Steelhead Spawner Enumeration in Inkaneep Creek – 2009

Authors:
Skyeler Folks, B.Sc. and Tatiana Kozlova, PhD., R.P.Bio.
Okanagan Nation Alliance Fisheries Department

Reviewed by:
Howie Wright, M.Sc., RPBio.

Prepared for:
John Arterburn
Colville Confederated Tribes

February 2010

Okanagan Nation Alliance
3255 C Shannon Lake Road,
Westbank, BC V4T 1V4
Phone: (250) 707-0095 Fax: (250) 707-0166

EXECUTIVE SUMMARY

Steelhead salmon that return to the Canadian Okanagan Basin migrate from the Pacific Ocean via the Columbia River then into Okanagan River and through Zosel Dam at the outlet of Osoyoos Lake. The video counter at Zosel Dam enumerated 424 adult steelhead (adipose clipped and unmarked) that were migrating into Osoyoos Lake between January and May, 2009. Less than this number would be expected to spawn in the Canadian portion of the Okanagan Basin due to accessible spawning creeks on the American side of Osoyoos Lake, north of Zosel Dam. Arterburn *et al.* (2010) have estimated that three (3) steelhead/rainbow trout entered Nine Mile Creek, while Tonasket Creek did not have sufficient flow for migration to occur.

The general timing of steelhead/rainbow trout spawning in Inkaneep Creek differed slightly compared to previous sampling years with fish presence beginning at the end of April and persisting to the first week of June. Migration through the fish fence on Inkaneep Creek began March 31st and continued to June 5th with no peak data indicated due to the lack of fish captured.

The fish fence enumerated a total of 20 steelhead/rainbow trout. Two were adipose clipped and of hatchery origin, with the remainder being of wild origin. The sex ratio was not determined this year. The mean fork length of all fish captured measured 50.84 $\pm$ 8.1cm.

Stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$) were used to differentiate between steelhead and rainbow trout spawners when we counted and bio-sampled them at the fish fence in 2008 and 2009. These analyses showed that spawners were mostly represented by rainbow trout. From 58 fish analyzed in 2008, 51 were rainbow trout and 7 were steelhead. From 19 fish analyzed in 2009, 16 were rainbow trout and 3 were steelhead.

A total of 93 redds were observed in the Canadian Okanagan Basin in the spring of 2009. Seventy five were located within Inkaneep Creek, while the remaining 5 were found in Vaseux Creek within the Canyon Reach below the migration barrier. Redds in both creeks were observed June 1st, and June 4th, 2009. The improved number of redds surveyed compared to previous years (Long *et al.* 2006, Benson and Squakin 2007, Folks *et al.* 2009) was likely the result of a lesser snowpack and reduced freshet resulting in less turbid conditions within the creeks.

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).

Disclaimer: Okanagan Nation Alliance Fisheries Department reports frequently contain preliminary data, and conclusions based on these may be subject to change. Please obtain the ONAFD Program manager's permission before citing this work.

Citation: Folks, S. and T. Kozlova. 2010. Steelhead spawner enumeration in Inkaneep Creek – 2009. Within the Okanagan Basin Monitoring and Evaluation Program (OBMEP). Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, BC.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

1.1 Project Background

According to Traditional Ecological Knowledge (TEK) as well as a series of historical accounts, steelhead salmon (*Oncorhynchus mykiss*) were found throughout the Okanagan Basin (Clemens *et al*. 1939; Atkinson 1967; Fulton 1970; Ernst 2000; Rae 2005), a sub-basin of the Columbia Basin. Okanagan steelhead (also known as Upper Columbia summer steelhead) numbers have declined to such an extent that they have been re-listed as an endangered species since 2007 (NOAA 2007). There is limited data about the population size and distribution of steelhead in the Canadian portion of the Okanagan Basin (Rae 2005).

In 2009, the Okanagan Nation Alliance (ONA), working with the Colville Confederated Tribes, surveyed the presence and distribution of steelhead spawners in the accessible portions of the Canadian Okanagan Basin as part of the Okanagan Basin Monitoring and Evaluation Program (OBMEP). OBMEP was created to establish a basin wide status and trend monitoring program with a 20 year life-span (Colville Tribes 2003). Within this program an annual estimation of steelhead spawner numbers (redd surveys) is completed to complement habitat surveys (including water quality and quantity surveys) and other biological surveys. This is the fifth year of the OBMEP program, while being the fourth year of steelhead spawner surveys in the Canadian portion of the Okanagan Basin. Only three years of the spawner surveys have included the use of a fish fence.

1.2 Project Objectives

To annually enumerate adult steelhead spawners returning to the Okanagan River Basin, a fish fence in Inkaneep Creek was monitored. Also, modified redd surveys in Inkaneep and Vaseux creeks were conducted as part of another project. The end objective is to determine the timing and distribution of the steelhead spawning run.

Specific objectives for operating the Inkaneep Creek fish fence included:

- Re-installation and maintenance of the fish fence on the lower reach of Inkaneep Creek throughout the spawner returns (end of March to June)
- Enumeration of all fish migrating upstream (primarily steelhead and rainbow trout)
- Collection of biological information including fish length and ratio of male to female trout
- Collection of fin samples for stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$)

Specific objectives for the redd surveys included:

- Focusing on redd surveys efforts to regions previously determined to have significant numbers of steelhead redds (Long *et al.* 2006; Benson and Squakin, 2008).
- Utilizing a fish fence in conjunction with redd surveys to determine run timing and distribution.

