Stave River Smolt Imprinting and Adult Enumeration Project: Year 4 2011/2012

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Executive Summary

The Stave River is a large tributary of the Fraser River with a watershed that encompasses an approximate area of 1,140 km^2. Hydroelectric generation has occurred within the watershed for approximately 90 years. The creations of these large hydroelectric dams have subsequently reduced the anadromous length of the Stave River from 8 km to less than 2 km. Ultimately, all of the original Stave River salmonid populations suffered, but the greatest decrease in numbers has been demonstrated by the steelhead trout (*Oncorhynchus mykiss*). With the native steelhead stocks in the Stave River decimated, the decision was made to turn the remaining anadromous length of the river into a purely hatchery raised (augmented) system. Steelhead progeny from the Chilliwack River and other Lower Mainland rivers were used to recreate a sport fishery on the Stave with hopes that some fishing pressure would be taken off of the wild steelhead stocks remaining in other Lower Mainland systems. However, low adult returns have plagued the river since steelhead stocking began in the late 1980's. The most reasonable hypothesis has revolved around the idea that the stocked steelhead smolts are not properly imprinting during their short stay in the Stave River after their release. To combat this problem and test this hypothesis, BC Hydro's Fish and Wildlife Compensation Program in partnership with the BC Conservation Foundation, Freshwater Fisheries Society of BC, Kwantlen First Nation, and the BC Ministry of Forest, Land, and Natural Resources Operations have partnered together to implement the Stave River Steelhead Smolt Imprinting Project. In this, the fourth consecutive year of this project, a net pen was used to raise juvenile steelhead in Hayward Lake prior to smolting. After approximately 40 days of imprinting, the steelhead smolts averaging 74 grams and were transported and released below Ruskin Dam and all components of the net pen were removed from the lake. An unknown portion of adult steelhead from the 2010 brood year (Year 3 Project) was expected to start returning to spawn in the winter of 2011 through spring 2012. A snorkel survey in combination with angler creel surveys were used to generate a relative estimation of adult return rates between net pen held steelhead adults and standard hatchery stocked steelhead adults. Snorkel surveys were primarily used to locate adult steelhead to subsequently increase angler success rates. Preliminary adult enumeration results calculated through the use of angler surveys have shown that there was a higher incidence of maxillary clipped adult steelhead caught during the 2010/2011 and 2011/2012 seasons than standard hatchery clipped adult steelhead. The percentage of steelhead type capture success was based on the total amount of smolts released compared the number of and type of adult steelhead caught and identified by anglers. In order to gauge the validity of the success rates between the two stocking techniques continued analysis of the adult catch rate should continue over the next year or two, in order to complete the data set.

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1. Introduction

Steelhead (*Oncorhynchus mykiss*) smolts have been annually released into the lower Stave River since 1986, with mixed results. The Stave River is currently ranked fifth in the region as a destination for steelhead anglers with approximately 563 angler days in 2009-10. Despite the annual stocking of approximately 20,000 steelhead smolts, success is poor at 0.099 hatchery fish per angler day (2009-10 Steelhead Harvest Analysis, MoE data on file). Juvenile steelhead to be stocked in the Stave River are currently hatched and held at both the Fraser Valley Trout Hatchery (FVTH) and Allco Park Fish Hatchery (ARCC), and not raised on Stave River water until released into the Stave as out-migrating smolts. The Stave River has an anadromous length of less than 3 km. This short river length, which limits rearing area and imprinting time, is theorized to be a contributing factor in the low return rates of adult steelhead.

The main objectives of the project was to re-install the portable net pen, purchased in 2008/2009, stock, feed, and monitor the hatchery-reared steelhead in Hayward Lake, and release the smolts into the Lower Stave with an increased rate of imprinting, leading to higher return rate and angling success for returning adult steelhead. The steelhead smolts were placed in the Hayward Lake net pen, after initial rearing at FVTH and ARCC, for approximately 40 days (April –May) to acclimatize to the Stave River/Hayward Lake water before being transported and released into the lower Stave River.

The funds received by BC Hydro – Fish and Wildlife Compensation Program (FWCP) were used in the set-up and initiation of the net pen project and in the continuation (this year) of the creel project. Partnership support by way of in-kind labour was received by the Freshwater Fisheries Society of BC (FFSBC) which was used in the monitoring, placement, and removal of the net pen and fish, the BC Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) for technical support, and community volunteer support to feed the fish two times a day. The steelhead smolts held in the net pen were differentially marked, adipose and right maxillary (adipose and left maxillary in the previous year), to enable evaluation of returns compared to a control group of smolts (adipose clip only) not held in the pens and stocked by current methods (i.e. direct release to the lower river from hatchery holdings).

With relationships forged between project partners in the initial project year 2007/2008, consultation with stakeholders for year four was easily accomplished and all stages of the project were completed.

