Enumeration of Adult Steelhead in the Upper Sustut River 2010

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Executive Summary

From August 1 to September 30, 2010, a floating PVC fish fence was in operation on the upper Sustut River. This fence is used as an annual indicator of adult steelhead (*Oncorhynchus mykiss*) abundance. One thousand fifty steelhead were enumerated during fence operation. This is the fourth highest recorded escapement and represents 101% of the estimated adult carrying capacity for the upper Sustut River.

The first steelhead migrated through the fence on August 3 and by September 6, 50% of the steelhead enumerated in 2010 had passed the fence (n=525). The last recorded fish travelled past the fence on September 30. The cumulative distribution of steelhead over time shows that from August 1 to September 30, half the steelhead crossing the Sustut fence did so during a seven day period. From September 1 to 7 a total of 531 or 51% of the total index was counted. During fence operation, the highest daily steelhead count was 181 (September 5). Steelhead were counted on 39 days of this 61 day project.

Of the 1,050 steelhead counted, 626 (60%) were female and 424 (40%) were male, resulting in a female to male ratio of 1.48:1. A total of 43 male and 65 female steelhead were measured for nose-fork length. Male lengths ranged from 660 to 935 mm and averaged 793 mm while female lengths ranged from 655 to 945 mm and averaged 746 mm. Male steelhead were found to be significantly larger than female steelhead.

Gillnet marks were present on 2.0% (n=21) of all steelhead that migrated past the fence. During the project, fish with gillnet marks arrived at the fence between August 25 and September 28, 2010. Sixteen of the steelhead observed with net marks were female and 5 were male.

Water temperature ranged from 2.0°C (September 21) to 16.9°C (August 15) with a mean temperature of 8.9°C. Water levels ranged between 0.011 m (August 15) and 0.30 m (September 28) and averaged 0.12 m. Graphically, a relationship between water level and temperature and steelhead migration was observed. Further analysis of these variables revealed a statistically significant relationship between mean water level and steelhead migration, indicating that water flow may be impacting steelhead movement past the fence. A significant correlation was not found between daily water temperature and steelhead fence counts.

Recommendations of this report include suggestions to enhance management and conservation of the upper Sustut steelhead population and a number of potential improvements to the design of this study.

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1.0 Introduction

Since 1994 the upper Sustut River summer-run steelhead stock has been used in a standardized manner as an annual indicator of stock status for all early run Skeena River summer steelhead (*Oncorhynchus mykiss*). These stocks are of management concern as their early run timing coincides with marine mixed stock commercial fisheries for sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon where they are captured incidentally (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. Annual enumeration of the upper Sustut River steelhead stock provides yearly spawning population estimates that are hypothesized to demonstrate trends in the abundance of all early run Skeena steelhead.

The upper Sustut River steelhead are a unique population within the Skeena River watershed. Over-wintering, spawning and rearing occur at high elevations in Sustut Lake (1306 m) and Johanson Lake (1448 m). 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).

The Sustut River is designated as a Class 1 Classified Water from September 1 to October 31. Access to the fishable portion of the Sustut River is most commonly limited to helicopter or jet boat from the two fishing lodges on the lower river. Angling is prohibited from January 1 to June 15 for the entire river and the section upstream of the BC Railway Bridge is closed 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 number and distribution of gillnet marked steelhead throughout the run
4. to examine the effect of water level and temperature on steelhead migration
5. to examine the relative run timing of male and female steelhead

Although the objectives of the project relate to steelhead, other species are enumerated during fence operation. Data for chinook (*O. tshawytscha*), sockeye, coho (*O. kisutch*), bull trout (*Salvelinus confluentus*), Rocky Mountain whitefish (*Prosopium williamsoni*) and rainbow trout were recorded concurrently during operation of the Sustut fence. Salmon data was forwarded to Fisheries and Oceans Canada for analysis and archiving (Appendix Table 1).

2.0 Study Area

The Sustut River is located in north central British Columbia and is a tributary of the upper Skeena River (Figure 1). It originates in the Omineca Mountains approximately 200 km north of Smithers, B.C. and flows for approximately 97 km from the outlet of Sustut Lake to the Skeena River (Gottesfeld and Rabnett, 2008). The mainstem section of river from Sustut Lake downstream to, and including, Johanson Creek form the primary spawning areas for steelhead in the upper Sustut River (Bustard 1993). This river drains approximately 3,574 km^2 and has seven main tributaries including 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, sockeye, coho, bull trout, Dolly Varden (*S. malma*), Rocky Mountain whitefish and burbot (*Lota lota*)[1](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). 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 1).

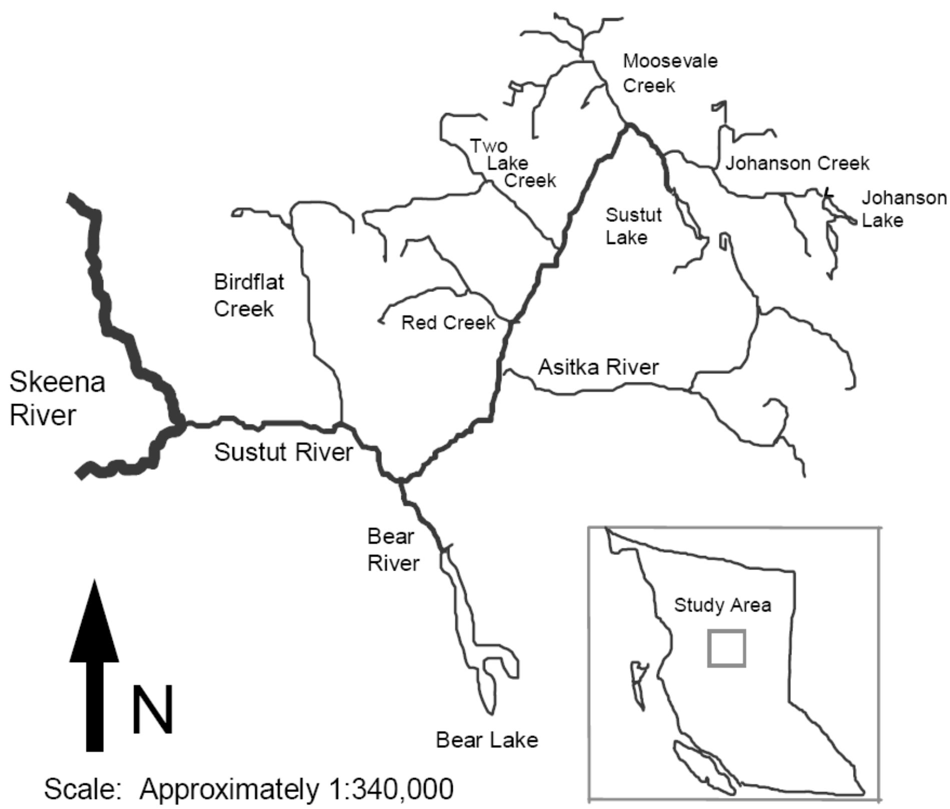

Figure 1. Sustut River and surrounding tributaries (from Saimoto, 2005).

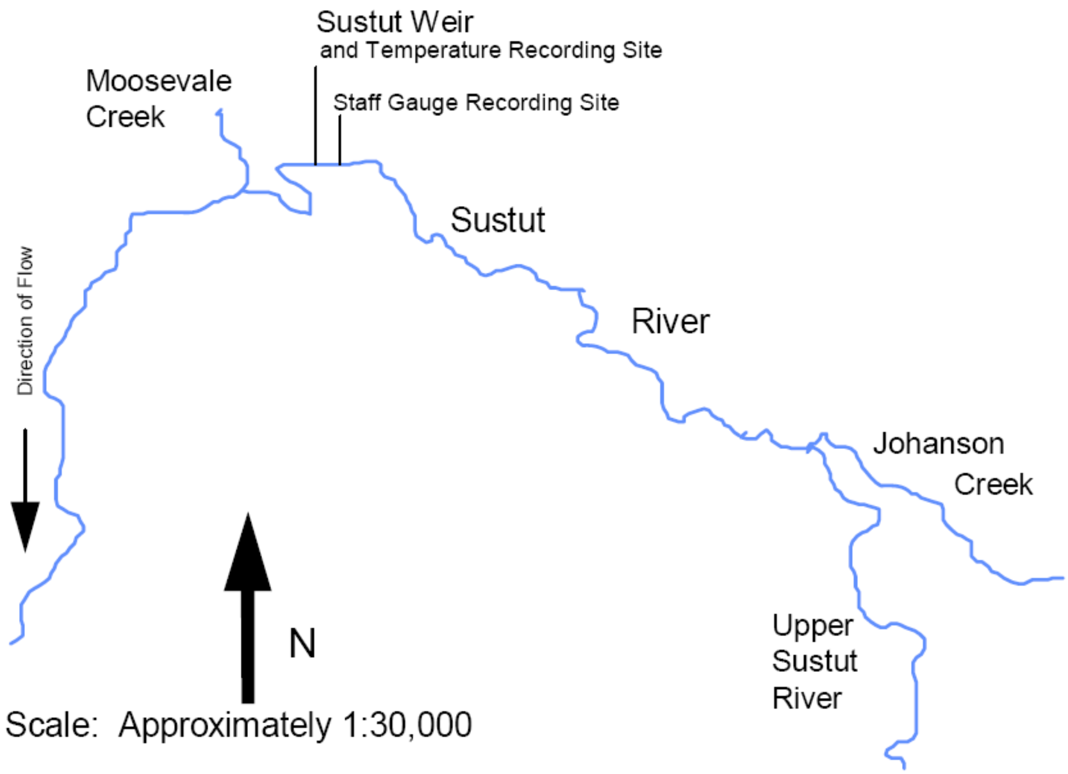

Figure 2. Weir location on the Sustut River (from Diewert, 2005).

3.0 Methods

3.1 Steelhead Enumeration

A floating fish 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, 2010. Upon arriving at the fence, fish were directed into an aluminum trap box where they remained until a gate was opened allowing upstream migration to continue (Figure 3).

The total count of steelhead migrating past the fence between August 1 and September 30 reflects the majority of the upper Sustut River steelhead population that spawns upstream of the fence. The count recorded during this time period is used for comparison amongst years. This information is also hypothesized to demonstrate trends for other upper Skeena tributaries. The total fence count is combined with a visual count of fish holding in the pool downstream of the fence to represent the estimated spawning escapement for the upper Sustut River steelhead population. It is important to note that the pool downstream of the fence contains multiple species which makes an accurate visual count of steelhead difficult (Figure 4).

During operation, the fence was inspected a minimum of three times a day. Debris was removed and repairs were 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 (Ron Steffey personal communication, 2010). Therefore, the removal of debris and carcasses from the fence was limited to avoid affecting fish migration. Past fence modifications implemented to reduce stress and mortality caused by the original fence design were used again in 2010 (Williamson, 1999).

Figure 3. Upper Sustut steelhead enumeration fence, trap box and sampling location. Photo courtesy of Brome and Leaf Steffey.

Figure 4. Steelhead enumeration fence and downstream holding pool. Photo courtesy of Brome and Leaf Steffey.

3.2 Management Framework

The upper Sustut steelhead stock is managed according to *A Conceptual Framework for the Management of Steelhead, Oncorhynchus mykiss* (Johnston *et al.* 2002). This framework identifies stock specific biological reference points for steelhead conservation. These include a minimum target reference point (TRP) and a limit reference point (LRP) to describe desired and highly undesired states for fish abundance (Figure 5).

For the purposes of this study, TRP was defined as 0.25**B* (the asymptotic maximum recruitment) as this value approximates the spawner abundance that produces the maximum long-term yield. If a stock falls below the TRP it is considered overfished. LRP was defined as 0.15**B,* the spawner abundance from which the population will recover to the TRP in one generation in the absence of harvest.

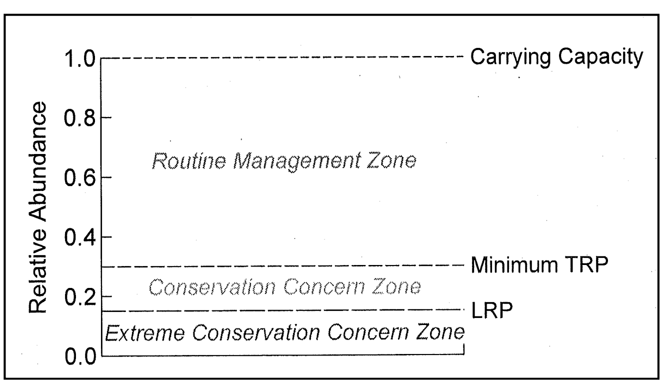

Figure 5. Management framework for the upper Sustut steelhead population. Johnston *et al.* (2002) proposes reference points that are defined in terms of steelhead abundance which results in three distinct management zones.

Below, between and above these thresholds are three management zones described as the Routine Management Zone, Conservation Concern Zone and the Extreme Conservation Concern Zone (Figure 5). These zones and their corresponding management actions are discussed in detail in Johnston *et al.* (2002).

Abundance estimates and steelhead carrying capacity were determined using a habitat based productivity model developed by Tautz *et al.* (2002). This model indicates an adult production potential of 1036 steelhead for the upper Sustut River. Annual steelhead counts were compared to this value, enabling abundance to be assessed relative to management thresholds.

