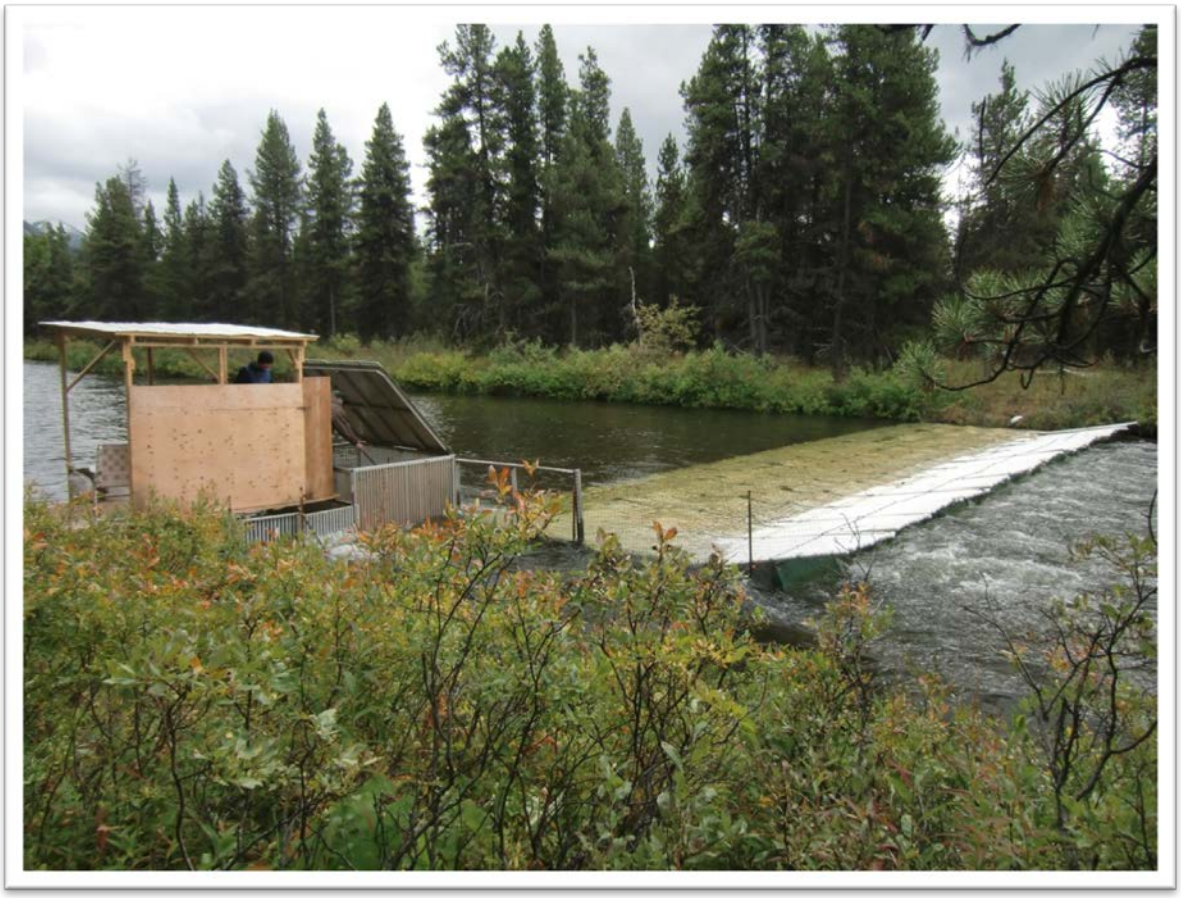
Enumeration of Adult Steelhead in the Upper Sustut River, 2015



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Executive Summary

From August 1 to September 30, 2015, a fish fence was in operation on the upper Sustut River. This fence is used to count migrating summer-run Steelhead (*Oncorhynchus mykiss*) and provides annual monitoring information for this species. Nine hundred and forty three Steelhead were counted crossing the fence during this project in 2015. This is the ninth highest recorded escapement over the past twenty-two years, 28% higher than the historical average annual count for this project (n=737).

The first Steelhead migrated through the fence on August 6 and by September 10, 50% of the Steelhead had passed the fence. The last recorded fish travelled past the fence on September 30. The cumulative proportional distribution of Steelhead over time indicates that approximately half (52%, n=495) of Steelhead counted crossed the fence in four days, on August 31 (n=156), September 9 (n=93), September 10 (n=83) and September 19 (n=163). Steelhead were counted on 46 days of this 61 day project.

Of the 943 Steelhead that migrated past the fence in August and September, 642 (68%) were female and 301 (32%) were male resulting in a female to male ratio of 2.13:1. This is the highest female to male ratio recorded for this project.

A total of 63 male and 125 female Steelhead were measured for nose-fork length. Male lengths ranged from 665 to 950 mm and female lengths ranged from 645 to 865 mm. Statistical analysis indicates that the mean length for female Steelhead ($\overline{x}$=743, SD=47, n=125) was significantly smaller than the mean length of male fish ($\overline{x}$=804, SD=66, n=63),

Gillnet marks were present on 2% (n=14) of all Steelhead that passed through the fence in 2015. Fish with gillnet marks arrived at the fence between August 29 and September 28, with half of marked fish arriving during a one week period between August 14 and August 21. Twelve of the Steelhead observed with net marks were female and 2 were male.

Water temperature at the Sustut fence ranged between 8.4°C and 10.1°C, averaging 9.1°C. Levels ranged from 0.21 m on August 17 to 0.50 m on August 31 and averaged 0.30 m. Comparison of mean water level at the Sustut fence in 2015 to historical measurements was not possible as the staff gauge was moved 100 m upstream from its former position. Given that stream flows at the fence site have been previously documented as declining and this can negatively impact Steelhead populations, continued monitoring of this variable in a consistent manner is warranted.

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. Evaluation of methods for stream temperature, stream discharge and air measurement should also be conducted. Following best practices is necessary to ensure this project accurately monitors these variables and can serve as a fisheries and climate change indicator in the Skeena Region.

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1.0 Introduction

Since 1994, the upper Sustut River Steelhead (*Oncorhynchus mykiss*) stock has been measured in a standardized manner at a counting fence during the months of August and September. This information provides insight into annual adult escapement for the stock and is believed to demonstrate trends in the abundance of all early summer-run Steelhead in the Skeena watershed. Perpetual concerns exist regarding the conservation of early summer-run Steelhead stocks in the Skeena watershed as their run timing coincides with marine mixed stock commercial fisheries for sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon where they are incidentally captured (Ward *et al.*, 1993; Cox-Rogers, 1994). Due to the long distance of their freshwater migration, Sustut River Steelhead are also exposed to First Nations and recreational fisheries where they are also intercepted and potentially harvested.

Upper Sustut River Steelhead are a unique population within the Skeena River watershed (Beacham *et al.*, 2012). 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. Angling is prohibited from January 1 to June 15 and in a zone above the BC Railway bridge near the Bear-Sustut river confluence (all year) to protect overwintering, spawning and emigrating Steelhead. There is no access to the section of river below the railway bridge via road; anglers most commonly reach this area by helicopter or jet boat from fishing lodges on the lower Sustut River.

The objectives of the upper Sustut River enumeration project are to:

1. enumerate the upper Sustut River summer-run Steelhead population
2. examine the sex ratio of Steelhead throughout the run
3. investigate the number and distribution of gillnet marked Steelhead throughout the run
4. examine the effect of water level and temperature on Steelhead migration
5. 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 are also recorded during operation of the Sustut fence. Salmon data is forwarded to Fisheries and Oceans Canada for analysis and archiving (Appendix Table 1).

2.0 Study Area

The Sustut River is a tributary of the upper Skeena River, located in north central British Columbia (Figure 1). It originates in the Omineca Mountains approximately 200 km north of Smithers, B.C. and flows for approximately 108 km from the outlet of Sustut Lake to the Skeena River. 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 Steelhead, Chinook, Sockeye, Coho, Bull trout, Dolly Varden (*S. malma*), Rocky Mountain whitefish and Burbot (*Lota lota*)(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; Figures 1 and 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).

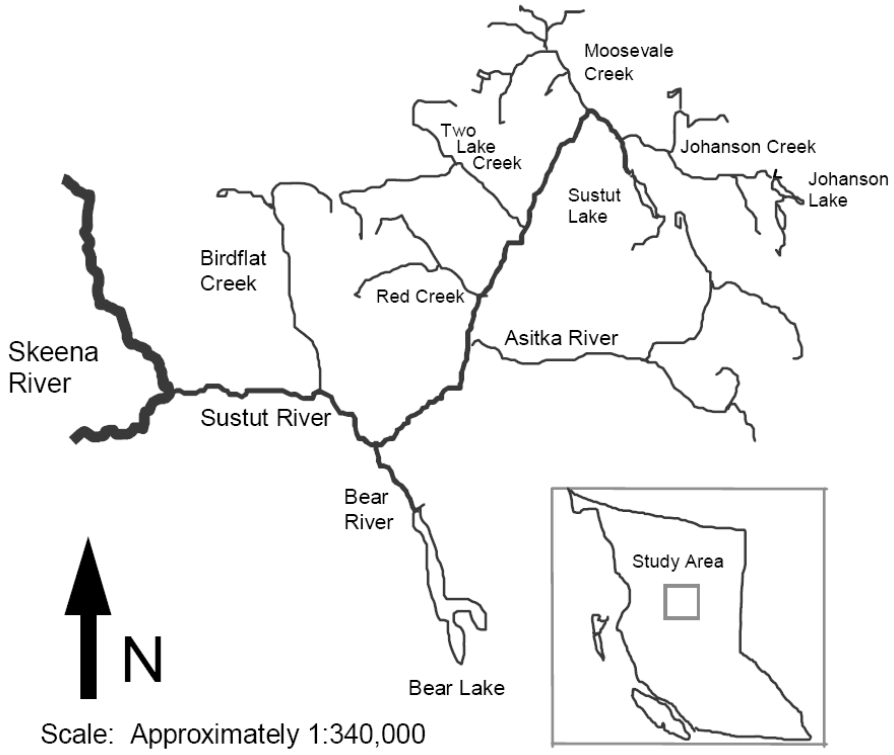

Figure 1. Sustut River and surrounding tributaries (from Saimoto, 1995).

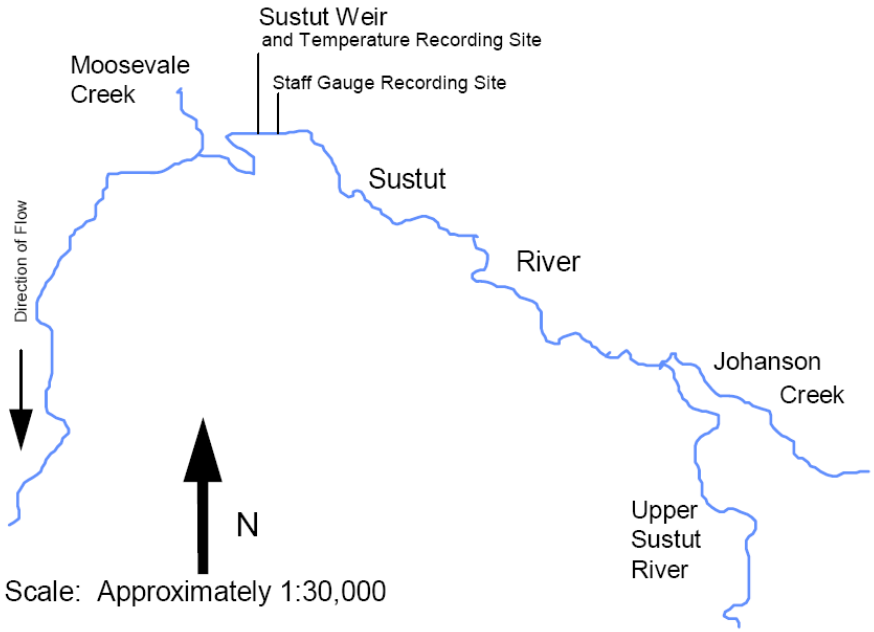

Figure 2. Weir location on the Sustut River (from Diewert, 2005).

Figure 3. Relocation of weir approximately 100 m upstream on the upper Sustut river.

3.0 Methods

3.1 Steelhead Enumeration

A floating fish fence constructed from 3.8 cm PVC pipe was installed in the Sustut River 600 m upstream of the Moosevale Creek confluence (Figures 2 and 3). This is approximately 97 km upstream from the confluence between the Skeena and Sustut rivers. The fence was in operation between August 1 and September 30, 2015. 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 (Figures 5, 6 and 7).

It is important to note the Sustut weir was repositioned in 2015, to a new location approximately 100 m upstream (Figures 3 and 4). This was completed as the fence sill was becoming undermined due to bedload movement at its former location. The fence operator determined that moving the fence site was easier than attempting to restore the original location (where it has been for the last 21 years). The new fence position places it further upstream of a large holding pool (Figure 8) and is believed to pass fish more effectively (Mark Beere personal communication).

The total count of Steelhead migrating past the fence between August 1 and September 30 has historically reflected 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 believed to demonstrate trends in Steelhead abundance for other upper Skeena tributaries. A count of Steelhead crossing the fence after September 30 is periodically recorded, in addition to Steelhead holding below the fence upon its removal. This information is not added to total counts as it is not consistently measured. In some years, water clarify is limited and accurate visual counts are not possible.

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 delays or halts migration (Ron Steffey personal communication). Therefore, the removal of debris and carcasses from the fence was limited to avoid affecting fish migration.

