

Steelhead spawner enumeration in the Okanagan River mainstem and tributaries: Inkaneep, Vaseux and Shuttleworth creeks - 2006



Author:

Karilyn Long, BSc & Mason Squakin
Okanagan Nation Alliance Fisheries Department
&
Colette Louie
Osoyoos Indian Band

Prepared for:

John Arterburn,
Colville Confederated Tribes

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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 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 147 clipped and 152 unmarked steelhead migrating into Osoyoos Lake. A total of 22 redds were observed in Canadian Okanagan Basin water-bodies surveyed in the spring of 2006. Ten redds were observed in each Vaseux and Inkaneep creeks. No redds were observed in Shuttleworth Creek with only two redds observed in the Okanagan River mainstem.

The general timing of fish migrating to the spawning areas for Vaseux Creek is between April 4th when no redds were observed and June 26th when all 10 redds were observed. Fish migrating into Inkaneep Creek began April 6th and peaked after April 25th however the bulk of fish were most likely on the spawning grounds by May 15th. In the case of the tributaries, fish migration corresponded with freshet flows that began late April. On the mainstem Okanagan River redds were noted as early as April 5th.

Along with redd surveys, a fish fence was monitored on Inkaneep Creek for 34 days (March 27th to April 29th, 2006) after which the fence blew out and was not able to be replaced until May 15th when the fence remained for only three days (until May 17th) before it was blown-out again by high flows. During the first 34 days when the fish fence was operational a total of 64 steelhead/rainbow trout migrated past the fence.

Of the 64 fish captured, none were adipose clipped and therefore are wild populations of steelhead/rainbow trout. The fish fence caught 23 male fish and 27 females with 14 undetermined. This sex ratio is fairly even with a male-to-female ratio of 0.85. Male steelhead/rainbow trout averaged 49 ± 11 cm long compared to the slightly smaller females that averaged 45 ± 9 cm long.

ACKNOWLEDGEMENTS

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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 (Atkinson 1967; Clemens et al. 1939; Ernst 2000; Fulton 1970; Rae 2005), a sub-basin of the Columbia Basin. Since these early days, Okanagan Steelhead (also known as Upper Columbia Summer Steelhead) numbers have declined to such an extent that they have been listed as an endangered species since 1997 (NOAA 2005). Today little is known about the population size and distribution of steelhead in the Canadian portion of the Okanagan Basin (Rae 2005).

In 2006, the Okanagan Nation Alliance (ONA) working with the Colville Confederated Tribes (CCT) 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 (CCT 2003). Within this program an annual estimation of steelhead spawner numbers (redd surveys and fish fence sampling) is completed to complement habitat surveys (including water quality and quantity surveys) and other biological surveys (snorkel and benthic invertebrate sampling).

1.2 Project Objectives

To estimate the return of steelhead to spawn a combination of (1) redd surveys in selected tributaries and the mainstem Okanagan was completed as well as (2) collecting population information from a fish fence in Inkaneep Creek. Specific objectives for the redd surveys include,

- surveying sections of the mainstem Okanagan River accessible to steelhead noting the presence and location of redds,
- surveying tributaries accessible to steelhead (Shuttleworth, Vaseux and Inkaneep creeks) again recording the presence and location of redds, and
- use the survey information to develop a more streamlined survey by recommending priority reaches to be surveyed in future years.

Specific objectives for the Inkaneep Creek fish fence include,

- installation and maintenance of the fish fence on the lower reach of Inkaneep Creek throughout the spawner returns (March to June),
- enumeration of all upstream migrating fish (primarily steelhead and rainbow trout), and
- collection of biological information including fish length and ratio of male to female trout.

1.3 Study Area

The area of the Canadian Okanagan Basin currently accessible to migrating steelhead salmon occurs downstream of McIntyre Dam. McIntyre Dam (24km upstream of Osoyoos Lake on the mainstem Okanagan River) was constructed without fish passage in 1920 (Long 2005a). Redd surveys were carried out on the Okanagan River from McIntyre Dam to its mouth with Osoyoos Lake.

Downstream of McIntyre Dam two large tributaries flow into the Okanagan system; Vaseux Creek flows into the Okanagan mainstem while further downstream Inkaneep Creek flows into the north basin of Osoyoos Lake. Vaseux Creek has a migration barrier in the form of boulder falls 5.5 km upstream of its confluence with Okanagan River (Walsh and Long 2005). The creek flows through a steep walled canyon then over its alluvial fan before reaching its confluence with the Okanagan River. Both reaches were surveyed for spawning steelhead in the spring of 2006.

In Inkaneep Creek, 3.7 km of its 23.5 km length is accessible to migrating salmon (Walsh and Long 2005) due to a 6 m high waterfall. The entire 3.7 km length of Inkaneep Creek was surveyed for steelhead redds as well as the monitoring of trout migrations through a fish fence located 575m from the mouth of the creek.

Projects are in progress to consider the options for providing fish passage at McIntyre Dam in the near future. Because of this work and that McIntyre Dam can be operated for short periods of time in the spring freshet in such a way that migration of salmon is possible, a main tributary upstream of McIntyre Dam, Shuttleworth Creek was included in the redd survey.

In summary, steelhead population and distribution estimates are based on redd surveys in the Okanagan River mainstem as well as the tributaries; Vaseux, Shuttleworth and Inkaneep creeks and the Inkaneep Creek fish fence (Fig. 1).

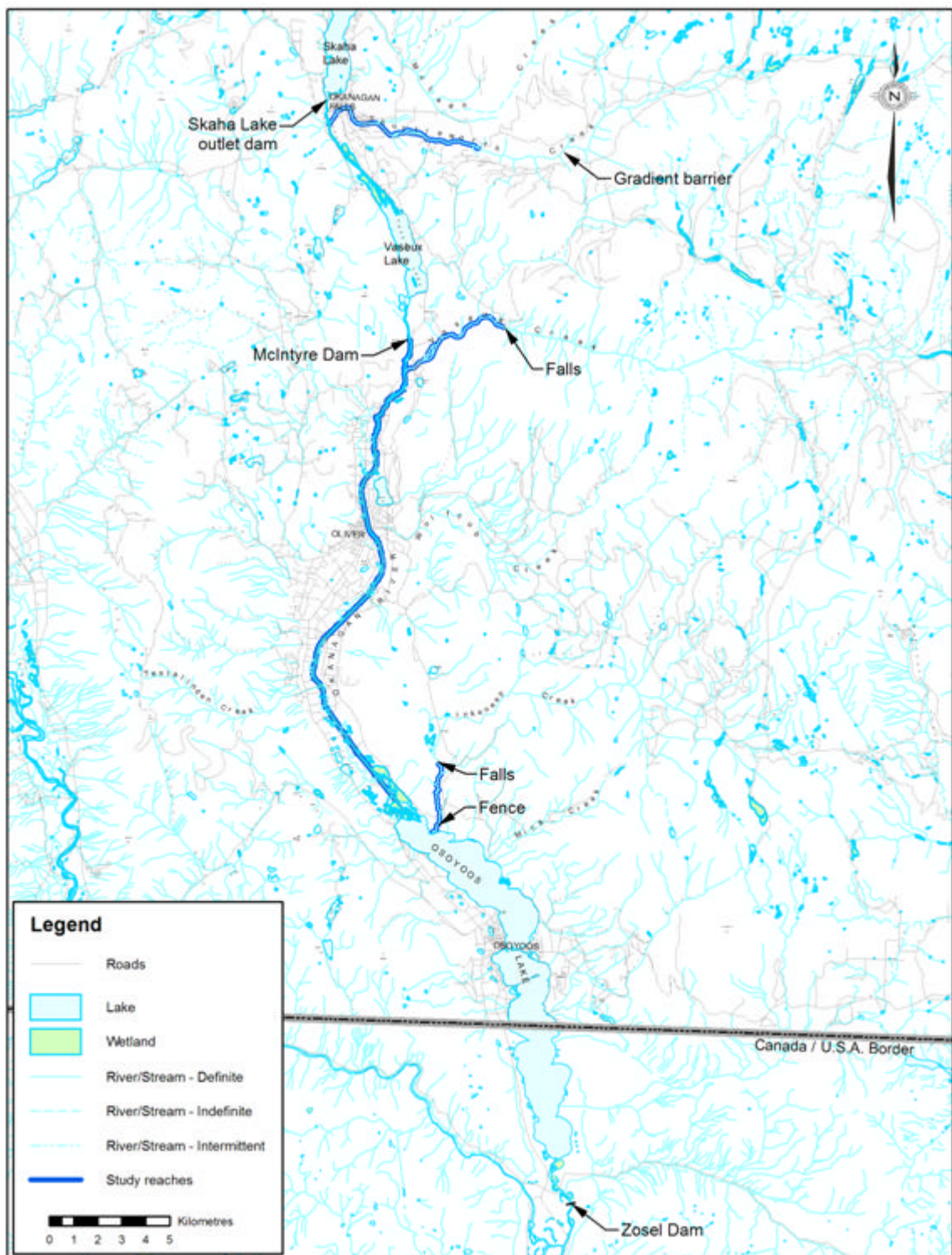


Figure 1. Study area

2.0 METHODS

2.1 Redd Surveys

Steelhead redd surveys occurred between April 5th and June 26th, 2006. Surveys were exploratory in nature as it was important in this first year to survey the entire accessible stream repeating reaches where redds were either suspected to occur or were located. Methods used were based on protocols set out in Arterburn et al. (2005b). Similar crew members were used on all the surveys. Crew members were wearing brimmed hats and polarized glasses for the surveys. The two areas surveyed are the mainstem and tributary streams (Table 1).

