-Aug-06	0	471	5	293	1	3
30-Aug-06	0	471	0	293	0	3
31-Aug-06	0	471	0	293	0	3
01-Sep-06	1	472	0	293	4	7
02-Sep-06	0	472	27	320	0	7
03-Sep-06	0	472	92	412	1	8
04-Sep-06	0	472	157	569	7	15
05-Sep-06	0	472	17	586	4	19
06-Sep-06	0	472	5	591	0	19
07-Sep-06	0	472	0	591	0	19
08-Sep-06	0	472	4	595	0	19
09-Sep-06	0	472	1	596	0	19
10-Sep-06	0	472	12	608	0	19
11-Sep-06	0	472	18	626	0	19
12-Sep-06	0	472	49	675	2	21

Continued	**Chinook**		**Sockeye**		**Coho**	
	Daily	Cum	Daily	Cum	Daily	Cum
13-Sep-06	0	472	7	682	0	21
14-Sep-06	0	472	2	684	0	21
15-Sep-06	0	472	2	686	0	21
16-Sep-06	0	472	4	690	0	21
17-Sep-06	0	472	5	695	0	21
18-Sep-06	0	472	10	705	1	22
19-Sep-06	0	472	22	727	3	25
20-Sep-06	0	472	5	732	0	25
21-Sep-06	0	472	14	746	3	28
22-Sep-06	0	472	7	753	1	29
23-Sep-06	0	472	37	790	3	32
24-Sep-06	0	472	7	797	1	33
25-Sep-06	0	472	2	799	41	74
26-Sep-06	0	472	3	802	16	90
27-Sep-06	0	472	3	805	13	103
28-Sep-06	0	472	0	805	2	105
29-Sep-06	0	472	1	806	8	113
30-Sep-06	0	472	2	808	8	121

Appendix Table 4. Daily staff gauge height, air and water temperature and weather conditions for the upper Sustut River, 2006.

Date	Time	Staff Gauge (m)	Water Temp °C Max	Water Temp °C Min	Air Temp °C Max	Air Temp °C Min	Weather
01-Aug-06	9:00	0.31					mostly cloudy
	20:15	0.305	13	9	17	6	mostly clear
02-Aug-06	9:00	0.3					clear patches, cold and windy
	20:00	0.295	12	9	17	4.5	mostly clear
03-Aug-06	8:30	0.285					mostly clear
	20:30	0.275	12	7	13	-3	mostly clear, rain earlier
04-Aug-06	8:45	0.275					completely clear
	20:00	0.265	13.5	6	19.5	-4.5	scattered high clouds
05-Aug-06	8:30	0.26					overcast, light sprinkles
	20:00	0.26	13.5	9	15	3.5	mostly cloudy
06-Aug-06	9:00	0.255					partly sunny
	20:10	0.25	12.5	9	17	1	partly cloudy
07-Aug-06	9:00	0.245					light overcast
	20:00	0.245	10	7.5	13	-3	overcast drizzle
08-Aug-06	9:00	0.25					rain overnight, clear
	20:30	0.255	13.5	8.5	18	-3	overcast drizzle
09-Aug-06	9:00	0.285					overcast drizzle
	20:30	0.285	12.5	9	13	4.5	mostly cloudy
10-Aug-06	9:00	0.275					clear patches
	20:30	0.275	13	9	16.5	4	some clearing
11-Aug-06	8:45	0.265					mostly cloudy
	20:15	0.255	13	8	17	-2	mostly clear
12-Aug-06	8:15	0.25					mostly cloudy
	20:00	0.245	13.5	8.5	14.5	0.5	mostly clear
13-Aug-06	9:00	0.24					overcast light rain
	20:00	0.24	12.5	8.5	16.5	2	overcast raining
14-Aug-06	8:45	0.24					overcast rain in early morning
	20:15	0.24	12	8.5	15	3	mostly clear rain earlier
15-Aug-06	8:45	0.24					partly sunny
	20:00	0.23	12	9	18.5	1	mostly clear
16-Aug-06	9:00	0.23					mostly sunny
	20:00	0.23	13	7	19.5	-2.5	mixed sun and clouds
17-Aug-06	9:15	0.225					completely clear
	19:30	0.225	14.5	8.5	23	0	mostly clear
18-Aug-06	8:45	0.225					mostly cloudy
	19:45	0.225	14	9.5	18	7	mostly clear
19-Aug-06	9:15	0.22					completely clear
	19:45	0.22	13.5	7.5	20	-3	completely clear
20-Aug-06	9:00	0.215					completely clear
	20:00	0.215	13	7	23	-5	clear
21-Aug-06	9:15	0.21					high overcast
	19:30	0.205	13	8.5	22.5	-3.5	scattered clouds
22-Aug-06	9:15	0.2					clear patches
	20:30	0.195	12.5	8.5	16	-0.5	mostly clear