While alternate carrying capacity estimates exist for the upper Sustut River steelhead population (Lessard, 2005), the value of 1036 was selected for this report. This value yields a more conservative Target Reference Point (TRP) which enhances the ability to protect the unique attributes of the upper Sustut steelhead including their early run timing, distance and elevation gained during migration (aka “mile high” steelhead) and the unique genetic heritage associated with these traits.

3.3 Steelhead Biological Information

Experienced personnel using the visual characteristics described in Scott and Crossman (1973) and McPhail and Carveth (1994) identified all fish passing the Sustut fence by species. This information was recorded and summarized daily. A plexiglass viewing box was used to identify fish by species and sex and to observe scars, wounds and general condition. In an attempt to reduce fish handling, approximately 20% of all male and female steelhead passing through the fence were sub-sampled. This was conducted near the apparent end of a “run” to avoid impacting migration.

Steelhead lengths were collected by netting fish from the trap box (Figure 3) and measuring their nose-fork length (mm). For age determination, five scales were collected from sampled fish mid-laterally between the dorsal and anal fins. Mortalities recovered from the fence were also measured for nose-fork length and had scale samples collected.

For statistical analysis purposes, an independent t-test assuming unequal variances was used to determine whether a difference in nose-fork length existed between males and females sampled during the study.

3.4 Steelhead Tagging

Steelhead intercepted in Alaskan commercial fisheries, Canadian commercial fisheries, First Nation fisheries and the Tyee Test Fishery may be tagged or marked prior to release. Adult steelhead enumerated at the Upper Sustut River fence were checked for the presence of these tags and marks. This information allows fisheries managers to assess migration rates, interception in domestic and international fisheries and survival following capture in these fisheries.

3.5 Steelhead Gillnet Marks

The presence of gillnet marks was noted for all steelhead as they migrated past the fence. The plexiglass viewing box allowed this information to be collected and avoided the need to handle fish.

3.6 Water Temperature and Level Measurement

Optic Stowaway temperature data loggers (Onset Computer Corporation, Pocasset, MA) were deployed in the river and in the air near the fence site to record hourly water and air temperatures. For backup purposes, stream water and air temperatures were recorded each day using a Brannon Ltd. minimum-maximum thermometer.

Water level measurements were recorded from a metric staff gauge located immediately upstream of the fence. Levels were recorded by fence staff twice a day, typically in the morning (~0900 hrs) and evening (~2000 hrs). Fence staff also recorded air temperature and weather conditions daily. For comparison purposes, the two daily water level measurements were averaged to determine the mean daily water level. Mean daily water temperature and level were compared against daily steelhead migration to measure potential links between these variables. Annual steelhead abundance was also compared to mean annual water level and cumulative daily temperature to investigate potential relationships between steelhead abundance and these two environmental parameters.

For statistical analysis purposes, a regression and Analysis of Variance (ANOVA) was conducted to determine whether water level and temperature were correlated to daily steelhead migration.

3.7 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 Enumeration

Between August 1 and September 30, 1,050 steelhead migrated past the upper Sustut River fence. This value is well above the long term average of 655 fish (Figure 6) and represents the fourth highest recorded steelhead count since the current fence location was established in 1994 (Table 1). After the fence was dismantled, the fence crew did not observe steelhead in the pool located downstream of the fence.

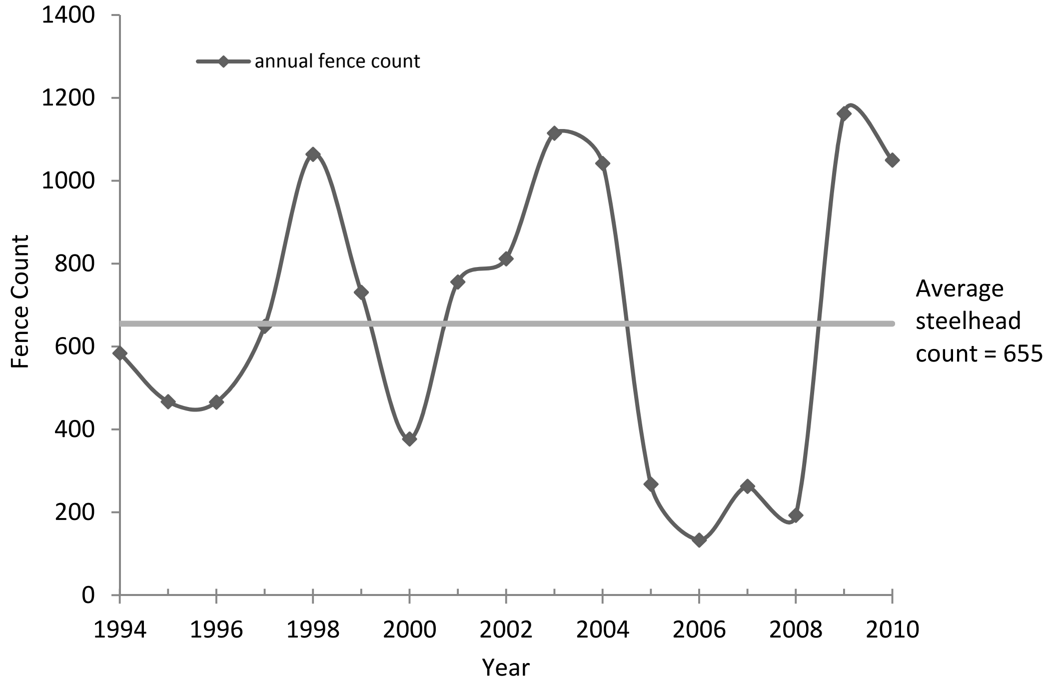

Figure 6. Annual fence count of steelhead at the upper Sustut River weir 1994-2010.

The first steelhead migrated through the fence on August 3 and by September 6, 50% of the steelhead enumerated in 2010 had passed the fence (n=525) (Figure 7). The last recorded fish travelled past the fence on September 30. Since 1994, the date on which the first steelhead arrived has ranged between July 28 and August 17 and the mean date of first arrival is August 8 (Table 1). 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. More recently (since 2002), the mean 50% migration date has been relatively consistent, occurring on September 4. Of note, during the last six days of this study, 24% (n=247) of the total steelhead counted were observed crossing the fence.

Table 1. Arrival timing, total fence count and mean water temperature and level from 1994 to 2010.

Year	Arrival Date of First Steelhead	Date of 50% Migration	50% Fence Count	Total Fence Count	Rank	Mean annual water temperature (°C)	Mean Annual water level (m)
1994	08-Aug	29-Aug	292	584	10	-	-
1995	08-Aug	08-Sep	234	467	11	-	-
1996	17-Aug	07-Sep	233	466	12	-	-
1997	09-Aug	13-Sep	325	649	9	-	-
1998	03-Aug	07-Sep	532	1064	3	-	0.27
1999	17-Aug	17-Sep	366	731	8	-	0.28
2000	08-Aug	07-Sep	186	377	13	-	0.3

2001	15-Aug	16-Sep	378	756	7	-	-
2002	09-Aug	02-Sep	406	812	6	-	0.23
2003	03-Aug	02-Sep	558	1115	2	-	0.31
2004	28-Jul	03-Sep	521	1042	5	-	0.34
2005	31-Jul	03-Sep	134	268	14	8.81	0.32
2006	09-Aug	04-Sep	66	133	17	8.71	0.21
2007	09-Aug	09-Sep	132	263	15	8.81	0.16
2008	08-Aug	07-Sep	97	193	16	9.11	0.23
2009	06-Aug	03-Sep	581	1162	1	9.61	0.2
2010	03-Aug	06-Sep	525	1050	4	8.91	0.12
Min	28-Jul	29-Aug	66	133		8.71	0.12
Max	17-Aug	17-Sep	581	1162		9.61	0.34
Average	08-Aug	07-Sep	327	655		8.99	0.25

*Note – total fence count does not include fish counted in the downstream pool following weir removal.

Graphical analysis of the cumulative proportional distribution of steelhead over time indicates that 51% (n=531) of steelhead counted crossing the fence occurred during the first seven days of September. On four separate days (September 1, 5, 6 and 25), almost 50% (n=499) of the total steelhead counted crossed the fence. The highest count occurred on September 5 (n=181). Steelhead were counted on 39 days of this 61 day project which corresponds to the average from 2002 to 2010.

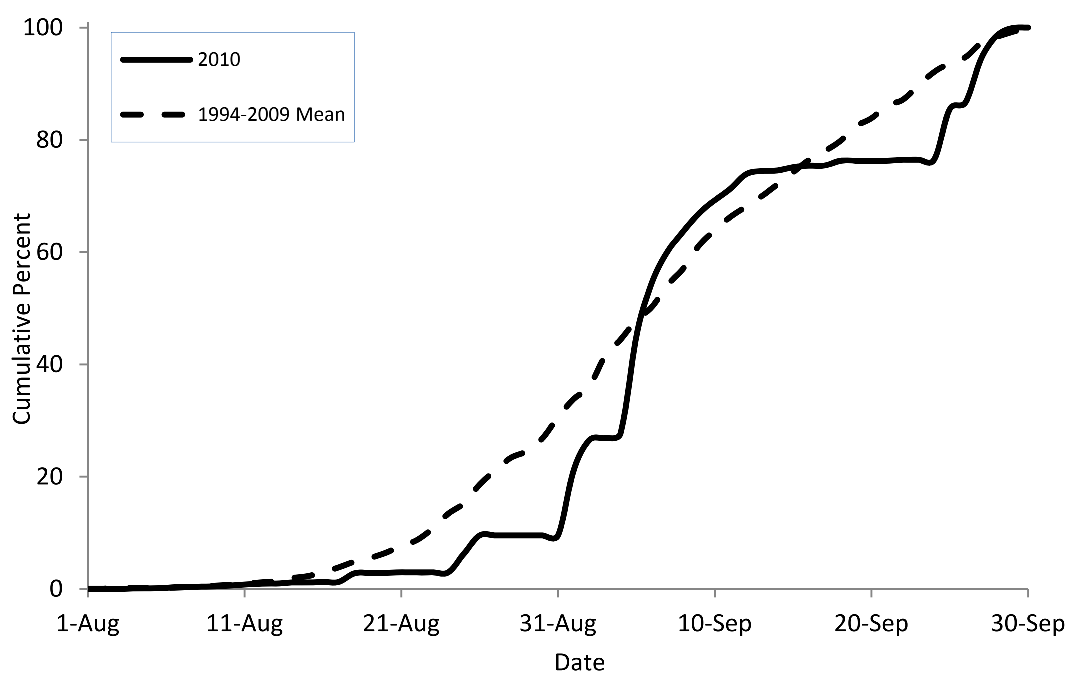

Figure 7. Daily cumulative percentage of upper Sustut River steelhead migrating past the fence for 2010.

4.2 Management Framework

Fence counts in 2009 and 2010 represent a significant increase compared to the previous three years when the upper Sustut spawning population was at or below the Conservation Concern Zone and Extreme Conservation Concern Zone (Figure 8). The 1050 steelhead that crossed the fence represents 101% of the estimated adult carrying capacity for the upper Sustut River.

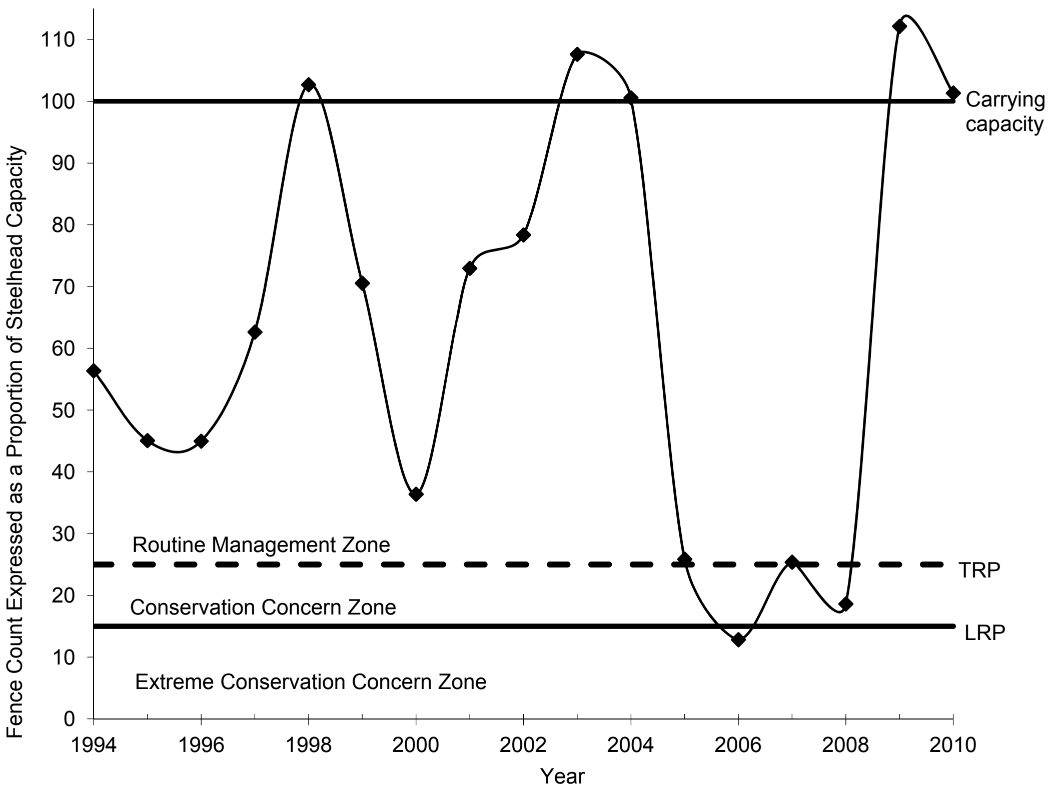

Figure 8. Annual steelhead fence count expressed as a proportion of adult steelhead capacity. LRP and TRP thresholds are based on Johnston *et al.* (2002) and carrying capacity is based on Tautz *et al.* (1992).

