

2009

**AQUATIC LIFE SAMPLING AND TESTING PROGRAM
FOR THE ANVIL RANGE MINE SITE,
ROSE AND VANGORDA CREEK WATERSHEDS,
FARO, YUKON**

Conducted: During August, 2009

**Prepared for
Type II Mines Department, YTG
And
Selkirk First Nation**

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1.0 Introduction

The following report details the results of field investigations conducted under the *Aquatic Life Sampling and Testing Program* for the Anvil Range Mine Site at Faro, Yukon. The investigation conducted in 2010 was a modification of the program of study conducted during the previous six years. Field investigations for this project were conducted during August 2010 under the authority of License to collect fish No. 10-70, issued by the Department of Fisheries and Oceans, Canada.

The primary goal of the investigations continues to be the annual sampling for fish utilization in the watersheds potentially affected by the Faro and Vangorda Plateau mine sites, the Faro Mine Complex (FMC). Specific sites within the Rose and Vangorda Creek watersheds have been identified to track the presence, relative abundance and condition of fish.

The sampling program for 2010 consisted of two separate long-term monitoring components; the continuation of species utilization at 5 previously sampled sites, and a "sentinel species" (slimy sculpin) monitoring program at three sites established over the past 3 years.

This investigation also continued the collection of quality data on fish habitats and fish utilization for use in long term monitoring. The sampling methodology used in 2010 builds on data collected in previous investigations to allow comparison between annual data sets.

2.0 Study Area

Investigations were conducted within the Rose and Vangorda Creek watersheds in potentially affected waters as well as on control (unaffected) sites on Anvil and Blind Creeks. Sample sites for the 2009 investigation included 5 of the original 7 previously established sites. Of the original sample sites, R1 and R4 have been removed from the sampling program and site TV1 (originated in 2009) has been included. In addition 3 sites with habitats that produce significant numbers of slimy sculpin were sampled for sentinel species evaluations. The following sites were sampled during the 2010 investigation:

Sample sites associated with Rose Creek (Figure 1):

- R2 The mixing zone downstream of the intersection of Rose Creek and the tailings pond discharge channel;
- R6A Anvil Creek upstream of the confluence with Rose Creek (control site),
- TV1 Unnamed tributary to Anvil Creek, downstream of the Rose confluence

Sampling sites associated with Vangorda Creek (Figure 2):

- V8 Lower Vangorda Creek below the town of Faro access road
- B1 Blind Creek near the lower bridge (control site),

Slimy sculpin sentinel species sites:

- 1) V8SS Vangorda Creek 300 meters downstream of the existing sample reach known as V8. This site was initially sampled in 2008 and includes the final reach of Anvil Creek before the Pelly River. This years sampling represents the 3rd year of sampling

2) RD5 Located in the upper reach of the Rose Creek diversion channel. This site was originally sampled as a component of a study to more fully document fish utilization in Rose Creek and the Diversion Channel conducted in 2009 (DeGraff, 2009).

3) RSS Located on Rose Creek 3.5 kilometers downstream of the FMC. This site, chosen in 2010, has the required habitats and sculpin populations and offers an option on access. During the 2010 sampling access was gained with a helicopter. Alternatively access to this site can be made using the quad trail from the mine site.

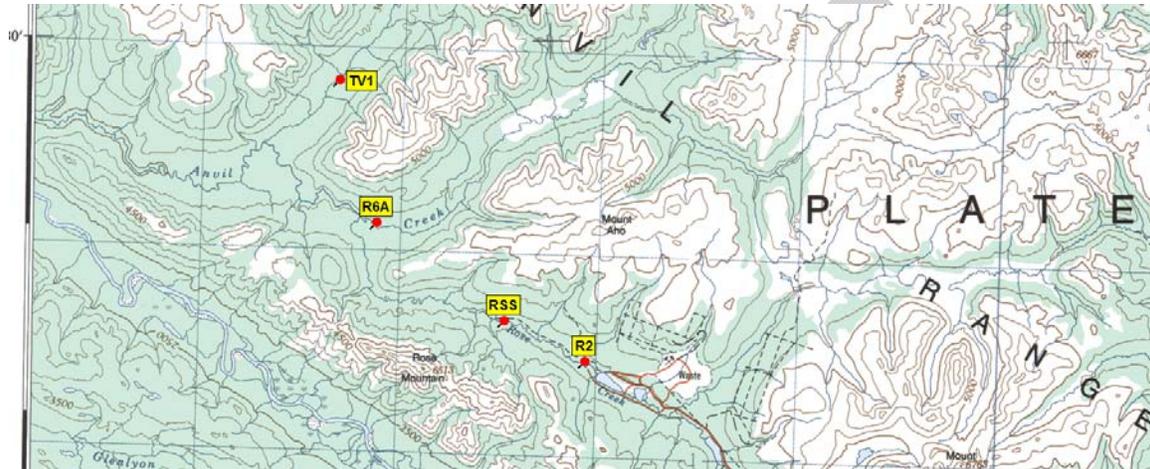


Figure 1: Sample sites from 2010 associated with Rose and Anvil Creeks, including site TV1 on the tributary to Anvil Creek. From 1:250,000 105K Tay River topographic map.

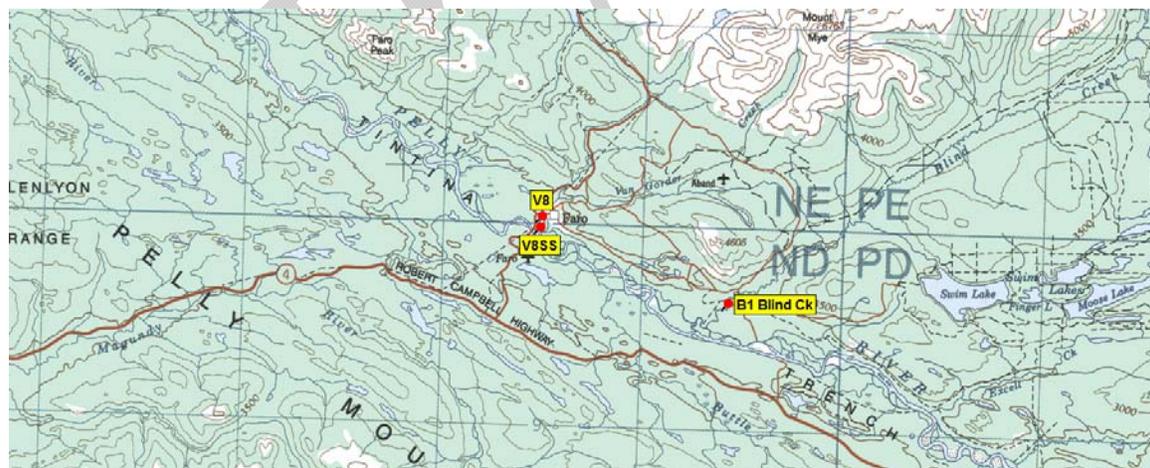


Figure 2: Sampling sites from 2010 associated with Vangorda and Blind Creeks from 1:250,000 105K, Tay River topographic map.

3.0 Methods

Field investigations were conducted between August 19 and 22, 2010 when water levels were stable and fish distribution was at its seasonal peak. This timing corresponds with previous investigations, which were also conducted during mid August.

Sample sites R6a, TV1 and RSS were accessed with a helicopter; all other sample sites were accessed by road.