Table 1. Reaches sampled during the 2006 redd surveys in the Canadian Okanagan

Study area	Stream	Reach descriptions		Reach length (km)
Mainstem	Okanagan Rv	Dam reach	McIntyre Dam to Deer Park Estates	1
Mainstem	Okanagan Rv	Index reach	Deer Park to Lougheed Property	5
Mainstem	Okanagan Rv	VDS reach	Lougheed Property to VDS1	18
Tributary	Vaseux Creek	Fan reach	Flume to 3km	2.3
Tributary	Vaseux Creek	Canyon reach	3km to 5.5km	2.5
Tributary	Shuttleworth Cr	Lower reach	Mouth to 2.2 km up logging road	5
Tributary	Shuttleworth Cr	Canyon reach	Start 2.2 km up logging road	2.5
Tributary	Inkaneep Creek	Downstream of the fish fence	Mouth to 575m	0.6
Tributary	Inkaneep Creek	Upstream of fish fence	Fish fence to falls	3.1

The quality of each survey was also recorded at the time the enumeration occurred similar to standardized protocols from the ONA sockeye enumerations (Alexis & Wright 2004). Information collected to determine the quality of the counts include,

- fish visibility (recorded as high, medium and low),
- water clarity (water depth of visibility),
- weather (cloud cover, brightness, precipitation),
- survey crew,
- start and end time 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.

The 24km long Okanagan River mainstem was broken down into three reaches. The bulk of spawning and spawning areas are typically found in what is referred to as the *index reach* (Audy and Walsh 2006; Long 2005b). The index reach was surveyed three times while the *dam* and the *VDS reaches* were both surveyed once. The VDS reach was surveyed over two days as visibility conditions degraded in the afternoon of the first day and the survey was completed a week later.

The dam survey was completed by a walking survey by a three person crew, where the index and VDS reaches were surveyed using the same 3 person crew in a one boat float (Fig. 2). During the float, side channels were walked due to their shallower water depths. All surveys were done at similar times of day (during the early afternoon). The water flows remained high in Okanagan river mainstem starting the end of April and continued until well into July 2006.



Figure 2. Floating surveys in the VDS reach

Tributary redd survey counts were conducted on foot, starting at the downstream most point and working upstream (Fig. 3). Crew members walked on either bank and walked each side channel encountered. In addition to the regular stream walks, Inkaneep Creek was surveyed just after the fish fence was installed to determine if any steelhead or rainbow trout had migrated into the system prior to the fence being installed. With water flows following a natural hydrograph, spring freshet began mid to end of April and flows remained high until mid June.



Figure 3. Walking surveys of the tributaries (Shuttleworth Creek)

2.2 Inkaneep Creek Fish Fence Monitoring

A fish fence was located 575m from the mouth of Inkaneep Creek (GPS co-ordinates: 49.074722, 119.501944). Counts of steelhead/rainbow trout migrating into Inkaneep Creek to spawn were conducted March 27th to May 23rd, 2006. Installation of the fish fence occurred before the early steelhead spawners migrated into the system. This was confirmed by stream walks upstream of the fence just after the fence was installed. The fence was located at the top of a riffle, where the capture box could sit in the deeper waters of a pool (Fig. 4). The fence panels were set up across the creek to herd the fish into the capture box.



Figure 4. Inkaneep Creek fish fence

The fish fence was checked at least twice daily from March 27th to April 29th and May 15th to 17th, 2006. At each check the capture box was monitored for the presence of fish. All fish were noted and steelhead/rainbow trout were bio-sampled. Biological samples include noting the nose-fork length (cm) and sex of each fish as well as photographing each fish (Fig. 5). All diligence was taken to minimize handling and stressing the fish. Insuring that there were no fish from the Wenatchee hatchery (unclipped) each fish was checked for the red dye mark in the eye. The fish were then released into a pool in the close radius of the capture box and were also monitored while recovering in the pool. Once the capture box was checked further fence maintenance included cleaning debris from the panels and the box and checking pickets to insure there were no breaches of the fence.



Figure 5. Processing samples from the capture box

The fence was constructed when water levels were 1.5m (WSC 2006). The spring freshets this year meant Inkaneep Creek experienced water levels well over expected levels due to heavy rains and higher than normal snow packs (RFC 2006). The heavy rains caused the crew to add additional fence panels to cope with the increase in flows. However, the higher than normal snow packs melted by warmer weather in the last week of April caused a large freshet in Inkaneep Creek that overwhelmed the fish fence by not only the high flows but the increase in large debris brought down. As a result the fish fence was blown out on April 29th (Fig. 6).



Figure 6. Photo of the high water that blew out the fish fence

After the water levels dropped and was once again safe to work in, the fence was relocated 50 m upstream on May 15th 2006 (Fig. 7). The efforts at this point were to try and capture the remaining migration and give us an idea of run timing. Unfortunately the fish fence was blown out again on May 17th with a second pulse of the freshet which remained too high for the fence to be operational until well into June and therefore it was not reinstalled again.



Figure 7. Photo of the second fish fence site

3.0 RESULTS

3.1 Redd Survey Results

A total of 22 redds were observed in the water-bodies surveyed in the spring of 2006 (Table 2; Appendix A). Ten redds were observed in each Vaseux and Inkaneep creeks. No redds were observed in Shuttleworth Creek and only two redds were observed in the Okanagan River mainstem.

Table 2. Redds observed in the water-bodies surveyed

Water-body	No of redds	GPS coordinates	Date observed	Comments
Inkaneep Creek	2	49.087806 119.503111	26-Jun-06	
Inkaneep Creek	2	49.073917 119.503667	26-Jun-06	
Inkaneep Creek	2	49.091389 119.501389	26-Jun-06	
Inkaneep Creek	2	49.096861 119.503139	26-Jun-06	
Inkaneep Creek	2	49.072500 119.511833	21-Apr-06 26-Jun-06	3 fish observed holding over or near the redds (April)
Vaseux Creek	2	49.255611 119.511833	26-Jun-06	
Vaseux Creek	5	49.258556 119.502667	26-Jun-06	GPS signal weak
Vaseux Creek	3	49.257667 119.499694	26-Jun-06	GPS signal weak
Okanagan River	1	49.235278 119.533889	26-Apr-06 5-Apr-06	
Okanagan River	1	49.221111 119.545000	26-Apr-06	

Both redds in the main-stem were located in side channels (Fig. 8). Redds located in Vaseux Creek occurred primarily in the canyon from 3km upstream of the mouth to the boulder falls located at 5.5km (Fig. 9). These redds were typically found in the pockets of gravel that accumulate around the boulder-step-pools typical of the canyon. Redds located in Inkaneep Creek were dispersed starting 1km from the mouth and extending to the falls at 3.7km. Inkaneep Creek redds were located at gravel bars and gravel margins within the cobble riffle habitat typical of these lower reaches (Fig. 10).

