Results of the Upper Sustut River Weir Steelhead Assessment Project 2007

Dean Peard[1]

British Columbia
Ministry of Environment
Fisheries Branch
Skeena Region
PO Box 5000
Smithers, B.C.
V0J 2N0

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Executive Summary

In 2007, 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 0.105 m to 0.235 m with a mean level of 0.161 m. Water temperatures ranged from 3.26°C to 15.57°C with a mean of 8.81°C.

Two hundred and sixty three adult steelhead were enumerated between August 1 and September 30, 2007. This is the second lowest recorded value for steelhead since the fence location and method was standardized in 1994. The three fence counts prior to 1994 were greater than 400 steelhead. The mean number of steelhead from1994 to 2006 is 651. The previous low count was 133 in 2006. Water conditions precluded a visual count immediately prior to fence removal. Based on a count conducted on September 25 the fence crew estimates there were 55 steelhead remaining in the fence pool when the fence was dismantled. Two hundred and sixty three represents 25.4% 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 Yield*) (Tautz *et al.* 1992). Other species enumerated in 2007 include: rainbow trout (n =3), bull trout (*Salvelinus confluentus*) (n=11), Rocky Mountain whitefish (*Prosopium williamsoni*) (n=29), chinook salmon (*O. tshawytscha*) (n=721), sockeye salmon (*O. nerka*) (n=2469) and coho salmon (*O. kisutch*) (n=48). The first steelhead was captured on August 13, and the last steelhead was captured on September 30.

Gillnet marks were observed on 2.7% of all steelhead enumerated during the 2007 project. The ratio of female to male steelhead that migrated past the fence was 1.39:1. 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. To minimize the potential for stressing steelhead, in a year of low abundance, biological parameters and steelhead scale samples for annual ageing analysis were not collected in 2007.

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1.0 Introduction

Upper Sustut River steelhead are a unique population within the Skeena River watershed (Baxter 1997). Over-wintering, spawning and rearing occur at 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 intercepted in marine commercial fisheries for sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon where they susceptible 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 catch and release 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 and char 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 remain until a gate is 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 are typically 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 used 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 gillnet marks, tags, wounds and general condition.

Figure 1. Location of Sustut River

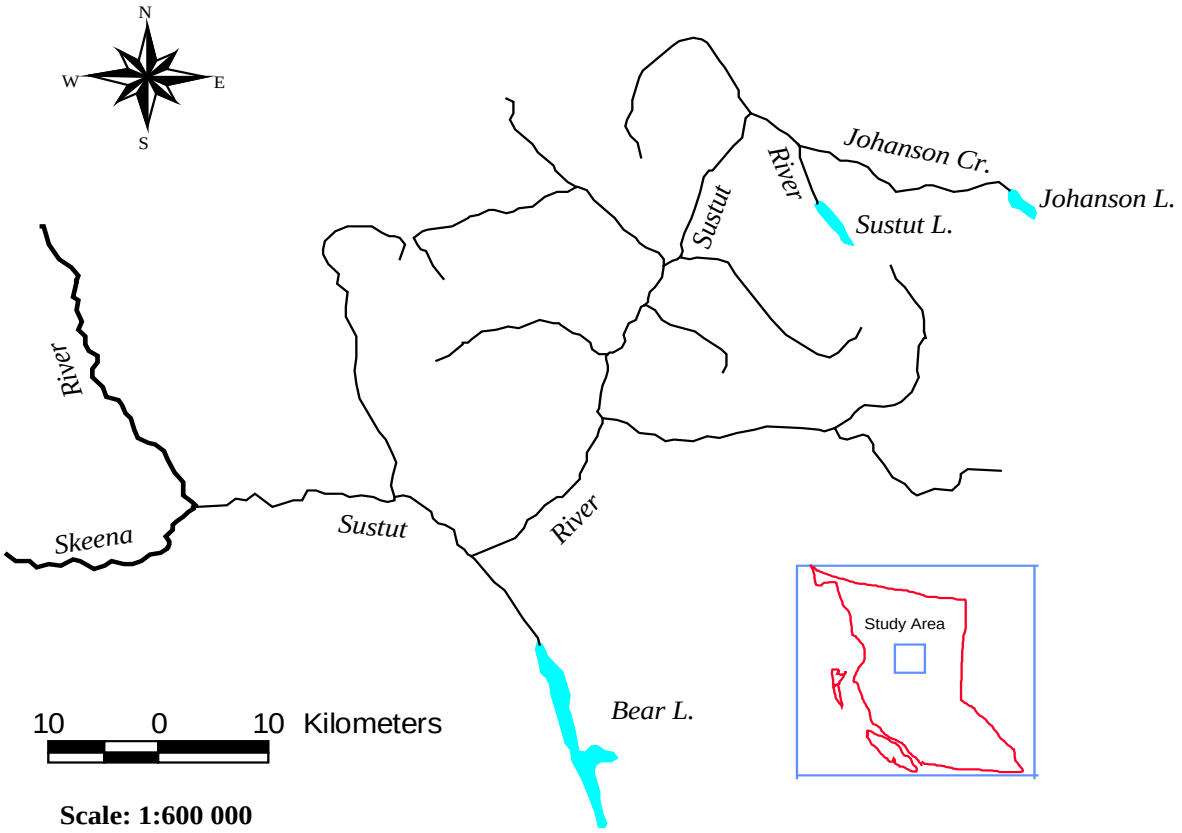

Figure 2. Map of Sustut River and tributaries.

