Results of the Upper Sustut River Steelhead Fence
2005

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Abstract

A floating PVC fish fence was installed into the upper Sustut River on July 28, 2005 and removed on October 2, 2005. The fish fence has been used in conjunction with a trap box, since 1992, as an indicator of annual upper Sustut River adult steelhead (*Oncorhynchus mykiss*) abundance.

In 2005, 271 adult steelhead were enumerated between July 29 and October 2. When the fence was removed on October 2, approximately 170 steelhead were counted in the first pool below the fence resulting in an overall upper Sustut River steelhead escapement estimate of 440. Presence of net marks, sex and general condition was recorded for all steelhead handled during the project. Fork length, scales and genetic samples were collected from 19% (*n* = 52) of the steelhead captured in the trap box. After capture, all species were released upstream of the fence. Other species enumerated in 2005 included: rainbow trout (*n* = 4), bull trout (*Salvelinus confluentus*) (*n* = 17), Rocky Mountain whitefish (*Prosopium williamsoni*) (*n* = 43), Chinook (*O. tshawytscha*) (*n* = 383), sockeye (*O. nerka*) (*n* = 1175) and coho (*O. kisutch*) (*n* = 88). The first steelhead was captured on July 31, and the last steelhead was captured on October 2. The 2005 steelhead count was the second lowest steelhead count since 1993 (208) and below the mean abundance estimate of 684.

A total of 5.2% of all steelhead handled during the project were observed with gillnet marks. The ratio of female to male steelhead was 2.01:1. Overall, males were significantly larger than females (Students t-test = 12.50 *p*<0.001). Length comparisons between sex and ocean residency could not be calculated because there was no representation of two ocean male steelhead in the sample (*♂* = 0)(*♀* = 21). A small representation of female steelhead in the three ocean sample (*♀* = 5) (*♂* = 16) precluded any further sex-length analysis. Repeat spawners represented 19% (*n* = 10) of the sample and all repeat spawners sampled had similar age structure 4.2S1+. The predominant freshwater age in the sample was 4 (80%) followed by 5 (20%). The marine age observed in the sample was evenly distributed between 2+ (50%) and 3+ (50%).

Water level was recorded twice a day during site visits by the contractor. Measurements were taken from an instream staff gauge located immediately upstream of the fence. Water levels ranged from 0.24 m to 0.50 m with a mean level of 0.31 m. Onset temperature data loggers were deployed on land and in the river to monitor water and air temperatures respectively. Water temperature was recorded hourly. Water temperatures ranged from 3.54°C to 13.17°C with a mean of 8.74°C.
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1.0 Introduction

Since 1992, the upper Sustut River adult summer run steelhead (*Oncorhynchus mykiss*) population has been used as an annual index of all early run Skeena River summer steelhead. The early run Skeena River steelhead stocks are susceptible to intense commercial fisheries for sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon where they susceptible to capture in a mixed stock fishery (Ward et al. 1993; Cox-Rogers 1994). Sustut River summer run steelhead also support a significant recreational fishery on the Skeena River and lower Sustut River.

The objectives of the Sustut River enumeration program are:

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

2.0 Study Area

The Sustut River is located in north central British Columbia and is a tributary to the upper Skeena River (Figure 1). Originating in the Omineca Mountains approximately 220 km north of Smithers, B.C. the Sustut River flows for 8 km northwest from Sustut and Mud lakes where it joins Johanson Creek near the main spawning area for upper Sustut steelhead (Bustard 1993). The river then flows 3 km west to it’s confluence with Moosevale Creek before turning southwest for approximately 100 km and flowing into the Skeena River. The Sustut River drains approximately 3,574 km² and has seven main tributaries: Birdflat Creek, Bear River, Asitka River, Red Creek, Two Lake Creek, Moosevale Creek and Johanson Creek. Fish species known to inhabit the upper Sustut River include steelhead, chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), bull trout (*Salvelinus confluentus*), Dolly Varden char (*S. malma*), Rocky Mountain whitefish (*Prosopium williamsoni*), and burbot (*Lota lota*)² (Bustard 1993). The physical area that defines the upper Sustut River steelhead population is the Sustut River upstream of the Moosevale Creek confluence including Johanson Creek and Sustut and Johanson lakes (Spence et al. 1990) (Figure 2). The physical area that defines the lower Sustut

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² In August, 1999 a single juvenile burbot (<10 cm fork-length) was found in a beaver impoundment by Ministry Staff on the Sustut River approximately 800 meters upstream of its confluence with Johanson Creek.
River steelhead population is the Sustut River downstream of the Bear River confluence, including Bear River and Bear Lake (Spence et al. 1990) (Figure 2).