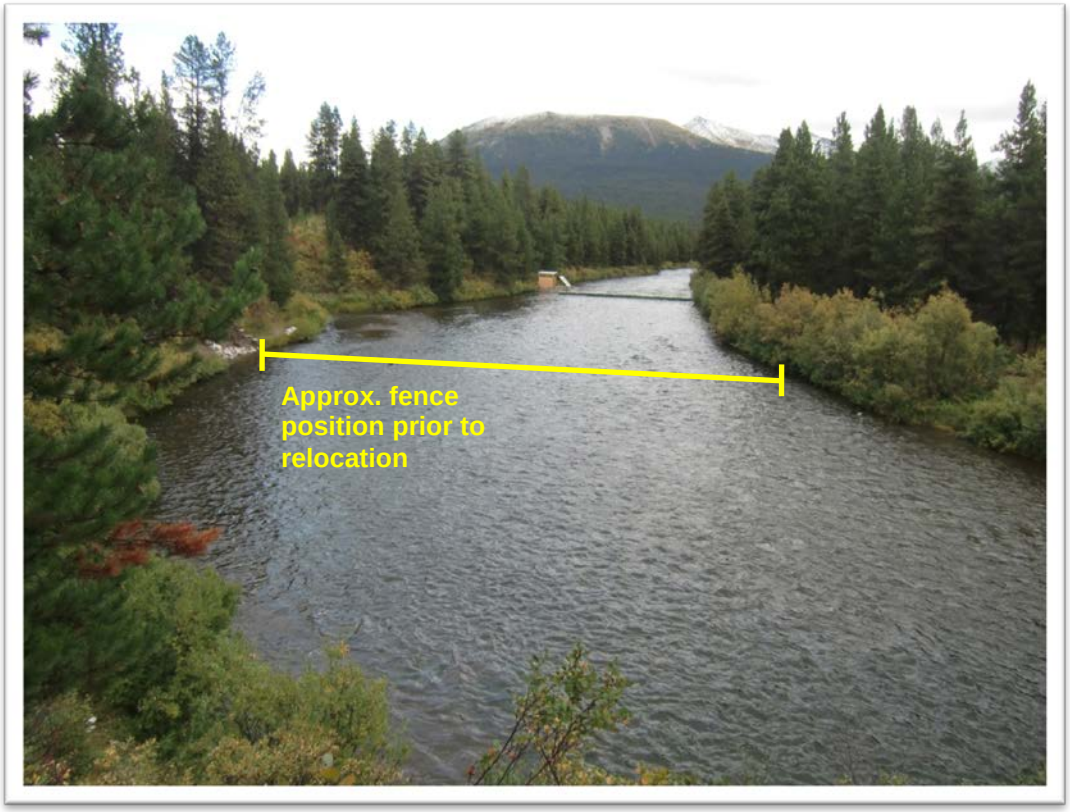

Figure 4. Upper Sustut Steelhead enumeration fence looking upstream. Note fence was relocated approximately 100 m upstream in 2015. Photo credit Mark Beere.

Figure 5. Steelhead enumeration fence looking downstream. Photo credit Mark Beere.

Figure 6. Steelhead enumeration fence looking upstream. Photo credit Mark Beere.

Figure 7. Trap box entrance looking upstream. Photo credit Mark Beere.

Figure 8. Fish holding in pool directly downstream of former fence location.

Figure 9. Repositioned staff gauge upstream of the Sustut fence. Photo credit Mark Beere

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 10).

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.

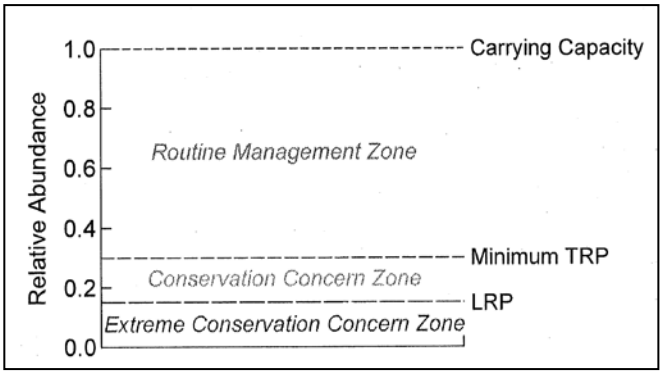

Figure 10. Management framework for the upper Sustut Steelhead population. The locations of the minimum TRP and LRP are for illustrative purposes only.

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 10). 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 adult production estimates exist for the upper Sustut River Steelhead population (884; 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 stock including early run timing, distance and elevation gained during migration ("mile high" Steelhead) and the unique genetic heritage associated with these traits (Beacham *et al.*, 2012).

3.3 Steelhead Biological Information

Experienced personnel using the visual characteristics described in Scott & Crossman (1973) and McPhail & 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 Steelhead passing through the fence were sub-sampled. This was conducted near the apparent end of a "run" to avoid deterring migration past the fence.

Steelhead lengths were collected by netting fish from the trap box (Figures 5 and 7) 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 that migrated past the fence to the extent possible. The plexiglass viewing box allowed this information to be collected and avoided the need to handle fish. In some cases, not all fish with net marks may have been recorded due to turbid water conditions or limited observation time during high rates of migration.

3.6 Water Temperature and Level Measurement

Onset Hobo Pro v2® temperature loggers were placed in the river and in the air near the fence site to record hourly water and air temperatures. The water temperature loggers were placed at the upstream and downstream sides of the trap box respectively (about 2.5 meters apart) and have been secured in consistent locations annually since the current fence technicians (the Steffey family) began operating the fence. Hourly data from the two water temperature loggers was averaged. For backup purposes, stream water and air temperatures were recorded each day using a 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.

As previously noted, the Sustut weir was repositioned in 2015, to a new location approximately 100 m upstream. The staff gauge used for measuring water level was also moved and was fixed upstream of the fence site (Figure 9). Moving the staff gauge has implications for this project, which are provided in the discussion and recommendations sections of this report.

3.7 Male and Female Steelhead Run Timing

Run timing of male and female Steelhead was examined by plotting the cumulative percent of male and female Steelhead 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, 943 Steelhead migrated past the upper Sustut River fence. This value is above the long term average (n=737; Table 1) and represents the ninth highest recorded Steelhead count since 1994 (Figure 11). On the morning of fence removal (October 1, 2015), 16 Steelhead crossed the fence and at least another 20 fish (species unknown) were observed in the pool located downstream of the fence.

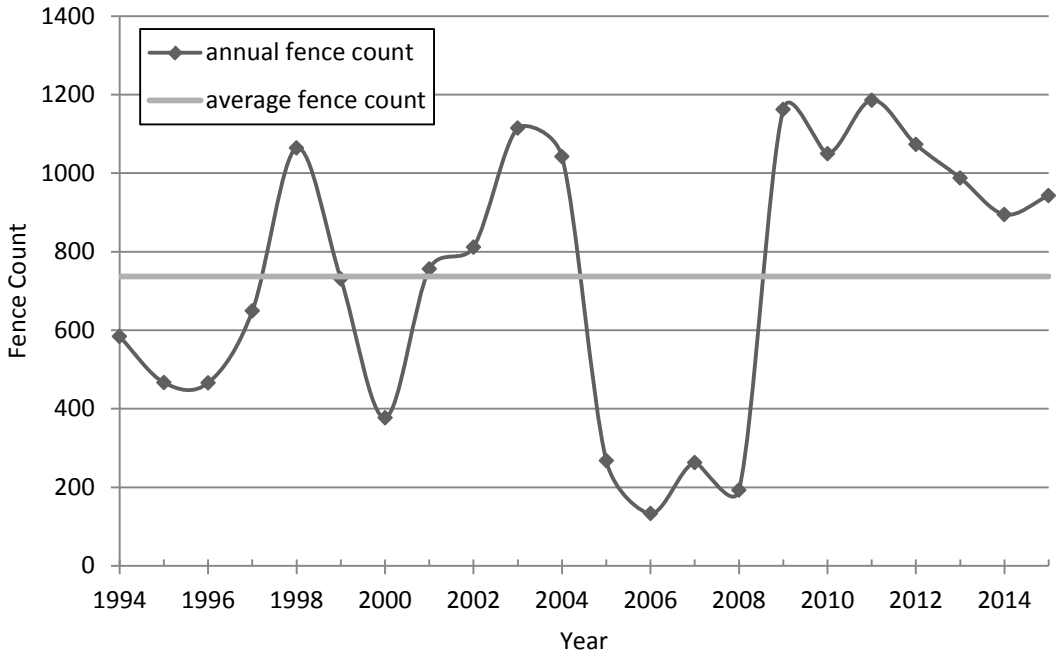

Figure 11. Annual fence count of Steelhead at the upper Sustut River weir

The first Steelhead migrated past the fence on August 6 and by September 10, 50% of the Steelhead enumerated had passed the fence (Table 1). Since 1994, the date on which the

first Steelhead arrived has ranged between July 28 and August 17. Information collected prior to 1994 was not included due to the variation in fence design and location.

Table 1. Arrival timing, total fence count and mean water temperature and level

Year	Arrival Date of First Steelhead	Date of 50% Migration	Fence Count (Aug-Sept)	Rank	Mean water temperature (°C)	Mean water level (m)
1994	08-Aug	29-Aug	584	15	-	-
1995	08-Aug	08-Sep	467	16	-	-
1996	17-Aug	07-Sep	466	17	-	-
1997	09-Aug	13-Sep	649	14	-	-
1998	03-Aug	07-Sep	1064	5	-	0.27
1999	17-Aug	17-Sep	731	13	-	0.28
2000	08-Aug	07-Sep	377	18	-	0.3
2001	15-Aug	16-Sep	756	12	-	-
2002	09-Aug	02-Sep	812	11	-	0.23
2003	03-Aug	02-Sep	1115	3	-	0.31
2004	28-Jul	03-Sep	1042	7	-	0.34
2005	31-Jul	03-Sep	268	19	8.81	0.32
2006	09-Aug	04-Sep	133	22	8.71	0.21
2007	09-Aug	09-Sep	263	20	8.81	0.16
2008	08-Aug	07-Sep	193	21	9.11	0.23
2009	06-Aug	03-Sep	1162	2	9.61	0.2
2010	03-Aug	06-Sep	1050	6	8.91	0.12
2011	13-Aug	08-Sep	1186	1	8.65	0.27
2012	11-Aug	05-Sep	1073	4	9.29	0.15
2013	03-Aug	06-Sep	988	8	10.1	0.096
2014	03-Aug	20-Sep	895	10	9.31	0.11
2015	06-Aug	10-Sep	943	9	8.38	0.30
Minimum	28-Jul	29-Aug	133	-	8.38	0.10
Maximum	17-Aug	17-Sep	1186	-	10.10	0.34
Average	-	-	737	-	9.06	0.23

Notes:
1 - Total fence count does not include fish counted in the downstream pool following weir removal
2 – Staff gauge used to measure water level was replaced in 2007 or 2008. It was moved again in 2015 approximately 100 m upstream of its former position to accommodate a similar re-location of the fence.

The cumulative proportional distribution of Steelhead over time indicates that approximately half (52%, n=495) of Steelhead counted crossed the fence in four days, on August 31 (n=156), September 9 (n=93), September 10 (n=83) and September 19 (n=163). Steelhead were counted on 46 days of this 61 day project.

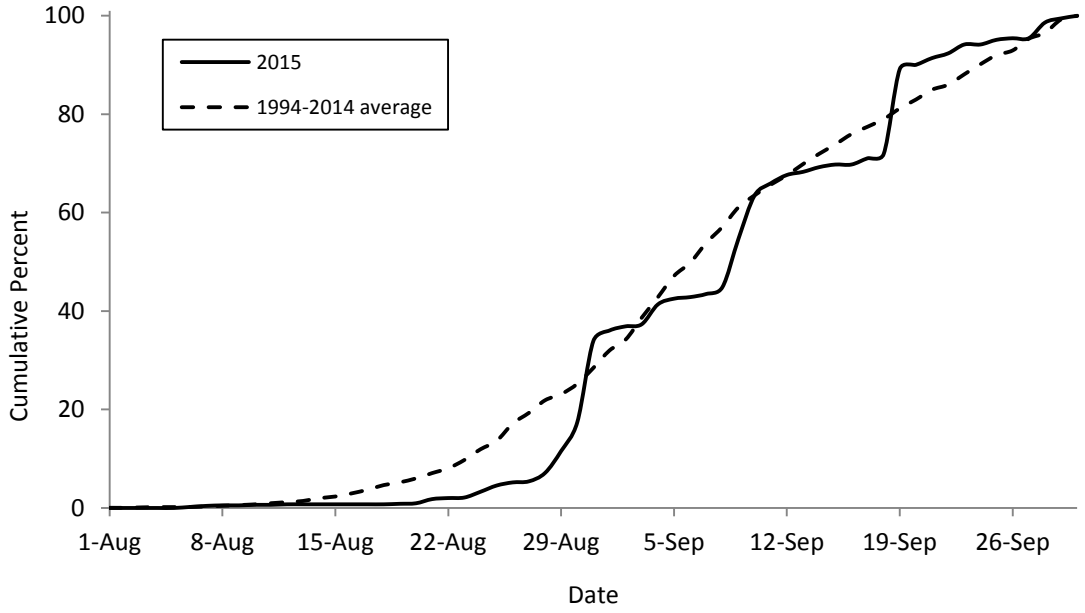

Figure 12. Daily cumulative percentage of upper Sustut River Steelhead migrating past the fence.

4.2 Management Framework

Steelhead counts at the Sustut fence have been at or above the Routine Management Zone for the last seven years. This is a significant increase compared to the preceding four years when the upper Sustut spawning population was within the Conservation Concern Zone and Extreme Conservation Concern Zone (Figure 13). The 943 Steelhead that crossed the fence represents 91% of the estimated adult production potential for the upper Sustut River (*n*=1036).

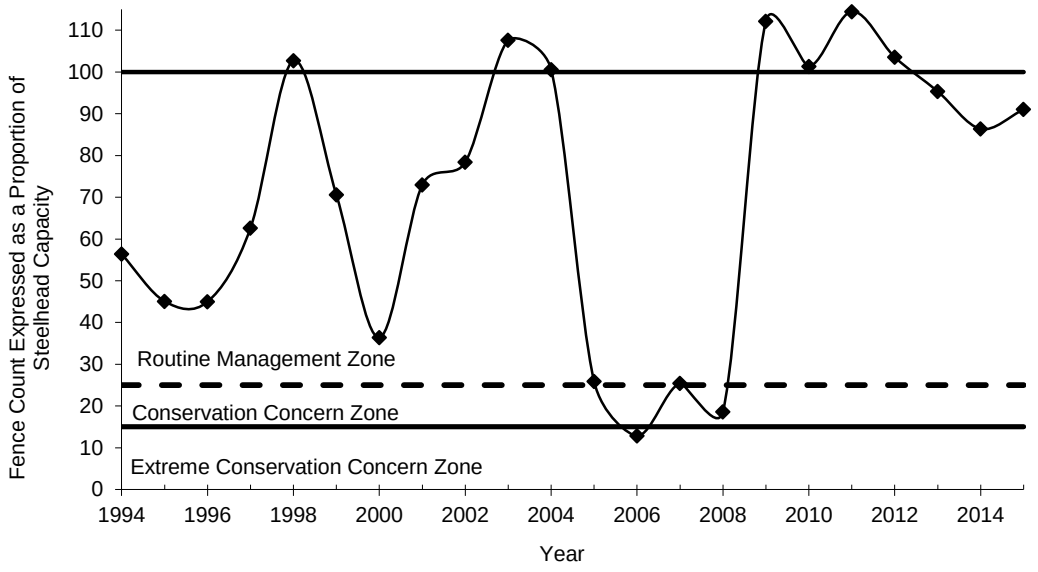

Figure 13. Annual Steelhead fence count expressed as a proportion of adult Steelhead capacity. LRP and TRP thresholds are based on Johnston *et al.* (2002) and carrying capacity is based on Tautz *et al.* (1992).

