Assessment of 2003 Steelhead Smolt Yield from the Englishman River, Vancouver Island

A pair of Englishman steelhead smolts

Prepared for

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Executive Summary

Building on the Pacific Salmon Endowment Fund Society's Englishman River recovery plan, a second year of mark-recapture was conducted in the spring of 2003 to assess coho and steelhead smolt production. The Community Fisheries Development Centre (Nanaimo) contracted the BC Conservation Foundation to complete the study's steelhead smolt component. The pooled Peterson estimate of steelhead smolts emigrating from the Englishman River between April 12 and June 3, 2003 was 2,657 fish (95% confidence interval: 1,756 and 3,557). The Schaefer estimate was 2,585. Slightly older and smaller than fish in 2002, the 2003 smolt group was composed of 71.4% two year olds and 28.6% three year olds (n=70), and had mean lengths and weights of 159 mm (SD 16) and 36.9 g (SD 12.1; n=131), respectively. Recommendations include continued monitoring and improved trap maintenance during high water and/or heavy wind periods.

Acknowledgments

Thanks are extended to Michael Gieringer (owner, Parrys RV Park and Campground), Weyerhaeuser Ltd. and TimberWest Forest Ltd. for allowing access to enumeration sites through their private land. Bob Brown, Mike Edwards, Don Henson, Clay Young, and Jeff Young installed and maintained the traps and fences. They also enumerated trout captures at the side-channel fences and at Centre Creek, and marked steelhead smolts captured at the latter location. Melissa Andrews supplied preliminary discharge data for the study period. Brad Smith, Harlan Wright and Scott Silvestri assisted with smolt marking and sampling. Brad Smith edited the report.

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1.0 Introduction

As part of the 1998 Canadian Fisheries Adjustment and Restructing Plan, the $30 million Pacific Salmon Endowment Fund was created to provide ongoing funding for initiatives to conserve, protect, and restore salmon and their habitat. The Vancouver Foundation invests Pacific Salmon Endowment Fund Society (PSEFS) capital, and annual interest managed by the Pacific Salmon Foundation is allocated to selected watersheds. In March 2001, the Englishman River was chosen by PSEFS as the first of seven BC watersheds that are now the focus of strategic recovery plans. PSEFS's technical committee approves projects identified by local advisory groups that meet the individual recovery plan objectives.

The Englishman River Watershed Recovery Plan (ERWRP; Bocking and Gaboury 2001) identified steelhead and coho smolt enumeration as a required activity to develop baseline information and follow stock trends in response to recovery efforts. In 2003, the ERWRP Round Table endorsed a project to complete the second year of smolt enumeration using local stream stewards employed by the Nanaimo-based Community Fisheries Development Centre (CFDC) and BC Conservation Foundation (BCCF) steelhead technicians. With the support of the Fisheries Section of the Ministry of Water, Land and Air Protection (MWLAP) in Nanaimo, CFDC subcontracted BCCF to design and conduct the steelhead smolt component of the enumeration.

Captures and estimates of coho, chinook, chum, and pink salmon, as well as non-salmonids are not included in this report.

2.0 Methods

2.1 Rotary Trap Installation/Operation

On April 7, 2003, CFDC staff installed two 6-foot rotary screw traps (RST) in the Englishman River at Top Bridge Park (T1) and at Parrys RV Park and Campground (T2), 5.0 and 1.8 km upstream of the mouth, respectively (Figure 1; Appendix A, photos 1-5). CFDC staff maintained the traps daily, regularly re-aligning them relative to the thalweg and verifying optimal drum rotation (4-6 rpm) to maximize catch efficiency.

2.2 Biophysical Monitoring

Water temperature was recorded each morning using hand held mercury thermometers, and approximate water levels were noted daily. The Water Survey of Canada (WSC) maintains a permanent station (#08HB002) on the lower river at the Highway 19a bridge crossing. WSC staff in Nanaimo supplied preliminary discharge data for the study period.

2.3 Catch Monitoring, Sampling and Marking

As in 2002, a BCCF technician performed trout counts and steelhead smolt marking at the RSTs 5-6 days per week. CFDC crew members completed salmon counts every morning and collected

trout data and marked steelhead smolts during days when a BCCF technician was not present. Daily catches at the three smolt fence sites, the TimberWest side-channel, the Weyerhaeuser side-channel, and Centre Creek (Appendix A, photo 6) were also monitored by CFDC staff. In an attempt to increase the number of marks put out during this study relative to 2002, CFDC staff were asked to mark steelhead smolts captured at Centre Creek from April 15 onwards.

