West Coast Region Steelhead Stock Assessment 2019/2020

Findings of investigations funded by the Freshwater Fisheries Society of BC, the Ministry of Forests, Lands, Natural Resource Operations and Rural Development, and the Habitat Conservation Trust Foundation

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Executive Summary

This project continues long-term steelhead stock assessment data collection on key Vancouver Island streams. A combination of methods including direct underwater observation (snorkel survey) and electrofishing assessment were used to determine relative abundance, habitat saturation and an estimate of absolute steelhead abundance in the Englishman River.

Winter steelhead snorkel surveys were completed, and results were contrasted against historic indices of abundance on the Englishman (1998–2019), Gold (1998–2019) and Salmon (1999 – 2019) Rivers. Summer steelhead snorkel surveys are summarized for the Tsitika (1976–2019), Heber (1975–2019) and Gordon (1985–2019) rivers. This year's results indicate relatively low steelhead abundance across their range for both summer and winter stocks.

Electrofishing data are summarised for the Cowichan (1999-2018), Englishman (1998-2018) and Gold (1990; 2017-2018) rivers. Gold River was added in 2018 in response to a large decline in adult and juvenile abundance noted in 2017. Future assessment activities will continue through 2022 under the British Columbia Conservation Foundation's (BCCF) Gold River steelhead assessment program and will be comprehensively reported under a separate cover.

Steelhead fry density on the Cowichan River continues to be below the 5-year average, but may be near the minimum abundance required to saturate available parr habitat. Steelhead density on the Englishman River is consistent with the small estimated adult population, and is likely below minimum abundance required to saturate parr habitat.

Englishman River peak counts of 45 steelhead in the spring of 2019 yielded a population estimate of 135 steelhead and is just above the lower quartile values within the intensively monitored period between 2002 – 2020 (n=19). The spring 2020 peak count of 28 adult steelhead yields a population estimate of 57 and represents the lowest recorded population estimate within the intensively monitored period. This level of abundance places the Englishman River in the **Extreme Conservation Concern Zone** based on both the absolute population size and our understanding of this stock.

These data are important for the management and maintenance of steelhead populations and angling opportunities on Vancouver Island. Additionally, this information builds upon available long-term trend monitoring inside and outside of the Georgia Basin.

Introduction

Vancouver Island contains a large diversity of steelhead ecotypes and populations that have historically supported a vibrant and world renowned sport fishery. Cyclical reductions in marine survival starting in the late 1990`s and subsequent declines in steelhead abundance have necessitated angling management actions including closures of several historically important streams, primarily on the central east coast of the island. Some populations have rebounded or remained resilient while others have persisted at levels that do not facilitate fishery openings. Active fishery management has become an important tool to ensure populations below key abundance thresholds are protected while sportfishery benefits continue to be derived where sustainable opportunities exist.

A combination of stock assessment methods are used to acquire population estimates and estimates of relative abundance using direct underwater observation, and indices of steelhead fry abundance using electrofishing assessments. Comprehensive assessment of steelhead population dynamics on the Keogh River are completed annually and are reported under a separate cover.

Funding for this work was provided by the Freshwater Fisheries Society of BC (FFSBC), the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development through the Land Based Investment Strategy and supported by the British Columbia Conservation Foundation (BCCF). Past work has been supported by the Greater Georgia Basin Steelhead Recovery Plan, Habitat Conservation Trust Foundation with some additional assistance by the Steelhead Society of British Columbia.

Project Objectives

1. Monitor winter-run and summer-run steelhead stocks through snorkel surveys of index sections on high priority streams including the Englishman, Gold, Heber, Salmon and Tsitika Rivers.
2. Complete standardized electrofishing surveys on Englishman and Cowichan Rivers.
3. Obtain a preliminary dataset of fry densities in the Gold River to compare with winter and summer run adult snorkel survey results.
4. Opportunistically document fish habitat condition, as well as changes to stream channel and riparian areas.

Methods

Snorkel Surveys

Snorkel survey results were used to estimate total abundance on the Englishman River, an index of the whole population on the Heber, Tsitika and Gordon Rivers as well as a relative index of abundance on the Gold and Salmon Rivers. The differences in results relate to the distance surveyed (i.e. whole or partial stream) and ecotype (i.e. summer or winter steelhead).

Standard equipment for all crew members included drysuits, felt-soled wading boots, neoprene hoods and gloves and rescue throw bags. Dive slates were used to record fish observations and digital or handheld thermometers recorded stream temperatures. A detailed safety plan was developed for each river, with egress points identified for each section. Waterproof hand-held VHF radios were carried on each reach and tuned to the same frequency as the radios mounted inside of each crew vehicle. A check-in/check-out procedure was used to ensure that the crew completed the survey and all members were accounted for upon completion.

Electrofishing depletion Estimates

Closed-site electrofishing consisted of enclosing approximately 100 m^2 of suitable steelhead fry habitat (typically cobble/gravel riffles, <30 cm in depth, and <25 cm/sec in velocity) with two 15.24 m by 1.52 m stop-nets (1/2" stretch knotless mesh). Site selection was primarily guided by access although an attempt was made to survey throughout individual watersheds. Smith-Root LR-24 back-pack electrofishers were used by crews of two to three to collect juvenile steelhead. Felt soled boots, leak proof waders, certified rubber linesman's gloves, polarized glasses, and brimmed hats were standard equipment for all crew members.

Fish were captured using the standard two-pass removal method whereby a population estimate (N) is derived by entering the number of fish caught in pass one (P1) and pass two (P2) in the formula N= (P1)2 /(P1-P2) (deLeeuw 1981). Lengths were recorded for all species captured and juveniles from each age class were weighed using Ohaus top loading scales (model CS 200, accurate to 0.1 g). Habitat parameters were documented consistent with current Fisheries Branch techniques (methodology by R. Ptolemy, Rivers Biologist, Ministry of Environment, Victoria), and each site was digitally photographed. Upon removal of the stop-nets, a depth/velocity profile across a representative transect

within the site was recorded using a Swoffer (model 2100) or equivalent velocity meter. The usability of habitat sampled for each species and age class was then calculated using habitat suitability index curves (BC Hydro Water Use Planning derived HSI curves). To standardize the data set, population estimates were then adjusted based on the depth-velocity profile.

As of this report, analysis of mean steelhead densities by watershed have changed from using a geometric mean to an Arithmetic mean. Therefore, slight discrepancies may be noted between data reported in this summary and past summary data.

Results

Englishman River

The Englishman River flows generally east from its headwaters near mount Arrowsmith and enters the ocean near Parksville on the east coast of Vancouver Island. This medium sized stream has historically supported a vibrant steelhead fishery. The majority of the fishable length has been closed since the late 1990's.

Snorkel Surveys

Snorkel surveys have been conducted intensively since 2002, with contemporary surveys bracketing the peak abundance period, typically observed in mid to late April. Based on a population distribution spanning the fiscal year-end period, summaries are provided for the 2019/2020 and 2020/2021 fiscal years.

Snorkel surveys in 2019 occurred on April 2 and April 26, finding 45 and 38 adult steelhead, respectively. The uncalibrated peak density in 2019 was 3.0 fish/km (Figure 1). The resultant population estimate using an area under the curve (AUC) method with a residence time of 50 days and a survey efficiency of 0.55 was 135 steelhead (Figure 2).

Snorkel surveys in 2020, occurred on March 5 and April 7 with 7 and 28 steelhead counted, respectively. The uncalibrated peak density in 2020 was 1.9 fish/km (Figure 1). The resultant population estimate using an area under the curve (AUC) method with a residence time of 50 days and a survey efficiency of 0.55 was 57 steelhead (Figure 2). Figure 1 illustrates the peak snorkel survey counts during the intensively monitored period between 2002 and 2020 (n=19).

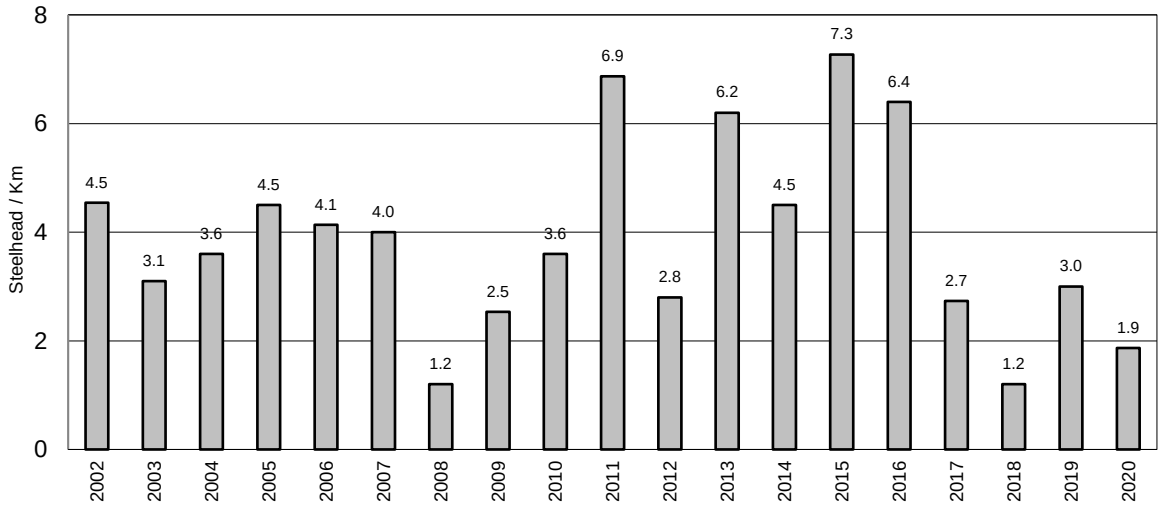

Figure 1. Uncalibrated peak adult steelhead count (steelhead/km) in the 15 km mainstem survey of the Englishman River for intensively surveyed years from 2002 to 2020.