4.3 Steelhead Biological Information

4.3.1 Scale analysis and age determination

In 2015, scales were removed from 194 Steelhead that crossed the upper Sustut River fence. Relative to the total number of fish counted during the study period, this represents a sampling rate of 21%. These scales were analyzed to determine length of freshwater and ocean residency and incidence of spawning events. Ninety four percent of the scales (n=183) were classified as being in partially or fully readable condition (Appendix Table 2; condition codes 1, 3, 5, 5a, 6, 8, 9). The remaining scale samples (n=11) were not included in the analysis below as they were in poor condition or were questionable in age (condition code 2).

The number of freshwater annuli identified on all readable scale samples ranged from three to five. The predominant freshwater age was four and represented 79% (n=120) of the scales sampled with this information (n=152). Freshwater age three and five represented 3% and 18% of the sample respectively. The number of marine annuli (prior to the first spawning event) ranged from one to four. The predominant marine age was two (n=133) and represented 73% of scales sampled with this information (n=183). This is consistent with the modal ocean age of Steelhead returning to rivers throughout the province (McPhail, 2007). Maiden Steelhead (those that have not previously spawned) represented 92% (n=168) of the sample and 8% (n=15) of the scales showed evidence at least of one previous spawning event. Including all life history phases (i.e. freshwater and marine components), Steelhead sampled for this project were found to be in their 6^{th} year of life to their 10^{th} year of life. Approximately 90% (n=136) of fish with scales removed were maidens in their 7^{th} or 8^{th} year of life.

Fish age was determined by adding freshwater and marine residency periods and spawning checks. For example, a Steelhead reported as 3.2S1 was deemed to have lived for approximately three years in freshwater, followed by two years in the ocean, it returned to spawn once, then returned to the ocean and was sampled during its second spawning migration. This adds to seven years plus the current year, and is reported as an individual in its 8^{th} year of life.

Age information from all fish sampled in 2015 is presented in Appendix Table 3.

4.3.2 Length measurement and size distribution

A total of 63 male and 125 female Steelhead were measured for nose-fork length. Male lengths ranged from 665 to 950 mm and female lengths ranged from 645 to 865 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 14).

To compare the lengths of male and female Steelhead, a two sample t-test for unequal variances was used. This statistical analysis found that the mean length for female Steelhead ($\overline{x}$=743, SD=47, n=125) was significantly smaller than the mean length of male fish ($\overline{x}$=804, SD=66, n=63), meaning that male fish measured in 2015 were on average larger than female fish; $t(95) = 6.63$, $p<0.05$.

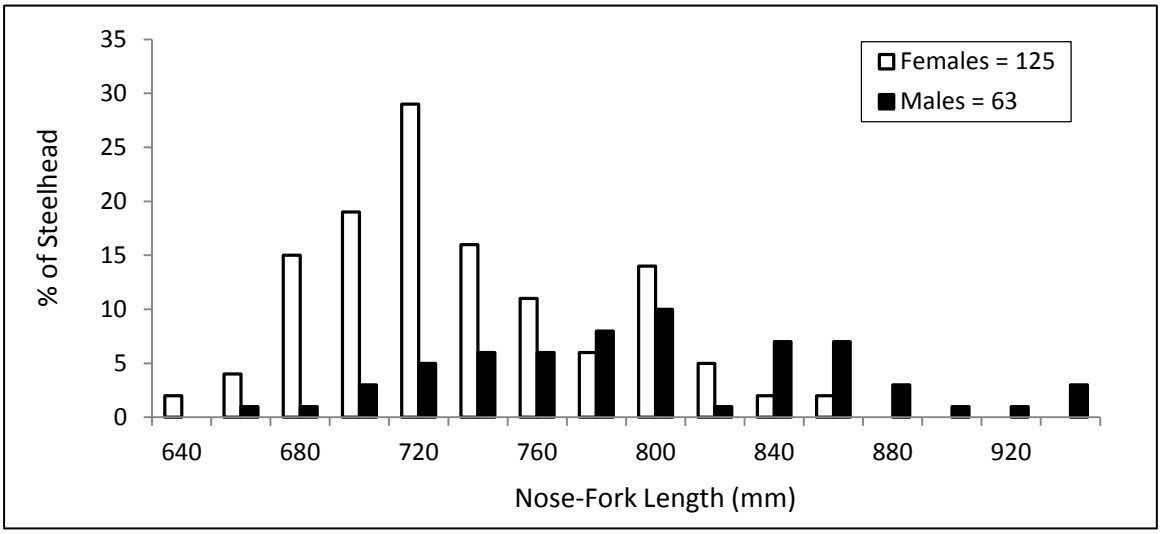

Figure 14. Percentage of male and female Steelhead by 20 mm categories of nose-fork length.

4.3.3 Sex ratio

Of the 943 Steelhead that migrated past the fence in August and September, 642 (68%) were female and 301 (32%) were male resulting in a female to male ratio of 2.13:1. This is the highest female to male ratio recorded for this project, with the lowest recorded at 1.23:1 in 1995 (Table 2).

4.3.4 Mortalities

There were no Steelhead mortalities observed at the fence during this project in 2015.

4.4 Steelhead Tagging

There were no Steelhead observed with tags at the fence in 2015.

4.5 Steelhead Gillnet Marks

Fence observers recorded the presence of gillnet marks on Steelhead to the extent possible. Gillnet marks were present on 2% (n=14) of all Steelhead that passed through the fence in 2015. Fish with gillnet marks arrived at the fence between August 29 and September 28, with half of marked fish arriving during a one week period between August 14 and August 21.

Twelve of the Steelhead observed with net marks were female and 2 were male. Given the small sample size and lack of complete length data of gillnet marked fish, additional comparisons between unmarked and marked fish were not conducted.

Table 2. Upper Sustut River Steelhead enumeration data.

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	4.000	-	-	6.0	1.23:1
1996	829	739	1.3	2.800	-	-	14.0	1.58:1
1997	814	733	0.6	1.500	9.2	17.8	15.4	1.43:1
1998	827	749		0.800	13.4	13.8	13.7	1.73:1
1999	848	756	2.5	0.300	6.1	9.9	8.5	1.64:1
2000	827	741	0.4	0.500	10.6	16.2	14.1	1.64:1
2001	864	771	2.5	1.900	10.1	14.5	12.8	1.63:1
2002			1.9	0.500	3.6	8.4	6.3	1.27:1
2003	780	730	1.2	0.300	8.3	14.2	11.8	1.39:1
2004	818	745	-	0.300	6.0	8.8	7.7	1.48:1
2005	859	741	19.0	0	3.3	5.5	4.8	2.01:1
2006	-	-	-	0	0.5	1.6	2.3	1.50:1
2007	-	-	-	0.004	2.7	4.6	3.8	1.39:1
2008	-	-	-	0.010	4.5	2.4	3.1	1.92:1
2009	-	-	-	0.300	0.7	1.5	1.2	1.66:1
2010	793	746	1.0	0	0.9	2.6	1.9	1.48:1
2011	824	756	10.3	0.300	3.7	8.0	6.4	1.73:1
2012	801	728	5.3	0.700	2.7	2.4	2.5	1.65:1
2013	816	752	9.2	0.600	0.5	0.5	1	1.96:1
2014	773	724	6.4	0.002	6.3	4.8	5.4	1.69:1
2015	804	743	8.2	0	0.2	1.3	1.5	2.13:1
Minimum	773	724	0.4	0	0.2	0.5	1.0	1.23
Maximum	864	771	19.0	4.0	13.4	17.8	15.4	2.01
Mean	819	743	4.7	0.7	4.9	7.3	6.6	1.62

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

4.6 Water Temperature

Water temperature was recorded hourly by a data logger from August 1 to September 30. As two devices were used simultaneously to gather this information, the average hourly temperature value was used for this report. It is important to note that the difference in hourly measurements from these devices ranged from 0.12 to 0.22°C, and was considered acceptable for the purposes of this study (accuracy specifications for Onset Hobo Pro v2 data loggers are ±0.21°C from 0° to 50°C).

The lowest temperature was recorded on September 21 (0800 hrs) at 2.8°C and the highest temperature was recorded on August 6 (1800 hrs) at 15.1°C (Figure 15). Since 2005, the average water temperature at the Sustut fence has ranged between 8.4°C and

10.1°C, averaging 9.1°C (Table 1). It is important to note the average value of hourly water temperature measurements in August and September combined was the lowest on record for this project. It is possible this is a result of moving the fence site in 2015 and recording this information at a new location and in a differing habitat type (new site is in a riffle habitat where the river is narrower and lower gradient; old site was at the head of a pool with a slightly higher gradient).

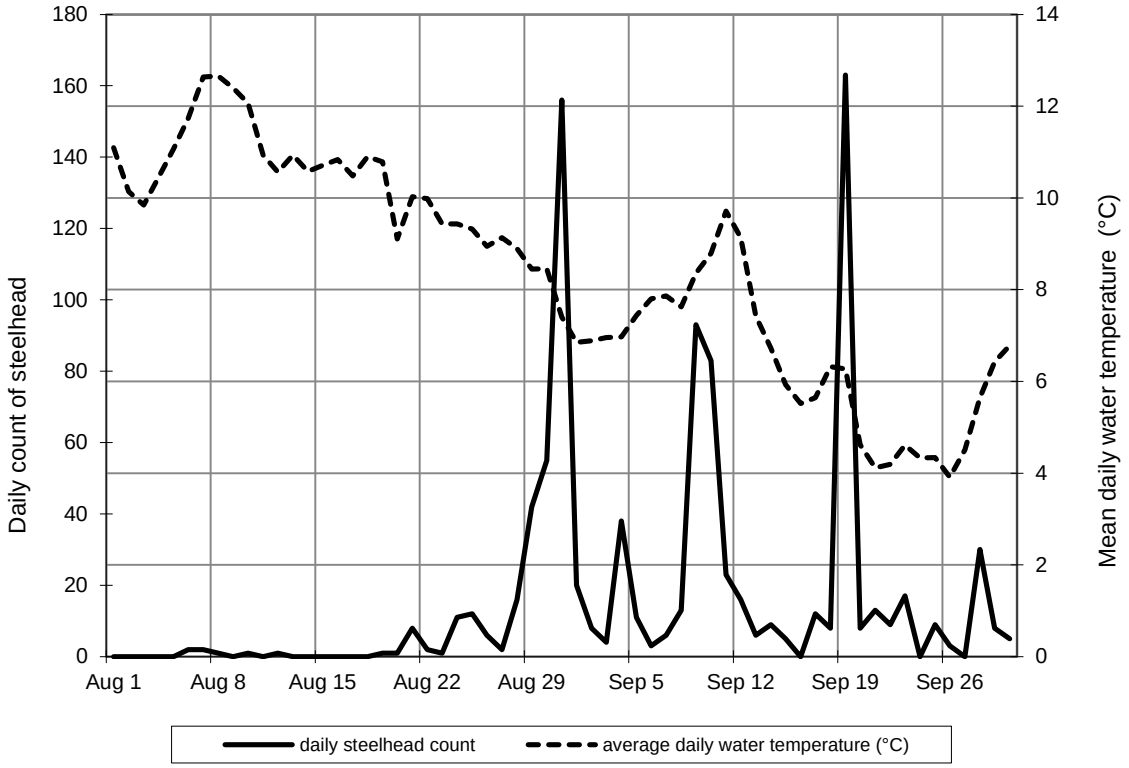

Figure 15. Mean daily water temperature and the number of Steelhead migrating past the Sustut fence.

4.7 Water Level

From August 1 to September 30, 2015, water levels ranged between 0.21 m (August 27) and 0.50 m (August 31; Figure 16). Water level measurements recorded for this project in 2015 could not be compared to historical values as the staff gauge was relocated in 2015. It was fixed within a narrower and lower gradient section of river than the former position.

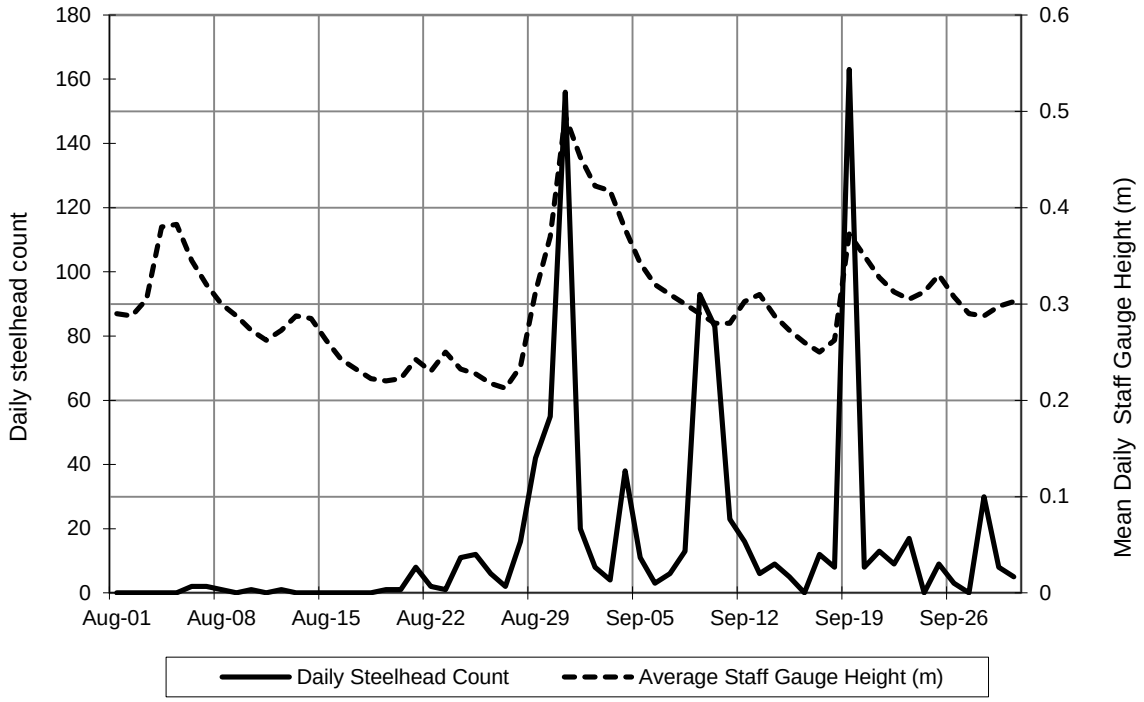

Figure 16. Mean daily staff gauge height and the number of Steelhead migrating past the Sustut fence.