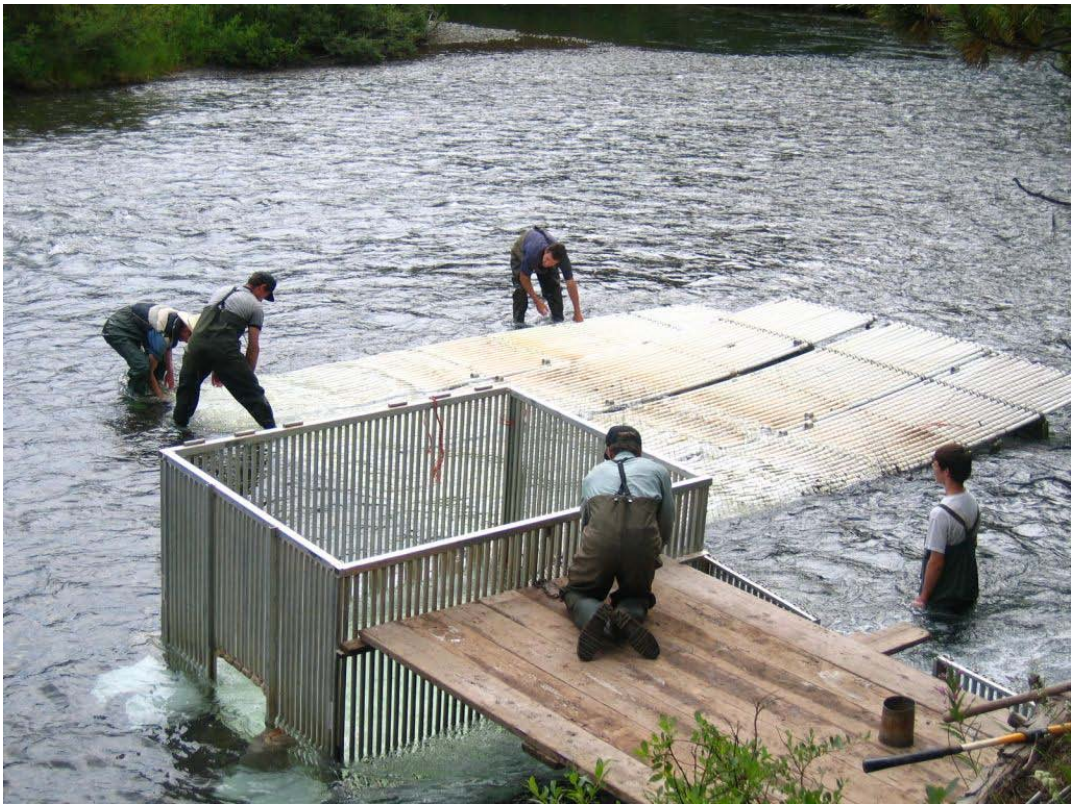

Figure 3. Photograph steelhead enumeration fence assembly (a) and fence in operation. b), 2008. Courtesy of Brome and Leaf Steffey.

3.2 Steelhead Migration and Physical Data

Stream water temperatures were recorded manually each day using a minimum-maximum thermometer (Brannon Ltd). Also, Optic Stowaway temperature data loggers (Onset Computer Corporation, Pocasset, MA) were deployed in the river and a tree near the fence site to record hourly water and air temperatures. Water levels were recorded in the morning and the evening using a metric staff gauge. Weather conditions were also recorded daily by the fence crew. 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, 2007, 263 steelhead migrated past the upper Sustut River fence (Table 1; Appendix Table 1). Approximately 55 steelhead were in the pool immediately downstream of the fence, prior to removal, resulting in a total count of 318 steelhead. The standardized count of 263 represents the second lowest recorded value since the current fence

location was established in 1994. Two hundred and sixty three represents 25% of the estimated carrying capacity (1036) for the upper Sustut River steelhead population (Tautz *et al.* 1992). Prior to 2007, the lowest recorded fence count was 133 in 2006 (Fig 4). The 13 year mean fence count (1994-2006) is 651.

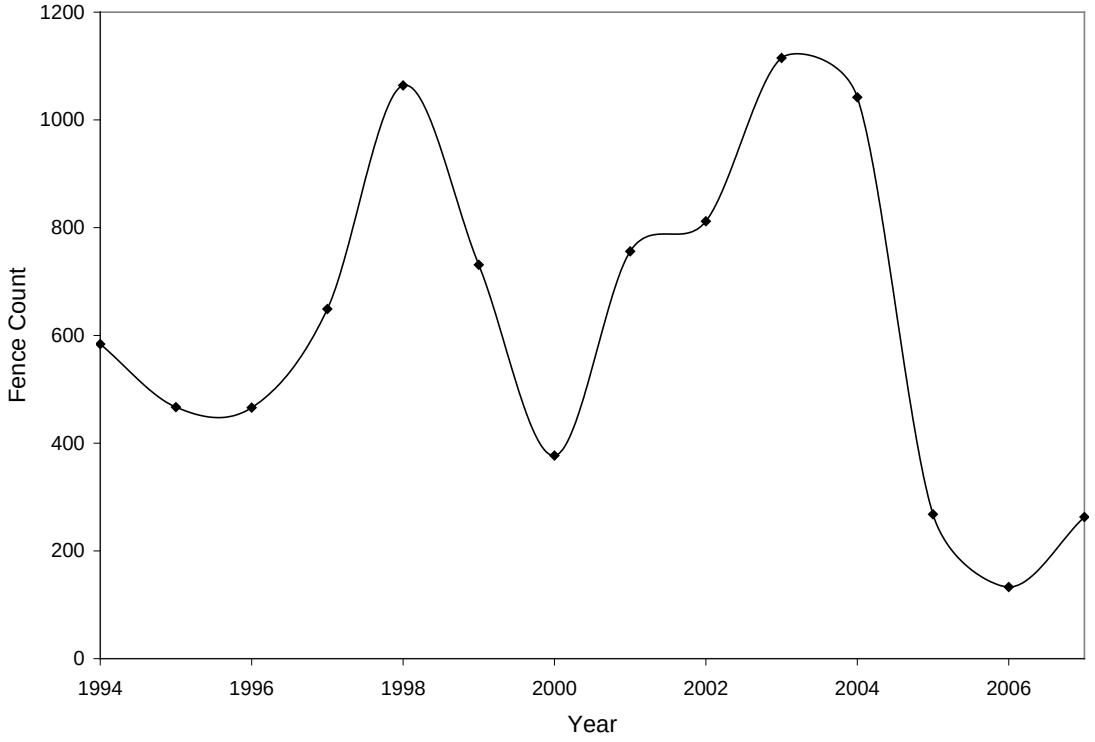

Figure 4. Annual fence count 1994-2007

The first steelhead migrated through the fence on August 13 and by September 9, 50% of the steelhead enumerated in 2007 had passed the fence (n=132) (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 2007. Since 1994, the date on which the first steelhead arrived has ranged between July 28 (2004) and August 17 (1999). The mean date of arrival is August 8 (SD=5.5) 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=5.5). 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=2.6) (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 2007.

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	14
2007	Sep-09	132	263	13
Earliest 50% Migration Date	Aug-29	Minimum Count	133	
Latest 50% Migration Date	Sep-17	Maximum Count	1115	
		Mean Count	690	

Graphical analysis of the cumulative proportional distribution of steelhead over time shows that, in 2007, almost half of the steelhead migration occurred in a four day period (Fig 5). On September 5 (n=28), September 9 (n=59), September 10 (n=15) and September 27 (n=23) a total of 125 or 47.5% of the total index were counted. The daily steelhead count ranged from 0 to 59, and steelhead were counted on 37 days of the 61 day project. In comparison, from 2002 through 2006, the mean number of days steelhead were counted during the 61 day project was 39.6 (SD=5.8). During this time period the fence count ranged from 133 to 1115 (Table 1).