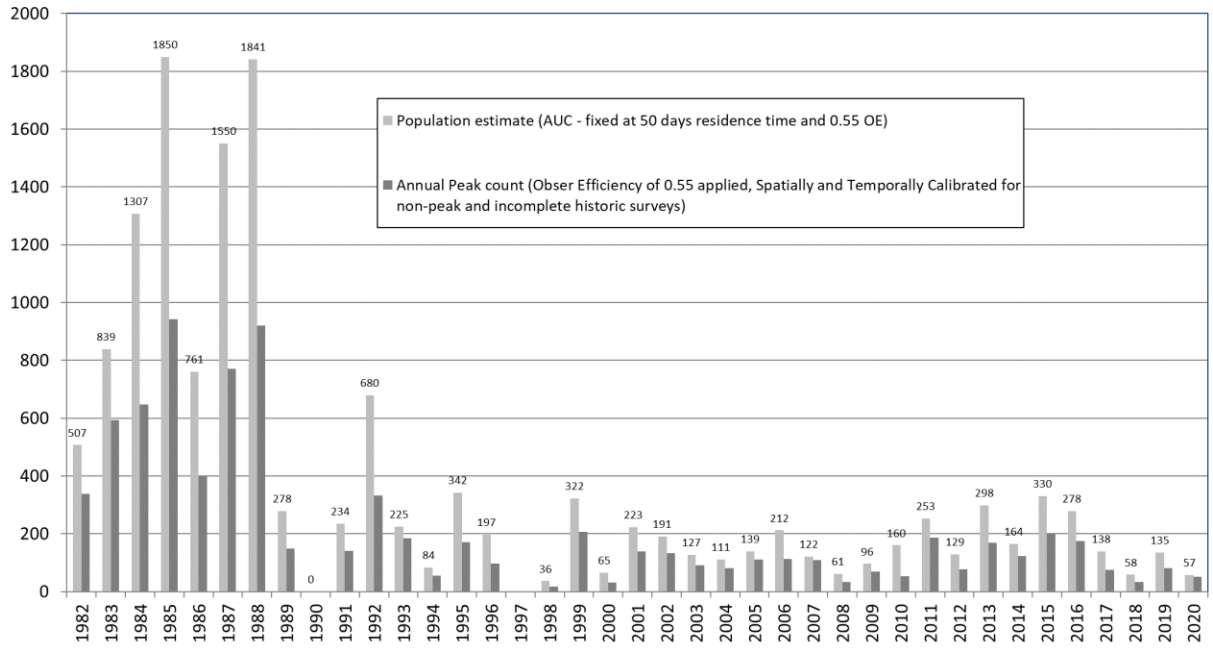

Figure 2. Steelhead population estimate and calibrated peak count/year for the Englishman River using a survey efficiency of 0.55 and an AUC method with a survey life of 50 days.

Electrofishing

Eight standardized steelhead fry electrofishing sites were surveyed between August 21 and September 17, 2018 (Table 2).

Table 1. Electrofishing site names and locations by river km, Englishman River, 1998-2018. Sites on the South Fork and Allsbrook Canyon have been discontinued.

Site #	Site Description	Site Reference (km)
1	50 m d/s of Hwy 19A bridge	1.26
2	Martindale Road	2.11
4	Grassy Bank	5.57
5	Powerlines	6.85
7	Side Channel Intake	8.72
8	End of Englishman River Road	9.84
9	Steelhead Place	13.14
10	Falls Site	14.83

Mean adjusted steelhead fry abundance estimates continue to be low and consistent relative to estimates of adult abundance.

The 2018 result of 25 FPU is ranked 6th out of 15 years, and slightly below the 2017 value of 28 FPU.

Fry density was highest in ‘site 8’ at the top of the anadromous reach (Figure 3). Figure 4 provides an arithmetic mean depth/velocity adjusted steelhead fry densities in the Englishman River from 1998 to 2018. An Allen Plot of density versus size data suggests that fry density at all sites was less than the estimated capacity of 202.1 g (Figure 5). However, biomass for all age classes of steelhead parr increased from 2016 estimates. See Appendix A for site photos and Appendix B for historic data.

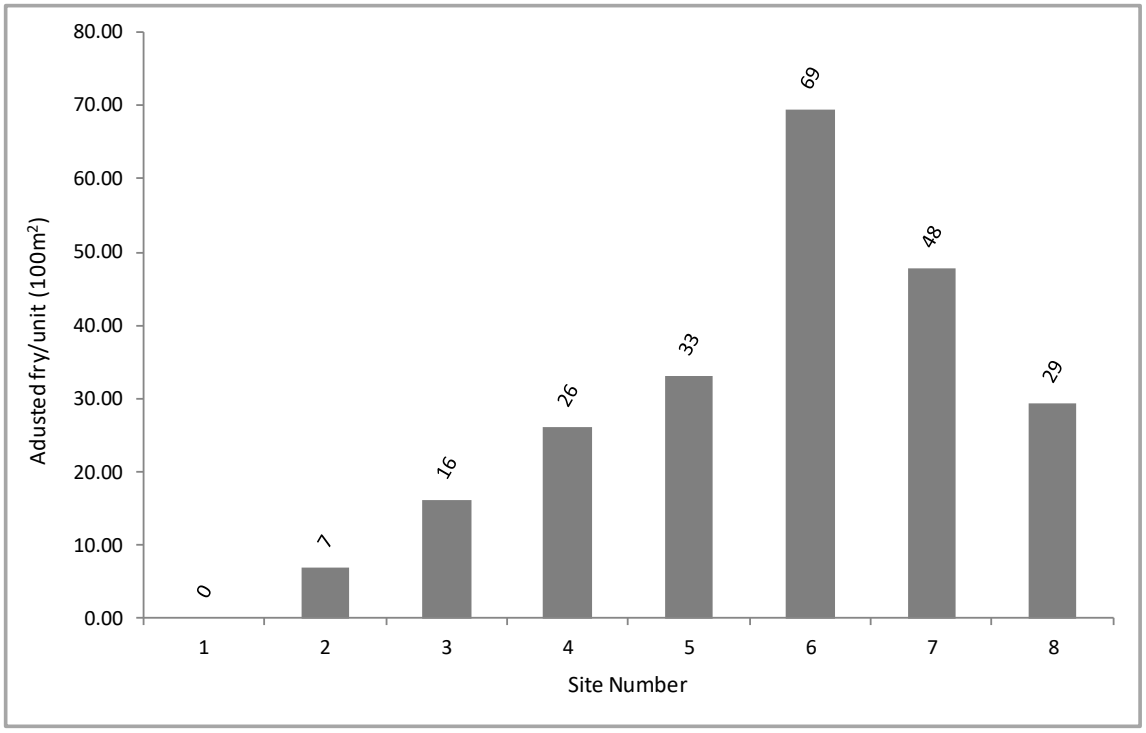

Figure 3. Depth/velocity adjusted steelhead fry density at 10 sites sampled on the Englishman River, 2018.

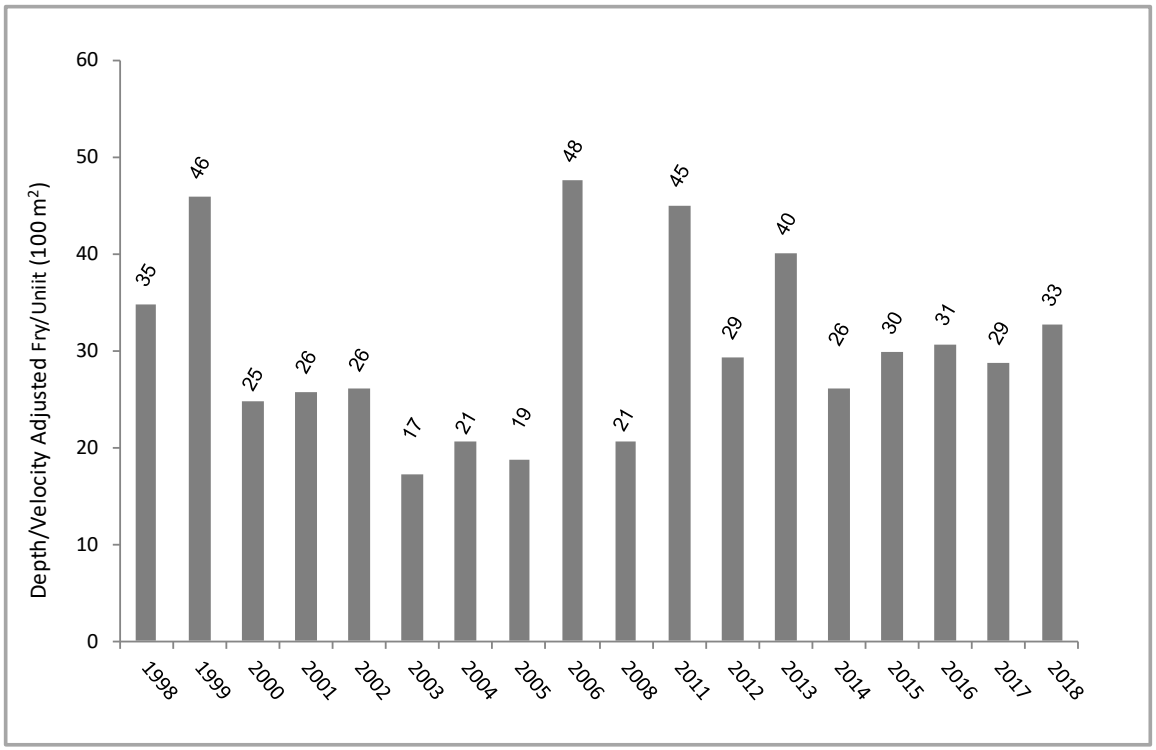

Figure 4. Summary of arithmetic mean depth/velocity adjusted steelhead fry densities in the Englishman River from 1998 to 2018.

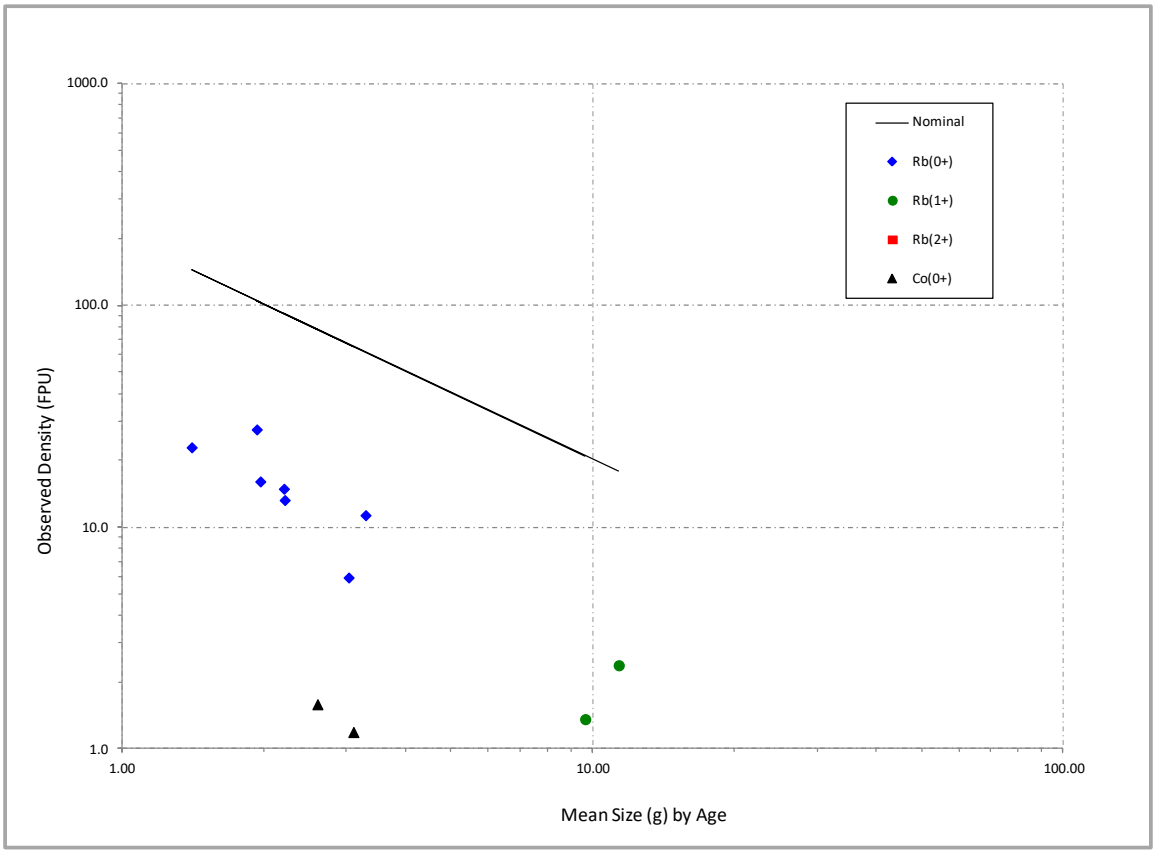

Figure 5. Allen plot of 2018 Englishman River electrofishing results across 8 sites and 2 species; unadjusted densities are displayed relative to a capacity of 202.1 g/100 m^2.