1.3 Study Area

The area of the Canadian Okanagan Basin currently accessible to migrating steelhead salmon occurs downstream of McIntyre Dam. McIntyre Dam (24 km upstream of Osoyoos Lake on the main stem Okanagan River) was constructed without fish passage in 1920 (Long 2005a). Downstream of McIntyre Dam, two large tributaries flow into the Okanagan system; Vaseux Creek flows into the Okanagan main stem while further downstream Inkaneep Creek flows into the north basin of Osoyoos Lake. Inkaneep Creek was again the focus of this year's steelhead spawner surveys conducted in the spring of 2009 and based on previous years sampling. In 2006 (Long *et al.* 2006) it was determined that Inkaneep Creek was the most productive spawning creek of those surveyed. In order to maximize enumeration efficiency, Inkaneep Creek was chosen for the fish fence.

In Inkaneep Creek, 3.7 km of its 23.5 km length is accessible to migrating salmon. The remainder is blocked by a 6 m high waterfall (Walsh and Long 2005). The accessible 3.7 km length of Inkaneep Creek was surveyed for steelhead redds. In addition, steelhead migrations were monitored through a fish fence located 600 m from the mouth of the creek.

In response to the blockage of fish migration at McIntyre Dam, the ONAFD and other groups have lobbied for fish passage. Construction has taken place to install 5 overshot gates at McIntyre Dam which now provide access upriver. Upstream migration was possible for the 2009 Sockeye migration period through October. Also, historically, prior to overshot gate installation, McIntyre Dam 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 McIntyre Dam - Shuttleworth Creek was occasionally included in enumerations. With fish passage now possible Shuttleworth Creek may be also included in surveys. This would help to assess the effectiveness of steelhead passage at McIntyre Dam.

Steelhead spawning distribution and timing estimates are currently based on redd surveys and fish fence data from Inkaneep Creek (Fig. 1).