3.1 General site sampling/ Long term monitoring

The five long term monitoring sites sampled have a history of sampling as part of the previous Faro Aquatics monitoring programs, these sites are: R2, R6a, V8, B1 and TV1. Site TV1 was initiated in 2009 and the others have all been evaluated annually since 2005. The sampling procedures for these sites followed protocols developed over the past six years to make the data compatible for comparison with the existing data set. The goal of sampling for these sites was to record the present level of utilization by fish at each site. Previous assessments included a laboratory analysis of the levels of metals in the flesh of Arctic grayling and slimy sculpin; this analysis was not conducted during the 2010 investigation.

The general description of fish habitat compiled in past years was re-evaluated at each site, including; flow parameters consisting of velocities (floating object method), depth, wetted and channel width, substrates, channel configuration, bank stability, water temperature, riparian vegetation and an assessment of available fish cover. Photographs representative of each site were taken.

The principle fish collection technique used was electro-fishing. Secondary techniques included minnow trapping and angling. Crew members wore polarized glasses at all times to enhance fish viewing abilities and all visual observations of fish were recorded.

Electro-fishing was conducted with a Smith-Route POW type 12A battery powered, back pack electro-fisher. The electro-fisher operator was accompanied by a crew member with a dip net. Each site was investigated using a single pass technique with sampling effort similar to that of previous years. Each site was sampled by moving in an upstream direction and sweeping from side to side through each reach; all shoreline areas were fished and accessible mid-stream habitats were also fished. Electro-fishing results have been calculated as the number of fish recorded per 100 seconds of shock time to allow comparison between sites and different years.

Minnow trapping was conducted with "Gee type" minnow traps (¼" mesh). Traps were baited with salmon roe (Yukon River origin) suspended in the trap in a nylon sack, and were set in a variety of habitat types at each site. Traps were set for an overnight period and the results have been expressed as number of fish captured per site per 24 hour period.

Angling was conducted with light spin casting gear and a variety of small lures and dry flies. Effort was recorded as minutes fished and all fish captured or observed were recorded.

All fish captured were handled delicately to allow for live release after sampling. Anaesthetics were not used. All fish captured or observed were identified as to species and general life stage (fry, juvenile, sub-adult, adult), a sub-sample was measured for fork length (± 1 mm) and then released unharmed as near as possible to the location from which they were sampled. A sub-sample of fish captured during collections were weighed (± 0.1 gram) and measured (± 1 mm). All fish captured or observed were recorded into a field book and the information was later entered into an excel data base.

3.2 Sentinel Species Monitoring

Over the past three seasons WMEC has been involved in locating sites associated with the FMC that have significant populations of slimy sculpin in habitats suitable for sampling. The sampling protocols and design were based on the recommendations of Minnow Consulting (Minnow, 2009). Sampling under the “sentinel species” program consists of an extended electro-fishing effort of approximately 1,000 seconds over at least 100 meters of habitat with fishing effort that targeted slimy sculpin. The total number of fish captured and observed was recorded and all sculpin specimens captured were live sampled for length (± 1 mm) and weight (± 0.1 gram).

The three sites sampled have been carefully selected over the past 3 years. Site selection consisted of ensuring the site had suitable habitat and utilization by slimy sculpin, had the ability to be sampled at different flow levels and were relevant to the FMC in terms of location. Attempts were made in previous years at locating “control sites”, outside of the zone of influence of the FMC, however to date no suitable sites have been identified. The sites sampled have been described in the study area section of this report.

4.0 2010 Results

Most of the sample sites have had only slight physical variations from conditions observed in previous years and fish habitats remained stable at these sample locations. Water levels at the time of the assessment were the low and similar to those observed in 2009. The low water reduced the amount of available cover and available fish habitats at most of the sites. An updated general description of fish habitats and a representative photo for each site has been presented in Appendix 1.

Fish distribution and habitat utilization varied at each site in relation to previous years, a fact likely related with low water levels. In 2009, as in 2008 juvenile chinook salmon (jcs) were less common in Blind Creek and Vangorda Creeks than in previous years, both years numbers correspond to adult salmon escapements from the previous years. The five jcs captured at R4 in 2009 represented an increase from 2008 and was consistent with several of the earlier years when jcs were more abundant. Jcs 1+ were recorded at the new site TV1. Jcs were absent from all other sites. The number and size of all fish at site R1 was the lowest recorded, although this site has seen continued declines in the number of fish since sampling started it was felt that a contributing factor to this years low densities was lack of cover due to low water levels.

Arctic grayling adults were present at all sites except for site TV1 which had few adults and large numbers of sub-adult grayling. At site R2 grayling were again dispersed and difficult to catch. Slimy sculpin at Blind Creek were again uncommon and difficult to capture, were uncommon at site V8, common in the lower reach of Vangorda, and common and easily captured at the other sites.

During the August sample period of 2009 two adult chinook salmon were observed spawning in the Rose Creek Diversion channel. The same salmon had been observed a week earlier at site R2 and moving into the diversion channel. The redd was built in a glide area near the cross valley dam. This is the first conclusive report of adult chinook salmon in Rose Creek in many years (see photo below) . Several anecdotal reports have been compiled over the past six years and it was suspected that salmon spawn in Rose Creek as salmon roe was found in grayling stomachs at R1 on two separate occasions

A summary of electro-fishing results for all species for 2009 has been presented in Table 1. A summary of minnow trapping results has been presented in Table 2 with a complete listing of all minnow trapping results for all years presented in Appendix 3. Angling data have been presented in Table 3.

Table 1: Summary of electro-fishing results for all sites sampled during August of 2010. Total number of fish recorded includes fish captured and fish missed but counted.

| Sample Site | Date Sampled | Sample Effort (seconds) | Sample Effort (area) | Arctic Grayling | Slimy Sculpin | Burbot | Juvenile chinook salmon | Other spp |
|-------------|--------------|-------------------------|----------------------|-----------------|------------------|--------|-------------------------|-----------|
| R2 | Aug. 21 | 710 | 100 m. | 0 | 32 ad 5 fry | 3 | 0 | 0 |
| R6A | Aug. 20 | 725 | 120 m. | 0 | 3 ad 39 fry | 0 | 0 | 0 |
| TV1 | Aug. 20 | 605 | 110 m | 11 sub ad | 9 | 0 | 104 | 0 |
| V8 | Aug. 21 | 628 | 120 m. | 9 sub ad | 8 | 1 s ad | 104 | 1 LNS |
| V8SS | Aug. 22 | 1,160 | 110 m | 0 | 87 ad | 0 | 66 | 0 |
| RD5 | Aug. 21 | 1,121 | 110 m | 0 | 160 ad 45 fry | 0 | 5 | 0 |
| RSS | Aug. 20 | 1,113 | 165 m | 1 fry | 49 ad 12 fry | 1 | 1 | 0 |

Summary of abbreviations: ad= adult, juv.= juvenile, sub. ad.= sub adult Round W. fish= round whitefish

Table 2: Summary of minnow trapping results for all sites sampled during Faro Aquatics program, August 2010. The number presented equals the total number of fish captured in all traps at each site.