3.0 Methods

3.1 Steelhead Enumeration

A floating fish counting fence constructed from 3.8 cm PVC pipe was placed 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 operated between July 28 and October 2. Fish were directed into an aluminum trap box where they remained until a gate was opened allowing continued upstream migration.

The total number of steelhead counted at the fence to September 30 is used to indicate the abundance of the adult upper Sustut River steelhead population and is the value used for annual comparisons. The Sustut River count is hypothesized to be reflective of steelhead abundances for other upper Skeena tributaries. Fish holding downstream of the fence were counted visually on October 2, immediately after fence removal.

The fence was inspected twice a day, and debris was removed and repairs made as necessary. The fence trap box was checked in the morning and evening during low levels of fish migration and was checked more frequently during heavier migration. Anecdotal information indicates that human activity around the fence often halts or delays migration. Therefore, periods of fish handling and the removal of debris and carcasses from the fence were limited to avoid affecting fish migration.

Sex and fork length data plus scale and genetic material was collected from approximately 20% of the fish handled during the project. Although the fence monitors tried to sample fish on a random basis, sampling biases more than likely occurred during periods of peak migration (pers. comm. Ron Steffey).
Figure 1. Sustut River
Figure 2. Map of Susut River and Tributaries
Figure 3. Photograph of the steelhead enumeration fence, trap box and sampling station (a) and of the fence and downstream holding pool (b), 2004.
The fence monitors used the visual characteristics described in Scott and Crossman (1973) and McPhail and Carveth (1994), to identify the species of all fish captured during the project. For data collection purposes, a plexiglass viewing box was used to identify fish by species, sex and to observe scars, wounds and general condition.

3.2 Steelhead Migration and Physical Data

Manual stream temperatures were recorded daily using a minimum-maximum thermometer (Brannon Ltd). Also, temperature data loggers (Onset Computer Corporation, Pocasset, MA) were deployed in the river and in the air near the fence site to record hourly temperatures. Water levels were recorded in the morning and the evening using a metric instream staff-gauge. Air temperature and weather conditions were also recorded daily. Maximum daily water temperature and level were examined against steelhead migration by graphical and statistical methods to determine if these physical factors influenced migration patterns.

3.3 Steelhead Gillnet Marks

The presence or absence of gillnet marks was noted for all steelhead as they migrated past the fence.

3.4 Male and Female Steelhead Run Timing

The run timing of male and female steelhead was examined by plotting cumulative percent male and female steelhead by date over the duration of fence operation. The date of first arrival and median migration date past the fence for male and female steelhead was also compared. Finally, daily numbers of male and female steelhead migrating past the fence were plotted and compared using a Students t-test for distribution comparisons.

4.0 Results

4.1 Steelhead Results

Between July 28 and September 30, 2005, 268 steelhead migrated upstream through the upper Sustut River fence (Table 1; Appendix Table 1). An additional three steelhead migrated past the fence between October 1 and October 2. Approximately 170 steelhead were counted in the pool immediately downstream
of the fence prior to its removal making the estimated spawning escapement to the upper Sustut River 441 steelhead.

The first steelhead migrated through the fence on July 31 and by September 3, 50% of the steelhead enumerated in 2005 had passed the fence (n=134) (Figure 4). For purposes of annual comparison, the previous dates by which 50% of the migration had occurred along with the corresponding total fence counts to September 30 are recorded in Table 1 for the years 1994 to 2005. Information prior to 1994 was not included due to the variability in fence design and location.

By annual comparison, the 50% migration date has been relatively consistent since 2002. September 3 was the reported 50% migration date for 2004 and 2005, and September 2 was the reported 50% migration date for 2002 and 2003 (Table 1). In the last 12 years, the mean date at which 50% of the steelhead run had passed the fence was September 7 (SD=5.88).

Table 1. Dates when 50% of the steelhead migrated through the fence and the total count to September 30, for the years 1994 to 2005.