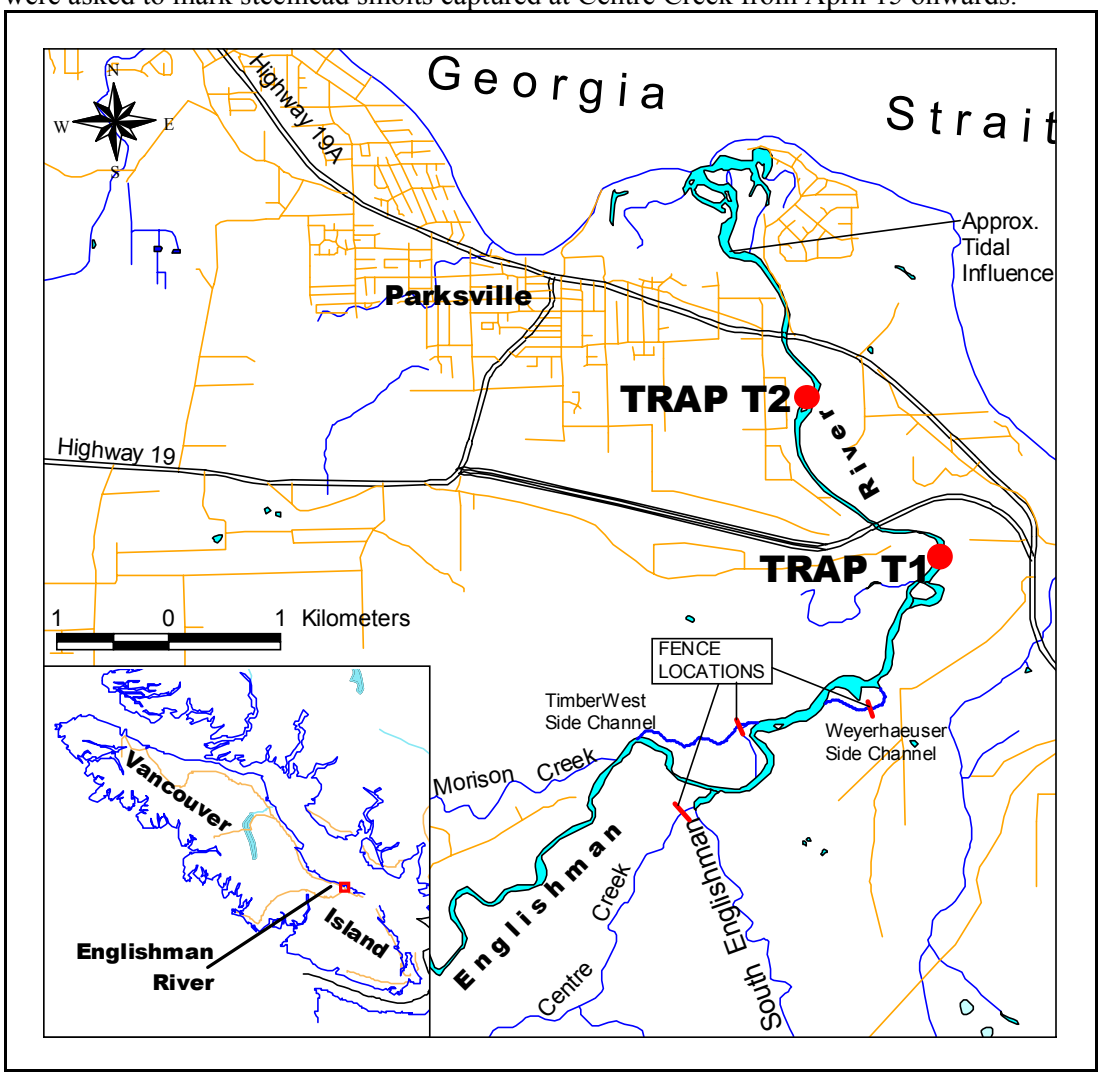

Figure 1. Map of lower Englishman River showing rotary screw trap (red circle) and smolt fence (red bar) locations relative to side-channels, tributaries and major access roads.

Trap T1 was used as a marking trap, while T2 was used to sample and enumerate marked and unmarked fish. All trout were categorized by species/life stage and counted. Appendix A contains photos (#7-12) of typical trout and salmon specimens. The following definitions were used:

- **Smolt** (steelhead and cutthroat): silver bright colouration, and fork length > 140 mm.
- **Parr** (steelhead and cutthroat): parr marks evident, and fork length < 140 mm. This would include 2002 brood juveniles that were slightly less than one year old, as well as 2001 brood parr.
- **Adult** (cutthroat): > 200 mm fork length.

T1 smolts were anaesthetized in a bath of dilute clove oil[1] to enable confirmation of minimum fork length and allow the appropriate mark to be applied with the least amount of stress. Handling was kept to a minimum and simple marks (no dye) were scheduled for application during the estimated peak of the outmigration (May 20), based on 2002 migration timing. The caudal fin was cut dorso-ventrally at a point less than one-fourth the distance from the tip of the lobe to the caudal peduncle. Alcian blue coloured dye was applied with a jet inoculator to produce a mark 4-8 mm in length along the fin. Marked smolts were allowed to fully recover and released 75 m downstream, in a deep pool with larger boulder cover.

