2000 TOBOGGAN CREEK STEELHEAD ASSESSMENT

Prepared for: **Fisheries Renewal BC**

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Abstract

The fish counting fence on Toboggan Creek near Smithers, B.C., was in operation from April 14 to June 2, 2000 for steelhead enumeration; this is the eighth consecutive year of operation. Fish were tagged and recaptured in order to derive a population estimate using the modified Petersen estimator, and additional information, stream discharge and water temperature, fish length, sex, and age, was also collected. A population estimate of 286 adult steelhead above the fence was calculated based on the tagging program. The sex ratio of females to males indicates 0.79 females per male. There was no significant difference in fork length between the sexes in 2000. Steelhead migration upstream occurred primarily between May 1st and 17th, 2000, and downstream movement of kelts was between May 11 and June 2, 2000. The return of downstream migrating kelts may have still been incomplete when the fence was laid down on June 3rd due to hydraulic risk. The age of the returning fish was from 4 to 9 years with most of them being 4 and 5 year olds. Thirteen percent of the returning fish had spawned at least once previously. A small number of previously tagged fish from Moricetown Canyon indicate that Toboggan Creek probably represents approximately 1% of the total steelhead run in the Bulkley-Morice system above the Moricetown Canyon.

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1. Introduction

1.1 Background

Toboggan Creek is a small system draining into the Bulkley River west of Smithers, B.C. and is one of three systems in the mid- and upper Skeena watershed with a fish counting fence located on it (the others being the Sustut and Babine rivers). Prior to 1993, assessment of the steelhead trout (*Oncorhynchus mykiss*) population in Toboggan Creek watershed was limited (see O'Neill, 1995, 1996; Gibson, 1997). The Toboggan Creek counting fence was first operated for steelhead in 1993 (O'Neill, 1996) though it has been in operation for coho salmon (*Oncorhynchus kisutch*) since 1989 (SKR Consultants, 1996). Since 1993 Toboggan Creek steelhead population estimates based on fence counts have ranged from 120 - 543 with most of the estimates being in the range of 200 - 400 individuals (see Section 4.3 Population Estimate).

The year 2000 was the eighth consecutive year of adult steelhead enumeration via fence counts on Toboggan Creek. This document details the findings of 2000, and also summarizes the previous seven years in order to determine trends and place this years results in context. Funding and support for this project was provided by Fisheries Renewal BC.

1.2 Objectives

The objectives of this project were to:

1) Estimate the size of the adult steelhead population utilizing Toboggan Creek above the fish counting fence by a mark-recapture procedure.
2) Document run timing of steelhead to Toboggan Creek in 2000.
3) Collect information on size, sex ratio, age and life histories (via scales).

2. Study Area

Toboggan Creek is 17 km long, draining north into the Bulkley River 23 km north-northwest of Smithers, B.C. (Gibson, 1997). There are numerous tributaries contributing to the mainstem, draining an area of approximately 110 km^2 (Tredger, 1979). The stream originates from twin glaciers on Hudson Bay Mountain and is located within two Biogeoclimatic zones; the Englemann Spruce-Subalpine Fir, wet-very cold (ESSFwv) at higher elevations and the Interior Cedar Hemlock moist-cold (ICHmc) lower down (Gibson, 1997). The stream flows largely through agricultural land and pasture leases in the reaches below Toboggan Lake. The creek is also paralleled on the west side by the Canadian National (CN) rail tracks.

Toboggan Creek supports rainbow/steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*O. clarki clarki*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), kokanee (*O. nerka*), Dolly Varden char (*Salvelinus malma*), mountain whitefish (*Prosopium williamsoni*), lamprey (*Lampetra* sp.) and sculpins (*Cottus* sp.) (SKR Consultants, 1996; Gibson, 1997). There is an estimated 17 km of available fish habitat in the system distributed between the mainstem and tributaries (Tredger, 1979).

The fish counting fence on Toboggan Creek is located approximately 2.5 km upstream of the confluence with the Bulkley River (SKR Consultants, 1996); the property surrounding this location of the stream is owned by Mr. K. Landrock.

3. Methods

3.1 Physical

Stream Flow

Stream height (m) was recorded daily by use of a staff gauge adjacent to the Toboggan Creek Fish Hatchery. This was converted to discharge (Litres per second [L/s]) using the function:

$$\text{Discharge (L/s)} = H_{staff} * (700\ L*min^{-1} * cm^{-1} / 60\ sec.*min^{-1})$$

Where H_{staff} = height on staff gauge (cm)
$L*min^{-1}$ = discharge in Litres/minute

These units (L/s) may be converted to the more standard m^3/s by multiplying by 0.001. However, for comparison with past reports and scaling on the graphs, L/s is more convenient for this document.

Temperature

Daily morning and afternoon temperatures (°C) were recorded in Toboggan Creek at a station adjacent to the Toboggan Creek Fish Hatchery. For purpose of this analysis, mean daily temperature was determined by averaging these morning and afternoon temperatures for each day.

3.2 Biological

Operation of the counting fence began on April 14, 2000 and continued until June 3, 2000. There were two interruptions in which the fence was laid down (Figure 1). These periods of laying the fence down were scheduled to prevent blocking fish passage upstream and occurred May 2 (24 hours), and May 9 (17 hours). While the fence was operational, fish travelling upstream were captured in the box at the fence and tagged by insertion of a spaghetti tag in the right dorsal muscle and secondarily marked by punching a small disc out of the right operculum. Tag number, fish sex (female vs male), origin (hatchery vs wild) and fork length were recorded, previous tags noted, and unusual scarring (i.e. gill net marks, predator bites, etc.) recorded. Scale samples were taken for aging from each of the first 100 fish captured then more selectively (targeting every second fish) after that.

Downstream migrating kelts were beach seined above the fence. Previously marked fish (those marked on the upstream migration) were recorded and released below the fence. Unmarked fish were spaghetti tagged, measured, origin and unusual scarring noted, and released downstream.

3.3 Population Estimation Procedure

The Seber (1982) estimator of the Petersen method was used to estimate the steelhead population size, and binomial 95% confidence intervals were calculated. The Seber estimator is (from Krebs, 1989):

$$N' = [((M+1)(C+1))/(R+1)]-1$$

Where N' = Estimate of population size at time of marking
M = Number of individuals marked in first sample
C = Total number of individuals captured in second sample
R = Number of individuals in second sample that are marked

The binomial 95% confidence intervals were calculated using the nomogram from Krebs (1989; p21):

3.4 Other Statistical Procedures

Steelhead fork length data for 2000 was assessed for probability that it comes from a normal distribution using normal probability plots. It was determined that these measurements were normally distributed and so parametric analyses were used. Mean lengths and 95% confidence intervals were calculated for each sex, and the Students *t*-test used to test for differences in length between sexes. 95% confidence intervals were calculated as (from DeVore, 1987):

$$\text{mean value} \pm z_{\alpha/2} * (s / n^{0.5})$$

Where: $z_{\alpha/2}$ = Standard normal deviate for $(1-\alpha)$ level of confidence;
(1.96 at $\alpha = 0.05$)
s = sample standard deviation
n = sample size

4. Results and Discussion

4.1 Stream Flow and Water Temperature

Stream Flow

Discharge in Toboggan Creek over the time of sampling ranged from 187 to 385 L/s (Figure 1, Appendix 1). Discharge remained relatively constant between 187 – 280 L/s through most of the period (April 16 – May 30) then began to rise through to June 3rd when the fence was laid down due to hydraulic risk.

Stream Temperature

Toboggan Creek daily mean stream temperature ranged from 3.0 to 10.5 °C and displayed a general increasing trend over the period of sampling (Figure 1, Appendix 1). The mean stream temperature on the day of first arrival of fish at the fence was 5.75 °C.

4.2 Run Timing

The first steelhead to pass upstream through the fence was sampled April 24, 2000 (1 male; stream discharge = 198 L/s) and the last date of fish passing upstream was June 1 (2 males; stream discharge = 292 L/s). Thus, the fish were passing upstream over a period of 38 days. The majority of the fish (76%) passed upstream between May 1st and 12th with 90% having passed by May 17th (Table 1, Figure 2(a)). See Appendix 2 for timing and data on upstream migrating fish.