Gold River Watershed

The Gold River originates in the Sutton Mountain Range, flowing 50 km south-southwest into Muchalat Inlet. It is fed by multiple tributaries including several small lakes draining a total watershed area of 1,010 km^2. The Gold River has historically contained the largest overall catch and highest CPUE of any large steelhead stream on Vancouver Island with the fishery primarily targeting winter run steelhead. Both the Heber River and the upper Gold River upstream of the confluence of the Muchalat support predominantly summer ecotype steelhead while the Muchalat and mainstem Gold downstream of the confluence contain predominantly winter ecotype steelhead. The winter steelhead fishery was closed on December 1, 2018, pursuant to large scale declines in winter steelhead abundance and the system remains closed indefinitely.

Assessment activity on the Gold River in 2017 led to a successful application by BCCF for funding from the Habitat Conservation Trust Fund to continue stock assessment investigating the decline of Gold River steelhead. This five-year project is moving into its second year. More comprehensive stock assessment and discussion regarding the Gold River will be reported under a separate cover documenting the findings of that project.

Gold River Snorkel Surveys

The typical winter steelhead survey index is 8.1 km in length, broken into two non-consecutive survey sections, from the #1 Bridge (in the town of Gold River) down to the Lion's Campsite, and one from the 'Circus Pool' (top of the lower canyon) to the Ucona River confluence. During the single winter 2019 survey on February 14, only four winter-run steelhead were observed in the 8.1 km index survey reach, for a density of 0.49 fish/km. These survey results represent a startling decline from the past peak average fish density of 46.4 fish/km but similar to 2017 and 2018 peak counts of one and three adult steelhead, respectively (Figure 6). Flow conditions prevented additional winter surveys prior to March 31, 2019.

The summer steelhead index is 13.4 km in length and extends downstream from the #5 Bridge to the #4 Bridge and from the #4 Bridge downstream to the 'Fire Break'. During the August 29 survey a total of 66 steelhead were observed (Figure 7). The distribution of fish was likely shifted due to extremely low flows observed at the time of the survey however this hypothesis was not tested through an expansion of survey area.

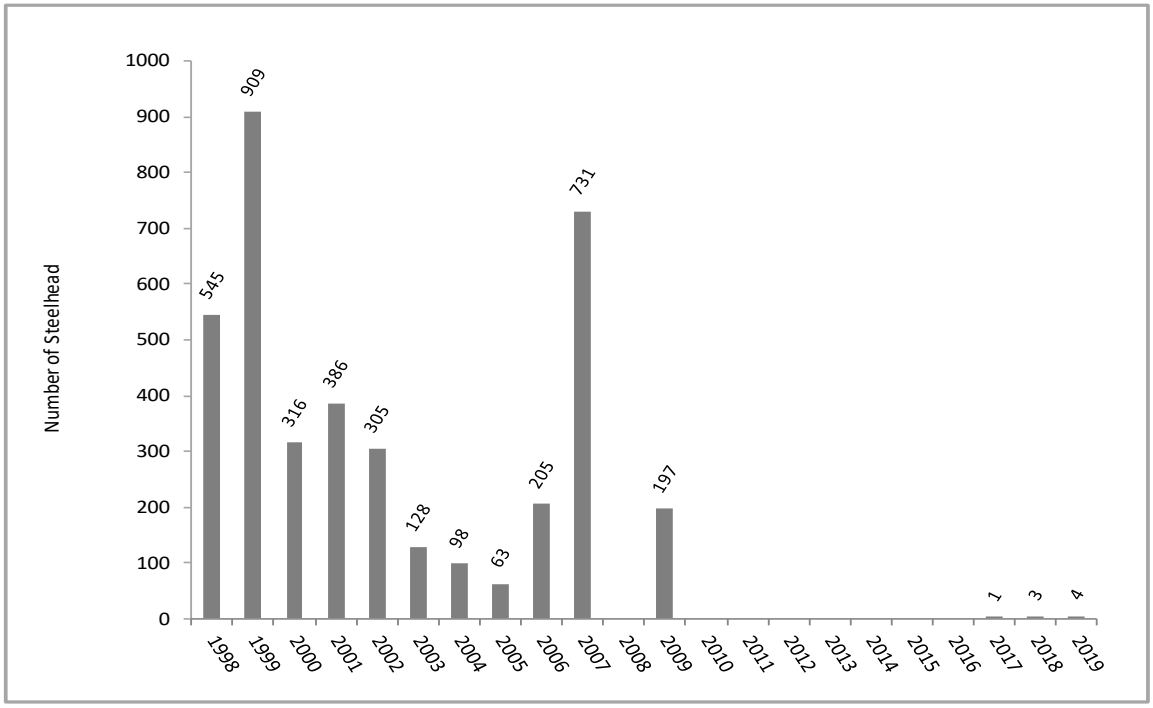

Figure 6. Uncalibrated peak adult steelhead count for the 8.1 km Gold River index from 1998 to 2019. Note that the 1998 survey was completed over 6 km. Years without data were not surveyed.

Heber River Snorkel Survey

Summer-run steelhead have been enumerated in the Heber River for 44 consecutive years starting in 1975. In 2018, a snorkel survey of the Heber River was conducted on August 30, 2018 (Figure 7). The Heber River is considered an indicator stream for wild, west coast, summer-run steelhead stocks but also represents an interesting contrast to very low winter steelhead observed in recent surveys of the Gold River. The physical characteristics of the watershed allow for a whole stream survey with high estimated observer efficiency. The 8.5 km index was split into two sections ending at the lower bridge near the Gold River confluence. Flows were extremely low and surveyors were required to walk large sections. Effective visibility was greater than 10 m allowing for a thorough inspection of all pools.

A total of 259 adult steelhead were observed for a density of 30 fish/km. Fish were not distributed uniformly between the upper and lower sections, with 56 observed in the upper section (including the Road Pool) and 203 observed in the lower section. The 2018 count is just over the 44 year average of 255 (Figure 7).

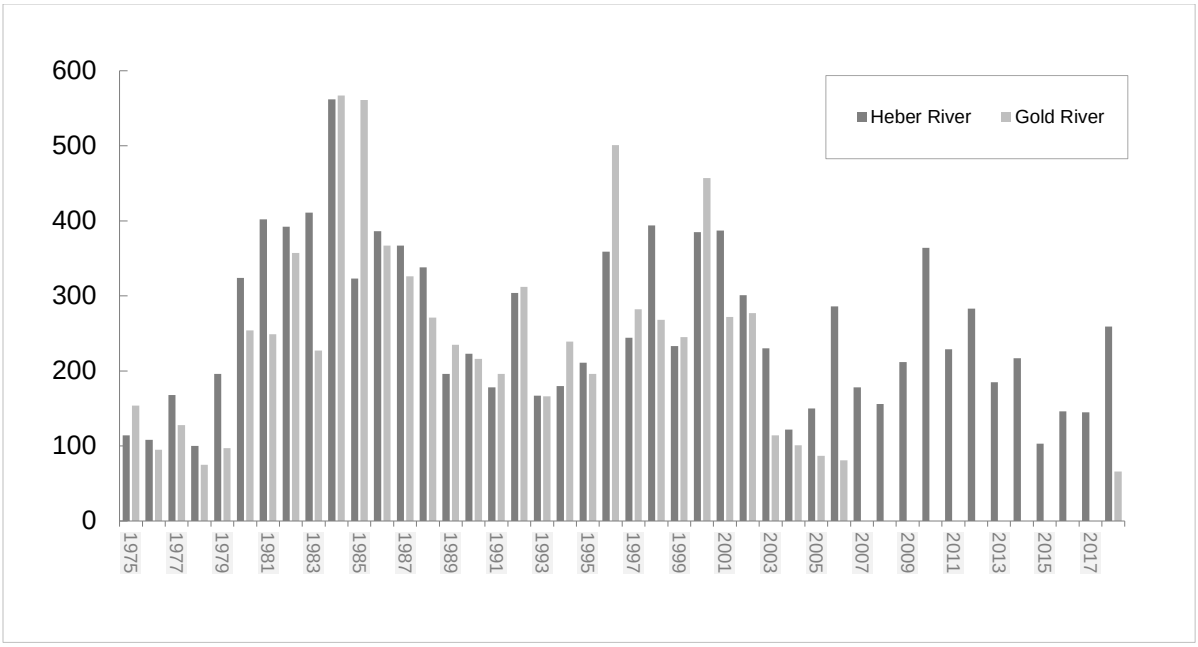

Figure 7. Uncalibrated peak adult steelhead count in the comprehensive survey of the Heber River and Upper Gold River index between 1975 and 2018.

Electrofishing

Five standardized steelhead fry electrofishing sites were assessed on the Gold River on September 5 and 6, 2018. Four sites on tributaries of the Gold, two on the Upper Gold River and two on the Heber River, were also added in 2018. Electrofishing site locations are provided in Table 2 below. This is the second consecutive year of standardized data to be collected. The only previous analogous data collected on the Gold River involved two electrofishing sites sampled in 1990.

Table 2. Electrofishing site names and locations by river km. River km for the Upper Gold and Heber Rivers begin at their confluence with the Gold River, 2018.

Site #	Site Description	Site Reference (km)
1	Big Bend	12.5
2	Town Bridge	15.3
3	Bridge 2	19.1
4	High Angler Trail	23.1
5	Muchalat Bridge	25.6
6	Bridge 4 (Upper Gold)	0.5
7	Bridge 5 (Upper Gold)	15.2
8	Cougar Run (Heber River)	3.2
9	Saunders Creek (Heber River)	6.7

The September 2018 Lower Gold River electrofishing revealed larger fry (4.0 g) relative to the 1990 electrofishing results (1.25 g and 2.94 g/site). The 2018 results are similar to the

2017 results of 4.4 g. This difference in size when compared with the 1990 results may be related to density dependence; that is, much lower densities observed in 2017 and 2018 (10 and 9.7 FPU) relative to the 1990 assessment (75 FPU). The average of 9.7 FPU is about 13% of the value noted in 1990, as illustrated in the density versus size Allen Plot provided below in Figures 8 and 9.

