Steelhead Spawner Enumeration in aksk^{w}ək^{w}ant (Inkaneep Creek) – 2011

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EXECUTIVE SUMMARY

Anadromous steelhead salmon (*Oncorhynchus mykiss*) that return to the Canadian q'awsitkʷ Basin migrate from the Pacific Ocean via the nx̌ʷəntkʷitkʷ (Columbia River) then into q'awsitkʷ and through Zosel Dam at the outlet of suwiw's (Osoyoos Lake). In 2011, the Okanagan Nation Alliance, working with the Colville Confederated Tribes, surveyed the presence and distribution of steelhead spawners in the accessible portions of the Canadian q̓awsitkʷ Basin as part of the Okanagan Basin Monitoring and Evaluation Program (OBMEP). These surveys included fish fence enumeration and biosampling in akskʷəkʷant (Inkaneep Creek), as well as, PIT tag detection at Vertical Drop Structure 3 in q̓awsitkʷ. Also, PIT tag data from Zosel Dam was also incorporated into the study.

The fish fence in akskʷəkʷant was installed and monitored from March 30th to May 11th, 2011 and was located ~50m upstream of the confluence with suwiw̓s. Only two steelhead/rainbow trout were enumerated at the fish fence (on May 9th - 10th and the fence was removed on May 11th). One was a 42cm female (fork length) and the other was of unknown sex and was 49 cm in length. The female did not have a clipped adipose and the unknown was not measured. Tissue and scale samples were taken from both. The scales were aged and the tissue samples are being stored.

PIT arrays at Zosel Dam detected 36 (10 wild & 26 hatchery) steelhead entering suwiw's between January and May 2011. Lower numbers would be expected to spawn in the Canadian portion of the Okanagan Basin due to accessible spawning creeks on the American side of suwiw's, north of Zosel Dam. Redds in the Canadian Okanagan Basin were not surveyed in 2011 due to flow conditions.

ACKNOWLEDGEMENTS

We would like to thank the Osoyoos Indian Band, and local landowner Sam Baptiste for allowing access to the survey sites. Funding for this section of the Okanagan Basin Monitoring and Evaluation Program is provided through the Colville Confederated Tribes by the Bonneville Power Administration (BPA).

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Project Background

According to Traditional Ecological Knowledge (TEK) as well as a series of historical accounts, anadromous steelhead salmon (*Oncorhynchus mykiss*) were found throughout the q̓awsitkʷ (Okanagan River)[1] Basin (Clemens *et al*., 1939; Atkinson, 1967; Fulton, 1970; Ernst, 2000; Rae, 2005), a sub-basin of the nx̌ʷəntkʷitkʷ (Columbia River)[2] Basin. Okanagan steelhead, also known as Upper Columbia summer steelhead, are anadromous populations of rainbow trout that spend a portion of their life history in the ocean but return to freshwater habitat to spawn. Freshwater rainbow trout remain in their native freshwater rivers and streams throughout their entire life cycle. Anadromous steelhead and rainbow trout belong to the same species, *Oncorhynchus mykiss*, and there are no major physical differences between them other than the general difference in size and subtle difference in color.

Okanagan steelhead numbers have declined to such an extent that they were re-listed as an endangered species in 2007 (NOAA, 2007). There is limited data about the population size and distribution of steelhead in the Canadian portion of the q̓awsitkʷ Basin (Rae, 2005).

In 2011, the Okanagan Nation Alliance (ONA), working with the Colville Confederated Tribes, surveyed the presence and distribution of steelhead spawners in the portions of the Canadian q̓awsitkʷ Basin accessible to anadromous salmon as part of the Okanagan Basin Monitoring and Evaluation Program (OBMEP). OBMEP was created to establish a basin wide status and trend monitoring program over a 20 year period (Colville Tribes, 2003). The program includes an annual estimation of returning adult steelhead numbers (through the use of a fish fence) complemented by physical habitat surveys (including water quality and quantity surveys) as well as other biological surveys.

Although the 2011 season is the seventh year that the OBMEP program has been in use, only six seasons have included adult steelhead spawner surveys in the Canadian portion of the q̓awsitkʷ Basin. Of the six seasons, only five have included the use of a fish fence.

[1] Commonly known as Okanagan River, but for the remainder of this report referred to as q̓awsitkʷ.
[2] Commonly known as Columbia River, but for the remainder of this report referred to as nx̌ʷəntkʷitkʷ.

1.2 Project Objectives

To annually enumerate adult steelhead spawners returning to the q̓awsitkʷ Basin, a fish fence in akskʷəkʷant (Inkaneep Creek)[3] was constructed and monitored. The end goal was to determine the timing and distribution of the steelhead spawning run. Specific objectives for operating the akskʷəkʷant fish fence included:

- Re-installation and maintenance of the fish fence on the lower reach of akskʷəkʷant throughout the spawner returns (end of March to late May),
- Enumeration of all fish migrating upstream (primarily steelhead and rainbow trout),
- Collection of biological information including fish length and gender ratios, and
- Collection of fin samples for stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$).

1.3 Study Area

The area of the Canadian q̓awsitkʷ Basin currently accessible to migrating steelhead salmon occurs downstream of nˁaylintən (McIntyre Dam)[4] (Figure 1). nˁaylintən is located 24 km upstream of suwiw̓s (Osoyoos Lake)[5] on the main stem q̓awsitkʷ (Figure 1). The dam was constructed in 1920 without allowing for fish passage (Long, 2005a). Downstream of nˁaylintən (McIntyre Dam), two large tributaries flow into the Okanagan system; nSaxʷl'qaxiyaʔ (Vaseux Creek)[6] flows into the q̓awsitkʷ main stem while further downstream akskʷəkʷant flows into the north basin of suwiw̓s.

In 2006, it was determined that akskʷəkʷant was the most productive spawning creek of those surveyed (Long *et al.,* 2006). Enumerating migrating steelhead salmon on akskʷəkʷant allows for maximum enumeration efficiency and was again the focus of this year's steelhead spawner surveys which were conducted in the spring of 2011 based on previous years sampling.

In akskʷəkʷant, only 3.7 km of its 23.5 km length is accessible to migrating salmon. The remainder of the creek is blocked by a 6 m high waterfall (Walsh & Long, 2005). Steelhead migrations were monitored through a fish fence located ~50 m from the mouth of the creek and by a Passive Integrated Transponder (PIT) array located downstream of the bridge crossing at the Water Service Canada (WSC) station.

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[3] Commonly known as Inkaneep Creek, but for the remainder of this report referred to as akskʷəkʷant.
[4] Commonly known as McIntyre Dam, but for the remainder of this report referred to as nˁaylintən.
[5] Commonly known as Osoyoos Lake, but for the remainder of this report referred to as suwiw̓s.
[6] Commonly known as Vaseux Creek, but for the remainder of this report referred to as nSaxʷl'qaxiyaʔ.