Returning downstream, the first fish were placed over the fence May 11 (1 male) and the last fish were June 2 (13 males, 8 females). The length of time of passage downstream was 22 days. The distribution of fish passage downstream over time are presented in Table 1 and Figure 2(b). Of the downstream migrating kelts intercepted by the fence to June 3rd, 86% of the run was completed by May 30th. See Appendix 3 for timing and data on downstream migrating kelts.

It appears that the sampling of the kelts may have been truncated by the hydraulic risk posed to the fence by the increasing stream discharge. Kelts appear to have still been moving downstream when sampling ended (i.e., 21 fish captured on last day). Therefore, it should be borne in mind that not all components of the run may have been sampled which in turn may affect the estimates of C and R below, and hence, the final population estimate. This possibility of missing a portion of the outbound kelts may also affect other estimates reported here (e.g., sex ratio, fork lengths, etc.) though the large sample size used in calculating these estimates suggest that they may be quite robust unless a large number of fish were missed.

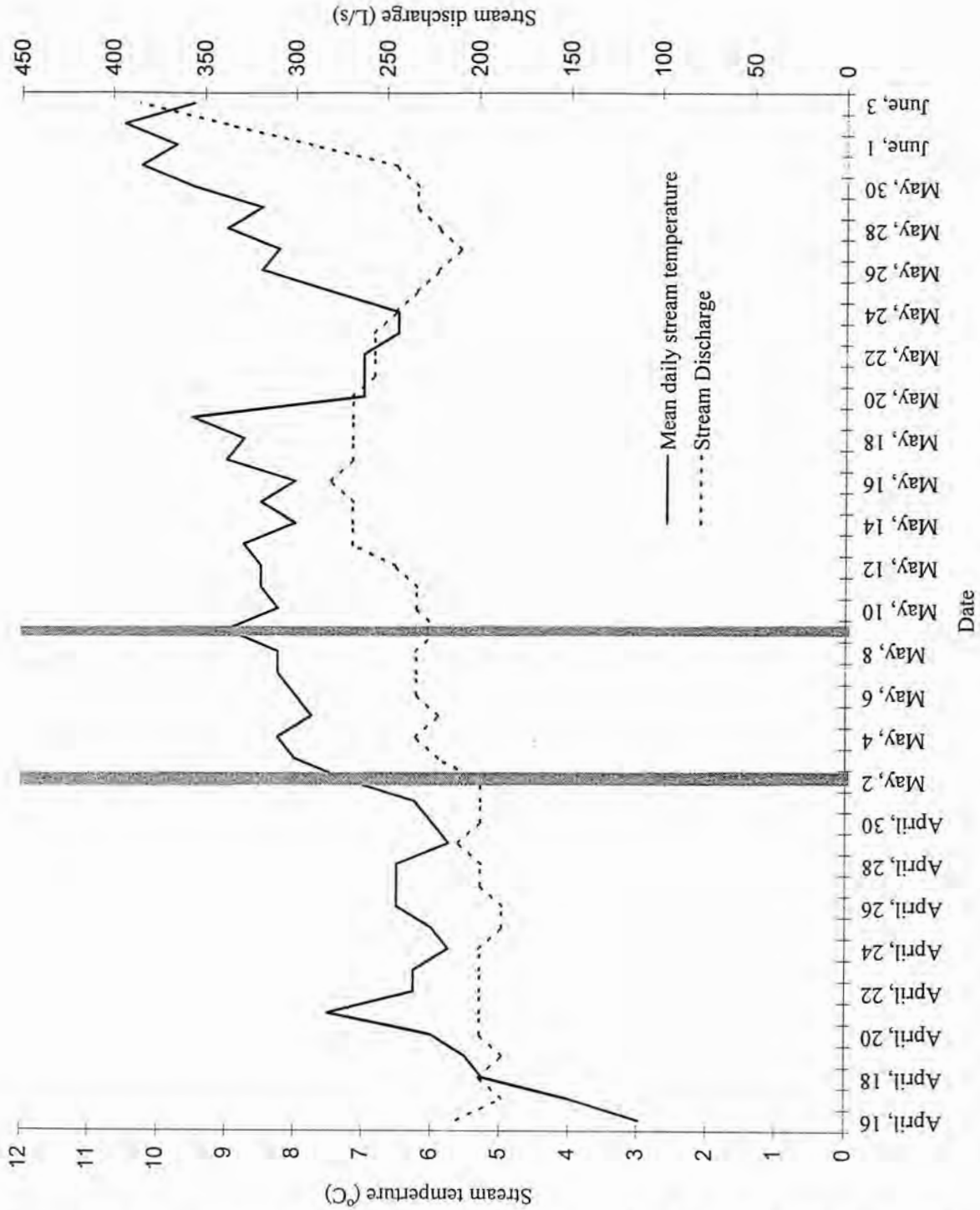
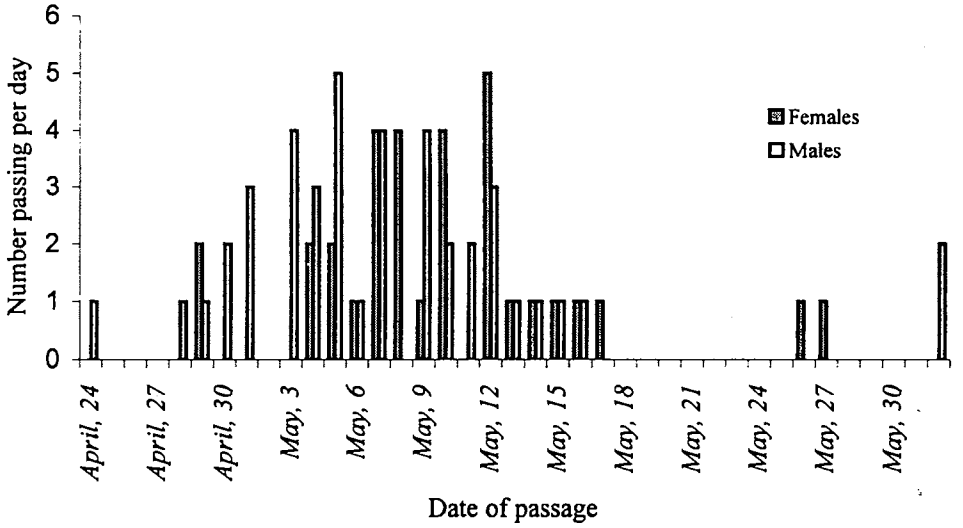


Figure 1: Stream temperature and discharge of Toboggan Creek, April 14 – June 3, 2000. Shaded lines indicate periods of the fence being laid down.

(a)



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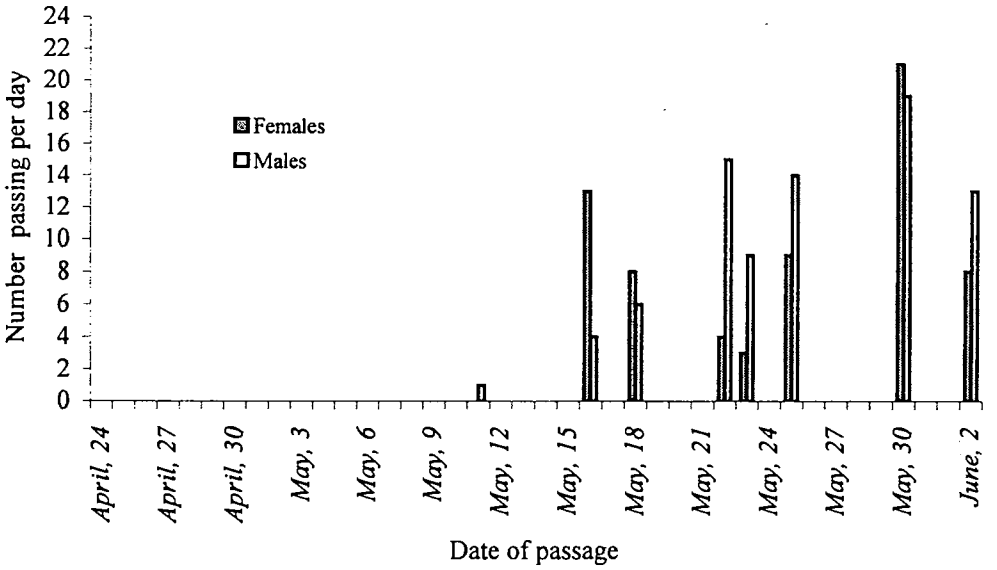

Figure 2: Upstream (a) and downstream (b) migration of steelhead through Toboggan Creek fence, April 14 – June 3, 2000.