4.3 Steelhead Biological Information

4.3.1 Scale analysis and age determination

In 2010, scales were removed from 108 steelhead at the upper Sustut River fence. These scales were analyzed to determine length of freshwater and ocean residency and incidence of spawning events. Forty-four percent of the scales (n=48) were classified as being in good condition (code 1) and 5% (n=5) were in poor condition (code 2) (Appendix Table 2). The remaining scale samples showed evidence of regeneration (45%, n=49), resorption (>1%, n=1) or the first freshwater annulus was not visible (1%, n=5). These factors are important to consider as scale regeneration typically causes uncertainty in estimating freshwater age and resorption can lead to uncertainty in determining marine age. Where age information was uncertain, it was not included in the analysis below. For future reference, a complete record of 2010 scale analysis is presented in Appendix Table 3.

The number of freshwater annuli identified on scale samples (prior to out migration) ranged from three to five. The predominant juvenile freshwater age was four and represented 82% (n=64) of the scales sampled with this information (n=78). Freshwater age three (n=7) and five (n=7) represented 9% of the sample respectively. Freshwater age could not be determined for thirty of the samples as these scales had regenerated. The number of marine annuli (prior to spawning) ranged from two to three. The predominant marine age was two (n=81) and represented 76% of scales sampled with this information (n=107). Maiden steelhead (those that have not previously spawned) represented 91% (n=97) of the sample and 9% (n=10) of the scales examined showed evidence of one previous spawning event. Ninety percent of repeat spawners (i.e. scales with spawning checks) had two years of previous marine growth, independent of freshwater residency period. Total fish age ranged from 5 to 9 years (n=78) and 67% of fish were 6 years of age.

It is important to note that previous studies found that upper Sustut River steelhead do not develop a detectable freshwater annulus in their first year due to their small size (i.e. >30mm; Spence *et al.* 1990). This should be taken into consideration when scale aging results are considered.

4.3.2 Length measurement and distribution

A total of 43 male and 65 female steelhead were measured for nose-fork length. Male lengths ranged from 660 to 935 mm and averaged 793 mm while female lengths ranged from 655 to 945 mm and averaged 746 mm. The percent of the total number of steelhead measured at the fence was plotted in 20 mm increments of nose-fork length for each sex (Figure 9). Statistical analysis revealed that male steelhead were significantly larger than female steelhead (t=3.44 p=0.0009).

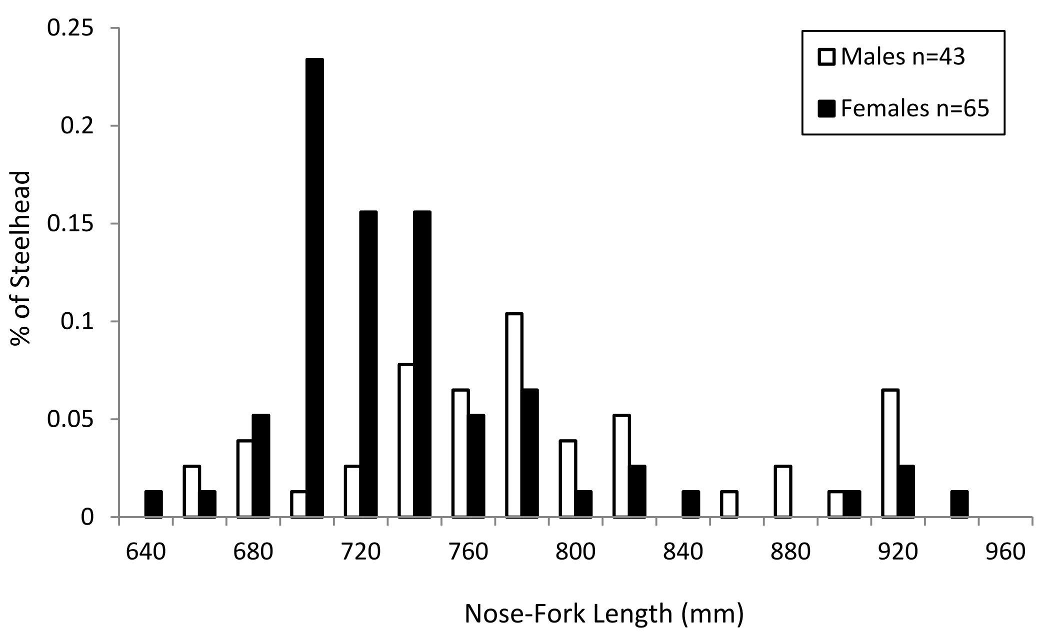

Figure 9. Percentage of male and female steelhead by 20mm categories of nose-fork length.

4.3.3 Sex ratio

Of the 1,050 steelhead counted migrating through the fence, 626 (60%) were female and 424 (40%) were male resulting in a female to male ratio of 1.48:1. Since 1998, the female to male sex ratio has ranged between 1.23:1 (1995) and 2.01:1 (2005). The mean female to male ratio from 1994 to 2010 is 1.56:1 (SD=0.21) (Table 2).

4.3.4 Mortalities

The mortality rate for steelhead migrating past the fence in 2010 was 0%, which is below the overall mean of 1.1% (Table 3). The reduction in observed steelhead mortality can partially be attributed to changes in handling procedures at the site.

4.4 Steelhead Tagging

There was one steelhead with a red tag observed at the fence in 2010, however, the tag number was not recorded.

4.5 Steelhead Gillnet Marks

Fence observers recorded the presence of gillnet marks on steelhead that were sampled during the project. Gillnet marks were present on 2.0% (n=21) of all steelhead that migrated past the fence. During the project, fish with gillnet marks arrived at the fence between August 25 and September 28, 2010. Over 50% (n=12) arrived during an eight day period between September 1 and 8. Sixteen of the steelhead observed with net marks were female and five were male.

Table 2. Upper Sustut River steelhead data from 1994 to 2010.

Year	Average Length (mm)		Repeat Spawners (% of Total)	Mortalities (% of Total)	Gillnet Marked (% of Total)			Sex Ratio (F:M)
	M	F			M	F	Total	
1994	824	737	-	-	-	-	2.0	1.55:1
1995	826	746	1.2	4.0	-	-	6.0	1.23:1
1996	829	739	1.3	2.8	-	-	14.0	1.58:1
1997	814	733	0.6	1.5	9.2	17.8	15.4	1.43:1
1998	827	749	-	0.8	13.4	13.8	13.7	1.73:1
1999	848	756	2.5	0.3	6.1	9.9	8.5	1.64:1
2000	827	741	0.4	0.5	10.6	16.2	14.1	1.64:1
2001	864	771	2.5	1.9	10.1	14.5	12.8	1.63:1
2002	-	-	1.9	0.5	3.6	8.4	6.3	1.27:1
2003	780	730	1.2	0.3	8.3	14.2	11.8	1.39:1
2004	818	745	-	0.3	6.0	8.8	7.7	1.48:1
2005	859	741	19.0	0.0	3.3	5.5	4.8	2.01:1
2006	N/A*	N/A*	N/A*	0.0	0.5	1.6	2.3	1.50:1
2007	N/A*	N/A*	N/A*	0.0	2.7	4.6	3.8	1.39:1
2008	N/A*	N/A*	N/A*	0.0	4.5	2.3	3.1	1.92:1
2009	N/A*	N/A*	N/A*	0.3	0.3	0.9	1.2	1.66:1
2010	793	746	1.0	0.0	0.5	1.5	2.0	1.48:1

Minimum	780	730	0.4	0.0	0.3	0.9	1.2	1.23
Maximum	864	771	19.0	4.0	13.4	17.8	15.4	2.01
Average	826	745	3.2	0.8	5.7	8.6	7.6	1.56

Note – Steelhead length, age and genetic information was not collected from 2006 to 2009 to eliminate handling stress while steelhead abundance was anticipated to be in the Conservation Concern Zone.

4.6 Water Temperature

Water temperature was recorded hourly by a data logger from August 1 to September 30 providing 1,464 data points for analysis. Overall, the highest temperature was recorded on August 15 (16.9°C) and the lowest was recorded on September 21 (2.0°C)(Figure 10). Since 2005, the mean water temperature at the Sustut fence has ranged between 8.7°C (2006) and 9.6°C (2009), averaging 9.0°C (Table 1).

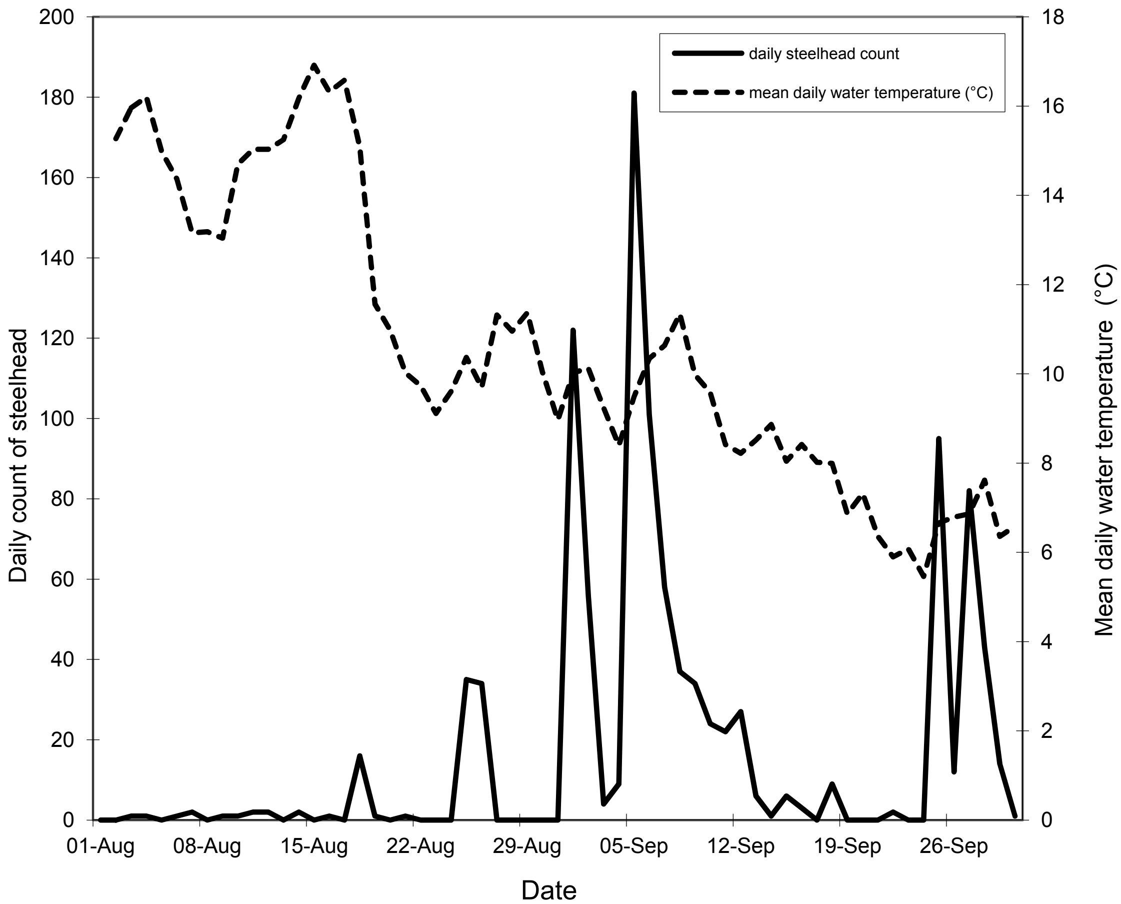

Figure 10. Mean daily water temperature and the number of steelhead migrating past the Sustut fence in 2010.

Cumulative daily water temperature (degrees Celsius) was stratified by hour to determine accumulated thermal units from August 2 to September 30. The warmest water temperatures in 2010 were recorded between 16:00 and 17:00 hours (Figure 11). During the study period 90% (n=943) of the steelhead entering the trap box did so between 1000 hrs and 2000 hrs. The remaining 10% of fish (n=107), 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 reached their daily maximum.

In 2009 and 2010 the maximum water temperature measured on August 1 was 27.0 and 30.5°C respectively. For the purposes of water temperature analysis, this data was considered erroneous and was not included.