2. Goals and Objectives

2.1 Project Objectives

Footprint issue/limiting factors– There are a number of limiting factors in the Stave River system that effect fish diversity and production. The obvious one is the blocked access to historic habitats. Anadromous and migratory resident populations of fish have been blocked out of river habitat occupied by Hayward Lake for nearly 76 years. Over 2 km of habitat such as spawning beds, rearing, and over wintering areas have been lost or reduced due to the dam locality and operations. Reductions in flow due to water diversion, reservoir flooding, and operating flows have also increased the footprint. The amount and types of habitat below the dam have been reduced; there is a noticeable lack of sediment recruitment and large woody debris collection downstream of the dam. There is a reduction in the tributary access for spawning and migrating fish, mainly due to the drawdown regimes of the reservoirs. In addition, the Stave River is highly populated with coarse fish that compete against the resident salmonid species.

Value added benefits –Allowing the set-up and initiation of this project will increase angling and recreational opportunities for the public and at the same time aid in the rehabilitation of winter run steelhead on the Stave River. The results gathered through this research will inform fisheries managers to help with the future direction of hatchery release techniques for steelhead used on the lower Stave River.

3. Study Area

3.1 Habitat attributes and/or biophysical description

The Stave River is a 5th order stream which drains an area of 1,140 km^2 of the Coastal Mountain range in southwestern BC (Lill 2002), and one of the larger tributaries in the lower Fraser watershed. The Stave Falls and Ruskin hydroelectric dams have regulated its flow since 1911. The Stave River historically supported winter steelhead and presently supports several other species of anadromous salmonids.

3.2 The specific location of the project site

The project is located on Hayward Lake, which is located 15 km east of Maple Ridge, and is part of the Alouette-Ruskin-Stave BC hydro generating system. The project specifically deals with fishery issues in the short anadromous reach of the Stave River downstream of Hayward Lake hydro reservoir. The BC Hydro Power Authority through the Stave Falls and Ruskin Dams regulates river flow. The Stave River, downstream of the Hayward reservoir, extends 2.8 km to its confluence with the Fraser River. Historically, only the lower 8.8 km of this river were accessible to anadromous salmon due to a number of natural barriers (BC Hydro 2000). The construction of Ruskin Dam and the Hayward Reservoir resulted in the loss of several kilometres of usable spawning and juvenile rearing habitat.

Specifically, the net pen was moored on the northwest shore of Hayward Lake (Figure 1). On site consultation meetings and phone conversations between BC Hydro, MFLNRO, and BC Conservation Foundation (BCCF) staff, it was agreed upon that an existing fenced and gated boat house moored at Hayward Lake recreational park was the perfect location to place the net pen. The site allowed for easy access for installation and removal of the net pen and fish as well as a safe platform to conduct feeding. Also, with BC Hydro Park operations staff stationed at the net pen location all day and the park closing every night, the chances of vandalism to the net pen and fish were minimized greatly.

Figure 1: Overview map highlighting specific locations and local landmarks used during the net pen project.

4. Methods

4.1 Project Rationale

The historic steelhead stock primarily used in the enhancement of the Stave River has come from steelhead smolts raised at varied locations, which include Chilliwack River, Inch Creek, Fraser Valley Trout, and Allco fish hatcheries. For the most part the juvenile steelhead are reared in hatcheries that utilize localized river and/or groundwater as their primary rearing medium. From there, hatchery steelhead juveniles are transported to another water body and subsequently released. This rearing of juveniles on none native water source and short anadromous length of the Stave River has been theorized to negatively affect the homing ability of the juveniles and possibly be a factor resulting in the low adult return rates experienced to date. To combat this problem, the use of localized juvenile steelhead produced from brood collected from the Stave River were hatched and reared to near smolt size (40-60 grams) at the FVTH and ARCC. The main difference between FVTH and the other hatcheries historically used to rear Stave River steelhead is the water source. FVTH is a groundwater based rearing facility that stocks trout in lake and river system across Region 2 and 3, meaning the fish raised in this facility aren't imprinted to a specific water source. However, prior to placement in Hayward Lake, Stave steelhead juveniles are held and fed at ARCC, which unfortunately uses Alouette River water as the main fish medium in the hatchery. The placement of these fish in the Hayward Lake net pen will hypothetically imprint the steelhead smolts to Stave River water and will increased their homing ability, thus increasing adult returns rates. All 2011/2012 net pen reared fish were marked with both an adipose and a right maxillary clip. Conversely, fish released directly to the lower Stave through hatchery releases will only have an adipose clip (Figure 2. below).

Figure 2. Pictures highlighting the different marks that are applied to hatchery steelhead smolts 1) adipose only and 2) adipose/maxillary prior to release into Stave River.

In the previous years' project (2008/09), net pen reared fish received an adipose clip and a left maxillary clip. The purposes of this additional differential clip is to accurately differentiate between returning hatchery adults from the net pen compared to smolts from the existing annual stocking program, in addition to being able to differentiate between fish stocked in 2008/09 (right max. clip), 2009/10 (left max. clip), 2010/2011 (right max clip), and 2011/2012 (right max clip). Unfortunately, due to some miss communication the smolts stocked in 2011 also received a right maxillary clip, not the scheduled left maxillary clip.