Yearling parr in 1990 averaged 21.7 g with a maximum density of 15.2 FPU. The at-capacity estimate for fry abundance in the control reach of the Gold River in 1990, assuming a mean fry size of 1.25 g, was 184 FPU given that Gold River alkalinity is approximately 20.5 mg/L with a suggested capacity of 230 g/100m^2 per age (R. Ptolemy pers com). Additional comprehensive analysis and summary data for the Gold River watershed will be available under a separate cover.

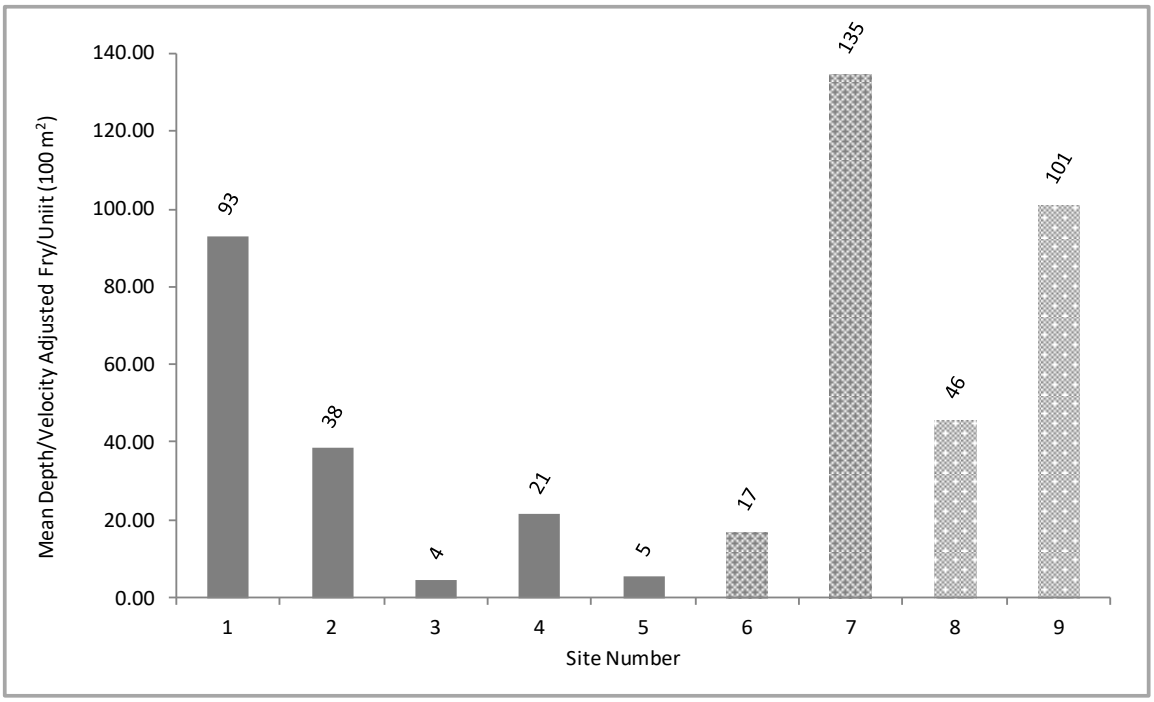

Figure 8. Depth/velocity adjusted steelhead fry density at 9 sites sampled on the Gold, Upper Gold, and Heber Rivers, 2018. Sites 6 and 7 are Upper Gold results while sites 8 and 9 are Heber results.

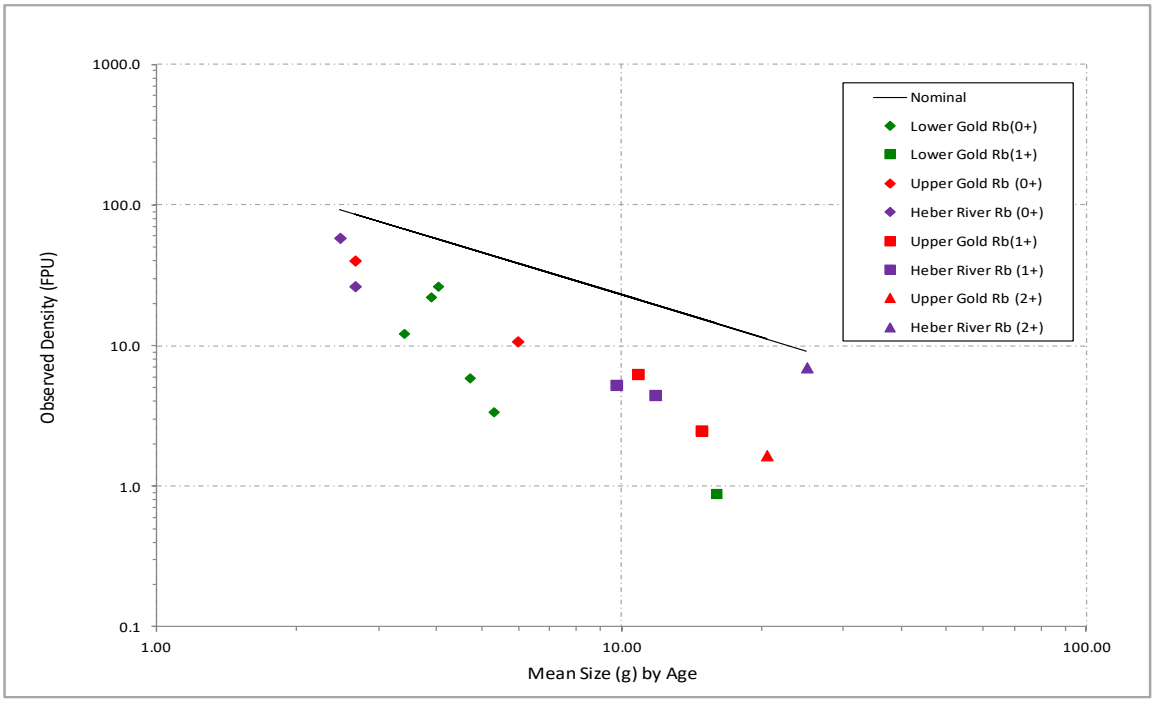

Figure 9. Allen plot of 2018 Gold River, Upper Gold River, and Heber River electrofishing results across 9 sites, including 5 Lower Gold, 2 Upper Gold, and 2 Heber River; unadjusted densities are displayed relative to a suggested capacity of 230 g/100m^2.

Salmon River

The Salmon River originates in the mountains at the north end of Strathcona Park, near Crown Mountain and flows 87 km north to Johnstone Strait entering at Kelsey Bay. The Salmon River has been one of the premier winter steelhead streams on Vancouver Island and continues to support a modest steelhead fishery.

Snorkel Survey

The survey index is 11.5 km in length, broken into two consecutive survey sections including an upper one from hydrometric station (08HD032) near the Kay Creek confluence to the Big Tree Creek confluence, and a lower one from the Big Tree Creek confluence to a roadside pullout. During the single winter 2019 survey on March 14, a total of 94 winter-run steelhead were observed, including 28 in the upper and 66 in the lower survey reach for a density of 8.2 fish/km. This result is higher than that obtained in recent years (2014-2017), but is lower than the long term average of 121 (Figure 9).

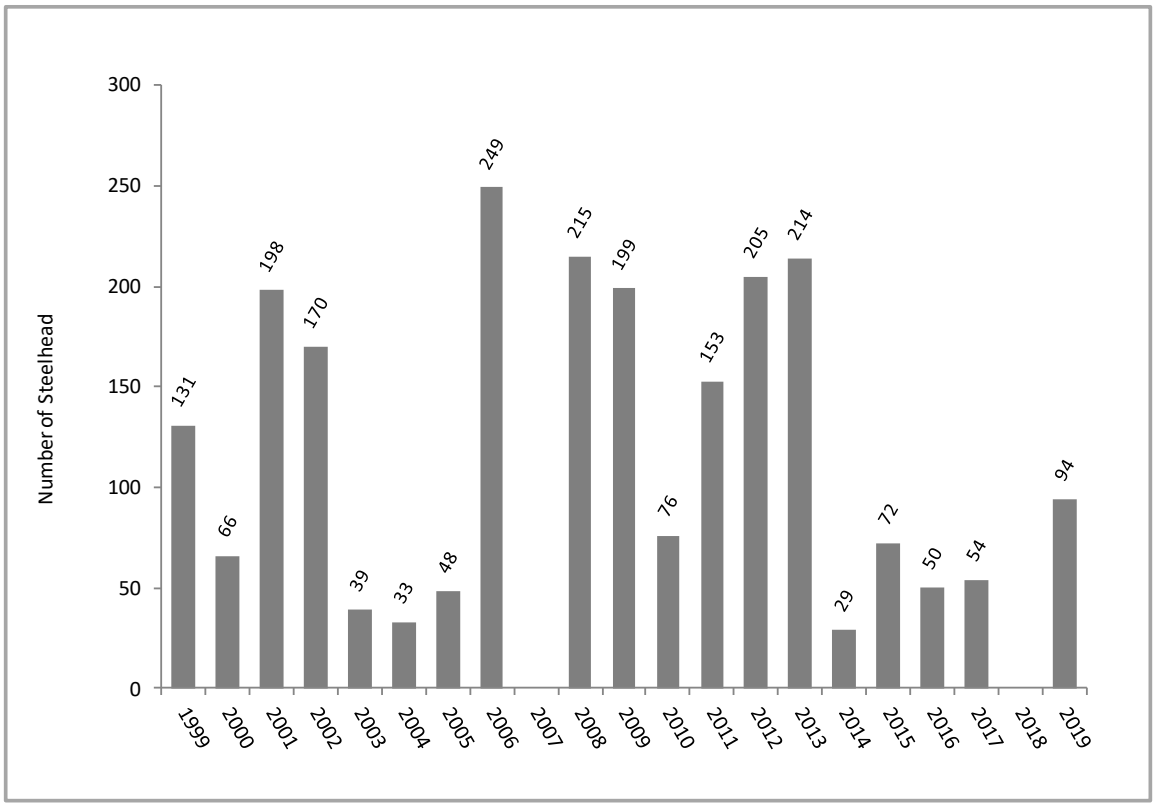

Figure 9. Uncalibrated peak adult steelhead count for the 11.5 km Salmon River index from 1999 to 2019. Years without data were not surveyed.

Gordon River

The Gordon River is a medium sized summer steelhead stream that flows south from its headwater near Cowichan Lake for more than 40 km before discharging into Port San Juan. This system produces somewhat variable stock assessment results with environmental conditions heavily influencing steelhead distribution between years. This annual survey is in part aimed at assessing passage constraints beyond selective obstructions and a bypass channel at Loup Creek Falls.