4.8 Male and Female Steelhead Run Timing

The first female Steelhead passed through the fence on August 6 and the first male arrived on August 7. The date when 50% of female and male Steelhead had migrated past the fence was September 9. A comparison between the cumulative percentage of female and male Steelhead crossing the fence and their arrival date indicates that female and males had corresponding migration timing (Figure 17).

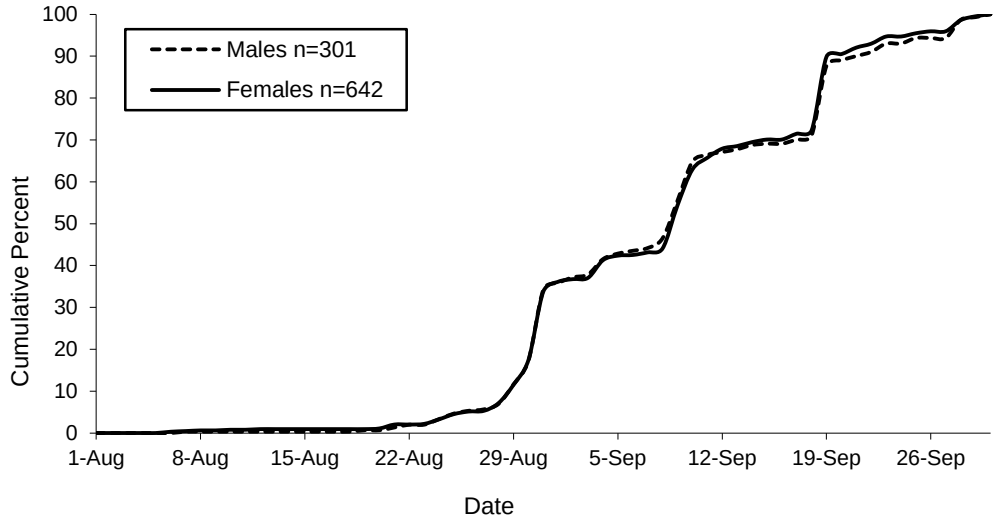

Figure 17. Daily cumulative percent of male and female Steelhead migrating past the fence.

5.0 Discussion

The objectives for this project were to enumerate the upper Sustut River summer-run Steelhead population and 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 addresses these objectives by discussing the 2015 results and making linkages to historical findings part of this ongoing monitoring project.

5.1 Enumeration of Upper Sustut River Summer-Run Steelhead

In 2015, the upper Sustut fence Steelhead count from August 1 to October 1 was 943. This value is the ninth highest since enumeration methods were standardized in 1994. During the last 20 years, fence counts have ranged from 133 (2006) to 1186 (2011). The 2015 population index value was approximately 28% above the long term average (n=737).

5.2 Management Framework

According to a habitat based productivity model developed for the Skeena drainage (Tautz *et al.*, 1992) the 943 Steelhead that migrated past the upper Sustut fence in 2015 was 9% below the estimated adult production at capacity for the system (1036 Steelhead).

In the context of interpreting annual fence count data relative to adult production potential thresholds, a factor to consider is the proportional difference between escapement measured in August and September and total adult returns to the upper Sustut River. In recent years, a large number of Steelhead have been observed moving through the fence site near the end of the project. For example, in 2014, 44% (n=394) of all Steelhead counted crossed the fence in the second to last day of this project. Further, in 2010 and 2012, 24% and 17% of all Steelhead counted crossed the fence in the last 10 days of September, which raises questions regarding the number of Steelhead that enter the upper Sustut after the fence is removed on October 1. Comparisons made between annual fence counts and adult production capacity estimates (Tautz *et al.*, 1992; Figure 13) rely on the assumption that fence counts represent total escapement into the Upper Sustut watershed. Based on the examples above, additional work is required assess the proportion of Steelhead entering the upper Sustut after fence removal. This may be achieved by extending fence operations into October in years when environmental conditions allow this to occur.

Since 1994, increases in Steelhead abundance have been followed by declines. Low returns during the 2005 to 2008 period fell within the conservation concern and extreme conservation concern zones (Figure 13). In light of this variability, management approaches must exercise caution. Potential impacts from climate change (Tydemers & Ward, 2001), shifts in freshwater and/or marine survival (Smith & Ward, 2000), interception in commercial salmon fisheries and losses from overwintering mortality (estimated at 11%; Beere, 1999) may lead to future fluctuations in Steelhead abundance. For these reasons, it is crucial that conservative approaches are taken by managers to support the long term sustainability of this unique and vulnerable Steelhead stock.

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

Of the 943 Steelhead that migrated past the fence, 642 were female and 301 were male, resulting in a female to male ratio of 2.1:1. This is the highest female to male ratio recorded for this project (Table 2).

While this skewed sex ratio in favor of females is consistent with observations at the Sustut fence since 1994, it is higher than sex ratios reported for other major Steelhead bearing tributaries in the Skeena watershed (Parken & Morten, 1996).

The skewed sex ratio observed at the Sustut River is of management concern and may be linked to natural and/or anthropogenic selective pressures. This topic has been discussed in previous reports for this project, most recently in Hirshfield (2011).

5.4 Distribution of Gillnet Marked Fish throughout the Run

Net marks were identified on 2% (n=14) of Steelhead migrating past the Sustut fence in 2015. This value is below the long term average of 6.6% (Table 2). Given few net marked fish had length measurements taken (5 females and 1 male), there was an insufficient sample size to compare the length or sex of marked and unmarked fish.

In 2015, Fisheries and Oceans Canada permitted four gillnet openings in Area 4 (Skeena approach waters). Half of these openings targeted Chinook and half targeted Sockeye (openings for the latter species occurred on August 23 and 24). This limited number of gillnet openings for Sockeye reflects the low index values for this species in the Tyee Test Fishery prior to August 17. As a result, this may be partially attributable to the few Sustut Steelhead observed with gillnet marks at the fence in 2015.[1]

5.5 Effect of Water Level and Temperature on Steelhead Migration

During the project, water level at the upper Sustut fence generally fluctuated, but did not substantially decline over the project (Figure 16). Levels ranged from 0.21 m on August 17 to 0.50 m on August 31 and averaged 0.30 m. Relative to the average water level, 35% (n=333) of Steelhead entered the trap box when water levels were below this level and 65% (n=610) entered when water levels were above. This is consistent with previous observations which found the majority of Steelhead migrated past the fence during above average water levels. Steelhead migration did appear to be linked to water levels on two occasions in 2015. Substantial runs (>150 fish) occurred on August 31 and September 19 in conjunction with periods when peaks stream flows were observed (Figure 16).

The average water level in the upper Sustut River (as measured at the fence site) has been generally decreasing inter-annually since 1998. A substantial increase was measured in 2015 (Figure 18), however, this is attributed to the staff gauge being moved to a new location (100 m upstream) in 2015. Given this change, it is not possible to know how water level at the fence compared to previous years and whether the trend in decreasing water level continued.

[1] In 2015, there were 27 gill net openings in the Skeena/Nass approach waters (Area 3). There were also First Nations gillnet fisheries in tidal and non-tidal waters of the Skeena River.

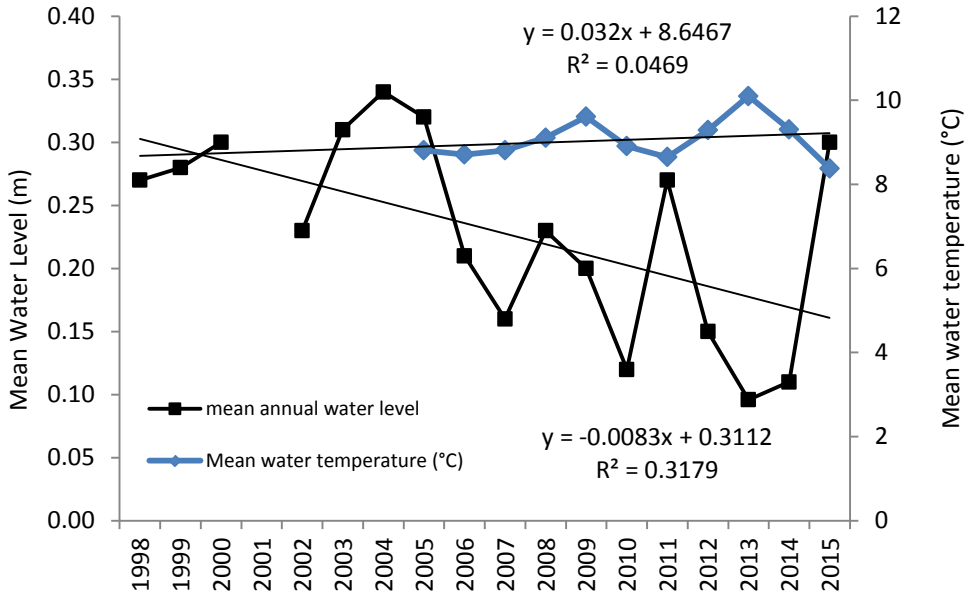

Figure 18. Mean annual water level and temperature at the Sustut River fence in September and October annually

Given the risks that decreasing water level present to the upper Sustut Steelhead population (migration restriction, impoundment, stress/mortality from increased water temperatures, increased vulnerability to predators and in-river fisheries) and considering climate related changes, monitoring water levels in a consistent manner within the upper Sustut River (preferably close to the fence site) is warranted. This is recommended as monitoring water level elsewhere in the Sustut watershed, or the broader Skeena watershed upstream of the Babine River, is not possible given the lack of hydrometric stations in this drainage area.

As for temperature related impacts, the average water temperature during the project in 2015 was 8.38°C, which is well below the upper lethal limit of 27°C for rainbow trout (McPhail, 2007). Research has proven, however, that increases in stream temperature can negatively impact Steelhead populations (Sloat & Osterback, 2013). As such, continued monitoring of stream temperature during this project is warranted. In addition to monitoring temperature during fence operation, it would be advantageous to monitor maximum stream temperature within juvenile rearing habitat. This is a sensitive life history stage and shallow water environments have an elevated probability of experiencing temperature fluctuations.

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 variables among and between years including annual abundance, effect of water level and temperature on migration, the

number and distribution of gillnet marked Steelhead throughout the run, the relative run timing of male and female Steelhead, sex ratios and age composition. The ability to detect changes in these parameters and establish linkages to natural and human-related impacts is vital to protecting the social, economic and ecological benefits Skeena Steelhead provide now and into the future.

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 manner in which environmental variables are monitored as part of this project should be evaluated. Confirming the location, timing and method where water temperature and flow and air temperature (and possibly other parameters) are measured with a hydrologist/climatologist would ensure that data is sampled using the best method possible. This improves the ability of this project to serve as an indicator for climate change monitoring in conjunction with fence operations. Monitoring water temperature during summer months is recommended to evaluate maximum steam temperatures and potential impacts to young of the year Steelhead. Also, when investigating the role environmental factors (water flow and temperature) have upon Steelhead migration, an explicit modeling approach capable of dealing with overdispersed data (Richards, 2008) should be explored. This may help better understand Steelhead migration patterns and links to environmental variables.
3. 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.
4. 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.
5. 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 and regionally relevant estimates.
6. 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.

7. A review of enumeration results at the Sustut fence should be undertaken every five years. Comparison of results inter-annually 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. 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. It is recommended that the sample rate be as consistent as possible throughout migration past the fence to minimize any bias associated with migration timing.
9. 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. Also, all efforts should be made to ensure that sex and length information is recorded for all fish that have scale samples removed and all fish exhibiting gillnet marks. This will allow analysis between these factors to be conducted.
10. If large relative proportions of Steelhead are observed crossing the Sustut fence at the end of September (e.g. 2010, 2014), or if significant numbers of Steelhead are counted below the fence prior to removal (e.g. 2012), 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

This project was funded by the Habitat Conservation Trust Foundation (HCTF). The HCTF was created by an act of the legislature to preserve, restore and enhance key areas of habitat for fish and wildlife throughout British Columbia. Hunters, anglers, trappers and guides contribute to HCTF enhancement projects through license surcharges. Tax deductible donations to assist in the work of HCTF are welcome.

Ron, Wanda, Clayton, Leaf, Brome and Hawk Steffey repaired, installed, maintained and removed 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.

Mark Beere coordinated this study and provided valuable comments for the final draft of this report. Furthermore, this annual report has been built upon the efforts of previous authors who more recently include Dean Peard, Ron Diewert, Regina and Ron Saimoto, Cory Williamson, Chuck Parken and Krista Morten.

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9.0 Appendices

Appendix Tables

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

Date	Chinook		Sockeye		Steelhead		Coho		Bull Trout		Whitefish		Rainbow Trout	
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
01-Aug-15	47	47	0	0	0	0	0	0		0	2	2	0	0
02-Aug-15	14	61	0	0	0	0	0	0	1	1	0	2	0	0
03-Aug-15	48	109	0	0	0	0	0	0	0	1	0	2	0	0
04-Aug-15	120	229	0	0	0	0	0	0	0	1	3	5	0	0
05-Aug-15	65	294	0	0	0	0	0	0	2	3	0	5	0	0
06-Aug-15	13	307	0	0	2	2	0	0	0	3	1	6	0	0