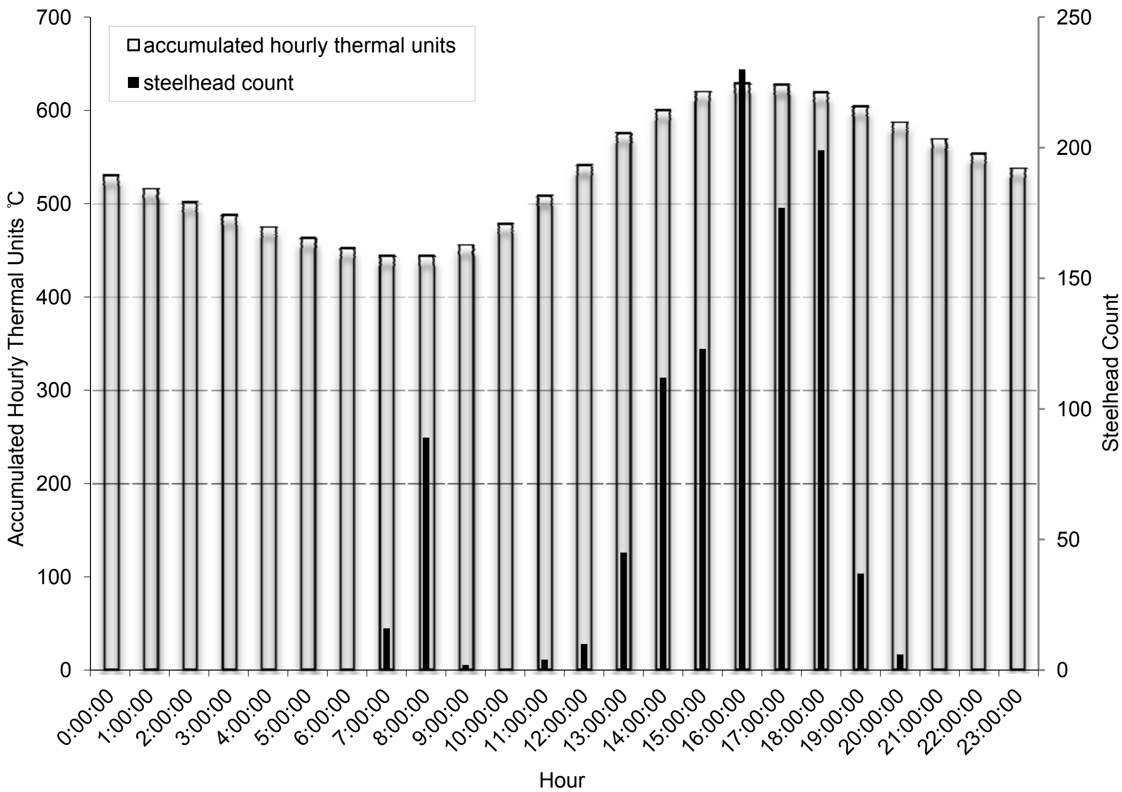

Figure 11. Water temperatures and steelhead migration stratified by hour from August 2 to September 30, 2010.

4.7 Water Level

From August 1 to September 30, 2010, water levels ranged between 0.011 m (August 15) and 0.30 m (September 28)(Figure 12). Since 1998, the annual mean water level from August 1 to September 30 has ranged between 0.12 m (2010) and 0.34 m (2004) and averaged 0.25 m (SD=0.07; Table 1). The mean daily water level in 2010 was the lowest on record since 1998 (Table 1).

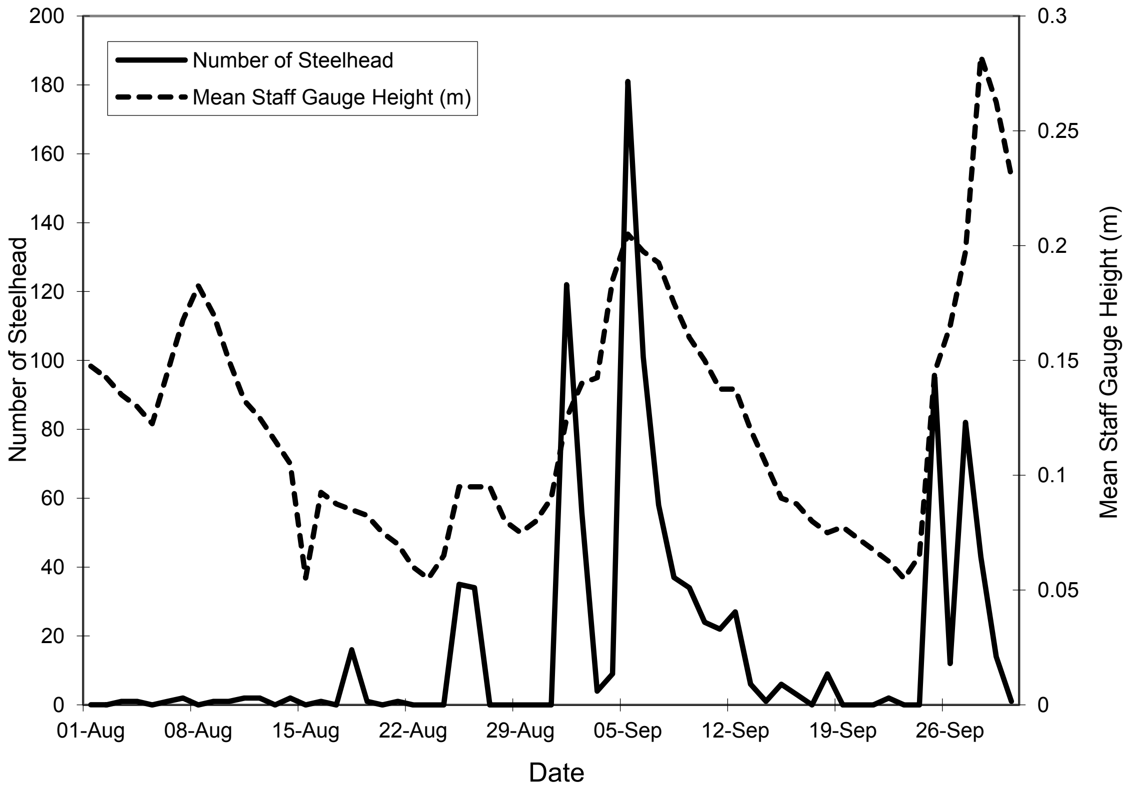

Figure 12. Mean daily staff gauge height and the number of steelhead migrating past the Sustut fence in 2010.

4.8 Male and Female Steelhead Run Timing

The first steelhead which passed through the fence in 2010 was a female on August 3 and the first male steelhead arrived at the fence the next day on August 4. The date when 50% of male and female steelhead had migrated past the Sustut fence was September 6 for both sexes. A comparison of cumulative percentage of male and female steelhead crossing the fence and arrival date indicates that males and females had similar migration timing (Figure 13).

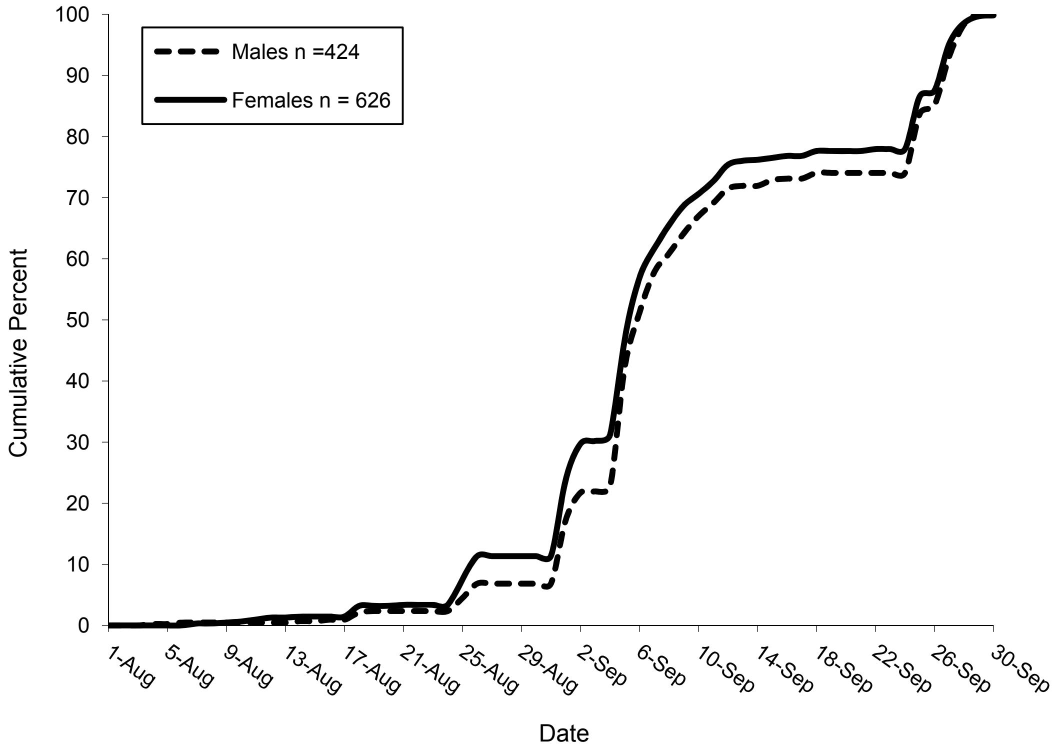

Figure 13. Daily cumulative percent of male and female steelhead migrating past the fence in 2010.

5.0 Discussion

The objectives for this project were to enumerate the upper Sustut River summer-run steelhead population, examine the sex ratio of steelhead throughout the run, the effect of water level and temperature on steelhead migration, the number and distribution of gillnet marked steelhead throughout the run, and the relative run timing of male and female steelhead. The following section attempts to address these objectives by discussing the 2010 results and making linkages to historical findings part of this ongoing monitoring project.

5.1 Enumeration of Upper Sustut River Summer-Run Steelhead

The 2010 upper Sustut steelhead fence count from August 1 to September 30 was 1050 fish. This value is the fourth highest since enumeration methods were standardized in 1994. During the last 17 years, fence counts have ranged from 133 (2006) to 1162 (2009). The 2010 population index value of 1050 was lower than results for 2009 (1162), higher than the period from 2005-2008 and approximately 60% above the long term average.

The pattern of steelhead migration past the Sustut fence in 2010 was characterized by periods where few fish were observed followed by substantial “runs” of fish past the fence. This trend also occurred in previous years (Peard 2008, 2009a, 2009b, 2010). On four separate days (September 1, 5, 6 and 25), almost 50% (n=499) of the total steelhead counted crossed the fence. The highest count occurred on September 5 (n=181) which was below the highest daily count in 2009 of 240 fish (September 2). Potential correlation between steelhead migration and environmental variables (water temperature and height) are discussed later in this section.

5.2 Management Framework

According to a habitat based productivity model developed for the Skeena drainage (Tautz *et al.,* 1992) the number of steelhead migrating past the upper Sustut fence in 2010 represents 101% of the estimated adult carrying capacity (1036 steelhead) for the system.

Since 1994, increases in steelhead abundance have been followed by declines. Most recently, these declines have been of conservation concern and extreme conservation concern (Figure 8). In light of this variability, management approaches must exercise caution. Potential impacts from climate change (Tydemers and Ward, 2001) and shifts in marine survival (Smith and Ward, 2000) may lead to future fluctuations in steelhead abundance. This uncertainty emphasizes the need for conservative management approaches and selective commercial salmon fisheries which preferably have no incidental catch of steelhead. Such actions will support the long term sustainability the Sustut and upper Skeena steelhead populations.

5.3 Sex Ratio and Relative Run Timing of Male and Female Steelhead

Of the 1,050 steelhead counted migrating through the fence, 626 (60%) were female and 424 (40%) were male resulting in a female to male ratio of 1.48:1. This value is similar to the long term trend of 1.56:1 (Table 2). While this skewed sex ratio in favor of females is consistent with observations at the Sustut fence since 1994 (excluding 2008), it is higher than sex ratios reported for other major steelhead bearing tributaries in the Skeena watershed (Parken and Morten, 1996).

The skewed sex ratio observed at the Sustut fence may be linked natural and/or anthropogenic selective pressures. While future investigation into both is warranted, managers have had concern regarding the latter for over 35 years (Chudyk and Narver, 1976). The morphological characteristics of female steelhead may provide them with a natural ability to escape gillnet fisheries. Supporting this claim, Diewert (2002) found female steelhead crossing the Sustut fence had a higher gillnet mark rate than males. This suggests that when the upper Sustut steelhead stock are exposed to a gillnet fishery, females can escape with greater success than males. This is possibly due to their smaller average size than males (less likely to be caught in mesh openings) and lack of secondary sexual characteristics (kype) that may increase entanglement.

If gillnet fisheries are selectively removing larger and potentially older fish from the spawning population, this may lead to a decline in the mean fish size (McAllister *et al.* 1992), alter the age composition of the stock and remove intrinsically faster growing fish (Boehlert, 1996). Further investigation into directional selection on steelhead by salmon gillnets used in the Skeena watershed may help validate these points in an effort to avoid impacts to the upper Sustut and upper Skeena steelhead populations.