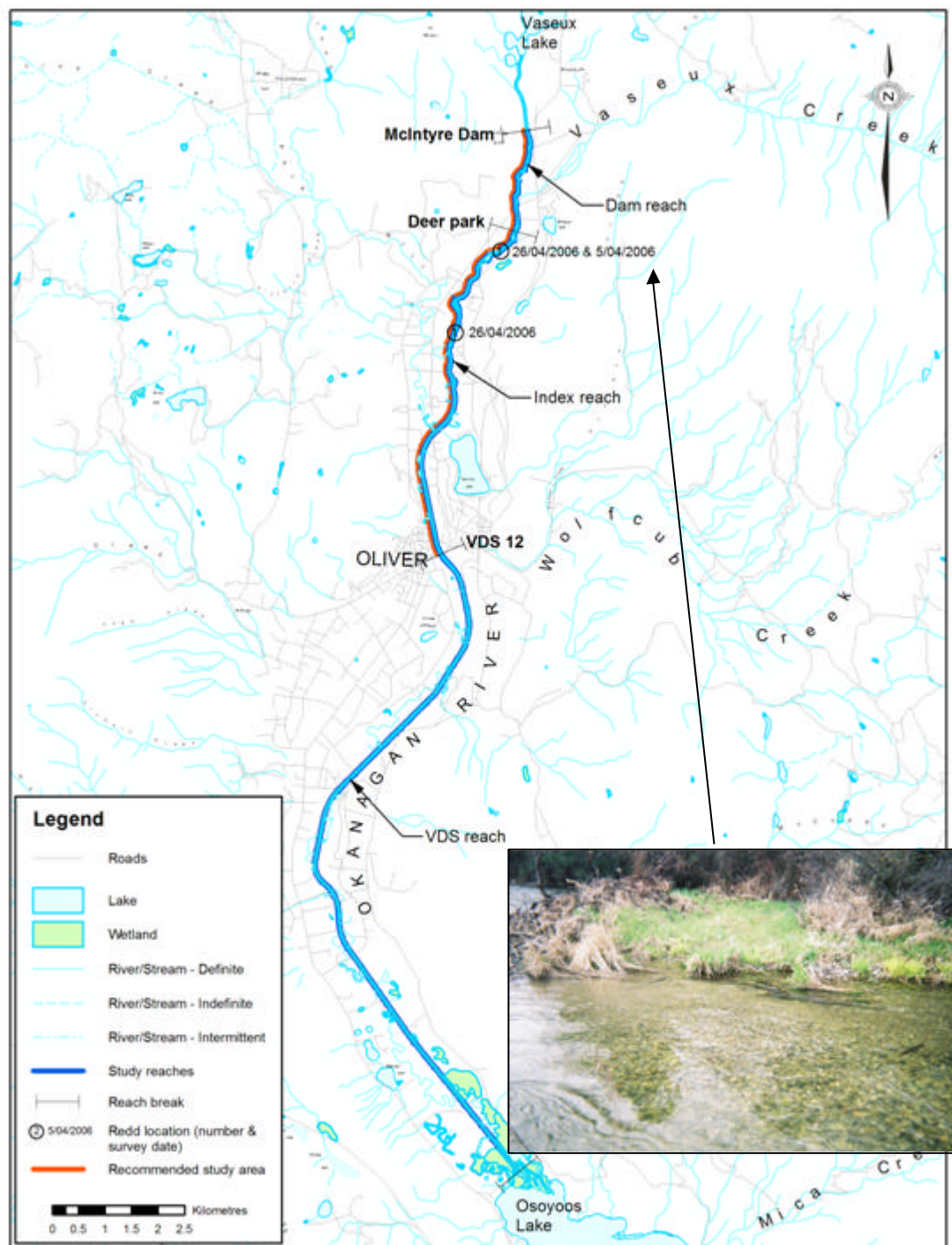


Figure 8. Redds in the Okanagan River mainstem

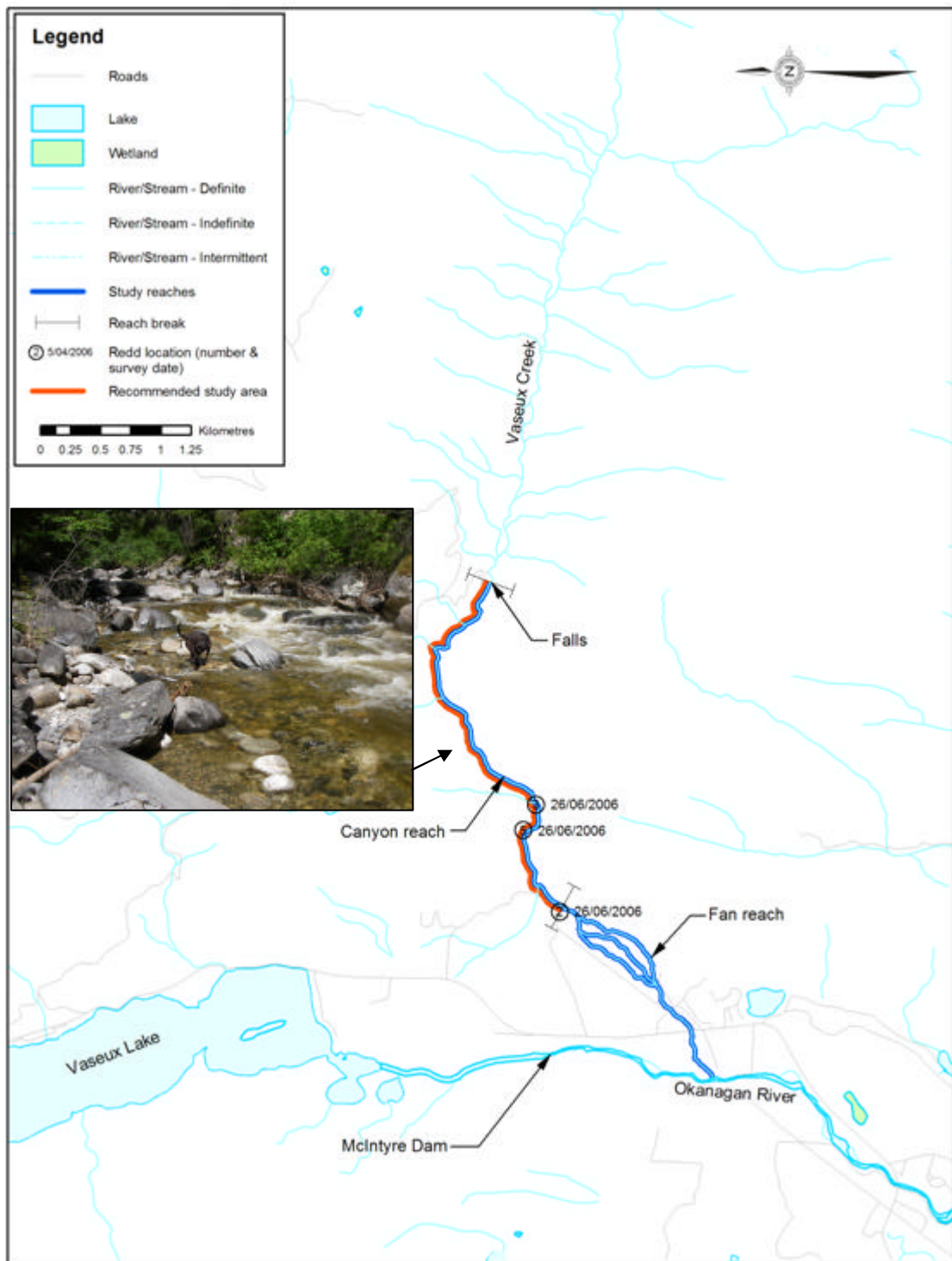


Figure 9. Redds in Vaseux Creek

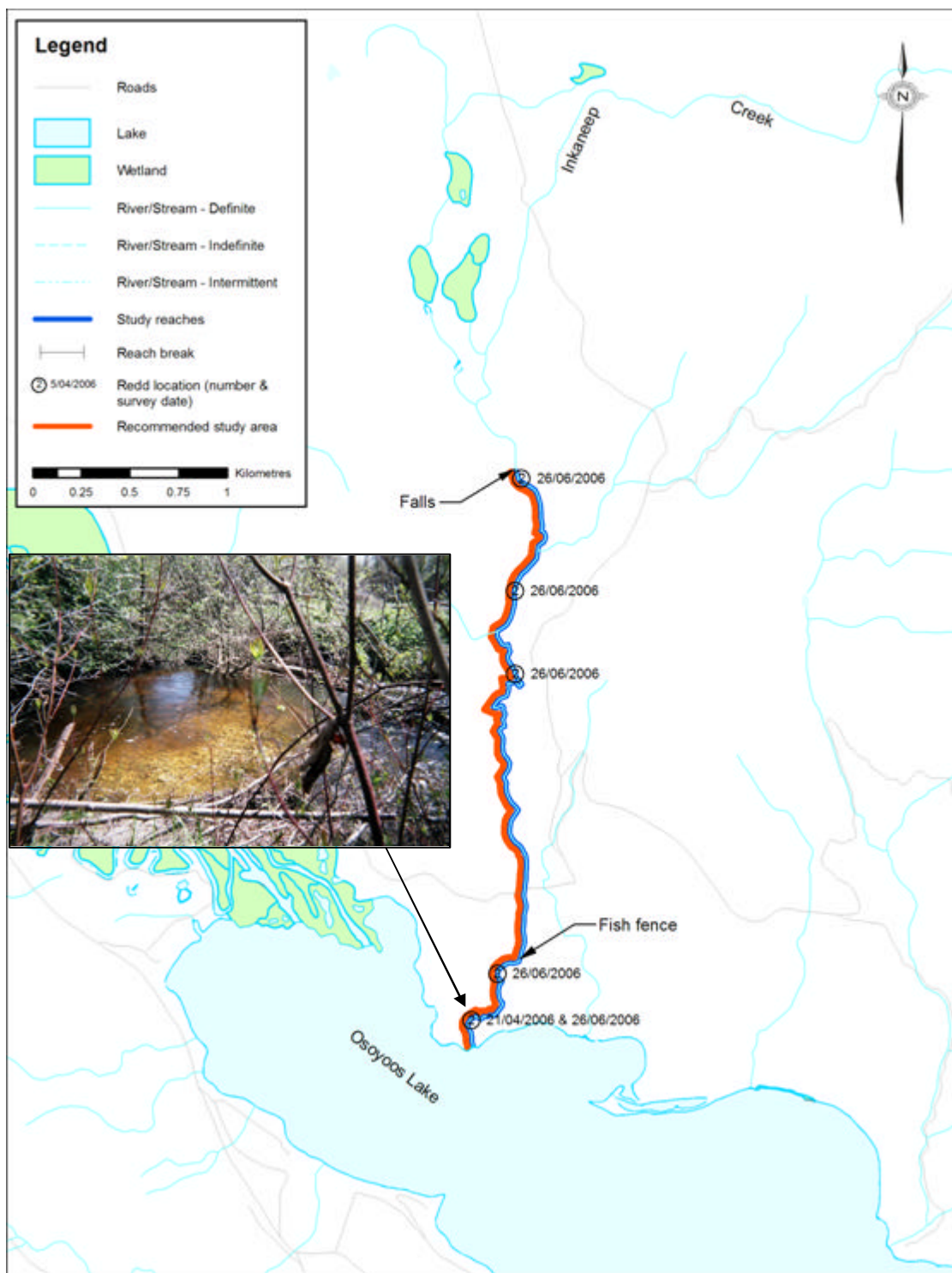


Figure 10. Redds in Inkaneeep Creek

Shuttleworth Creek enters the Okanagan River upstream of McIntyre Dam, the upstream most point of salmon migration, however this year on May 9th, 2006 (WSC station #08NM050) the dam was operated for flows of over 50 m³/s where the dam gates were raised above the water level therefore allowing for upstream migrations. Given that steelhead could access Shuttleworth Creek this year, we were hoping to see redds however the spawning areas in this creek appear to be limiting (Fig. 12).

The length of Shuttleworth Creek surveyed for redds was 7.5 km (lower and canyon reaches) to focus on the boulder-step-pool habitat in the canyon reach where the bulk of spawning sized gravel is accumulating (Fig. 11). However, a few more years of data at a variety of flows would be beneficial before reducing reach lengths.