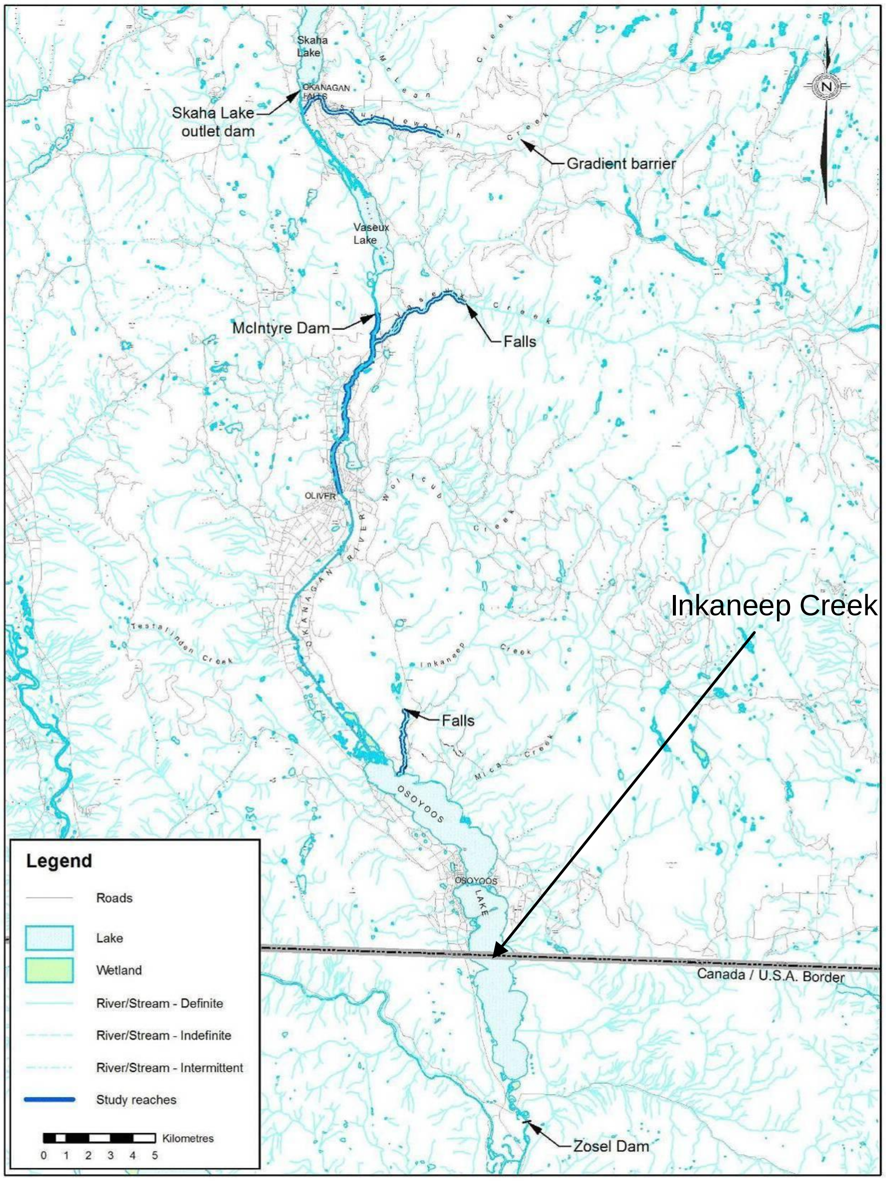

Figure 1. Canadian q̓awsitkʷ Basin steelhead/rainbow trout study area.

2.0 METHODS

2.1 aksk^{w}ək^{w}ant *Fish Fence Monitoring and Biosampling*

The aksk^{w}ək^{w}ant fish fence was installed on March 30th, 2011 and was located ~50m upstream of the confluence with suwiw̓s at GPS 11U.317159.5438478 (Figures 2 and 3). The fence was located further downstream than other years to be below known spawning gravels and also in an attempt to minimize structural issues with the fence experienced in past years (Long *et al.* 2006). The fence was constructed during low flow conditions at mean depths of approximately 1.80m (WSC 2010). aksk^{w}ək^{w}ant typically experiences flash flood flow dynamics where the water levels in the creek are prone to rapid changes over a short time period (Long *et al.* 2006). In response to this, the fish fence orientation is occasionally altered to adapt to aksk^{w}ək^{w}ant in order to reduce the likelihood of failure.

Figure 2. aksk^{w}ək^{w}ant fish fence installation March 30, 2011.

Figure 3. akskʷəkʷant fish fence installation March 30, 2011.

Counts of *O. mykiss* migrating into akskʷəkʷant to spawn were conducted March 30th to May 11th, 2011. Installation of the fish fence occurred before the early steelhead spawners migrated into the system, based on peak dates from previous years sampling (Long *et al.*, 2006; Benson and Squakin, 2009; Folks and Kozlova, 2010). The fence was located at the top of a riffle, where the capture box could sit in the deeper waters of a pool (Figures 2 and 3). Sand bags and rebar were placed so as to reinforce the panels, the box, and to create a live well for biological sampling. The fence panels were then set up across the creek to herd the fish into the capture box.

The fish fence was checked daily from March 30th to May 11th, 2011. At each check the sampling box was monitored for fish presence. All fish were noted, irrespective of species, and *O. mykiss* were bio-sampled (Figure 4). Biological sample data included: fork length (cm), head length (cm), caudal peduncle length (cm), sex, adipose fin presence, fin tissue and scale samples[7]. *O. mykiss* were also checked for PIT tags. All diligence was taken in order to minimize both handling and stressing fish. The fish were then released into a pool within close proximity to the sampling box and were monitored during recovery. Additionally, daily fence maintenance occurred insuring there were no breaches in the fence. Lastly, fish were examined for red dye eye marks which would indicate that they would be of Wenatchee Hatchery (unclipped adipose) origin.

[7] These samples will be processed in 2010/2011 for aging and stable isotope analysis to determine exposure to marine environments.

Figure 4. Female *O. mykiss* sampled May 10, 2011.

2.2 Stable Isotope Analyses

Because of the physical similarities between anadromous steelhead and adfluvial freshwater rainbow trout, stable isotope analyses were done in order to determine exposure to marine environment. For biological samples taken at the akskʷəkʷant fish fence, stable isotope analyses (carbon δ^{13}C and nitrogen δ^{15}N) were done for 2008 and 2009 samples. A total of 58 non-destructive fin tissue samples were taken in 2008 and 19 in 2009. Samples were sent to the University of Regina for stable isotope analyses. The principal investigator was Dr. Bjoern Wissel.

Migratory fish differ greatly in their stable isotope values (up to 10-15 ‰) when they migrate between marine and freshwater systems making stable isotope analyses easier (Peterson and Fry, 1987; Doucett *et al.*, 1999). Marine food webs are typically enriched in the heavier carbon isotope (δ^{13}C) compared to freshwater food webs, and these distinct signatures are reflected in the tissue of animals living in these ecosystems. It usually takes from several weeks to several months for the isotope ratio to change in fish muscle tissue (Hesslein *et al.*, 1993).