4.2 Net Pen Placement

The net pen is constructed from plastic moulded sections which are secured to one another using large rubber grommets. This design creates a very stable platform and one capable of withstanding considerable weight and the stressors from environmental elements. In addition, the sections are lightweight and can be easily moved by hand, making for very little effort in assembling, disassembling and storing the net pen. The overall dimensions of the net pen are 20 feet by 18.5 feet, therefore, a net measuring 20 feet wide by 20 feet long by 20 feet deep is used to house the imprinting smolts. To mitigate against fish losses due to outside predation, the net pen is covered by fine plastic netting.

After consultation with BC Hydro, the same net pen location that was utilized during the 2008/2009 project was again used in the spring of 2011 for the 2011/2012 project. With help from FVTH staff, the net pen segments were transported from the FVTH in Abbotsford to the Hayward Lake recreation site. Assembling, disassembling, and mooring of the net were completed by BCCF fisheries technicians with help from FVTH staff. The dock sections are stored at FVTH and all the required hardware is stored at BCCF to prevent the non-seasonal use by other organizations.

4.3 Monitoring

Monitoring of this project consists of two components. First, the steelhead smolts will be monitored while in freshwater (in the net pens) to ensure that predators such as herons and otters were not able to access the fish. Steelhead smolts were placed into the pens between late March and early April and were fed twice a day. Along with the daily feeding, observations of mortalities and feed rate were recorded in order for FFSBC staff to accurately gauge fish numbers and growth rates. Periodic fish sampling or sample counts were performed at various times to monitor the health and weight gain of the pen held steelhead smolts. Sample counts aid FFSBC staff in determining the timing for release, with the optimal weight range for release being between 70-100 grams.

The second step of monitoring was the initiation of an angler's creel survey along with snorkel surveys to collect data on returning adult steelhead numbers to the Stave River. In 2011/2012 BCCF staff members completed a roving two zone creel survey. Because the anadromous length and area of the Stave River is so small the two zone methodology was the best option. The two zones were broken into east and west sides of the river starting from Ruskin Dam and ending 1.5 km downstream (Figure 3. below).

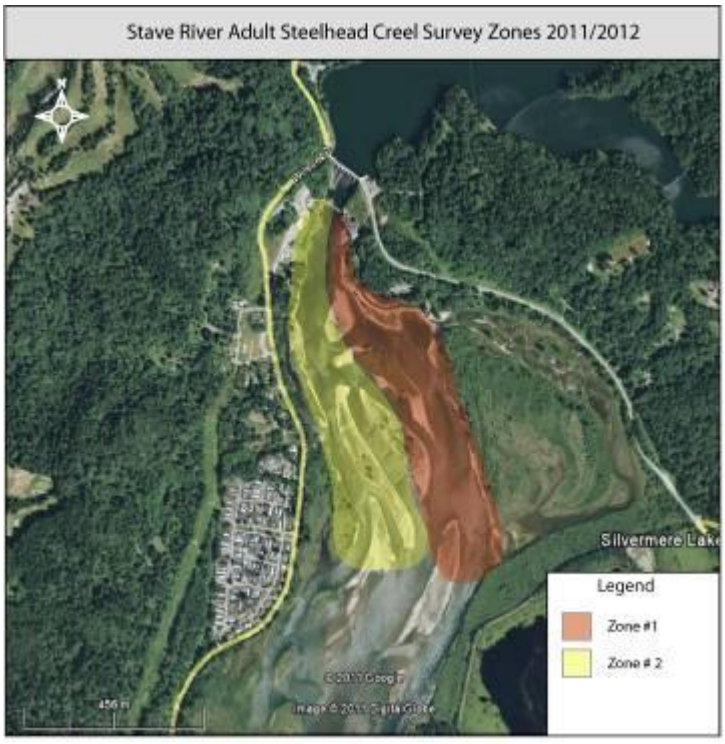

Figure 3. Spatial map of the Stave River illustrating the general location of the 2 zones of the 2010/2011 creel survey.

The surveys were completed during the peak steelhead return time for the Stave River (January-April). The creel survey was administered by BCCF technicians and completed by anglers on voluntary basis and was designed to take less than 5 minutes to complete. The most important information collected from anglers was the amount of time fished and the number and type (hatchery, wild, and hatchery max clip) steelhead hooked and landed. Brood-stock anglers, anglers that volunteer to collect adult steelhead for hatchery production, were given DNA sampling kits to use when capturing adipose and maxillary clipped fish. As well, to possibly intercept early returning fish prior to brood stock collection, DNA sampling kits were handed out to certain anglers that are known to heavily fish the Stave River each winter for steelhead. The kits included all the utensils, equipment, and written instructions needed to take proper fish measurements and scale and DNA samples (Figure 4).