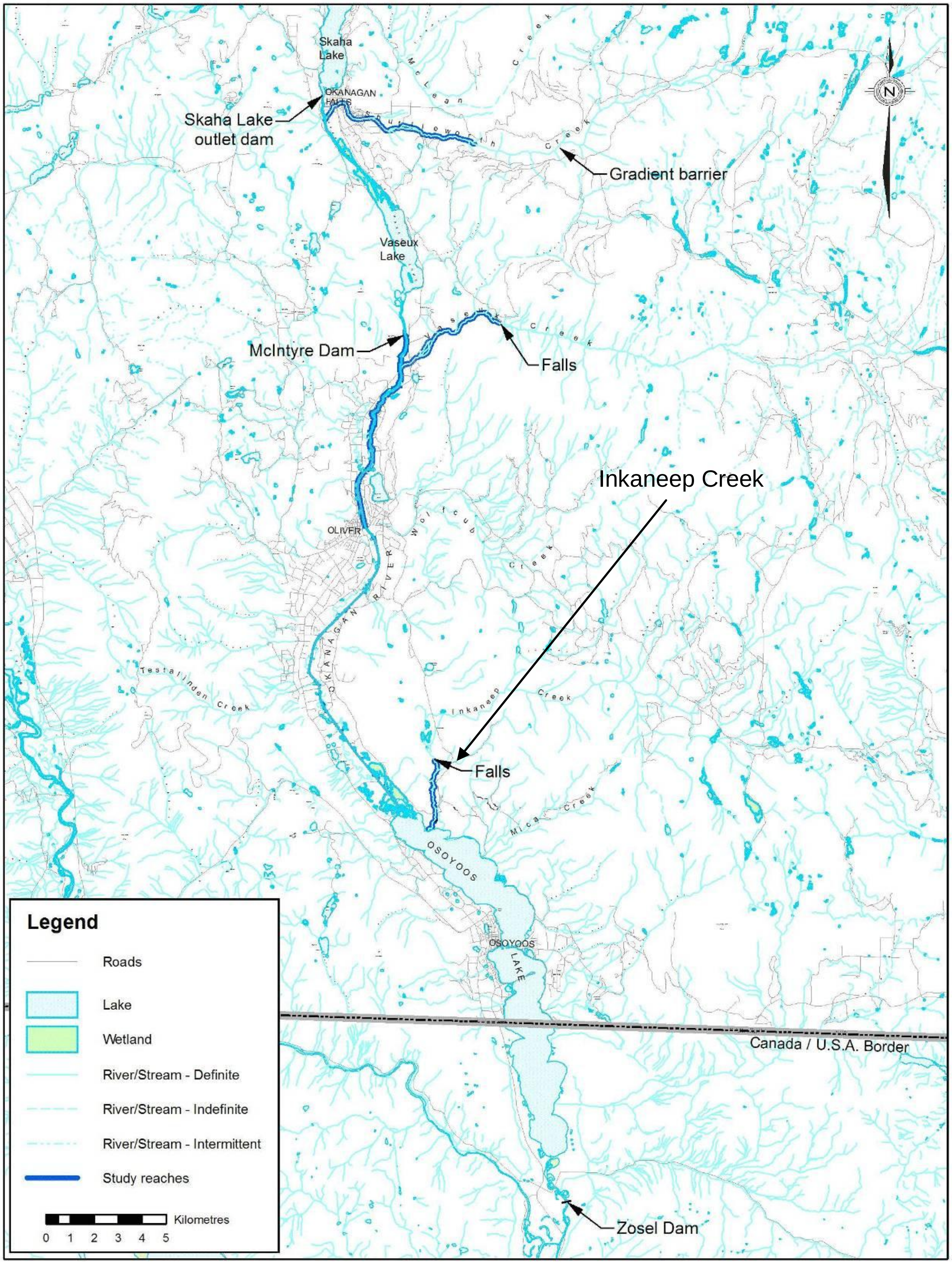

Figure 1. Canadian Okanagan Basin steelhead/rainbow trout study area

2.0 METHODS

2.1 Inkaneep Creek Fish Fence Monitoring

This year, 2009, is the fourth year of the steelhead/rainbow spawner monitoring within the Canadian Okanagan Basin, and the third year in which a fish fence has been used on Inkaneep Creek. In 2006, a fish fence provided good enumeration results compared to the sampling season in 2007 which relied primarily on redd surveys. This year's fence was installed on March 31st, 2009 and located 600m from the mouth of Inkaneep Creek (GPS N49.00077220, W119.50360). The fence was constructed during low flow conditions at mean depths of approximately 1.78m (WSC 2009). Inkaneep Creek 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 Inkaneep Creek in order to reduce the likelihood of failure.

Counts of steelhead/rainbow trout migrating into Inkaneep Creek to spawn were conducted March 31st to June 5th, 2009. 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, 2008). The fence was located at the top of a riffle, where the capture box could sit in the deeper waters of a pool (Fig. 2, Fig. 3). The fence panels were set up across the creek to herd the fish into the capture box.

Figure 2. Inkaneep Creek fish fence 2009

Figure 3. Inkaneep Creek fish fence and observed vandalism/public interference

The fish fence was checked daily from March 31st to June 5th, 2009. At each check the sampling box was monitored for fish presence. All fish were noted, irrespective of species, and steelhead/rainbow trout (Figure 4) were bio-sampled. Biological sample data included: nose fork length (cm), sex[1], adipose fin presence, fin tissue and scale samples[2]. 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, it was insured that Wenatchee Hatchery (unclipped adipose) fish, indicated by their red dye eye marks, were not released.

Figure 4. Female steelhead/rainbow trout sampled May 2009

2.2 Redd Surveys

Based on the failure of previous years surveys (2006 and 2007) to significantly detect and quantify steelhead/rainbow spawner redds, the redd survey methodology was modified to include only Vaseux and Inkaneep creeks with the majority of the survey effort in the latter. Redd detection has previously been difficult within Okanagan River tributaries due to high turbidity and high freshet flows. The decision to modify the

[1] While the intention was to collect sex data, this data is unfortunately missing.
[2] These samples will be processed in 2009/2010 for aging and stable isotope analysis to determine exposure to marine environments.

surveys was made in order to allocate resources to streams particularly productive in terms of Canadian Okanagan Basin (COB) steelhead/rainbow spawner numbers (Long *et al.* 2006; Benson and Squakin, 2008).

Combined with the fish fence, (a method proven to provide good enumeration results), redd surveys were conducted within both Inkaneep Creek and other COB waterways. Redd surveys, as mentioned, have proven difficult in previous years and have failed to provide a reliable record of spawner distribution. Thus, with improved enumeration in Inkaneep Creek along with continually improving data from Zosel Dam a more complete picture of steelhead spawning distribution can be determined.

Redd surveys were conducted by two ONAFD personnel versed in redd survey methodology. Also, one member of the Colville Confederated Tribes (CCT) participated in the survey on a number of days. The surveys took place in early June while fish were observed in the fish fence (Arterburn *et al.* 2007a; Benson and Squakin, 2008)[3]. The entire reach of Inkaneep Creek accessible to steelhead/rainbow was surveyed from the stream mouth upstream to the permanent fish barrier. The quality of each survey was recorded at the time the enumeration occurred similar to standardized protocols from the ONA sockeye salmon (*Oncorhynchus nerka*) enumerations (Alexis and Wright 2004). Information collected to determine the quality of the counts included:

- water clarity (water depth of visibility)
- weather conditions (cloud cover, brightness, precipitation)
- survey crew
- starting and ending times for the survey

The number and location (GPS) of redds were recorded as well as any note of live or dead fish present and the quality of the survey. Redds were verified by at least two trained crew members. Locations and physical data were entered into a Trimble Geo XT GPS data logger in accordance with Arterburn *et al*. (2007a). In order to prevent double-counting of existing redds, confirmed redds were marked with flagging tape tied to a tree or bush on the adjacent stream bank. The flag was marked with survey date, number of redds, and location and distance of redds from the flag.

As in past years (Long *et al.* 2006; Benson and Squakin, 2008) the VDS reach was not surveyed due to the limited steelhead/rainbow trout spawning activity (Long 2004; Long 2005b; Audy and Walsh 2006; Long *et al*. 2006; Wodchyc *et al*. 2007).

[3] Redd surveys were conducted under the Okanogan Sub-basin Habitat Improvement Program (OSHIP)

3.0 RESULTS

3.1 Inkaneep Fish Fence Monitoring

The Inkaneep fish fence was monitored for 66 days (March 31st to June 5th, 2009). After that the fence was disassembled due to warmer water temperatures and dates beyond typical migration and spawning peak times (Appendix A). During the sampling period a total of 20 steelhead/rainbows were enumerated. The fence was left in place for longer than in previous years since numbers were low. A number of factors could have affected the numbers such as any combination of low freshet, later onset of snowmelt, cooler stream temperatures, or dysfunctional fish fence. Fish were spaced over the entire sampling period and the daily catch never surpassed 5 fish.