To assess the catch efficiency of T2, all steelhead smolts from T1 were marked in unique release groups according to Table 1:

Table 1. Mark schedule for steelhead smolts trapped at T1.

Date	Mark	Code
April 13-20:	Lower caudal clip, plus dye left pectoral	(LCLP)
April 21-30:	Upper caudal clip, plus dye anal	(UCA)
May 1-10:	Lower caudal clip, plus dye anal	(LCA)
May 11-20:	Upper caudal clip	(UCO)
May 21-30:	Lower caudal clip	(LCO)
May 31-June 7:	Upper caudal clip, plus dye anal (second round)	(UCA)

Steelhead smolts captured at the Centre Creek fence had a dye mark applied to the left ventral fin in addition to the marks outlined in Table 1.

All steelhead smolts trapped at T2 were anaesthetized with clove oil, checked for marks, and sampled for fork length and weight. Scale samples were taken from all smolts every second day. All rainbow parr were sampled for length and weight, and a few larger parr were sampled for scales to allow better separation of age cohorts. Length and life stage were recorded for all cutthroat.

Rainbow and cutthroat smolts and parr were also counted daily by CFDC staff at each of three fence operations (Figure 1). Fences were operated near the mouth of Centre Creek, and near the bottoms of the TimberWest (north side of mainstem) and Weyerhaeuser (south side of mainstem) side-channels primarily to evaluate coho production.

2.4 Population Estimates

Using the mark-recapture data, a Peterson estimate (Ricker 1975) was generated following procedures and assumptions outlined in last year's report (Craig and McCubbing 2002). For comparison, a Schaefer estimate (Schaefer 1951) and maximum likelihood Darroch estimate (Plante 1990) were also produced.

[1] One eye dropper of 1:10 clove oil:ethanol in 4-6 litres of river water.

3.0 Results

3.1 Biophysical Monitoring

Morning water temperatures (generally the minimum daily value) ranged from a low of 5.5°C on April 14 to a high of 10.8°C on June 1 and averaged 0.8°C higher than temperatures recorded during the same period in 2002 (Figure 2).

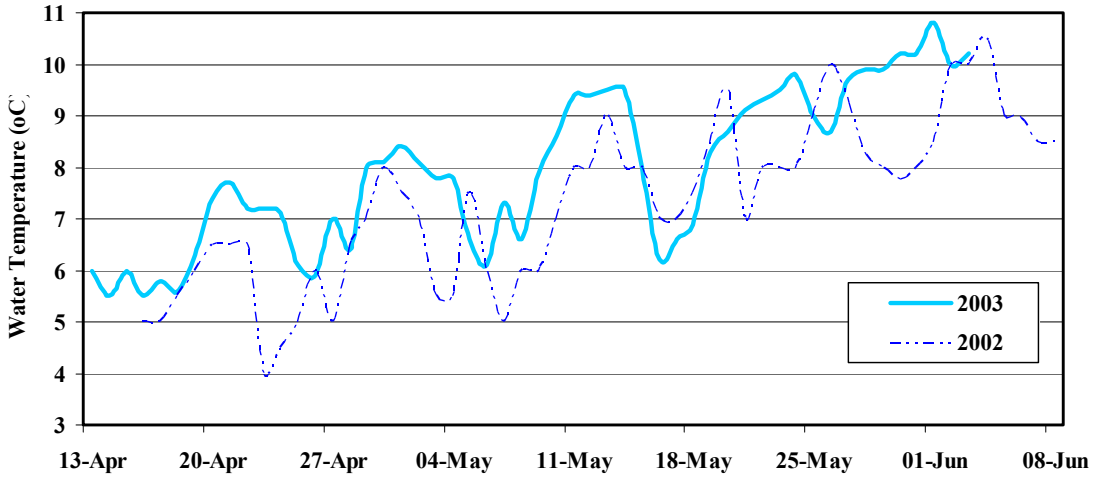

Figure 2. Morning water temperatures recorded in the Englishman River mainstem during 2002 and 2003 smolt migration periods.

With the exception of a small, rain-related pulse on May 24-25, daily discharge generally decreased through the study period from a high of 21.6 m^3/s (156% of MAD) on April 12 to low of 2.84 m^3/s (20.5% of MAD) on May 20 (Water Survey of Canada, preliminary unadjusted data). Throughout the sampling period, flows were significantly lower than last year (Figure 3).