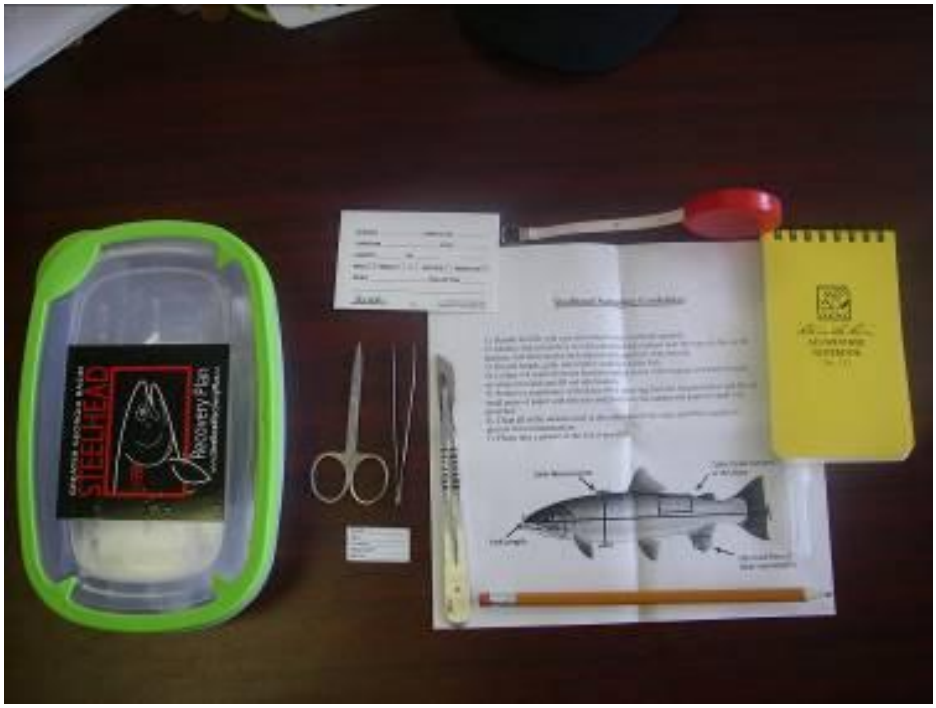

Figure 4: DNA sampling kit handed out to Stave River brood stock anglers to record evidence of returning net pen fish.

Anglers were also asked to get photo documentation of the captured fish to show the differentially marked maxillary clips (Figure 5). The secondary mark will enable researchers to differentiate between the net pen fish and regularly stock steelhead. In order to evaluate the success of this type of project a data set of snorkel survey counts and angler creel information should be collected for a 4-5 year period.