Table 1: Weekly steelhead movement upstream and downstream in Toboggan Creek April 24 - June 3, 2000.

	UPSTREAM			DOWNSTREAM		
Week ending	Male	Female	Total	Male	Female	Total
April 30	5	2	7			
May 7	20	9	29			
May 14	13	16	29	1		1
May 21	2	3	5	10	21	31
May 28	0	2	2	38	16	54
June 3	2	0	2	32	29	61
n	42	32	74	81	66	147

4.3 Population Estimate and Confidence Interval

The 2000 steelhead population estimate for Toboggan Creek above the fish counting fence is 286 fish, with 95% confidence intervals bracketing the range of 218-412 individuals (Table 2). There were 74 individuals marked migrating upstream (M), and of 147 passing downstream (C), 38 were fish that had been tagged on their upstream migration (R). The sex ratio of the population is estimated at 0.786 female:male. Figures 3 and 4 and Table 2 illustrate the current population estimate and female to male ratio together with historic estimates since 1993 (historic data from O'Neill 1994, 1995, 1996; Toboggan Creek Hatchery files, 1993, 1997; Mitchell, 1999).

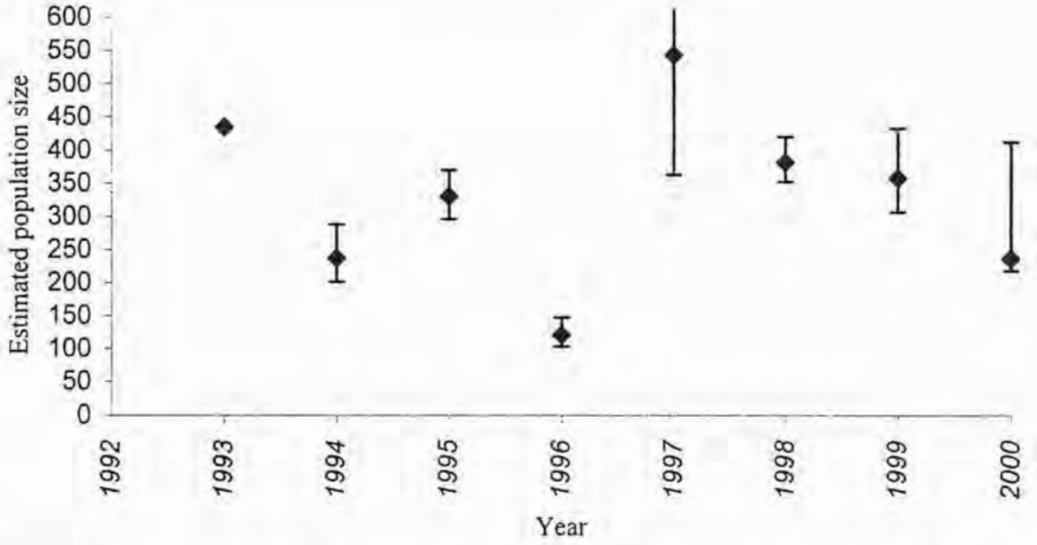

Figure 3: Steelhead population estimates with 95% confidence intervals for Toboggan Creek, 1993-2000. (1993 not mark-recapture so no confidence intervals; 1997 upper interval (1482) not shown for clarity of remaining points).

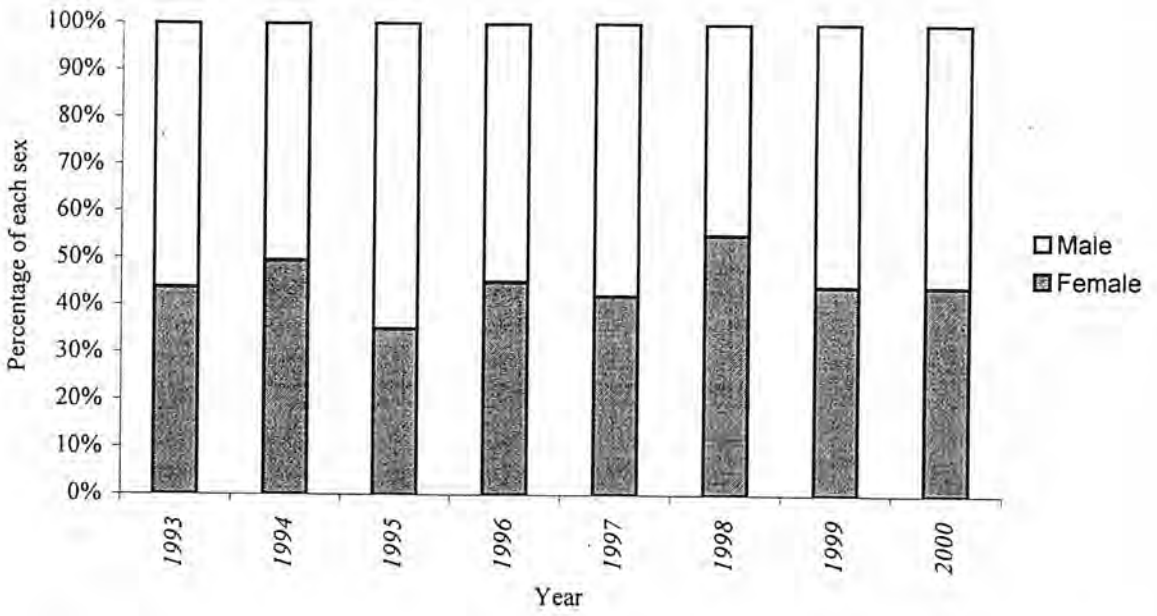

Figure 4: Proportion of each sex comprising steelhead population in Toboggan Creek, 1993-2000.

Table 2: Population estimates, with 95 % confidence intervals, and female to male ratio for Toboggan Creek, 1993-2000.

Year	Population estimate (95% Confidence Intervals in brackets)	Female:Male ratio
1993	435 *	0.775
1994	237 (201 – 288)	0.977
1995	330 (296 – 370)	0.538
1996	120 (103 – 147)	0.818
1997	543 (363 - 1482) **	0.724
1998	381 (352 – 420)	1.19
1999	357 (306 – 433)	0.766
2000	286 (218 – 412)	0.786

* 1993 did not involve a recapture phase, estimate is based on visual observation of tagged to untagged above fence.

** 1997 estimate based on small sample size of marked (M = 43, R = 10) relative to unmarked (C = 135), thus inflating the 95% confidence intervals

The mean annual population estimate in Toboggan Creek above the counting fence between 1993 and 2000 is 336 fish (SD=127, n=8). The number of fish actually

using the stream will be dependent upon environmental conditions and spawning history in that area, and estimates from some previous years (i.e., 1996) should be considered as conservative. There exists some spawning habitat below the fence (personal observation; M. O'Neill pers. comm.) so some fish are expected to remain below the fence and not be included in these estimates. Steelhead use below the fence for spawning is unknown in detail but may be substantial in some years of low flows, such as 1996. The count below the fence during Spring 2000 also indicates a heavy spawn downstream (M. O'Neill, pers. comm.).

The sex ratio of the fish has ranged from 0.54 females to males to 1.19. Interestingly, 1998 is the only year that females numbers have exceeded males though in 1994 they were equal. This may demonstrate either of two things; a naturally occurring degree of variability in female:male ratios or a sampling bias as a result of differing movement patterns between male and female spawners. Over the eight years of record, the mean ratio is 0.822 females to males (SD = 0.19).

There has been some concern raised over the counting fence holding up spawner migration upstream and kelt movement downstream (M. O'Neill, pers. comm.). Saimoto (1995) reports the fence on the Sustut system delaying steelhead movement. This may result in spawners utilizing downstream areas due to difficulty accessing upstream sites, and postponement of downstream movements of kelts. Either of these activities may affect the population estimation.