Table 1. Counts of steelhead/rainbow trout through the Inkaneep fish fence

Date	Number of fish
21-Apr-09	3
22-Apr-09	1
2-May-09	1
3-May-09	1
9-May-09	1
12-May-09	1
14-May-09	1
16-May-09	1
24-May-09	1
26-May-09	5
1-Jun-09	2
2-Jun-09	2

Based on data collected by the ONAFD a peak date of migration and spawning is difficult to estimate this year. The fish fence did not capture enough steelhead/rainbow trout to indicate a peak date. The redd surveys in early June showed a good number of redds which indicates that spawning occurred in May, and the surveys also showed the distribution of redds. 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) make mention that this time period is also experienced in tributaries to the Okanogan River in Washington State. Peak dates have previously tended to correlate with peak water flows through Inkaneep Creek monitored at the Water Survey of Canada water gauge 08NM200 (Fig. 5). The fish fence was installed when water depths were less than 1.8 m.

In previous years, the fish fence has experienced stability issues due to freshet flows. This year, however, a year of reduced snowpack and minimal spring precipitation (WSC 2009) led to consistent flows of less than 0.8 m^3/s (Fig. 5). Previous year's peak flows have exceeded 2.0 m^3/s). While the fish fence was not structurally compromised this year, there have still been issues with either public vandalism (Fig 2) or the possibility of fish passage due to a weakened fence. Passage may have possibly occurred under the fence as a result of this year's fish fence orientation and construction.

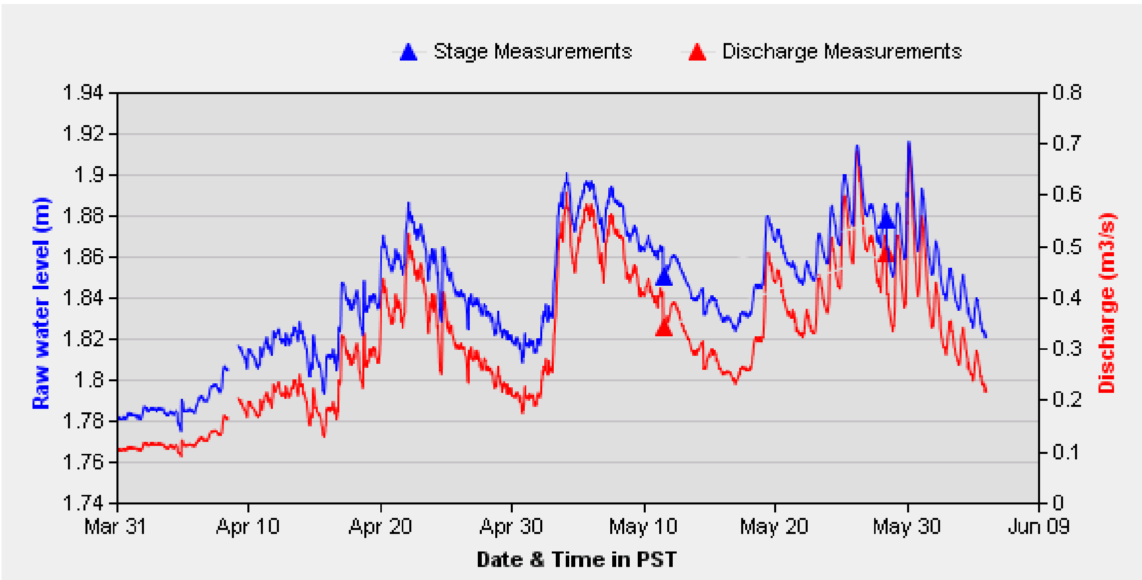

Figure 5. Water levels (blue) and discharge (red) in Inkaneep Creek at station 08NM200 (WSC 2009).

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. Peak timing this season was based on consistency of fish movement over a number of days, while the presence of 5 fish on May 26th may indicate later onset of migration. The lack of data makes peak timing determination difficult.

3.1.1 Biological sampling of Inkaneep Creek steelhead/rainbow trout

Of the 20 fish captured, 2 were adipose clipped and of hatchery origin (Appendix A). As per previous years, the majority (90% compared to 91.53% in 2008; Folks *et al.* 2009) of the fish enumerated were most likely a wild population of steelhead and/or rainbow trout. The fish fence caught 3 females, and 17 of unknown sex. Sex determination is lacking due to a miscommunication with field crews. Previous years female to male sex ratios however, have been 0.69 in 2008 and 0.85 in 2007. Osoyoos Lake is also known for having a resident adfluvial rainbow population (Long *et al.* 2006). The interaction and influence of this population on the steelhead spawners is still unknown. Stable isotope analyses (carbon δ13C and nitrogen $\delta^{15}N$) on fin tissue samples are ongoing attempts to answers these unknowns.

The average length of all the steelhead/rainbow trout that passed through the fish fence was 50.8± 8.08cm (Table 2). Comparison of male versus female mean lengths is not possible, however the range of all fish observed lies within previously observed values (Long *et al.* 2006; Benson & Squakin, 2008, Folks *et al.* 2009).

Table 2. Length of Canadian Okanagan Basin male and female steelhead/rainbow trout in 2006, 2008, and 2009.