07-Aug-15	50	357	1	1	2	4	0	0	2	5	2	8	3	3
08-Aug-15	34	391	0	1	1	5	0	0	1	6	4	12	0	3
09-Aug-15	29	420	0	1	0	5	0	0	0	6	1	13	0	3
10-Aug-15	7	427	0	1	1	6	0	0	1	7	0	13	1	4
11-Aug-15	25	452	0	1	0	6	0	0	0	7	0	13	0	4
12-Aug-15	7	459	0	1	1	7	0	0	0	7	1	14	0	4
13-Aug-15	6	465	0	1	0	7	0	0	0	7	1	15	0	4
14-Aug-15	6	471	1	2	0	7	1	1	0	7	0	15	0	4
15-Aug-15	2	473	0	2	0	7	1	2	0	7	0	15	0	4
16-Aug-15	4	477	0	2	0	7	0	2	0	7	1	16	0	4
17-Aug-15	2	479	0	2	0	7	1	3	0	7	0	16	0	4
18-Aug-15	3	482	1	3	0	7	3	6	0	7	0	16	0	4
19-Aug-15	3	485	1	4	1	8	0	6	0	7	0	16	0	4
20-Aug-15	8	493	0	4	1	9	0	6	0	7	0	16	0	4
21-Aug-15	5	498	307	311	8	17	11	17	0	7	2	18	0	4
22-Aug-15	1	499	33	344	2	19	1	18	0	7	0	18	0	4
23-Aug-15	0	499	4	348	1	20	0	18	0	7	1	19	0	4
24-Aug-15	3	502	267	615	11	31	9	27	0	7	1	20	0	4
25-Aug-15	1	503	36	651	12	43	3	30	0	7	0	20	0	4
26-Aug-15	0	503	9	660	6	49	2	32	2	9	5	25	0	4
27-Aug-15	0	503	9	669	2	51	0	32	0	9	0	25	0	4
28-Aug-15	0	503	155	824	16	67	7	39	1	10	1	26	0	4
29-Aug-15	1	504	180	1004	42	109	18	57	0	10	4	30	0	4
30-Aug-15	1	505	138	1142	55	164	16	73	1	11	5	35	0	4
31-Aug-15	0	505	129	1271	156	320	11	84	1	12	6	41	1	5
01-Sep-15	0	505	30	1301	20	340	2	86	1	13	0	41	0	5
02-Sep-15	0	505	31	1332	8	348	2	88	0	13	0	41	0	5
03-Sep-15	0	505	10	1342	4	352	1	89	1	14	2	43	0	5
04-Sep-15	0	505	33	1375	38	390	10	99	0	14	0	43	0	5
05-Sep-15	0	505	8	1383	11	401	4	103	1	15	4	47	0	5
06-Sep-15	0	505	1	1384	3	404	2	105	0	15	2	49	0	5
07-Sep-15	0	505	1	1385	6	410	1	106	0	15	0	49	0	5
08-Sep-15	0	505	1	1386	13	423	1	107	0	15	1	50	0	5
09-Sep-15	0	505	3	1389	93	516	12	119	0	15	1	51	0	5
10-Sep-15	0	505	4	1393	83	599	3	122	0	15	1	52	0	5
11-Sep-15	0	505	8	1401	23	622	1	123	1	16	0	52	0	5
12-Sep-15	0	505	4	1405	16	638	23	146	3	19	0	52	0	5
13-Sep-15	0	505	5	1410	6	644	8	154	1	20	1	53	0	5
14-Sep-15	0	505	10	1420	9	653	7	161	0	20	1	54	0	5
15-Sep-15	0	505	14	1434	5	658	0	161	0	20	2	56	0	5
16-Sep-15	0	505	8	1442	0	658	0	161	0	20	1	57	0	5
17-Sep-15	0	505	7	1449	12	670	4	165	0	20	1	58	0	5
18-Sep-15	0	505	5	1454	8	678	5	170	0	20	0	58	0	5

19-Sep-15	0	505	5	1459	163	841	32	202	2	22	3	61	0	5
20-Sep-15	0	505	0	1459	8	849	0	202	1	23	1	62	1	6
21-Sep-15	0	505	1	1460	13	862	1	203	2	25	1	63	0	6
22-Sep-15	0	505	0	1460	9	871	2	205	0	25	1	64	0	6
23-Sep-15	0	505	0	1460	17	888	1	206	1	26	0	64	0	6
24-Sep-15	0	505	2	1462	0	888	1	207	1	27	1	65	0	6
25-Sep-15	0	505	1	1463	9	897	1	208	1	28	2	67	0	6
26-Sep-15	0	505	0	1463	3	900	0	208	2	30	0	67	0	6
27-Sep-15	0	505	0	1463	0	900	0	208	1	31	4	71	0	6
28-Sep-15	0	505	0	1463	30	930	4	212	0	31	0	71	0	6
29-Sep-15	0	505	0	1463	8	938	1	213	0	31	0	71	0	6
30-Sep-15	0	505	1	1464	5	943	1	214	0	31	3	74	0	6

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)
5a	Starting to regenerate, wide focus (freshwater age not under-estimated)
6	Regenerated (eg. R.2)
7	Missing
8	Resorption (eg. last marine annulus on edge of scale)
9	First freshwater annulus very vague, but must be present due to high circuli count and spacing relative to other freshwater annuli
Abbreviation	**Definition**
ann.	annulus
est.	estimate
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. Steelhead sampling data from the Sustut River fence in 2015

Fish Number	Date	Time	Sex	Nose Fork Length (mm)	Gill Net Mark	Fish Age	Scale Condition Code	Scale Analysis Comments
1	06-Aug-15	8:00	F		no			
2	06-Aug-15	8:00	F		no			
3	07-Aug-15	15:00	F		no			
4	07-Aug-15	15:00	M		no			
5	08-Aug-15	15:00	F		no			
6	10-Aug-15	15:00	F	835	no	4.3	1	
7	12-Aug-15	8:00	F	710	no	4.2	5	probably lacking 1st fw annulus; ie. 5.2
8	19-Aug-15	8:00	M	870	no	4.4	9	1st fwa barely visible
9	20-Aug-15	8:00	F		no			
10	21-Aug-15	13:00	M		no			
11	21-Aug-15	16:00	M		no			
12	21-Aug-15	16:00	F		no			
13	21-Aug-15	16:00	F		no			
14	21-Aug-15	16:00	F		no			
15	21-Aug-15	17:00	F		no			
16	21-Aug-15	17:00	F		no			
17	21-Aug-15	19:00	F	730	no	4.2	1	
18	22-Aug-15	8:00	M	795	no	4.2	5a	
19	22-Aug-15	20:00	M		no			
20	23-Aug-15	8:00	F	675	no	5.2	9	1st fwa not visible
21	24-Aug-15	7:00	M		no			
22	24-Aug-15	14:00	F		no			
23	24-Aug-15	14:00	F		no			
24	24-Aug-15	14:00	F		no			
25	24-Aug-15	15:00	M		no			
26	24-Aug-15	15:00	F		no			
27	24-Aug-15	15:00	F		no			
28	24-Aug-15	15:00	F		no			
29	24-Aug-15	18:00	M		no			
30	24-Aug-15	18:00	M		no			
31	24-Aug-15	18:00	F		no			
32	25-Aug-15	7:30	M	860	no	R.3	6	at least 3.3
33	25-Aug-15	7:30	M	800	no	4.3	2	distorted shape
34	25-Aug-15	7:30	F	770	no	4.2	1	
35	25-Aug-15	7:30	F	775	no	4.2	1	
36	25-Aug-15	7:30	M	810	no	R.2	6	
37	25-Aug-15	7:30	F	730	no	4.2	5a	
38	25-Aug-15	7:30	F	810	no	R.3	6	
39	25-Aug-15	7:30	F	805	no	4.3	1	

40	25-Aug-15	7:30	F	720	no	4.2	1	
41	25-Aug-15	7:30	M		no			
42	25-Aug-15	7:30	F		no			
43	25-Aug-15	16:00	F		no			
44	26-Aug-15	8:00	F	750	no	4.2	1	
45	26-Aug-15	8:00	M	780	no	4.2	5	
46	26-Aug-15	8:00	F	830	no	4.3	1	
47	26-Aug-15	8:00	F	695	no	R.2	6	
48	26-Aug-15	8:00	F	720	no	4.2	1	
49	26-Aug-15	19:00	M		no			
50	27-Aug-15	8:00	F	825	no	3.3	1	
51	27-Aug-15	8:00	M	820	no	R.3	6	
52	28-Aug-15	7:45	F	700	no	4.2	9	1st fwa barely visible
53	28-Aug-15	7:45	F	730	no	4.2	5a	
54	28-Aug-15	7:45	F	670	no	4.2	2	fw zone distorted
55	28-Aug-15	7:45	F	720	no	4.2	2	distorted shape
56	28-Aug-15	7:45	F	745	no	5.2	1	
57	28-Aug-15	7:45	M	865	no	4.3	1	
58	28-Aug-15	7:45	F		no	R.3	6	estimate 5.3
59	28-Aug-15	7:45	F		no	R.3	6	
60	28-Aug-15	7:45	M		no	4.2	9	1st fwa not visible
61	28-Aug-15	7:45	F		no	5.2	9	1st fwa barely visible
62	28-Aug-15	19:00	F		no			
63	28-Aug-15	19:00	F		no			
64	28-Aug-15	19:00	F		no			
65	28-Aug-15	20:00	M		no			
66	28-Aug-15	20:00	M		no			
67	28-Aug-15	20:00	F		no			
68	29-Aug-15	8:00	M		no			
69	29-Aug-15	8:00	M		no			
70	29-Aug-15	8:00	M		no			
71	29-Aug-15	8:00	M		no			
72	29-Aug-15	8:00	M		no			
73	29-Aug-15	8:00	M		no			
74	29-Aug-15	8:00	M		no			
75	29-Aug-15	8:00	M		no			
76	29-Aug-15	8:00	M		yes			
77	29-Aug-15	8:00	M		no			
78	29-Aug-15	8:00	M		no			
79	29-Aug-15	8:00	M		no			
80	29-Aug-15	8:00	F		no			
81	29-Aug-15	8:00	F		no			
82	29-Aug-15	8:00	F		no			

83	29-Aug-15	8:00	F		no			
84	29-Aug-15	8:00	F		no			
85	29-Aug-15	8:00	F		no			
86	29-Aug-15	8:00	F		no			
87	29-Aug-15	8:00	F		no			
88	29-Aug-15	8:00	F		no			
89	29-Aug-15	8:00	F		no			
90	29-Aug-15	8:00	F		no			
91	29-Aug-15	8:00	F		no			
92	29-Aug-15	8:00	F		no			
93	29-Aug-15	8:00	F		no			
94	29-Aug-15	8:00	F		no			
95	29-Aug-15	8:00	F		no			
96	29-Aug-15	8:00	F		no			
97	29-Aug-15	8:00	F		no			
98	29-Aug-15	8:00	F		no			
99	29-Aug-15	8:00	F		no			
100	29-Aug-15	9:00	F		no			
101	29-Aug-15	9:00	F		no			
102	29-Aug-15	14:00	M		no			
103	29-Aug-15	14:00	F		no			
104	29-Aug-15	14:00	F		no			
105	29-Aug-15	14:00	F		yes			
106	29-Aug-15	14:00	F		no			
107	29-Aug-15	18:00	M		no			
108	29-Aug-15	18:00	F		no			
109	29-Aug-15	18:00	F		no			
110	30-Aug-15	8:00	M		no			
111	30-Aug-15	8:00	M		no			
112	30-Aug-15	8:00	M		no			
113	30-Aug-15	8:00	M		no			
114	30-Aug-15	8:00	M		no			
115	30-Aug-15	8:00	M		no			
116	30-Aug-15	8:00	M		no			
117	30-Aug-15	8:00	F		no			
118	30-Aug-15	8:00	F		no			
119	30-Aug-15	8:00	F		no			
120	30-Aug-15	8:00	F		no			
121	30-Aug-15	8:00	F		no			
122	30-Aug-15	8:00	F		no			
123	30-Aug-15	8:00	F		no			
124	30-Aug-15	8:00	F		no			
125	30-Aug-15	8:00	F		no			

126	30-Aug-15	8:00	F		no			
127	30-Aug-15	8:00	F		no			
128	30-Aug-15	8:00	F		no			
129	30-Aug-15	8:00	F		no			
130	30-Aug-15	8:00	F		no			
131	30-Aug-15	8:00	F		no			
132	30-Aug-15	9:00	M		no			
133	30-Aug-15	9:00	M		no			
134	30-Aug-15	9:00	M		no			
135	30-Aug-15	9:00	M		no			
136	30-Aug-15	9:00	M		no			
137	30-Aug-15	9:00	M		no			
138	30-Aug-15	9:00	M		no			
139	30-Aug-15	9:00	F		no			
140	30-Aug-15	9:00	F		no			
141	30-Aug-15	9:00	F		no			
142	30-Aug-15	9:00	F		no			
143	30-Aug-15	9:00	F		no			
144	30-Aug-15	9:00	F		no			
145	30-Aug-15	9:00	F		no			
146	30-Aug-15	9:00	F		no			
147	30-Aug-15	9:00	F		no			
148	30-Aug-15	9:00	F		no			
149	30-Aug-15	12:00	F		no			
150	30-Aug-15	14:00	F		no			
151	30-Aug-15	14:00	F		no			
152	30-Aug-15	16:00	M		no			
153	30-Aug-15	16:00	F		no			
154	30-Aug-15	17:00	M		no			
155	30-Aug-15	17:00	F		no			
156	30-Aug-15	17:00	F		no			
157	30-Aug-15	18:00	F		no			
158	30-Aug-15	18:00	F		no			
159	30-Aug-15	19:00	M		no			
160	30-Aug-15	19:00	F		no			
161	30-Aug-15	19:00	F		no			
162	30-Aug-15	19:00	F		no			
163	30-Aug-15	19:00	F		no			
164	30-Aug-15	19:00	F		no			
165	31-Aug-15	7:30	M		no			
166	31-Aug-15	7:30	M		no			
167	31-Aug-15	7:30	M		no			
168	31-Aug-15	7:30	M		no			

169	31-Aug-15	7:30	M		no			
170	31-Aug-15	7:30	M		no			
171	31-Aug-15	7:30	F		no			
172	31-Aug-15	7:30	F		no			
173	31-Aug-15	7:30	F		no			
174	31-Aug-15	7:30	F		no			
175	31-Aug-15	7:30	F		no			
176	31-Aug-15	11:00	M		no			
177	31-Aug-15	11:00	F		no			
178	31-Aug-15	12:00	M		no			
179	31-Aug-15	14:30	M		no			
180	31-Aug-15	14:30	M		no			
181	31-Aug-15	14:30	F		no			
182	31-Aug-15	14:30	F		no			
183	31-Aug-15	14:30	F		no			
184	31-Aug-15	14:30	F		no			
185	31-Aug-15	15:00	M		no			
186	31-Aug-15	15:00	F		no			
187	31-Aug-15	16:00	M		no			
188	31-Aug-15	16:00	M		no			
189	31-Aug-15	16:00	F		no			
190	31-Aug-15	17:00	M		no			
191	31-Aug-15	17:00	M		no			
192	31-Aug-15	17:00	M		no			
193	31-Aug-15	17:00	M		no			
194	31-Aug-15	17:00	M		no			
195	31-Aug-15	17:00	F		no			
196	31-Aug-15	17:00	F		no			
197	31-Aug-15	17:00	F		no			
198	31-Aug-15	17:00	F		no			
199	31-Aug-15	17:00	F		no			
200	31-Aug-15	17:00	F		no			
201	31-Aug-15	17:00	F		no			
202	31-Aug-15	17:00	F		no			
203	31-Aug-15	17:00	F		no			
204	31-Aug-15	17:00	F		no			
205	31-Aug-15	17:00	F		no			
206	31-Aug-15	17:00	F		no			
207	31-Aug-15	17:00	F		no			
208	31-Aug-15	17:00	F		no			
209	31-Aug-15	17:00	F		no			
210	31-Aug-15	17:00	F		no			
211	31-Aug-15	17:00	F		no			