In order to more closely approximate free movement upstream and downstream for fish (i.e., allowing them to behave normally), the fence was lowered twice to allow fish passage. Examination of the numbers of fish moving upstream on the dates prior to and after the period of the fence being down indicate that for May 1st and 3rd (bracketing the fence being down on the 2nd) the daily number of fish moving into the trap were three and four, respectively. On May 8th, 9th and 10th (fence down for 17 hours on the 9th) fish passage upstream consisted of four, five, and six fish respectively. These data suggest that there was relatively little movement in the intervening periods while the fence was down. However, a visual survey (May 11th) counted 73 fish upstream of the fence, yet the count at the fence to that same time was only 53 so it does appear that a number of fish may be moving upstream uncounted. This also indicates that even short removals of the fence panels can improve natural fish movement to reaches of the stream above the fence. A second visual survey (May 17th) counted 61 fish while the cumulative fence count to that day was 70. On these same dates, the number of fish counted as spawning downstream of the fence was 168 (May 11) and 107 (May 17). On this latter date, 90% of the fish to go upstream through the fence had passed (Section 4.2), only a further four fish passed through after this date. This indicates considerable spawning downstream of the fence (i.e., around 100 fish which is approximatelly one third the number estimated above the fence). A method of sampling near to the mouth of the creek (see recommendations) would allow an estimate of steelhead use in this lower section by subtraction of fish moving through the fish fence from total fish moving upstream from the stream mouth.

The fence was not intentionally lowered to allow passage once the downstream-migrating kelts began coming through (i.e., after May 11).

The intentional lowering of the fence to provide more natural fish movement is subject to criticism as not all fish passing upstream are marked, which may result in loss of accuracy of the resulting population estimate (i.e., reduced value of M). However, this must be balanced with the loss of accuracy due to altering the behavior of the fish in moving through the system and preventing them from moving upstream. The spawning habitat in the lower 2.5 km of Toboggan Creek is of lesser value than above the fence (personal observation) and so blocking of a large proportion of the run that may otherwise move upstream may have significant population level effects. A systematic sampling regime, in which the fence is lowered on a regular pre-determined schedule (e.g., for 12 hours every fourth day) may allow more natural fish behaviour at a small cost in population estimate accuracy.

4.4 Steelhead Age, Size and Recaptures

In addition to deriving a population estimate, ancillary data on captured steelhead was collected to provide information on the age structure, spawning history, and size distribution of the sexes within the population. The occurrence of recaptures was also assessed.

Age

Scale samples were collected from 146 individual fish, however, three of these fish had regenerating scales and so were not included in analyses as their history prior to regeneration was unknown. Results are provided in Appendices 2 and 3 and indicate that the mean age of first-time spawners in 2000 was 5.0 years (Note: This is not a standard age notation; the mean age is five point zero years). The minimum age (fresh-water and sea-water histories combined) was 4+ and the maximum 7+ (Figure 5). The fresh water residency of these trout prior to migration to salt water included 2 years (1 fish or 0.8%), 3 years (95 fish or 76.6%), 4 years (27 fish or 21.8%) and 5 years (1 fish or 0.8%).

Of the scales sampled from the 146 individual fish, 19 (13%) were found to be repeat spawners. Of these, 18 were found to have spawned once before and one had spawned twice previously. The twice-previous spawner had a fresh water residency and initial seawater duration of 3.2, then one year at sea between spawning occurrences. The total age of this female steelhead was 9+. For the once only repeat spawners their fresh water and marine residencies were 3.1 (6 fish), 3.2 (8 fish), 4.1 (2 fish) and 4.2 (2 fish). These results are very similar to those of 1999 (see Mitchell, 1999).

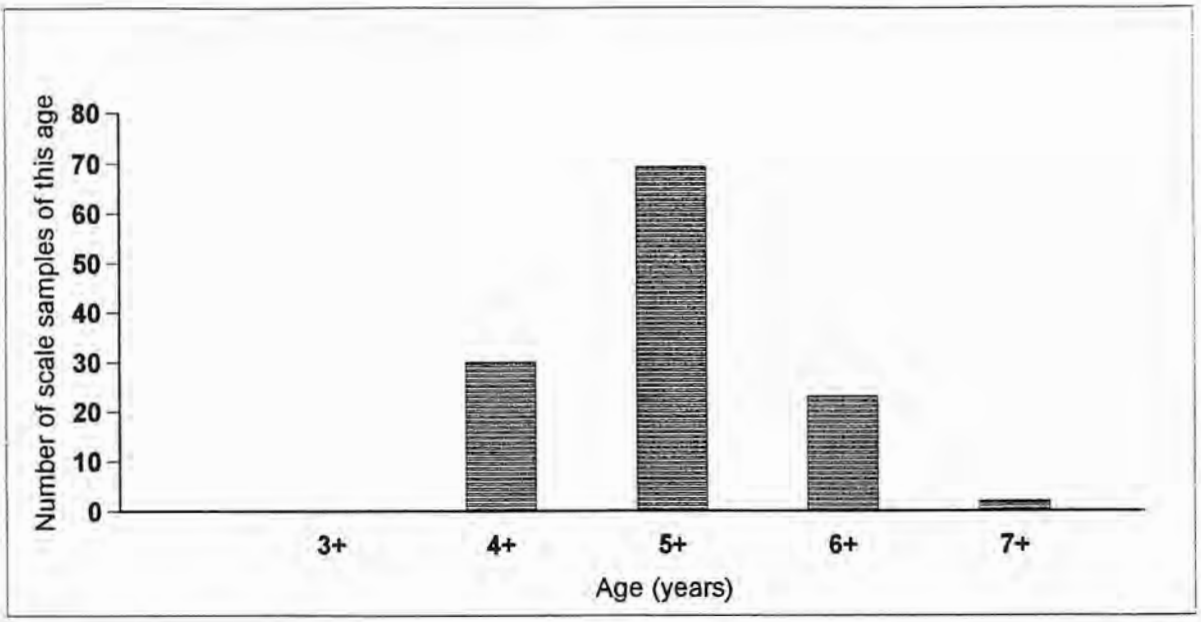

Figure 5: Age distribution of steelhead in Toboggan Creek, 2000

Thus, it appears that within Toboggan Creek most fish spend three years in the fresh water, one or two years at sea and return to spawn in their 4th or 5th year. There is variability in this however, with some fish leaving the fresh water environments between two and five years of age. This implies that the stream contains up to five year classes of juveniles in any given year. Very few of these fish appear to spend three full years at sea. In order to better understand the age structure and repeat spawner make-up of this system, compilation and analysis of all data from the last eight years is recommended to evaluate trends and the stability of these parameters over time.

Size

A length-frequency histogram of the distribution of fork length by sex (Figure 6) indicates that male length has a bimodal distribution peaking around 550 and 760 mm. The females, in contrast, have a unimodal distribution peaking at approximately 750 mm. The mean fork length of the female steelhead sampled in Toboggan Creek in Spring 2000 was 703.9 mm (SD = 70.5 mm) and the mean fork length of males was 696.8 mm (SD = 117.8 mm). The difference was found to not be statistically significant ($t = 0.5012$, $p = 0.308$, $df = 171$). Comparison of 2000 results with historic data is provided in Table 3 and Figure 7 and illustrates that the mean lengths of fish this year were considerably lower than the long term average.