The sex-specific run timing of steelhead counted at the upper Sustut fence in 2010 indicated that female fish were more abundant throughout the run (Figure 13). This differs from previous findings that found males dominated the beginning of the run and females were dominant near the end of the run (personal communication in Parken *et al.* 1997).

5.4 Distribution of Gillnet Marked Fish throughout the Run

A total of 2% (n=21) of steelhead migrating past the Sustut fence exhibited gillnet marks in 2010. This value falls well below the long term average of 7.6% and is the second lowest value on record since 1994 (Table 2). Collectively, gillnet marked steelhead arrived at the fence between August 25 and September 28, 2010. Interestingly, over 50% (n=12) arrived during an eight day period between September 1 and September 8, 2010. Of all the steelhead with gillnet marks observed, 16 (76%) were females and 5 (24%) were males. These results support past studies which found females had a higher gillnet mark rate than males (Diewert 2002; Table 2). Given few (n=2) gillnet marked fish had length measurements taken, size comparison between male and female steelhead with and without gillnet marks was not possible.

5.5 Effect of Water Level and Temperature on Steelhead Migration

During the 2010 study, water level (i.e. flow) at the upper Sustut fence underwent three distinct peaks on August 8, September 5 and September 28 (Figure 12). Graphically, the latter two peaks appear to be linked to an increased number of steelhead crossing the Sustut fence. A regression analysis of mean staff gauge height and daily steelhead count revealed a statically significant relationship between these variables, indicating that water flow appears to be impacting steelhead migration (R^2=0.1896; ANOVA F=13.80 P=0.0005; Appendix Figure 2). This was not the case when mean annual water level was compared to the annual steelhead fence counts from 1998 to 2010 (R^2=0.0070; ANOVA F=0.073 P=0.796; Appendix Figure 3).

During the project, the mean and median water level was 0.12 m. Eleven percent (n=114) of steelhead were found to enter the trap box when water levels were below this level and 89% (n=936) entered when water levels were above 0.12 m. This supports the concept that at very low water levels, steelhead will migrate during time periods with elevated flow. Given the average water level in the upper Sustut River has been generally decreasing since 1998 (Table 1), continued monitoring is recommended. If continued decreases are observed, steelhead migration may become restricted during periods of low water level, potentially resulting in fish impoundment within deeper sections of river (pools), increased vulnerability to in-river fisheries and stress-related mortality from elevated water temperatures.

Water temperature at the upper fence generally declined over the study period, from 16.9°C (August 15) to 2.0°C (September 21). A plot of daily steelhead count and water temperature indicated that the largest peaks in steelhead migration occurred when water temperature was rising (Figure 10). During each day it was also found that 80% (n=841) of steelhead that crossed the fence did so between 1400 and 1800 hours when daily water temperatures were the warmest. While these findings were also observed in previous years (Peard 2008, 2009a, 2009b, 2010), the relationship between mean daily water temperature and steelhead movement past the fence in 2010 was not statistically significant (R^2=0.0411; ANOVA F=2.485 *P*=0.120; Appendix Figure 4).

It is important to note that investigations regarding steelhead migration and water flow and temperature using traditional parametric techniques (e.g. regression analysis) may not be effective. Considering the large pulses of fish observed and the lack of independence between data points, a more explicit modeling approach capable of dealing with overdispersed data (Richards, 2008) may help better understand steelhead migration patterns and links to environmental variables. Work to develop such a model was initiated during drafting of this report and can be expanded upon and reported if this topic continues to be of interest in the future.

5.6 The Importance of Continued Monitoring.

The upper Sustut River counting 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. This long term data set allows fisheries managers to compare annual abundance, run timing, sex ratios and age composition of adult steelhead in the upper Sustut. The ability 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 conducted annually. The long term monitoring data from this project provides fisheries managers with valuable information on abundance trends for all early run Skeena steelhead populations and feedback on the impact of fisheries on these stocks.

2. The current minimum Target Reference Point (TRP) of 25% carrying capacity should be evaluated to determine if it will conserve the upper Sustut steelhead population above the Limit Reference Point and yield a precautionary approach to steelhead management.

3. Agreement must be reached between BC and Canada as to the plan when the upper Sustut steelhead stock falls below the TRP. This plan should be reflected through the steelhead objectives section of the North Coast Integrated Fisheries Management Planning process. Management actions described in Johnston *et al.* (2002) should be put forward to federal agencies for consultation. In the latter part of this decade, multiple fence counts at or below the TRP have not resulted in the development of any plans or

agreements that would mitigate commercial fishery impacts on this population.

4. Adult production estimates for the upper Sustut River should be reconciled (Lessard, 2005; Tautz *et al.* 1992) and the smolt-to-adult survival rates used for these studies (14%) should be updated to reflect the most current estimates of steelhead survival while at sea.

5. Efforts to visually count steelhead below the fence should continue. This should be undertaken when the fence is removed, and also on a daily basis. Counts of steelhead holding below the fence each day would provide beneficial information for assessing the correlation between flow and temperature and steelhead migration. This would allow the data to be standardized to fish counted vs. fish available (i.e. holding in pool downstream) and provide insight into how steelhead respond to differing flow and temperature regimes.

6. Future emphasis should be placed upon the approach taken when investigating the role environmental factors (water flow and temperature) have upon steelhead migration. Traditional parametric techniques including regression analysis may not be effective. A more explicit modeling approach capable of dealing with overdispersed data may help better understand steelhead migration patterns and links to environmental variables.

7. A review of enumeration results at the Sustut fence should be undertaken every five years. Comparison of results across years would provide useful insight into changing environmental factors (water supply, ocean and climatic conditions) and anthropogenic impacts (in river and ocean fisheries, resource development etc) as they relate to conserving the upper Sustut steelhead population.

8. Steelhead scales collected for age analysis should be removed mid-laterally between the dorsal and anal fins, avoiding the lateral line. This is the optimal location to avoid collecting scale samples showing evidence of regeneration. A large proportion of scales collected in 2010 (45%) showed evidence of regeneration which causes uncertainty in estimating freshwater age. If this trend is observed in the future, it is recommended that alternate sampling locations are selected (i.e. collect scales from both sides of the fish) and additional scale samples are collected (increase from five to seven samples).

9. Data loggers measuring water temperature should be placed in the water at least one day (preferably longer) prior to study commencement. This will allow instrumentation to properly adjust to water temperature following transport to the fence site.

10. The target where 20% of steelhead crossing the Sustut fence are sampled should be investigated. A power analysis should be conducted to determine whether the current sampling target is adequate to detect changes in sampled parameters. Consideration regarding the sampling methodology is

also warranted to assess assumptions and explore changes which may increase the ability to collect samples which are representative of steelhead crossing the upper Sustut counting fence.

11. The objectives of this report should be broadened to include steelhead length and age investigation. Presenting an analysis of these parameters annually would increase the ability to monitor changes over time as they relate management of the upper Sustut steelhead population.

12. If large relative proportions of steelhead are observed crossing the Sustut fence at the end of September (as was the case in 2010), consideration should be given to operating the fence into October as weather conditions allow. This would assist in accurately enumerating the upper Sustut steelhead population and monitoring future changes to steelhead migration timing.

7.0 Acknowledgments

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

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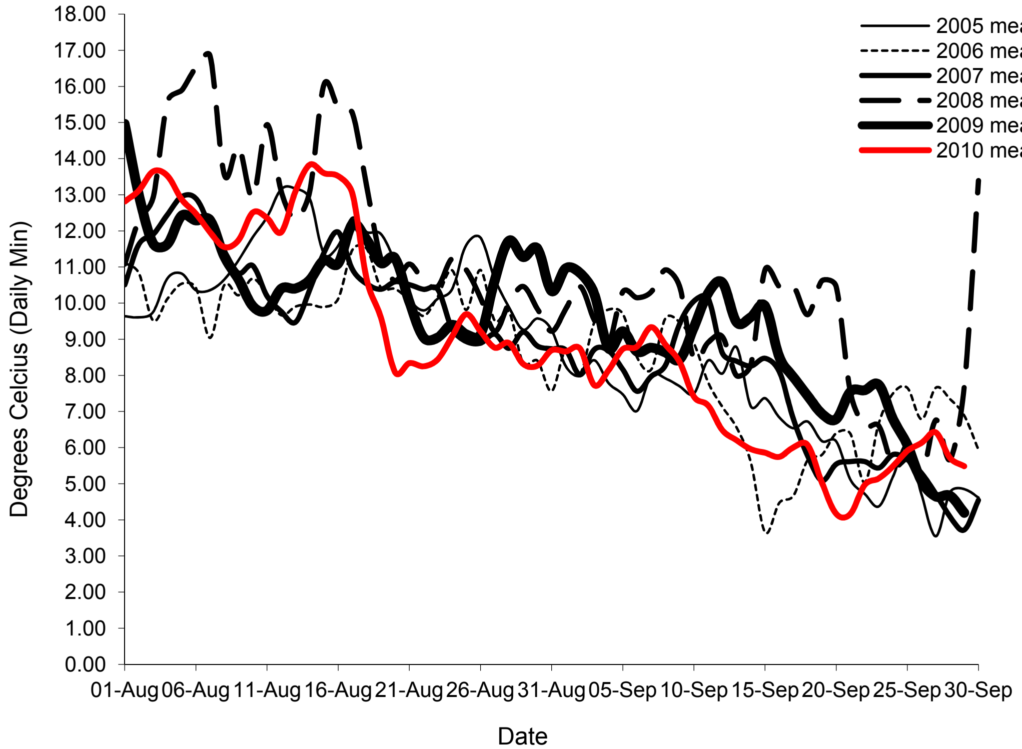
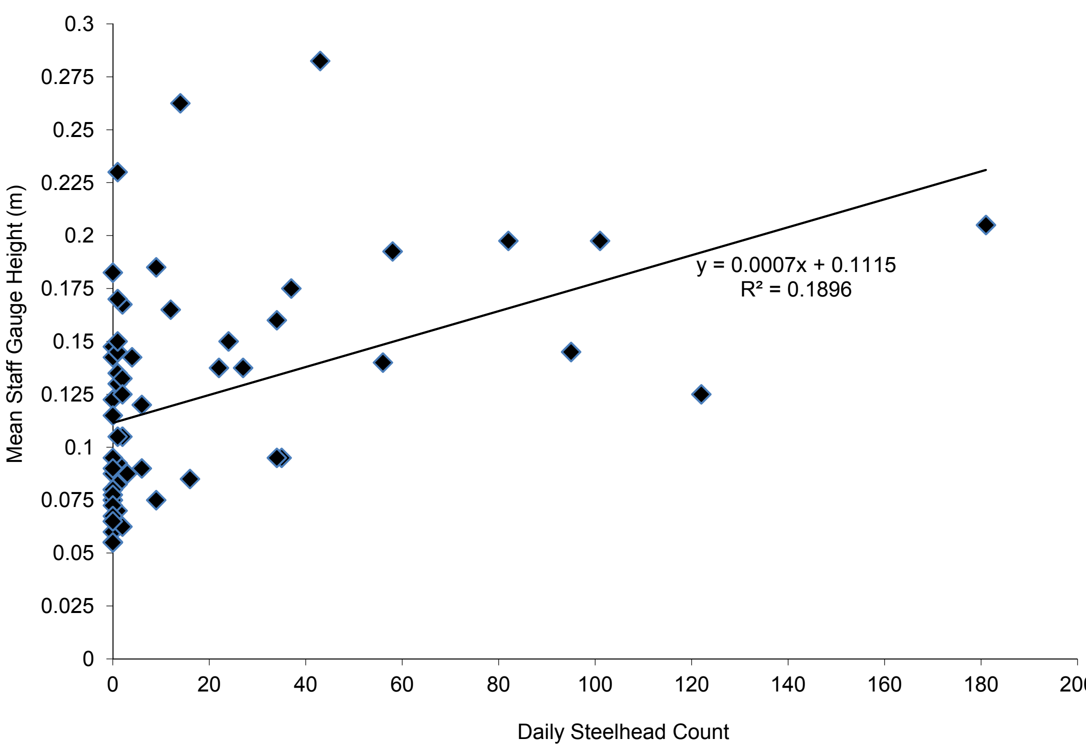
9.0 Appendices