<table>
<thead>
<tr>
<th>Year</th>
<th>Date of 50% Migration</th>
<th>50% Fence Count</th>
<th>Aggregate Fence Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Aug-29</td>
<td>292</td>
<td>584</td>
</tr>
<tr>
<td>1995</td>
<td>Sep-08</td>
<td>234</td>
<td>467</td>
</tr>
<tr>
<td>1996</td>
<td>Sep-07</td>
<td>233</td>
<td>466</td>
</tr>
<tr>
<td>1997</td>
<td>Sep-13</td>
<td>325</td>
<td>649</td>
</tr>
<tr>
<td>1998</td>
<td>Sep-07</td>
<td>532</td>
<td>1064</td>
</tr>
<tr>
<td>1999</td>
<td>Sep-17</td>
<td>366</td>
<td>731</td>
</tr>
<tr>
<td>2000</td>
<td>Sep-07</td>
<td>186</td>
<td>377</td>
</tr>
<tr>
<td>2001</td>
<td>Sep-16</td>
<td>378</td>
<td>756</td>
</tr>
<tr>
<td>2002</td>
<td>Sep-02</td>
<td>406</td>
<td>812</td>
</tr>
<tr>
<td>2003</td>
<td>Sep-02</td>
<td>558</td>
<td>1115</td>
</tr>
<tr>
<td>2004</td>
<td>Sep-03</td>
<td>521</td>
<td>1042</td>
</tr>
<tr>
<td>2005</td>
<td>Sep-03</td>
<td>134</td>
<td>268</td>
</tr>
</tbody>
</table>

Earliest 50% Migration Date Aug-29 Minimum Count 268
Latest 50% Migration Date Sep-17 Maximum Count 1115
Mean Count 694

Graphical analysis of the cumulative proportional distribution of steelhead over time indicates that, in 2005, steelhead migration past the fence was more gradual than in 2004 (Figure 4). In 2004, 49.8% (n=520) of the steelhead migration was accounted for on three dates: August 26 (n=110), September 3 (n=290) and September 24 (n=120) (Diewert 2004). During the 2004 study, the mean daily upstream count was 15.8 (SD=40.6) and the maximum daily count was 290. In comparison, in 2005, the mean daily count was 4.1 (SD=6.83) and the maximum count was 37.
Prior to the 2002, all steelhead captured in the trap box were marked with an anchor tag before being released upstream of the fence. Annual handling mortality rates were estimated by comparing fish handled to the number of mortalities recovered from the upstream side of the fence. Although measured mortality may include death by natural processes, it is assumed that all observed mortality is a byproduct of handling. Since 2002, the anchor tagging component of the program has been discontinued. The fence monitors now collect genetic material, scales and length data from a sub sample of the upper Sustut River steelhead (~20%) captured at the site. 4,510 steelhead were enumerated at the site between 1995 and 2001. A total of 68 steelhead mortalities were recovered resulting in a handling mortality rate of 1.5%. In comparison, 2,969 steelhead were enumerated between 2002 and 2004 and 11 mortalities were recovered resulting in a handling mortality rate of 0.36%. There was not any steelhead mortality observed in 2005.

Steelhead that had been previously anchor tagged in the Tyee test fishery or at the Sustut fence are subject to recapture during the study period. Since the Sustut tagging component was discontinued in 2001, it is unlikely that any further tags applied at the Sustut fence will be recovered. In 2005, there was one steelhead observed with an anchor tag. A comprehensive search of the tag database revealed that tag number 37190 (yellow) had been issued to Fisheries and Oceans Canada in 2001. Specific information about the tag application was unavailable. However, based on the tag number series, tag 37190 was more than likely applied in the 2003 Tyee Test Fishery. Diewert 2004 reported that a female steelhead tagged at the fence in 2000 was recaptured as a mortality in 2004. (Table 2). An examination of historical tagging data revealed that tag 14270 (white) had also been recaptured at the fence in 2002 (Table 2). Measured growth from the date of initial capture to the date of first recapture and second recapture was 60mm and 50mm respectively.
Table 2. History of Tag 14270 (White) recaptured at the upper Sustut River fence 2002-2004.

<table>
<thead>
<tr>
<th>Initial Capture</th>
<th>Date</th>
<th>NF Length (mm)</th>
<th>Tag Number</th>
<th>Tag Colour</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sept 17,2000</td>
<td>700</td>
<td>14270</td>
<td>White</td>
<td>Bright; clean</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1st Recapture</th>
<th>Date</th>
<th>NF Length (mm)</th>
<th>Tag Number</th>
<th>Tag Colour</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August 24,2002</td>
<td>760</td>
<td>14270</td>
<td>White</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Recapture</th>
<th>Date</th>
<th>NF Length (mm)</th>
<th>Tag Number</th>
<th>Tag Colour</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August 19,2004</td>
<td>810</td>
<td>14270</td>
<td>White</td>
<td>Mort</td>
</tr>
</tbody>
</table>

Figure 5. Photo of female steelhead captured at Sustut Fence 2000, 2002 and 2004.