2.3 Passive Integrated Transponder (PIT) Arrays

In the fall of 2009 a Passive Integrated Transponder (PIT) pass by array was installed downstream of Vertical Drop Structure (VDS) 3, Road 18, Oliver BC. The site is 45m downstream of the drop structure in the riffle tail-out. The PIT array consists of four 6m x 1.8m x 0.3m arrays aligned perpendicular to the river channel. Coverage is essentially 100% of the wetted width of the channel at flows between 0-10cms. Historically the q̓awsitkʷ (Okanagan River) has a mean peak flow of less than 50m^3/s, meaning the array is well situated to detect all passing fish.

While the focus of the array is to detect migrating sockeye in the fall seasons, additional data including that of migrating *O. mykiss* will be detected by the array. This data will contribute to the migratory distribution and timing of Okanagan Basin *O. mykiss*. Data from the PIT array can be found on the PTAGIS website (http://www.ptagis.org/ptagis/) with the listing as OKC (Okanagan Channel VDS-3) small system detection arrays. The PIT array was fully monitored for the 2011 season.

A small scale PIT array was tested within akskʷəkʷant as a trial enumeration technique. The PIT array was a Biolite provided by Biomark Inc. The Biolite antennas were installed May 6th, 2011 and the multiplexer and batteries were installed June 1st, 2011. The two antennas are 3mx1m in 4' PVC and attached to a Deston Fearing FS1001M multiplexer with an acumen data logger. The antennas were installed upstream and downstream of the bridge crossing akskʷəkʷant at the WSC station. The unit was powered by four 12V DC batteries that were changed on a weekly basis.

Results were not used as an enumeration technique for this year. The object was to make land owner contact, introduce the idea to the community, and trial install and operate the PIT array within the creek. The fish fence was the primary method of enumeration within Inkaneep for the 2011 season.

2.4 Redd Surveys

Due to the high turbidity and high freshet flows of the q̓awsitkʷ tributaries, redd surveys in the past have proven difficult and do not provide reliable *O. mykiss* spawning distribution. For this reason, redd surveys were not conducted in 2011. The modification of spawner surveys to exclude redd surveys allows resources to be allocated to improved enumeration in akskʷəkʷant along with continually improving data from Zosel Dam, and the addition of PIT arrays will provide a more complete picture of steelhead spawning distribution.

3.0 RESULTS

3.1 akskʷəkʷant *Fish Fence Monitoring and Biosampling*

The akskʷəkʷant fish fence was monitored for 43 days (March 30th to May 11th, 2011). After that the fence was disassembled due to high flows (Figure 5). During the sampling period a total of 2 *O. mykiss* were enumerated. Fish were caught between May 9th and May 10th 2011.

Figure 5. Fence removal on May 11, 2011.

Based on the data collected, peak timing is difficult to ascertain due to difficulties with the fence. However, typically migration has occurred in the latter half of April and the 1st week of May in previous years (Benson and Squakin, 2008; Folks *et al.,* 2009). Arterburn *et al.* (2007) makes mention that this time period is also experienced in tributaries to the q̓awsitkʷ in Washington State. Peak dates have previously tended to correlate with peak water flows through akskʷəkʷant monitored at the Water Survey of Canada water gauge 08NM200 (Figure 6). The fish fence was installed when water depths were less than 1.8 m.

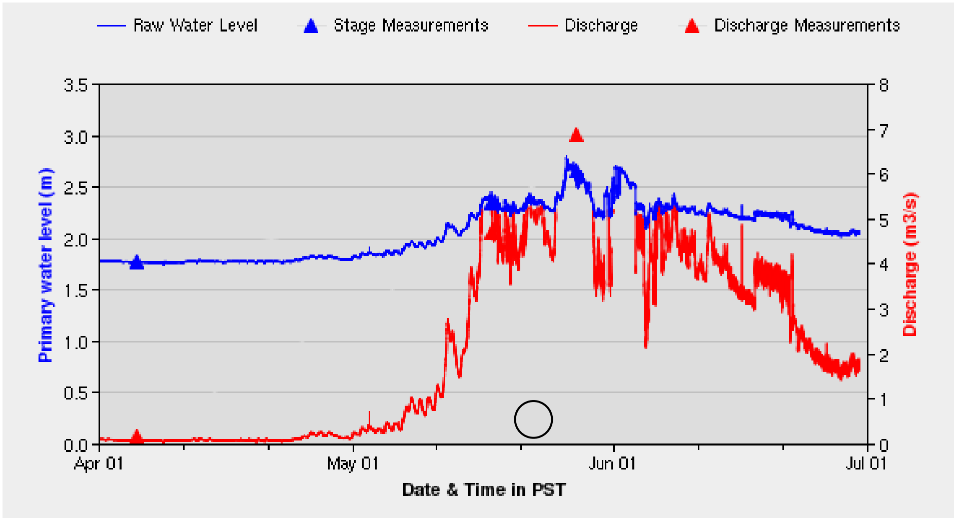

Figure 6. Water levels (blue) and discharge (red) in akskʷəkʷant at station 08NM200 (WSC2011).

The fish fence data from Long *et al.* (2006) corroborates the timing witnessed this season, with peak migration periods occurring broadly during the last week of April into the 1st week of May. In 2006, the fish fence was operated over a longer time period to note pre- and post-peak spawning events.

This year, as in previous years (with 2009 as the exception where flows did not exceed 0.7m^3/s, Folks & Kozlova, 2009), the fish fence experienced stability issues due to freshet flows. Previous years have shown that the fence continually experienced failure at flows greater than 2.0 cms. Flows in akskʷəkʷant flashed in response to a higher than average snowpack and warm spring temperatures which resulted in a high freshet. This year, the fence was removed at 1.9cms and the discharge continued at greater than this rate until July (Figure 6).

On April 4th, 2011, the erosion along the bank by trap box was noted and slowed by adding more sandbags (Figure 7). April 16th, it was noted that there was a huge sand bar at the mouth of akskʷəkʷant which needed to be dug out for fish passage and this was completed on April 19th. The fence pickets had to be hammered down almost daily due to increasing flows starting on May 2nd (Figure 8) and continuing until the fence was removed. The debris build up on the fence pushed it over May 8th, 2011.

Figure 7. Fence on the morning of April 4, 2011, showing erosion of the bank.

Figure 8. Fence on May 3, 2011.

3.1.1 Biological sampling of aksk^{w}ək^{w}ant steelhead/rainbow trout

Only one of the 2 *O. mykiss* captured was checked for an adipose clip and it was not clipped (Appendix I). As per previous years, the majority (90% in 2010 and 2009, 91.53% in 2008; Folks *et al.,* 2009) of the fish enumerated were unmarked and either of hatchery, or natural steelhead/rainbow trout origin. The fish fence caught one female, and one of unknown sex. Previous years male to female sex ratios have been 0.85 in 2007, 0.69 in 2008, and 0.57 in 2010 (no data for 2009).

The average length of all the *O. mykiss* that passed through the fish fence (2 fish) was 45.5 ± 4.95cm (Table 1). This is very similar to previously observed values (Long *et al.,* 2006; Benson & Squakin, 2008, Folks *et al.,* 2009).