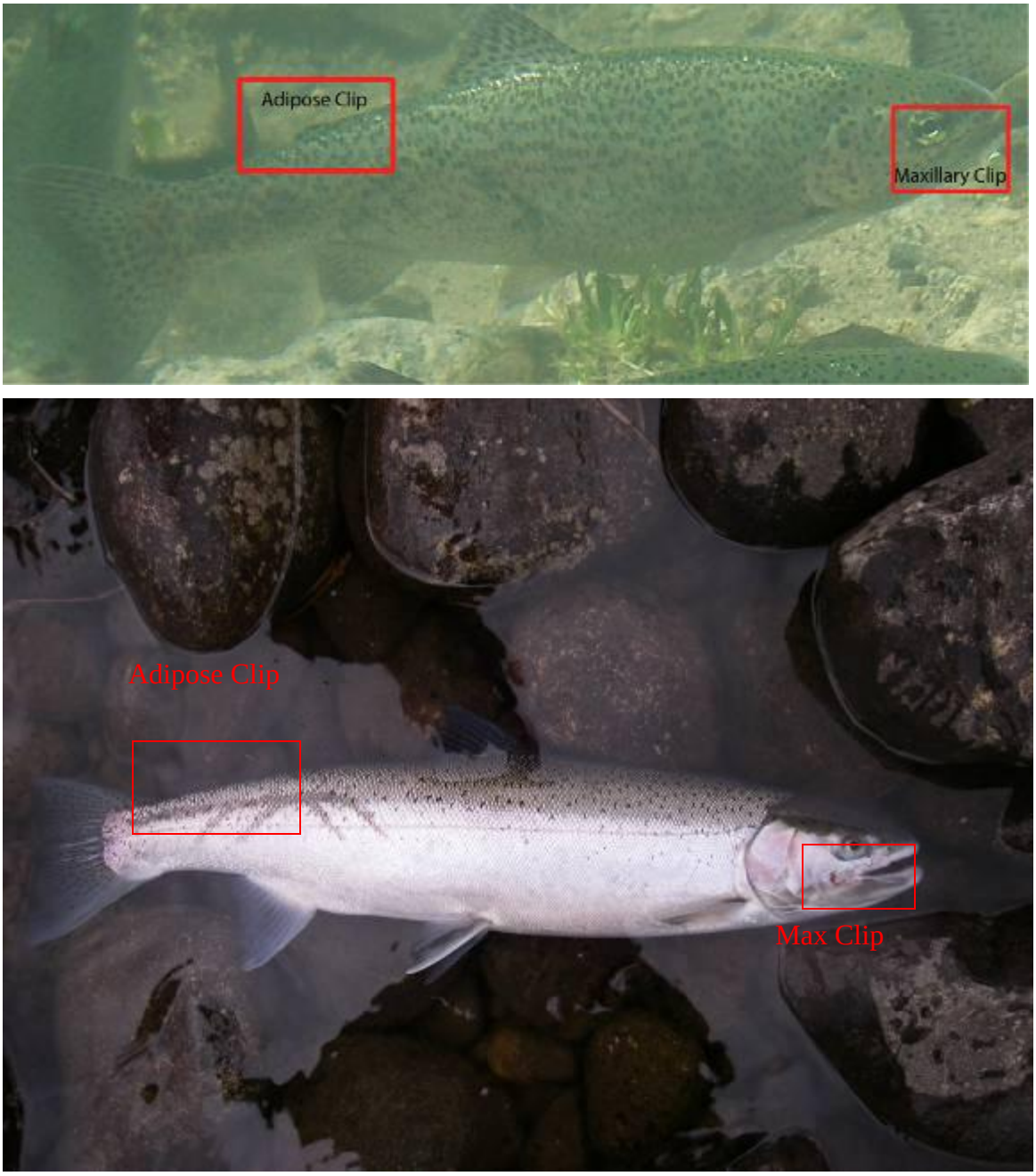

Figure 5: Picture of a steelhead smolt and adult highlighting the general location of the adipose and maxillary clips given to Stave River net pen smolts.

After the completion of snorkel survey in 2010/2011 it was apparent that it would be very difficult for observers to positively identify max clipped fish from regular adipose clipped and wild fish. So, for 2011/2012 snorkel surveys were used to locate adult steelhead to increase angler catch efficiency.

4.4 Creel Methods

The 2012 angler creel survey was a duplication of the 2011 survey which was modeled on guidelines used by the FFSBC during a 2002 survey conducted during a six week opening on the Coquihalla River for summer steelhead.

This survey used the same AM/PM and weekday/weekend strata river zones as the 2011 survey, and chose random sampling dates and start zones for each stratum (Appendix 1). Calculations for analysis of data were duplicated from Miyazaki and Harper (2011). This survey followed the design of a roving-roving random-access stratified survey (Bernard et al, 1998). This consisted of 2 strata; weekend AM (WEAM) and weekday AM (WDAM), covering the daylight period (approx. 6:00am to 12:00pm). The AM stratification accounts for the differences of effort over the course of a typical steelhead angling day. It also allows for efficient coverage of a typical steelhead angling day using a normal work shift of eight hours. AM surveys began around 6:00 AM and lasted until 12:00 PM. Day class (weekend/weekday) stratification accounted for expected weekday effort biases. Approximately 80% of total sampling was scheduled on weekdays and 20% during the weekends. BCCF tasked a BCIT student with the completion of the weekend surveys, unfortunately less weekend surveys were completed than was originally hoped. The survey schedule was altered in the last four weeks of the survey to adapt to a shortage of staff. One or two surveyors were conducting a creel once a week and another on the weekends.

Table 1: Distribution of surveys as a percent of the total number of weekend and weekday surveys, and AM and PM surveys

Survey Type	% of Total Surveys Conducted	Survey Type and Time	% of Weekend/Weekday
Weekday Survey	89%	Weekend AM	89%
Weekend Survey	11%	Weekday AM	11%

Total # of Surveys	19	Total # of Possible Survey Times	119

4.5 Effort Estimate

Angling effort for each angler was determined by the total number of hours angled on a particular survey. Total effort per survey for each survey strata type was measured for each two-week period. The typical return timing for adult winter steelhead was analysed in two-week periods to represent times of similar weather, temperature, and water conditions. A small number of data entries meant it was not possible to analyse shorter periods.

i. Effort per survey type
Fishing effort for each survey type was determined by multiplying the number of anglers by the number of hours fished divided by the number of surveys conducted of a survey type for each two week period. Since a survey could be conducted at any time during the anglers trip, the surveyed 'hours angled' was

considered the mid-point of that anglers trip. Total effort per survey for each survey type (WDAM and WEAM) was measured for each two-week period. This calculation accounts for the effort of anglers observed but not surveyed.

Effort per survey = $\frac{\text{[\# anglers · \# hours fished (WDAM Jan 1-15)]}}{\text{[\# surveys conducted (WDAM Jan 1-15)]}}$

ii. Expanded effort

Expanded effort was calculated by multiplying the average fishing effort for each survey type by the number of possible surveys of that type in the two week period. Effort across all survey types was then summed. For example, for WDAM surveys between Jan 1-15:

Expanded Effort = [Effort (WDAM, Jan 1-15) · # possible surveys (WDAM Jan 1-15 +
[Effort (WEAM, Jan 1-15) · # possible surveys (WEAM, Jan 1-15)]

4.6 Catch Estimate

i. Catch Per Unit Effort (CPUE)

CPUE was determined by dividing the total catch per survey (steelhead hooked plus released) by the total effort for a particular survey type in a particular two-week period.