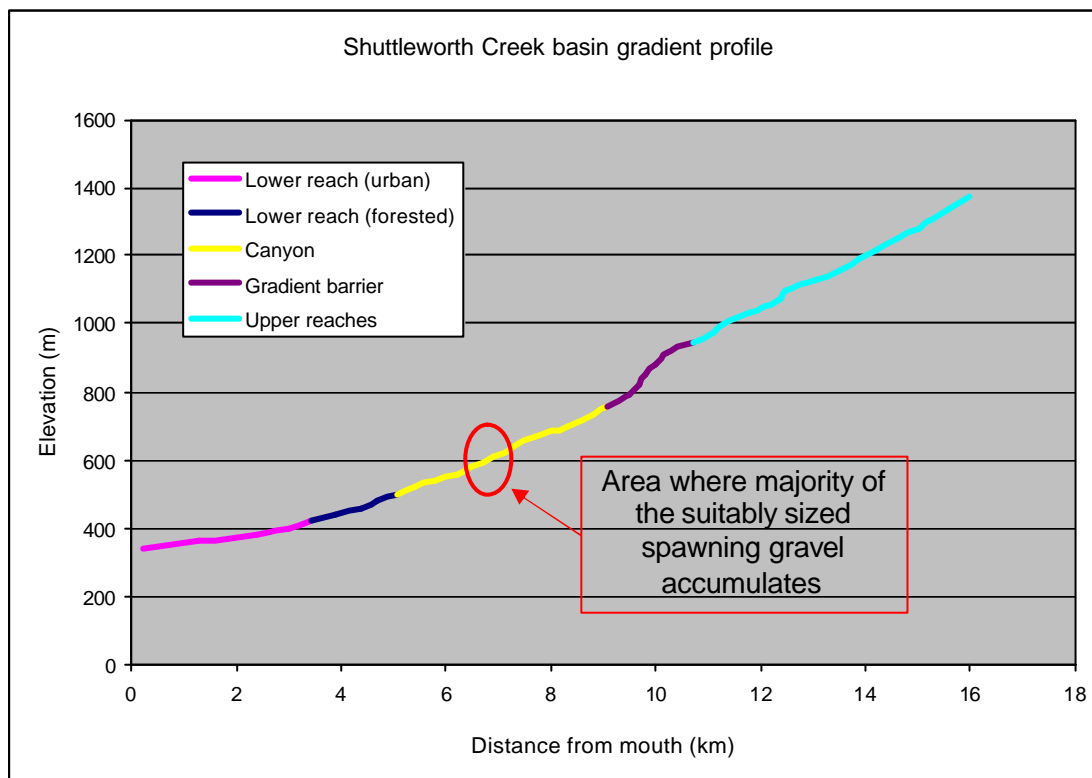


Figure 11. Basin long gradient profile of Shuttleworth Creek

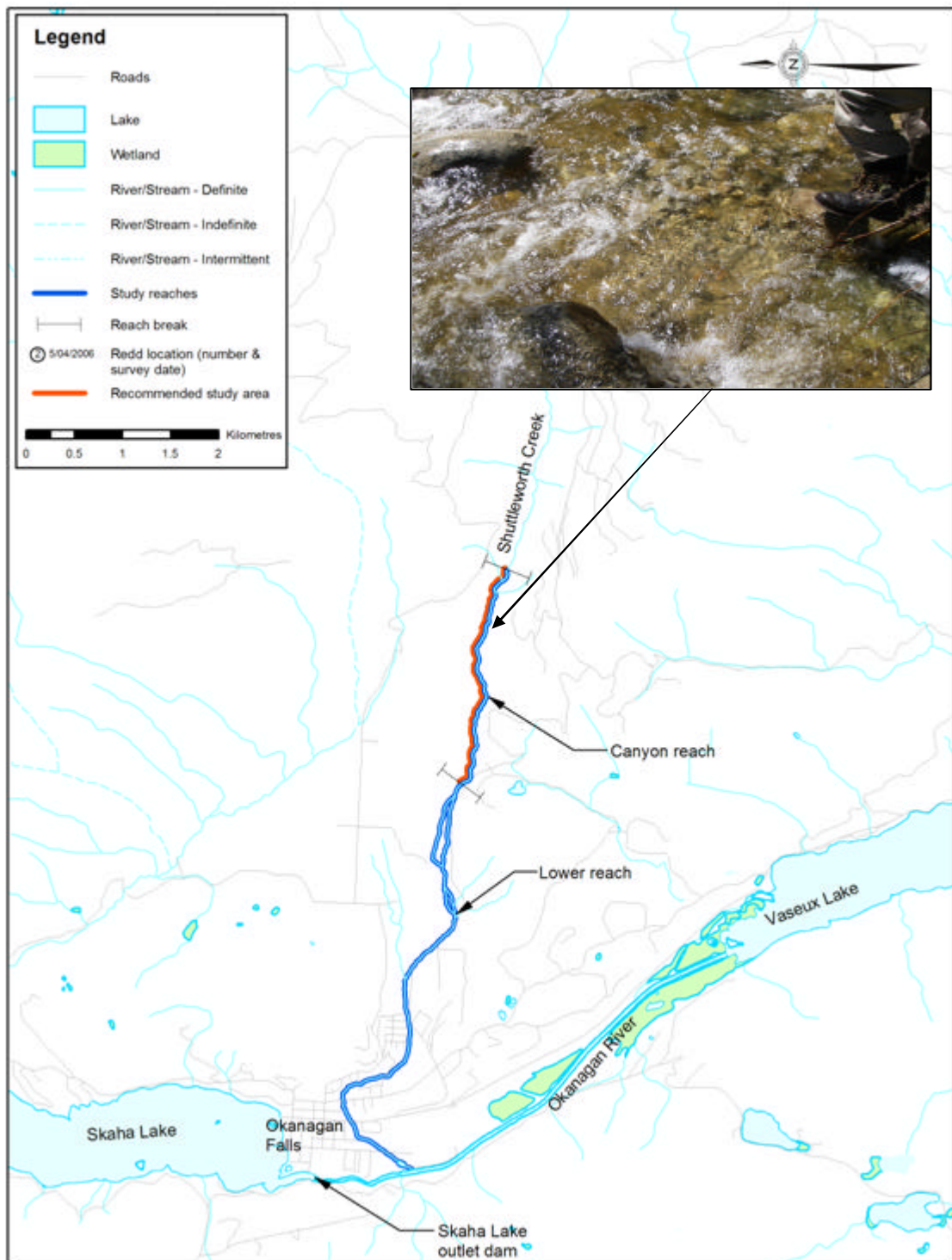


Figure 12. Survey area in Shuttleworth Creek 2006 and suggested survey area

3.2 Inkaneep Creek Fish Fence Enumeration

The Inkaneep Creek fish fence was monitored for 34 days (March 27th to April 29th, 2006) after which the fence blew out and was not able to be replaced until May 15th when the fence remained for only three days (until May 17th) before it was blown-out again by high flows. During the first 34 days the fish fence was operational, a total of 64 steelhead/rainbow trout migrated past the fence. Over the three days in May, when the fish fence was replaced, only one spawned out steelhead/rainbow trout was caught as it washed against the upstream side of the fence. This fish was not one of the 64 that originally was counted migrating past the fence. Looking at the daily migration patterns of steelhead/rainbow trout past the fence (Fig 13), peaks in migration occurred on April 10th, 21st, and 25th.

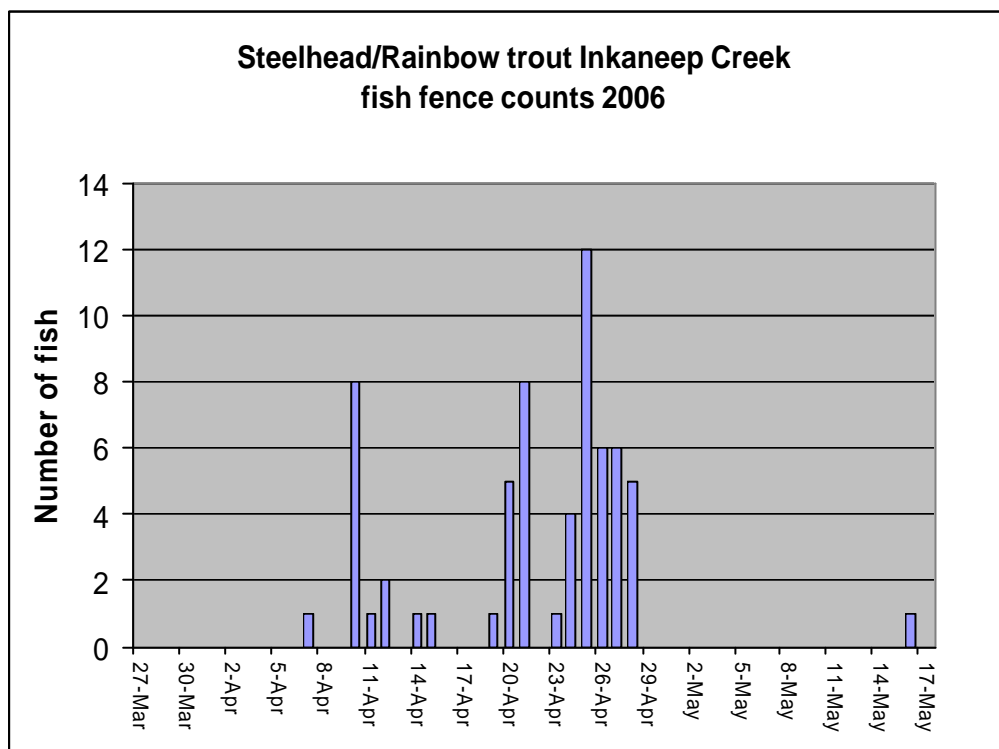


Figure 13. Daily counts of steelhead/rainbow trout through the Inkaneep Creek fish fence

The daily peaks in migration correspond with days of high water flows and high water turbidity recorded 500m upstream of the fish fence at Water Survey of Canada station 08NM200 (Fig 14). The fish fence was installed during water levels of 1.5m. On peak fish migration days (April 10th, 21st and 25th) the water levels rose drastically in relation to heavy