	Count			Length			Std Dev		
	2006	2008	2009	2006	2008	2009	2006	2008	2009
Female	27	32	-	45	44	-	9	11	-
Male	23	22	-	49	46	-	11	11	-
Unknown	14	5	20	-	-	50.8	-	-	8.07
	Length Min			Length Max					
	2006	2008	2009	2006	2008	2009			
Female	16	16	-	59	60	-			
Male	31	20	-	76	67	-			
Unknown	-	-	37	-	-	75			

3.2 Stable isotope analyses for steelhead/rainbow trout spawners collected in 2008 and 2009

It is known, that Okanagan steelhead is an anadromous (migrating) rainbow trout that has spent a part of its life in the ocean. Rainbows remain in their native rivers and streams throughout their entire life cycle. 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.

In order to determine exposure to marine environment and differentiate between steelhead and rainbow trout spawners when we counted and bio-sampled them at the fish fence, stable isotope analyses (carbon $\delta^{13}C$ and nitrogen $\delta^{15}N$) were used for 2008 and 2009 samples. A total of 58 non-destructive fin tissue samples in 2008 and 19 in 2009 were collected in Inkaneep Creek. Samples were sent to the University of Regina for stable isotope analyses. The principal investigator was Dr. Bjoern Wissel.

Identifying migratory fish using stable isotope analyses is easier when the fish migrate between marine and freshwater system, which differ greatly (up to 10-15 ‰) in their stable isotope values (Peterson and Fry 1987; Doucett *et al*. 1999). Marine food webs are typically enriched in the heavier carbon isotope ($\delta^{13}C$) 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).

As stable isotope results show (Table 3), mean $\delta^{13}C$ and $\delta^{15}N$ of the rainbow trout fins were significantly depleted compared with the steelhead fins ($\delta^{13}C$, -25.1 ±0.79‰ cf. -19.2±0.84‰; $\delta^{15}N$, 15.4±1.25‰ cf. 11.9±0.96‰).

Table 3. Mean values (± standard deviation) for $\delta^{13}C$ and $\delta^{15}N$ in fins of O. mykiss sampled in Inkaneep Creek 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 6 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‰.

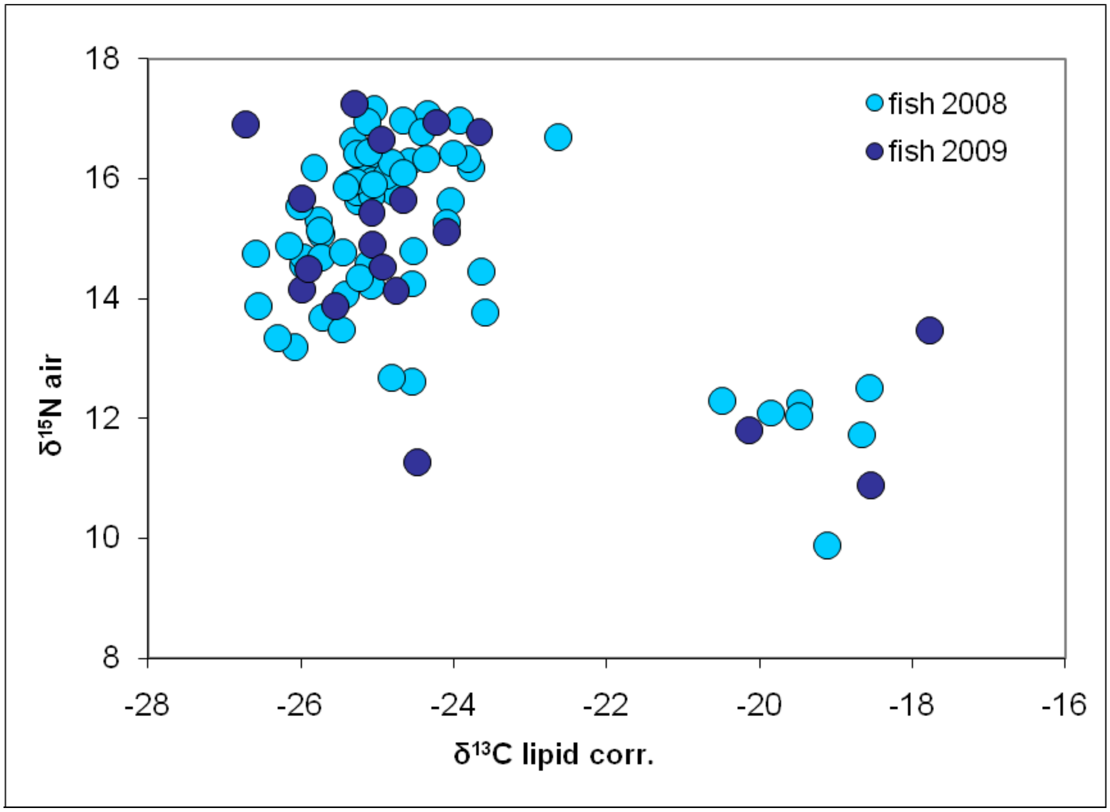

Figure 6. Combined δ13C and δ15N signatures of fin samples from *O. mykiss* (sampled in Inkaneep Creek fish fence in 2008 and 2009) identified as either resident freshwater rainbow trout (left group) or anadromous steelhead (right group).