CPUE = $\frac{\text{[\# fish hooked + released (WDAM Jan 1- 15)]}}{\text{[\# anglers surveyed · \# hours fished (WDAM Jan 1-15)]}}$

ii. Expanded catch per month

The average fishing effort per survey type was multiplied by the CPUE for that survey type to obtain average catch per survey type in a particular month. The expanded monthly catch was determined by multiplying the average catch per survey by the number of possible surveys of that type in the month. Catch across all survey types was then summed. For example, Jan 1-15:

Expanded Catch

[Effort (WDAM Jan 1-15) · # possible surveys (WDAM Jan 1-15) ·
CPUE (WDAM Jan 1-15)] +
[Effort (WEAM, Jan 1- 15) · # possible surveys (WEAM, Jan 1-15) ·
CPUE (WEAM, Jan 1-15)]

iii. Expanded total anglers for a two week period

The total number of anglers observed for that survey type multiplied by the number of possible surveys of that type in that two week period, divided by the number of that type of survey conducted in that two week period. The total for all survey types in that two week period is presented.

5. Results

On March 25, 2011, 11,607 juvenile steelhead averaging 50 grams were transported to the Hayward Lake net pens from the ARCC fish hatchery. Twice per day, the fish were fed 1.5 mm fish feed prills and the net pen was routinely inspected for holes from predators and vandalism. Notes were recorded on the feed rate and any observations such as mortalities. Net pen losses were quite low with a total of 47 fish being lost during the imprinting process. During the holding period no holes were observed in the net, no fish were lost to outside predation, and no human-caused vandalism was observed.

Fish sampling in late-April showed the majority of the fish ranged from 70 to 120 grams. On April 28, 2011 after reaching a collective weight of 74 grams, 11,560 fish, were removed from the pen by FFSBC, BCCF, and FWCP staff and transported to the lower Stave River and released. FFSBC, BCCF, and FWCP staff members were present at the time of the release and did not observe any transport-related mortality.

The second stage of the project began in early January 2012 with the initiation of the adult steelhead monitoring program. As mentioned in the method section, snorkel and roving creel surveys were completed. Snorkel surveys were used not to enumerate the steelhead population, but to identify steelhead holding locations to assist angler success. However, because of poor water clarity over the entire length of the monitoring period only two snorkel surveys were completed. During the two snorkel surveys two adult steelhead were observed, this was primarily due to poor water visibility. Roving creels were completed once a week on either a week day or weekend to gauge angler success on maxillary and adipose clip, adipose only, and wild steelhead. Creel surveys were conducted in the mornings during the typical fishing periods for steelhead angling. When conducting the roving creel, zone two was typically assessed first. This occurred because zone one, the east side of the Stave River, is a BC Hydro controlled recreational park and opens daily at 8:00 am. Because of the park timing we found that most anglers fished zone two first before moving over to zone one after 8 am to continue fishing.

5.1 Temporal Distribution of Angling Effort

During the January 1 to April 12 steelhead angling season, 191 anglers were observed fishing for steelhead on the Stave River. This is almost double the number (103) observed in the 2010/2011 survey (Miyazaki and Harper 2011). Of these observed anglers, 102 were interviewed and spent an estimated 502 hours angling the Stave; each angler spent an average of 4.9 hours angling per day. This could be due to the fact that most anglers interviewed in the morning were spoken to as they were just arriving on the river. Expanding the hours angled to account for anglers who were observed but not interviewed yields an estimated 1,004 hours of total effort. When these numbers were expanded to account for the entire opening, 979 angling days accounted for 7,799 hours of angling on the Stave River (Tables 2 and 3).

Table 2: Distribution of anglers for each two week period expanded from angler interviews.

Temporal Angler Distribution

	Jan 1-15	Jan 20-27	Jan 30 - Feb 7	Feb 17-25	Feb 27-Mar 8	Mar 14-23	Mar 28-Apr 3	Totals
Anglers Interviewed	13	6	19	23	22	8	7	98
Anglers Observed	15	9	43	37	37	17	23	181
Expanded Total Anglers (angler days) per two-week period	75	45	215	168	188	165	120	976

Table 3: Distribution of effort for each two week period expanded from angler interviews.

Temporal Effort Distribution (expanded angler hours)

Survey Type	Jan 1-15	Jan 20-27	Jan 30 - Feb 7	Feb 17-25	Feb 27-Mar 8	Mar 14-23	Mar 28-Apr 3	Totals
WDAM	778.75	597.50	2580.40	577.40	694.00	1237.14	1280.00	7745
WEAM	0	0	0	30.00	24.00	0		54
Total Expanded Effort (hours) per two-week period	**778.75**	**597.5**	**2580.4**	**607.403**	**718**	**1237.14**	**1280**	7799

Angling pressure during the opening was highest during the weeks of Jan 30 – Feb 7, when 19 interviews were conducted and 43 anglers were observed. The expanded results suggest that 215 anglers angled during this time (Table 2). Effort was the lowest in early and mid-January, this was mainly due to timing. Many of the anglers interview believed that winter steelhead run in the Stave typically starts in February and ends in early April.

5.2 Steelhead Catch and CPUE

Anglers spent an estimated 7,779 hours angling during the 2012 Stave River winter steelhead season. There was an estimated 539 adult winter run steelhead caught between Jan 1 and April 3, 2012 (Table 4). Majority of the effort occurred in a two-week period around the end of January through the first week of February. This time period represents the typical fishing period for steelhead throughout the Lower Mainland. As well, during this period of time, other steelhead bearing systems, such as the Chilliwack and Chehalis rivers may have been experiencing adverse water conditions making steelhead fishing less desirable and successful.