Table 1. Length of Canadian Okanagan Basin male and female steelhead/rainbow trout from 2006 to 2011.

			Length			
		Count	**Mean**	**Min**	**Max**	**St Dev**
Female	**2006**	27	45	16	59	9
	2008	32	44	16	60	11
	2009	-	-	-	-	-
	2010	46	48.7	32	66	9
	2011	1	42	42	42	-
Male	**2006**	23	49	31	76	11
	2008	22	46	20	67	11
	2009	-	-	-	-	-
	2010	26	51.4	35.9	65	9.4
	2011	-	-	-	-	-
Pooled Totals	**2006**	64	-	-	-	-
	2008	59	-	-	-	-
	2009	20	50.8	37	75	8.07
	2010	77	38.8	17.5	62	22.3
	2011	2	45.5	42	49	4.95

3.2 Stable Isotope Analyses for 2008 and 2009

suwiw̓s is known for also having a resident adfluvial rainbow trout population (Long *et al.*, 2006). The interaction and influence of resident populations on spawning steelhead is still relatively unknown and of ongoing study. Stable isotope analyses (carbon δ13C and nitrogen δ^{15}N) on fin tissue samples are ongoing attempts to answers these unknowns. Data from 2008 and 2009 demonstrate that the majority of the steelhead/rainbow trout within akskʷəkʷant are of freshwater origin (Folks & Kozlova, 2009).

As stable isotope results show (Table 2), mean δ^{13}C and δ^{15}N of the Rainbow Trout fins were significantly depleted compared with the Steelhead fins (δ^{13}C, -25.1 ±0.79‰ cf. -19.2±0.84‰; δ^{15}N, 15.4±1.25‰ cf. 11.9±0.96‰).

Table 2. Mean values (± standard deviation) for δ13C and δ15N in fins of *O. mykiss* sampled in akskʷəkʷant fish fence in 2008 and 2009.

	Rainbow trout	Steelhead
$\delta^{13}C$	-25.1 (0.79)	-19.2 (0.84)
$\delta^{15}N$	15.4 (1.25)	11.9 (0.96)
Number of fish	67	10

Our data are within the range of $\delta^{13}C$ known for freshwater and migratory fish. For example, $\delta^{13}C$ in freshwater *Salmo trutta* and *Salvelinus alpines* was -28.1±0.7‰ and -27.5±0.7‰, respectively, whereas in migratory *S.alpinus*, Salmo salar, and *Oncorhynchus kisutch* it was -22.1±1.3‰, -19.5±1.0‰, and -17.9±0.3‰, respectively (McCarthy and Waldron 2000).

Resident freshwater rainbow trout and anadromous steelhead were clearly identifiable as two distinct groups and are displayed on Figure 10 using a combined δ13C and δ15N scatter plot. All rainbow trout has a carbon value of from -27 to -23‰, whereas Steelhead of from -21 to -18‰.

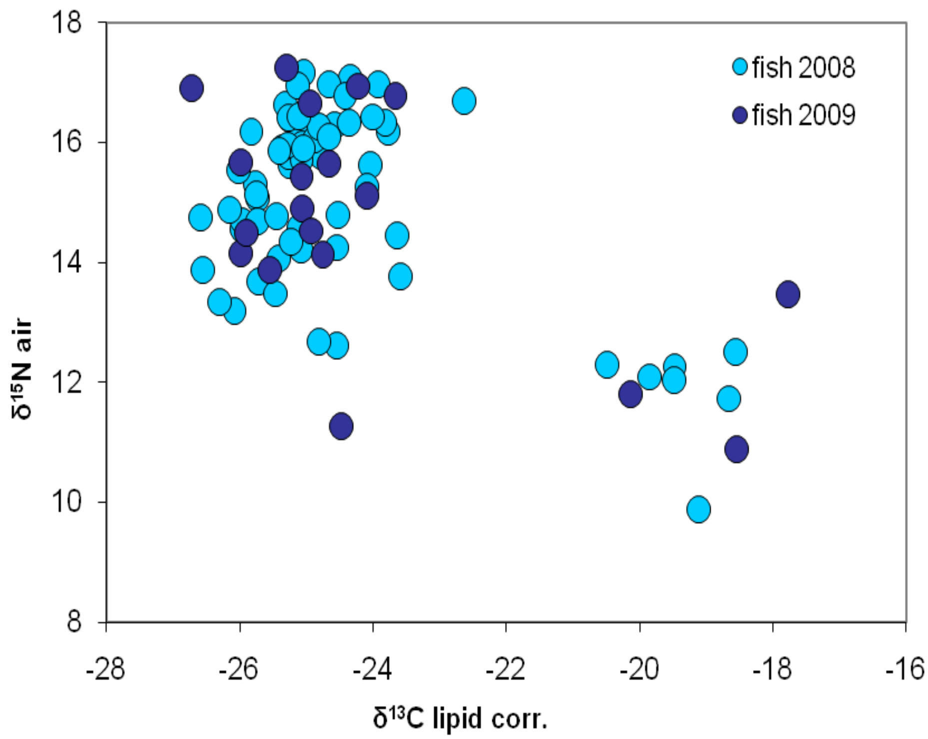

Figure 9.Combined δ13C and δ15N signatures of fin samples from *O. mykiss* (sampled in 2008 and 2009) identified as either resident freshwater rainbow trout (left group) or anadromous steelhead (right group).

According to stable isotope data, *O. mykiss* enumerated in akskʷəkʷant fish fence in 2008 and 2009 was mostly represented by rainbow trout (51 rainbow trout out of 58 fish in 2008 and 16 rainbow trout out of 19 fish in 2009).

The results of this study show that the measurement of $\delta^{13}C$ and $\delta^{15}N$ signatures can clearly distinguish between non-anadromous and anadromous fish, and can be used for further studies in order to separate rainbow trout and steelhead.

3.3 Passive Integrated Transponder (PIT) arrays at VDS 3

Six *O. mykiss* were detected by the Passive Integrated Tag (PIT) array installed in the q̓awsitkʷ at VDS 3 (Table 3). As there are no downstream detections of these fish, it is thought that these fish would have spawned in either the q̓awsitkʷ, nSaxʷl'qaxiyaʔ, or in Shuttleworth Creek as fish passage has been possible at nˁaylintən since October 15, 2009 (Rivard-Sirois & Alex 2011).

Table 3. Summary of steelhead/rainbow trout detected at VDS 3.