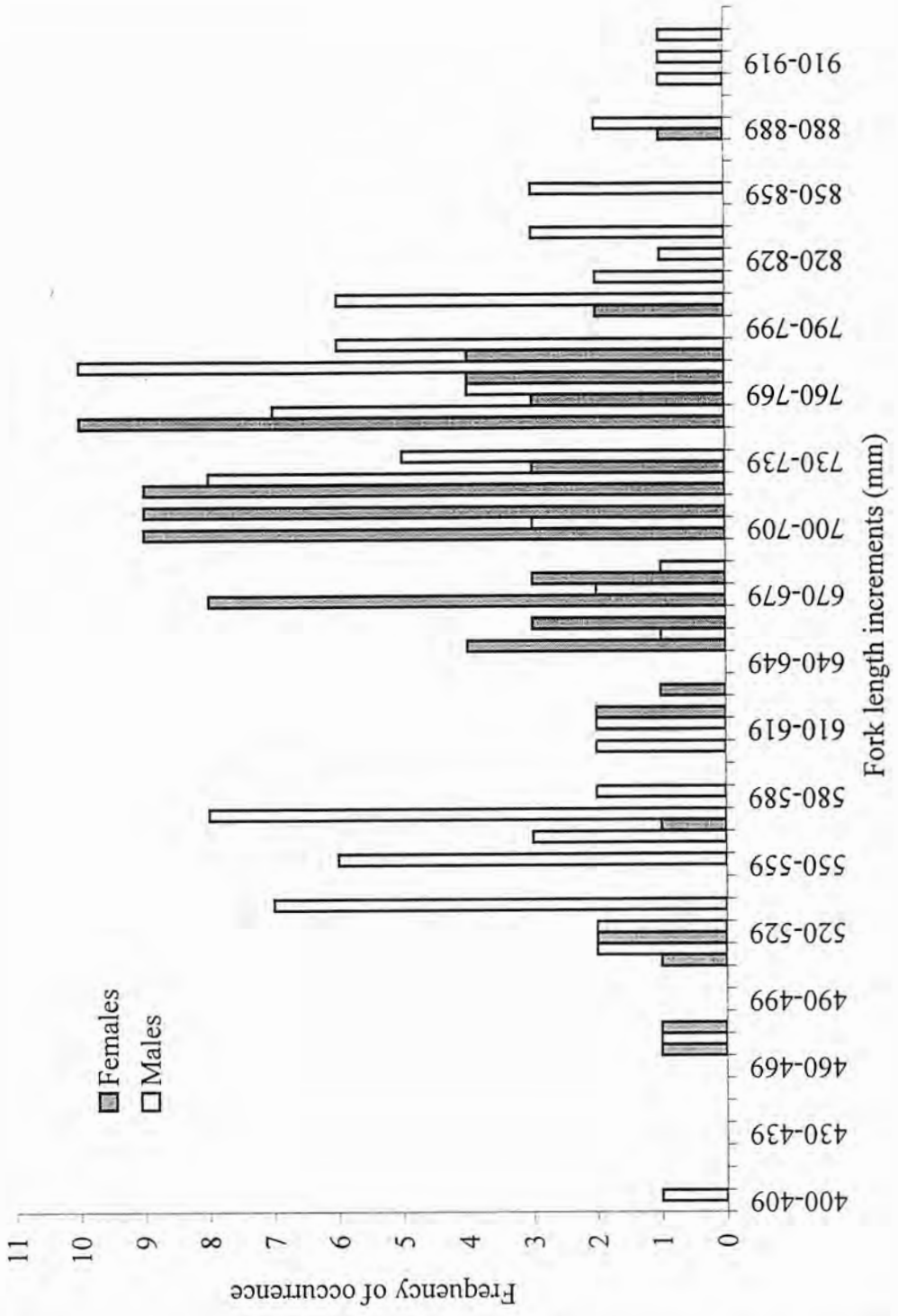

Figure 6: Frequency of occurrence of fork lengths for male and female steelhead, Toboggan Creek, 2000

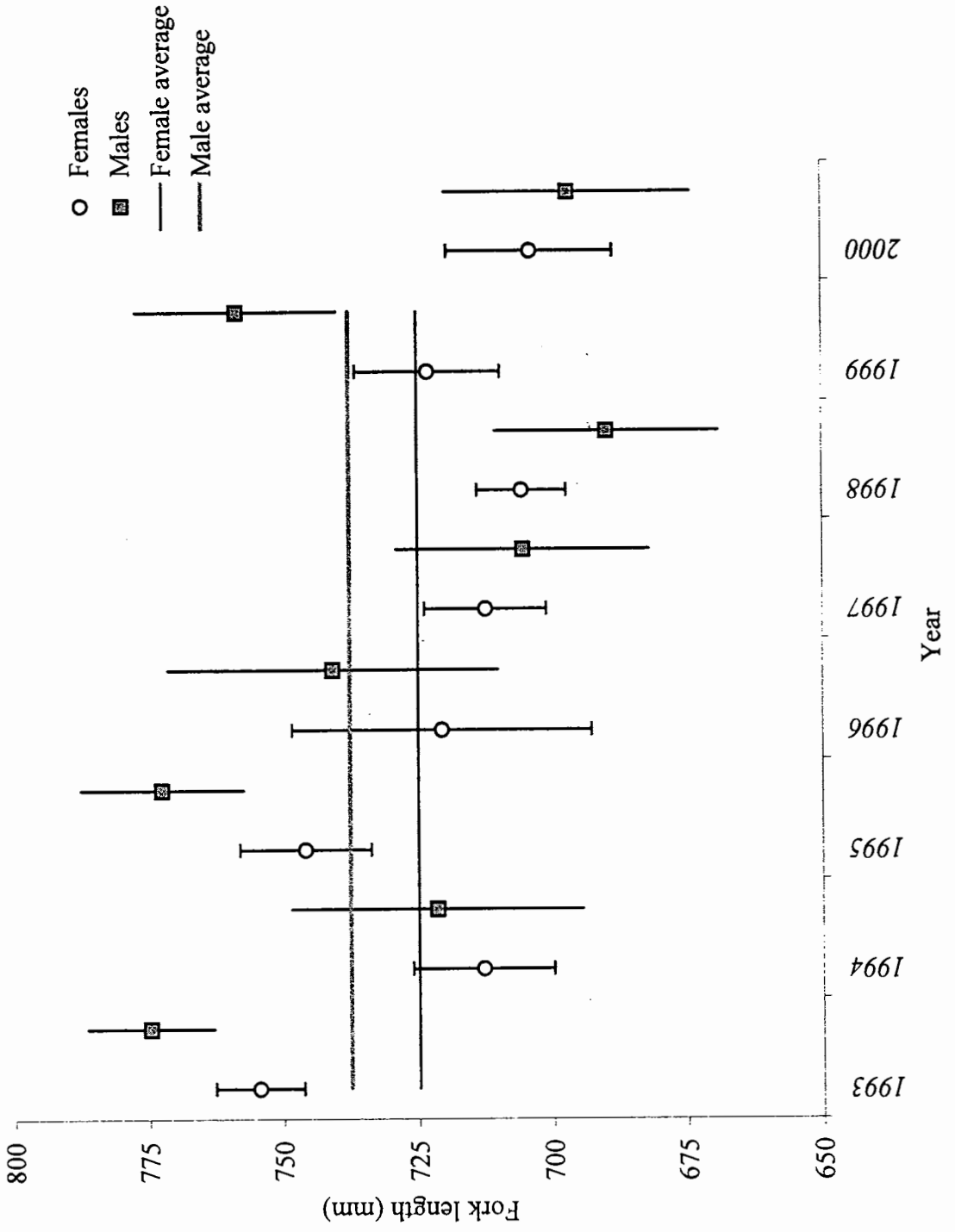

Figure 7: Fork length of male and female steelhead in Toboggan Creek, 1993-2000. Horizontal lines indicate mean fork lengths for each sex , 1993-1999.

Table 3: Minimum, mean, and maximum fork lengths (mm), and sample sizes, for steelhead in Toboggan Creek, 1993-2000.

	Female				Male			
Year	Min.	Mean	Max.	n	Min.	Mean	Max.	n
1993	635	754.5	901.7	76	609.7	774.7	939.8	98
1994	431.8	712.9	965.2	89	342.9	721.4	914.4	91
1995	558.8	745.8	873.6	112	444.5	772.4	965.2	135
1996	533.4	720.5	939.8	37	508	740.7	939.8	68
1997	560	712.4	814	67	330.5	705.4	967	101
1998	533.4	705.6	838.2	145	330.2	689.7	914.4	122
1999	510	722.9	890	111	300	758.4	1,030	145
2000	**475**	**703.9**	**887.5**	**81**	**400**	**696.8**	**925**	**103**

Recaptures

Of the 74 steelhead tagged passing upstream, 38 were recaptured moving downstream, for a recapture rate of 51.3%. Of these recaptures one (2.6%) was found to have lost its tag. A total of eight adult steelhead were found dead (Appendix 3) for a mortality rate of 2.8% of the estimated population. None of these dead steelhead had been handled during their migration upstream.