rains early in April). By late April and into May the warmer air temperatures created snowmelt causing the spring freshet to occur. By the time we had to pull the fish fence out the second time (May 17th) the water levels had risen to 2.5m, a meter higher than when the fish fence was put in place. At water levels of near 2m the capture box of the fish fence is completely under water.

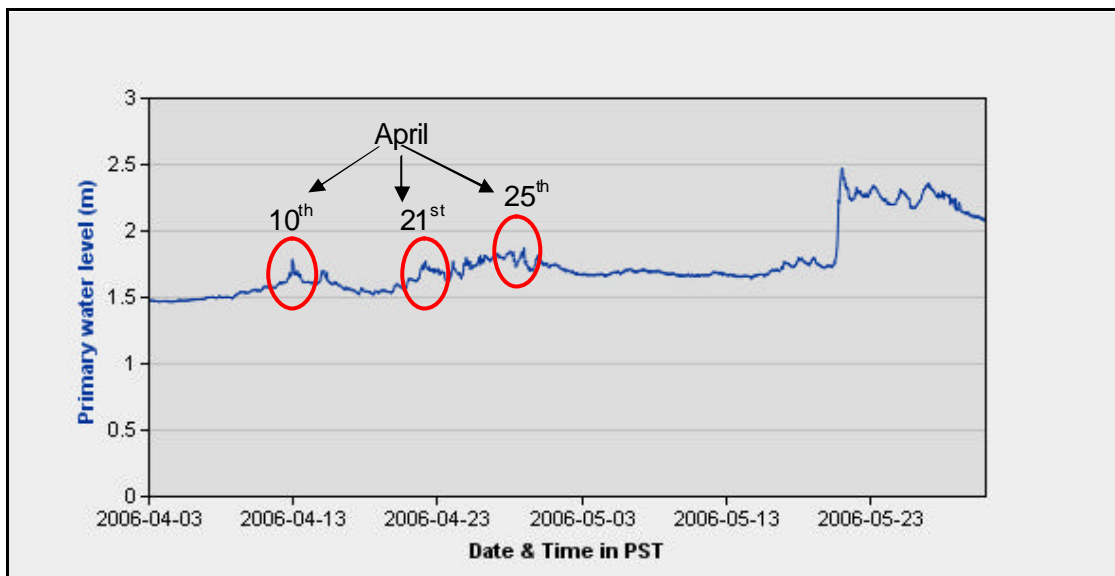


Figure 14. Water levels in Inkaneep Creek at Station 08NM200 (WSC 2006)

In addition to the fish fence being blown out, during sampling the fence was breached where fish were able to by-pass the fence April 22nd and 28th (just before the fence blew out) due to rising water levels where fish were able to migrate around the fence. In both cases the fish fence was compromised for less than 12 hours before the problem was rectified.

Unfortunately, the total population of the steelhead/rainbow trout in Inkaneep Creek is not available except to say that the population is greater than 64 fish. No fish were found upstream of the fish fence once it was in place on March 27th determined by stream walks conducted on April 3rd seven days after the fence had been installed. It is speculated given the high daily migration counts when the fish fence blew-out, that the fish fence was able to capture the pre-peak migration if not the peak. This is illustrated in Figure 15, as the cumulative totals of fish are on the increase as the fish fence becomes inoperable where a plateau in the graph would suggest that the peak was witnessed.