| Sample Site | No. of traps | Average soak time (hrs) | Arctic Grayling | Slimy Sculpin | Burbot | Juvenile chinook salmon | Juv. Ch. Salmon +1 |
|-------------|--------------|-------------------------|-----------------|---------------|--------|-------------------------|--------------------|
| R2 | 8 | 17 | 0 | 1 | 2 | 10 | 0 |
| R6a | 8 | 22.5 | 0 | 0 | 0 | 0 | 0 |
| TV1 | 8 | 22.5 | 0 | 7 | 1 | 148 | 0 |
| V8 | 8 | 19 | 0 | 0 | 0 | 134 | 0 |
| B1 | 16 | 16 | 0 | 0 | 1 | 245 | 3 |

Table 3: Summary of angling results for all sites sampled during Faro Aquatics program, August 2010

| Sample Site | Angling Effort (minutes) | Catch (Number of Arctic Grayling) |
|-------------|--------------------------|-----------------------------------|
|-------------|--------------------------|-----------------------------------|

| | | |
|-----|----|----|
| R2 | 15 | 0 |
| R6a | 15 | 6 |
| TV1 | 30 | 3 |
| B1 | 15 | 11 |

4.1 Site R2 Rose Creek

Fish Habitat and Utilization

This site provides a wide variety of stable habitats, including riffles, rapids, glide areas and deep corner and side pools. The site has slowly changed over the 6 years of sampling. Large bank slumps that had just occurred at the initiation of the sampling program have stabilized, the deep corner pool created below the large slumped area has become shallower and the riffles have become deeper. The deposition point has extended over 4 meters in 7 years and grows on an annual basis. This active channel morphology does not seem to be out of the ordinary, although the initial slumping may have been caused in part by the proximity of the road and placement of rip rap for bank stabilizing immediately upstream of the largest slump area. The sample reach begins immediately downstream of the discharge channel from the FMC.

Electro-fishing at R2 consisted of 710 seconds of effort and was conducted through the 100 meter sample reach; the amount of time shocked typical of previous efforts. Fish recorded by electro-fishing consisted of 32 adult and 5 fry slimy sculpin and 3 burbot (Table 1). The sculpin catch was consistent with catches at this site for the past 5 years. (Figure 3).

Minnow trapping at site R2 consisted of 8 traps set for an average soak time of 17 hours each. The total catch from the minnow trapping consisted of 1 adult slimy sculpin, 10 jcs and 2 burbot (Table 2). The minnow traps set at R2 were all set downstream of the confluence of the tailings pond channel with Rose Creek. Although sculpin catches were slightly lower than average the jcs catch was the largest jcs catch by minnow traps at this site in any of the years of sampling (Figure 4).

Angling for 15 minutes downstream of the tailings pond channel for 300 meters captured no fish (Table 3). No grayling were observed in this reach during 2010.

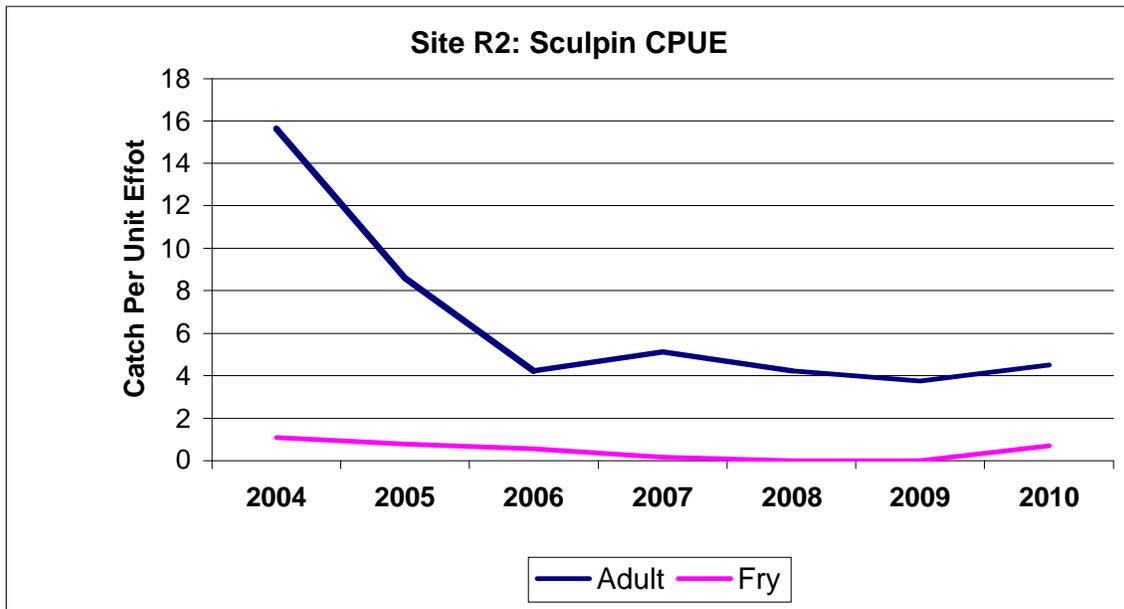


Figure 3: Sculpin catch per unit of effort (fish per 100 seconds) for electro-fishing at R2 for the seven year sample period

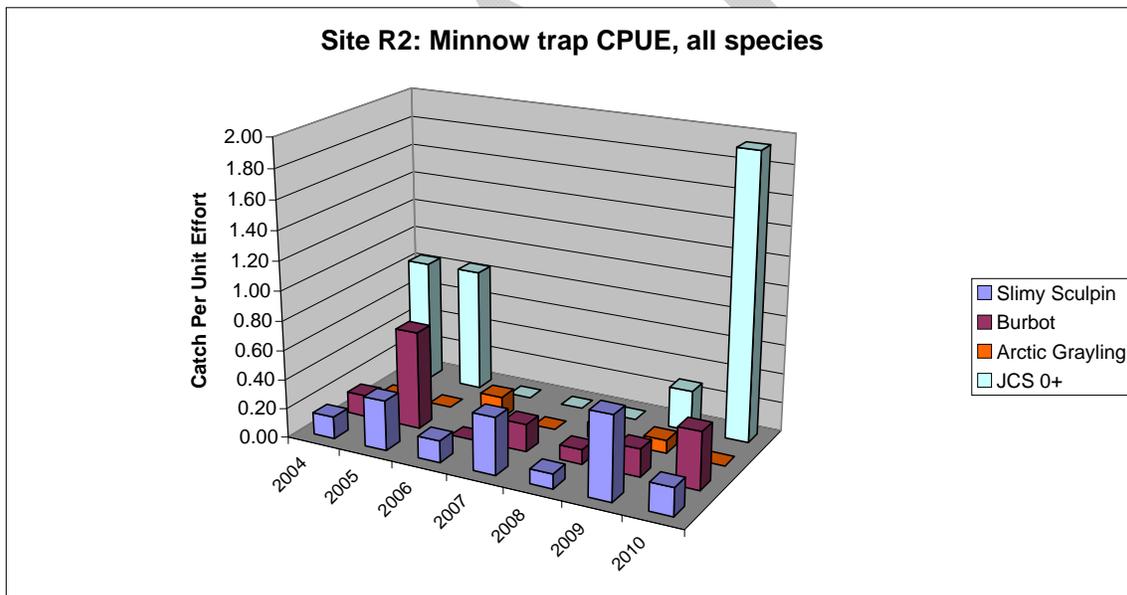


Figure 4: Multi year minnow trap data for site R2, 2010 had the greatest jcs catch of any of the years of sampling.