A total of 16 previously tagged fish (i.e., tagged elsewhere or in previous years) were captured during the 2000 sampling. These are presented in Table 4:

Table 4: Recaptures of previously tagged steelhead between April 14 and June 3, 2000

Tag Number	Capture date	Origin of previous tag
N03861 (orange)	April 29, 2000	Toboggan Creek – May 2, 1998
23562 (brown)	May 1, 2000	Moricetown – September 22, 1999
21475 (brown)	May 4, 2000	Moricetown – August 29, 1999
N05193 (orange)	May 5, 2000	Toboggan Creek – May 24, 1998
23089 (brown)	May 10, 2000	Moricetown – No record
C06726 (orange)	May 11, 2000	Toboggan Creek – June 5, 1998
21796 (brown)	May 16, 2000	Moricetown – September 1, 1999
23453 (brown)	May 22, 2000	Moricetown – September 14, 1999
S00867 (orange)	May 25, 2000	Toboggan Creek – April 28, 1998
C06719 (orange)	May 27, 2000	Toboggan Creek – June 5, 1998
N08287 (orange)	May 30, 2000	Toboggan Creek – May 21, 1998
N08332 (orange)	May 30, 2000	Toboggan Creek – May 19, 1998
20113 (brown)	May 30, 2000	Moricetown – October 14, 1999
21263 (brown)	May 30, 2000	Moricetown – August 27, 1999
21919 (brown)	May 30, 2000	Moricetown – September 2, 1999
21472 (brown)	June 2, 2000	Moricetown – August 23, 1999

In the Autumn of the years 1997, 1998, and 1999 Bulkley River bound steelhead have been tagged at Moricetown Canyon. Recaptures of these Moricetown tagged fish in Toboggan Creek may give an estimate of the proportion of the Bulkley/Morice River run that Toboggan Creek accounts for. In 1997, tags were applied at Moricetown to 709 steelhead, of which five of these tags (0.7% of total tagged) were recaptured in the Spring in Toboggan Creek. During the 1998 tagging program between 1,950 and 2,250 tags were applied of which 12 (0.5-0.6% of total tagged) were found in Toboggan Creek the following Spring. The Wet'suwet'en Fisheries applied 1,701 tags in the Fall of 1999 and nine of these (0.5%) were recaptured in Toboggan Creek in the Spring of 2000. Assuming that tag recovery of these fish is representative of their distribution, the data suggests that Toboggan Creek represents <1.0% of the steelhead run above Moricetown Canyon. Previous studies indicate that Toboggan Creek accounts for between 0% (Beere 1991) and 1.07% (Lough 1992, 1993) of the entire Bulkley/Morice run. It is estimated that the steelhead run in the Bulkley/Morice in Autumn 1999 was 27,005 fish (Mitchell, 2000). Using this value Toboggan Creek accounts for (=286/27,005) 1.06% of the Bulkley/Morice run.

5. Conclusions and Recommendations

Conclusions

Sampling at the Toboggan Creek counting fence in 2000 provided an estimate of 286 adult steelhead utilizing Toboggan Creek upstream of the fence. However, truncated sampling of kelt movement downstream due to high flows may have resulted in missing a portion of the run which would have unknown effects on the population estimate by affecting estimates of R and C. The sex ratio of females to males indicates 0.79 females per male, and the mean fork length of the two sexes was not significantly different. Steelhead migration upstream occurred primarily between May 1st and 17th, and the downstream movement of kelts was between May 11 and June 2, 2000. The age of the returning fish was from 4 to 9 years with most of them being 4 and 5 year olds. Thirteen percent of the returning fish had spawned at least once previously. A small sample of previously tagged fish from Moricetown Canyon indicates that Toboggan Creek probably represents approximately 1% or less of the total steelhead run in the Bulkley-Morice system above the Moricetown Canyon.

Recommendations

The following recommendations are for the future operation of the Toboggan Creek steelhead enumeration program.

1. Continued fence operation for the monitoring of population size, fish length and sex ratio should be a high priority. This fence provides valuable information and now has an eight year database for examining changes over time.

2. The installation of a resistivity counter immediately upstream of the highway crossing at Toboggan Creek, 2.5 kilometers downstream of the counting fence would allow an estimate of steelhead use of the stream below the fish counting fence. This would improve the understanding of the total steelhead (and coho salmon in the fall spawning runs) escapements that may be using this area. It would also allow the fence to be operated less intensively which may benefit spawner movement. While this may not be needed in all months, it would be an obvious benefit in some.

3. The compilation and analysis of age and repeat spawner information from the previous years data would assist in better understanding the age structure and repeat spawner make-up of this system. This information would be valuable in evaluating trends and examining the stability of these parameters over time.

4. The compilation and analysis of stream discharge and water temperature data, correlated with movement of steelhead upstream in Toboggan Creek, over the last eight years would assist in better understanding movement cues initiating upstream migration of these fish. This information would be valuable in evaluating the importance of water conditions (e.g., low water during dry years) on steelhead movements into the stream and up past the fence; this movement affects the derived population estimates and so is important to assess.

5. An evaluation of the advantages and disadvantages to a regularly scheduled fence lowering regime to allow more natural fish behavior is recommended, and from this an optimum sampling schedule devised. This would provide a compromise between required rigorous statistical sampling and interfering with the behaviour of the animals.

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APPENDICES

Appendix 1: Daily stream discharge and water temperature data for Toboggan Creek as measured at the Toboggan Creek fish hatchery

Appendix 2: Upstream migrating steelhead spawners put throughToboggan Creek counting fence, April 24 – June 3, 2000

Appendix 3: Downstream migrating steelhead kelts put through Toboggan Creek counting fence, May 11 - June 3, 2000

Appendix 1: Daily stream discharge and water temperature data for Toboggan Creek as measured at the Toboggan Creek fish hatchery

Date	Creek level (m)	Temperature AM	Temperature PM	Mean daily stream temperature (°C)	Stream Discharge (L/s)
April, 16	0.18	1.5	4.45	2.975	210.00
April, 17	0.16	2	6	4	186.67
April, 18	0.17	4	6.5	5.25	198.33
April, 19	0.16	4	7	5.5	186.67
April, 20	0.17	5	7	6	198.33
April, 21	0.17	5	10	7.5	198.33
April, 22	0.17	4.5	8	6.25	198.33
April, 23	0.17	5	7.5	6.25	198.33
April, 24	0.17	4.5	7	5.75	198.33
April, 25	0.16	4	8	6	186.67
April, 26	0.16	4.5	8.5	6.5	186.67
April, 27	0.17	5.5	7.5	6.5	198.33
April, 28	0.17	5	8	6.5	198.33
April, 29	0.18	5	6.5	5.75	210.00
April, 30	0.17	5	7	6	198.33
May, 1	0.17	4.5	8	6.25	198.33
May, 2	0.17	5	9.5	7.25	198.33
May, 3	0.19	6	10	8	221.67
May, 4	0.2	7	9.5	8.25	233.33
May, 5	0.19	6.5	9	7.75	221.67
May, 6	0.2	6	10	8	233.33
May, 7	0.2	5.5	11	8.25	233.33
May, 8	0.2	5.5	11	8.25	233.33
May, 9	0.19	7	11	9	221.67
May, 10	0.2	6.5	10	8.25	233.33
May, 11	0.2	6	11	8.5	233.33
May, 12	0.21	6	11	8.5	245.00
May, 13	0.23	6	11.5	8.75	268.33
May, 14	0.23	6	10	8	268.33
May, 15	0.23	6	11	8.5	268.33
May, 16	0.24	6.5	9.5	8	280.00
May, 17	0.23	7	11	9	268.33
May, 18	0.23	6	11.5	8.75	268.33
May, 19	0.23	7.5	11.5	9.5	268.33
May, 20	0.23	6	8	7	268.33
May, 21	0.22	6.5	7.5	7	256.67
May, 22	0.22	6	8	7	256.67
May, 23	0.22	5.5	7.5	6.5	256.67
May, 24	0.21	6	7	6.5	245.00
May, 25	0.2	5	10	7.5	233.33
May, 26	0.19	6	11	8.5	221.67
May, 27	0.18	6.5	10	8.25	210.00