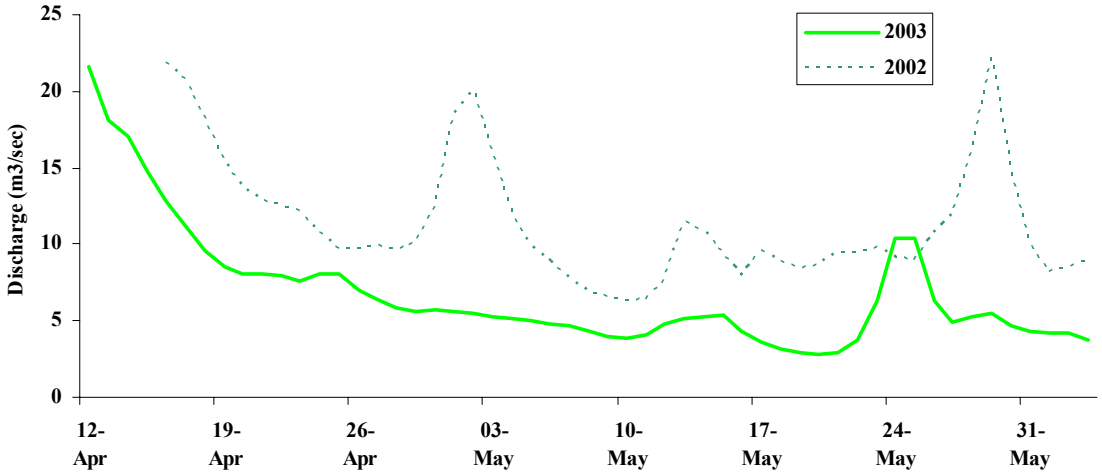

Figure 3. Preliminary discharge at the Highway 19a bridge crossing (WSC station 08HB002) during the sampling period, compared to 2002 discharge.

3.2 Catch Monitoring

Due to a minor high water event, traps were not fished until April 12, five days after installation. Traps were then operated 24 hours per day until June 3, 2002. During this period, T1 (upper trap) was found jammed with small woody debris and not turning on five occasions (April 21, May 2, 4, 7 and 11) resulting in low numbers or no fish captured. Over the same period, T2 was found not turning due to debris accumulation on May 23, 24, 26 and on June 1. Despite the nine RST jams, only one steelhead smolt mortality was observed during the project (T1, May 2) while coho mortalities ranged from none to approximately 35. To improve catch efficiency, T2 was re-positioned on April 26 about 8 m further upstream, adjacent to a large rootwad on the stream bank. Unlike 2002, when catch numbers at each RST were similar, T1 appeared to be over three times as efficient as T2, as the following data reflects.

At T1 between April 13 and June 2, a total of 477 smolts were captured and marked (Figure 4). Several individuals that displayed obvious smolt characteristics but were smaller than the 140 mm guideline were also marked. Other trout captures included one resident rainbow, 168 rainbow "parr" and 32 cutthroat (12 smolts, 16 parr, and four adults including one mortality).

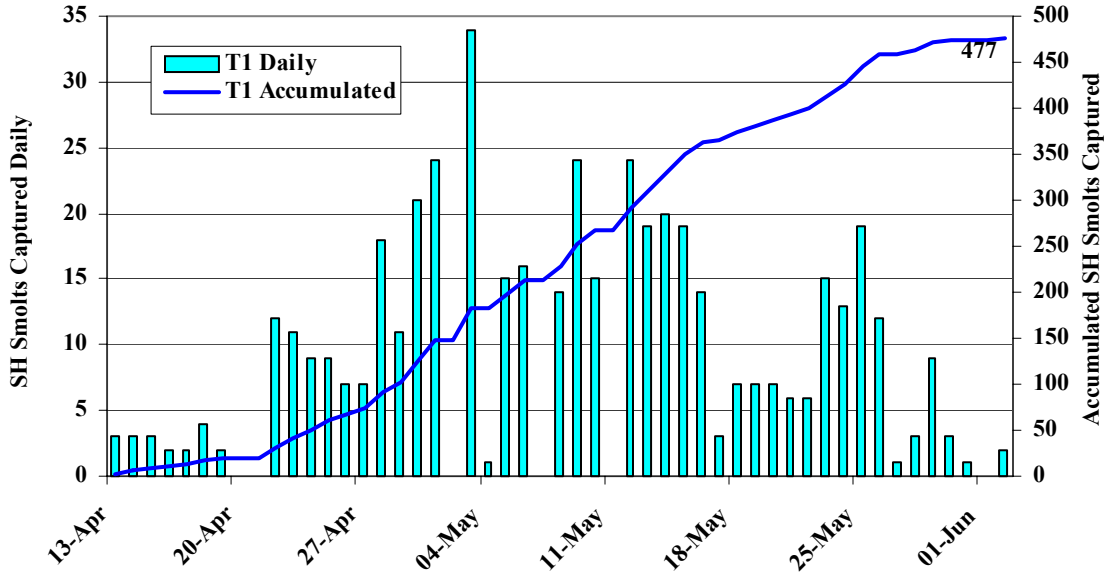

Figure 4. Steelhead smolt captures at T1 (Top Bridge Park) April 13-June 2, 2003.