4.2 Steelhead Migration and Physical Data

Environmental data recorded by the fence monitors daily are presented in Appendix Table 4. For purposes of analysis, water temperatures collected via Stowaway data loggers will be utilized. The data logger recorded water temperatures from August 1 to October 1, 2005. Water temperature was recorded hourly providing 1,464 data points for analysis. Overall, the highest temperature was recorded on August 12 (15.83°C) and the lowest was recorded on September 27 (1.82°C). The mean temperature during this time period was 8.74°C. Daily minimum and maximum water temperatures are shown graphically
in Appendix Figure 1. Water levels, measured by staff gauge, ranged from 0.2475 m to 0.505 m and averaged 0.316 m. Stratified by hour, the warmest water temperatures were recorded between 5:00 PM and 6:00 PM (Figure 6). Based on 2005 records, 73.8% (n=200) of the steelhead entering the trap box did so between 3:00 PM and 8:00 PM. The remainder, 26.2% (n=71), were captured outside of that period. Figure 6 shows a high number of steelhead captured between 8:00 AM and 10:00 AM. Since fence staff is not present after dusk, steelhead could have entered the trap box at any time after dusk. As a result, this number does not reflect the specific hour migration into the trap box may have occurred.

Figure 6. Water temperatures and steelhead migration stratified by hour August 1- October 1, 2005.

Water levels were recorded by fence staff twice daily. The two daily measurements were averaged to determine a daily level (Figure 7). Measurements were recorded from a metric staff gauge located immediately upstream of the fence. In 2005, water levels ranged between 0.245 m and 0.505 m. The mean level was 0.312 m and the standard deviation was 0.048. The highest daily water level was 0.505 m measured on August 2, 2005 and the lowest level was 0.2475 m measured on September 27, 2005. A Petersen correlation coefficient test was performed to determine if there was a significant linear relationship between water level and steelhead migration past the fence. The result was (r=0.03) and indicated no significant relationship between steelhead migration and water level.
4.3 Steelhead Length Distributions by Sex

Of the 271 steelhead counted migrating through the fence, 90 (33.3%) were male and 181 (66.6%) were female resulting in a female to male ratio of 2.01:1. A total of 16 male and 36 female steelhead were measured for nose-fork length. Male lengths ranged from 790 to 930 mm and averaged 850 mm while female lengths ranged from 665 to 835 mm and averaged 740 mm. Overall, males were significantly larger than females (Students t-test =12.50 p<0.001).

4.4 Steelhead Gillnet Marks

Fence observers recorded the presence of gillnet marks on steelhead that were handled during the project. Gillnet marks were present on 5.1% (n=14) of all steelhead that migrated past the fence. In total, 11 of the steelhead observed with net marks were female and three were male. Length was determined for only four of the net marked steelhead observed in the 2005 sample. The small sample size precluded any comparisons with data collected in previous years.
4.5 Male and Female Steelhead Run Timing

The first female steelhead passed through the fence on July 28 while the first male steelhead migrated upstream on August 9 (Appendix Table 2). The median migration date was September 3 for both sexes. The plot of daily cumulative percentage of male and female steelhead arriving at the fence revealed a similar migration pattern for both sexes (Figure 8). When the daily numbers of male and female steelhead migrating past the fence were plotted and compared, the student’s t-test revealed no significant difference between the arrival time of females and males Student’s t-test (t=1.29) (p>0.1).

![Figure 8. Daily cumulative percent of male and female steelhead migrating past the fence 2005.](image)

4.6. Steelhead Ages

In 2005, scales were removed from 52 steelhead at the upper Sustut River fence. These scales were analyzed to determine freshwater and ocean residency age and repeat spawning rates. 80% of the scales (n=42) were classified as being in good condition (code 1) (Appendix Table 11) while 2% (n=1) were in poor
condition (code 2) (Appendix Table 7). The remaining scale samples 17.25% (n=9) were showing evidence of regeneration. Regeneration may have affected the accuracy of the ageing of these nine samples. (Appendix Table 11, 12). Freshwater residency ranged from four to five winters. Four was the predominant freshwater age and represented 80% (n=36) of the scales collected and freshwater age five represented 20% (n=9) of the sample. Freshwater age could not be determined for seven of the scale samples collected (Appendix Table 6). In the 2005 sample marine residency ranged from two to three winters. Maiden spawners represented 80.7% (n=42) of the sample, and 19% (n=10) of the scales examined showed evidence of repeat spawning.