Snorkel Surveys

On October 9, 2018, a snorkel survey of the Gordon River was conducted to enumerate and index of summer-run steelhead abundance. The 7.0 km index is typically surveyed in two sections, consisting of a 3.2 km upper reach and a 3.8 km lower reach. However, the survey of the lower reach had to be abandoned due to higher than average flows. A total of 46 wild adult summer steelhead were observed in the upper index for a density of 14.4 fish/km (Figure 10).

As the Gordon River index length has varied over time, the density of fish/km for all years is provided in Figure 11.

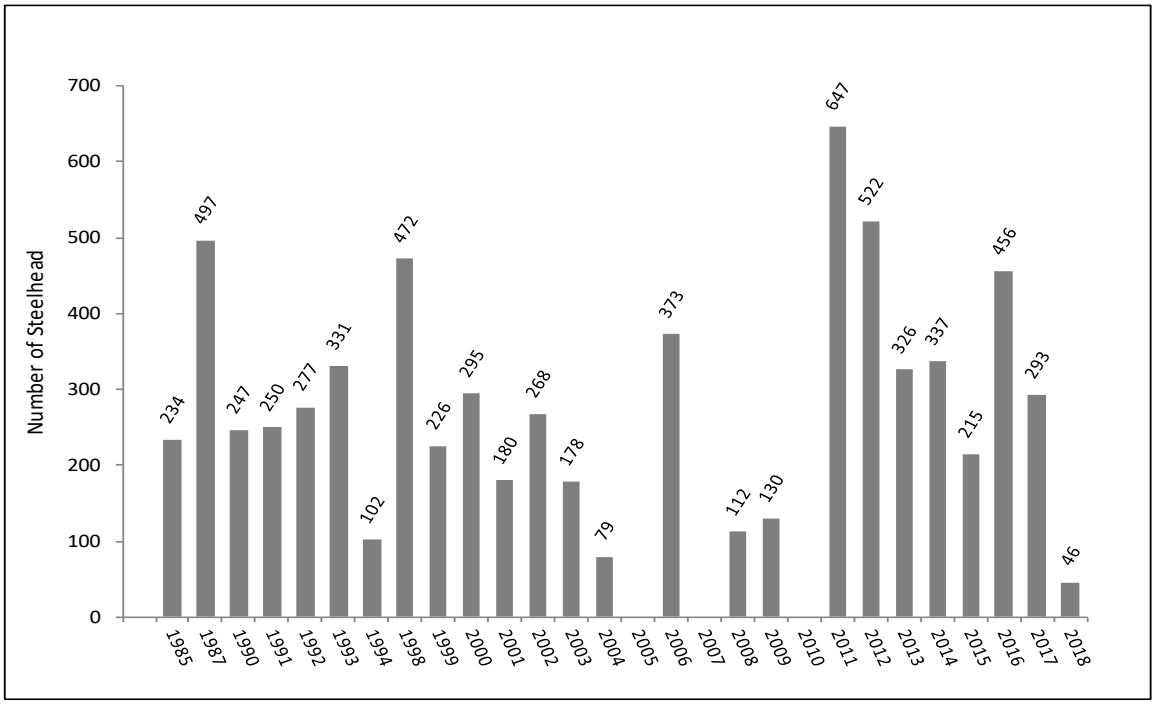

Figure 10. Uncalibrated peak adult steelhead count in the index section of the Gordon River between the TR3 Bridge and Bugaboo Creek confluence. In the fall of 2018 only the upper reach (3.2 km) was surveyed due to high flows. Years without data were not surveyed.

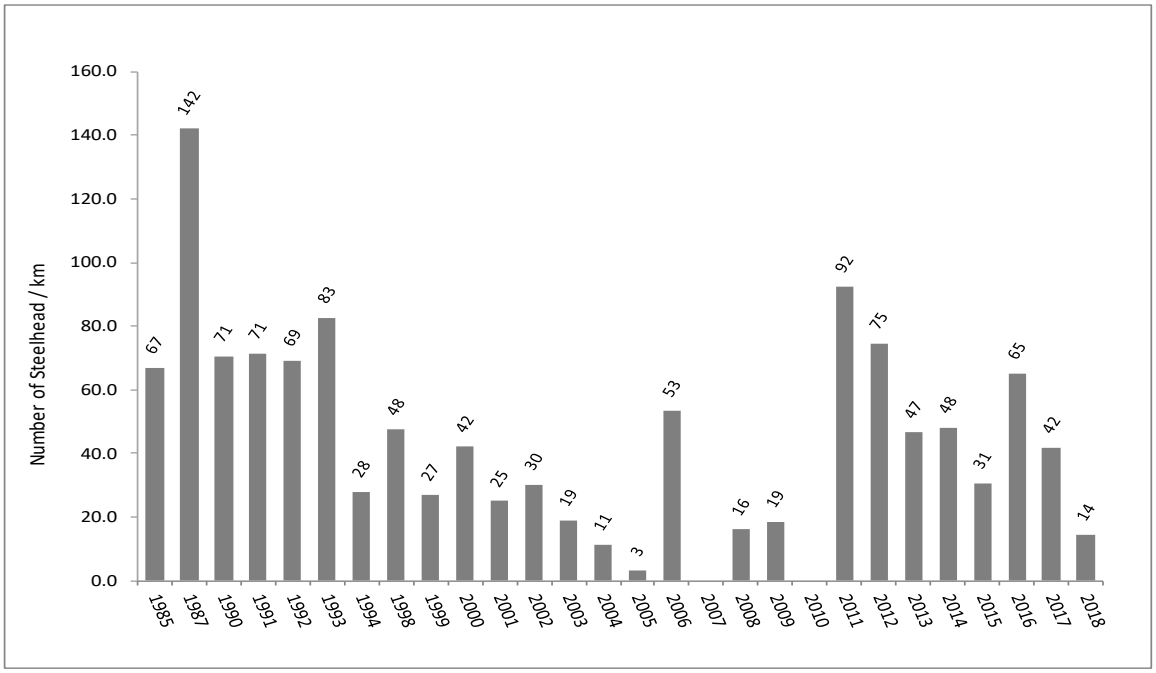

Figure 11. Average steelhead count per kilometer in the Gordon River from 1985 to 2018. Years without data were not surveyed.

Tsitika River

The Tsitika is a medium sized summer steelhead stream that flows north into Robson Bight on north east Vancouver Island. The Tsitika has typically contained the largest population of east coast summer-run steelhead and hosts a moderate fishery. It is considered an indicator for North Island Summer steelhead but has also been monitored relative to a nutrient enrichment program completed in the mid 2010's.

Snorkel surveys

Summer-run steelhead have been enumerated in the Tsitika River for 43 consecutive years, beginning in 1976. In 2018, a snorkel survey of the Tsitika River was conducted on September 26, 2018. The original 9.2 km long index has been reduced to 7.6 km due to the trail out from the Water Survey Canada (WSC) station becoming too overgrown for use around 2013. The index was split into two sections, with one from 'Fannin's Fan' to 'Debris Torrented Tributary' (3.2 km) and one from 'Slide Hole' to 'Catherine Creek' (4.4 km).

During the 2018 snorkel survey, 64 steelhead were observed over the 7.6 km index for a density of 7.8 fish/km. Distribution of adult steelhead was restricted almost exclusively to deep bedrock controlled pools in both sections. A total of 30 summer-run coho salmon were enumerated during the survey, with the majority located with steelhead in bedrock controlled holding pools. Additionally, 1 cutthroat trout was observed. The 2018 count ranks 40th overall (near lower quartile) and is below the long-term average of 188 (Figure 12). The timing of the snorkel survey was delayed by several weeks due to high late-summer flows, likely resulting in a shift of abundance away from the reference reaches.

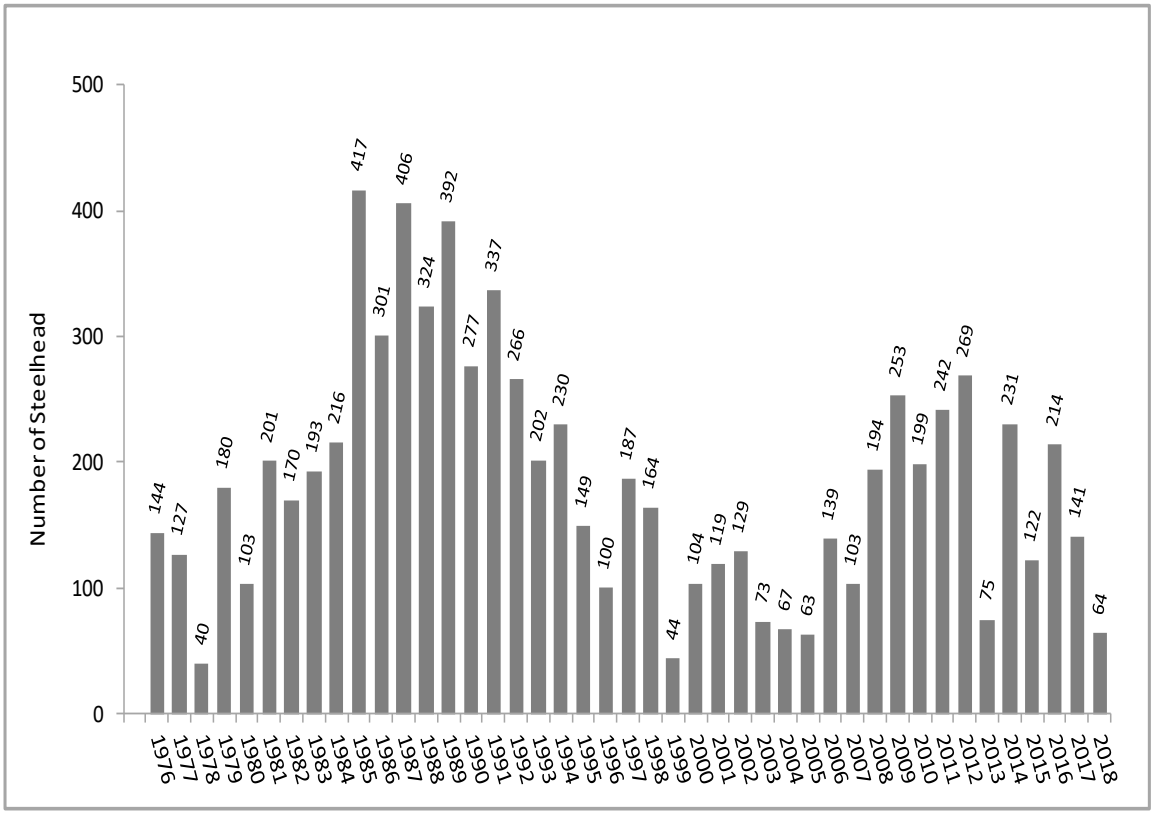

Figure 12. Uncalibrated peak adult steelhead count in the 7.6 km Tsitika River index, from 1975 to 2018.

Cowichan River

The Cowichan River is one of the largest watersheds on Vancouver Island draining 1227 Km^2. The stream flows generally Eastward draining in to Cowichan Bay near the city of Duncan. Cowichan Lake provides a great deal of hydrologic stability through the rainy winter months while a water storage facility substantially augments the summer base flow in the Cowichan River.