4.2 Site R6a Anvil Creek

Fish Habitat and Utilization

Flows in Anvil Creek during 2010 were low and similar to those of 2009, which had lower water than the preceding 2 years. The site has a good variety of habitats including a fast moving thalweg, a small side channel and a deep corner pool.

Fishing effort was extended through the entire reach. Electro-fishing was conducted along the shoreline areas of both banks and in the shallow side flow on the right bank and covered similar areas to previous investigations. A total of 725 seconds of effort recorded 3 adult slimy sculpin and 39 fry (Table 1), this was a significant decrease in adult numbers and an increase in the number of fry recorded (Figure 5).

Minnow trapping at site R6a consisted of 8 traps set for an average soak time of 22.5 hours each. No fish were captured in any of the traps (Table 2), minnow trap catches at this site have been low at all of the sample periods.

A total of 15 minutes of angling effort captured 6 adult Arctic grayling (Table 3).

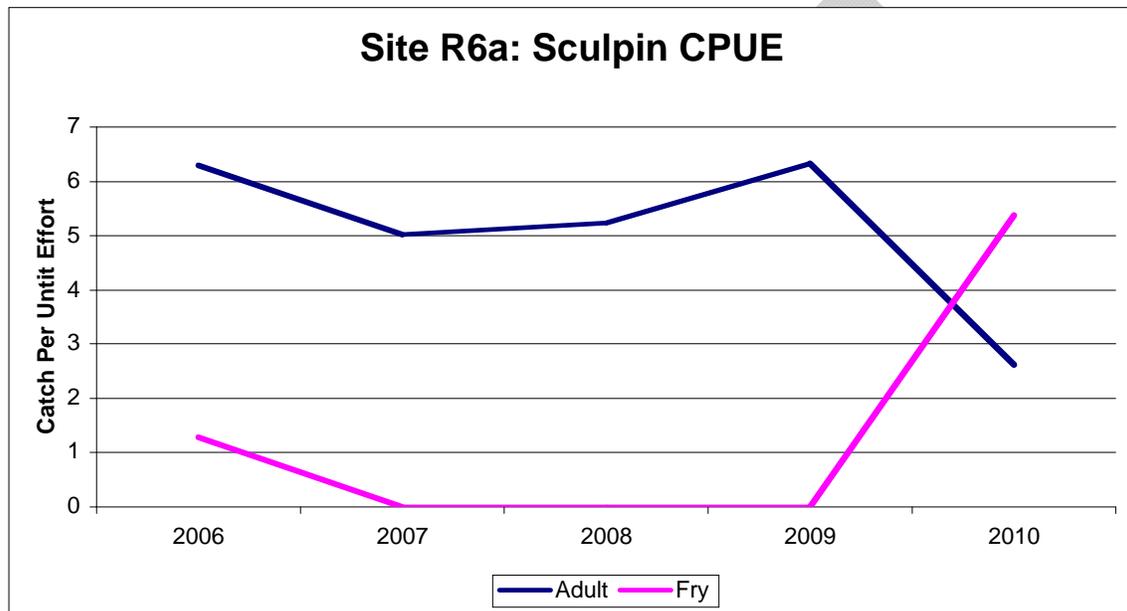


Figure 5: Sculpin catch per unit of effort (fish per 100 seconds) for electro-fishing at R6a for the entire seven year sample period.

4.3 Site TV1 Tributary to Anvil Creek

Fish Habitat and Utilization

This site was pioneered during the 2009 sampling season for its potential as a control site in an unaffected area. The site chosen is approximately 4 km upstream of Anvil Creek on the unnamed tributary that enters Anvil Creek on the right bank 8 km downstream of the Rose Creek confluence. This creek has an unusual upwelling of turbid water that makes the lower reaches very turbid. The upwelling is thought to be caused by a melting, underground ice lens. The small creek that enters the tributary immediately upstream of the sample station also had a turbid flow in 2010 and the lower more significant plume of turbidity (1 kilometer downstream of the sample station) was still present. The site has a good variety of fish habitats and one of the few locations with helicopter accessibility.

This site is comprised of 30 % riffles, 20% pools and 50% glide over a gravel substrate. The site has an average wet width of 5.5 meters inside a channel of 6.5 meters, an

average velocity of slightly less than 1m/second and an average depth of 0.6 meters. A complete physical description of the site is presented in Appendix 1.

Electro-fishing was conducted through the entire reach as the creek was easily wadeable with few pools greater than 1.5 meter in depth. A total of 605 seconds of effort over a 120 meter reach recorded 3 adult slimy sculpin and 39 fry, 1 jcs, 3 sub adult, 11 juveniles and 3 fry Arctic grayling (Table 1). This was significant decrease in catches from the previous years effort.

Minnow trapping at site TV1 consisted of 8 traps set for an average soak time of 19 hours each. The catch from the minnow traps consisted of 7 adult slimy sculpin, 148 jcs and 1 burbot (Table 2). During the 2009 season only a single jcs was captured.

A total of 10 minutes of angling effort captured 6 sub-adult Arctic grayling.

4.4 Site Summary: V8 Vangorda Creek

Fish Habitat and Utilization

The study reach of Vangorda Creek has varied from year to year in the amount of turbidity caused by sloughing side banks. Active slumping that occurred in 2008 has stabilized and in 2010 the flows were slightly chalky but mostly clear as it was during the 2008 and '09 seasons.

Electro-fishing was conducted for a total of 628 seconds through the entire 120 meter reach (Table 1). Fish recorded consisted of, 66 jcs, 9 sub-adult / juvenile Arctic grayling, 1 sub adult burbot and 1 adult round whitefish. These catches are within the range of previous catches although slightly low for grayling and burbot (Figures 6, 7 and 8).

Minnow trapping at site V8 consisted of 8 traps set for an average soak time of 19 hours each. The total catch from the minnow trapping consisted of 134 jcs, representing an increase from 2009 (Table 2). Although the jcs catches were significant they were average for the 7 years of sampling (Figure 9).

Angling on Vangorda Creek was not conducted during 2010 due to low water and small habitats unsuitable for angling.

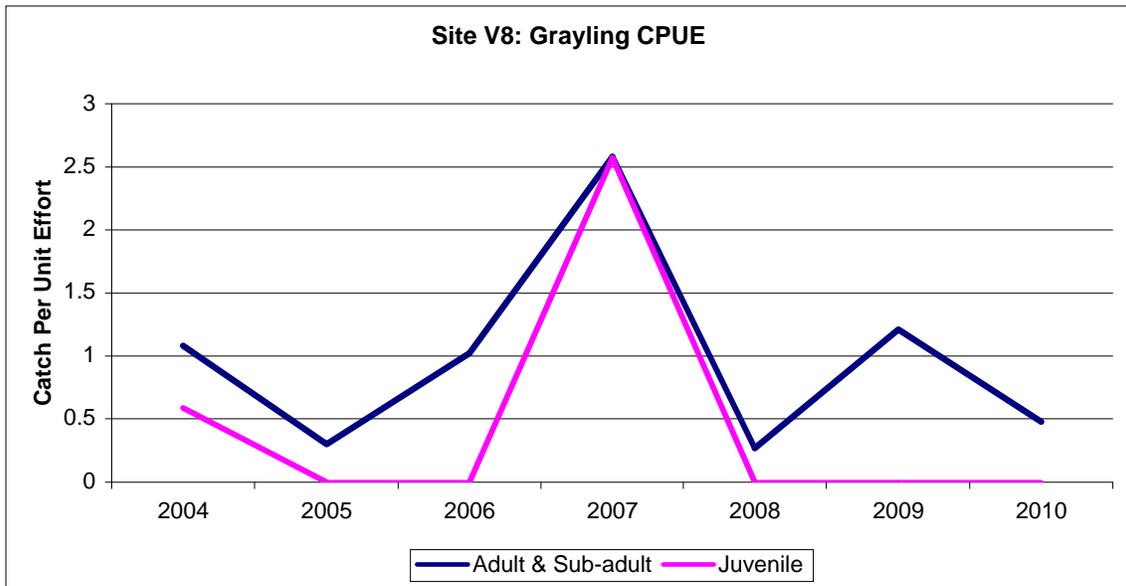


Figure 6: Grayling catch per unit of effort (fish per 100 seconds) for electro-fishing at V8 for the seven year sample period.