5.0 Discussion

The 2005 upper Sustut River steelhead fence count to September 30 was 269. This value is the lowest recorded count since methods were standardized in 1994 (Table 3). An unusually high number of steelhead (~170) were observed downstream of the fence prior to its removal. The sum of the 2005 fence count and steelhead observed downstream of the fence prior to removal, results in an abundance estimate of 441. Since 1994, annual fence counts have ranged from a high of 1,115 in 2003 to a low of 269 in 2005 (Table 30). Recent trends in ocean productivity have negatively affected adult steelhead recruitment in southern British Columbia (Ward et al 2006). Unfortunately, ocean survival of Skeena summer run steelhead stocks can not be measured like it is on the south coast. 2005 data collected from steelhead sampled from the upper Sustut River seemed to indicate a change in the proportional representation of marine age. Age data collected over time indicates that two ocean steelhead represent a significant portion of the annual upper Sustut river escapement (Diewert 2001,2002,2003,2004). In 2005, excluding repeat spawners, the proportional representation of two ocean steelhead in the sample declined. A similar comparison of Nass summer run steelhead stocks indicated a similar general shift in marine age composition. This may indicate that a shift in ocean survival rates may have affected adult recruitment in 2005.
The mortality rate for steelhead migrating past the fence in 2005 was 0%, which is below the overall mean of average of 1.05% (Table 3). The reduction in observed steelhead mortality can probably be attributed to changes in handling procedures at the site. Rather than handling and sampling all steelhead captured at the site, site monitors now sample only 20% of the steelhead captured annually.

In 2005, 67% of the steelhead migrating past the fence were female and 33% were male. These results suggested a sex ratio of 2.05:1 females to males. The

Table 3. Historical upper Sustut River steelhead data for the years 1994 to 2005.

<table>
<thead>
<tr>
<th>Year</th>
<th>Date of Steelhead Migration</th>
<th>Index</th>
<th>Average Length (cm)</th>
<th>Repeat Spawner %</th>
<th>Handling Mortality %</th>
<th>% Gillnet Marked</th>
<th>M</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>199</td>
<td>8-Aug</td>
<td>29-Aug</td>
<td>584</td>
<td>82</td>
<td>4</td>
<td>2.0</td>
<td>73</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>8-Aug</td>
<td>8-Sep</td>
<td>467</td>
<td>6</td>
<td>6</td>
<td>1.2</td>
<td>4.0</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>17-Aug</td>
<td>7-Sep</td>
<td>466</td>
<td>9</td>
<td>9</td>
<td>1.3</td>
<td>2.8</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>9-Aug</td>
<td>13-Sep</td>
<td>649</td>
<td>4</td>
<td>3</td>
<td>0.6</td>
<td>1.5</td>
<td>9.2</td>
<td>17.8</td>
</tr>
<tr>
<td>199</td>
<td>3-Aug</td>
<td>7-Sep</td>
<td>1064</td>
<td>7</td>
<td>9</td>
<td>0.8</td>
<td>13.4</td>
<td>13.8</td>
<td>13.7</td>
</tr>
<tr>
<td>199</td>
<td>17-Aug</td>
<td>17-Sep</td>
<td>731</td>
<td>8</td>
<td>6</td>
<td>2.5</td>
<td>0.3</td>
<td>6.1</td>
<td>9.9</td>
</tr>
<tr>
<td>200</td>
<td>8-Aug</td>
<td>7-Sep</td>
<td>377</td>
<td>7</td>
<td>1</td>
<td>0.4</td>
<td>0.5</td>
<td>10.6</td>
<td>16.2</td>
</tr>
<tr>
<td>200</td>
<td>15-Aug</td>
<td>16-Sep</td>
<td>756</td>
<td>4</td>
<td>1</td>
<td>2.5</td>
<td>1.9</td>
<td>10.1</td>
<td>14.5</td>
</tr>
<tr>
<td>200</td>
<td>9-Aug</td>
<td>2-Sep</td>
<td>812</td>
<td>1.9</td>
<td>3.6</td>
<td>8.4</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>3-Aug</td>
<td>2-Sep</td>
<td>1115</td>
<td>0</td>
<td>0</td>
<td>1.2</td>
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sex ratio in favor of females is similar to that found in previous years (Parken et al. 1997; Williamson 1998, 1999a, 2000; Diewert 2001, 2002, 2003, 2004). In 2005, 4.8% of all steelhead migrating past the fence exhibited gillnet marks. This falls in the lower end of previously recorded values which have ranged from 2.0 to 15.4% (Table 3). Female steelhead tended to exhibit a higher gillnet mark rate than males (5.5% and 3.3%, respectively). Past studies have found that gillnet marked males and females were significantly smaller than unmarked fish (e.g. Diewert 2002).

5.1 The Importance of Continued Monitoring.

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

6.0 Recommendations

1. Enumeration of the upper Sustut River steelhead population should continue to be carried out annually. We recommend a small raft be used to assist in counting steelhead downstream to the Moosevale Creek confluence. This count should coincide with the fence removal in the fall. The valuable time series of data that results from this project provides fisheries managers with information on abundance trends for all early run Skeena steelhead populations and provides feedback on the impact of fisheries on these important stocks.