This system contains the largest steelhead fishery on Vancouver Island due to its relatively stable steelhead population, long steelhead season and its proximity to densely populated centers including Victoria, Duncan and Nanaimo.

Electrofishing

Ten standardized steelhead fry electrofishing sites in preferred juvenile steelhead habitats were surveyed between September 11 and 19 on the Cowichan River (Table 3). Electrofishing on the Cowichan River has typically been conducted from late-August to mid-September, when flows measured at the outlet of Cowichan Lake were approximately 4.5 m^3/s.

Table 3. Electrofishing site names and locations by river km, Cowichan River, 1998-2018.

Site Number	Site Description	Site Reference (km)
1	90 m u/s of Silver Bridge	6.0
2	Vimmy Boat Launch	13.9
3	200 m d/s Bible Camp/Sandy Pool	21.8
4	400 m u/s Rip-rap corner	25.8
5	150 m u/s Stoltz launch	26.7
6	50 m d/s Horseshoe Bend	32.3
7	750 m u/s Skutz Falls	33.7
8	Block 51 Log Jam/3 firs (d/s 100 m)	38.7
9	100 m u/s 70.2 Mile Trestle	40.0
10	Saysell's Riffle	45.0

This year's density of 139.7 fry/$100m^2$ (FPU) in preferred habitats is below the recent five-year average of 206.7 FPU, but above the 1999-2005 average of 77.8 FPU. Of the ten sites surveyed in 2018, sites 5, 7, and 8 (middle to upper reaches) contained the highest densities of steelhead (Figure 13). Figure 14 provides a summary of arithmetic mean depth/velocity adjusted steelhead fry densities in the Cowichan River from 1999 to 2018.

See Appendix A for site photos and Appendix B for historic data.

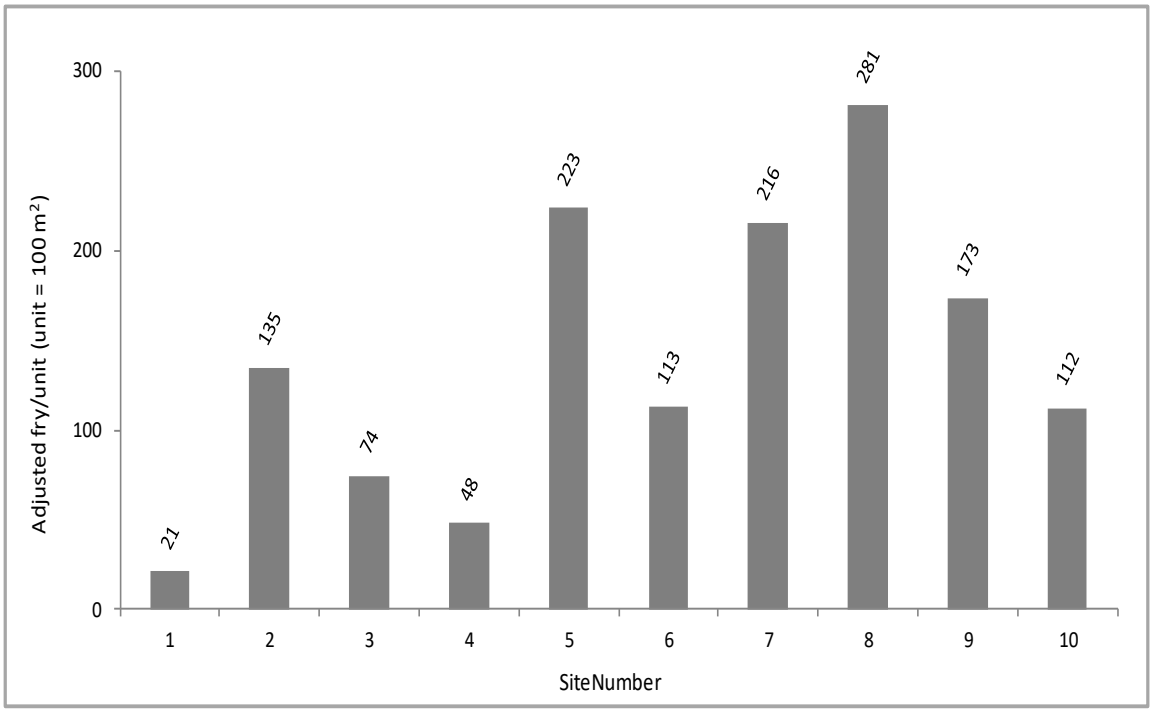

Figure 13. Depth/velocity adjusted steelhead fry density at 10 sites sampled on the Cowichan River in 2018.

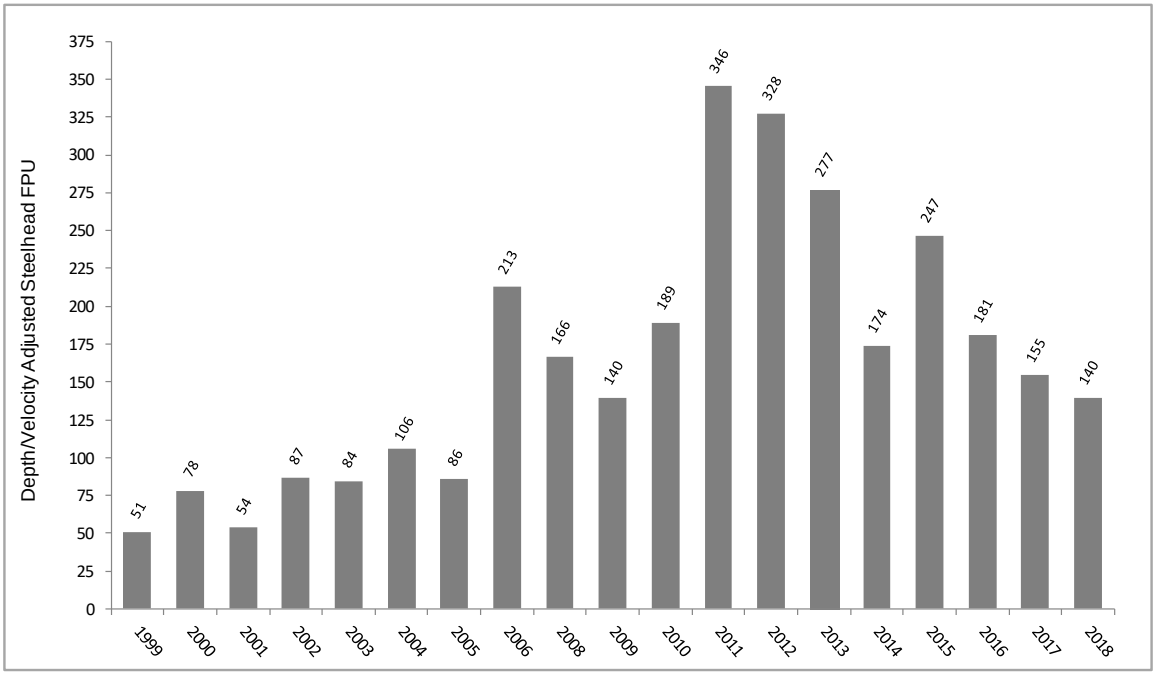

Figure 14. Summary of arithmetic mean depth/velocity adjusted steelhead fry densities in the Cowichan River from 1999 to 2018.

An Allen Plot was completed for density versus size of all species and age classes captured at each site (Figure 15). The nominal line is generated by an alkalinity model predicting a maximum capacity of 1000 g/unit per species and age class. Points closer to the line represent sites that are closer to the modelled capacity. Steelhead fry biomass did not appear to be near predicted maximal values at any site. Steelhead parr biomass varied throughout all sites, but all sites with parr present were found to be well below the predicted capacity. Two-year-old (2+) rainbow and cutthroat trout parr were absent from catches. It is important to note that juvenile steelhead habitat was targeted at each site and representative rainbow trout parr and coho fry habitat were not sampled in most cases.

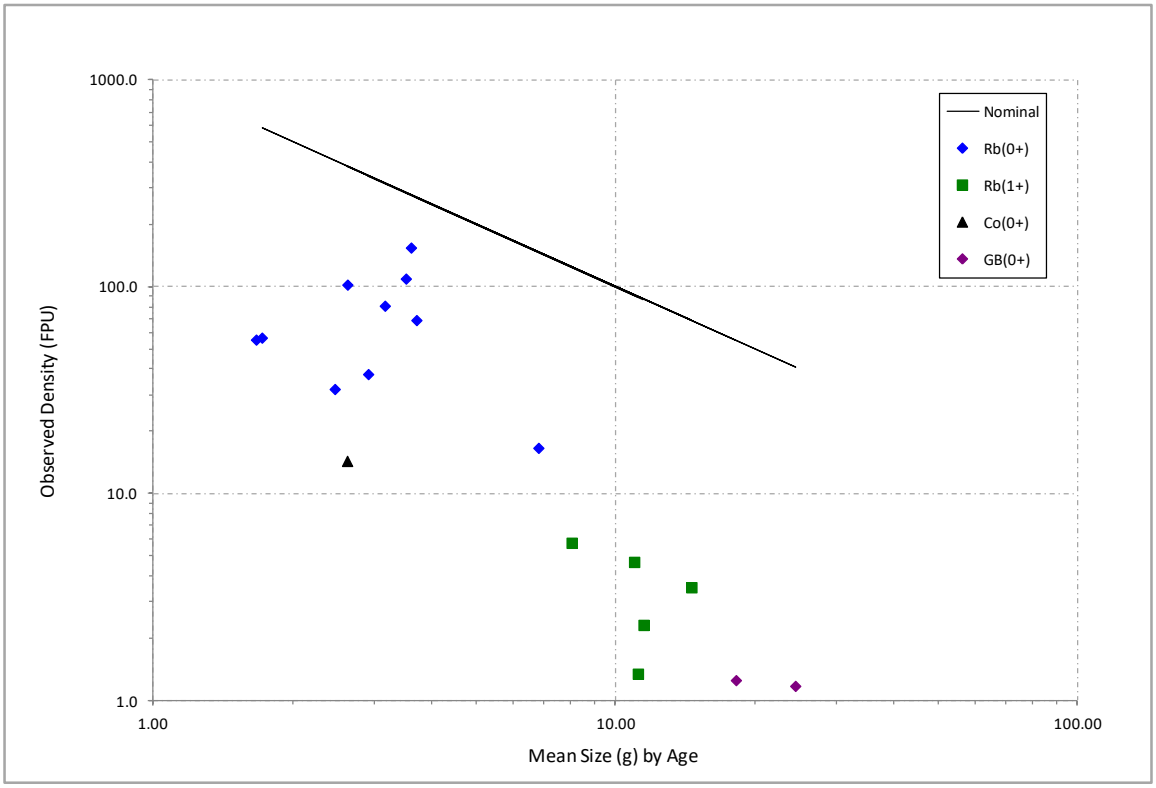

Figure 15. Allen plot of local fish density (unadjusted) versus size for discrete habitats electrofished (10 sites) in the Cowichan River (2018). Predicted biomass per age is 1000 g/100 m^2.