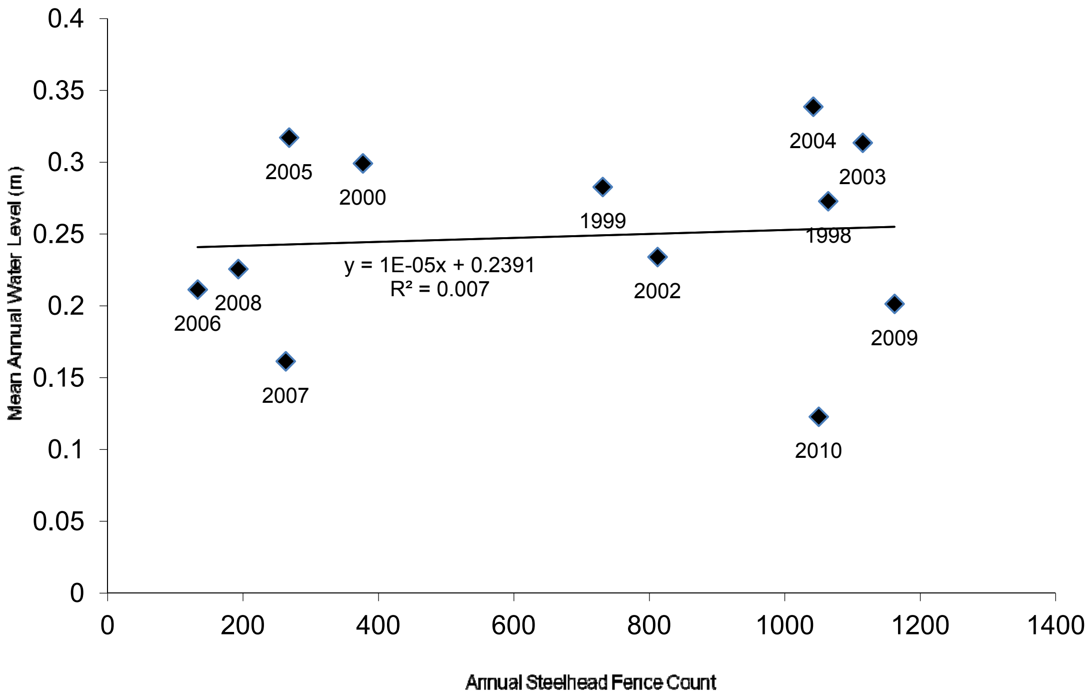
Appendix Figures



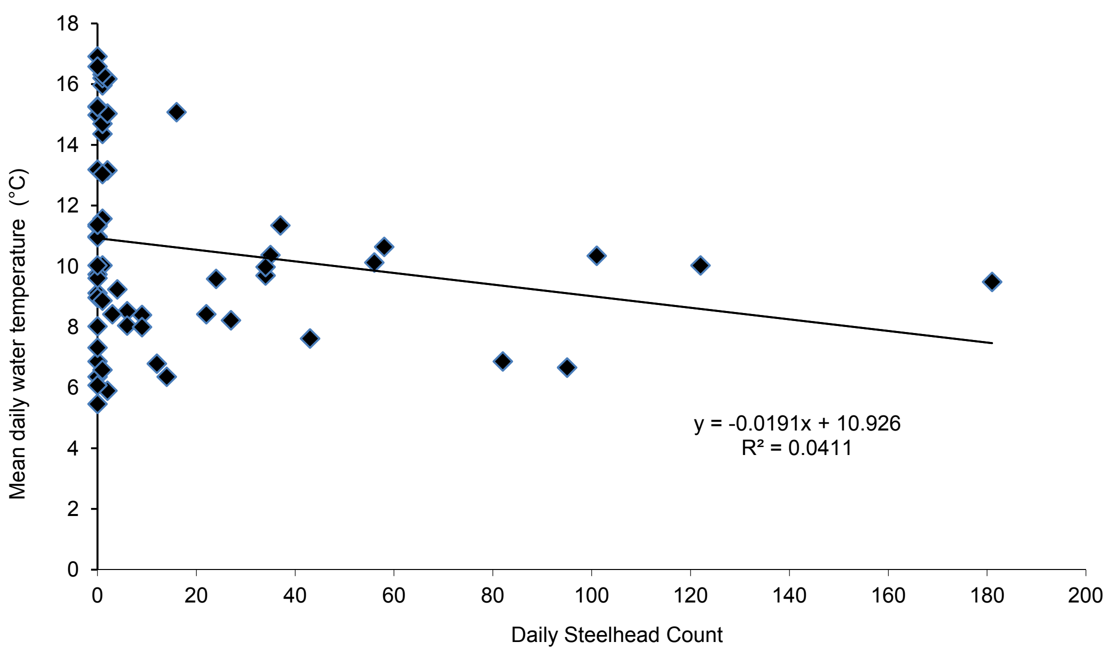
Appendix Figure 1. Mean daily water temperature at the Sustut River fence from 2005 to 2010.



Appendix Figure 2. Mean daily water level versus steelhead migration past the upper Sustut River enumeration weir 2010.



Appendix Figure 3. Mean annual water level versus. steelhead fence count from 1998 to 2010.



Appendix Figure 4. Mean daily water temperature versus steelhead migration past the upper Sustut River enumeration weir 2010.

Appendix Tables

Appendix Table 1. Daily and cumulative totals for all fish species enumerated at the Upper Sustut River weir in 2010.

Date	Chinook		Sockeye		Steelhead		Coho		Bull Trout		Whitefish		Rainbow Trout	
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
2010-08-01	21	21	0	0	0	0	0	0	0	0	0	0	0	0
2010-08-02	7	28	0	0	0	0	0	0	0	0	0	0	0	0
2010-08-03	5	33	1	1	1	1	0	0	1	1	3	3	0	0
2010-08-04	26	59	7	8	1	2	0	0	0	1	2	5	0	0
2010-08-05	8	67	1	9	0	2	0	0	0	1	0	5	0	0
2010-08-06	21	88	11	20	1	3	0	0	0	1	0	5	0	0
2010-08-07	22	110	17	37	2	5	0	0	0	1	0	5	0	0
2010-08-08	8	118	38	75	0	5	0	0	0	1	0	5	0	0
2010-08-09	16	134	60	135	1	6	3	3	0	1	0	5	0	0
2010-08-10	11	145	54	189	1	7	0	3	0	1	0	5	0	0
2010-08-11	19	164	45	234	2	9	0	3	0	1	0	5	1	1
2010-08-12	2	166	14	248	2	11	0	3	1	2	0	5	0	1
2010-08-13	1	167	15	263	0	11	1	4	0	2	1	6	0	1
2010-08-14	3	170	17	280	2	13	4	8	0	2	1	7	0	1
2010-08-15	2	172	0	280	0	13	0	8	0	2	0	7	0	1
2010-08-16	2	174	0	280	1	14	0	8	0	2	1	8	0	1
2010-08-17	0	174	4	284	0	14	0	8	0	2	0	8	0	1
2010-08-18	0	174	49	333	16	30	3	11	1	3	0	8	0	1
2010-08-19	0	174	0	333	1	31	0	11	0	3	0	8	0	1
2010-08-20	0	174	1	334	0	31	0	11	0	3	0	8	0	1
2010-08-21	0	174	0	334	1	32	0	11	0	3	0	8	0	1
2010-08-22	0	174	0	334	0	32	0	11	0	3	0	8	0	1
2010-08-23	0	174	0	334	0	32	0	11	0	3	0	8	0	1
2010-08-24	0	174	0	334	0	32	0	11	0	3	0	8	0	1
2010-08-25	0	174	15	349	35	67	0	11	0	3	4	12	0	1
2010-08-26	0	174	25	374	34	101	1	12	0	3	4	16	1	2
2010-08-27	0	174	0	374	0	101	0	12	0	3	0	16	0	2
2010-08-28	0	174	0	374	0	101	0	12	0	3	0	16	0	2
2010-08-29	0	174	0	374	0	101	0	12	0	3	0	16	0	2
2010-08-30	0	174	0	374	0	101	0	12	0	3	0	16	0	2
2010-08-31	0	174	0	374	0	101	0	12	0	3	0	16	0	2
2010-09-01	0	174	8	382	122	223	11	23	0	3	1	17	0	2
2010-09-02	0	174	1	383	56	279	8	31	0	3	0	17	0	2
2010-09-03	0	174	0	383	4	283	1	32	0	3	0	17	0	2
2010-09-04	0	174	14	397	9	292	1	33	1	4	0	17	0	2
2010-09-05	0	174	22	419	181	473	22	55	1	5	1	18	1	3
2010-09-06	0	174	4	423	101	574	8	63	0	5	1	19	0	3
2010-09-07	0	174	0	423	58	632	5	68	1	6	0	19	0	3
2010-09-08	0	174	1	424	37	669	6	74	2	8	2	21	0	3
2010-09-09	0	174	0	424	34	703	8	82	0	8	1	22	0	3
2010-09-10	0	174	0	424	24	727	2	84	0	8	1	23	0	3
2010-09-11	0	174	0	424	22	749	1	85	1	9	2	25	0	3

2010-09-12	0	174	0	424	27	776	0	85	0	9	0	25	0	3
2010-09-13	0	174	0	424	6	782	2	87	0	9	2	27	0	3
2010-09-14	0	174	0	424	1	783	0	87	0	9	1	28	0	3
2010-09-15	0	174	0	424	6	789	0	87	0	9	0	28	0	3
2010-09-16	0	174	0	424	3	792	0	87	0	9	3	31	0	3
2010-09-17	0	174	0	424	0	792	0	87	0	9	0	31	0	3
2010-09-18	0	174	0	424	9	801	0	87	0	9	2	33	0	3
2010-09-19	0	174	0	424	0	801	0	87	0	9	0	33	0	3
2010-09-20	0	174	0	424	0	801	0	87	0	9	0	33	0	3
2010-09-21	0	174	0	424	0	801	0	87	0	9	0	33	0	3
2010-09-22	0	174	0	424	2	803	0	87	0	9	0	33	0	3
2010-09-23	0	174	0	424	0	803	0	87	0	9	0	33	0	3
2010-09-24	0	174	0	424	0	803	0	87	0	9	1	34	0	3
2010-09-25	0	174	2	426	95	898	18	105	0	9	0	34	0	3
2010-09-26	0	174	0	426	12	910	4	109	0	9	0	34	0	3
2010-09-27	0	174	0	426	82	992	4	113	0	9	0	34	0	3
2010-09-28	0	174	0	426	43	1035	1	114	1	10	1	35	0	3
2010-09-29	0	174	0	426	14	1049	0	114	0	10	0	35	0	3
2010-09-30	0	174	0	426	1	1050	0	114	0	10	0	35	0	3

Appendix Table 2. Condition code definitions and abbreviation descriptions.

Condition Code	**Definition**
1	Good condition
2	Poor condition or questionable age
3	Freshwater age unreadable (eg. U.2)
4	Unreadable (eg. U.U)
5	Starting to regenerate (freshwater age may be under-estimated)
6	Regenerated (eg. R.2)
7	Missing
8	Resorption (eg. last marine annulus on edge of scale)
9	First freshwater annulus very vague, but must be present due to high circuli count and spacing relative to other freshwater annuli
Abbreviation	**Definition**
ann.	annulus
fw	freshwater
fwa	freshwater annulus
fws	freshwater stress
ma	marine annulus
ms	marine stress
p/c	poor condition
pg zone	zone of closely spaced circuli immediately following last freshwater annulus; may resemble another year of freshwater growth
rg	regenerated
sp. ch.	spawning check

Appendix Table 3. Scale analysis by condition code and freshwater and marine age.

Condition Code	Age	Marine Age	Age Comments
1	3.2	2	
1	3.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	3rd fwa clearer on other rg scale
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.2	2	
1	4.3	3	
1	4.3	3	
1	4.3	3	
1	4.3	3	

1	4.3	3	
1	4.3	3	
1	4.3	3	
1	5.2	2	
1	5.2	2	
1	5.2	2	
1	5.2	2	
1	5.2	2	
1	4.2S1	2S1	
2	3.2	2	pg zone
2	4.2	2	fw in p/c; age estimate
2	4.2	2	
2	4.2	2	fws in 2nd year
2	5.2S1	2S1	fw image clearer on scanner
5	3.3	3	
5	4.2	2	
5	4.2	2	
5	4.2	2	
5	4.2	2	may be lacking 1st fw annulus
5	4.2	2	
5	4.2	2	
5	4.2	2	
5	4.2	2	fws in 2nd year
5	4.2	2	
5	4.2	2	
5	4.2	2	may be lacking 1st fw annulus
5	4.3	3	
5	4.3	3	
5	5.2	2	
5	3.2S1	2S1	
5	3.2S1	2S1	
5	4.2S1	2S1	fws not on other scale
5	4.2S1	2S1	1st fw annulus barely visible
6	R.1	1	steelhead?; possible coho scale?
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	estimate at least 4.2
6	R.2	2	estimate at least 4.2

6	R.2	2	
6	R.2	2	estimate at least 4.2
6	R.2	2	
6	R.2	2	
6	R.2	2	estimate at least 4.2
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	
6	R.2	2	estimate at least 4.2
6	R.2	2	estimate at least 4.2
6	R.2	2	
6	R.2	2	
6	R.2S1	2S1	
6	R.2S1	2S1	
6	R.2S1	2S1	
6	R.3	3	
6	R.3	3	
6	R.3	3	
6	R.3S1	3.S1	p/c; marine age estimate
8	3.3	3	
9	4.2	2	1st fw annulus barely visible
9	4.2	2	1st fw annulus not visible
9	4.2	2	1st fw annulus not visible
9	4.3	3	1st fw annulus not visible
9	4.3	3	1st fw annulus not visible

Appendix Table 4. Steelhead sampling data from the Sustut River fence in 2010.