2. Efforts to visually enumerate steelhead below the fence prior to fence removal should continue. These counts provide the basis for estimating total steelhead spawning escapement to the upper Sustut River allowing for an evaluation of stock status relative to carrying capacity. Surveys should take place throughout the latter portion of the project to ensure that a count of steelhead below the fence is always available. A final count should be carried out as close to the date of fence removal as possible. How the count occurs should be standardized to maintain the long term consistency of the data.
3. It is recommended that approximately 20% of the male and female steelhead migrating past the fence continue to be sampled for age and length. This compromise ensures that the valuable time series of biological data will continue while handling mortality remains at a low level. It is also recommended that steelhead captured with anchor tags be sampled for age and length for comparative reasons.

7.0 Acknowledgments

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

Mark Beere assisted with the installation of the enumeration weir.

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

BC Conservation Foundation, Kamloops, BC provided general contracting services.

This project was funded by BC Environment’s Habitat Conservation Trust Fund and was developed by personnel of BC Environment. The Habitat Conservation Trust Fund 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.
8.0 Literature Cited

Cox-Rogers, S. 1994. Description of daily simulation model for the Area 4 (Skeena) commercial gillnet fishery. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2256.


McPhail, J.D. and R. Carveth. 1994. Field key the freshwater fishes of British Columbia. British Columbia Resource Inventory Committee Publication #44.


Appendix Figure 1. Daily minimum and maximum water temperatures at the upper Sustut River fence, August 1 to October 1, 2005.
Appendix Tables

Appendix Table 1. Daily and cumulative totals of steelhead, rainbow trout, bull trout and Rocky Mountain whitefish migrating past the upper Sustut River fence, 2005.

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<td>foggy</td>
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Appendix Table 5. Statistical week definitions for 2005.

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<th>Calendar Week</th>
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<tbody>
<tr>
<td>7-5</td>
<td>July 29 to August 1</td>
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<tr>
<td>8-1</td>
<td>August 2 to 8</td>
</tr>
<tr>
<td>8-2</td>
<td>August 9 to 15</td>
</tr>
<tr>
<td>8-3</td>
<td>August 16 to 22</td>
</tr>
<tr>
<td>8-4</td>
<td>August 23 to 29</td>
</tr>
<tr>
<td>9-1</td>
<td>August 30 to September 5</td>
</tr>
<tr>
<td>9-2</td>
<td>September 6 to 12</td>
</tr>
<tr>
<td>9-3</td>
<td>September 13 to 19</td>
</tr>
<tr>
<td>9-4</td>
<td>September 20 to 26</td>
</tr>
<tr>
<td>10-1</td>
<td>September 27 to October 2</td>
</tr>
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Appendix Table 6. Age data from scale analysis for steelhead sampled at the upper Sustut River 2005.