Fish ID	Date Detected	Release Date	Released At:	Hatchery Fish?
3D9.1BF26C227A	4/7/2011	9/3/2009	LGRRBR	Yes
3D9.1C2D60CB76	4/14/2011	8/18/2009	WELLD2	Yes
3D9.1C2D613643	4/29/2011	9/28/2009	WELLD2	Yes
3D9.1C2D6158CD	4/9/2011	7/23/2008	WELLD2	No
3D9.1C2D8E1C2D	4/27/2011	7/28/2009	PRDLD1	No
3D9.1C2D8F6F21	3/24/2011	9/3/2009	PRDLD1	No

Due to low numbers, ratios of hatchery fish to wild fish (listed in Table 3) can't be compared to those enumerated at the fence. These fish passed by the array in water levels below 0.8m depth and ~10m^3/s (Figure 10). While detection was disrupted prior to migration from November 19, 2009 to March 18, 2010, the majority of PIT tagged fish are expected to have been detected from later March through June. However, it is accepted that any number may have passed undetected prior to March 18.

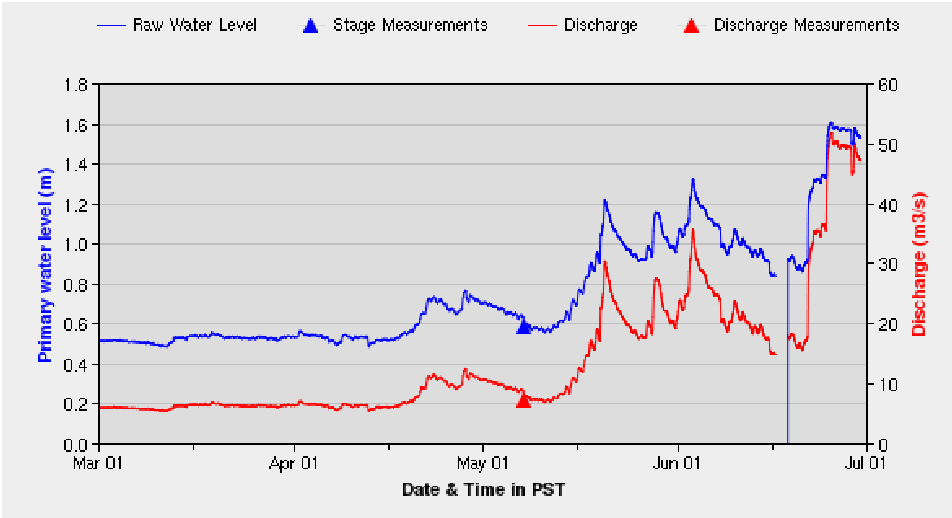

Figure 10. Water levels (blue) and discharge (red) in the q̓awsitkʷ at VDS3, station 08NM085 (WSC 2011).

Detection at the array was lost between the dates listed above due to a combination of faulty test tags, a faulty exciter cable, and a series of power related issues. In the future, every effort will be made to maintain consistent operation of the PIT array during migration timing and through the year to increase the understanding of steelhead/rainbow trout movement in the Canadian Okanagan Basin.

4.0 DISCUSSION

Anadromous *O. mykiss* returning to the Canadian q̓awsitkʷ Basin migrate up the nx̌ʷəntkʷitkʷ and enter the q̓awsitkʷ in Washington, then pass through Zosel Dam at the suwiw̓s outlet. The video counter at Zosel Dam counted zero hatchery and wild adult steelhead/rainbow trout (Figure 11), although there were 36 (10 wild & 26 hatchery) PIT detections at Zosel Dam.

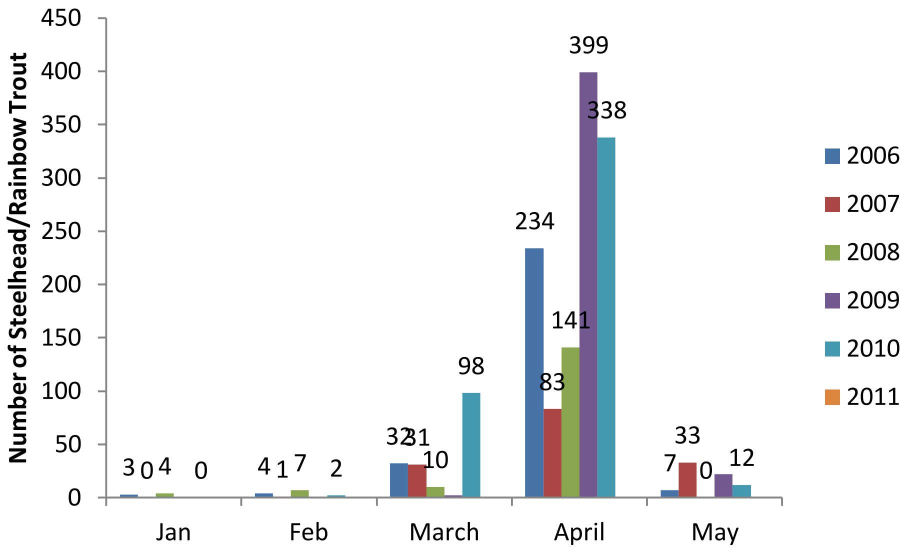

Figure 11. Adult steelhead (hatchery and wild) migrations through the Zosel Dam fish counter for 2006-2010 (Columbia Basin Research 2006-2011).

Within the American portion of the Southern Basin of suwiw̓s, both Nine Mile and Tonasket creeks host populations of spawning steelhead/rainbow trout (Arterburn and Miller 2008, Arterburn *et al.* 2010). In the past two years these estimates have varied from 0 to 124 steelhead/rainbow trout. These variances have been attributed to land owner access issues, as well as low flows and/or no water within either creek. Despite these issues, it is suspected that some number of spawners may utilize these creeks and therefore should be subtracted from the numbers presented as Zosel dam counts.

Of the steelhead/rainbow trout entering the Canadian q'awsitkʷ Basin it has been noted by Long *et al.* (2006) and Benson and Squakin (2008) that the majority return to akskʷəkʷant . As in 2008 to 2010, in 2011 most of the sampling effort was allocated to this stream. Enumeration results provided a count of 2 adults migrating past the akskʷəkʷant fish fence. This seasons sampling continued to demonstrate limitations of the current fish fence. This year the fish fence did experience structural failures due to freshet flows, and had to be removed on May 11th. Despite the flaws of the fish fence, an improved version should continue to be employed as an enumeration technique within akskʷəkʷant.

In addition to distribution and population estimates, the interaction and role of adfluvial rainbow trout is an ongoing question. The level of interaction between resident rainbow trout and anadromous steelhead is currently unknown. Our first data from stable isotope analyses (carbon $\delta^{13}C$ and nitrogen $\delta^{15}N$) showed that *O. mykiss* enumerated in akskʷəkʷant fish fence in 2008 and 2009 was mostly represented by freshwater rainbow trout (67 rainbow trout out of 77 fish). Assessing the interactions of these different life history roles of *O. mykiss* is important for listing Okanagan steelhead (Upper Columbia summer steelhead) with the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The q̓awsitkʷ and upstream tributaries are suspected to account for the remaining steelhead/rainbow trout population within the Canadian Okanagan Basin (Arterburn *et al.* 2009). PIT detection within the q̓awsitkʷ detected 6 Steelhead (1 of hatchery origin). Based on proportions of fish detected, the q̓awsitkʷ represents 7.23% of the steelhead/rainbow trout run. Additional data from coming years via both fish fence enumeration and PIT detections within the q̓awsitkʷ and akskʷəkʷant will provide additional data to better distribution and population estimates.

akskʷəkʷant continues to appear to have the most steelhead spawners in the entire Canadian q̓awsitkʷ Basin (Long *et al.*, 2006; Arterburn *et al.*, 2007b). Due to budget constraints future steelhead research and management will focus on this tributary. We have included the use of Passive Integrated Transponder (PIT) tag technology, so that passage and timing of steelhead/rainbow trout will be improved in the q̓awsitkʷ, Zosel Dam, and akskʷəkʷant.