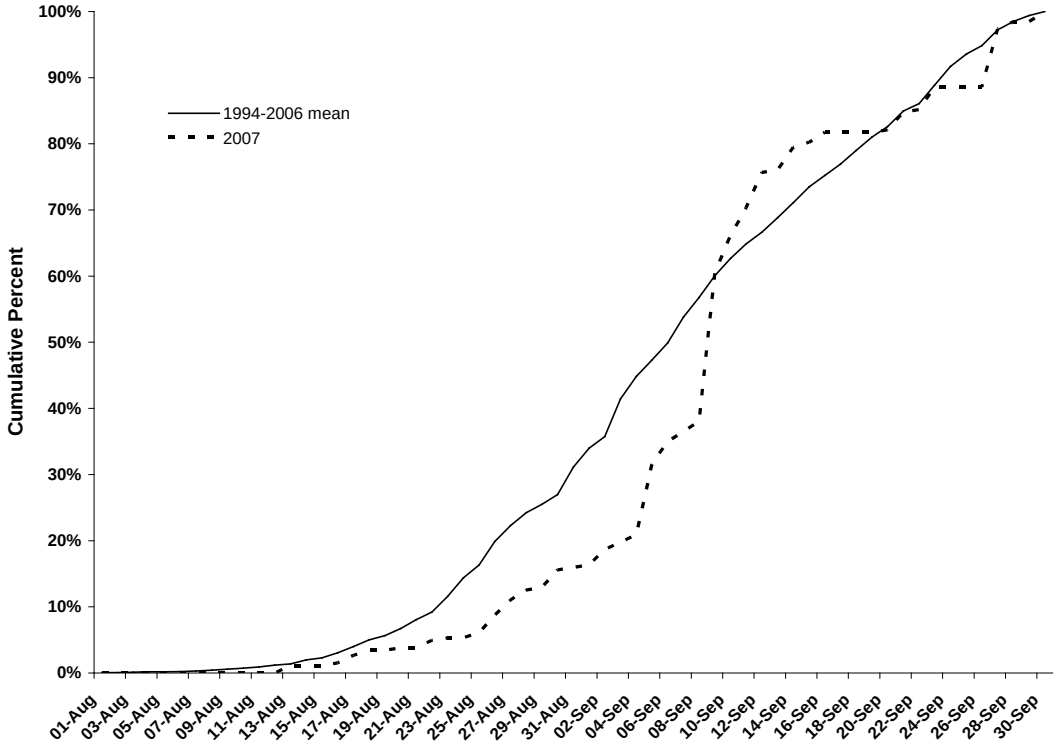

Figure 5. Daily cumulative percentage of upper Sustut River steelhead migrating past the fence for the years 2007.

4.2 Steelhead Ageing and Tagging Information

Prior to 2002, all steelhead captured in the trap box were marked via Anchor-T tag 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 2007.

Until 2006 the fence staff attempted to collect biological information samples from approximately 20% of all steelhead captured at the fence. This information included length data and scale samples for ageing purposes. Since 2006 steelhead abundance has been well below average. Therefore, the decision has been made to suspend steelhead handling until such a time that abundance levels increase. Therefore, there is no ageing information available for the 2007 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, 2007. Water temperature was recorded hourly providing 1,464 data points for analysis. Overall, the highest temperature was recorded on August 5 (15.57°C) and the lowest was recorded on September 29 (3.26°C). The mean temperature during the 2007 project was 8.81°C. The lowest mean daily water temperature recorded when a steelhead was captured was 4.08°C on September 28. Daily minimum water temperatures are shown graphically in Appendix Figure 1. Mean water temperatures in 2004, 2005, 2006 and 2007 were 9.81°C, 8.81°C, 8.71°C and 8.81°C respectively. 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 89% (n=233) of the steelhead entering the trap box did so after the morning site visit. The remainder, 11% (n=30), 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 trap box cannot be determined. However, the data indicates that the majority of steelhead that entered the trap box 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.

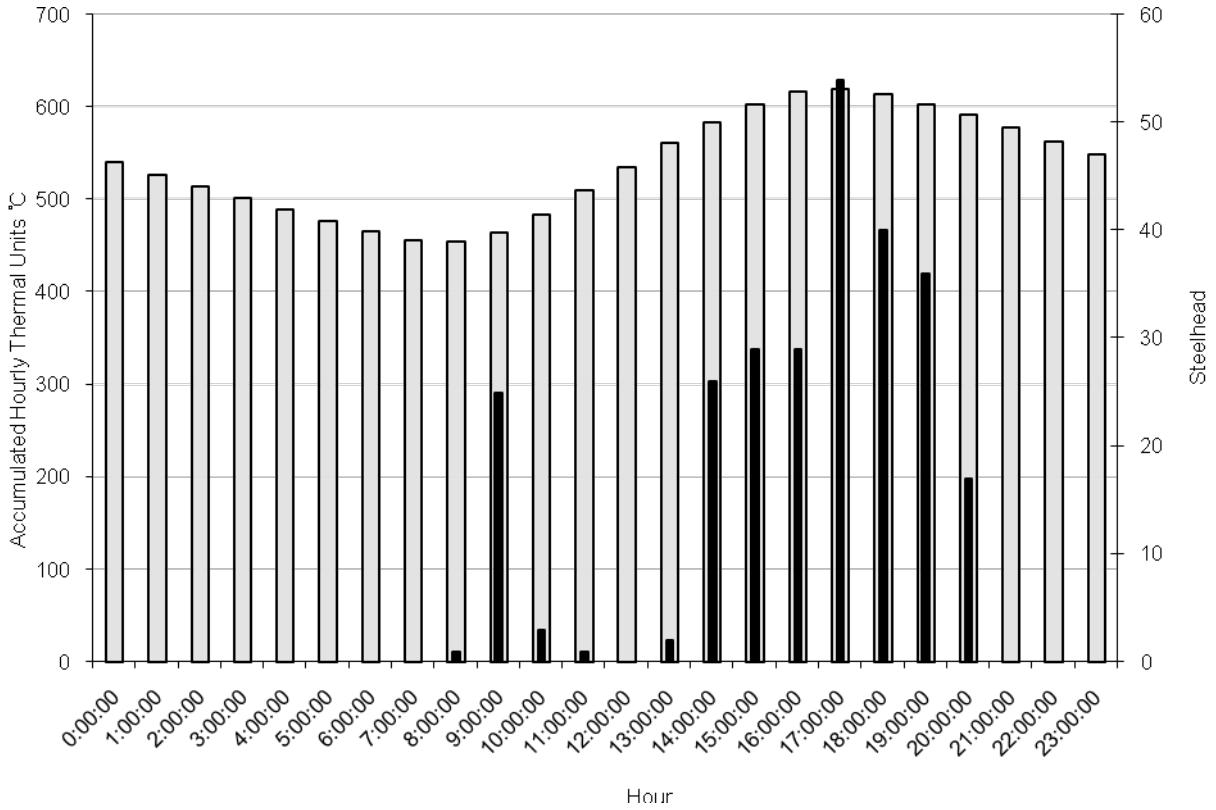

Figure 6. Water temperatures and steelhead migration stratified by hour
August 1- September 30, 2007

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 2007, water levels ranged between 0.11 m and 0.24 m. Steelhead entered the trap box in water levels ranging between 0.11 m and 0.24 m. The mean level was 0.16m and the standard deviation was 0.03. The highest water level was 0.24m measured on September 4, and the lowest level was 0.11m measured on September 20. Figure 7 shows the combined 2007 daily water levels and steelhead migration at the fence from August 1 to September 30.