<table>
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<tr>
<th>Date</th>
<th>Sex</th>
<th>NF(cm)</th>
<th>Scale</th>
<th>Book #</th>
<th>Cond. Code</th>
<th>Age</th>
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<tbody>
<tr>
<td>11-Aug-05</td>
<td>F</td>
<td>80</td>
<td>1~41</td>
<td>44195</td>
<td>1</td>
<td>4.2S1 +</td>
</tr>
<tr>
<td>16-Aug-05</td>
<td>M</td>
<td>87.5</td>
<td>2~42</td>
<td>44195</td>
<td>1</td>
<td>4.3+</td>
</tr>
<tr>
<td>17-Aug-05</td>
<td>M</td>
<td>81</td>
<td>3~43</td>
<td>44195</td>
<td>1</td>
<td>4.3+</td>
</tr>
<tr>
<td>20-Aug-05</td>
<td>F</td>
<td>78</td>
<td>4~44</td>
<td>44195</td>
<td>1</td>
<td>4.3+</td>
</tr>
<tr>
<td>20-Aug-05</td>
<td>F</td>
<td>71</td>
<td>5~45</td>
<td>44195</td>
<td>2</td>
<td>5.2+</td>
</tr>
<tr>
<td>20-Aug-05</td>
<td>F</td>
<td>79.5</td>
<td>6~46</td>
<td>44195</td>
<td>1</td>
<td>4.2S1 +</td>
</tr>
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<td>75</td>
<td>7~47</td>
<td>44195</td>
<td>1</td>
<td>4.2+</td>
</tr>
<tr>
<td>23-Aug-05</td>
<td>F</td>
<td>69</td>
<td>8~48</td>
<td>44195</td>
<td>1</td>
<td>5.2+</td>
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<td>F</td>
<td>72</td>
<td>9~49</td>
<td>44195</td>
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<td>4.2+</td>
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<td>F</td>
<td>69</td>
<td>10~50</td>
<td>44195</td>
<td>5</td>
<td>4.2+</td>
</tr>
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<td>24-Aug-05</td>
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<td>68</td>
<td>1~41</td>
<td>44196</td>
<td>1</td>
<td>4.2+</td>
</tr>
<tr>
<td>25-Aug-05</td>
<td>F</td>
<td>81</td>
<td>2~42</td>
<td>44196</td>
<td>1</td>
<td>4.2S1 +</td>
</tr>
<tr>
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<td>84</td>
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<td>44196</td>
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<td>4.3+</td>
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<td>44196</td>
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<td>R.3+</td>
</tr>
<tr>
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<td>44196</td>
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<td>4.3+</td>
</tr>
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<td>25-Aug-05</td>
<td>F</td>
<td>83.5</td>
<td>6~46</td>
<td>44196</td>
<td>1</td>
<td>4.3+</td>
</tr>
<tr>
<td>25-Aug-05</td>
<td>F</td>
<td>78.5</td>
<td>7~47</td>
<td>44196</td>
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<td>44199</td>
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<td>4.2+</td>
</tr>
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<td>Sex</td>
<td>NF(cm)</td>
<td>Scale</td>
<td>Book #</td>
<td>Cond. Code</td>
<td>Age</td>
</tr>
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<td>-----------</td>
<td>-----</td>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>------------</td>
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<td>4.2S1+</td>
</tr>
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<td>4.3+</td>
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<td>6~46</td>
<td>44199</td>
<td>1</td>
<td>4.2+</td>
</tr>
<tr>
<td>21-Sep-05</td>
<td>F</td>
<td>73</td>
<td>7~47</td>
<td>44199</td>
<td>1</td>
<td>5.2+</td>
</tr>
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<th>Sex</th>
<th>NF(cm)</th>
<th>Scale</th>
<th>Book #</th>
<th>Cond. Code</th>
<th>Age</th>
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<tbody>
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<td>M</td>
<td>82.5</td>
<td>8~48</td>
<td>44199</td>
<td>1</td>
<td>4.3+</td>
</tr>
<tr>
<td>29-Sep-05</td>
<td>M</td>
<td>82.5</td>
<td>9~49</td>
<td>44199</td>
<td>1</td>
<td>4.3+</td>
</tr>
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<td>29-Sep-05</td>
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<td>77</td>
<td>10~50</td>
<td>44199</td>
<td>1</td>
<td>4.3+</td>
</tr>
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<td>2-Oct-05</td>
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<td>83</td>
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<td>44200</td>
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<td>4.3+</td>
</tr>
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<td>2~42</td>
<td>44200</td>
<td>1</td>
<td>5.2+</td>
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<td>3~43</td>
<td>44200</td>
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<td>4.2+</td>
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Appendix Table 7. Scale condition code definitions.

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<th>Condition Code</th>
<th>Definition</th>
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<tr>
<td>1</td>
<td>good condition</td>
</tr>
<tr>
<td>2</td>
<td>poor condition or questionable age (i.e. difficult to interpret due to poor</td>
</tr>
<tr>
<td></td>
<td>quality)</td>
</tr>
<tr>
<td>3</td>
<td>freshwater age unreadable (e.g. U.2+)</td>
</tr>
<tr>
<td>4</td>
<td>unreadable (e.g. U.U+)</td>
</tr>
<tr>
<td>5</td>
<td>starting to regenerate (may underestimate freshwater age)</td>
</tr>
<tr>
<td>6</td>
<td>regenerated (e.g. R.2+)</td>
</tr>
<tr>
<td>7</td>
<td>missing</td>
</tr>
<tr>
<td>8</td>
<td>resorption at scale edge (e.g. Last marine annulus just visible on edge of</td>
</tr>
<tr>
<td></td>
<td>scale)</td>
</tr>
<tr>
<td>9</td>
<td>first freshwater annulus very vague, but must be present due to high curculi</td>
</tr>
<tr>
<td></td>
<td>count and spacing relative to other freshwater annuli.</td>
</tr>
</tbody>
</table>
Appendix Table 8. Summary, by sex and freshwater age, of all steelhead sampled at the Sustut River fence, 2005.