At the Centre Creek fence between April 15 and June 2, a total of 14 smolts were captured and marked. In the initial days of fence operation (April 8-14), an additional 24 smolts were captured but not marked. A rain event on April 8 and 9 (~1,200% MAD) caused the fence to fail.

At T2, a total of 138 steelhead smolts were captured (Figure 5), including 10 fish between 130 and 139 mm in length that were obviously smolting. Other trout captures included one resident rainbow, 95 rainbow "parr" and 18 cutthroat (9 smolts, 3 parr and 6 adults). Minor widening of the channel's wetted width where T2 was situated may have accounted for the lower number of smolts captured compared to 2002 (n=260).

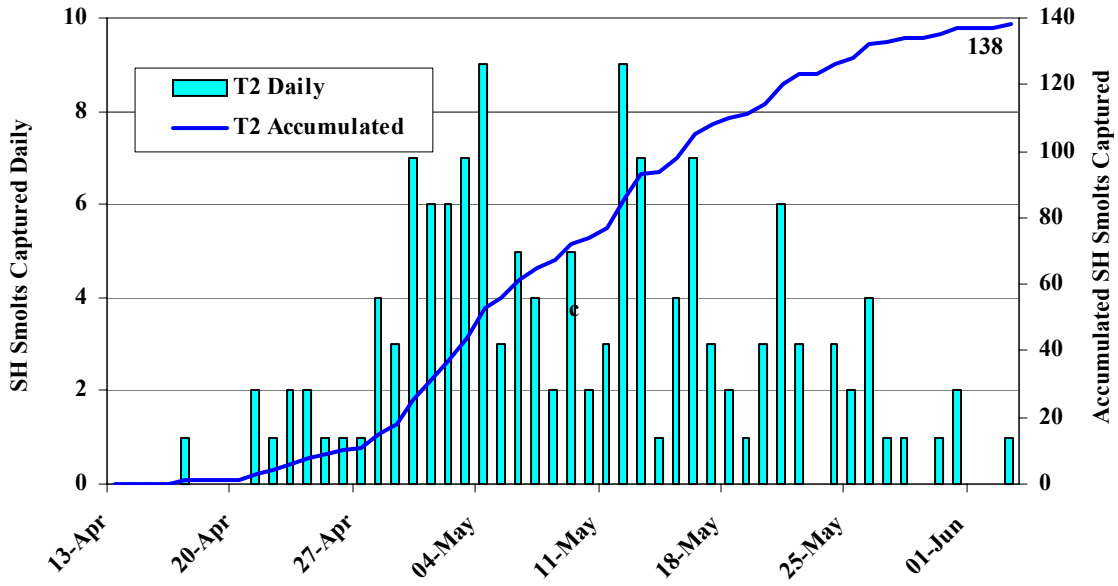

Figure 5. Steelhead smolt captures at T2 (Parrys RV Park) April 13-June 3, 2003.

In 2003, smolt emigration appeared to peak two weeks earlier than in 2002, with 62% of the total catch (both traps) sampled between April 28 and May 16. This emigration was closely associated with morning water temperatures near and above 8.0°C (Figure 6).