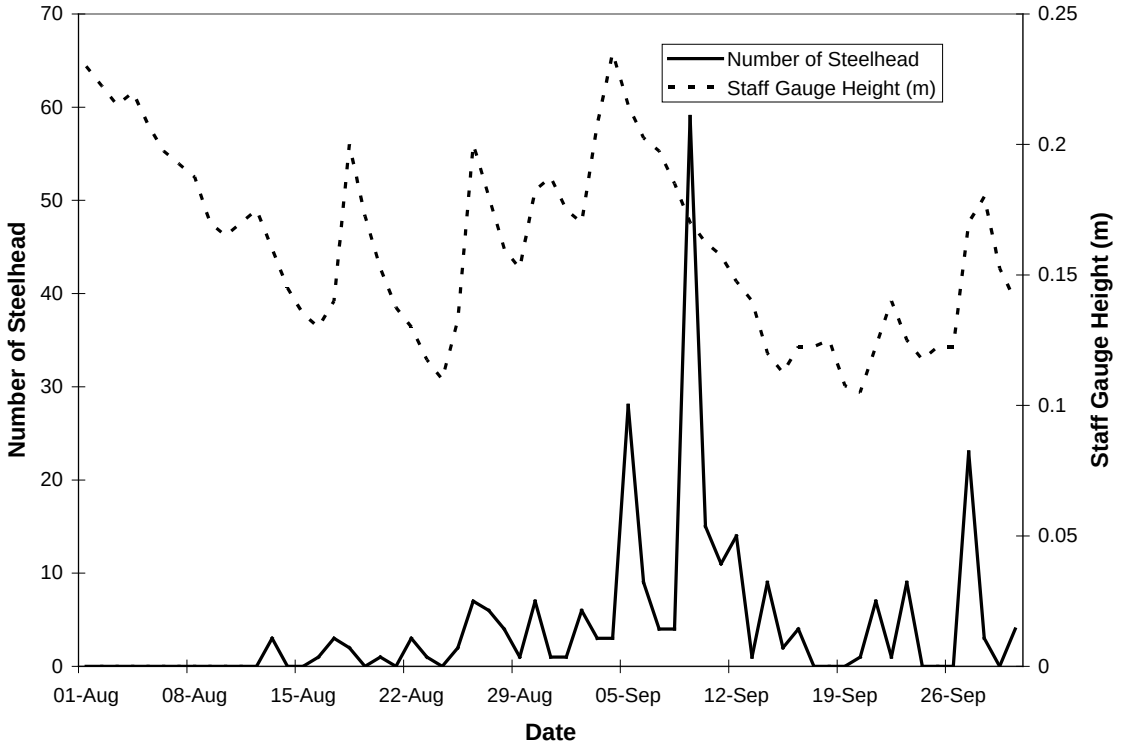

Figure 7. Daily staff gauge height and the number of steelhead migrating past the fence in 2007.

Comparing 2007 daily water level to steelhead migration into the trap box indicated a poor relationship between the variables (Fig.8). In 2007, the median water level was 0.16 m. During the project (28% n=75) steelhead entered the trap box when water levels were below 0.16 m, and (72% n=188) entered the trap box when water levels were above 0.16 m.

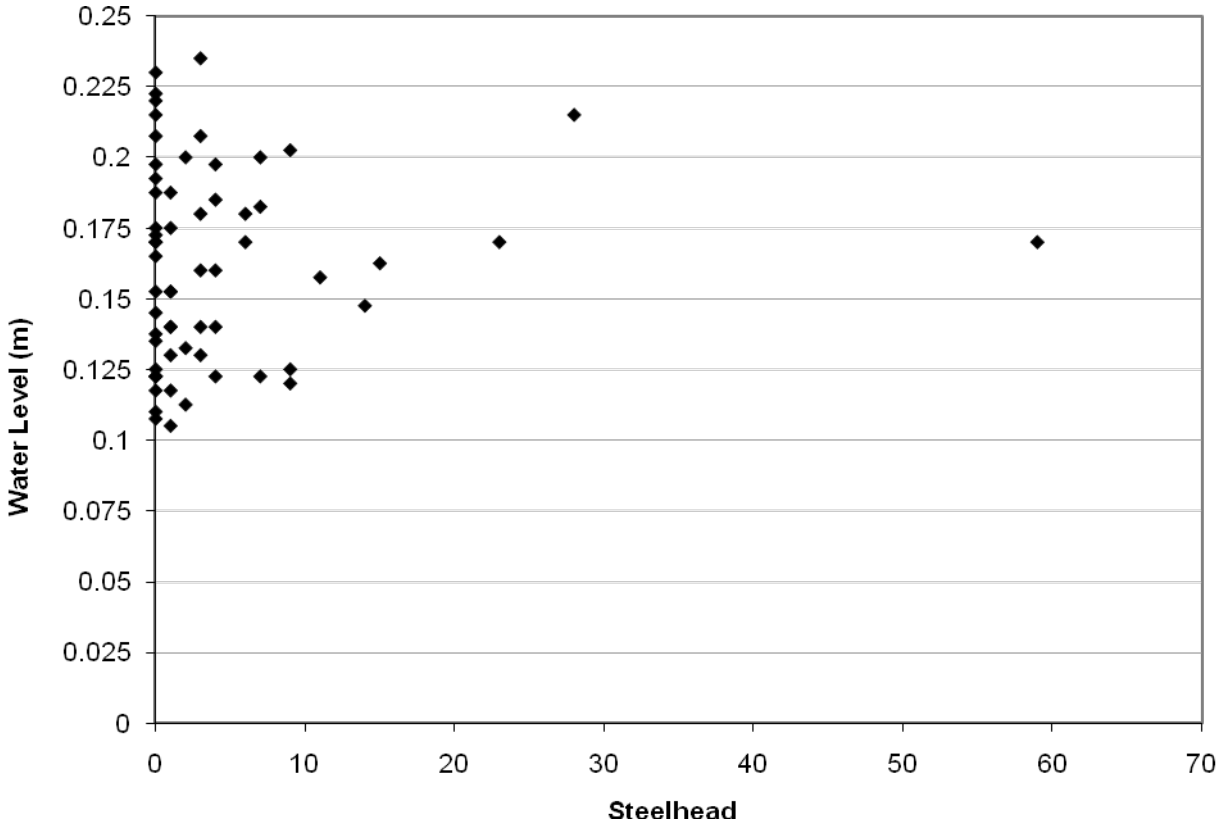

Figure 8. Water level vs. steelhead migration past the Sustut River enumeration weir 2007

Since 1998 the annual mean level from August 1 to September 30 has ranged between 0.34 m (2004) and 0.16 m (2007). The mean water level in this nine year period is 0.27 m (SD=0.05). Figure 9 compares the mean annual water level and fence count. The R^2 value (0.25) indicates that there is not a strong linear relationship between annual water level and fence count.