212	31-Aug-15	17:00	F		no			
213	31-Aug-15	17:00	F		no			
214	31-Aug-15	17:00	F		no			
215	31-Aug-15	17:00	F		no			
216	31-Aug-15	17:00	F		no			
217	31-Aug-15	17:00	F		no			
218	31-Aug-15	17:00	F		no			
219	31-Aug-15	17:00	F		no			
220	31-Aug-15	17:00	F		no			
221	31-Aug-15	17:00	F		no			
222	31-Aug-15	17:00	F		no			
223	31-Aug-15	17:00	F		no			
224	31-Aug-15	18:00	M		no			
225	31-Aug-15	18:00	M		no			
226	31-Aug-15	18:00	M		no			
227	31-Aug-15	18:00	M		no			
228	31-Aug-15	18:00	M		no			
229	31-Aug-15	18:00	M		no			
230	31-Aug-15	18:00	M		no			
231	31-Aug-15	18:00	M		no			
232	31-Aug-15	18:00	M		no			
233	31-Aug-15	18:00	M		no			
234	31-Aug-15	18:00	M		no			
235	31-Aug-15	18:00	M		no			
236	31-Aug-15	18:00	M		no			
237	31-Aug-15	18:00	M		no			
238	31-Aug-15	18:00	M		no			
239	31-Aug-15	18:00	M		no			
240	31-Aug-15	18:00	M		no			
241	31-Aug-15	18:00	M		no			
242	31-Aug-15	18:00	M		no			
243	31-Aug-15	18:00	M		no			
244	31-Aug-15	18:00	M		no			
245	31-Aug-15	18:00	M		no			
246	31-Aug-15	18:00	M		no			
247	31-Aug-15	18:00	M		no			
248	31-Aug-15	18:00	M		no			
249	31-Aug-15	18:00	M		no			
250	31-Aug-15	18:00	F		no			
251	31-Aug-15	18:00	F		no			
252	31-Aug-15	18:00	F		no			
253	31-Aug-15	18:00	F		no			
254	31-Aug-15	18:00	F		no			

255	31-Aug-15	18:00	F		no			
256	31-Aug-15	18:00	F		no			
257	31-Aug-15	18:00	F		no			
258	31-Aug-15	18:00	F		no			
259	31-Aug-15	18:00	F		no			
260	31-Aug-15	18:00	F		no			
261	31-Aug-15	18:00	F		no			
262	31-Aug-15	18:00	F		no			
263	31-Aug-15	18:00	F		no			
264	31-Aug-15	18:00	F		no			
265	31-Aug-15	18:00	F		no			
266	31-Aug-15	18:00	F		no			
267	31-Aug-15	18:00	F		no			
268	31-Aug-15	18:00	F		no			
269	31-Aug-15	18:00	F		no			
270	31-Aug-15	18:00	F		no			
271	31-Aug-15	18:00	F		no			
272	31-Aug-15	18:00	F		no			
273	31-Aug-15	18:00	F		no			
274	31-Aug-15	18:00	F		no			
275	31-Aug-15	18:00	F		no			
276	31-Aug-15	18:00	F		no			
277	31-Aug-15	18:00	F		no			
278	31-Aug-15	18:00	F		no			
279	31-Aug-15	18:00	F		no			
280	31-Aug-15	18:00	F		no			
281	31-Aug-15	18:00	F		no			
282	31-Aug-15	18:00	F		no			
283	31-Aug-15	18:00	F		no			
284	31-Aug-15	18:00	F		no			
285	31-Aug-15	18:00	F		no			
286	31-Aug-15	18:00	F		no			
287	31-Aug-15	18:00	F		no			
288	31-Aug-15	18:00	F		no			
289	31-Aug-15	18:00	F		no			
290	31-Aug-15	18:00	F		no			
291	31-Aug-15	18:00	F		no			
292	31-Aug-15	18:00	F		no			
293	31-Aug-15	18:00	F		no			
294	31-Aug-15	18:00	F		no			
295	31-Aug-15	19:00	M		no			
296	31-Aug-15	19:00	M		no			
297	31-Aug-15	19:00	M		no			

298	31-Aug-15	19:00	M		no			
299	31-Aug-15	19:00	M		no			
300	31-Aug-15	19:00	M		no			
301	31-Aug-15	19:00	M		no			
302	31-Aug-15	19:00	F		no			
303	31-Aug-15	19:00	F		no			
304	31-Aug-15	19:00	F		no			
305	31-Aug-15	19:00	F		no			
306	31-Aug-15	19:00	F		no			
307	31-Aug-15	19:00	F		no			
308	31-Aug-15	19:00	F		no			
309	31-Aug-15	19:00	F		no			
310	31-Aug-15	19:00	F		no			
311	31-Aug-15	19:00	F		no			
312	31-Aug-15	19:00	F		no			
313	31-Aug-15	19:00	F		no			
314	31-Aug-15	19:00	F		no			
315	31-Aug-15	19:00	F		no			
316	31-Aug-15	19:00	F		no			
317	31-Aug-15	20:00	F		no			
318	31-Aug-15	20:00	F		no			
319	31-Aug-15	20:00	F		no			
320	31-Aug-15	20:00	F		no			
321	01-Sep-15	7:00	M		no			
322	01-Sep-15	7:00	M		no			
323	01-Sep-15	7:00	F		no			
324	01-Sep-15	7:00	F		no			
325	01-Sep-15	15:00	M		no			
326	01-Sep-15	15:00	F		no			
327	01-Sep-15	15:00	F		no			
328	01-Sep-15	16:00	M		no			
329	01-Sep-15	17:00	F		no			
330	01-Sep-15	17:00	F		no			
331	01-Sep-15	17:00	F		no			
332	01-Sep-15	17:00	F		no			
333	01-Sep-15	18:00	M	815	no	5.2	2	distorted shape
334	01-Sep-15	18:00	F		no			
335	01-Sep-15	18:00	F		no			
336	01-Sep-15	18:00	F		no			
337	01-Sep-15	18:00	F		no			
338	01-Sep-15	18:00	F		no			
339	01-Sep-15	18:00	F		no			
340	01-Sep-15	18:00	F		no			

341	02-Sep-15	8:00	M		no			
342	02-Sep-15	8:00	M		no			
343	02-Sep-15	8:00	M		no			
344	02-Sep-15	8:00	F		no			
345	02-Sep-15	8:00	F		no			
346	02-Sep-15	13:00	F		no			
347	02-Sep-15	15:00	M		no			
348	02-Sep-15	15:00	F		no			
349	03-Sep-15	7:45	M	930	no	4.3	2	marine zone in p/c
350	03-Sep-15	17:00	M		no			
351	03-Sep-15	17:00	F	685	no	4.2	1	
352	03-Sep-15	20:00	F		no			
353	04-Sep-15	8:30	F	680	no	4.2	1	
354	04-Sep-15	8:30	M	840	no	5.3	8	
355	04-Sep-15	8:30	F	725	no	4.2	5a	
356	04-Sep-15	8:30	F	710	no	4.2	5a	
357	04-Sep-15	8:30	M	745	no	5.2	1	
358	04-Sep-15	8:30	F	705	no	4.2	1	
359	04-Sep-15	8:30	M	775	no	4.2	1	
360	04-Sep-15	8:30	F	745	no	4.2	1	
361	04-Sep-15	8:30	F	865	no	4.3	5a	
362	04-Sep-15	8:30	M	950	no	4.3	9	1st fwa barely visible
363	04-Sep-15	8:30	F	715	yes	R.2	6	
364	04-Sep-15	8:30	F	645	no	4.2	5	may be lacking 1st fw annulus; ie. 5.2
365	04-Sep-15	16:00	M		no			
366	04-Sep-15	16:00	M		no			
367	04-Sep-15	16:00	M		no			
368	04-Sep-15	16:00	F		no			
369	04-Sep-15	16:00	F		no			
370	04-Sep-15	16:00	F		no			
371	04-Sep-15	16:00	F		no			
372	04-Sep-15	17:00	M		no			
373	04-Sep-15	17:00	M		no			
374	04-Sep-15	17:00	F		no			
375	04-Sep-15	17:00	F		no			
376	04-Sep-15	17:00	F		no			
377	04-Sep-15	17:00	F		no			
378	04-Sep-15	17:00	F		no			
379	04-Sep-15	17:00	F		no			
380	04-Sep-15	17:00	F		no			
381	04-Sep-15	17:00	F		no			
382	04-Sep-15	17:00	F		no			
383	04-Sep-15	17:00	F		no			

384	04-Sep-15	17:00	F		no			
385	04-Sep-15	18:00	M		no			
386	04-Sep-15	18:00	M		no			
387	04-Sep-15	18:00	F		no			
388	04-Sep-15	18:00	F		no			
389	04-Sep-15	18:00	F		no			
390	04-Sep-15	18:00	F		no			
391	05-Sep-15	8:30	M	720	no	4.2	1	
392	05-Sep-15	15:00	F		no			
393	05-Sep-15	16:00	M		no			
394	05-Sep-15	16:00	M		no			
395	05-Sep-15	16:00	F		no			
396	05-Sep-15	16:00	F		no			
397	05-Sep-15	16:00	F		no			
398	05-Sep-15	16:00	F		no			
399	05-Sep-15	16:00	F		no			
400	05-Sep-15	20:00	M	695	no	5.2	5a	
401	05-Sep-15	20:00	F	740	no	4.3	5a	
402	06-Sep-15	8:15	M	715	no	5.2	2	fw in p/c; used several scales to age fw zone
403	06-Sep-15	8:15	M	900	no	R.3	6	
404	06-Sep-15	19:00	F	795	no	4.3	1	
405	07-Sep-15	8:30	F	750	no	5.2	1	
406	07-Sep-15	8:30	M	780	no	4.2	1	
407	07-Sep-15	8:30	F	810	yes	4.3	1	
408	07-Sep-15	12:00	F	710	no	R.2	6	
409	07-Sep-15	12:00	M		no			
410	07-Sep-15	12:00	F		no			
411	08-Sep-15	8:15	F		no			
412	08-Sep-15	17:00	M		no			
413	08-Sep-15	17:00	M		no			
414	08-Sep-15	17:00	M		no			
415	08-Sep-15	17:00	M		no			
416	08-Sep-15	17:00	F		no			
417	08-Sep-15	17:00	F		no			
418	08-Sep-15	17:00	F		no			
419	08-Sep-15	17:00	F		no			
420	08-Sep-15	19:30	M	805	no	4.2	1	
421	08-Sep-15	19:30	F	730	no	5.2	2	fw in p/c; used several scales to age fw zone
422	08-Sep-15	19:30	M	745	no	4.2	9	1st fwa not visible
423	08-Sep-15	19:30	M	780	no	4.2	1	
424	09-Sep-15	16:00	M		no			
425	09-Sep-15	16:00	M		no			

426	09-Sep-15	16:00	M		no			
427	09-Sep-15	16:00	M		no			
428	09-Sep-15	16:00	M		no			
429	09-Sep-15	16:00	M		no			
430	09-Sep-15	16:00	M		no			
431	09-Sep-15	16:00	M		no			
432	09-Sep-15	16:00	M		no			
433	09-Sep-15	16:00	M		no			
434	09-Sep-15	16:00	M		no			
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436	09-Sep-15	16:00	F		no			
437	09-Sep-15	16:00	F		no			
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450	09-Sep-15	16:00	F		no			
451	09-Sep-15	16:00	F		yes			
452	09-Sep-15	16:00	F		no			
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454	09-Sep-15	16:00	F		no			
455	09-Sep-15	16:00	F		no			
456	09-Sep-15	16:00	F		no			
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458	09-Sep-15	16:00	F		no			
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472	09-Sep-15	17:00	M		no			
473	09-Sep-15	17:00	M		no			
474	09-Sep-15	17:00	M		no			
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476	09-Sep-15	17:00	F		no			
477	09-Sep-15	17:00	F		no			
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479	09-Sep-15	17:00	F		no			
480	09-Sep-15	17:00	F		no			
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487	09-Sep-15	17:00	F		no			
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492	09-Sep-15	17:00	F		no			
493	09-Sep-15	17:00	F		no			
494	09-Sep-15	17:00	F		no			
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508	09-Sep-15	18:00	F		no			
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510	09-Sep-15	18:00	F		no			
511	09-Sep-15	18:00	F		no			

512	09-Sep-15	18:00	F		no			
513	09-Sep-15	18:00	F		no			
514	09-Sep-15	18:00	F		no			
515	09-Sep-15	18:00	F		no			
516	09-Sep-15	18:00	F		no			
517	10-Sep-15	8:00	F	750	no	5.2	5a	
518	10-Sep-15	8:00	M	775	no	4.2	9	1st fwa barely visible
519	10-Sep-15	8:00	F	695	no	4.2	5	may be lacking 1st fw annulus; ie. 5.2
520	10-Sep-15	8:00	M	885	no	R.3	6	
521	10-Sep-15	8:00	M	800	no	4.3	1	
522	10-Sep-15	8:00	M	855	no	4.3	1	
523	10-Sep-15	8:00	F	800	no	4.2S1	1	
524	10-Sep-15	8:00	M	760	no	R.2	6	
525	10-Sep-15	8:00	F	770	no	5.2S1	9	fw in p/c; 1st fwa not visible
526	10-Sep-15	8:00	F	670	no	4.2	1	
527	10-Sep-15	14:00	M		no			
528	10-Sep-15	14:00	M		no			
529	10-Sep-15	14:00	M		no			
530	10-Sep-15	14:00	M		no			
531	10-Sep-15	14:00	M		no			
532	10-Sep-15	14:00	F		no			
533	10-Sep-15	14:00	F		no			
534	10-Sep-15	14:00	F		no			
535	10-Sep-15	14:00	F		no			
536	10-Sep-15	14:00	F		no			
537	10-Sep-15	14:00	F		no			
538	10-Sep-15	14:00	F		no			
539	10-Sep-15	14:00	F		no			
540	10-Sep-15	14:00	F		no			
541	10-Sep-15	14:00	F		no			
542	10-Sep-15	14:00	F		no			
543	10-Sep-15	14:00	F		no			
544	10-Sep-15	14:00	F		no			
545	10-Sep-15	15:00	M		no			
546	10-Sep-15	15:00	M		no			
547	10-Sep-15	15:00	M		no			
548	10-Sep-15	15:00	M		no			
549	10-Sep-15	15:00	M		no			
550	10-Sep-15	15:00	M		no			
551	10-Sep-15	15:00	M		no			
552	10-Sep-15	15:00	M		no			
553	10-Sep-15	15:00	M		no			
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555	10-Sep-15	15:00	M		no			
556	10-Sep-15	15:00	M		no			
557	10-Sep-15	15:00	F		no			
558	10-Sep-15	15:00	F		no			
559	10-Sep-15	15:00	F		no			
560	10-Sep-15	15:00	F		no			
561	10-Sep-15	15:00	F		no			
562	10-Sep-15	15:00	F		no			
563	10-Sep-15	15:00	F		no			
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565	10-Sep-15	15:00	F		no			
566	10-Sep-15	15:00	F		no			
567	10-Sep-15	15:00	F		no			
568	10-Sep-15	15:00	F		no			
569	10-Sep-15	15:00	F		no			
570	10-Sep-15	15:00	F		no			
571	10-Sep-15	15:00	F		no			
572	10-Sep-15	15:00	F		no			
573	10-Sep-15	15:00	F		no			
574	10-Sep-15	15:00	F		no			
575	10-Sep-15	15:00	F		no			
576	10-Sep-15	15:00	F		no			
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580	10-Sep-15	15:00	F		no			
581	10-Sep-15	15:00	F		no			
582	10-Sep-15	16:00	M		no			
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584	10-Sep-15	16:00	M		no			
585	10-Sep-15	16:00	M		no			
586	10-Sep-15	16:00	F		no			
587	10-Sep-15	16:00	F		no			
588	10-Sep-15	16:00	F		no			
589	10-Sep-15	16:00	F		no			
590	10-Sep-15	16:00	F		no			
591	10-Sep-15	16:00	F		no			
592	10-Sep-15	16:00	F		no			
593	10-Sep-15	16:00	F		no			
594	10-Sep-15	16:00	F		no			
595	10-Sep-15	16:00	F		no			
596	10-Sep-15	17:00	F	750	no	4.2	9	1st fwa barely visible
597	10-Sep-15	17:00	M	770	no	4.2	1	