In response to the blockage of fish migration at nˁaylintən, the ONA and other groups have lobbied for fish passage. Construction has taken place to install 5 overshot gates at nˁaylintən which now provide access upriver. Upstream migration has been possible since the 2010. Also, historically, prior to overshot gate installation, nˁaylintən could be operated for short periods of time during the spring freshet in such a way that migration of salmon was possible. For these reasons, a main tributary upstream of nˁaylintən, Shuttleworth Creek, was occasionally included in enumerations. With fish passage now possible Shuttleworth Creek may be also included in surveys in future. This would help to assess the effectiveness of steelhead passage at nˁaylintən.

5.0 RECOMMENDATIONS

1. Future steelhead surveys should continue to focus on akskʷəkʷant, as this tributary has the strongest spawning run. Improved enumeration will improve population estimates within the Canadian q’awsitkʷ Basin.

2. Continue with PIT detection testing and deployment, with the support of Colville Confederated Tribes.

3. Continue to use q’awsitkʷ to detect upstream migration of steelhead into upper sections of the river

4. Trial PIT detection in nSaxʷl’qaxiya? and Shuttleworth Creek.

5. Bio-sample collection and stable isotope analyses should continue in 2011 to move towards better understanding the adfluvial/anadromous interaction and life history of Okanagan steelhead/rainbow trout. Sex ratio data and other biometrics should also be collected on an annual basis.

6. Look at other harvest options to gather biological data: creel, donations from community, and/or hook and line angling.

7. Redd surveys on all Canadian q’awsitkʷ Basin tributaries and streams should be utilized to determine fish distribution and to strengthen information collected at the fish fence.

8. Continue to examine alternative enumeration methods to better determine distribution results of steelhead/rainbow trout within the Canadian q’awsitkʷ Basin, including PIT tag, and acoustic tagging technologies.

9. The public should be informed about the reason for the fish fence to help prevent future vandalism. Perhaps a fixed sign on site explaining both the structure and the project would help. In addition, a press release should be produced for the Community of Oliver and for the Osoyoos Indian Band.

10. Implement an intensive community based creel survey, as suspected harvest rates vary and can be quite high.

11. Research TEK for steelhead.

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APPENDICES

APPENDIX I – 2011 Fish Fence Biosampling Data

Steelhead Biosampling								
Fish #	Length (mm)			Adipose clip	Fin sample	Scale# book-box	Sex	Photo #
	Head-fork	Tail	Head					
	490				Y			
	420	45	100	N	Y		F	969

APPENDIX II: Summary of PIT Tag Detections at OKC in 2011

Tag ID	Fish Type	Tag Site	Release Site	Date Released	Date Detected	qa/qc
3D9.1BF26C227A	Hat. Summer Steelhead	LGR	LGRRBR	26-May-08	7-Apr-11	FALSE
3D9.1C2D60CB76	Hat. Summer Steelhead	WEL	WELLD2	20-Sep-10	14-Apr-11	FALSE
3D9.1C2D613643	Hat. Summer Steelhead	WEL	WELLD2	29-Sep-10	29-Apr-11	FALSE
3D9.1C2D6158CD	Wild Summer Steelhead	WEL	WELLD2	21-Sep-10	9-Apr-11	FALSE
3D9.1C2D8E1C2D	Wild Summer Steelhead	PRDLD1	PRDLD1	17-Aug-10	27-Apr-11	FALSE
3D9.1C2D8F6F21	Wild Summer Steelhead	PRDLD1	PRDLD1	22-Jul-10	24-Mar-11	FALSE

APPENDIX III – Carbon and nitrogen isotope data in steelhead and rainbow trout

Sample ID	type	date	$\delta^{15}N_{AIR}$	$\delta^{13}C_{VPDB}$	%N	%C	C/N	% fat	$\delta^{13}C_{VPDB}$
									lipid corr.
									Sweeting
27950	fish fin	spring 2009	15.67	-26.23	14.22	43.69	3.58	0.04	-26.0
27951	fish fin	spring 2009	13.88	-26.39	6.85	23.46	3.99	0.14	-25.6
27952	fish fin	spring 2009	14.15	-26.56	64.85	211.44	3.80	0.10	-26.0
27953	fish fin	spring 2009	11.81	-20.71	12.31	40.14	3.80	0.10	-20.1
27954	fish fin	spring 2009	13.47	-17.81	10.87	32.26	3.46	0.01	-17.8
27955	fish fin	spring 2009	14.13	-25.39	7.28	24.02	3.85	0.11	-24.8
27957	fish fin	spring 2009	10.89	-19.08	9.69	31.38	3.78	0.09	-18.5
27959	fish fin	spring 2009	16.91	-28.06	8.64	32.76	4.42	0.22	-26.7
27960	fish fin	spring 2009	17.25	-25.50	11.32	34.55	3.56	0.03	-25.3
27962	fish fin	spring 2009	15.65	-25.00	9.03	28.22	3.65	0.06	-24.7
27963	fish fin	spring 2009	16.64	-25.29	8.35	26.07	3.64	0.06	-24.9
27964	fish fin	spring 2009	16.78	-24.08	5.30	16.80	3.70	0.07	-23.7
27965	fish fin	spring 2009	16.94	-24.62	6.90	21.77	3.68	0.07	-24.2
27970	fish fin	spring 2009	15.11	-24.54	107.11	341.83	3.72	0.08	-24.1
27971	fish fin	spring 2009	14.89	-25.47	9.91	31.28	3.68	0.07	-25.1
27972	fish fin	spring 2009	14.50	-26.13	7.47	22.91	3.58	0.04	-25.9
27973	fish fin	spring 2009	14.52	-24.95	11.66	34.50	3.45	0.00	-24.9
27992	fish fin	spring 2009	15.44	-25.99	11.14	38.74	4.06	0.15	-25.1
27993	fish fin	spring 2009	11.27	-25.57	7.19	25.92	4.21	0.18	-24.5
36541 01	fish fin	spring 2008	12.26	-19.75	13.31	41.09	3.60	0.05	-19.5
36541 02	fish fin	spring 2008	16.18	-24.23	10.06	32.05	3.72	0.07	-23.8
36541 03	fish fin	spring 2008	12.61	-24.70	7.20	21.78	3.53	0.03	-24.5
36541 03	fish fin	spring 2008	12.68	-24.86	7.42	22.03	3.46	0.01	-24.8
36541 04	fish fin	spring 2008	14.22	-25.44	8.88	27.88	3.66	0.06	-25.1
36541 05	fish fin	spring 2008	11.73	-18.85	10.53	32.01	3.55	0.03	-18.7
36541 06	fish fin	spring 2008	15.63	-24.62	7.65	24.97	3.81	0.10	-24.0
36541 07	fish fin	spring 2008	16.62	-25.43	15.19	45.63	3.50	0.02	-25.3
36541 07a	fish fin	spring 2008	12.09	-20.25	14.45	45.63	3.68	0.07	-19.9
36541 07a	fish fin	spring 2008	12.03	-20.00	14.45	46.70	3.77	0.09	-19.5
36541 08	fish fin	spring 2008	14.56	-26.46	8.83	28.33	3.74	0.08	-26.0
sample	**type**	**date**	$\delta^{15}N_{AIR}$	$\delta^{13}C_{VPDB}$	**%N**	**%C**	**C/N**	**% fat**	$\delta^{13}C_{VPDB}$