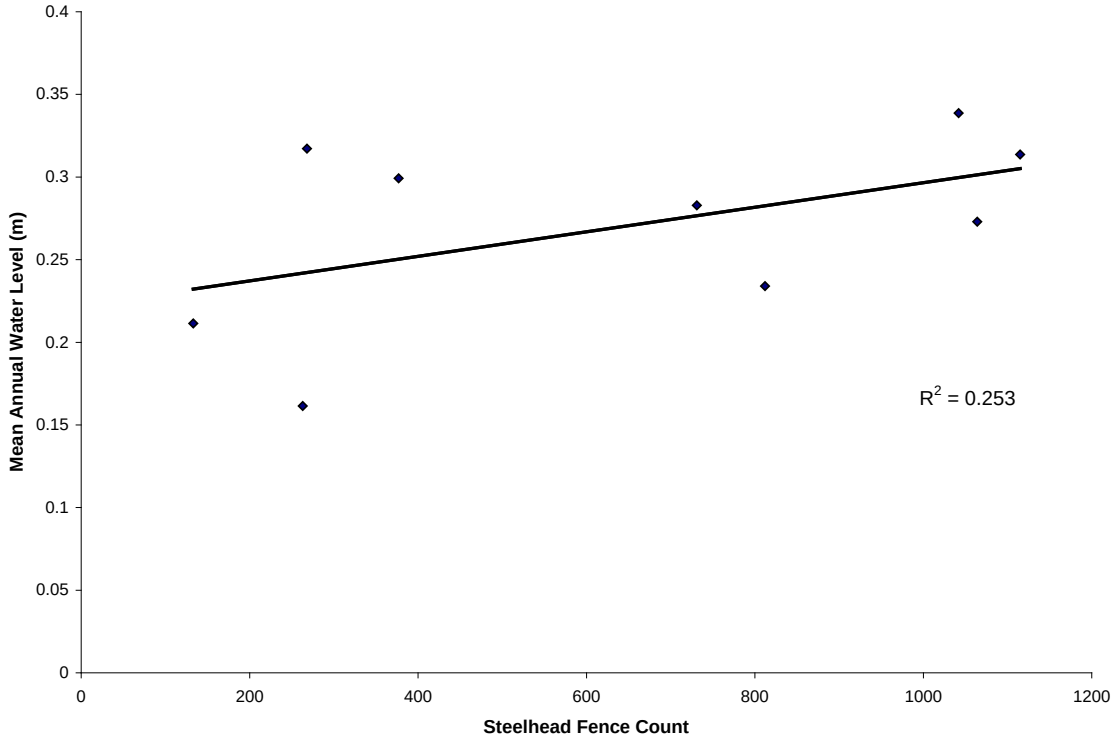

Figure 9. Annual water level vs. steelhead fence count 1998-2007

4.4 Steelhead Sex Ratio

Of the 263 steelhead counted migrating through the fence, 110 (42%) were male and 153 (58%) were female resulting in a female to male ratio of 1.39:1. Since 2004, the female to male sex ratio has ranged between 1.39:1 (2007) and 2.01:1 (2004).

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 3.8% (n=10) of all steelhead that migrated past the fence. Seven of the steelhead observed with net marks were female and three were male.

4.6 Male and Female Steelhead Run Timing

The first female steelhead passed through the fence on August 13, and the first male steelhead migrated upstream on August 16 (Fig 10). The median migration date for males was September 9 and the median date for females was September 9. 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).

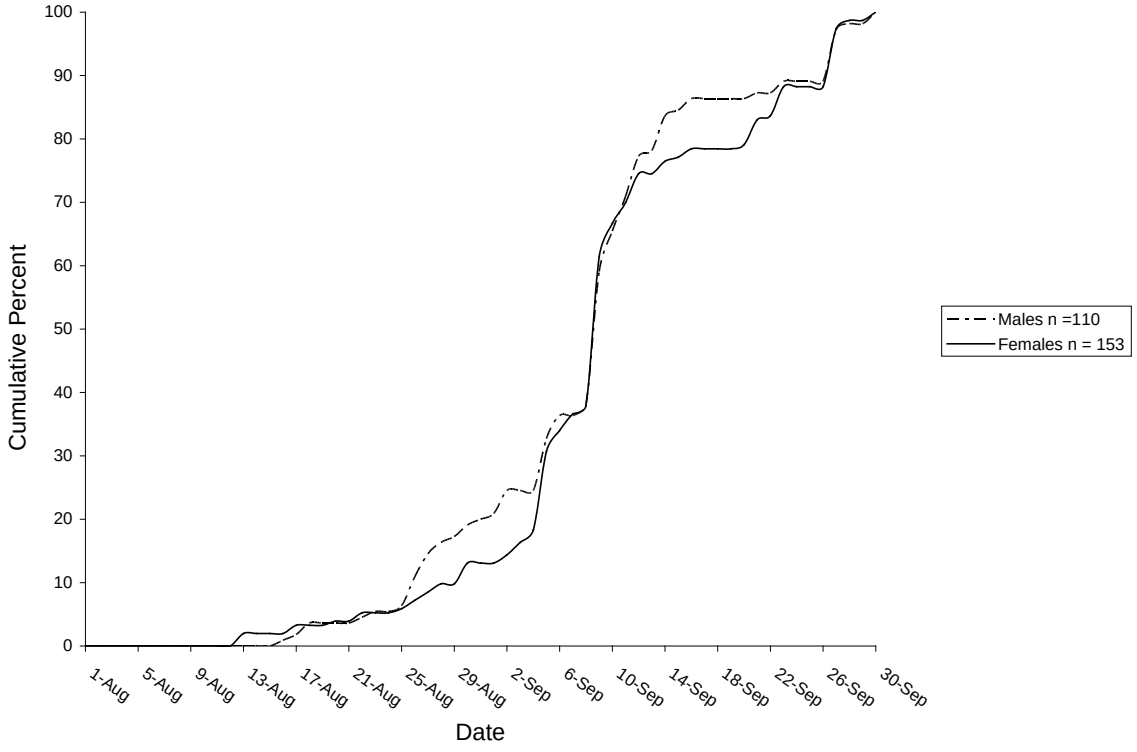

Figure 10. Daily cumulative percent of male and female steelhead migrating past the fence 2007.

5.0 Discussion

Johnston *et al.* 2002 describes a framework that establishes reference points to represent steelhead stock status. The conservation concern threshold (CCT) or precautionary threshold (PT) is identified as spawner abundance levels at 25% of maximum recruitment. Since 2005, annual fence counts combined with visual counts have resulted in aggregate counts at or near the PT. Spawner abundance below this PT is described as a conservation concern and the productivity of the population is impaired. The 2007 upper Sustut River steelhead fence count to September 30 was 263. Early steelhead data suggested that the

index could be poor. As a result of the low numbers, ageing and length data were not collected to reduce potential handling mortalities. Two hundred and sixty three represents the second lowest recorded count since methods were standardized in 1994 (Table 3). Approximately 55 steelhead were observed downstream of the fence prior to its removal. The sum of the 2007 fence count and steelhead observed downstream of the fence prior to removal, results in an abundance estimate of 318. 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 2007[3].

Year	Date of First Steelhead	Date of 50% Migration	Count	Average Length (cm) M	Average Length (cm) F	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
2007	9-Aug	9-Sep	263	N/A*	N/A*	N/A*	0.004	2.7	4.6	3.8
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			623	829	744	N/A*				

One steelhead mortality was found by the fence crews in 2007. The steelhead was found deceased in the trap box.