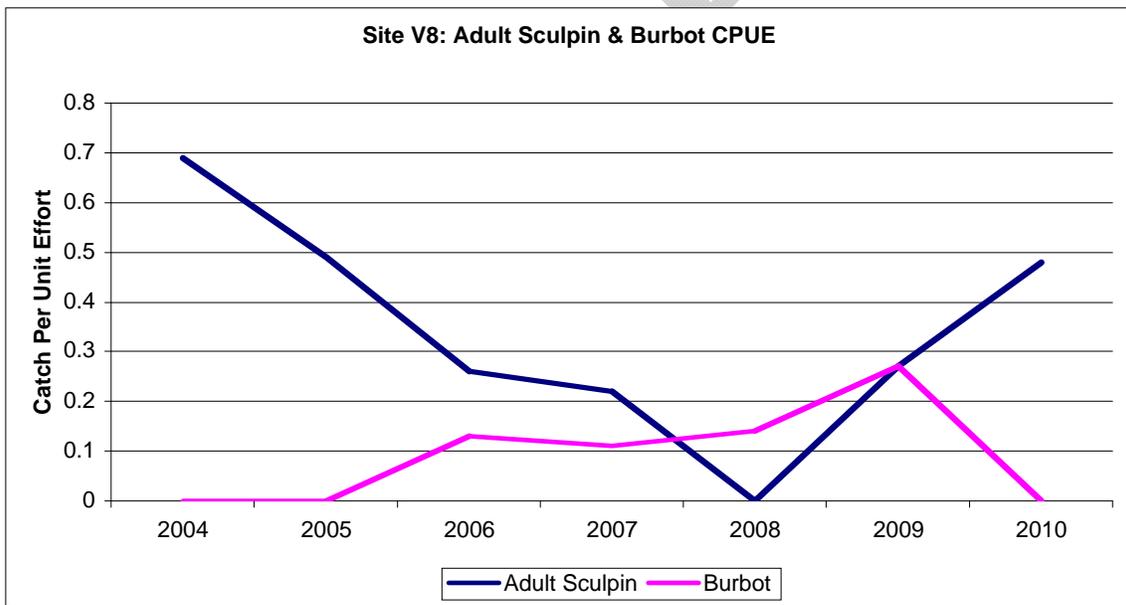


Figure 7: Sculpin and burbot catch per unit of effort (fish per 100 seconds) for electro-fishing at V8 for the seven year sample period

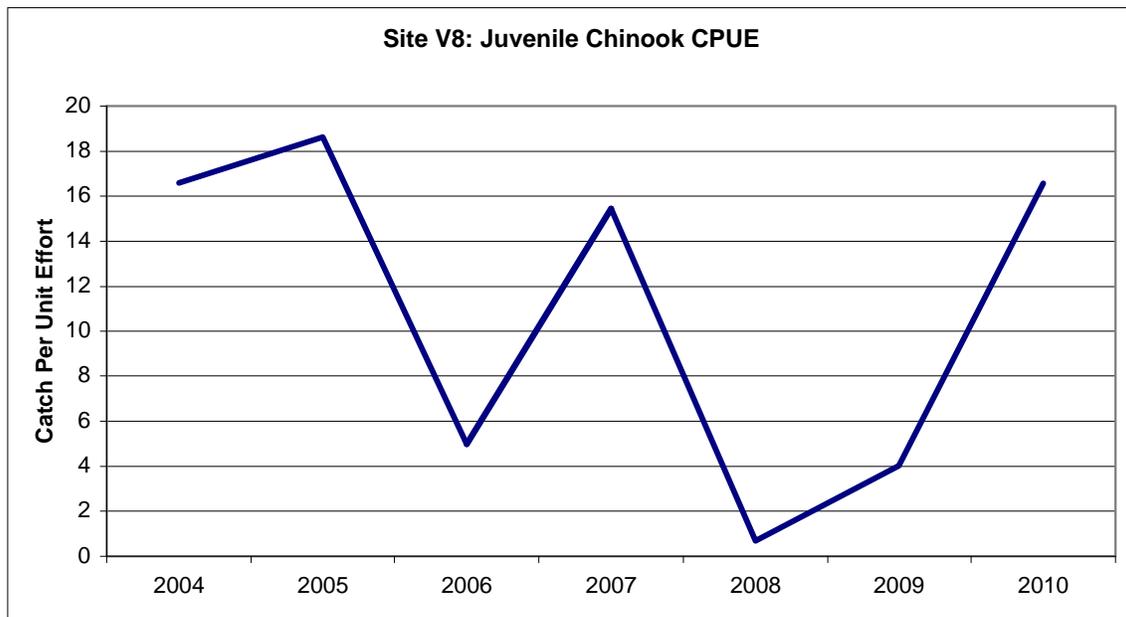


Figure 8: Sculpin catch per unit of effort (fish per 100 seconds) for electro-fishing at V8 for the seven year sample period.

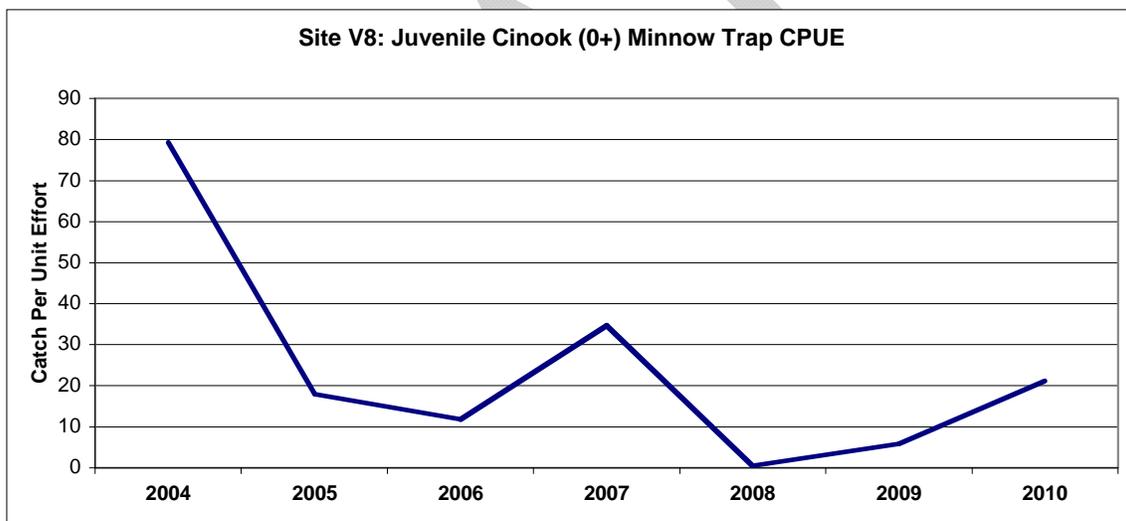


Figure 9: Minnow trap catches for site V8 on Vangorda Creek for each of the seven years of sampling.