Appendix 1: (con't)

Date	Creek level (m)	Temperature AM	Temperature PM	Mean daily stream temperature (°C)	Stream Discharge
May, 28	0.19	8	10	9	221.67
May, 29	0.2	7	10	8.5	233.33
May, 30	0.2	6	13	9.5	233.33
May, 31	0.21	8	12.5	10.25	245.00
June, 1	0.25	7	12.5	9.75	291.67
June, 2	0.29	8	13	10.5	338.33
June, 3	0.33	7	12	9.5	385.00
Minimum	0.16	1.50	4.45	2.98	186.67
Maximum	0.33	8.00	13.00	10.50	385.00
Mean	0.20	5.70	9.35	7.53	233.57
Std. Dev.	0.03	1.32	2.03	1.56	39.46
Median	0.20	6.00	10.00	8.00	233.33

Appendix 2: Upstream migrating steelhead spawners put through Toboggan Creek counting fence, April 24 - June 3, 2000

Date	Sex	Length (mm)	Tag Number	Scale Number	Age	Previous Tags / Comments
Apr-24	M	837.5	12401	56878 Row 1	3.3+	
Apr-28	M	762.5	12402			
Apr-29	M	787.5	12403	56878 Row 2	3.1S1+	Wound on peduncle.
	F	712.5	12404	56878 Row 3	3.2+	Center not clear on scale
	F	775	12405	56878 Row 4	3.2S1+	Orange MOE N03861
Apr-30	M	675	12406	56878 Row 5	3.2+	
	M	600	12407	56879 Row 1	3.1+	
May-01	M	400	12408	56879 Row 2	3.1+	Brown MOE 23562
	M	750	12409	56879 Row 3	3.2+	
	M	725	12410	56879 Row 4	4.2+	
May-03	M	650	12411	56879 Row 5	4.1+	
	M	800	12412	56880 Row 1	3.2S1+	
	M	550	12413	56880 Row 2	3.1+	
	M	537.5	12414	56880 Row 3	3.1+	
May-04	M	912.5	12415	56880 Row 4	3.3+	
	F	662.5	12416	56880 Row 5	3.2+	Brown MOE 21475. Scale loss, caudal and dorsal fin damaged.
	M	750	12417	56881 Row 1	3.2+	
	F	750	12418	56881 Row 2	4.2+	Old Net Mark
	M	575	12419	56881 Row 3	3.1+	
May-05	M	612.5	12420	56881 Row 4	3.1+	3 inch scar on left side
	M	800	12421	56881 Row 5	3.2+	
	M	750	12422	56882 Row 1	3.2+	
	M	850	12423	56882 Row 2	3.2S1+	Orange MOE N05193 Piece missing from right ventral fin.
	F	775	12424	56882 Row 3	3.2S1+	Dorsal and adipose fin damage 1st f.w. annulus of scale vague
	M	537.5	12425	56882 Row 4	3.1+	
	F	700	12426	56882 Row 5	3.2+	
May-06	F	725	12427	56883 Row 1	3.1+	One slight tear in the dorsal fin
	M	787.5	12428	56883 Row 2	3.2+	
May-07	M	837.5	12429	56883 Row 3	3.3+	
	F	787.5	12430	56883 Row 4	3.2S1+	Bad scar 1 st f.w. annulus on scale not apparent
May-07	M	725	12431	56883 Row 5	4.1S1+	
	F	725	12432	56884 Row 1	3.2+	
	M	737.5	12433	56884 Row 2	3.2+	Damaged on top of caudal fin
	M	700	12434	56884 Row 3	4.2+	
	F	712.5	12435	56884 Row 4	3.2+	
	F	750	12436	56884 Row 5	4.2+	

Appendix 2 (con't)

Date	Sex	Length (mm)	Tag Number	Scale Number	Age	Previous Tags / Comments
May-08	F	675	12437	56885 Row 1	3.2+	
	F	712.5	12438	56885 Row 2	3.2+	
	F	725	12439	56885 Row 3	3.2+	
	F	575	12440	56885 Row 4	4.1+	
May-09	M	775	12441	56885 Row 5	3.2+	Old Tail Punch
	F	725	12442	56886 Row 1	3.2+	
	M	762.5	12443	56886 Row 2	3.2+	
	M	512.5	12444	56886 Row 3	3.1+	Large scar on left side above anal fin
	M	575	12445	56886 Row 4	4.1+	
May-10	M	612.5	12446	56886 Row 5	4.1+	Brown MOE 23089
	F	675	12447	56887 Row 1	3.2+	Piece of anal fin missing
	M	575	12448	56887 Row 2	3.1+	Large piece missing from lower part of caudal fin
	F	737.5	12449	56887 Row 3	4.2+	Piece missing from upper portion of caudal fin
	F	487.5	12450	56887 Row 4	2.2+*	
	F	687.5	12451	56887 Row 5	R.2+	
May-11	M	850	12452	56888 Row 1	3.3+	Some scale loss and fungus dorsally.
	M	787.5	12453	56888 Row 2	R.2+	
May-12	F	725	12454	56888 Row 3	3.2+	
	M	562.5	12455	56888 Row 4	3.1+	Scar left side.
	M	675	12457	56888 Row 5	3.1S1+	
	F	712.5	12458	56889 Row 1	3.1S1+	Rt. Vent. fin torn, scar above rt. vent, caudal fin torn Scale may have two spawning checks
	F	787.5	12459	56889 Row 2	4.2+	
	F	725	12460	58889 Row 3	4.2+	
	M	600	12461	58889 Row 4	4.1+	
	F	475	12462	56889 Row 5	2.2+*	
May-13	F	787.5	12463	56890 Row 1	3.2S1+	
	M	562.5	12464	56890 Row 2	3.1+	Poor scale
May-14	F	662.5	12465	56890 Row 3	3.2+	
	M	575	12466	56890 Row 4	3.1+	
May-15	F	725	12467	56890 Row 5	3.2+	
	M	725	12468	56891 Row 1	3.1S1+	Poor scale, spawning check vague
May-16	M	562.5	12469	56891 Row 3	4.1+	
	F	662.5	12470	56891 Row 4	3.2+	1st f.w. annulus vague
May-17	F	700	12471	56894 Row 4	4.2+	
May-26	F	738	12472			
May-27	F	800	12473			Orange MOE C06719
Jun-01	M	575	12474	57102 Row 5	4.1+	
	M	550	12475	57103 Row 1	3.1+	

* = scale reader claims fish not a steelhead

Appendix 3: Downstream migrating steelhead kelts out through Toboggan Creek counting fence May 11 - June 2, 2000