Date	Time	Sex	Nose Fork Length (mm)	Gillnet Marks	Comments
2010-08-03	8:30	F			
2010-08-04	20:00	M			
2010-08-06	8:45	M			
2010-08-07	8:30	F			
2010-08-07	8:30	F			
2010-08-09	8:45	F			
2010-08-10	13:30	F			
2010-08-11	8:45	F			
2010-08-11	19:30	F			
2010-08-12	19:30	F	710		
2010-08-12	19:30	F	700		
2010-08-14	17:45	M			
2010-08-14	17:45	F			
2010-08-16	8:45	M			
2010-08-18	17:00	F			
2010-08-18	18:00	M			
2010-08-18	18:00	F			
2010-08-18	18:00	F			
2010-08-18	18:00	F			
2010-08-18	18:30	M			
2010-08-18	18:30	M			
2010-08-18	18:30	M			
2010-08-18	18:30	M			
2010-08-18	18:30	F			
2010-08-18	18:30	F			
2010-08-18	18:30	F			
2010-08-18	18:30	F			
2010-08-18	18:30	F			
2010-08-18	19:30	F			
2010-08-18	19:30	F			
2010-08-19	9:00	M			
2010-08-21	13:00	F	710		small abrasion on side
2010-08-25	15:30	F		yes	
2010-08-25	15:30	F	750	yes	
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	M			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			

2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
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2010-08-25	14:00	F			
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2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:00	F			
2010-08-25	14:30	F			
2010-08-25	14:30	F			
2010-08-25	14:30	F			
2010-08-25	14:30	F			
2010-08-25	15:30	M			
2010-08-26	9:00	M			
2010-08-26	17:30	M			
2010-08-26	17:30	M			
2010-08-26	17:30	M			
2010-08-26	17:30	M			
2010-08-26	17:30	M			
2010-08-26	17:30	F			
2010-08-26	17:30	F			
2010-08-26	17:30	F			
2010-08-26	17:30	F			
2010-08-26	17:30	F			
2010-08-26	18:00	M			
2010-08-26	18:00	F			
2010-08-26	18:00	F			
2010-08-26	18:00	F			
2010-08-26	18:00	F			
2010-08-26	18:00	F			
2010-08-26	18:15	F			
2010-08-26	18:15	F			
2010-08-26	18:15	F			
2010-08-26	18:15	F			
2010-08-26	18:15	F			
2010-08-26	18:30	M			
2010-08-26	18:30	M			
2010-08-26	18:30	F			
2010-08-26	18:30	F			
2010-08-26	18:30	F			
2010-08-26	18:30	F			
2010-08-26	18:30	F			
2010-08-26	19:00	F			
2010-08-26	19:00	F	790		

2010-08-26	19:00	F	745		
2010-08-26	19:00	F	745		
2010-08-26	19:00	M	790		
2010-09-01	18:30	F		yes	
2010-09-01	18:30	F		yes	
2010-09-01	11:00	F	710		
2010-09-01	11:00	M	765		
2010-09-01	11:00	F	710		
2010-09-01	11:00	F	690		
2010-09-01	16:00	F			
2010-09-01	16:00	F			
2010-09-01	16:30	M			
2010-09-01	16:30	M			
2010-09-01	16:30	M			
2010-09-01	16:30	M			
2010-09-01	16:30	M			
2010-09-01	16:30	F			
2010-09-01	16:30	F			
2010-09-01	16:30	F			
2010-09-01	16:30	F			
2010-09-01	16:30	F			
2010-09-01	17:00	M			
2010-09-01	17:00	M			
2010-09-01	17:00	M			
2010-09-01	17:00	M			
2010-09-01	17:00	M			
2010-09-01	17:00	F			
2010-09-01	17:00	F			
2010-09-01	17:00	F			
2010-09-01	17:00	F			
2010-09-01	17:00	F			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	M			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
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2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	17:30	F			
2010-09-01	18:00	M			
2010-09-01	18:00	M			
2010-09-01	18:00	M			
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2010-09-01	18:00	F			
2010-09-01	18:00	F			
2010-09-01	18:00	F			
2010-09-01	18:30	M			
2010-09-01	18:30	M			
2010-09-01	18:30	F			
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2010-09-01	18:30	F			
2010-09-01	18:30	F			
2010-09-01	18:30	F			
2010-09-01	18:30	F			
2010-09-01	19:00	F	750		
2010-09-01	19:00	F	700		
2010-09-02	18:00	F		yes	
2010-09-02	20:30	F		yes	
2010-09-02	8:00	F			
2010-09-02	8:00	F	720		
2010-09-02	8:00	F	770		
2010-09-02	8:00	F	750		
2010-09-02	8:00	F	700		
2010-09-02	8:00	F	730		
2010-09-02	8:00	M	745		
2010-09-02	8:00	M	770		
2010-09-02	17:45	M			
2010-09-02	17:45	M			
2010-09-02	17:45	F			
2010-09-02	17:45	F			
2010-09-02	17:45	F			
2010-09-02	17:45	F			
2010-09-02	17:45	F			
2010-09-02	18:00	M	775		
2010-09-02	18:00	F	720		
2010-09-02	18:00	M	920		
2010-09-02	18:00	M	730		
2010-09-02	18:00	M			
2010-09-02	18:00	M			
2010-09-02	18:00	M			
2010-09-02	18:00	M			
2010-09-02	18:00	M			
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2010-09-02	18:00	F			
2010-09-02	18:00	F			
2010-09-02	18:00	F			
2010-09-02	18:00	F			
2010-09-03	8:30	M			
2010-09-03	8:30	F			
2010-09-03	8:30	F			
2010-09-03	8:30	F			
2010-09-04	8:30	M			
2010-09-04	8:30	M			
2010-09-04	8:30	M			
2010-09-04	8:30	F			
2010-09-04	8:30	F			
2010-09-04	8:30	F			
2010-09-04	8:30	F			
2010-09-04	12:45	F	730		
2010-09-04	12:45	F	715		
2010-09-05	14:15	F		yes	
2010-09-05	14:45	M		yes	
2010-09-05	14:45	F		yes	
2010-09-05	15:15	M		yes	
2010-09-05	8:00	F	815		
2010-09-05	8:00	M	680		
2010-09-05	8:00	M	670		
2010-09-05	8:00	M	910		
2010-09-05	8:00	F	705		
2010-09-05	13:00	F			

2010-09-05	14:15	M			
2010-09-05	14:15	M			
2010-09-05	14:15	M			
2010-09-05	14:15	M			
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2010-09-05	14:45	M			
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2010-09-05	15:15	M			
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2010-09-05	15:15	F			
2010-09-05	15:15	F			
2010-09-05	15:15	F			
2010-09-05	16:00	M	830		wounds
2010-09-05	16:00	M	920		
2010-09-05	16:00	F	755		
2010-09-05	16:00	M	820		
2010-09-05	16:00	M	935		
2010-09-05	16:00	F	925		
2010-09-05	16:00	F	935		
2010-09-05	16:00	M	785		
2010-09-05	16:00	F	720		
2010-09-05	16:00	F	735		
2010-09-05	16:00	F	710		
2010-09-05	16:00	F	775		
2010-09-05	16:00	M			
2010-09-05	16:00	M			
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2010-09-05	16:00	F			
2010-09-05	16:00	F			
2010-09-05	16:00	F			
2010-09-06	18:00	F	735	yes	
2010-09-06	8:00	F	695		
2010-09-06	8:00	F	770		
2010-09-06	8:00	F	790		
2010-09-06	8:00	F	690		scars
2010-09-06	8:00	M	795		
2010-09-06	8:00	F	715		
2010-09-06	8:00	M	885		side wound
2010-09-06	8:00	M	735		
2010-09-06	8:00	F	730		wounds
2010-09-06	8:00	M	660		
2010-09-06	8:00	F	655		
2010-09-06	8:00	F	705		
2010-09-06	8:00	M			
2010-09-06	8:00	F			
2010-09-06	13:30	M			
2010-09-06	13:30	F			
2010-09-06	13:30	F			
2010-09-06	13:30	F			
2010-09-06	13:30	F			
2010-09-06	13:30	F			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	M			
2010-09-06	14:30	F			
2010-09-06	14:30	F			

2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
2010-09-06	14:30	F			
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2010-09-06	15:30	F			
2010-09-06	15:30	F			
2010-09-06	15:30	F			
2010-09-06	15:30	F			
2010-09-06	15:30	F			
2010-09-06	15:30	F			
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2010-09-06	16:00	M			
2010-09-06	16:00	M			
2010-09-06	16:00	M			
2010-09-06	16:00	M			
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2010-09-06	16:00	F			
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2010-09-06	17:30	F			
2010-09-06	17:30	F			
2010-09-06	17:30	F			
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2010-09-06	17:30	F			

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2010-09-06	17:30	F			
2010-09-06	17:30	F			
2010-09-06	17:30	F			
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2010-09-06	18:00	M			
2010-09-06	18:00	M			
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2010-09-06	18:00	M			
2010-09-06	18:00	M			
2010-09-06	18:00	M	885		
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2010-09-06	18:00	F			
2010-09-06	18:00	F			
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2010-09-07	18:00	F		yes	
2010-09-07	8:00	F	820		
2010-09-07	8:00	M	755		
2010-09-07	8:00	M	820		scars
2010-09-07	8:00	M	745		
2010-09-07	8:00	F	705		
2010-09-07	8:00	F	780		
2010-09-07	8:00	F			
2010-09-07	8:00	F			
2010-09-07	16:30	M			
2010-09-07	16:30	M			
2010-09-07	16:30	M			
2010-09-07	16:30	M			
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2010-09-07	17:00	F			
2010-09-07	17:00	F			
2010-09-07	17:00	F			
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2010-09-07	18:00	M			
2010-09-07	18:00	M			
2010-09-07	18:00	M			
2010-09-07	18:00	F			
2010-09-07	18:00	F			
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2010-09-07	18:30	M			
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2010-09-07	19:00	F			
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2010-09-08	12:30	F		yes	
2010-09-08	8:00	M			
2010-09-08	8:00	M			
2010-09-08	8:00	M			
2010-09-08	8:00	M			
2010-09-08	8:00	F	710		scars
2010-09-08	8:00	F	725		
2010-09-08	8:00	F			
2010-09-08	8:00	F			
2010-09-08	8:00	F			
2010-09-08	8:00	F			
2010-09-08	8:00	F			
2010-09-08	8:00	F			
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2010-09-08	13:00	M			
2010-09-08	13:00	M			
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2010-09-08	13:00	F			

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2010-09-08	13:00	F			
2010-09-08	13:00	F			
2010-09-08	13:00	F			
2010-09-08	13:00	F			
2010-09-08	13:00	F			
2010-09-08	13:00	F			
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2010-09-08	15:45	M			
2010-09-08	15:45	F			
2010-09-09	16:30	F		yes	
2010-09-09	8:00	F			
2010-09-09	13:00	M			
2010-09-09	13:00	M			
2010-09-09	13:00	F			
2010-09-09	13:00	F			
2010-09-09	15:00	M			
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2010-09-09	17:30	F			
2010-09-09	17:30	F			
2010-09-09	17:30	F			
2010-09-09	18:00	F	745		
2010-09-09	18:00	M	930		
2010-09-09	18:00	F	705		
2010-09-09	18:00	F	725		
2010-09-10	17:00	F		yes	scars
2010-09-10	8:00	M	785		
2010-09-10	8:00	F	945		
2010-09-10	8:00	M	930		
2010-09-10	8:00	F	740		
2010-09-10	8:00	M	795		
2010-09-10	8:00	F			

2010-09-10	15:45	M			
2010-09-10	15:45	M			
2010-09-10	15:45	M			
2010-09-10	15:45	M			
2010-09-10	15:45	M			
2010-09-10	15:45	M			
2010-09-10	15:45	F			
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2010-09-11	15:00	F			
2010-09-11	15:00	F			
2010-09-11	15:45	M			
2010-09-11	15:45	M			wounds
2010-09-11	15:45	F			
2010-09-11	15:45	F			
2010-09-11	15:45	F			
2010-09-11	15:45	F			
2010-09-11	15:45	F			
2010-09-11	16:30	F			
2010-09-11	17:30	F			
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2010-09-11	17:30	F			
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2010-09-11	18:45	M			
2010-09-11	18:45	M			
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2010-09-12	8:15	M			
2010-09-12	8:15	F			
2010-09-12	8:15	F			
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2010-09-12	15:00	M			
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2010-09-12	15:00	F			
2010-09-12	15:00	F			
2010-09-12	15:00	F			
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2010-09-12	15:45	F			

2010-09-12	15:45	F			
2010-09-12	15:45	F			
2010-09-12	15:45	F			
2010-09-12	15:45	F			
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2010-09-12	16:15	M			
2010-09-12	16:15	M			
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2010-09-12	16:15	F			
2010-09-12	16:15	F			
2010-09-13	8:30	M	780		
2010-09-13	16:45	M			
2010-09-13	16:45	F			
2010-09-13	16:45	F			
2010-09-13	16:45	F			
2010-09-13	16:45	F			
2010-09-14	8:00	F	745		
2010-09-15	20:00	M		yes	
2010-09-15	8:00	M	750		
2010-09-15	19:00	F			
2010-09-15	20:00	M			
2010-09-15	20:00	M			
2010-09-15	20:00	F			
2010-09-16	19:00	F			
2010-09-16	19:30	M			
2010-09-16	19:30	F			wound
2010-09-18	18:00	F			
2010-09-18	18:15	M			
2010-09-18	18:15	M			scars
2010-09-18	18:15	M	760		
2010-09-18	18:15	F	720		
2010-09-18	18:15	F			
2010-09-18	18:15	F			
2010-09-18	19:15	M			
2010-09-18	19:15	F			
2010-09-22	19:30	F		yes	
2010-09-22	19:30	F			
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2010-09-25	13:00	M			
2010-09-25	13:00	M			
2010-09-25	13:00	M			
2010-09-25	13:00	M			
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2010-09-25	13:00	F			