4.5 Site B1 Blind Creek

Fish Habitat and Utilization

The Blind Creek is a much larger than any of the other creeks and supports a significant population of chinook salmon spawners. An enumeration weir has been operated on Blind Creek since 1999 and is run as an index count for the Yukon River salmon return monitoring as it is an early run. A small return was recorded in 2010. The chinook salmon enumeration weir located 50 meters downstream of the bridge had been removed at the time of sampling. Adult salmon were observed below the bridge and active redds were within the study area although the majority of the spawn had occurred.

The creeks channel was modified by beavers during the 2009 season; a partial dam was constructed 30 meters upstream of the bridge. The dam blocked flow just downstream of an area that had been used as a spawning redd for the past several years. The dam also created a new set of long gravel bars downstream of the bridge that continued to build during 2010 although the dam was not complete nor active.

Electro-fishing was not and has not been conducted on Blind Creek at the request of the Department of Fisheries and Oceans due to the presence of spawning adult chinook salmon.

Arctic grayling were in groups throughout the study area, with most aggregated in deep pools near the redds. Slimy sculpin were uncommon even near salmon redds.

Extra minnow traps were set in Blind Creek to match effort extended in previous years. A total of 16 minnow traps were set in the sample reach for an average soak time of 16 hours each (Table 2). The catch consisted of 1 burbot, 150 jcs (0+) and 3 jcs (1+), which was an increase from catches in the past 4 years but not as high as in 2004 and 2005.

Angling effort at Blind Creek, both upstream and downstream of the bridge for 15 minutes captured 11 adult Arctic grayling (Table 3). This was a significant increase in the catch per unit effort likely due to the fact that active spawning was mostly complete and the number of spawners was small. The time of sampling was slightly later than in previous years and the chinook return was slightly earlier. In previous years most of the grayling angled were engorged with salmon roe, this was not the case in 2010.

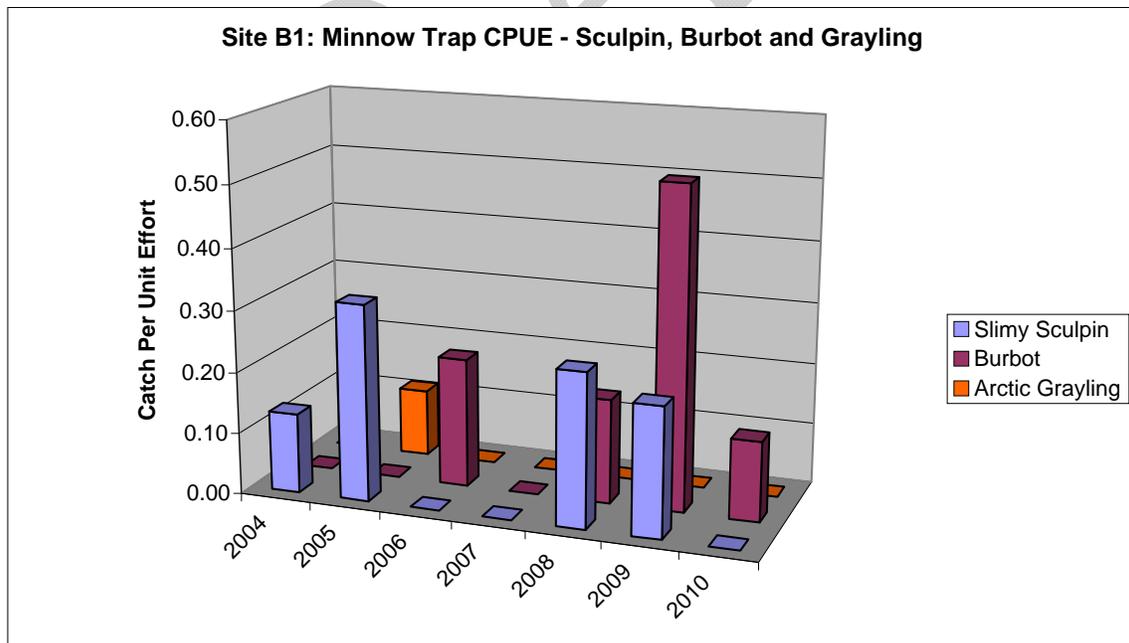


Figure 10: Multi-year minnow trap catches from Blind Creek for slimy sculpin, burbot and Arctic grayling.

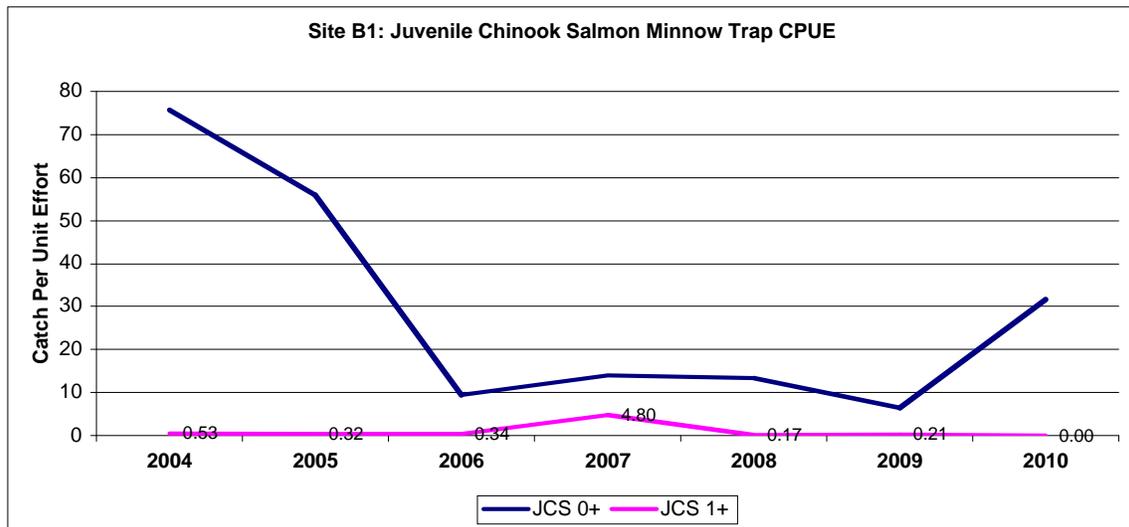


Figure 11: Multi-year minnow trap jcs catches from sets made on Blind Creek.