Acknowledgements

The contributions of the FFSBC with additional partnership funding provided by the Province of British Columbia, Habitat Conservation Trust Foundation and the Living Rivers- Georgia Basin/Vancouver Island have made this work possible.

The efforts of BCCF crewmembers who participated in snorkel surveys and electrofishing are greatly appreciated, including: Jeramy Damborg, Gary Horncastle, Jennifer Sibbald, Patricia Halinowski, Wayne Page Jr. and James Craig. Isaac Anderton prepared a number of the figures and reviewed a preliminary draft of the report.

APPENDIX A:

PHOTOS: Electrofishing Depletion Estimates

Cowichan River

1. Electrofishing site #1 – Silver Bridge

2. Electrofishing site #2 – Vimy Road

3. Electrofishing site #3 – Sandy Pool

4. Electrofishing site #4 – Rip-rap corner

5. Electrofishing site #5 - Stoltz

6. Electrofishing site #6- Horseshoe Bend

7. Electrofishing site #7 – Skutz Falls

8. Electrofishing site #8 – Three Firs

9. Electrofishing site #9 – 70.2 Trestle

10.Electrofishing site #10 – Saysell's Riffle

English River

11. Electrofishing site #1 – Hwy 19 A Bridge

12. Electrofishing site #2 – Martindale Road

13. Electrofishing site #4 – Grassy Bank

14. Electrofishing site #5 – Powerlines

15. Electrofishing site #7 – Side Channel Intake

16. Electrofishing site #8- Englishman River Rd.

17. Electrofishing site #9 – Englishman River Falls

18. Electrofishing site #10 – Steelhead Place

Gold River

19. Electrofishing site #1 – Golf Course

20. Electrofishing site #2 – Bridge #1 (In Town)

21. Electrofishing site #3 – High Anglers Trail

22. Electrofishing site #4 – Bridge #2

23. Electrofishing site #7 – Muchalat Bridge

APPENDIX B:

Electrofishing Data To 2018

Englishman River

1998

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	1.36	2.4	5.00	148.6	3%
2	1.08	17.5	67.40	187.1	36%
3	0.7	7.2	9.50	288.7	3%
4	1.43	11.6	15.70	141.3	11%
5	0.71	27.2	85.10	284.7	30%
6	0.95	12.4	12.40	212.7	6%
7	1.19	8.5	9.30	169.8	5%
8	0.65	25.4	33.00	310.9	11%
9	0.53	57.9	75.20	381.3	20%
MEAN	**0.96**	**18.91**	**34.73**		**14%**

1999

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	0.51	6.1	12.30	396.3	3%
2	1.08	12.1	37.80	187.1	20%
3	0.37	46.0	68.70	546.2	13%
4	0.72	32.8	45.60	280.7	16%
5	0.66	30.5	41.20	306.2	13%
6	0.97	28.7	31.60	208.4	15%
7	0.92	17.2	19.50	219.7	9%
8	0.56	59.3	59.30	360.9	16%
9	0.59	60.8	96.40	342.6	28%
MEAN	**0.71**	**32.61**	**45.82**		**15%**

2000

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.61	12.0	37.09	77.4	48%
2	1.43	9.8	15.83	141.5	11%
3	1.60	1.3	1.65	126.3	1%
4	1.86	8.7	10.48	108.5	10%
5	1.50	5.7	7.81	135.1	6%
6	1.06	9.6	11.08	190.3	6%
7	0.59	2.6	3.93	341.3	1%
8	0.92	10.2	13.52	219.0	6%
9	1.14	44.1	122.11	177.2	69%
MEAN	**1.41**	**11.55**	**24.83**		**18%**

2001

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.54	8.4	21.27	79.5	27%
2	2.21	7.2	10.83	91.6	12%
3	1.12	7.9	15.89	181.0	9%
4	1.03	18.0	25.58	195.7	13%
5	1.20	22.0	30.89	168.2	18%
6	1.15	6.9	11.50	175.2	7%
7	1.39	7.7	8.68	145.7	6%
8	1.75	10.7	21.22	115.4	18%
9	1.07	36.7	86.17	188.6	46%
MEAN	**1.50**	**13.94**	**25.78**		**17%**

2002

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	1.75	13.5	21.24	115.8	18%
2	1.58	16.3	24.09	127.9	19%
3	2.80	2.6	5.46	72.2	8%
4	1.82	5.7	10.49	110.8	9%
5	1.28	28.6	39.21	158.4	25%
6	1.37	28.0	50.26	148.0	34%
7	1.18	14.8	21.13	171.0	12%
8	1.62	5.0	11.14	124.4	9%
9	0.79	36.2	51.05	257.1	20%
MEAN	**1.58**	**16.73**	**26.01**		**17%**

2003

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.1	10.6	22.6	65.5	34.5%
2	2.7	12.5	14.0	74.9	18.7%
3	2.1	7.2	10.8	95.7	11.2%
4	2.6	2.2	4.5	77.3	5.9%
5	2.2	6.9	10.5	93.4	11.3%
6	2.3	18.0	30.6	86.5	35.3%
7	1.3	10.2	12.1	152.9	7.9%
8	1.5	8.4	13.6	133.5	10.2%
9	1.7	19.7	35.8	119.3	30.0%
MEAN	**2.17**	**10.62**	**17.15**		**18.3%**

2004

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.92	25.27	49.36	44.1	112%
2	1.72	9.00	12.26	117.3	10%
3	1.44	5.68	7.26	140.0	5%
4	2.07	17.18	50.55	97.7	52%
5	2.21	3.94	5.80	91.6	6%
6	1.31	7.25	16.51	154.6	11%
7	1.87	3.78	4.07	108.3	4%
8	1.40	1.05	1.54	144.4	1%
9	1.27	20.39	38.60	158.7	24%
MEAN	**1.91**	**10.39**	**20.66**		**25%**

2005

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.04	12.97	18.16	66.4	27%
2	3.32	4.15	4.61	60.9	8%
3	2.08	5.92	9.85	97.4	10%
4	3.72	6.50	7.91	54.4	15%
5	2.49	8.48	18.90	81.1	23%
6	2.26	16.53	28.17	89.4	32%
7	2.77	16.67	25.29	73.0	35%
8	2.21	9.31	11.81	91.6	13%
9	1.43	28.94	44.58	141.2	32%
MEAN	**2.59**	**12.16**	**18.81**		**21%**

2006

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	1.26	25.41	55.59	160.0	35%
2	2.17	7.92	11.52	93.0	12%
3	2.44	5.97	11.07	82.7	13%
4	1.93	17.41	41.91	104.5	40%
5	1.38	17.75	30.49	146.0	21%
6	1.39	45.89	136.74	145.3	94%
7	2.03	11.56	17.96	99.5	18%
8	2.09	15.00	22.94	96.7	24%
9	1.31	57.58	99.69	154.5	65%
MEAN	**1.78**	**22.72**	**47.55**		**36%**

2008

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.18	7.94	31.81	63.5	50%
4	2.70	1.14	1.40	74.9	2%
5	1.15	19.89	30.92	175.7	18%
7	1.92	9.46	12.74	105.1	12%
8	1.34	3.11	5.08	151.0	3%
9	1.51	19.47	42.14	134.1	31%
MEAN	**1.97**	**10.17**	**20.68**		**19%**

2011

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	1.27	12.13	23.12	159.1	15%
2	0.99	17.11	27.80	203.8	14%
3	1.91	2.74	3.82	105.8	4%
4	2.15	23.83	40.80	94.1	43%
5	1.29	32.41	46.15	156.6	29%
6					
7	2.00	6.07	11.19	101.2	11%
8	0.94	13.95	21.35	215.6	10%
9	1.21	62.40	185.57	166.5	111%
MEAN	**1.47**	**21.33**	**44.98**		**30%**

2012

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.36	18.34	28.26	85.7	33%
2	1.22	24.02	32.39	165.1	20%
3	2.71	12.35	15.84	74.6	21%
4	2.87	24.30	40.64	70.5	58%
5	1.80	1.38	2.56	112.3	2%
6					
7	1.28	16.01	23.51	158.2	15%
8	0.93	25.04	48.06	216.4	22%
9	1.43	18.37	43.33	141.6	31%
MEAN	**1.82**	**17.48**	**29.32**		**25%**

2013

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.46	20.31	30.08	82.3	37%
2	1.17	18.37	22.43	172.8	13%
3					
4	4.01	22.58	57.48	50.4	114%
5	2.68	29.04	43.68	75.3	58%
6					
7	1.51	17.57	22.19	133.4	17%
8	1.29	29.87	52.38	156.4	34%
9	1.72	38.21	69.14	117.7	59%
10	1.52	14.70	22.78	132.9	17%
MEAN	**2.05**	**23.83**	**40.02**		**47%**

2014

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	5.80	1.30	1.81	34.8	5%
2	1.49	10.57	16.82	135.8	12%
3					
4	4.85	10.51	12.64	41.7	30%
5	3.64	4.83	6.21	55.5	11%
6					
7	2.51	3.08	3.86	80.4	5%
8	2.75	17.39	29.37	73.4	40%
9	2.29	62.40	87.91	88.2	100%
10	3.98	15.87	50.50	50.8	99%
MEAN	**3.41**	**15.74**	**26.14**		**29%**

2015

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	7.11	3.30	6.02	28.4	21%
2	3.52	21.32	32.41	57.5	56%
3					
4	5.33	19.28	38.92	37.9	103%
5	4.90	38.69	57.55	41.3	139%
6					
7	5.78	7.42	14.00	35.0	40%
8	3.69	13.72	24.66	54.7	45%
9	4.05	26.94	46.35	49.9	93%
10	3.92	9.51	18.50	51.6	36%
MEAN	**4.79**	**17.52**	**29.80**		**71%**

2016

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	5.59	20.35	52.44	36.2	145%
2	3.73	17.59	27.44	54.1	51%
3					
4	5.65	17.57	34.78	35.8	97%
5	4.33	12.05	16.14	46.7	35%
6					
7	2.99	9.74	14.16	67.7	21%
8	2.87	15.15	21.40	70.4	30%
9	2.16	24.86	46.45	93.7	50%
10	1.73	22.25	32.76	116.7	28%
MEAN	**3.63**	**17.44**	**30.70**		**61%**

2017

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	0.10	22.12	27.84	2119.4	1%
2	3.94	4.53	12.07	51.2	24%
3	4.11	6.11	10.86	49.1	22%
4	3.07	13.06	23.10	65.9	35%
5	1.99	19.95	25.64	101.4	25%
6	2.18	12.74	37.95	92.8	41%
7	1.61	19.14	35.27	125.7	28%
8	1.99	34.94	57.39	101.4	57%
MEAN	**2.37**	**16.57**	**28.77**		**29%**