2010-09-25	13:00	F			
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2010-09-25	14:15	M			
2010-09-25	14:15	F	715		
2010-09-25	14:15	M	695		
2010-09-25	14:15	F	690		
2010-09-25	14:15	F	705		
2010-09-25	14:15	F			
2010-09-25	14:15	F			
2010-09-25	14:15	F			
2010-09-25	14:15	F			
2010-09-25	14:15	F			
2010-09-25	15:45	M			
2010-09-25	15:45	M			
2010-09-25	15:45	M			
2010-09-25	15:45	M			
2010-09-25	15:45	M			wound
2010-09-25	16:30	F			wound
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	16:30	F			
2010-09-25	17:00	M			wound
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	M			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:00	F			
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2010-09-25	17:00	F			
2010-09-25	17:00	F			
2010-09-25	17:30	M			
2010-09-25	17:30	M			
2010-09-25	17:30	M			
2010-09-25	17:30	M			

2010-09-25	17:30	M			
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2010-09-25	17:30	M			
2010-09-25	17:30	M			
2010-09-25	17:30	M			
2010-09-25	17:30	M			
2010-09-25	17:30	F			
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2010-09-25	18:00	M			
2010-09-25	18:00	M			
2010-09-25	18:00	F			
2010-09-25	18:00	F			
2010-09-25	18:00	F			
2010-09-25	18:00	F			
2010-09-25	18:00	F			
2010-09-25	19:00	F	900		
2010-09-25	19:00	M	810		
2010-09-25	19:00	F	700		
2010-09-25	19:00	F	735		
2010-09-25	19:00	F	785		
2010-09-25	19:00	M	750		
2010-09-25	19:00	M	790		
2010-09-25	19:00	M	805		
2010-09-25	19:00	M			
2010-09-25	19:00	F			
2010-09-25	19:00	F			
2010-09-26	7:30	M			
2010-09-26	7:30	M			
2010-09-26	7:30	M			
2010-09-26	7:30	F			
2010-09-26	7:30	F			
2010-09-26	7:30	F			
2010-09-26	15:30	F			
2010-09-26	16:00	M			
2010-09-26	16:00	M			
2010-09-26	16:00	M			
2010-09-26	17:00	F			
2010-09-26	19:00	F			
2010-09-27	13:30	F		yes	
2010-09-27	8:00	M			
2010-09-27	8:00	M			
2010-09-27	8:00	M			

2010-09-27	8:00	F	765		
2010-09-27	8:00	F			
2010-09-27	8:00	F			
2010-09-27	8:00	F			
2010-09-27	8:00	F			
2010-09-27	13:30	M			
2010-09-27	13:30	M			
2010-09-27	13:30	M			
2010-09-27	13:30	M			head wound
2010-09-27	13:30	F			
2010-09-27	13:30	F			
2010-09-27	13:30	F			
2010-09-27	13:30	F			
2010-09-27	15:30	M			
2010-09-27	15:30	M			
2010-09-27	15:30	M			
2010-09-27	15:30	M			
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2010-09-27	15:30	F			
2010-09-27	15:30	F			
2010-09-27	15:30	F			
2010-09-27	15:30	F			
2010-09-27	15:30	F			
2010-09-27	16:00	M			red tag
2010-09-27	16:00	M			
2010-09-27	16:00	M			
2010-09-27	16:00	M			
2010-09-27	16:00	M			
2010-09-27	16:00	F			
2010-09-27	16:00	F			
2010-09-27	16:00	F			
2010-09-27	16:00	F			
2010-09-27	16:00	F			
2010-09-27	16:30	M			
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2010-09-27	16:30	M			
2010-09-27	16:30	M			
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2010-09-27	16:30	M			
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2010-09-27	16:30	M			
2010-09-27	16:30	M			
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2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			

2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	16:30	F			
2010-09-27	17:00	M			wound
2010-09-27	17:00	M			
2010-09-27	17:00	M			
2010-09-27	17:00	M			
2010-09-27	17:00	M			
2010-09-27	17:00	M			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	17:00	F			
2010-09-27	18:30	F	780		
2010-09-27	18:30	F	845		
2010-09-27	18:30	F			
2010-09-28	15:00	M		yes	
2010-09-28	15:00	F		yes	
2010-09-28	7:15	M	690		
2010-09-28	7:15	M	820		scar
2010-09-28	7:15	F	740		
2010-09-28	7:15	M	775		
2010-09-28	7:15	M	780		
2010-09-28	7:15	M	705		
2010-09-28	14:00	M			
2010-09-28	14:00	F			
2010-09-28	14:00	F			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	M			
2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	15:00	F			

2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	15:00	F			
2010-09-28	16:00	M			
2010-09-28	16:00	M			
2010-09-28	16:00	M			
2010-09-28	16:00	F			
2010-09-28	16:00	F			
2010-09-28	16:00	F			
2010-09-28	16:00	F			
2010-09-28	16:00	F			
2010-09-28	17:00	M			
2010-09-28	17:00	F			
2010-09-28	17:00	F			
2010-09-28	18:30	M	745		scars
2010-09-28	18:30	F	740		
2010-09-28	18:30	M	860		
2010-09-29	7:30	M	800		
2010-09-29	7:30	F	830		
2010-09-29	7:30	F	745		
2010-09-29	7:30	F	675		
2010-09-29	14:15	M			
2010-09-29	15:30	F			
2010-09-29	15:30	F			
2010-09-29	16:00	M			
2010-09-29	16:00	F			
2010-09-29	16:30	M			
2010-09-29	18:00	M			
2010-09-29	18:00	M			
2010-09-29	18:00	M			
2010-09-29	18:00	F			
2010-09-30	18:00	F			

Appendix Table 5. Staff gauge height, water and air temperature and weather conditions recorded at the Upper Sustut River Weir in 2010.

Date	Time	Staff Gauge Height (m)	Water Temperature (°C)		Air Temperature (°C)		Weather Conditions
			Max	Min	Max	Min	
2010-08-01	9:00	0.150					overcast, light rain
	20:00	0.145	*	*	20.5	-	partly clear
2010-08-02	9:00	0.145					completely clear
	20:30	0.140	*	*	25	2	clear
2010-08-03	8:30	0.135					clear
	19:45	0.135	*	*	27	1	clear
2010-08-04	8:30	0.135					clear, smoky
	20:00	0.125	*	*	26	2.5	partly cloudy
2010-08-05	8:45	0.120					clear, smoky
	20:00	0.125	*	*	24	6	drizzle
2010-08-06	8:45	0.145					mostly cloudy
	20:00	0.145	*	*	18	7	mostly cloudy
2010-08-07	8:30	0.160					overcast, light rain
	20:00	0.175	*	*	14	9	partly clear
2010-08-08	8:45	0.185					partly clear
	20:00	0.180	*	*	15	7	overcast
2010-08-09	8:45	0.175					partly clear
	20:00	0.165	*	*	16	6	cloudy
2010-08-10	8:45	0.155					completely clear
	19:45	0.145	*	*	23	-1	cloudy
2010-08-11	8:45	0.135					cloudy
	20:00	0.130	*	*	24	6	partly cloudy
2010-08-12	8:45	0.130					clear
	19:45	0.120	*	*	24	5	completely clear
2010-08-13	8:45	0.120					completely clear
	20:00	0.110	*	*	27	-2	completely clear
2010-08-14	9:00	0.105					completely clear
	20:00	0.105	15	11	28	2	completely clear
2010-08-15	8:45	0.011					completely clear
	21:00	0.100	19	11	31	2	completely clear
2010-08-16	8:45	0.095					high clouds
	20:30	0.090	19	11	28	1	clear
2010-08-17	8:45	0.090					clear, smoky
	19:15	0.085	19	11	30	1	completely clear
2010-08-18	8:30	0.085					mostly clear
	20:00	0.085	14	12	24	7	mostly cloudy
2010-08-19	9:00	0.080					partly clear
	18:30	0.085	13	11	16	4	cloudy
2010-08-20	8:45	0.075					overcast
	19:00	0.075	13	11	13	4	mostly clear
2010-08-21	8:45	0.070					clear patches
	19:30	0.070	13	6	13	-4	mostly cloudy
2010-08-22	9:15	0.065					high clouds
	19:00	0.055	10	6	13	-1	cloudy

2010-08-23	9:15	0.055					mostly clear
	19:45	0.055	9	5	12	1	overcast, raining
2010-08-24	9:15	0.060					overcast
	19:45	0.070	10	10	10	5	mostly cloudy
2010-08-25	9:00	0.095					overcast
	19:30	0.095	14	10	12	5	partly clear
2010-08-26	9:00	0.095					partly clear
	20:00	0.095	13	6	18	3	partly clear
2010-08-27	9:00	0.095					mostly cloudy
	19:00	0.095	14	10	19	3	mostly clear
2010-08-28	9:15	0.080					mostly clear
	19:45	0.080	13	10	19	-2	partly cloudy
2010-08-29	9:15	0.075					mostly clear
	19:00	0.075	14	10	18	1	mostly clear
2010-08-30	8:45	0.075					high broken clouds
	21:30	0.085	9	6	15	-3	drizzle
2010-08-31	8:30	0.085					overcast, light rain
	19:00	0.095	9	9	8.5	4.1	overcast, light rain
2010-09-01	11:00	0.100					mostly cloudy
	19:30	0.150	10	10	15	3.9	mostly cloudy
2010-09-02	8:00	0.150					drizzle
	19:00	0.130	10	10	12.4	4.3	mostly cloudy
2010-09-03	8:30	0.135					cloudy
	19:30	0.150	10	10	12	6	mostly cloudy
2010-09-04	8:30	0.185					overcast
	19:00	0.185	9	8	7.9	3.1	drizzle
2010-09-05	8:00	0.210					mostly clear
	19:15	0.200	10	10	12.5	0.9	mostly cloudy
2010-09-06	8:00	0.195					drizzle
	19:45	0.200	10	10	13.2	4.3	mostly clear
2010-09-07	8:00	0.195					mostly cloudy
	20:00	0.190	10	10	20.3	1.1	partly cloudy
2010-09-08	7:45	0.180					partly cloudy
	19:00	0.170	11.5	10.5	17.1	1.5	mostly cloudy
2010-09-09	8:00	0.165					partly cloudy
	19:00	0.155	12	10	15.5	1.3	mostly cloudy
2010-09-10	8:00	0.155					drizzle
	19:00	0.145	9.5	9.5	12.3	1.8	mostly cloudy
2010-09-11	8:15	0.135					light rain
	19:00	0.140	9	6.5	7.7	1.1	some clearing
2010-09-12	8:15	0.140					partly sunny
	19:00	0.135	9	6	10.3	2.1	partly sunny
2010-09-13	8:30	0.125					mostly cloudy
	20:00	0.115	8	6	15.3	-4.6	mostly clear
2010-09-14	8:00	0.110					clear and sunny
	19:00	0.100	9	6	17.1	-6.7	mostly clear
2010-09-15	8:00	0.090					clear
	20:00	0.090	8	6	14.9	-6.9	mostly clear
2010-09-16	8:30	0.090					mostly clear
	19:30	0.085	8.5	6	17.5	-7	partly cloudy
2010-09-17	8:15	0.080					clear

	19:30	0.080	8	6	18.1	-7.3	partly cloudy
2010-09-18	8:00	0.075					clear
	19:30	0.075	8	6	18.7	-6.9	mostly cloudy
2010-09-19	8:00	0.080					cloudy
	18:00	0.075	8	6	9.1	0.6	partial clearing
2010-09-20	7:45	0.075					partly clear
	19:00	0.070	7	6	12.9	-4.7	completely clear
2010-09-21	7:45	0.070					clear
	19:00	0.065	7	6	13.9	-9.7	mostly clear
2010-09-22	8:30	0.065					overcast
	19:15	0.060	7	6	10.9	-7.1	partly cloudy
2010-09-23	7:45	0.055					cloudy
	19:15	0.055	7	6	9	2	partly clear
2010-09-24	7:15	0.055					cloudy, light rain
	19:00	0.075	7	5	6	1	drizzle
2010-09-25	7:30	0.115					overcast, drizzle
	19:15	0.175	7	6	9.1	2.9	mostly cloudy, clearing
2010-09-26	7:30	0.170					mostly cloudy, drizzle
	19:15	0.160	7.5	6	10.3	2	overcast, drizzle
2010-09-27	8:00	0.175					overcast, drizzle
	19:00	0.220	-	-	10.3	2	overcast, light rain
2010-09-28	7:15	0.270					some clearing, drizzle
	19:00	0.295	8	6	9.5	4.1	clearing, partly cloudy
2010-09-29	7:30	0.270					cloudy
	18:30	0.255	7	6	7.3	7.3	cloudy
2010-09-30	8:30	0.230					clear
	19:30	0.230	8	6	10.7	-3	clear

*Note – Water temperature not manually checked until August 15, 2010 as necessary equipment was not on site.