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5.0 Discussion of Multi-Year Results

5.1 Fish Utilization

Comparisons of fish utilization recorded over the past six years shows variations at several of the sites and amongst species (table 4 and figures 3 through 11). The numbers of jcs at Blind and Vangorda Creeks accurately reflect the anticipated numbers of the species in the area for each year based on the number of adult salmon from the previous year. Low returns of adult salmon in 2007 produced small recruitment for the 2008 season; the same was seen in 2009, the small escapement in 2008 resulted in few jcs in 2009. The good escapement of 2009 shows up in the moderate numbers of jcs encountered. The largest catch of jcs made at R2 during 2010 may well be an result of the spawning observed in the diversion channel in 2009 and should be considered as an indication of stream health. Small variations in occurrence of other species may be a function of sampling conditions and food distribution or in the case of B1, a result of the timing of the sampling.

Careful observations in the diversion channel for spawning salmon were conducted in 2010 and no evidence of any salmon spawning activity was observed.

Minnow trapping at site R2 recorded the largest catches of jcs of all the years sampling, conversely the number of fish recorded by electro-fishing was the lowest recorded.

Slimy sculpin numbers from site R4 have gone up and down through the years and may offer a good insight into natural fluctuations of fish populations and catch ability due to water levels. For example in 2008 fewer sculpin were recorded than in 2009. In 2009 the site was much easier to fish due to lower water levels and resulting lower velocities. Also at lower water levels the fish densities become higher due reduction of available habitat.

Table 4: Summary of multi-year electro-fishing results for investigations conducted between 2004 and 2010. Catches have been expressed as the number of fish recorded per 100 seconds shocking time.

| SITE | YEAR | grayling sub ad. & adult | grayling juvenile | sculpin adult | sculpin fry | Burbot | C.salmon juvenile | R. whitefish |
|------|------|--------------------------|-------------------|---------------|-------------|--------|-------------------|--------------|
| R2 | 2004 | 0.27 | 0 | 15.65 | 1.1 | 0.27 | 0 | 0 |
| | 2005 | 1.81 | 0.11 | 8.6 | 0.79 | 0.79 | 0.23 | 0 |
| | 2006 | 0 | 0 | 4.22 | 0.55 | 0.08 | 0 | 0 |
| | 2007 | 0 | 0.18 | 5.12 | 0.18 | 0 | 0 | 0 |
| | 2008 | 0.24 | 0.12 | 4.23 | 0 | 0.12 | 0 | 0 |
| | 2009 | 0 | 0 | 3.74 | 0 | 0.45 | 0.15 | 0 |
| | 2010 | 0 | 0 | 4.51 | 0.7 | 0 | 0 | 0 |
| TV1 | 2009 | 2.07 | 0.44 | 5.62 | 0 | 0.3 | 4.44 | 0.15 |
| | 2010 | 1.82 | 0 | 1.49 | 0 | 0.17 | 17.19 | 0 |
| R6a | 2006 | 0 | 0 | 6.29 | 1.28 | 0.26 | 0 | 0 |
| | 2007 | 0 | 0 | 5.02 | 0 | 0.18 | 0 | 0 |
| | 2008 | 0 | 0 | 5.24 | 0 | 0 | 0 | 0 |
| | 2009 | 0 | 0 | 6.33 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0.14 | 2.62 | 5.38 | 0 | 0 | 0 |
| V8 | 2004 | 1.08 | 0.59 | 0.69 | 0 | 0 | 16.6 | 0 |
| | 2005 | 0.3 | 0 | 0.49 | 0 | 0 | 18.62 | 0 |
| | 2006 | 1.02 | 0 | 0.26 | 0 | 0.13 | 4.99 | 0 |
| | 2007 | 2.58 | 2.57 | 0.22 | 0 | 0.11 | 15.45 | 0.11 |
| | 2008 | 0.27 | 0 | 0 | 0 | 0.14 | 0.68 | 0.27 |
| | 2009 | 1.21 | 0 | 0.27 | 0 | 0.27 | 4.02 | 0.13 |
| | 2010 | 0.48 | 0 | 0.48 | 0 | 0 | 16.56 | 0 |

APPENDIX 1

GENERAL SITE DESCRIPTIONS

SITE: R2 Rose Creek

UTM: down stream end 05 79 401 E, 69 14 972 N

Site Location: reach starts at the confluence of the tailing pond discharge channel with Rose Creek and extends downstream for 110 meters through the mix water zone.

Date Sampled: August 18 and 19, 2004

August 15 and 16, 2005

August 15 and 16, 2006

August 14 and 15, 2007

August 16 and 17, 2008

August 13 and 14, 2009

August 20 and 21, 2010

CHANNEL CHARACTERISTICS:

Surveyed Length: 110 meters

Average Channel Width: 14 meters

Average Wetted Width: 12 meters

Average Depth: 0.7 meters

Average Velocity 0.8 meters per second

% Pool, Riffle, Run / Glide: 30% pool, 30% riffle, 40% glide

Cover Large woody debris, undercut banks and deep pools

Overhead vegetation No overhead vegetation

Riparian Vegetation Willow, dwarf birch and dead spruce

BED MATERIAL: 30% cobble, 50% gravel, 20% sand with sand and gravel increasing in deeper pools and exposed point bars mostly sand and gravel.

BANK CHARACTERISTICS: Sand and gravel point bars opposite of mud cut banks that rise 1.5 to 2.5 meters to an open flood plain. The channel has become more stable after extensive bank failures that occurred in 2003.

CHANNEL MORPHOLOGY CHARACTERISTICS: Meandering channel with corner pools, small riffles and point bars adjacent to cut banks. Water levels in 2008 were similar to, 2006 and approximately 0.3 meters lower than the highest flows experienced in 2005. Water levels in 2009 were the lowest recorded by at least 0.3 meters



Photo 3: Rose Creek at site R2 during August of 2009. The discharge from the treatment pond can be seen in the upper right corner of the photo.



Photo 4: The tailings pond discharge channel entering Rose Creek at the upstream end of the sample reach site R2 during August, 2008. The foreground of this photo was out of the water in 2009.



Photo 5: Site R2, Rose Creek. The downstream end of the diversion channel flows in to the photo from the right upstream of the out flow of treated water and the sample site. August 2007. The sample site begins at the outflow and continues downstream to the right margin of the photo.

SITE: R6A Anvil Creek

UTM: down stream end 05 68 768 E, 69 21 412 N

Site Location: reach starts 1.35 km by creek channel (800 meters direct) upstream of the confluence of Anvil Creek with Rose Creek and extends upstream a further 100 meters.

Date Sampled: August 16 and 17, 2006

August 17 and 18, 2007

August 19, 2008

August 14 and 15, 2009

August 19 and 20, 2010

Anvil Creek upstream of the confluence with Rose Creek (control site).

CHANNEL CHARACTERISTICS:

| | |
|------------------------------|--|
| Surveyed Length: | 130 meters |
| Average Channel Width: | 14 meters |
| Average Wetted Width: | 9 meters |
| Average Depth: | 0.7 meters |
| Average Velocity | >1 meter per second |
| % Pool, Riffle, Run / Glide: | 10% rapid, 15% riffle, 20% run, 40% race, 15% pool |
| Cover | Large boulders, pools and LOD and undercut bank. |
| Crown Closure | < 5% cover |
| Riparian Vegetation | Alder, spruce, willow mix with grasses, sedge and cinquefoil |

BED MATERIAL:

80% small boulder, 15% cobble, 5% gravel, with sand deposits at downstream point bar.

BANK CHARACTERISTICS: Consistent well defined and stable banks rise abruptly 0.7 to 1.0 meter height.