According to stable isotope data, *O. mykiss* enumerated in Inkaneep Creek fish fence in 2008 and 2009 was mostly represented by rainbow trout (51 rainbows out of 58 fish in 2008 and 16 rainbows 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 Redd Survey Results

Inkaneep and Vaseux creeks were surveyed by ONAFD members versed in redd survey methodology. A total of 93 redds were observed in Inkaneep Creek in the spring of 2009 while 5 redds were observed in Vaseux Creek (Table 4). Distribution in both Inkaneep and Vaseux creeks were similar to what has been observed in previous years (Long *et* *al.* 2006; Folks *et al.* 2009). Inkaneep Creek redds have been observed primarily near the mouth of the creek and near the impassable falls 3.7 Km upstream. Within Vaseux Creek redds were primarily upstream within the canyon section and below the fish passage barrier where pockets of gravel accumulate around boulder-step-pool habitats.

Table 4. Steelhead redd surveys data in the Canadian Okanagan Basin

Waterbody	No of redds	Reach	Date	Comments
Inkaneep Creek	11	Mouth to fish fence	1-Jun-09	
Inkaneep Creek	10	Fish fence to Bridge	1-Jun-09	
Inkaneep Creek	72	Bridge to canyon barrier	1-Jun-09	
Vaseux Creek	0	Mouth to HWY bridge	4-Jun-09	Turbid flow, many locations could have contained redds.
Vaseux Creek	1	HWY bridge to end of braided section	4-Jun-09	
Vaseux Creek	4	End of braided section to canyon barrier	4-Jun-09	

Shuttleworth Creek and the Okanagan River were not surveyed given lack of redds in previous sampling years (Long *et al.* 2006; Benson & Squakin, 2008; Folks *et al.* 2009). However, the increased number of redds in Inkaneep Creek would lead one to expect there could have been spawning within each system. Long *et al.* (2006) found redds within side channels of the Okanagan River, which would lend one to expect additional redds within these regions for this year; however, estimates for production are not possible given the lack of surveys conducted within these regions. Table 5 demonstrates redd numbers found in both creeks in the past as well as those for this season in Inkaneep and Vaseux creeks.

Table 5. Steelhead redd surveys in the Canadian Okanagan Basin

Redd Locations	2006	2007	2008	2009
Inkaneep	10	2	6	93
Vaseux	10	1	-	5
Okanagan[4]	2	-	-	-
Shuttleworth	-	1	-	-

The total number of redds observed in 2009 has far exceeded all previous numbers – as is shown in table 5. Redd survey data clearly demonstrate a greater number of fish present than the results from the Inkaneep fish fence. Without reliable numbers from the

[4] Okanagan River and Shuttleworth Creek were not surveyed for redds in 2008 and 2009.

fish fence, population estimates should be read with an air of caution. However, based on the success of the redd surveys and the fish passage numbers at Zosel Dam one can speculate that a minimum of 196 steelhead/rainbow trout have entered the Canadian portion of the Okanagan Basin (COB). The Zosel Dam fish counter, operated by the Colville Confederated Tribes (CCT), indicates 424 clipped and unclipped steelhead/rainbow trout entered Osoyoos Lake between January and May 2009. Arterburn *et al.* (2010) note that only three fish were observed in either Nine Mile or Tonasket creeks. Subtracting fish spawned in Inkaneep Creek (93 observed redds x 2: 186 minimum), Vaseux Creek (5 observed redds x 2: 10 minimum) and the three observed in Nine Mile Creek, 225 adults remain unaccounted for.

4.0 DISCUSSION

Steelhead returning to the Canadian Okanagan Basin migrate up the Columbia River and enter the Okanogan River in Washington, then pass through Zosel Dam at the Osoyoos Lake outlet. The video counter at Zosel Dam counted a total of 424 hatchery and wild adult steelhead (or possibly rainbow trout): a 38% increase over the same time period in 2008, and the single largest return in the past 4 season's worth of enumeration data (Figure 7).