In 2007, 58% of the steelhead migrating past the fence were female and 42% were male. These results suggested a sex ratio of 1.39:1 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, 2006). The mean ratio during this time period is 1.58: 1 SD=0.21.

[3] Due to the low numbers of steelhead in 2006 and 2007, length, ageing and genetic information was not collected.

In 2007, 3.8% 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).

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 this stock.

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 three years, the values recorded at the upper Sustut River index have been poor. If 2007 fence counts are representative of the 2008 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, 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.

Mark Beere directed this study and provided editorial reviews and valuable comments for the final draft.

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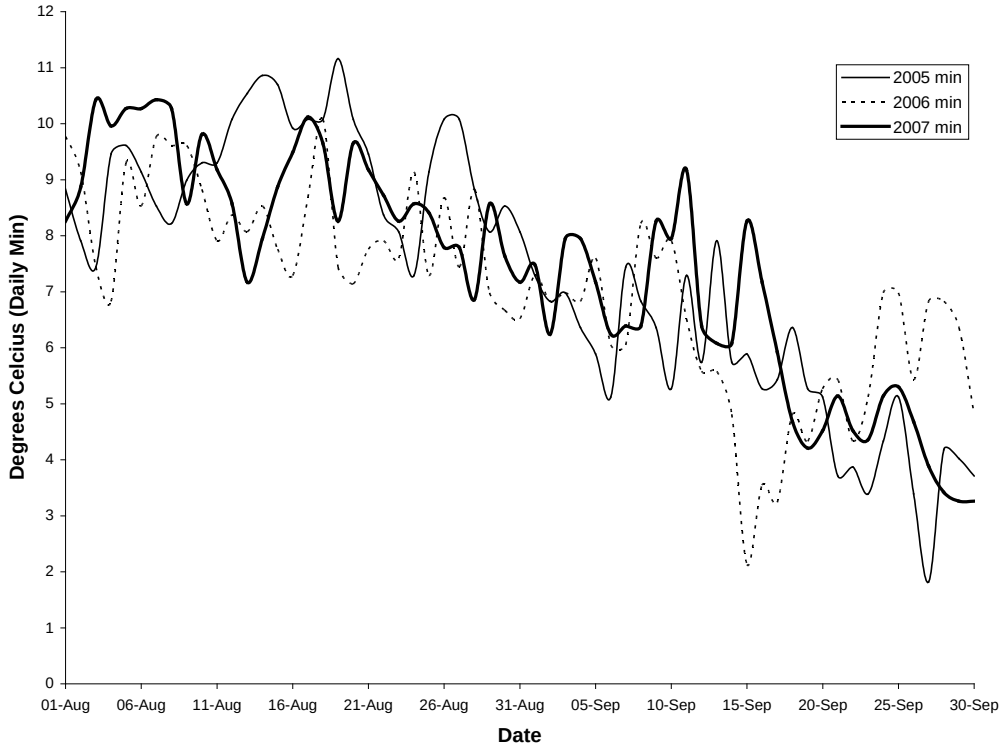
Appendix Figures



Appendix Figure 1. Daily minimum water temperatures at the Sustut River fence 2005, 2006 and 2007.

Appendix Tables

Appendix Table 1. Daily and cumulative totals for non salmon species, 2007.

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	0	0
2-Aug	0	0	0	0	0	0	0	0
3-Aug	0	0	0	0	0	0	0	0
4-Aug	0	0	0	0	0	0	0	0
5-Aug	0	0	0	0	0	0	2	2
6-Aug	0	0	0	0	3	3	0	2
7-Aug	0	0	0	0	0	3	2	4
8-Aug	0	0	0	0	0	3	0	4
9-Aug	0	0	0	0	0	3	0	4
10-Aug	0	0	0	0	0	3	0	4
11-Aug	0	0	0	0	0	3	0	4
12-Aug	0	0	0	0	1	4	0	4
13-Aug	3	3	0	0	0	4	2	6
14-Aug	0	3	0	0	0	4	0	6
15-Aug	0	3	0	0	2	6	0	6
16-Aug	1	4	1	1	0	6	0	6
17-Aug	3	7	0	1	0	6	1	7
18-Aug	2	9	0	1	0	6	1	8
19-Aug	0	9	0	1	0	6	2	10
20-Aug	1	10	0	1	0	6	0	10
21-Aug	0	10	0	1	0	6	1	11
22-Aug	3	13	0	1	0	6	2	13
23-Aug	1	14	0	1	0	6	2	15
24-Aug	0	14	0	1	0	6	0	15
25-Aug	2	16	0	1	0	6	1	16
26-Aug	7	23	0	1	0	6	0	16
27-Aug	6	29	0	1	0	6	0	16
28-Aug	4	33	0	1	0	6	0	16
29-Aug	1	34	0	1	1	7	2	18
30-Aug	7	41	0	1	0	7	0	18
31-Aug	1	42	0	1	0	7	0	18
1-Sep	1	43	0	1	0	7	0	18
2-Sep	6	49	0	1	0	7	1	19
3-Sep	3	52	0	1	0	7	2	21
4-Sep	3	55	1	2	0	7	1	22
5-Sep	28	83	1	3	0	7	0	22
6-Sep	9	92	0	3	0	7	0	22
7-Sep	4	96	0	3	0	7	0	22
8-Sep	4	100	0	3	0	7	1	23
9-Sep	59	159	0	3	1	8	1	24

Date	ST Daily	ST Cumulative	RB Daily	RB Cumulative	BT Daily	BT Cumulative	WF Daily	WF Cumulative
10-Sep	15	174	0	3	0	8	0	24
11-Sep	11	185	0	3	0	8	0	24
12-Sep	14	199	0	3	0	8	3	27
13-Sep	1	200	0	3	0	8	0	27
14-Sep	9	209	0	3	1	9	0	27
15-Sep	2	211	0	3	0	9	1	28
16-Sep	4	215	0	3	0	9	0	28
17-Sep	0	215	0	3	0	9	0	28
18-Sep	0	215	0	3	1	10	1	29
19-Sep	0	215	0	3	0	10	0	29
20-Sep	1	216	0	3	0	10	0	29
21-Sep	7	223	0	3	0	10	0	29
22-Sep	1	224	0	3	1	11	0	29
23-Sep	9	233	0	3	0	11	0	29
24-Sep	0	233	0	3	0	11	0	29
25-Sep	0	233	0	3	0	11	0	29
26-Sep	0	233	0	3	0	11	0	29
27-Sep	23	256	0	3	0	11	0	29
28-Sep	3	259	0	3	0	11	0	29
29-Sep	0	259	0	3	0	11	0	29
30-Sep	4	263	0	3	0	11	0	29

Appendix Table 2. Steelhead sampling data from the Sustut River fence, 2007.