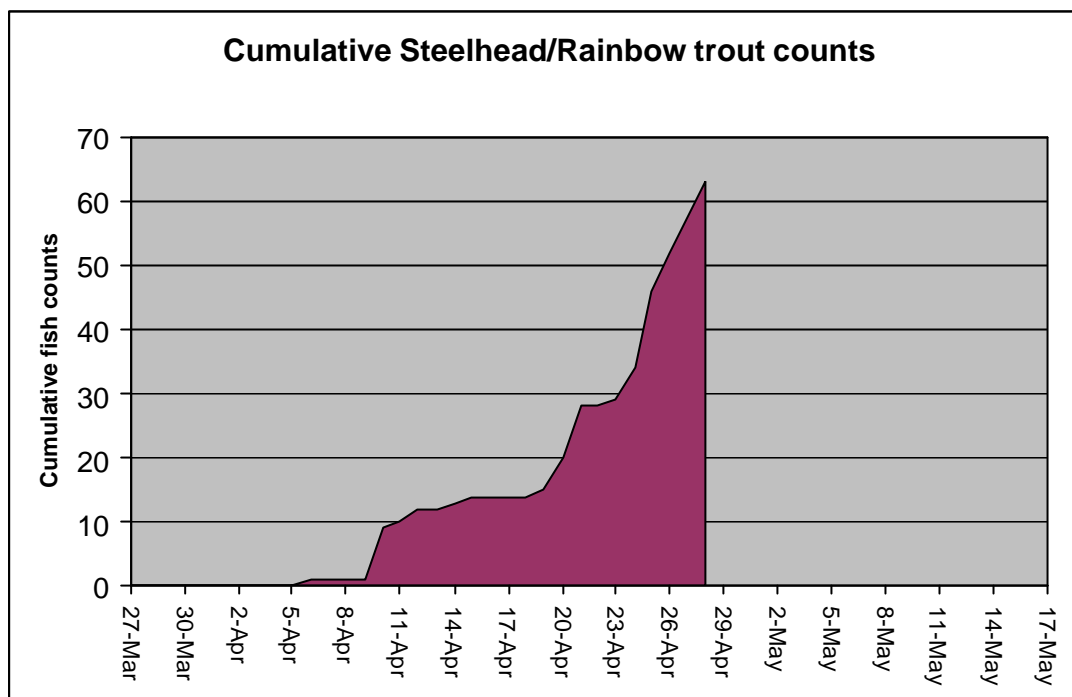


Figure 15. Cumulative totals of Steelhead/rainbow trout at the fish fence

During the fences replacement, May 15th to 17th, one spawned out steelhead/rainbow trout was caught, not in the capture box but upstream of the fence. This fish was not caught migrating upstream between March 27 and April 29th (all fish caught were marked with a dorsal punch) so it migrated into Inkaneep Creek and spawned between April 30th and May 16th. Although this is just one fish, the presence of post-spawn fish suggests that the population may be past the peak of migration by mid May.

The timing of the run is between April 6th when the first fish appeared and possibly some time before May 15th, however we only had two days of sampling at the end of the run. The peak of migration possibly occurred between April 29th and May 15th when no more fish were caught migrating upstream due to fence not being in operation.

3.2.1 Biological sampling of Inkaneeep Creek steelhead/rainbow trout

Of the 64 fish captured, none were adipose clipped (Appendix B) and therefore are most likely a wild population of steelhead/rainbow trout. The fish fence caught 23 male fish and 27 females with 14 undetermined. This sex ratio is fairly even with a male-to-female ratio of 0.85 or 0.85 males to every 1 female (Fig. 16). Osoyoos Lake is known to have large adfluvial rainbow trout (Wilson, p.comm. 2006) where adfluvial rainbow trout could be as large as their steelhead counterparts.

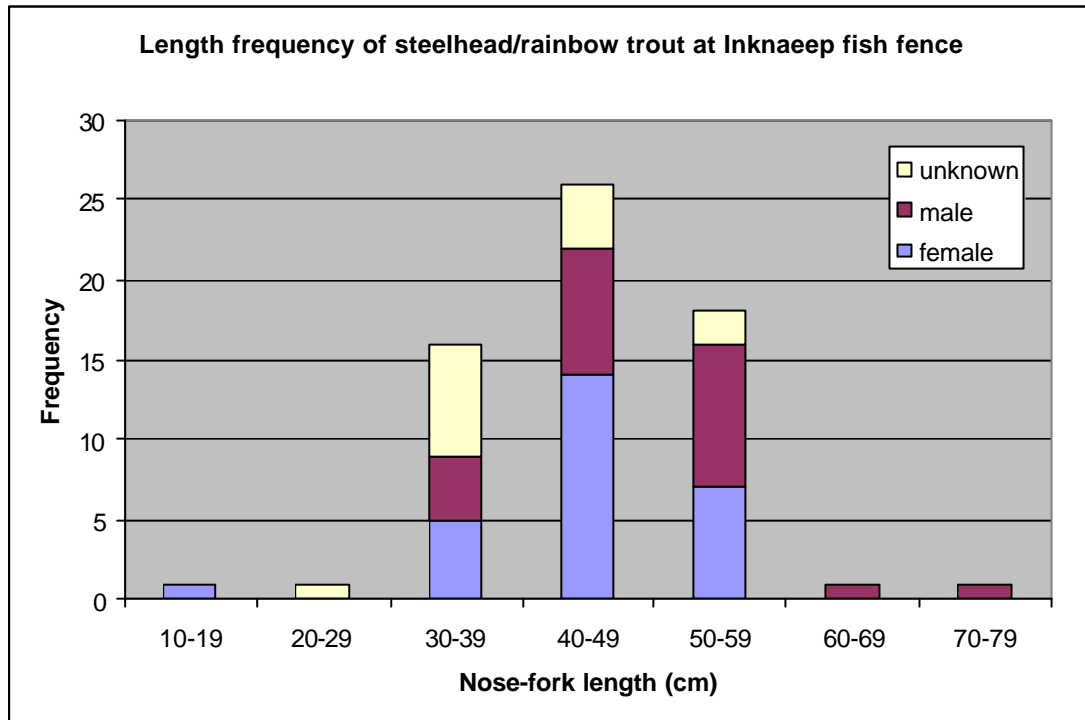


Figure 16. Length frequency of steelhead/rainbow trout caught in the fish fence

Male steelhead/rainbow trout averaged 49 ± 11 cm long compared to the females that averaged 45 ± 9 cm long (Table 3).

Table 3. Length of male and female steelhead/rainbow trout in 2006

Sex	Total count	Mean length (cm)	Standard Deviation	Maximum	Minimum
Male	23	49	11	76	31
Female	27	45	9	59	16
Unknown	14				

4.0 DISCUSSION AND RECOMMENDATIONS

Steelhead salmon that return to the Canadian Okanagan Basin migrate from the 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 147 clipped and 152 unmarked steelhead migrating into Osoyoos Lake (Fig. 17).

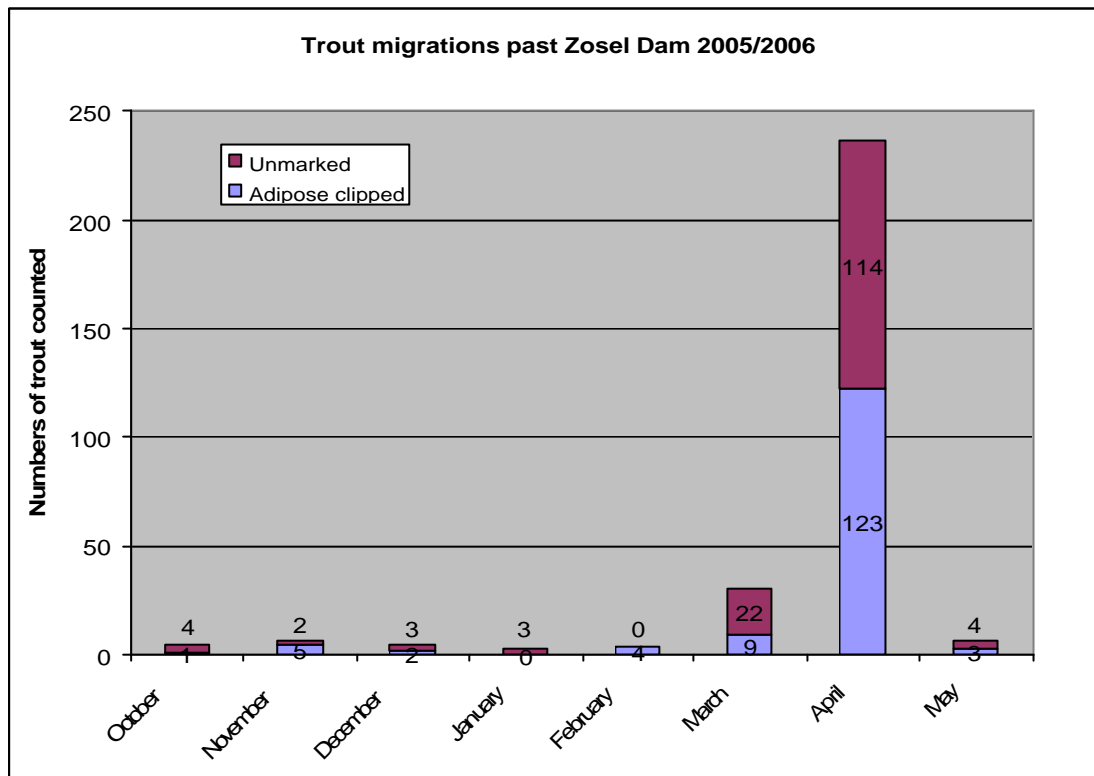


Figure 17. Steelhead migrations through the Zosel Dam fish counter (Rayton 2006 p. comm.)