598	10-Sep-15	17:00	M	810	no	4.2	1	
599	10-Sep-15	17:00	F	740	no	4.2	5	
600	11-Sep-15	8:00	F	725	no	R.2	6	
601	11-Sep-15	8:00	M	805	no	4.2	5	
602	11-Sep-15	8:00	M	805	no	4.2	1	
603	11-Sep-15	13:00	F	725	no	5.2	9	1st fwa barely visible
604	11-Sep-15	13:00	F	710	no	4.2	5a	
605	11-Sep-15	13:00	F	805	no	4.3	5	
606	11-Sep-15	13:00	F	745	no	4.2	1	
607	11-Sep-15	13:00	F	850	no	5.3	1	
608	11-Sep-15	13:00	F	695	no	4.2	1	
609	11-Sep-15	13:00	M	750	no	R.2	6	
610	11-Sep-15	13:00	F	725	no	5.2	1	
611	11-Sep-15	13:00	F		no			
612	11-Sep-15	13:00	F		no			
613	11-Sep-15	13:00	F		no			
614	11-Sep-15	13:00	F		no			
615	11-Sep-15	15:00	F	800	no	R.2S1	6	
616	11-Sep-15	15:00	F		no			
617	11-Sep-15	15:00	F		no			
618	11-Sep-15	15:00	F		no			
619	11-Sep-15	16:00	M	745	no	4.2	1	
620	11-Sep-15	16:00	F		no			
621	11-Sep-15	17:00	M	860	no	4.3	2	marine zone in p/c
622	11-Sep-15	17:00	F	770	no	4.2	9	1st fwa not visible
623	12-Sep-15	8:15	F	760	no	3.3	1	
624	12-Sep-15	8:15	F	800	no	4.3	5a	
625	12-Sep-15	8:15	F	725	no	5.2	1	
626	12-Sep-15	8:15	F	815	no	4.2S1	1	
627	12-Sep-15	8:15	F	740	no	R.2	6	
628	12-Sep-15	8:15	F	810	no	4.3	1	
629	12-Sep-15	12:00	F	805	no	R.3	6	
630	12-Sep-15	12:00	F	810	no	5.3	1	
631	12-Sep-15	14:00	F	715	no	R.2	6	
632	12-Sep-15	15:00	F	690	no	4.2	1	
633	12-Sep-15	16:00	M		no			
634	12-Sep-15	17:00	F	795	no	4.3	1	
635	12-Sep-15	17:00	F		no	4.2	1	
636	12-Sep-15	17:00	F		no	5.2	9	1st fwa barely visible
637	12-Sep-15	19:00	F	860	no	4.2S1	1	
638	12-Sep-15	19:00	M		no			
639	13-Sep-15	8:15	F	795	no	4.2S1	1	
640	13-Sep-15	8:15	M	740	no	4.2	5	

641	13-Sep-15	8:15	F	735	no	R.2	6	at least 4.2
642	13-Sep-15	13:00	M	885	no	4.3	1	
643	13-Sep-15	14:00	F	780	no	4.3	1	
644	13-Sep-15	16:00	F	700	no	4.2	1	
645	14-Sep-15	8:00	M	780	no	4.2	1	
646	14-Sep-15	8:00	F	705	no	5.2	1	
647	14-Sep-15	8:00	M	950	no	4.3	2	marine zone in p/c
648	14-Sep-15	8:00	F	730	no	R.2	6	
649	14-Sep-15	14:00	F	730	no	R.2	6	at least 4.2
650	14-Sep-15	14:00	F		no			
651	14-Sep-15	15:00	F	740	yes	3.2	1	
652	14-Sep-15	16:00	F	725	no	4.2	1	
653	14-Sep-15	16:00	M	715	no	4.2	5a	
654	15-Sep-15	8:15	F	710	no	R.2	6	
655	15-Sep-15	8:15	M	720	no	4.2	9	1st fwa not visible
656	15-Sep-15	13:00	F	810	no	4.3	1	
657	15-Sep-15	16:00	F	755	no	5.2	9	1st fwa barely visible
658	15-Sep-15	18:00	F	690	no	4.2	1	
659	17-Sep-15	8:30	M	735	no	5.2	9	1st fwa not visible
660	17-Sep-15	14:00	F	720	no	5.2	9	1st fwa not visible
661	17-Sep-15	15:00	F	735	no	4.2	1	
662	17-Sep-15	16:00	M		no			
663	17-Sep-15	16:00	M		no			
664	17-Sep-15	16:00	F		no			
665	17-Sep-15	16:00	F		no			
666	17-Sep-15	16:00	F		no			
667	17-Sep-15	16:00	F		no			
668	17-Sep-15	16:00	F		no			
669	17-Sep-15	16:00	F		no			
670	17-Sep-15	17:00	F	690	no	4.2	1	
671	18-Sep-15	8:15	F	695	no	5.2	1	
672	18-Sep-15	8:15	F	720	no	5.2	1	
673	18-Sep-15	8:15	M	715	no	4.2	5a	
674	18-Sep-15	15:00	F	810	no	4.3	5	may be lacking 1st fw annulus; ie. 5.3
675	18-Sep-15	15:00	M	850	no	R.3	6	at least 4.3
676	18-Sep-15	17:00	F	695	no	4.2	1	
677	18-Sep-15	17:00	F	685	no	4.2	5a	
678	18-Sep-15	19:00	M	665	no	4.2	1	
679	19-Sep-15	8:00	M	780	no	4.2S1	1	
680	19-Sep-15	8:00	F	715	no	R.2	6	
681	19-Sep-15	8:00	F	745	no	R.2	6	
682	19-Sep-15	8:00	F	700	no	5.2	1	
683	19-Sep-15	8:00	F	730	no	5.2	2	fw in p/c; fw age estimate

684	19-Sep-15	8:00	F	735	yes	4.2	1	
685	19-Sep-15	8:00	M	870	no	4.3	1	
686	19-Sep-15	8:00	F	710	no	5.2	1	
687	19-Sep-15	8:00	M	870	no	3.3	5	may be lacking 1st fw annulus; ie. 4.3
688	19-Sep-15	8:00	F	720	no	4.2	9	1st fwa barely visible
689	19-Sep-15	8:00	F	830	no	4.2S1	1	
690	19-Sep-15	8:00	F	725	no	4.2	1	
691	19-Sep-15	8:00	F		no			
692	19-Sep-15	12:00	F		no			
693	19-Sep-15	14:00	M		no			
694	19-Sep-15	14:00	M		no			
695	19-Sep-15	14:00	M		no			
696	19-Sep-15	14:00	F		no			
697	19-Sep-15	14:00	F		no			
698	19-Sep-15	14:00	F		no			
699	19-Sep-15	14:00	F		no			
700	19-Sep-15	14:00	F		no			
701	19-Sep-15	14:00	F		no			
702	19-Sep-15	14:00	F		no			
703	19-Sep-15	15:00	M		no			
704	19-Sep-15	15:00	M		no			
705	19-Sep-15	15:00	M		no			
706	19-Sep-15	15:00	M		no			
707	19-Sep-15	15:00	F		no			
708	19-Sep-15	15:00	F		no			
709	19-Sep-15	15:00	F		no			
710	19-Sep-15	15:00	F		no			
711	19-Sep-15	15:00	F		no			
712	19-Sep-15	15:00	F		no			
713	19-Sep-15	15:00	F		no			
714	19-Sep-15	15:00	F		no			
715	19-Sep-15	15:00	F		no			
716	19-Sep-15	15:00	F		no			
717	19-Sep-15	15:00	F		no			
718	19-Sep-15	16:00	M		no			
719	19-Sep-15	16:00	M		no			
720	19-Sep-15	16:00	M		no			
721	19-Sep-15	16:00	M		no			
722	19-Sep-15	16:00	M		no			
723	19-Sep-15	16:00	M		no			
724	19-Sep-15	16:00	M		no			
725	19-Sep-15	16:00	M		no			
726	19-Sep-15	16:00	M		no			

727	19-Sep-15	16:00	M		no			
728	19-Sep-15	16:00	M		no			
729	19-Sep-15	16:00	M		no			
730	19-Sep-15	16:00	M		no			
731	19-Sep-15	16:00	M		no			
732	19-Sep-15	16:00	M		no			
733	19-Sep-15	16:00	F		no			
734	19-Sep-15	16:00	F		no			
735	19-Sep-15	16:00	F		no			
736	19-Sep-15	16:00	F		no			
737	19-Sep-15	16:00	F		no			
738	19-Sep-15	16:00	F		no			
739	19-Sep-15	16:00	F		yes			
740	19-Sep-15	16:00	F		no			
741	19-Sep-15	16:00	F		no			
742	19-Sep-15	16:00	F		no			
743	19-Sep-15	16:00	F		no			
744	19-Sep-15	16:00	F		no			
745	19-Sep-15	16:00	F		no			
746	19-Sep-15	16:00	F		no			
747	19-Sep-15	16:00	F		no			
748	19-Sep-15	16:00	F		no			
749	19-Sep-15	16:00	F		no			
750	19-Sep-15	16:00	F		no			
751	19-Sep-15	16:00	F		no			
752	19-Sep-15	16:00	F		no			
753	19-Sep-15	16:00	F		no			
754	19-Sep-15	16:00	F		no			
755	19-Sep-15	16:00	F		no			
756	19-Sep-15	16:00	F		no			
757	19-Sep-15	16:00	F		no			
758	19-Sep-15	16:00	F		no			
759	19-Sep-15	16:00	F		no			
760	19-Sep-15	16:00	F		no			
761	19-Sep-15	16:00	F		no			
762	19-Sep-15	16:00	F		no			
763	19-Sep-15	16:00	F		no			
764	19-Sep-15	16:00	F		no			
765	19-Sep-15	16:00	F		no			
766	19-Sep-15	16:00	F		no			
767	19-Sep-15	16:00	F		no			
768	19-Sep-15	16:00	F		no			
769	19-Sep-15	16:00	F		no			

770	19-Sep-15	16:00	F		no			
771	19-Sep-15	16:00	F		no			
772	19-Sep-15	16:00	F		no			
773	19-Sep-15	17:00	M		no			
774	19-Sep-15	17:00	M		no			
775	19-Sep-15	17:00	M		no			
776	19-Sep-15	17:00	M		no			
777	19-Sep-15	17:00	M		no			
778	19-Sep-15	17:00	M		no			
779	19-Sep-15	17:00	M		no			
780	19-Sep-15	17:00	M		no			
781	19-Sep-15	17:00	M		no			
782	19-Sep-15	17:00	M		no			
783	19-Sep-15	17:00	M		no			
784	19-Sep-15	17:00	M		no			
785	19-Sep-15	17:00	M		no			
786	19-Sep-15	17:00	M		no			
787	19-Sep-15	17:00	M		no			
788	19-Sep-15	17:00	M		no			
789	19-Sep-15	17:00	M		no			
790	19-Sep-15	17:00	M		no			
791	19-Sep-15	17:00	F		no			
792	19-Sep-15	17:00	F		no			
793	19-Sep-15	17:00	F		no			
794	19-Sep-15	17:00	F		no			
795	19-Sep-15	17:00	F		no			
796	19-Sep-15	17:00	F		no			
797	19-Sep-15	17:00	F		yes			
798	19-Sep-15	17:00	F		no			
799	19-Sep-15	17:00	F		no			
800	19-Sep-15	17:00	F		no			
801	19-Sep-15	17:00	F		no			
802	19-Sep-15	17:00	F		no			
803	19-Sep-15	17:00	F		no			
804	19-Sep-15	17:00	F		no			
805	19-Sep-15	17:00	F		no			
806	19-Sep-15	17:00	F		no			
807	19-Sep-15	17:00	F		no			
808	19-Sep-15	17:00	F		no			
809	19-Sep-15	17:00	F		no			
810	19-Sep-15	17:00	F		no			
811	19-Sep-15	17:00	F		no			
812	19-Sep-15	17:00	F		no			