Date	Time	Sex	GN	Comments, Scars?
Aug 13	15:30	F		
	19:30	F		
	20:00	F		
Aug 16	17:00	M	yes	
Aug17	9:15	F		
	17:15	F		
	19:45	M		
Aug 18	9:30	M		
	11:45	M		
Aug 20	9:00	F		
Aug 22	9:15	M		pale, rough shape
		F		
	15:45	F		very large
Aug 23	21:00	M		
Aug 25	9:30	M		pale, a few marks
	20:15	F		clean
Aug 26	17:00	M		very large, hook in side of mouth
	20:00	M		
		M		
		M		
		M		
		F		
	20:30	F		
Aug 27	9:30	M		
		F		wound on left side of nose, possibly from a hook
	16:45	M		
		M		
		F		
	18:30	M		
Aug 28	16:30	M		
		M		
		F		
		F		
Aug 29	13:45	M		
Aug 30	9:30	M		
		F		
		F		
	16:00	M	yes	
		F		
		F		
	17:30	F		
Aug 31	16:30	M		
Sep 1	20:00	M		
Sep 2	17:00	M		
		M		

Date	Time	Sex	GN	Comments, Scars?
		F		
		F		
	18:00	M		
		M		
Sep 3	9:30	F		
		F		
		F		
Sep 4	16:30	F		
		F		
		F		
Sep 5	9:30	M		
		M		
	15:15	M		
		M		
		M		
		M		
		M		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
	18:45	M		
		M		
		F		
		F		
		F		
		F		
Sep 6	9:30	M		
		F		
	19:45	M		
		M		
		M	yes	
		F		
		F		
		F		
		F		
Sep 7	16:00	F		
		F		

		F		
Date	**Time**	**Sex**	**GN**	**Comments, Scars?**
	17:45	F	yes	
Sep 8	15:30	M		
		F		
		F		
	20:15	M		
Sep 9	9:15	F		
	14:15	M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		F		
		F		
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		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
	17:30	M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		M		
		F		
		F		
		F		
		F		

		F		
		F		
Date	**Time**	**Sex**	**GN**	**Comments, Scars?**
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
	20:00	M		
		F		
		F		
		F		
Sep 10	13:45	M		
	17:00	M		
		M		
		M		
		M		
		M		
		M		
		F		
		F		
		F		
		F		
		F		
		F		
		F	yes	
	19:45	F		
Sep 11	8:45	F	yes	
	16:15	M		
		M		
		M		
		M		
		F		
		F		
		F		
		F		
		F		
	19:45	M		
Sep 12	15:30	M		
	18:21	M		
		M		
		M		
		F		
		F		
		F		

		F		
	20:30	M		
		M		
Date	**Time**	**Sex**	**GN**	**Comments, Scars?**
		M		
		F		
		F		
		F		
Sep 13	19:45	M		
Sep 14	9:15	M		
		F		
	16:15	M		
		M		
		M		
		M		mark on top of head
		F		
		F		wound on left side
	20:15	M		
Sep 15	9:15	M		
		F		
Sep 16	17:12	M		
		M		
		F		
		F		
Sep 20	20:15	F	yes	
Sep 21	19:45	M		
		F		
		F		
		F		
		F		
		F		
		F		
Sep 22	9:45	F		
Sep 23	19:45	M		
		M		
		F		
		F		
		F		
		F		
		F		
		F		
		F		
Sep 27	10:00	M		
		F		
		F	yes	
	18:30	M		
		M		
		F		
		F		
		F		

		F		
		F		
	18:45	M		
		M		
Date	**Time**	**Sex**	**GN**	**Comments, Scars?**
		M		
		M		
		M		
		F		
		F		
		F		
		F		
		F		
	19:00	M		
		F		
		F		
Sep 28	9:30	F		
	19:30	M		
		F		
Sep 30	18:00	M		
		M		
		F	yes	
		F	yes	

.

Appendix Table 3. Daily and cumulative total of chinook, sockeye and coho salmon migrating past the Sustut River fence, 2007.

Date	Chinook		Sockeye		Coho	
	Daily	Cum	Daily	Cum	Daily	Cum
01-Aug	4	4	0	0	0	0
02-Aug	7	11	0	0	0	0
03-Aug	20	31	0	0	0	0
04-Aug	41	72	0	0	0	0
05-Aug	34	106	0	0	0	0
06-Aug	45	151	0	0	0	0
07-Aug	64	215	0	0	0	0
08-Aug	55	270	0	0	0	0
09-Aug	47	317	3	3	0	0
10-Aug	80	397	5	8	0	0
11-Aug	46	443	22	30	0	0
12-Aug	34	477	27	57	0	0
13-Aug	53	530	105	162	0	0
14-Aug	44	574	126	288	0	0
15-Aug	24	598	192	480	0	0
16-Aug	26	624	222	702	0	0
17-Aug	28	652	520	1222	2	2
18-Aug	33	685	364	1586	0	2
19-Aug	8	693	193	1779	1	3
20-Aug	14	707	102	1881	0	3
21-Aug	5	712	77	1958	0	3
22-Aug	3	715	37	1995	1	4
23-Aug	1	716	46	2041	0	4
24-Aug	0	716	17	2058	0	4
25-Aug	1	717	37	2095	0	4
26-Aug	0	717	30	2125	0	4
27-Aug	2	719	71	2196	2	6
28-Aug	0	719	54	2250	2	8
29-Aug	1	720	6	2256	2	10
30-Aug	0	720	18	2274	3	13
31-Aug	0	720	6	2280	2	15
01-Sep	0	720	8	2288	0	15
02-Sep	0	720	6	2294	1	16
03-Sep	0	720	12	2306	4	20
04-Sep	0	720	42	2348	7	27
05-Sep	1	721	7	2355	3	30
06-Sep	0	721	14	2369	0	30
07-Sep	0	721	24	2393	2	32
08-Sep	0	721	8	2401	2	34
09-Sep	0	721	18	2419	1	35
10-Sep	0	721	14	2433	1	36
11-Sep	0	721	8	2441	0	36
12-Sep	0	721	8	2449	0	36

continued	**Chinook**		**Sockeye**		**Coho**	
	Daily	Cum	Daily	Cum	Daily	Cum
13-Sep	0	721	1	2450	2	38
14-Sep	0	721	8	2458	4	42
15-Sep	0	721	1	2459	1	43
16-Sep	0	721	3	2462	2	45
17-Sep	0	721	2	2464	0	45
18-Sep	0	721	2	2466	0	45
19-Sep	0	721	1	2467	0	45
20-Sep	0	721	0	2467	0	45
21-Sep	0	721	0	2467	0	45
22-Sep	0	721	0	2467	0	45
23-Sep	0	721	0	2467	0	45
24-Sep	0	721	0	2467	0	45
25-Sep	0	721	0	2467	0	45
26-Sep	0	721	0	2467	0	45
27-Sep	0	721	2	2469	2	47
28-Sep	0	721	0	2469	0	47
29-Sep	0	721	0	2469	0	47
30-Sep	0	721	0	2469	1	48

Appendix Table 4. Daily staff gauge height, air and water temperature and weather conditions for the upper Sustut River, 2007.