2018

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	3.03	5.93	6.81	66.7	10%
3	3.29	11.32	16.21	61.4	26%
4	2.21	14.90	26.10	91.6	28%
5	1.93	27.58	33.11	104.6	32%
6	2.22	13.25	69.44	91.2	76%
7	1.40	22.90	47.77	143.9	33%
8	1.97	16.07	29.38	102.8	29%
MEAN	**2.29**	**15.99**	**32.69**		**33.52%**

Cowichan River

1999

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	-	-	-	-	-
2	2.91	30.1	41.20	343.6	12%
3	-	-	-	-	-
4	-	-	-	-	-
5	2.71	29.2	49.40	369.0	13%
6	-	-	-	-	-
7	-	-	-	-	-
8	4.65	31.9	55.90	215.1	26%
9	-	-	-	-	-
10	2.62	33.2	57.20	381.7	15%
MEAN	3.2	31.1	50.9		17%

2000

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	4.34	9.9	10.73	230.3	5%
2	2.13	20.8	28.55	470.3	6%
3	3.79	43.6	71.92	264.1	27%
4	4.52	53.1	85.27	221.4	39%
5	2.28	8.9	10.85	439.3	2%
6	2.97	59.8	101.47	337.1	30%
7	3.17	85.2	128.47	315.7	41%
8	3.57	43.4	57.36	280.4	20%
9	2.20	120.0	216.11	455.3	47%
10	1.88	39.9	71.27	533.1	13%
MEAN	3.1	48.5	78.2		23%

2001

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.28	8.9	16.59	438.0	4%
2	1.67	28.6	30.15	599.4	5%
3	3.66	40.2	71.68	273.5	26%
4	3.33	66.5	86.80	300.0	29%
5	2.42	16.2	29.05	413.2	7%
6	4.96	11.0	12.87	201.6	6%
7	3.03	16.4	17.71	330.0	5%
8	2.63	31.3	74.51	379.7	20%
9	1.84	84.5	119.44	544.5	22%
10	2.47	53.3	75.99	405.0	19%
MEAN	2.8	35.7	53.5		14%

2002

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.00	1.3	1.59	500.0	0%
2	2.36	41.8	94.74	424.1	22%
3	2.97	46.7	61.73	337.2	18%
4	3.48	78.4	176.90	287.7	61%
5	2.35	80.3	127.69	426.0	30%
6	2.40	76.0	137.67	416.8	33%
7	1.99	95.2	179.84	503.0	36%
8	8.23	2.8	3.72	121.6	3%
9	3.97	3.6	5.14	251.6	2%
10	2.43	43.6	76.11	412.0	18%
MEAN	3.2	47.0	86.5		22%

2003

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.98	15.4	17.19	335.5	5%
2	4.08	32.9	58.42	245.1	24%
3	-	-	-		
4	-	-	-		
5	3.89	43.1	59.63	257.2	23%
6	3.39	44.0	62.70	294.6	21%
7	3.68	79.3	128.21	271.7	47%
8	3.08	107.2	204.70	324.3	63%
9	2.64	72.7	86.84	379.1	23%
10	1.35	48.5	55.31	739.2	7%
MEAN	3.1	55.4	84.1		27%

2004

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.30	26.6	33.68	435.6	8%
2	2.17	83.2	142.97	460.1	31%
3	2.11	32.9	50.13	474.2	11%
4	2.50	48.9	62.87	399.7	16%
5	3.41	37.2	89.33	292.9	30%
6	2.82	91.6	244.76	354.3	69%
7	2.60	59.2	94.52	383.9	25%
8	3.07	38.3	79.66	325.7	24%
9	2.38	129.8	192.36	420.1	46%
10	2.30	54.4	65.42	434.6	15%
MEAN	2.6	60.2	105.6		27%

2005

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.07	11.4	26.21	325.5	8%
2	2.83	53.4	107.20	353.2	30%
3	2.28	40.8	53.62	439.4	12%
4	3.51	30.1	59.79	284.9	21%
5	3.25	21.5	47.02	307.8	15%
6	4.99	57.9	180.67	200.6	90%
7	2.71	31.0	48.15	369.3	13%
8	4.02	40.3	86.07	248.7	35%
9	3.44	60.2	133.45	290.5	46%
10	4.05	74.3	113.05	246.8	46%
MEAN	3.4	42.1	85.5		32%

2006

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.01	20.4	32.89	332.8	10%
2	2.00	94.0	397.14	499.3	80%
3	2.46	101.9	234.94	406.3	58%
4	1.73	124.3	199.03	578.6	34%
5	2.13	122.0	265.35	469.0	57%
6	3.23	120.8	225.12	309.8	73%
7	2.66	114.9	132.23	375.4	35%
8	3.56	51.9	147.66	280.6	53%
9	3.50	274.6	407.49	286.0	142%
10	1.80	50.1	86.41	554.3	16%
MEAN	2.6	107.5	212.8		56%

2008

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1					
2	3.53	26.8	71.87	283.4	25%
3	2.80	135.1	377.13	357.0	106%
4					
5	4.24	28.7	89.43	236.1	38%
6	2.07	121.4	181.62	482.0	38%
7	2.45	79.0	196.14	407.6	48%
8					
9	3.89	122.4	291.81	257.1	114%
10	1.98	37.0	140.08	505.3	28%
MEAN	3.0	78.6	192.6		57%

2009

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.04	5.4	11.66	329.4	4%
2	2.20	54.3	136.41	454.3	30%
3	1.56	139.1	209.45	639.8	33%
4	2.94	72.1	130.23	340.6	38%
5	2.98	95.2	129.10	335.5	38%
6	2.50	128.0	193.41	400.3	48%
7	2.02	112.5	249.42	494.2	50%
8	3.98	49.5	105.35	251.5	42%
9	2.42	73.9	92.74	412.5	22%
10	3.16	86.1	138.70	316.8	44%
MEAN	2.7	81.6	139.6		35%

2010

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.32	31.1	67.08	430.5	16%
2	2.79	42.8	168.27	357.8	47%
3	2.01	72.0	155.96	498.4	31%
4	4.12	59.4	114.73	242.8	47%
5	3.42	39.8	90.39	292.5	31%
6	3.01	159.1	291.29	331.7	88%
7	2.16	156.4	328.63	464.0	71%
8	4.95	131.7	190.47	202.1	94%
9	2.70	183.7	388.34	370.3	105%
10	1.25	48.7	96.49	799.7	12%
MEAN	2.9	92.5	189.2		54%

2011

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.36	15.0	19.75	422.8	5%
2	1.39	65.5	112.66	717.7	16%
3	1.37	165.3	253.54	728.6	35%
4	2.21	102.0	213.64	451.7	47%
5	1.37	306.2	591.51	728.5	81%
6	1.91	153.7	298.03	522.2	57%
7	1.67	272.8	596.51	598.8	100%
8	2.29	308.0	513.26	437.0	117%
9	1.99	345.3	727.81	503.4	145%
10	1.74	63.3	129.58	573.6	23%
MEAN	1.8	179.7	345.6		62%

2012

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.11	4.6	6.71	321.4	2%
2	2.71	102.8	219.48	369.7	59%
3	1.34	210.6	516.43	744.5	69%
4	1.98	111.9	223.86	504.8	44%
5	1.68	185.1	453.92	596.3	76%
6	2.53	141.9	299.06	395.1	76%
7	2.18	187.8	470.43	459.7	102%
8	1.75	262.3	378.01	572.1	66%
9	1.94	259.0	401.42	514.2	78%
10	1.94	159.6	308.11	514.2	60%
MEAN	2.1	162.6	327.7		63%

2013

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.28	6.0	6.77	439.2	2%
2	1.33	126.4	204.40	750.2	27%
3	1.01	296.1	402.13	990.0	41%
4	1.99	56.5	74.93	502.6	15%
5	1.38	188.2	325.94	725.4	45%
6	1.92	153.4	269.07	522.1	52%
7	1.11	346.1	510.29	898.1	57%
8	1.37	318.6	554.84	730.0	76%
9	1.78	226.5	332.82	561.0	59%
10	1.37	49.7	91.54	729.9	13%
MEAN	1.6	176.8	277.3		39%

2014

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	N/A	N/A	N/A	N/A	N/A
2	3.85	40.7	62.81	259.8	24%
3	2.18	116.8	144.47	459.2	31%
4	5.83	22.8	42.14	171.5	25%
5	3.36	94.1	170.01	297.5	57%
6	3.08	122.0	326.12	324.9	100%
7	2.77	105.2	166.05	360.7	46%
8	2.50	263.5	367.05	400.4	92%
9	2.65	147.8	249.92	377.8	66%
10	2.58	21.7	37.74	387.1	10%
MEAN	3.2	103.8	174.0		50%

2015

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	N/A	N/A	N/A	N/A	N/A
2	3.43	90.7	244.30	291.4	84%
3	2.68	138.5	239.69	372.8	64%
4	3.36	72.8	108.26	298.1	36%
5	2.35	200.6	348.80	425.2	82%
6	2.06	165.7	326.17	484.7	67%
7	2.54	140.9	243.97	394.0	62%
8	3.04	262.0	343.34	328.5	105%
9	3.17	135.2	240.18	315.3	76%
10	2.45	65.9	127.69	408.6	31%
MEAN	2.8	141.4	246.9		68%

2016

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	7.62	6.1	11.48	131.3	9%
2	5.79	45.0	70.46	172.6	41%
3	3.27	56.0	70.78	305.9	23%
4	8.03	27.4	32.84	124.5	26%
5	6.40	34.4	86.14	156.3	55%
6	4.13	152.8	268.61	242.0	111%
7	4.82	145.9	320.22	207.6	154%
8	4.18	217.6	495.04	239.2	207%
9	3.68	150.6	247.64	271.8	91%
10	2.99	103.3	203.65	334.8	61%
MEAN	5.1	93.9	180.7		78%

2017

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.84	2.0	3.23	260.6	1%
2	4.48	5.2	9.68	223.4	4%
3	2.23	48.0	80.37	449.3	18%
4	3.48	11.6	16.22	287.3	6%
5	2.99	70.3	127.44	334.7	38%
6	2.79	145.5	317.72	358.7	89%
7	1.88	155.5	281.62	530.7	53%
8	3.36	100.4	183.39	297.5	62%
9	2.03	209.8	368.35	491.8	75%
10	2.10	112.4	156.72	475.2	33%
MEAN	2.9	86.1	154.5		38%

2018

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	6.80	16.6	21.16	147.0	14%
2	2.91	37.8	134.77	343.4	39%
3	1.67	55.5	74.41	600.3	12%
4	2.47	32.0	47.98	405.6	12%
5	2.63	102.4	223.49	380.8	59%
6	3.70	69.0	113.17	270.0	42%
7	3.16	81.0	215.65	316.0	68%
8	3.60	154.7	280.82	277.4	101%
9	3.51	109.5	173.27	284.5	61%
10	1.71	56.8	112.49	583.2	19%
MEAN	3.2	71.5	139.7		43%