ID								lipid corr.	Sweeting
36541 09	fish fin	spring 2008	15.07	-26.45	10.47	35.06	3.91	0.12	-25.7
36541 10	fish fin	spring 2008	12.51	-18.76	9.18	27.99	3.56	0.03	-18.6
36541 11	fish fin	spring 2008	14.45	-24.50	6.21	21.38	4.01	0.14	-23.6
36541 12	fish fin	spring 2008	17.08	-24.68	11.33	35.36	3.64	0.05	-24.3
36541 13	fish fin	spring 2008	15.62	-26.00	10.87	36.58	3.93	0.12	-25.3
36541 14	fish fin	spring 2008	12.29	-21.39	13.38	46.33	4.04	0.15	-20.5
36541 15	fish fin	spring 2008	16.18	-25.95	10.31	31.02	3.51	0.02	-25.8
36541 16	fish fin	spring 2008	16.69	-22.70	9.89	29.52	3.48	0.01	-22.6
36541 17	fish fin	spring 2008	15.77	-25.80	9.95	32.23	3.78	0.09	-25.3
36541 18	fish fin	spring 2008	14.07	-25.72	10.32	32.07	3.62	0.05	-25.4
36541 19	fish fin	spring 2008	9.87	-19.38	12.16	37.51	3.60	0.04	-19.1
36541 20	fish fin	spring 2008	17.17	-25.12	21.95	65.59	3.49	0.01	-25.0
36541 21	fish fin	spring 2008	14.58	-25.57	8.89	28.37	3.72	0.08	-25.1
36541 22	fish fin	spring 2008	16.98	-24.82	11.16	33.77	3.53	0.03	-24.7
36541 22	fish fin	spring 2008	16.77	-24.67	10.43	32.11	3.59	0.04	-24.4
36541 23	fish fin	spring 2008	16.33	-24.00	9.98	30.38	3.55	0.03	-23.8
36541 23	fish fin	spring 2008	16.43	-24.31	10.28	31.90	3.62	0.05	-24.0
36541 24	fish fin	spring 2008	14.25	-25.14	8.94	29.23	3.81	0.10	-24.5
36541 25	fish fin	spring 2008	14.35	-25.70	8.79	28.12	3.73	0.08	-25.2
36542 01	fish fin	spring 2008	16.95	-25.36	14.78	45.33	3.58	0.04	-25.1
36542 02	fish fin	spring 2008	16.38	-25.83	14.14	46.12	3.81	0.10	-25.3
36542 02	fish fin	spring 2008	16.22	-25.52	9.10	28.92	3.71	0.07	-25.1
36542 03	fish fin	spring 2008	16.29	-24.85	14.73	45.54	3.61	0.05	-24.6
36542 04	fish fin	spring 2008	16.97	-24.24	10.66	33.12	3.63	0.05	-23.9
36542 06	fish fin	spring 2008	16.41	-25.61	14.41	45.10	3.65	0.06	-25.3
36542 07	fish fin	spring 2008	13.76	-24.18	5.94	19.43	3.81	0.10	-23.6
36542 08	fish fin	spring 2008	15.31	-26.17	10.84	34.29	3.69	0.07	-25.8
36542 10	fish fin	spring 2008	15.96	-25.35	13.09	40.52	3.61	0.05	-25.1
36542 10	fish fin	spring 2008	15.78	-25.21	10.61	33.65	3.70	0.07	-24.8
36542 11	fish fin	spring 2008	13.68	-26.00	10.50	32.49	3.61	0.05	-25.7
36542 12	fish fin	spring 2008	15.90	-25.59	11.00	33.69	3.57	0.04	-25.4
36542 13	fish fin	spring 2008	15.27	-24.62	10.01	32.36	3.77	0.09	-24.1
36543 01	fish fin	spring 2008	13.48	-26.17	7.69	25.68	3.90	0.12	-25.5
sample	**type**	**date**	$\delta^{15}N_{AIR}$	$\delta^{13}C_{VPDB}$	**%N**	**%C**	**C/N**	**% fat**	$\delta^{13}C_{VPDB}$

ID								lipid corr.	Sweeting
36543 02	fish fin	spring 2008	15.71	-25.54	10.06	32.16	3.73	0.08	-25.1
36543 03	fish fin	spring 2008	14.69	-26.53	13.84	44.93	3.79	0.09	-26.0
36543 04	fish fin	spring 2008	16.34	-24.89	9.72	31.38	3.77	0.09	-24.4
36543 05	fish fin	spring 2008	15.54	-26.31	14.36	44.50	3.62	0.05	-26.0
36543 06	fish fin	spring 2008	14.75	-27.23	13.63	45.01	3.85	0.11	-26.6
36543 07	fish fin	spring 2008	13.18	-27.24	11.82	43.19	4.26	0.19	-26.1
36543 08	fish fin	spring 2008	14.80	-24.62	11.71	35.05	3.49	0.02	-24.5
36543 09	fish fin	spring 2008	16.05	-25.00	14.37	43.18	3.51	0.02	-24.9
36543 10	fish fin	spring 2008	14.69	-25.96	9.21	28.22	3.57	0.04	-25.7
36543 11	fish fin	spring 2008	16.26	-25.16	11.43	35.75	3.65	0.06	-24.8
36543 12	fish fin	spring 2008	15.96	-25.49	9.95	30.41	3.57	0.04	-25.3
36543 13	fish fin	spring 2008	14.77	-25.82	8.67	27.24	3.67	0.06	-25.5
36543 14	fish fin	spring 2008	15.85	-26.16	13.54	45.66	3.93	0.13	-25.4
36543 15	fish fin	spring 2008	13.88	-27.53	6.83	24.03	4.10	0.16	-26.6
36543 16	fish fin	spring 2008	14.88	-27.08	13.53	47.12	4.06	0.15	-26.2
36543 17	fish fin	spring 2008	16.43	-25.39	14.30	44.18	3.60	0.05	-25.1
36543 18	fish fin	spring 2008	15.90	-25.92	11.65	40.17	4.02	0.14	-25.1
36543 19	fish fin	spring 2008	16.10	-25.17	11.35	36.56	3.76	0.08	-24.7
36543 20	fish fin	spring 2008	15.13	-27.68	11.46	49.82	5.07	0.32	-25.7
36543 23	fish fin	spring 2008	13.34	-27.43	11.88	43.12	4.23	0.19	-26.3