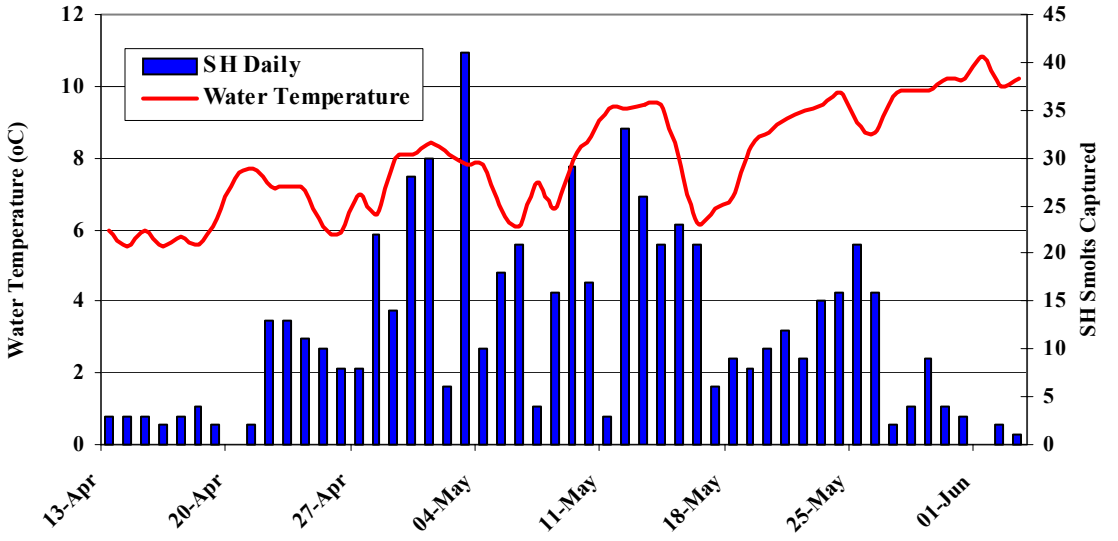

Figure 6. Combined steelhead smolt captures for 2003 (T1+T2) in relation to morning water temperatures.

Length and weight data of 131 steelhead smolts sub-sampled at T2 are summarized in Table 2. This year's smolt group was slightly smaller than that of last year, with mean lengths and weights 8 mm and 6.3 g less, respectively, than in 2002 (Figure 7). With a factor of 0.89 x 10^{-5}, mean smolt condition was identical to that observed in 2002. Based on 70 readable scale samples, this year's smolt group was composed of 71.4% two year olds and 28.6% three year olds, similar to 2002 (77.6% 2 year, 22.4% 3 year; n=246).

Table 2. Summary of juvenile steelhead sampling results from T2, Englishman River 2003.

		Length (mm)	Weight (g)
Steelhead Smolts	N=	131	131
	Max	221	80.4
	Mean	159	36.9
	Min	130	18.1
	S.D.	16	12.1
Steelhead Parr[1]	N=	57	56
	Max	158	41.0
	Mean	84	7.0
	Min	56	2.0
	S.D.	18	5.7

[1.] Steelhead parr defined as juveniles <140 mm fork length without smolt characteristics.

Of 95 rainbow parr captured at T2, about 60% were randomly sampled for length and weight (Table 2). Using last year's inferred maximum length of 100 mm for fish just less than one year old, the 2002 brood juveniles comprised 91% of the total parr sampled, and had average lengths, weights and condition factors of 80 mm, 5.3 g, and 1.01 x 10^{-5}, respectively. In 2002, this cohort had average lengths and weights slightly larger (81 mm and 5.7 g, n=163, Figure 7) and had the same condition factor.

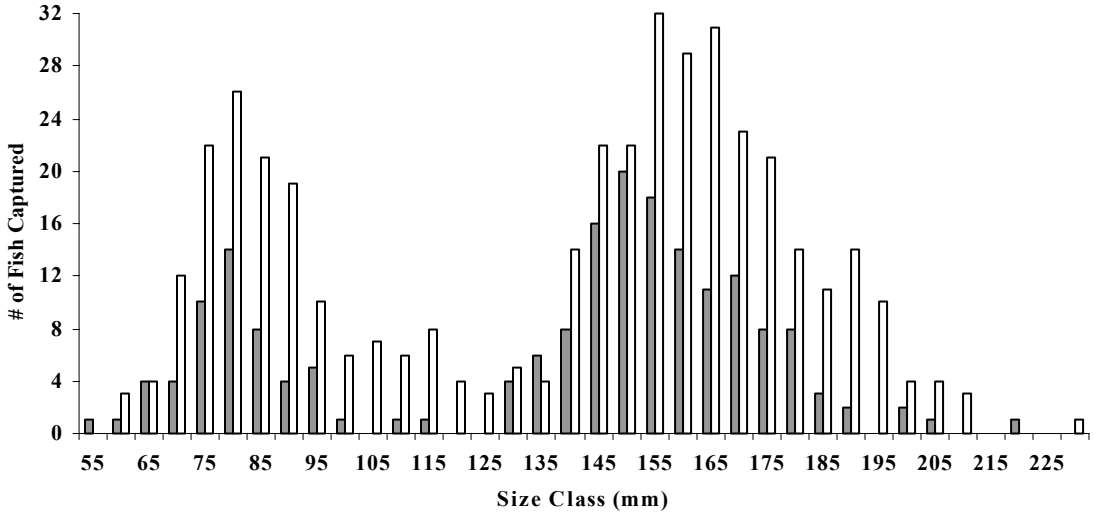

Figure 7. Length frequencies of Englishman River steelhead juveniles sampled at T2 in 2003 (solid bars) versus 2002 (open bars).