Date	Sex	Length (mm)	Tagged/ Punched	Tag Number	Scale Number	Age	Previous Tags/Comments
May-11	M	700	N/N		No Scales		Orange MOE C06726 Dead Pitch
May-16	M	837.5	N/N	C06743	56891 Row 2	4.2+	Scale indicates large marine growth
	F	725	N/N	C06744	56891 Row 5	3.2+	
	M	737.5	N/N	C06745	56892 Row 1	3.2+	Cut on bottom lobe of tail
	F	675	N/N	C06746	56892 Row 2	3.2+	
	M	775	N/N	C06747	56892 Row 3	4.2+	
	F	800	N/N	C06748	56892 Row 4	3.2S1+	
	F	762.5	N/N	C06749	56892 Row 5	3.2+	
	F	675	N/N	C06750	56893 Row 1	3.2+	Predator bite on anal fin
	F	712.5	N/N	C06751	56893 Row 2	3.2+	
	M	812.5	N/N	C06752	56893 Row 3	4.2+	
	F	675	N/N	C06753	56893 Row 4	3.2+	
	F	675	N/N	C06754	56893 Row 5	3.2+	Brown MOE 21796 Ripped Tail
	F	712.5	N/N	C06755	56894 Row 1	3.2+	
	F	750	N/N	C06756	56894 Row 2	4.2S1+	
	F	750	N/N	C06757	56894 Row 3	3.2+	
	F	PS	Y/Y	12451	PS		
	F	PS	Y/Y	12427	PS		
May-18	M	825	N/N	C06758	56895 Row 1	3.3+	Scale edge resorbed
	F	512.5	N/N	C06759	56895 Row 2	3.1+	
	F	750	N/N	C06760	56895 Row 3	4.2+	
	M	725	N/N	C06761	56895 Row 4	3.2+	
	F	650	N/N	C06762	56895 Row 5	3.2+	
	F	625	N/N	C06763	56896 Row 1	3.2+	
	F	675	N/N	C06764	56896 Row 2	4.2+	
	M	775	N/N	C06765	56896 Row 3	3.2+	
	M	512.5	N/N	C06766	56896 Row 4	4.1+	Scale in poor condition
	M	PS	Y/Y	12428	PS		
	F	PS	Y/Y	12454	PS		
	F	PS	Y/Y	12465	PS		
	F	PS	Y/Y	12416	PS		
	M	850	N/N		56894 Row 5	3.2+	Dead Pitch Possible resorption of scale; could be 3.3+
May-22	M	550	N/N	C06767	56896 Row 5	3.1+	
	M	550	N/N	C06768	56897 Row 1	3.1+	
	M	550	N/N	C06769	56897 Row 2	3.1+	
May-22	M	775	N/N	C06770	56897 Row 3	3.3+	
	F	625	N/N	C06771	56897 Row 4	3.1+	
	F	750	N/N	C06772	56897 Row 5	3.2+	
	M	475	N/N	C06773	56898 Row 1	3.1+	
	M	575	N/N	C06774	56898 Row 2	3.1+	Brown MOE 23453
	M	787.5	N/N	C06775	56898 Row 3	3.2+	
	M	587.5	N/N	N04401	56899 Row 1	3.1+	
	M	775	N/N	N04402	56899 Row 2	3.2+	
	M	575	N/N	N04403	56899 Row 3	3.1+	
	F	525	N/N	N04404	56899 Row 4	3.1+	
	M	PS	Y/Y	12461	PS		
	F	PS	Y/Y	12440	PS		
	M	PS	Y/Y	12431	PS		
	M	PS	Y/Y	12423	PS		

Appendix 3 (Con't)

Date	Sex	Length (mm)	Tagged/ Punched	Tag Number	Scale Number	Age	Previous Tags/Comments
May-22	M	812.5	N/N		56898 Row 4	3.2S1+	Dead Pitch
	M	787.5	N/N		56898 Row 5	4.2+	Dead Pitch
May-23	M	537.5	N/N	N04405	56899 Row 5	3.1+	
	M	800	N/N	N04406	No scales		
	M	775	N/N	N04407	56900 Row 1	3.1S1+	
	M	750	N/N	N04408	No scales		
	M	787.5	N/N	N04409	56900 Row 2	4.2+	
	F	750	N/N	N04410	No scales		
	F	700	N/N	N04411	56900 Row 3	3.2+	
	F	712.5	N/N	N04412	No scales		
	M	725	N/N	N04413	56900 Row 4	4.2+	
	M	737.5	N/N	N04414	No scales		
	M	PS	Y/Y	12469	PS		
	M	PS	Y/Y	12401	PS		
May-25	M	750	N/N	N04415	56900 Row 5	3.2+	
	M	687.5	N/N	N04416	No scales		
	M	762.5	N/N	N04417	57248 Row 1	3.2+	
	F	637.5	N/N	N04418	No scales		Top of tail cut
	F	650	N/N	N04419	57248 Row 2	4.2+	
	F	762.5	N/N	N04420	No scales		
	M	750	N/N	N04421	57248 Row 3	3.2+	Top of tail cut
	F	525	N/N	N04422	No scales		
	M	800	N/N	N04423	56248 Row 4	3.2+	
	M	537.5	N/N	N04424	No scales		
	M	725	N/N	N04425	56248 Row 5	3.2+	
	F	675	N/N	N04426	No scales		
	F	712.5	N/N	N04427	56249 Row 1	3.2+	
May-25	M	725	N/N	N04428	57249 Row 2	3.1S1+	Orange MOE S00867 Old DNA clip on adipose
	F	PS	Y/Y	12426	PS		
	F	PS	Y/Y	12459	PS		
	M	PS	Y/Y	12402	PS		
	F	PS	Y/Y	12442	PS		
	M	PS	Y/Y	12455	PS		
	M	PS	Y/Y	12446	PS		
	M	PS	Y/Y	12420	PS		
	M	PS	Y/Y	12421	PS		
	M	762.5	N/N		No scales		Dead Pitch
May-30	M	800	N/N	N04430	No scales		
	F	700	N/N	N04436	57249 Row 5	3.2+	
	M	737.5	N/N	N04437	52150 Row 1	4.1S1+	Orange MOE N08287
	M	550	N/N	N04438	No scales		
	F	712.5	N/N	N04439	52150 Row 2	3.2+	
	F	762.5	N/N	N04440	No scales		Hook scar
	F	650	N/N	N04441	52150 Row 3	3.2+	
	M	775	N/N	N04442	No scales		Brown MOE 21263 Some tail damage
	M	925	N/N	N04443	52150 Row 4	3.3+	
	F	700	N/N	N04444	No scales		
	F	687.5	N/N	N04445	52150 Row 5	R.2+	Brown MOE 20113
	F	700	N/N	N04446	No scales		
	F	750	N/N	N04447	57101 Row 1	3.2+	
	M	775	N/N	N04448	No scales		
	F	700	N/N	N04449	57101 Row 2	3.2+	
	F	787.5	N/N	N04450	No scales		

Appendix 3 (Con't)

Date	Sex	Length (mm)	Tagged/ Punched	Tag Number	Scale Number	Age	Previous Tags/Comments
May-30	F	775	N/N	N04451	57101 Row 3	3.2+	
	F	687.5	N/N	N04452	No scales		
	M	775	N/N	N04453	57101 Row 4	3.2+	
	F	887.5	N/N	N04454	57101 Row 5	3.2S1S1+	
	F	775	N/N	N04455	57102 Row 1	4.2S1+	Orange MOE N08332
	M	537.5	N/N	N04456	57102 Row 2	4.1+	
	M	800	N/N	N04457	No scales		
	M	525	N/N	N04458	57102 Row 3	3.1+	
	M	700	N/N	N04459	No scales		Brown MOE 21919
	F	700	N/N	N04460	57102 Row 4	3.2+	
	M	PS	Y/Y	12441	PS		
	F	PS	Y/Y	12458	PS		
	F	PS	Y/Y	12418	PS		
	M	PS	Y/Y	12413	PS		
May-30	M	PS	Y/Y	12417	PS		
	F	PS	Y/Y	12471	PS		
	M	PS	Y/Y	12406	PS		
	F	PS	Y/Y	12467	PS		
	M	PS	Y/Y	12411	PS		
	F	PS	Y/Y	12449	PS		
	M	PS	Y/Y	12429	PS		
	F	PS	Y/Y	12463	PS		
	M	900	N/N		No scales		Dead Pitch
	M	887.5	N/N		No scales		Dead Pitch
Jun-02	M	775	N/N		No scales		Dead Pitch
	F	725	N/N	N04461	57103 Row 2	3.2+	
	M	737.5	Y/N	N04463	No scales		Gill Punch / No Tag
	M	587.5	N/N	N04464	57103 Row 3	3.1+	
	M	537.5	N/N	N04465	No scales		Brown MOE 21472
	F	750	N/N	N04466	57103 Row 4	3.2+	
	M	750	N/N	N04467	No scales		
	M	537.5	N/N	N04468	57103 Row 5	3.1+	
	F	700	N/N	N04469	No scales		
	M	725	N/N	N04470	57104 Row 1	5.2+	
	M	575	N/N	N04471	No scales		
	M	525	N/N	N04472	57104 Row 2	3.1+	
	M	887.5	N/N	N04473	57104 Row 3	4.3+	
	F	737.5	N/N	N04474	57104 Row 4	3.2+	
	F	650	N/N	03006 blue	57104 Row 5	3.2+	
	F	750	N/N	03007 blue	57105 Row 1		
	M	PS	Y/Y	12434	PS		
	F	PS	Y/Y	12437	PS		
	M	PS	Y/Y	12445	PS		
	F	PS	Y/Y	12405	PS		Old DNA clip on adipose
	M	PS	Y/Y	12466	PS		