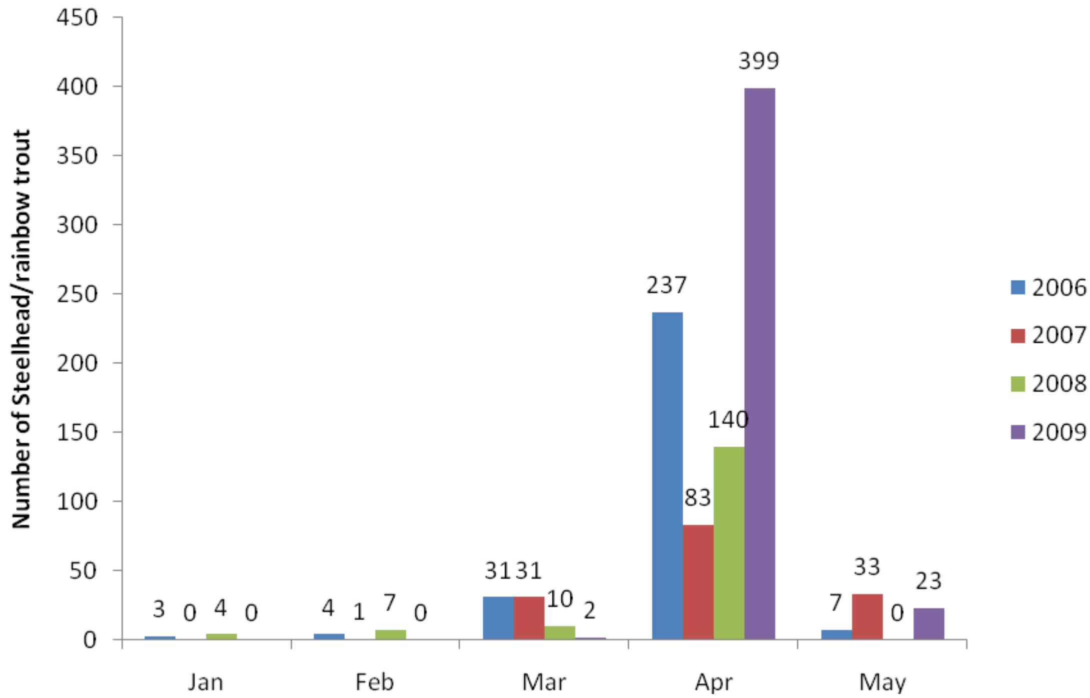

Figure 7. Adult steelhead (hatchery and wild) migrations through the Zosel Dam fish counter for 2006-2009 (Long *et al*. 2006; Benson and Squakin 2008; Columbia River DART 2009).

Within the American portion of the Southern Basin of Osoyoos Lake both Nine Mile and Tonasket creeks host populations of spawning steelhead/rainbow trout (Arterburn and Miller 2008). These numbers should be subtracted from the numbers presented as Zosel dam counts; however, as mentioned in Arterburn and Miller (2008), enumerations within these creeks has proven difficult due to private land ownership and lack of access to the creeks. The use of the fish counter on Nine Mile Creek, and counts from Tonasket Creek during flow years would be helpful to improve both the estimates of escapement within these creeks as well as steelhead/rainbow trout entering the Canadian Okanagan Basin (COB).

Of the steelhead/rainbow trout entering the COB it has been noted by Long *et al.* (2006) and Benson and Squakin (2008) that the majority return to Inkaneep Creek. As in 2008, again in 2009 most of the sampling effort was allocated to this stream. Enumeration results provided a count of 20 adults migrating past the Inkaneep Creek fish fence. These results demonstrate a consistent migration pattern to that of previous years (late April to early May peak). However, this seasons sampling continued to demonstrate limitations of the current fish fence. While this year the fish fence did not experience structural failures due to freshet flows, the fence did experience problems associated with the base of the fence. Steelhead/rainbow trout were presumed to have been able to pass under the fence through excavating bed material. For the 2010 field season a better location is required, as well as a structurally sound fish fence so as to meet both the freshet pulse demands on the fence, as well as being able to efficiently trap fish. Despite the flaws of the fish fence, an improved version should continue to be employed as an enumeration technique within Inkaneep Creek.

Population estimates will be calculated for Inkaneep Creek, Vaseux Creek, and the Okanagan River upon further collection of data from within the COB. From improved population data, distribution results will then be possible. While there are estimates from Arterburn and Miller (2008) for Canadian tributaries to the Okanagan River, further analysis of said estimates is required for management decisions to be made.

In addition to distribution and population estimates, the interaction and role of adfluvial rainbow trout is an ongoing question. The level of interaction between these fish and anadromous steelhead/rainbow trout 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 Inkaneep Creek fish fence in 2008 and 2009 was mostly represented by rainbow trout (67 rainbow trout out of 77 fish). The determination of the role of these fish in the life history of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed Okanagan Basin steelhead is of importance in determining the fate of this population.

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

5.0 RECOMMENDATIONS

1. Future steelhead surveys should continue to focus on Inkaneep Creek, as this tributary has the strongest spawning run. An improved fish counting fence used in conjunction with improved Zosel Dam counts and/or future PIT tag readers could be used to obtain a population estimate.

2. Operation of the Inkaneep Creek fish fence should follow the recommendations outlined by Long *et al*. (2006).

3. The Inkaneep fish fence should be reinforced to better cope with spring freshet flows and should be installed with more vertical slots so as to minimize fish passage under the fence.

4. Bio-sample collection and stable isotope analyses should continue in 2010 to move towards better understanding the adfluvial/anadromous interaction and life history of Okanagan steelhead/rainbow trout. Also, sex ratio data should be collected in the future.

5. Redd surveys on all Canadian Okanagan Basin (COB) tributaries and streams should be utilized to determine fish distribution and to strengthen information collected at the fish fence.

6. Continue to examine alternative enumeration methods to better determine distribution results of steelhead/rainbow trout within the COB, including PIT tag technologies.

7. 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.

6.0 REFERENCES

Alexis, F. and R.H. Wright. 2004. Okanagan river sockeye spawner enumeration and biological sampling 2003. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, B.C.

Arterburn, J., K. Kistler, P. Wagner, R. Dasher. 2007a. Okanogan monitoring and evaluation program field manual: Redd survey methodology. Final Draft. March 7, 2007. Prepared by Colville Tribes Department of Fish and Wildlife, Omak, WA.

Arterburn, J., K. Kistler, C. Fisher, and M. Rayton. 2007b. Okanogan Basin spring spawner report for 2007. Prepared by Colville Tribes Department of Fish and Wildlife, Omak, WA.

Arterburn, J.A., B. Miller. 2008. Spring spawner estimates for the Okanagan River basin (2008). Prepared by Colville Tribes Department of Fish and Wildlife, Omak, WA.

Arterburn, J.A., B. Miller, J. Panther, 2010. 2009 Okanagan Basin steelhead redd surveys. Prepared by Colville Tribes Department of Fish and Wildlife, Omak, WA.