<table>
<thead>
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<th>Age</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
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<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>4.2+</td>
<td>0</td>
<td>0%</td>
<td>10</td>
<td>27.7%</td>
<td>10</td>
<td>19.2%</td>
</tr>
<tr>
<td>4.2S1+</td>
<td>0</td>
<td>0%</td>
<td>10</td>
<td>27.7%</td>
<td>10</td>
<td>19.2%</td>
</tr>
<tr>
<td>4.3+</td>
<td>11</td>
<td>68.75%</td>
<td>5</td>
<td>13.8%</td>
<td>16</td>
<td>30.76%</td>
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<tr>
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<td>68.75%</td>
<td>25</td>
<td>69.2%</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>5.2+</td>
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<td>0%</td>
<td>8</td>
<td>22.2%</td>
<td>8</td>
<td>15.3%</td>
</tr>
<tr>
<td>5.3+</td>
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<td>6.25%</td>
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<td>1</td>
<td>1.9%</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>6.25%</td>
<td>8</td>
<td>0%</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>R.2+</td>
<td>0</td>
<td>0%</td>
<td>3</td>
<td>8.3%</td>
<td>3</td>
<td>5.76%</td>
</tr>
<tr>
<td>R.3+</td>
<td>4</td>
<td>25%</td>
<td>0</td>
<td>0%</td>
<td>4</td>
<td>7.69%</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>25%</td>
<td>3</td>
<td>8.3%</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>16</td>
<td>100.0%</td>
<td>36</td>
<td>100.0%</td>
<td>52</td>
<td>100.0%</td>
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</table>
Appendix Table 9. Summary, by sex and marine age, of all steelhead sampled at the upper Sustut River fence, 2005.

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>4.2+</td>
<td>0</td>
<td>0%</td>
<td>10</td>
</tr>
<tr>
<td>4.2S1+</td>
<td>0</td>
<td>0%</td>
<td>10</td>
</tr>
<tr>
<td>5.2+</td>
<td>0</td>
<td>0%</td>
<td>8</td>
</tr>
<tr>
<td>R.2+</td>
<td>0</td>
<td>0%</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
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<td>0%</td>
<td>31</td>
</tr>
<tr>
<td>4.3+</td>
<td>11</td>
<td>68.75%</td>
<td>5</td>
</tr>
<tr>
<td>5.3+</td>
<td>1</td>
<td>6.25%</td>
<td>0</td>
</tr>
<tr>
<td>R.3+</td>
<td>4</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>100%</td>
<td>5</td>
</tr>
<tr>
<td>Grand Total</td>
<td>16</td>
<td>100.0%</td>
<td>36</td>
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Appendix Table 10. Historical review of the repeat spawner rate for the upper Sustut River steelhead population, based on scale sample analysis.

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<th>Source</th>
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<td>Spence et al. 1990</td>
</tr>
<tr>
<td>1983</td>
<td>13</td>
<td>1</td>
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</tr>
<tr>
<td>1994</td>
<td>na</td>
<td>na</td>
<td>6.0%</td>
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</tr>
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<td>7</td>
<td>12.7%</td>
<td>Baxter 1997</td>
</tr>
<tr>
<td>2001</td>
<td>89</td>
<td>6</td>
<td>6.7%</td>
<td>Diewert 2002</td>
</tr>
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<td>228</td>
<td>5</td>
<td>2.2%</td>
<td>Diewert 2003</td>
</tr>
<tr>
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<td>208</td>
<td>20</td>
<td>9.6%</td>
<td>Diewert 2004</td>
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<tr>
<td>2005</td>
<td>52</td>
<td>10</td>
<td>19%</td>
<td>Peard 2005</td>
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</tbody>
</table>

Appendix Table 11. Number of steelhead past the fence and the number and percent of steelhead sampled, by sex, for statistical weeks 7-5 to 10-1 2005.

<table>
<thead>
<tr>
<th>Statistical Week</th>
<th>Steelhead Past the Fence</th>
<th>Steelhead Sampled</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>Total</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>7-5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>8-1</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>8-2</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>13%</td>
</tr>
<tr>
<td>8-3</td>
<td>3</td>
<td>18</td>
<td>21</td>
<td>2</td>
<td>24%</td>
</tr>
<tr>
<td>8-4</td>
<td>28</td>
<td>54</td>
<td>82</td>
<td>5</td>
<td>15%</td>
</tr>
<tr>
<td>9-1</td>
<td>10</td>
<td>16</td>
<td>26</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>9-2</td>
<td>16</td>
<td>45</td>
<td>61</td>
<td>3</td>
<td>100%</td>
</tr>
<tr>
<td>9-3</td>
<td>15</td>
<td>17</td>
<td>31</td>
<td>2</td>
<td>27%</td>
</tr>
<tr>
<td>9-4</td>
<td>12</td>
<td>18</td>
<td>30</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>10-1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>181</td>
<td>271</td>
<td>16</td>
<td>30.8%</td>
</tr>
</tbody>
</table>