CHANNEL MORPHOLOGY CHARACTERISTICS: The channel is partially entrenched by a small hill on the upper right bank, becomes confined and deep centered before spreading to over 50 meters wide at a small side channel in the lower portion of the reach on the right bank. The reach ends with a shoot rapid entering a deep corner pool with undercut banks.



Photo 9: Anvil Creek at site R6A during August of 2009. Note the amount of exposed channel compared to the 2008 photo below.



Photo 10: Reach R6a sample site, flowing right to left. August, 2008. The corner pool in the lower end of the reach is the location used to capture Arctic grayling samples.

SITE: TV1, Unnamed tributary to Anvil Creek

UTM: landing site 5 66 951 E, 69 28 686 N

Site Location: This site is located 5.2 air kilometers from upstream from Anvil Creek. The sample reach starts 20 meters downstream of right bank tributary and extends downstream for 130 meters.

Date Sampled: August 14 and 15, 2009

August 19 and 20, 2012

| | |
|------------------------------|--|
| Surveyed Length: | 135 meters |
| Average Channel Width: | 6.0 meters |
| Average Wetted Width: | 4.2 meters |
| Average Depth: | 0.4 meters |
| Average Velocity | >1 meter per second |
| % Pool, Riffle, Run / Glide: | 30% riffle, 20% pool, 50% glide |
| Cover | Corner pools and limited amounts of debris |
| Overhead vegetation | none |
| Riparian Vegetation | Dwarfed willows and birch with sedges |

BED MATERIAL:

Loosely compacted consisting of 40% gravel, 35% cobble, 20% sand and 5% silt.

BANK CHARACTERISTICS: Banks well defined rising 0.5 meter from the channel edge to an open flood plain. A single corner abuts on bedrock. Tight corners create deep corner pools.

CHANNEL MORPHOLOGY CHARACTERISTICS: Uniform channel with a deep side opposite of a side of point bars. The creek has tight corners, one that has a steep eroding bedrock face. The bottom is flat in much of the reach



Photo 11: Lower section of sample reach at TV1 during August of 2009. The corner pool at right is 1.8 meters in depth and had numerous juvenile and sub adult Arctic grayling.



Photo 12: An aerial view of site TV1 during August of 2009. The sample reach starts just below the tributary and extends to the bottom of the photo. The point bar is an excellent helicopter landing site.

SITE: B1 Blind Creek

UTM: down stream end 05 36 680 E, 68 96 005 N

Site Location: reach starts immediately upstream of the bridge and extends upstream for 100 meters; reaches below the bridge have been used for fish sample collections.

| | |
|--------------------------------------|------------------------|
| Date Sampled: August 14 and 15, 2004 | August 19 and 20, 2005 |
| August 18 and 19, 2006 | August 17 and 18, 2007 |
| August 19 and 20, 2008 | August 15 and 16, 2009 |
| August 22 and 23, 2010 | |

CHANNEL CHARACTERISTICS:

| | |
|------------------------------|---|
| Surveyed Length: | 350 meters |
| Average Channel Width: | 15.5 meters |
| Average Wetted Width: | 14 meters |
| Average Depth: | 0.7 meters |
| Average Velocity | 0.4 meters per second |
| % Pool, Riffle, Run / Glide: | 100% glide |
| Cover | Fine organic debris, cut banks (up to 40%), small woody debris against shore and a beaver lodge |
| Overhead vegetation | 10% cover |
| Riparian Vegetation | Alder, willow with some spruce, with high bush cranberry, raspberry and cinquefoil adjacent |

BED MATERIAL:

Sand silt and organic debris overlaying 60% cobble, 40% gravel.

BANK CHARACTERISTICS: Shallow point bars occur opposite of cut and eroding banks near gentle corners. Cut banks rise between 1 and 2 meters to an open flood plain.

CHANNEL MORPHOLOGY CHARACTERISTICS: Uniform channel with a deep side opposite of a side of deposition. Flows in Blind Creek were slightly higher in 2006 than during 2005 sampling which were very similar to those encountered during 2004. The flows in 2009 were lower than in any of the previous years. A beaver dam that partially blocked the creeks flow created new gravel bars downstream of the bridge (see photos).



Photo 13: A small, partial beaver dam was built on Blind Creek during August of 2009. The area immediately upstream of the dam on the right side was a chinook spawning redd in previous years. Low flows in 2009 allowed the construction of the dam, in previous years the current would likely have washed the dam out.



Photo 14: Collecting minnow traps in Blind Creek downstream of the bridge and upstream of the enumeration weir during August of 2009. The gravel bar Martin is standing on was created during the summer of 2009 by the beaver dam upstream of the bridge.

SITE: V8 Vangorda Creek

UTM: down stream end 05 84 790 E, 69 00 606 N

Site Location: reach starts immediately upstream of a small foot bridge that crosses the creek at the site of the town of Faro sewage discharge pipe crossing and extends upstream for 100 meters

Date Sampled: August 14 and 15, 2004
 August 17 and 18, 2006
 August 17 and 18, 2008
 August 20 and 21, 2010

August 17 and 18, 2005
 August 15, 16, 17 and 23, 2007
 August 13 and 14, 2009

CHANNEL CHARACTERISTICS:

| | |
|------------------------------|--|
| Surveyed Length: | 100 meters |
| Average Channel Width: | 6.0 meters |
| Average Wetted Width: | 3.3 meters |
| Average Depth: | 0.5 meters |
| Average Velocity | 1.5 meters per second |
| % Pool, Riffle, Run / Glide: | 80% riffle (almost rapid), 20% eddy and side pools |
| Cover | Over head vegetation, large and small woody debri, flood washed shrubby vegetation and boulder pools |
| Overhead vegetation | 20% cover |
| Riparian Vegetation | Alder and willow with occasional spruce and poplar |

BED MATERIAL: Exposed substrate consists of 50% boulder, 20% cobble, 15% gravel, 15% sand with occasional bedrock outcrop in upper part of reach. Most substrates loosely consolidated and highly silted. The creek channel was heavily modified by a high water event in 2007 and was stable in 2009, turbidity associated with the 2007 event has cleared. An acid generating (?) bedrock slump that occurred in 2008 stabilized in 2009 and continued to be stable in 2010.

BANK CHARACTERISTICS: Well defined channel with newly eroded, but stable, banks that rise gently to a maximum of 2 meters. A small area of bedrock confines the channel on the left bank at the upstream end of the reach.

CHANNEL MORPHOLOGY CHARACTERISTICS: Very little meandering in an entrenched valley, unconsolidated materials from 2004 have been washed out and boulders protrude in most of the channel.



Photo 15: Vangorda Creek in 2009, low flows exposed considerable channel materials and the water was mostly clear.



Photo 16: Rock slide at the upstream end of Vangorda Creek site V8 sample site during 2008. The materials that slid are surrounded by mineralized materials visible on the left side of the photo.

SENTINAL SPECIES MONITORING SITES

Sentinel species monitoring results are not complete at this tie and continue to be in production at this time, March3, 2012

SITE: V8SS Vangorda Creek



Photo 17: Lower Vangorda Creek during August of 2009. This was the lowest reach sampled for slimy sculpin and had the highest densities of sculpin on Vangorda Creek. The Pelly River is visible at the top of the photo.

SITE: RSS Rose Creek

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SITE: RD5 Rose Creek Diversion Channel

SITE: V8SS Vangorda Creek

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