Date	Time	Staff Gauge	Water Temp °C	Water Temp °C	Air Temp °C	Air Temp °C	Weather
		(m)	Max	Min	Max	Min	
23-Aug-06	9:00	0.195					mostly sunny
	20:00	0.19			19	-1	mostly cloudy
24-Aug-06	9:00	0.19					mostly clear
	20:00	0.185			19	5	clear
25-Aug-06	9:30	0.185					broken clouds
	20:00	0.185			16	-3.5	cloudy
26-Aug-06	9:00	0.19					partly cloudy
	20:30	0.185			21.3	-4.1	thin overcast at night
27-Aug-06	9:30	0.185					thin cloud
	19:20	0.185			21.3	-2.5	overcast, raining
28-Aug-06	10:00	0.185					overcast
	19:45	0.205			14.5	3.1	mostly cloudy
29-Aug-06	9:00	0.21					overcast
	20:00	0.21			12	0.5	cloudy, beginning to clear
30-Aug-06	9:15	0.21					foggy, clear above
	21:00	0.205			13	0	mostly clear
31-Aug-06	9:30	0.2					overcast
	21:00	0.2			8.5	-1.5	overcast, light rain most of the day
01-Sep-06	9:30	0.195					overcast
	21:00	0.195			16.5	6	mostly clear
02-Sep-06	8:45	0.195					mostly cloudy
	20:00	0.195			11	-1.5	overcast
03-Sep-06	8:30	0.195					completely clear
	20:00	0.195			21.5	1	clear
04-Sep-06	9:00	0.195					clear and sunny
	20:00	0.195			27	-2.6	mostly clear
05-Sep-06	9:00	0.19					mostly sunny
	20:00	0.19			20.5	-2	mostly clear
06-Sep-06	8:45	0.19					clear with high overcast
	19:45	0.185			18.5	-4	clear
07-Sep-06	9:15	0.18					high overcast, clearing
	19:30	0.18			20	-3.5	overcast
08-Sep-06	9:15	0.18					mostly clear, high thin clouds
	20:15	0.175			19	5	mostly cloudy some clear patches
09-Sep-06	8:45	0.175					clear
	19:45	0.175			16.5	0.5	mostly cloudy
10-Sep-06	8:45	0.17					overcast, light rain
	20:15	0.175			12	5	light rain most of day, clear tonight
11-Sep-06	9:15	0.175					overcast
	21:00	0.18			12	0.5	partly clear
12-Sep-06	9:00	0.175					a few clear patches
	21:00	0.175			12.5	-2	mostly clear
13-Sep-06	9:15	0.17					fairly low cloud cover
	20:50	0.17			10	0	mostly cloudy
14-Sep-06	9:15	0.175					high cloud cover
	20:45	0.175			7	-1	partly clear

Continued							
Date	Time	Staff Gauge	Water Temp °C	Water Temp °C	Air Temp °C	Air Temp °C	Weather
15-Sep-06	9:30	0.175					overcast, light snow around
	20:30	0.175			3	-9.5	cloudy
16-Sep-06	9:30	0.17					fairly high clouds
	20:15	0.17			6	-1	fairly high clouds
17-Sep-06	8:40	0.17					partly cloudy
	20:45	0.17			9	-3.7	cloudy, light rain
18-Sep-06	9:30	0.17					low cloud cover
	20:30	0.17			8	2	cloudy, light rain
19-Sep-06	9:30	0.17					50% clear
	20:30	0.17			13.5	-2	partly clear
20-Sep-06	9:00	0.17					low cloud, light rain
	20:00	0.17			9	2.5	overcast, drizzle
21-Sep-06	9:00	0.17					clear patches
	20:00	0.17			11	2	partly clear
22-Sep-06	9:00	0.175					overcast, drizzle
	20:00	0.175			4.5	-2.5	overcast, drizzle
23-Sep-06	8:45	0.17					mostly cloudy, light mist
	20:00	0.17			13	3.5	overcast, some breaks
24-Sep-06	9:00	0.165					overcast
	20:00	0.185			11.5	7	overcast
25-Sep-06	9:00	0.215					mostly cloudy
	20:00	0.24			10	6	mostly cloudy
26-Sep-06	9:30	0.24					foggy, partly clear above fog
	20:00	0.235			14	0	partly clear
27-Sep-06	9:00	0.23					mostly cloudy
	19:45	0.23			18	4.5	light rain
28-Sep-06	9:30	0.23					mostly cloudy
	19:30	0.23			11	5	overcast, drizzle
29-Sep-06	9:00	0.235					overcast, drizzle
	19:30	0.235			10	5	overcast, drizzle
30-Sep-06	9:00	0.245					mostly cloudy
	19:30	0.24			9	-0.5	some clearing