813	19-Sep-15	17:00	F		yes			
814	19-Sep-15	17:00	F		no			
815	19-Sep-15	17:00	F		no			
816	19-Sep-15	17:00	F		no			
817	19-Sep-15	17:00	F		no			
818	19-Sep-15	17:00	F		no			
819	19-Sep-15	17:00	F		no			
820	19-Sep-15	17:00	F		no			
821	19-Sep-15	18:00	M	870	no	4.3S1	9	1st fwa not visible
822	19-Sep-15	18:00	M	845	no	4.3	8	
823	19-Sep-15	18:00	F	845	no	4.3	1	
824	19-Sep-15	18:00	M	840	yes	4.3	1	
825	19-Sep-15	18:00	M	850	no	4.3	2	marine zone in p/c
826	19-Sep-15	18:00	F	710	no	4.2	5	p/c
827	19-Sep-15	18:00	M	760	no	R.2	6	
828	19-Sep-15	18:00	F	730	no	4.2	9	1st fwa barely visible
829	19-Sep-15	18:00	F	690	no	5.2	9	1st fwa not visible
830	19-Sep-15	18:00	M	840	no	4.3	1	
831	19-Sep-15	18:00	F	750	no	R.2S1	6	
832	19-Sep-15	18:00	F	730	no	4.2	1	
833	19-Sep-15	18:00	M	890	no	4.3	9	p/c; 1st fwa not visible; fw age estimate
834	19-Sep-15	18:00	F		no			
835	19-Sep-15	18:00	F		no			
836	19-Sep-15	18:00	F		no			
837	19-Sep-15	18:00	F		no			
838	19-Sep-15	18:00	F		no			
839	19-Sep-15	18:00	F		no			
840	19-Sep-15	18:00	F		no			
841	19-Sep-15	18:00	F		no			
842	20-Sep-15	8:30	M	725	no	4.2	1	
843	20-Sep-15	8:30	M	800	no	R.2S1	6	estimate 4.2S1
844	20-Sep-15	8:30	M	785	no	4.2	5a	
845	20-Sep-15	8:30	F	705	no	4.2	1	
846	20-Sep-15	8:30	M	940	no	R.4	6	
847	20-Sep-15	15:00	F	720	no	4.2	1	
848	20-Sep-15	15:00	F	695	no	4.2	1	
849	20-Sep-15	18:00	F	730	no	4.2	1	
850	21-Sep-15	9:00	M	805	no	5.2	1	
851	21-Sep-15	9:00	F	755	yes	4.2S1	1	
852	21-Sep-15	9:00	F	770	no	4.3	1	
853	21-Sep-15	9:00	F	820	no	4.3	1	
854	21-Sep-15	9:00	F	750	no	4.3	5a	
855	21-Sep-15	9:00	F	765	no	4.2S1	1	

856	21-Sep-15	19:00	M	750	no	4.2	5a	
857	21-Sep-15	19:00	F	760	no	R.3	6	
858	21-Sep-15	19:00	F	800	no	4.3	8	
859	21-Sep-15	19:00	F	675	no	4.2	1	
860	21-Sep-15	19:00	M	780	no	5.2	9	1st fwa barely visible
861	21-Sep-15	19:00	F	650	no	4.2	9	1st fwa not visible
862	21-Sep-15	19:00	F	795	no	4.3	1	
863	22-Sep-15	18:00	M		no			
864	22-Sep-15	18:00	M		no			
865	22-Sep-15	18:00	M		no			
866	22-Sep-15	18:00	F		no			
867	22-Sep-15	18:00	F		no			
868	22-Sep-15	18:00	F		no			
869	22-Sep-15	18:00	F		no			
870	22-Sep-15	18:00	F		no			
871	22-Sep-15	18:00	F		no			
872	23-Sep-15	15:00	M		no			
873	23-Sep-15	15:00	F		no			
874	23-Sep-15	15:00	F		no			
875	23-Sep-15	16:00	F		no			
876	23-Sep-15	16:00	F		no			
877	23-Sep-15	16:00	F		no			
878	23-Sep-15	16:00	F		no			
879	23-Sep-15	16:00	F		no			
880	23-Sep-15	17:00	M		no			
881	23-Sep-15	17:00	M		no			
882	23-Sep-15	17:00	M		no			
883	23-Sep-15	17:00	M		no			
884	23-Sep-15	17:00	M		no			
885	23-Sep-15	17:00	F		no			
886	23-Sep-15	17:00	F		no			
887	23-Sep-15	17:00	F		no			
888	23-Sep-15	18:00	F		no			
889	25-Sep-15	8:15	F	765	no	4.3	1	
890	25-Sep-15	13:00	M		no			
891	25-Sep-15	13:00	F		no			
892	25-Sep-15	15:00	M		no			
893	25-Sep-15	15:00	M		no			
894	25-Sep-15	15:00	M		no			
895	25-Sep-15	15:00	F		no			
896	25-Sep-15	15:00	F		no			
897	25-Sep-15	15:00	F		no			
898	26-Sep-15	8:30	F	760	no	4.2	9	1st fwa not visible

899	26-Sep-15	8:30	F	700	no	5.2	1	
900	26-Sep-15	8:30	F	695	no	4.2	5a	
901	28-Sep-15	15:00	M		no			
902	28-Sep-15	15:00	M		no			
903	28-Sep-15	15:00	M		no			
904	28-Sep-15	15:00	M		no			
905	28-Sep-15	15:00	M		no			
906	28-Sep-15	15:00	M		no			
907	28-Sep-15	15:00	M		no			
908	28-Sep-15	15:00	M		no			
909	28-Sep-15	15:00	M		no			
910	28-Sep-15	15:00	M		no			
911	28-Sep-15	15:00	F		no			
912	28-Sep-15	15:00	F		no			
913	28-Sep-15	15:00	F		no			
914	28-Sep-15	15:00	F		no			
915	28-Sep-15	15:00	F		no			
916	28-Sep-15	15:00	F		no			
917	28-Sep-15	15:00	F		yes			
918	28-Sep-15	15:00	F		no			
919	28-Sep-15	15:00	F		no			
920	28-Sep-15	15:00	F		no			
921	28-Sep-15	16:00	M		no			
922	28-Sep-15	16:00	F		no			
923	28-Sep-15	16:00	F		no			
924	28-Sep-15	16:00	F		yes			
925	28-Sep-15	16:00	F		no			
926	28-Sep-15	17:00	M		no			
927	28-Sep-15	17:00	M		no			
928	28-Sep-15	17:00	F		no			
929	28-Sep-15	18:00	F	705	no	4.2	5a	
930	28-Sep-15	18:00	F	730	no	4.2	5	may be lacking 1st fw annulus; ie. 5.2
931	29-Sep-15	8:30	F	715	no	4.2	1	
932	29-Sep-15	8:30	F	730	no	4.2	1	
933	29-Sep-15	14:00	M		no			
934	29-Sep-15	16:00	F		no			
935	29-Sep-15	18:00	F	780	no	4.2S1	1	
936	29-Sep-15	18:00	F	760	no	4.2S1	5	
937	29-Sep-15	18:00	F	680	no	5.2	9	1st fwa barely visible
938	29-Sep-15	18:00	M	720	no	4.2	5a	
939	30-Sep-15	8:00	M	770	no	R.2	6	
940	30-Sep-15	14:00	M		no			
941	30-Sep-15	14:00	F		no			

942	30-Sep-15	17:00	F		no			
943	30-Sep-15	17:00	F		no			

Appendix Table 4. Staff gauge height, water and air temperature and weather conditions recorded at the Upper Sustut River Weir.

Date	Time (hrs)	Staff Gauge Height (m)	Water Temperature (°C)		Air Temperature (°C)		Weather Conditions
			Max	Min	Max	Min	
01-Aug-15	8:00	0.290					fog lifting
01-Aug-15	20:45	0.290	14	9	19	3	clearing
02-Aug-15	8:00	0.280					cloudy
02-Aug-15	21:00	0.295	14	11	13.5	-1.5	some clearing
03-Aug-15	7:45	0.300					cloudy
03-Aug-15	20:30	0.310	12	10	10	5.5	overcast; drizzle
04-Aug-15	7:30	0.370					light rain
04-Aug-15	20:00	0.390	13	12	15.5	6.5	hard rain
05-Aug-15	8:00	0.390					fog lifting
05-Aug-15	20:00	0.375	14	11	19.5	2.5	mostly sunny
06-Aug-15	8:00	0.355					clear
06-Aug-15	20:00	0.335	15	11	26	-1	mostly clear
07-Aug-15	8:00	0.325					mostly cloudy
07-Aug-15	20:00	0.315	15	11	22	8	mostly cloudy
08-Aug-15	8:00	0.305					mostly sunny
08-Aug-15	20:00	0.295	15	11	23.5	3.5	cloudy
09-Aug-15	8:00	0.290					cloudy
09-Aug-15	20:00	0.285	15.5	11.5	18	6	mostly cloudy
10-Aug-15	7:45	0.275					mostly cloudy
10-Aug-15	20:00	0.270	13.5	11.5	20	10	mostly cloudy
11-Aug-15	8:00	0.265					cloudy
11-Aug-15	20:00	0.260	13	11	13	9	cloudy
12-Aug-15	8:00	0.270					drizzle
12-Aug-15	20:00	0.275	13	11	13	9	mostly cloudy
13-Aug-15	8:00	0.285					mostly cloudy
13-Aug-15	20:00	0.290	13.5	11	13.5	7	partly clear
14-Aug-15	8:00	0.295					clear
14-Aug-15	20:00	0.275	14	7	21	-2.5	partly cloudy
15-Aug-15	8:00	0.270					partly cloudy
15-Aug-15	20:00	0.255	14	10	20.5	-2	partly cloudy
16-Aug-15	8:00	0.250					partly cloudy
16-Aug-15	20:00	0.235	14	9	22	-2	clear
17-Aug-15	8:00	0.235					mostly cloudy
17-Aug-15	20:00	0.230	14	10	16	3	partly cloudy
18-Aug-15	8:00	0.225					overcast; drizzle
18-Aug-15	20:00	0.220	13.5	11	18.5	9	mostly cloudy; light rain
19-Aug-15	8:00	0.220					mostly sunny
19-Aug-15	19:30	0.220	13	10	18.5	2	partly clear
20-Aug-15	8:00	0.220					fog; drizzle
20-Aug-15	20:00	0.225	11	9	10.5	1	mostly cloudy
21-Aug-15	8:00	0.250					partly sunny
21-Aug-15	20:00	0.235	13	9	18	1.5	mix of sun and clouds

22-Aug-15	8:00	0.230					cloudy
22-Aug-15	21:00	0.230	13	10.5	13	6.5	rain
23-Aug-15	8:00	0.250					partly cloudy
23-Aug-15	20:00	0.250	12	9	13.5	3	mostly cloudy
24-Aug-15	8:00	0.235					cloudy
24-Aug-15	20:00	0.230	12	9	16.5	1	cloudy
25-Aug-15	7:30	0.230					fog
25-Aug-15	20:00	0.225	12	8	17	0	partly cloudy
26-Aug-15	8:00	0.220					partly cloudy
26-Aug-15	20:00	0.215	12	7	15.5	-2.5	mostly clear
27-Aug-15	8:00	0.215					mostly cloudy
27-Aug-15	20:00	0.210	12	8.5	15	1.5	light rain
28-Aug-15	7:45	0.215					light rain
28-Aug-15	20:15	0.255	11.5	9	10	6.5	rain clearing
29-Aug-15	8:00	0.315					mostly sunny
29-Aug-15	20:00	0.310	11	8	13	1.5	light rain
30-Aug-15	8:00	0.325					light rain
30-Aug-15	20:00	0.415	10.5	9	8	4	rain
31-Aug-15	7:30	0.500					mostly cloudy
31-Aug-15	20:00	0.490	11	7	12	0	partly clear
01-Sep-15	7:30	0.465					mostly clear
01-Sep-15	19:45	0.440	9.5	6	10.5	-5	mostly cloudy
02-Sep-15	8:00	0.415					overcast; rain
02-Sep-15	20:00	0.430	10	7	6	0.5	partly clearing
03-Sep-15	7:45	0.430					cloudy; drizzle
03-Sep-15	20:00	0.405	10	7	10.5	0	partly clear
04-Sep-15	8:30	0.395					sunny
04-Sep-15	19:30	0.360	10	7	17	-6	mostly clear
05-Sep-15	8:30	0.350					mostly cloudy
05-Sep-15	20:00	0.335	10	6	15	-3	mostly cloudy
06-Sep-15	8:15	0.325					mostly cloudy
06-Sep-15	20:00	0.315	10	7	12	1.5	partly clearing
07-Sep-15	8:30	0.310					fog
07-Sep-15	19:30	0.310	10	7	12	1	mostly cloudy
08-Sep-15	8:15	0.310					sunny
08-Sep-15	20:00	0.290	10	6.5	13	-2.5	mostly cloudy
09-Sep-15	8:00	0.290					mostly cloudy
09-Sep-15	20:00	0.290	10	7	14	4	mostly cloudy
10-Sep-15	8:30	0.285					mostly cloudy
10-Sep-15	20:00	0.275	10.5	8	17.5	6.5	mostly cloudy
11-Sep-15	8:00	0.275					overcast; drizzle
11-Sep-15	19:30	0.285	11	10	17	10	overcast; drizzle
12-Sep-15	8:15	0.290					partly clearing
12-Sep-15	19:45	0.315	12	9	15.5	4.5	partly cloudy
13-Sep-15	8:15	0.310					partly cloudy
13-Sep-15	19:45	0.310	11	7	11.5	-0.5	mostly cloudy
14-Sep-15	7:45	0.290					partly sunny
14-Sep-15	20:00	0.285	10	6.5	9.5	-2.5	mostly cloudy
15-Sep-15	8:15	0.275					mostly cloudy
15-Sep-15	19:45	0.270	9	6	10	-5	mostly cloudy

16-Sep-15	8:15	0.265					mostly sunny
16-Sep-15	19:30	0.255	9	6	8.5	-4	mostly cloudy
17-Sep-15	8:15	0.250					mostly cloudy
17-Sep-15	19:30	0.250	9	6	9	-3	overcast; drizzle
18-Sep-15	8:15	0.255					overcast; drizzle
18-Sep-15	19:45	0.270	9	6	8	3.5	overcast; drizzle
19-Sep-15	8:00	0.360					mostly cloudy
19-Sep-15	19:30	0.385	9.5	6	8	0	partial clearing
20-Sep-15	8:30	0.355					mostly sunny
20-Sep-15	19:15	0.345	9	4	8.5	-7	partly cloudy
21-Sep-15	9:00	0.330					mostly cloudy
21-Sep-15	20:00	0.325	8	3	6	-7.5	mostly cloudy
22-Sep-15	8:15	0.315					snowing
22-Sep-15	19:15	0.310	6	4	4	-3.5	cloudy
23-Sep-15	8:30	0.310					light snow
23-Sep-15	19:15	0.300	6.5	4	6	-2	rain
24-Sep-15	8:30	0.310					overcast
24-Sep-15	19:00	0.315	6.5	5	4	-1	some clearing
25-Sep-15	8:15	0.335					partly sunny
25-Sep-15	19:30	0.325	6.5	4	6.5	-1	mostly cloudy
26-Sep-15	8:30	0.310					light snow
26-Sep-15	20:00	0.305	6	4	3.5	-0.5	overcast
27-Sep-15	8:30	0.295					overcast
27-Sep-15	18:30	0.285	6	4	7.5	1.5	cloudy
28-Sep-15	8:30	0.285					mostly cloudy
28-Sep-15	18:30	0.290	7	5	9	5	light rain
29-Sep-15	8:30	0.300					mostly cloudy
29-Sep-15	18:30	0.295	8	6	10	6	cloudy
30-Sep-15	8:00	0.295					mostly cloudy
30-Sep-15	18:30	0.310	8	6	10.5	7	overcast; rain