From Osoyoos Lake, tributaries such as Inkaneep and Vaseux creeks are accessible as well as the mainstem Okanagan River. However 18km of the mainstem Okanagan's 24 km length is channelized and mostly unsuitable for spawning salmon. Therefore until the upstream migration barrier (McIntyre Dam) has fish passage, steelhead typically return to one of the three above mentioned areas to spawn. Within the Okanagan River mainstem, only 6 km, termed the index reach contains suitable spawning areas and therefore the only areas where redds were located.

The ONA redd survey crew were able to locate redds in all three systems however with the high and turbid water flows typical of late April when steelhead are also known to spawn, only a portion of the suspected number of steelhead counted through Zosel Dam were located in terms of redds identified (Table 4).

Table 4. Steelhead spawner estimates for the Canadian Okanagan Basin 2006

Location	Total no. of redds observed	Date redds observed	Redd density (redd/km)	Steelhead pop'n based on Inkaneeep fence sex ratio ¹	Steelhead pop'n based on Wells Dam sex ratio ²
Okanagan River Mainstem	2	April 5 to April 26	0.3	4	6
Inkaneeep Creek	10	April 21 to June 26	2.7	20	28
Vaseux Creek	10	June 26	4.0	20	28
Shuttleworth Creek	0	n/a	0	0	0
			Total estimate	44	62

¹ Inkaneeep Creek sex ratio of 0.85 (or 0.85 males to every 1 female)

² Well's Dam sex ratio of 1.64 (Arterburn et al. 2005a)

The population estimate of 44 to 62 steelhead is the first estimate in the Canadian Okanagan Basin, however comparing this range to the counts through Zosel Dam totaling 299, an estimate based solely on redd counts seems low. Even Inkaneeep Creek counted a total of 64 pre-peak migrating steelhead/rainbow trout. And this number does not take into account the mix of adfluvial rainbow trout (that are known to be as large as steelhead) in Osoyoos Lake.

There is uncertainty caused by the presence of adfluvial rainbow trout and poor visibility conditions at the time of peak spawning. It is interesting to note that the highest density of steelhead spawners occurred in Vaseux Creek compared with the Okanagan River mainstem.

Shuttleworth Creek, although no redds were noted, was accessible to anadromous salmon this spring for a few days as McIntyre Dam (downstream of the confluence on the mainstem) was opened completely to allow for the passage of the spring freshet making it possible for salmon to migrate past. This creek may soon become permanently accessible to salmon with the creation of fish passage at the dam. During our redd surveys several rainbow trout were noted in the creek.

The general timing of fish migrating to the spawning areas for Vaseux Creek is between April 4th when no redds were observed and June 26th when all 10 redds were observed. Fish migrating into Inkaneeep Creek began April 6th and peaked after April 25th however the bulk of fish were most likely on the spawning grounds by May 15th. In the case of the tributaries, fish migration corresponded with freshet flows that began late April. On the mainstem, Okanagan River redds were noted as early as April 5th but was impossible to complete surveys any later than April 26th as water flows became very high. Migrations of steelhead past Zosel Dam peaked in April.

Male steelhead/rainbow trout are typically larger than females but there does not seem to be a distinct difference in the length of steelhead and rainbow trout which is not surprising as Osoyoos Lake is known to have large adfluvial rainbow trout.

4.1 Recommendations

Recommendations for the completion of redd surveys in the future:

1. Float surveys from McIntyre Dam to the Loughheed Property (Index and Dam reach) is recommended.
2. The VDS reach can most efficiently be surveyed by visual observations from the 12 VDS where a good vantage point can be achieved along with the fact that the areas just upstream of the VDS frequently contain small patches of suitable spawning habitat (see Alexis and Wright 2004, for detailed methods).
3. Inkaneep Creek surveys need to be conducted over the whole 3.7 km length making a distinction between reaches above and below the fence similar to this years survey.
4. Vaseux Creek redd surveys are most effectively done by walking the 2.5km long canyon reach, however this section is the first to become completely inaccessible in freshet flows.
5. Shuttleworth Creek surveys need to continue to be aware of the operations of McIntyre Dam (upstream migration barrier) in order to focus surveys on times most likely to encounter steelhead.
6. The scope of the redd surveys in Shuttleworth Creek can be decreased from 7.5 km (lower and canyon reaches) to focus on the boulder-step-pool habitat in the canyon reach where the bulk of spawning sized gravel is accumulating. This section of the canyon reach is located from 6900m to 7700m from the mouth (Fig. 11).

Recommendations for the Inkaneep Creek fish fence future operations:

1. Floods that reach water levels of 2.5m were common in Inkaneep Creek in the past however the dry or drought conditions have been more common in recent years (RFC 2006) where the current dimensions of the fish fence may be functional.
2. Future fence installation needs to cover more of the bankfull width with the need of two more fence panels
3. The bars that support the fence panels are the first to become compromised and bend under the pressure. In future a reinforced support pole is recommended.
4. The second location selected for the fence is preferred for sampling in future years.

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APPENDIX A – Redd Survey Raw Data

Date	Drainage	Area	D/s Location	U/s location	Survey length (km)	Time start	End time	Method	Redd count	Visibility	Weather	Water clarity (m)	Comments
5-Apr-06	Okanagan River	index reach	Lougheed property 49.202500 119.551944	Deer Park 49.23884 119.53043	5	11:00	13:00	zodiac float	1	high	overcast	2	
12-Apr-06	Okanagan River	index reach	Lougheed property 49.202500 119.551944	Deer Park 49.23884 119.53043	5	11:00	12:45	zodiac float	1	medium	overcast & windy	1	windy
19-Apr-06	Okanagan River	VDS reach	VDS 4 49.11823 119.56942	VDS 12 49.18353 119.54621	12	10:40	14:10	zodiac float	0	medium	sun & wind	1	
21-Apr-06	Okanagan River	dam reach	Deer Park 49.23884 119.53043	McIntyre Dam 49.25704 119.52794	1	11:30	13:00	stream walk	0	medium	overcast	1.5	walked along river left bank
26-Apr-06	Okanagan River	index reach	Lougheed property 49.202500 119.551944	Deer Park 49.23884 119.53043	5	11:00	13:00	zodiac float	2	low	overcast	0.5	vaseux adding much turbidity
28-Apr-06	Okanagan River	VDS reach	VDS 1 49.093000 119.537167	VDS 4 49.11823 119.56942	6	10:00	12:00	zodiac float	0	low	sunny	0.5	turbid
28-Mar-06	Inkaneep Creek	upstream of the fence	fish fence 49.074722 119.501944	6m Falls 49.097667 119.503528	3.12	9:00	13:00	stream walk	0	medium	sunny	1.5	vo 1 RBT
21-Apr-06	Inkaneep Creek	downstream of the fence	Osoyoos Lake 49.073917 119.503667	fish fence 49.074722 119.501944	0.58	13:30	14:30	stream walk	2	medium	overcast	0.5	3 fish observed digging and holding
26-Jun-06	Inkaneep Creek	mouth to falls	Osoyoos Lake 49.073917 119.503667	6m Falls 49.097667 119.503528	2.9	9:40	11:40	stream walk	10	high	sun, hot	1.5	mosquitos to drive you nuts
7-Apr-06	Shuttleworth	lower reach	confluence pond 49.338056 119.575833	2.2km logging rd 49.329500 119.520528	5.1	10:40	14:30	stream walk	0	low	overcast	0.2	turbid water vo 3 RBT 20cm
22-Jun-06	Shuttleworth	canyon reach	2.2km logging rd 49.329500 119.520528	w/in canyon 49.329444 119.446306	2.5	10:00	12:00	stream walk	0	high	sun, hot	1.5	several patches of gravel noted
4-Apr-06	Vaseux Creek	fan & canyon reach	Flume crossing 49.24742 119.52294	5.5km from mouth 49.329444 119.446306	4.9	10:30	14:30	stream walk	0	high	overcast	2	vo 5 RBT 20cm GPS signal weak
26-Jun-06	Vaseux Creek	canyon reach	3km from mouth 49.255611 119.511833	5.5km from mouth 49.329444 119.446306	2.5	14:00	15:30	stream walk	10	high	sun, hot	1.5	weak GPS signal in the canyon