Table 4: Distribution of steelhead catch per two-week period for each survey type and total steelhead catch expanded from angler interviews.

Survey type		Jan 1-15	Jan 20-27	Jan 30 - Feb 7	Feb 17-25	Feb 27-Mar 8	Mar 14-23	Mar 28-Apr 3	Totals
WDAM									
	Hatchery	31	19	118	33	16	15	32	263
	Max Clipped Hatchery	0	0	22	0	45	56	38	161
	Wild	0	48	45	23	0	0	0	115
WDAM									
	Hatchery				0	0			0
	Max Clipped Hatchery				0	0			0
	Wild				0	0			0
Total Catch		**31**	**66**	**185**	**55**	**60**	**71**	**70**	**539**

The average CPUE for the entire opening was 0.061 fish. Angling pressure was relatively high on weekday mornings throughout the end of January and into the beginning of February (Tables 3) and showed decreased effort during the beginning of January and March and throughout the middle portions February. Effort seemed to increase into the mid portions of March, but this was primarily due to the influx of fisherman targeting cutthroat with the hopes of steelhead as by-catch (Table 5). The low CPEU during the early part of February and the beginning of March could have been due to high early pressure that may have altered the behaviour of the steelhead, making them successively more wary of anglers and therefore more difficult to catch. Toward the end of the season CPUE improved with the late portion of the steelhead run entering the river.

Table 5: Distribution of catch per unit effort for each two week period expanded from angler interviews.

CPEU

Survey Type	Jan 1-15	Jan 20-27	Jan 30 - Feb 7	Feb 17-25	Feb 27-Mar 8	Mar 14-23	Mar 28-Apr 3
WDAM	0.040	0.111	0.072	0.048	0.043	0.058	0.054
WEAM				0.000	0.000		

6. Discussion

As in the previous years, the placement, holding and releasing of the steelhead smolts went as planned and without any major issues and very few smolt mortalities occurred during the duration of the imprinting process.

Much like the previous year, the breakdown of the adult steelhead monitoring information was quite similar. When the ratio of stocking numbers of hatchery adipose non-net pen smolts are compared to the hatchery adipose maxillary clipped net pen steelhead smolts there seems to be a telling difference. In 2010, the total number of steelhead smolts released into the Stave River numbered 23,073. Of the 23,000 steelhead released 20,000 or 87% of the stocked population was of standard hatchery release origin. The remaining 3,073 or 13% of the smolts made up the population of maxillary clipped smolts that were subsequently head in the Hayward Lake net pen. Of the 23,073 an expanded estimated 539 steelhead adults returned and were captured during the 2012 steelhead season. Of the 539 steelhead captured 263 were of normal hatchery stocking, 161 were of net pen stocking, and 115 were of wild origin. When these estimated numbers are compared to the number of steelhead of the same origin stocked in 2010 a relative percentage of return rates can be developed. The standard hatchery raised and released steelhead for 2011/2012 had a return rate of 1.3%, this was compared to the net pen and max clipped hatchery steelhead which showed a greater return rate of 5.2%. When these numbers are compared to actual number of steelhead sampled during the project a similar trend is followed. In total, 28 steelhead were visually sampled by the creelers. Of the 28 steelhead positively identified 14 were of typical hatchery origin and 7 were of net pen origin. This gave a relative return rate of 0.007% for standard hatchery and 0.22% for net pen held steelhead. These numbers once again show that the hatchery fish held in Hayward Lake exhibit a greater relative return rate compared to hatchery steelhead released by typical hatchery practices. Further monitoring will continue with the return of the net pen held fish in the winter of 2012.

7. Recommendations

BCCF recommends continued monitoring in the winter/spring of 2012 and 2013 to capture the majority (peak run) of the fish from the final year of the net pen project. Communications with BC Hydro to coordinate a lowering of water release would be beneficial during snorkel surveys to increase visibility, especially in the deeper pools, to improve chances of enumerating and identifying steelhead adults.

Through consultation with BC Hydro, BCCF has been notified that due to the proposed upgrades on Ruskin Dam, scheduled for 2011 onward, will have a negative impact on Hayward Lake water levels making future net pen projects not possible to complete. BCCF recommends that the BC Hydro continue to aid in the implementation of this project and perhaps work with FFSBC to create a community-based project that is run annually at a location within the Stave Lake watershed. This type of project can highlight the work that BC Hydro is doing in the watershed to aid in the restoration and creation of a once important fishery. Mentoring on the placement and construction of the existing pen can be

completed by the BCCF and easily taught to BC Hydro staff and volunteers. It's also recommended that the FFSBC work with BCCF to continue the monitoring program to add validity to the hypothesis and ensure that the fish are not missed when they return in two to three years.

8. Acknowledgements

The BC Conservation Foundation would like to acknowledge BC Hydro's Fish and Wildlife Compensation Program for funding the fourth year of this important research and enhancement project. Also, Ashley Uittenbogaard is recognized for her dedication to feeding the steelhead smolts twice a day while the juveniles were reared in the net pens in Hayward Lake. Staff members at the Freshwater Fisheries Society of BC were instrumental in transporting the dock sections to the site and especially with the care and handling of the fish while stocking the pens and releasing the fish to the lower river. In addition, the Fraser Valley Trout Hatchery is to be recognized for allowing us to store the dock sections at their facility in Abbotsford. We would also like to thank all of the anglers that participated in the creel and helped BCCF staff members collect adult return data.