3.4 Steelhead Smolt Yield Estimates

In total 477 steelhead smolts were captured at the upstream trap (Top Bridge), with no mortalities. Of this total all were marked and released downstream of the trap location. An additional 14 smolts were marked at Centre Creek. Twenty-four of the marked fish (all from the T1 – Top Bridge site) were recaptured at the lower trap site (T2 – Parrys), giving an average estimated catch efficiency (ECE) of 5.0%. None of the 14 steelhead smolts marked at Centre Creek were recaptured at the lower site, thus these fish were excluded from the statistical analysis. Of the six mark groups of steelhead smolts released over the migration period, recapture rates ranged from 0% to 5.8% (Table 3). Based on the combined mark and recapture data (i.e., pooled Peterson estimator) the total steelhead smolt emigration past the trap site was estimated to be 2,657 fish, 95% confidence interval: 1,756 and 3,557. The assumption of complete mixing was met, indicating the percentage of marks recovered between release periods was similar (chi-square, df = 5, X^2=1.47, p = 0.92), albeit low. However the assumption of equal proportions of marked versus unmarked fish among recovery strata was only partially true (chi-square, df = 7, X^2 = 6.97, p = 0.43), as can be seen by the variance in Table 3. These tests indicate that pooling may create bias in the population estimate. In an attempt to examine the bias, we pooled recovery strata 1 with 2 and 7 with 8 (no recaptures in strata 1 and 8). We also pooled marking strata 1 with 2 (low numbers of marked fish in strata 1. A ML Darroch estimate of 2,706 steelhead smolts, 95% confidence limits: 1,673 to 3,740 was calculated, although the low G^2 value associated with this estimate (G^2 = 2.04, df =2, p=0.36) indicates a poor fit to the data (Arnason et al. 1996). The Schaefer estimate was 2,585.

Table 3. Summary of steelhead smolt mark and recapture data, Englishman River 2003.

Release Stratum	Period	Fish Marked	Recovery Stratum								Percent Recoveries
			1	2	3	4	5	6	7	8	
			20-Apr	27-Apr	04-May	11-May	18-May	25-May	01-Jun	08-Jun	
1	April 14-20	19	0	0	0	0	0	0	0	0	**0**
2	April 21-30	105	0	4	2	0	0	0	0	0	**5.7**
3	May 1-10	143	0	0	3	4	0	0	0	0	**4.9**
4	May 11-20	120	0	0	0	0	6	1	0	0	**5.8**
5	May 21-30	87	0	0	0	0	0	1	3	0	**4.6**
6	May 31-Jun 10	3	0	0	0	0	0	0	0	0	**0**
Untagged Fish			**1**	**6**	**37**	**20**	**27**	**16**	**6**	**1**	
Total Recovered			**1**	**10**	**42**	**24**	**33**	**18**	**9**	**1**	
Marked proportion			**0**	**40.0**	**11.9**	**16.7**	**18.2**	**11.1**	**33.3**	**0**	

Fences were operated from April 8 to June 8 on Centre Creek and the two mainstem side-channels. Trout captures (CFDC data) are summarized in Table 4.

Table 4. Summary of trout captures in Centre Creek and in the TimberWest and Weyerhaeuser side-channels, April 8 to June 4, 2003 (CFDC data).

Location	Rainbow/Steelhead			Cutthroat		
	smolt	parr	adult	smolt	parr	adult
Centre Creek	38	86	1	33	42	0
TimberWest S/C	20	69	0	15	20	2
Weyerhaeuser S/C	12	9	1	0	1	0

Note: breakdown of Centre Creek cutthroat smolts and adults not available.

4.0 Discussion/Recommendations

As in 2002, this year's pooled Peterson steelhead smolt estimate of 2,657 includes relatively large confidence intervals (± 900 fish, or 34%). To a large degree, the efficiency of T2 dictates estimate precision. Though crews continually adjusted T2 position relative to thalweg and natural "pinch points" in stream, an average of only 5% efficiency was observed during the sampling. An additional screw trap operating in the same area as T2 could be considered. However, even a doubling of the average ECE observed this year may not justify the additional expense, as the estimate would still have confidence intervals of ±25%. Smolt production in 2003 represents 33% to 58% of the river's estimated capacity based on available smolt models (Figure 8).