Atkinson, R.N. 1967. Historical souvenir of Penticton, BC 1867-1967. Harris, J.G. (ed). Penticton Branch of the Okanagan Historical Society, Penticton.

Audy, N., and M. Walsh. 2006. Okanagan River sockeye spawner enumeration and biological sampling 2005. Prepared by Okanagan Nation Alliance – Fisheries Department, Westbank, BC.

Benson, R., and M. Squakin. 2008. Steelhead spawner enumeration in the Okanagan River mainstem and tributaries: Inkaneep, Vaseux and Shuttleworth creeks – 2007. Within the Okanagan Basin Monitoring and Evaluation Program (OBMEP). Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Columbia River DART. 2009. www.cbr.washington.edu/dart/dart.html

Colville Tribes. 2003. Project #2003-02200. http://nrd.colvilletribes.com/obmep/pdfs/Final%20FY06%20SOW.pdf

Clemens, W.A., D.S. Rawson, and J.L. McHugh. 1939. A biological survey of Okanagan Lake British Columbia. Fisheries Research Board of Canada, Ottawa, 70pp.

Doucett, R.R., W. Hooper, and G. Power. 1999. Identification of anadromous and nonanadromous brook trout and their progeny in the Tabusintac River, New Brunswick, by means of multiple-stable-isotope analysis. Transactions of the American Fisheries Society, 128: 278-288.

Ernst, A. 2000. Aboriginal fisheries information within the Okanagan Basin. Vedan, A. (ed). Prepared for the Okanagan Nation Fisheries Commission, Westbank, BC.

Folks, S., M. Squakin, and T. Kozlova. 2009. Steelhead spawner enumeration in Inkaneep Creek – 2008. Within the Okanagan Basin Monitoring and Evaluation Program (OBMEP). Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye and chum salmon in the Columbia River Basin – Past and Present. Washington, U.S. National Marine Fisheries Service.

Hesslein, R.H., K.A. Hallard, and P.Ramlal. 1993. Replacement of sulfur, carbon, and nitrogen in tissue of growing broad whitefish (Coregonus nasus) in response to a change in diet traced by δ^{34}S, δ^{13}C, and δ^{15}N. Canadian Journal of Fisheries and Aquatic Sciences, 50: 2071-2076.

Long, K. 2005a. History and configuration of Okanagan Falls, BC. prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Long, K. 2005b. Okanagan River sockeye spawning habitat assessment 2004. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Long, K. 2004. Okanagan River sockeye spawner enumeration and biological sampling 2004. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Long, K., M. Squakin, and C. Louie. 2006. Steelhead spawner enumeration in the Okanagan River mainstem and tributaries: Inkaneep, Vaseux, and Shuttleworth creeks – 2006. Within the Okanagan Basin Monitoring and Evaluation Program (OBMEP). Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, B.C.

McCarthy, I.D., and S. Waldron. 2000. Identifying migratory Salmo trutta using carbon and nitrogen stable isotope ratios. Rapid Communications in Mass Spectrometry, 14, 1325-1331.

NOAA (National Oceanic and Atmospheric Administration). 2007. www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Steelhead/STUCR.cfm

Peterson, B.J., and B. Fry. 1987. Stable isotopes in ecosystem studies. Annual Review of Ecology and Systematics, 181: 293-320.

Rae, R. 2005. The State of fish and fish habitat in the Okanagan and Similkameen Basins. Prepared for the Canadian Okanagan Basin Technical Working Group, Westbank, BC

Walsh, M., and K. Long. 2005. Survey of barriers to anadromous fish migration in the Canadian Okanagan sub-basin. Prepared by the Okanagan Nation Alliance Fisheries Department, Westbank, BC.

Water Survey of Canada (WSC) 2009. Retrieved from http://www.wsc.ec.gc.ca

Wodchyc, K., L. Wiens and R. Benson. 2007. Okanagan River sockeye spawner enumeration and biological sampling 2006. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.

APPENDIX A – 2009 Fish Fence Survey Data

Steelhead Bio-sampling					
Fish #	Length (cm)	Adipose clip	Fin sample	Scale# book-box	Photo #
27950	54.5	N	Y	69472-1	
27951	44	N	Y	69472-2	
27952	45	N	Y	69472-3	
27953	75	N	Y	69472-4	
27954	60	Y	Y	69472-5	129-2377
27955	49.5	N	Y	69473-6	AS photos
27957	56	Y	Y	69472-7	N/A
27959	44	N	Y	69472-8	N/A
					137-2446
N/A	45.5	N/A	N/A	69472-9	137
27960	57.5	N	Y	69472-10	
27961	51	N	Y	69472-11	
27962	51.5	N	Y	69472-12	N/A
27963	51	N	Y	69472-13	Y
27964	47.5	N	N/A	69472-14	Y
27965	52	N	Y	69472-15	N
27992 (?)		N	Y	N/A	Y
27972	44	N	Y		167-blue
27973	37	N	Y		167-blue
27970	53	N	Y	69472-17	N/A
27971	48	N	Y	69472-16	N/A
COUNT	**20**				

APPENDIX B – 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 ID	type	date	$\delta^{15}N_{AIR}$	$\delta^{13}C_{VPDB}$	%N	%C	C/N	% fat lipid corr.	$\delta^{13}C_{VPDB}$ 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 ID	type	date	$\delta^{15}N_{AIR}$	$\delta^{13}C_{VPDB}$	%N	%C	C/N	% fat lipid corr.	$\delta^{13}C_{VPDB}$ 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