Finally, the BC Conservation Foundation would like acknowledge the following project supporters for their in-kind and technical contributions for the duration of the project:

- BC Hydro
- Freshwater Fisheries Society of BC
- BC Ministry Forest, Land, and Natural Resources Operations
- Kwantlen First Nation

9. References

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Appendix I – Financial Statement

Project # 11.SFN.02

Financial Statement Form

	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
INCOME				
Total Income by Source	10,000.00	8,000.00	10,000.00	7,480.00
Grand Total Income (BCRP + other)		18,000.00		17,480.00
EXPENSES				
Project Personnel				
Wages	6,600.00	0.00	6,556.53	0.00
Consultant Fees	600.00	0.00	300.00	0.00
(List others as required) volunteer stipend		3,500.00	1,000.00	2,500.00
FFSBC Hy staff		1,500.00		1,500.00
FSSBC snorkellers		1,500.00		1,500.00
Ministry biologist		15,000.00		1,500.00
Materials & Equipment				
Equipment Rental	200.00		273.11	
Materials Purchased	100.00			
Travel Expenses			115.00	
Permits				
(List others as required) mileage	700.00		430.00	
fish sampling kits	480.00		0.00	480.00
work and safety supplies	300.00		300.00	
Project Communications	110.91		110.91	
Administration				
Office Supplies				
Photocopies & printing			4.61	
Postage				
(List others as required)				
Admin (approved at 10%)	909.09		909.09	
Total Expenses	10,000.00	8,000.00	10,000.00	7,480.00
Grand Total Expenses (BCRP + other)		18,000.00		17,480.00
BALANCE (Grand Total Income – Grand Total Expenses)	*The budget balance should equal $0*	0.00	*The actual balance might not equal $0**	0.00

Appendix II – Performance Measures

Performance Measures – Target Outcomes													
Project Type	Primary Habitat Benefit Targeted of Project (m2)	Primary Target Species	Habitat (m2)										
			Estuarine	In-Stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous	Upland	Wetland
Impact Mitigation												
Fish passage technologies	Area of habitat made available to target species	steelhead					400m^2					
Drawdown zone revegetation/stabilization	Area turned into productive habitat											
Wildlife migration improvement	Area of habitat made available to target species											
Prevention of drowning of nests, nestlings	Area of wetland habitat created outside expected flood level (1:10 year)											
Habitat Conservation												
Habitat conserved – general	Functional habitat conserved/replaced through acquisition and mgmt											
	Functional habitat conserved by other measures (e.g. riprapping)											
Designated rare/special habitat	Rare/special habitat protected											
Maintain or Restore Habitat forming process												
Artificial gravel recruitment	Area of stream habitat improved by gravel plmt.											
Artificial wood debris recruitment	Area of stream habitat improved by LWD plcmt											
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing											
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved											
Habitat Development												
New Habitat created	Functional area created											

Appendix III – BCRP Recognition

On-site signage was posted in several high visibility locations to inform the public of the project and the funders during the time the net pens were in place.

Appendix IV – Project Photo Documentation

Assembled net pen moored to the boatshed

Typical feed used during the net pen project.

Head shot of a maxillary clipped juvenile steelhead.

Steelhead smolt prior to release showing final weight of 126 grams.

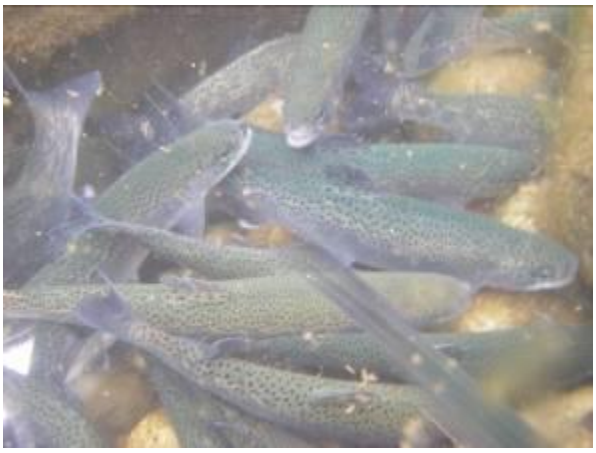
Example of the parr size prior to placement in the net pen.

BCCF and BC Hydro staff members assembling the Hayward Lake net pen.

BCCF transporting the net pen to storage.

BCCF technician taking scale samples from a max clipped steelhead prior to release.

BCCF and BC Hydro staff assisting FFSBC in the transport of smolts from Hayward Lake to the Stave River for release.



Steelhead smolts after release acclimatizing after their short truck ride.

Close-up of a maxillary clipped adult steelhead caught on the Stave River.

Satisfied angler with a wild steelhead captured on the Stave River.

Example of a hatchery steelhead captured by a Stave River angler.