Date	Time	Staff	Water Temp		Air Temp		Weather
		Gauge	Max	Min	Max	Min	
01-Aug	8:45	0.225					partly clear
	20:15	0.235	12.5	~	17.5	0	high thin cloud cover
02-Aug	9:00	0.23					clear
	20:30	0.215	13.5	11.5	22.5	-0.5	partly cloudy
03-Aug	9:00	0.215					partly clear
	20:30	0.215	12.5	11.5	22	5.5	mostly clear, a few storm clouds
04-Aug	9:00	0.225					foggy, clear above
	20:30	0.215	14.5	11.5	23.5	5.5	scattered clouds
05-Aug	9:15	0.21					clear
	20:30	0.205	16.5	11	24	3	clear
06-Aug	9:00	0.2					clear
	20:30	0.195	16.5	10	25	1	partly cloudy, 50/50
07-Aug	9:00	0.195					partly clear
	20:00	0.19	14.5	10.5	19.5	5	overcast, rain showers earlier
08-Aug	9:00	0.19					overcast, lt. rain last night
	20:30	0.185	13	11	15	6	clear patches
09-Aug	9:15	0.175					partly clear
	20:00	0.165	12.5	7.5	17.5	-1	overcast, raining
10-Aug	9:30	0.165					overcast
	20:30	0.165	13	11	15	5	mostly clear
11-Aug	9:15	0.165					overcast
	19:45	0.175	12	10	12	2	partly clear
12-Aug	8:45	0.175					overcast
	21:00	0.175	12	7	12	2	partly clear
13-Aug	9:15	0.165					clear
	20:30	0.155	12	7	17	-2.5	drizzle
14-Aug	9:15	0.15					mostly clear
	20:00	0.14	-	-	19	-2	partly clear
15-Aug	9:30	0.135					clear
	20:15	0.135	13	7	27	0	clear
16-Aug	9:30	0.13					clear
	20:30	0.13	14	10	27	1	clear
17-Aug	9:15	0.135					overcast, rain overnight
	20:00	0.145	13	10.5	15	3	overcast, raining - harder rain earlier
18-Aug	9:15	0.2					mostly overcast
	19:45	0.2	12.5	11.5	14	6	mostly clear
19-Aug	9:15	0.18					foggy in AM, clear
	20:45	0.165	12.5	7.5	21.5	-2	clear
20-Aug	9:00	0.155					partly clear
	20:30	0.15	12.5	11.5	14	6.5	mostly overcast
21-Aug	9:15	0.14					partly clear
	20:00	0.135	12.5	11.5	15.5	5	partly clear
22-Aug	9:15	0.13					clear
	20:30	0.13	12.5	11.5	20.5	1.5	partly clear, rain earlier
23-Aug	9:30	0.12					clear

Date	Time	Staff	Water Temp		Air Temp	Date	Weather
		Gauge	Max	Min	Max	Min	
	21:00	0.115	12.5	11.5	19	1	mostly clear
24-Aug	9:30	0.11					overcast
	20:30	0.11	12.5	10	10	0	overcast
25-Aug	9:30	0.115					overcast, raining
	20:15	0.15	10	10	11	5	drizzling rain
26-Aug	9:45	0.2					overcast, light rain
	20:30	0.2	10	8	11	3	mostly overcast
27-Aug	9:30	0.185					partly clear
	20:00	0.175	13	3??	18	3	clear patches
28-Aug	9:30	0.165					clear
	20:15	0.155	10	8	17	-3	overcast, light rain
29-Aug	9:15	0.15					overcast, light rain
	20:00	0.155	-	-	12	6	partly cloudy
30-Aug	9:30	0.17					partly clear, rain overnight
	20:30	0.195	9	8	13.5	2	clear
31-Aug	9:45	0.195					mostly cloudy, light rain
	20:00	0.18	10	7	16	1	partly clear
01-Sep	9:45	0.175					partly clear
	20:15	0.175	10	10	15	2	mostly clear
02-Sep	9:30	0.175					clear
	20:30	0.165	9	7	18	-1.5	overcast, rain earlier
03-Sep	9:30	0.19					overcast, raining, 1/2 inch overnight
	19:45	0.225	?	?	12.5	6	overcast, drizzle
04-Sep	9:30	0.24					partly clear
	20:00	0.23	?	?	9	3	mostly overcast, light rain
05-Sep	9:30	0.215					overcast
	20:45	0.215	10	9	12	5	cloudy
06-Sep	9:30	0.205					clear patches
	20:15	0.2	9	6	11.5	0	clear
07-Sep	9:30	0.2					mostly clear
	20:15	0.195	8	7	12	0	partly clear
08-Sep	9:15	0.185					high cloud cover
	20:15	0.185	9	6	15	-2	mostly clear
09-Sep	9:15	0.175					mostly clear
	20:15	0.165	12	10	18	7	clear
10-Sep	9:30	0.165					clear
	20:00	0.16	11	9	23	2	mostly clear
11-Sep	8:45	0.16					clear
	19:45	0.155	16	9	19.5	5	clear
12-Sep	9:00	0.15					completely clear
	20:30	0.145	9	6	19	-4	completely clear
13-Sep	9:00	0.145					completely clear
	20:00	0.135	9	7	21	-5	completely clear
14-Sep	9:15	0.125					clear
	20:15	0.115	9	7	20	-4.5	high cloud cover
15-Sep	9:15	0.115					overcast, light rain last night
	20:30	0.11	-	-	10	6	overcast, light rain (water thermometer no longer working)

Date	Time	Staff	Water Temp		Air Temp	Date	Weather
		Gauge	Max	Min	Max	Min	
16-Sep	9:30	0.115					partly clear, rain overnight, snow above treeline
	20:15	0.13	-	-	11	3	mostly cloudy
17-Sep	9:45	0.125					cloudy
	20:30	0.12	-	-	11	1	mostly clear
18-Sep	9:30	0.115					clear
	20:30	0.135	-	-	11.5	-3	mostly clear
19-Sep	9:45	0.105					overcast
	20:15	0.11	-	-	6	-5	light rain, snow up higher
20-Sep	9:45	0.105					cloudy
	20:15	0.105	-	-	9	0	cloudy
21-Sep	9:30	0.115					overcast, light rain
	19:45	0.13	-	-	5	1	overcast, light rain all day
22-Sep	9:45	0.145					partly clear, wet snow and rain overnight
	19:30	0.135	-	-	9	-1	mostly cloudy
23-Sep	9:00	0.125					partly clear
	19:45	0.125	-	-	9	-2	mostly cloudy
24-Sep	9:15	0.115					overcast, light rain
	19:45	0.12	-	-	7	2	overcast, light rain
25-Sep	9:45	0.12					overcast
	19:45	0.125	-	-	6	2	overcast, light rain
26-Sep	9:45	0.12					partly clear
	18:30	0.125	-	-	8	0	overcast, light rain
27-Sep	10:00	0.155					wet heavy snow, app. 1/2 inch accumulation
	19:15	0.185	-	-	4	0	overcast
28-Sep	9:30	0.185					partly clear, app. 1 inch snow overnight
	19:30	0.175	-	-	2	-1	mostly cloudy
29-Sep	9:45	0.155					overcast, partly clear earlier, dusting of snow overnight
	19:30	0.15	-	-	2	-2	lt. rain/snow
30-Sep	10:00	0.145					partly clear
	19:00	0.135	-	-	5	2	overcast, lt. rain