APPENDIX IV: Summary of PIT Tagged Adult Returns at ZSL in 2011

Tag ID	Fish Type	Tag Site	Release Site	Date Released	Date Detected	QA/QC
3D9.1BF2000570	Wild Summer Steelhead	WEL	WELH	2-Aug-10	30-Apr-11	FALSE
3D9.1C2CDD6D1A	Wild Summer Steelhead	TWISPR	TWISPR	15-May-08	5-May-11	FALSE
3D9.1C2D042922	Summer Steelhead	RIS	RI2BYP	29-Apr-09	13-Apr-11	FALSE
3D9.1C2D414320	Summer Steelhead	BONAFF	BONAFF	8-Jul-10	14-Apr-11	FALSE
3D9.1C2D46292F	Wild Summer Steelhead	WEL	WELLD2	30-Aug-10	28-Apr-11	TRUE
3D9.1C2D46292F	Wild Summer Steelhead	WEL	WELLD2	30-Aug-10	29-Apr-11	FALSE
3D9.1C2D6158CD	Wild Summer Steelhead	WEL	WELLD2	21-Sep-10	2-Apr-11	FALSE
3D9.1C2D8E1C2D	Wild Summer Steelhead	PRDLD1	PRDLD1	17-Aug-10	24-Apr-11	FALSE
3D9.1C2D8E3CA2	Wild Summer Steelhead	PRDLD1	PRDLD1	12-Aug-10	16-Apr-11	FALSE
3D9.1C2D8E5FB6	Wild Summer Steelhead	PRDLD1	PRDLD1	21-Sep-10	20-Apr-11	FALSE
3D9.1C2D8F6F21	Wild Summer Steelhead	PRDLD1	PRDLD1	22-Jul-10	23-Mar-11	FALSE
TOTAL NUMBER OF WILD SUMMER STEELHEAD						**10**

APPENDIX IV – Continued

Tag ID	Fish Type	Tag Site	Release Site	Date Released	Date Detected	QA/QC
3D9.1BF26C227A	Hat. Summer Steelhead	LGR	LGRRBR	26-May-08	1-Apr-11	FALSE
3D9.1C2D3F308E	Hat. Summer Steelhead	BONAFF	BONAFF	5-Aug-10	18-Apr-11	FALSE
3D9.1C2D418117	Hat. Summer Steelhead	BONAFF	BONAFF	23-Jul-10	28-Apr-11	FALSE
3D9.1C2D45F081	Hat. Summer Steelhead	WEL	WELLD1	31-Aug-10	12-Apr-11	FALSE
3D9.1C2D460927	Hat. Summer Steelhead	WEL	WELLD2	21-Sep-10	12-Apr-11	FALSE
3D9.1C2D46213E	Hat. Summer Steelhead	WEL	WELLD2	26-Jul-10	28-Mar-11	TRUE
3D9.1C2D46213E	Hat. Summer Steelhead	WEL	WELLD2	26-Jul-10	14-Apr-11	FALSE
3D9.1C2D4629CC	Hat. Summer Steelhead	WEL	WELLD2	29-Sep-10	22-Apr-11	FALSE
3D9.1C2D60AE97	Hat. Summer Steelhead	WEL	WELLD2	7-Sep-10	5-May-11	FALSE
3D9.1C2D60CB76	Hat. Summer Steelhead	WEL	WELLD2	20-Sep-10	14-Apr-11	FALSE
3D9.1C2D613643	Hat. Summer Steelhead	WEL	WELLD2	29-Sep-10	27-Apr-11	FALSE
3D9.1C2D615869	Hat. Summer Steelhead	WEL	WELLD2	4-Oct-10	7-Apr-11	TRUE
3D9.1C2D615869	Hat. Summer Steelhead	WEL	WELLD2	4-Oct-10	8-Apr-11	TRUE
3D9.1C2D615869	Hat. Summer Steelhead	WEL	WELLD2	4-Oct-10	28-Apr-11	FALSE
3D9.1C2D8D38B3	Hat. Summer Steelhead	PRDLD1	PRDLD1	17-Aug-10	23-Apr-11	FALSE
3D9.1C2D8DF50C	Hat. Summer Steelhead	PRDLD1	PRDLD1	10-Sep-10	27-Apr-11	FALSE
3D9.1C2D8E0632	Hat. Summer Steelhead	PRDLD1	PRDLD1	21-Sep-10	27-Apr-11	FALSE
3D9.1C2D8E2351	Hat. Summer Steelhead	PRDLD1	PRDLD1	16-Sep-10	10-Apr-11	FALSE
3D9.1C2D8E2C10	Hat. Summer Steelhead	PRDLD1	PRDLD1	12-Aug-10	17-Apr-11	FALSE
3D9.1C2D8E2D13	Hat. Summer Steelhead	PRDLD1	PRDLD1	16-Sep-10	5-Apr-11	FALSE
3D9.1C2D8E2FC0	Hat. Summer Steelhead	PRDLD1	PRDLD1	2-Sep-10	7-May-11	FALSE
3D9.1C2D8E361E	Hat. Summer Steelhead	PRDLD1	PRDLD1	29-Jul-10	2-May-11	FALSE
3D9.1C2D8E5FA6	Hat. Summer Steelhead	PRDLD1	PRDLD1	10-Sep-10	4-Apr-11	FALSE
3D9.1C2D8E6781	Hat. Summer Steelhead	PRDLD1	PRDLD1	31-Aug-10	12-Apr-11	FALSE
3D9.1C2D8E7174	Hat. Summer Steelhead	PRDLD1	PRDLD1	3-Aug-10	24-Apr-11	TRUE
3D9.1C2D8E7174	Hat. Summer Steelhead	PRDLD1	PRDLD1	3-Aug-10	6-May-11	FALSE
3D9.1C2D8E7E37	Hat. Summer Steelhead	PRDLD1	PRDLD1	2-Sep-10	29-Apr-11	FALSE
3D9.1C2D8F6F2C	Hat. Summer Steelhead	PRDLD1	PRDLD1	14-Sep-10	26-Apr-11	FALSE

APPENDIX IV - Continued

Tag ID	Fish Type	Tag Site	Release Site	Date Released	Date Detected	QA/QC
3D9.1C2D8F8794	Hat. Summer Steelhead	PRDLD1	PRDLD1	10-Aug-10	28-Apr-11	FALSE
3D9.1C2D8F8907	Hat. Summer Steelhead	PRDLD1	PRDLD1	10-Sep-10	26-Apr-11	TRUE
3D9.1C2D8F8907	Hat. Summer Steelhead	PRDLD1	PRDLD1	10-Sep-10	2-May-11	FALSE
TOTAL NUMBER OF HATCHERY SUMMER STEELHEAD						**26**