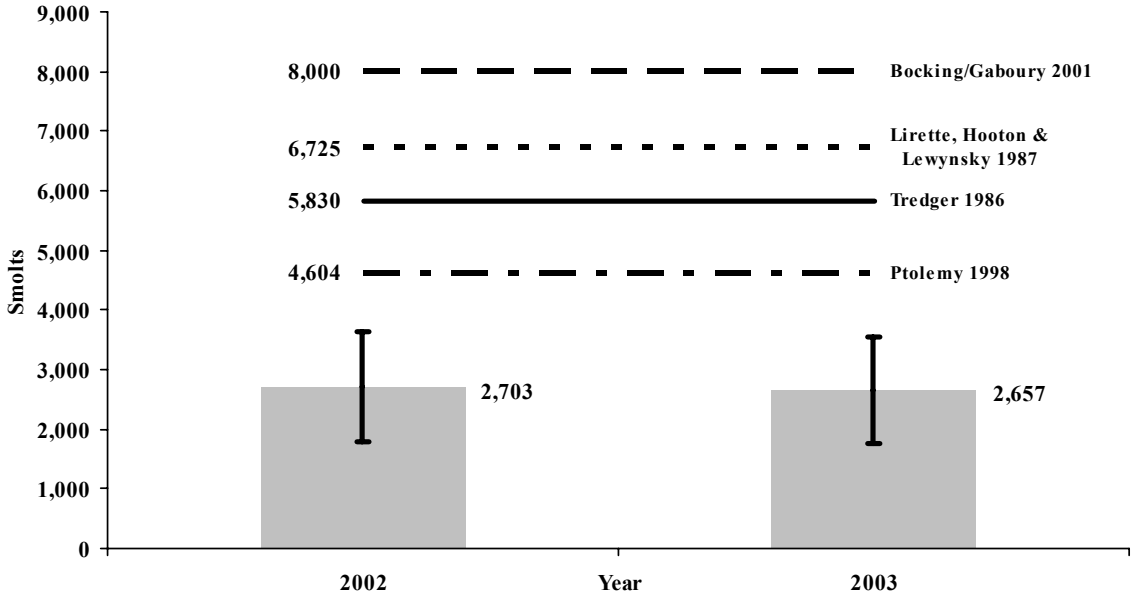

Figure 8. 2003 Englishman River steelhead smolt yield compared to the 2002 estimate and predictions based on available smolt models.

Contributing brood year peak adult densities observed during snorkel surveys were generally low, ranging from 1.8 fish/km to 8.0 fish/km (2000 and 2001, respectively, MWLAP Files, Nanaimo). Assuming 4% marine survival, this smolt group should contribute 106 steelhead adults to the Englishman River in coming years. **Because steelhead smolt production directly relates to watershed health and Recovery Plan efforts are focused on improving freshwater life cycle stages, smolt enumerations are critical and should continue in conjunction with adult escapement programs**. Development of stock recruitment relationships (based on a steelhead generation of data) will be an important tool to assess the Plan's effectiveness.

Flows in the Englishman River during the spring of 2003 were consistently lower than in 2002 but appeared adequate for smolt migration. No extreme events occurred, with flows ranging from 156% to 20% of mean annual discharge. Estimated catch efficiencies were also relatively consistent, ranging from 0% to 5.8% at the downstream trap. From April 21 to May 30, when the majority of migration occurred, ECE was particularly consistent, ranging from 4.6% to 5.8%.

Debris accumulations between May 23 and June 1 caused four jams at T2 (trap not rotating), with no related steelhead mortalities. Though there was no indication of when traps jammed (and thus what proportion of a day's migration was not sampled), it must be assumed that some fish were missed and that our estimate is correspondingly low. **If budgets are insufficient for a maintenance component to address high-water/heavy wind periods, an agreement with a campground resident or the operator to keep an eye on the trap in the evening and to call if a problem arises may reduce the number of lost/incomplete sampling days.**

Most of the required assumptions for the mark-recapture were met. As in 2002, the lower trap was located 1.8 km upstream of the mouth, and the area's low gradient and degree of tidal influence would suggest that very few steelhead smolts are generated in the reach below the trap. Spatially speaking, virtually all steelhead smolts would have to pass T2.

In temporal terms, the smolt migration appeared to be reasonably well-sampled, as seen by the capture results. Smolt captures were low to nil at the start and end of the trapping period.

Though not strictly assessed, tagging-related mortality was believed to be low to non-existent. Care was taken to minimize handling and maximize recovery time prior to release, and release locations offered depth with LWD and/or boulder cover for fish.

Similar to 2002, steelhead smolt production from side-channels was relatively low (mean of 0.6% of total estimated production). The contribution from Centre Creek was 38 smolts (1.43% of the total), down from 153 (6%) reported in 2002 by CFDC staff. Centre Creek's more moderate temperatures and a high water event in early April may have initiated an early migration of steelhead smolts and/or pre-smolts that would not have been included in fence counts.

5.0 References

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Appendix A. Photo Documentation.

Photo 1. Upstream view of T2 at start of season (moderate flows).

Photo 2. Downstream view of T2 at start of season (moderate flows).

Photo 3. Upstream view of T2 re-positioned mid-season during low flows.

Photo 4. Downstream view of T2 re-positioned mid-season during low flows.

Photo 5. Close up of T1 rotary screw trap.

Photo 6. Downstream view of CFDC smolt fence on Centre Creek.

Photo 7. Cutthroat parr captured in RST operation.

Photo 8. RST captures: coho smolt (upper), chinook smolt, rainbow parr, chum fry (lower)

Photos 9-12. Steelhead smolt compared to chum fry (smolt), chinook smolt, coho smolt, and rainbow (steelhead) yearling.