APPENDIX B – Inkaneep Creek Fish Fence Data

Date 2006	Crew	Time	ONA Fish #	Sex M/F	Nose-fork length (cm)	Adipose clips Y/N	Photo no. (roll- frame)	Water Temp. (°C)	Comments
27-Mar	CL	15:00							
28-Mar	CL MS	10:00							
31-Mar	CL	10:30							
3-Apr	CL DH	8:30							
4-Apr	CL DH	8:30							
4-Apr	CL DH	16:00							
5-Apr	CL DH	8:30							
5-Apr	CL DH	15:30							
6-Apr	CL MS	9:00							
6-Apr	CL MS	15:30	5	unk	66	N	1-1	12.5	
7-Apr	CL DH	8:30							
7-Apr	CL DH	16:00						8.7	
8-Apr	CL DH	13:00						8.6	
9-Apr	CL DH	17:00						9.3	water rising
10-Apr	DH MS	9:30	6	F	46	N	1-2	6	highwater
10-Apr	DH MS	9:30	7	F	44	N	1-3	6	
10-Apr	DH MS	9:30	8	F	37	N	1-4	6	
10-Apr	DH MS	9:30	9	M	43	N	1-5	6	
10-Apr	DH MS	9:30	10	F	42	N	1-6	6	
10-Apr	DH MS	16:00	11	F	49	N	1-7	8.6	highwater, caught whitefish in box
10-Apr	DH MS	16:00	12	unk	47	N	1-8	8.6	
10-Apr	DH MS	16:00	13	F	16	N	1-9	8.6	
11-Apr	CL DH	9:30						5.1	highwater
11-Apr	CL DH	16:00	14	F	40	N	1-10	9.2	
12-Apr	CL DH	8:30						4.9	rain
12-Apr	CL DH KL	15:00	15	unk	42	N	1-11,12,13	8	rain
12-Apr	CL DH KL	15:00	16	unk	63	N	1-14	8	
13-Apr	CL MS	9:30						5.7	highwater flow on the sides of fence; caught rainbow trout (12cm length)
13-Apr	CL MS	16:00						6.6	
14-Apr	CL DH	11:30						7.5	
14-Apr	CL DH	18:45	20	unk	44	N	1-15	6.9	caught rainbow trout (10cm length)
15-Apr	CL DH	11:30	17	M	34	N	1-16	5.7	
15-Apr	CL DH	18:30					1-17	6	left the gate board in
16-Apr	CL DH	12:00						6	

Date 2006	Crew	Time	ONA Fish #	Sex M/F	Nose-fork length (cm)	Adipose clips Y/N	Photo no. (roll- frame)	Water Temp. (°C)	Comments
16-Apr	CL DH	19:00					1-18	5.4	
17-Apr	DH MS	9:00						3.3	
17-Apr	DH MS	15:45						9.7	
18-Apr	DH MS	9:00					1-19	3.7	
18-Apr	DH MS	14:00						3.7	
19-Apr	CL DH KL	9:30	18	M	53	N	digital #52	4.8	found one dead in cage
19-Apr	CL DH	17:00						10.3	
20-Apr	CL KL	9:30	24	M	46	N	1-20	5.5	lost scale book
20-Apr	CL RH	14:30	22	M	53	N	1-21	10.2	
20-Apr	CL RH	14:30	23	F	42	N	1-22	10.2	
20-Apr	CL RH	14:30	19	M	58	N	1-23	10.2	
20-Apr	CL RH	14:30	21	M	32	N	1-24	10.2	
21-Apr	CL DH	9:00	5042	unk	58	N	1-26	5.9	rain
21-Apr	CL DH	9:00	5058	unk	53	N	1-27	5.9	
21-Apr	CL DH	9:00	5047	unk	41	N	1-28	5.9	
21-Apr	CL DH	9:00	5049	unk	44	N		5.9	
21-Apr	CL DH	9:00	5060	M	49	N	2-23	5.9	
21-Apr	CL DH	15:00	5052	M	68	N	2-22	7.1	
21-Apr	CL DH	15:00	5041	F	47	N	2-21	7.1	
21-Apr	CL DH	15:00	5026	M	57	N	2-20	7.1	
22-Apr	CL DH	10:30						5.4	hole in fence, full debris, overflow on sides
22-Apr	CL DH	19:00						6.4	highwater
23-Apr	CL DH	10:30						5.4	highwater
23-Apr	CL DH	19:00	5034	unk	37	N		7.8	highwater, fish got away before finished
24-Apr	DH MS	9:30						5.4	high water
24-Apr	DH MS	16:30	5035	M	49	N	2-19	9	
24-Apr	DH MS	16:30	5036	F	42	N	2-18	9	
24-Apr	DH MS	16:30	5037	F	39	N	2-17	9	
24-Apr	DH MS	16:30	5038	F	39	N	2-16	9	
24-Apr	DH MS	16:30	5039	M	50	N	2-15	9	
25-Apr	DH MS	9:30	5045	M	53	N	2-14	5.3	
25-Apr	DH MS	9:30	5054	unk	49	N	2-13	5.3	
25-Apr	DH MS	9:30	5029	M	48	N	2-12	5.3	
25-Apr	DH MS	16:00	5030	M	42	N	2-11	9.5	
25-Apr	DH MS	16:00	5053	F	40	N	2-10	9.5	
25-Apr	DH MS	16:00	5027	M	47	N	2-9	9.5	
25-Apr	DH MS	16:00	5046	F	44	N	2-8	9.5	
25-Apr	DH MS	16:00	5043	F	56	N	2-7	9.5	

Date 2006	Crew	Time	ONA Fish #	Sex M/F	Nose-fork length (cm)	Adipose clips Y/N	Photo no. (roll-frame)	Water Temp. (°C)	Comments
25-Apr	DH MS	16:00	5032	F	39	N	2-6	9.5	
25-Apr	DH MS	16:00	5057	M	57	N	2-5	9.5	
25-Apr	DH MS	16:00	5055	M	53	N	2-4	9.5	
25-Apr	DH MS	16:00	5040	unk	51	N	2-3	9.5	
26-Apr	CL DH	9:00	5059	M	42	N	2-2	5	
26-Apr	CL DH KL	14:30	5028	F	53	N	2-1	7.2	
26-Apr	CL DH KL	14:30	5051	unk	54	N		7.2	fish got away downstream
26-Apr	CL DH KL	14:30	5044	F	55	N	2-0	7.2	
26-Apr	CL DH KL	14:30	5050	F	56	N	3-27	7.2	
26-Apr	CL DH KL	14:30	5033	F	46	N	3-26	7.2	
27-Apr	CL MS	9:30	5048	M	50	N	3-24	5.2	high water
27-Apr	CL MS	9:30	5061	M	36	N	3-25	5.2	
27-Apr	CL MS	9:30	5070	F	45	N	3-23	5.2	
27-Apr	CL MS	15:30	5056	M	31	N	3-22	8.3	
27-Apr	CL MS	15:30	5065	F	59	N	3-21	8.3	
27-Apr	CL MS	15:30	5075	F	32	N	3-20	8.3	
28-Apr	CL DH	9:00	5025	F	58	N	3-19	6.5	Water flowing over capture box
28-Apr	CL DH	14:30	5068	unk	48	N	3-18	9.6	
28-Apr	CL DH	14:30	5064	F	56	N	3-17	9.6	
28-Apr	CL DH	14:30	5063	F	42	N	3-16	9.6	
28-Apr	CL DH	14:30	5073	F	41	N	3-15	9.6	
29-Apr	CL DH								Fence blownout by the highwater and debris.
15-May	CL MS JA KL								fence replaced 50m upstream at 1:30pm
16-May	CL JA MS	9:30							high water
16-May	CL MS JA	15:30	no number	M	76	unk	digital	13.8	fins beaten-up couldn't determine if it was already sampled; caught up stream of fence
17-May	CL JA MS	9:00							much debris, water rising - pulled out some pickets to save the fence
18-May	CL MS	9:30							Fence blown out by the highwater and debris.
19-May	CL JA MS	9:00							
19-May	CL JA MS	15:00							
23-May	CL JA MS	10:00						10.7	creek flooded out of banks into the field, removed the whole fence
25-May	CL MS	15:00							

APPENDIX C – Photos of Fish caught in the Fence



Female #5028 caught in the fence April 26th 2006.



Male # 5045 caught in the fence April 25th 2006



Male #22 caught in the fence April 20th, 2006



Male #5057 caught in the fence April 25th 2006